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INDIA POLICY FORUM 2009|10

VOLUME 6

Rajnish Mehra on Fundamental Valuation of Indian Equity Markets

Ila Patnaik and Ajay Shah on Capital Controls and Indian Multinationals in the Crisis

Arvind Panagariya on India's Climate Change Challenge and Policy Response

Laura Alfaro and Anusha Chari on Transformation of India's Microeconomic Industrial Structure

Klaus Deininger and Hari K. Nagarajan on India's Land Market Policies

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SUMAN BERY, BARRY BOSWORTH
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Editors' Summary *vii*

RAJNISH MEHRA
Indian Equity Markets: Measures of Fundamental Value *1*
Comments by Ajay Shah and Surjit S. Bhalla *31*
General Discussion *35*

ILA PATNAIK *and* AJAY SHAH
Why India Choked when Lehman Broke *39*
Comments by Eswar Prasad and Abhijit V. Banerjee *64*
General Discussion *69*

ARVIND PANAGARIYA
Climate Change and India: Implications and Policy Options *73*
Comments by Vijay Joshi, Devesh Kapur, and Jessica Wallack *129*
General Discussion *147*

LAURA ALFARO *and* ANUSHA CHARI
India Transformed? Insights from the Firm Level 1988–2005 *153*
Comments by Robert Z. Lawrence and Shashanka Bhide *212*
General Discussion *217*

KLAUS DEININGER *and* HARI K. NAGARAJAN
Land Reforms, Poverty Reduction, and Economic Growth: Evidence from India *225*
Comments by Pranab Bardhan and Surjit S. Bhalla *267*
General Discussion *273*

PURPOSE

India Policy Forum 2009–10 comprises papers and highlights of the discussions from the sixth India Policy Forum (IPF) conference, held on July 14–15, 2009, in New Delhi. IPF is a joint venture of the Brookings Institution and the National Council of Applied Economic Research (NCAER) that aims to examine India's reforms and economic transition using policy-relevant empirical research. The sponsoring organizations acknowledge the generous support of State Bank of India, HDFC Ltd, ITC, Reliance Industries, and HSBC Ltd.

The objective of the IPF is to generate theoretically rigorous, empirically informed research on important current and unfolding issues of Indian economic policy. A rotating panel of established local and overseas researchers interested in India has agreed to support this initiative through advice, personal participation, and contribution of papers. Overall guidance is provided by a distinguished international advisory panel.

Papers appear in this publication after presentation and discussion at a yearly conference in New Delhi. During discussions at the conference, the authors obtain helpful comments and criticism about various aspects of their papers. These comments are reflected in the journal as discussants' comments. The papers, however, are finally the authors' products and do not imply any agreement by either those attending the conference or those providing financial support. Nor do any materials in this journal necessarily represent the views of the staff members or officers of the NCAER and the Brookings Institution.

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Editors' Summary

The sixth annual conference of the India Policy Forum was held on July 14 and 15, 2009 in New Delhi. The meeting was dominated by considerations of the global financial crisis and its implications for India. The events of 2009 provided evidence of India's growing integration with the global economy, an illustration of the resilience of country's economic growth, and its emergence as a major participant in an expanded system of governance for the global economic system. This issue of the journal includes four papers and the associated discussion from the conference, and a fifth paper that was originally presented at the 2007 conference.

Beginning in 2005, the Indian equity market underwent a period of explosive growth rising from a valuation equal to about 50 percent of GDP to a peak of 150 percent by early 2008. Growth of this magnitude raised concerns that the market was hugely overvalued and it was often characterized as an example of an asset market bubble. The market valuation subsequently fell back to about 70 percent of GDP during the global financial crisis. This experience stimulated interest in India in the question of what would constitute a reasonable or fair value for equities that could be use as a standard for evaluating market fluctuations. In "India Equity Markets: Measures of Fundamental Value," Rajnish Mehra examines this question by comparing corporate valuations in India over the period of 1991–2008 relative to three key market fundamentals: the corporate capital stock, after-tax corporate cash flows, and net corporate debt.

Mehra's model builds on the idea of a link between the market value of the capital stock and the debt and equity claims on that stock—a concept known as Tobin's q. He extends the existing framework using some prior work by McGrattan and Prescott on US equity valuations, and he incorporates both intangible capital and key features of the tax code. It is a multi-period model in which firms maximize shareholder value subject to a production function with labor and two kinds of capital—tangible and intangible—as the inputs. Wages, intangible investment and depreciation of tangible capital are treated as tax-deductible expenses. It yields an equilibrium representation of the relationship between the market value of equity and the reproduction value of tangible and intangible capital in the corporate sector. All of the nominal values are normalized by GDP and the result is a framework that can be used to evaluate the effect on equity prices of a range of different policy actions, such as changes in the taxation of corporate dividends.

The model is calibrated to the Indian situation with respect to the capital stock, tax rates, and the characteristics of economic growth in the non-agricultural sector. Mehra also develops his own estimates of the valuation of intangible capital using three different methodologies. The first method is that used by McGrattan and Prescott and is based on the assumption that tangible and intangible capital earn the same rate of return along a balanced growth path. That assumption allows him to derive the equilibrium ratio of tangible and intangible capital. The alternative methods are based on recent work in the United States by Corrado, Hulten, and Sichel that involves cumulating investment flows to estimated stocks. Mehra uses two different methods to calibrate the Indian data with information from the United States, and he estimates the stock of intangible capital for two periods of 1991–2004 and 2005–08. The focus on two sub-periods is designed to capture a structural break in the data: Indian equity valuations as a fraction of GDP were fairly constant over the period 1991–2004, rising sharply starting in 2005. The two estimates of the stock of intangibles based on the comparison with the United States are very similar, but they are significantly lower than the estimates obtained with the McGrattan and Prescott methodology.

His analysis suggests that an optimistic estimate of the fundamental value of the *current* Indian equity market is about 1.2 times GDP, considerably lower than the 1.6 value observed in 2008, but close to the average over the full period. One effect on equity prices that the study does not account for is a change in investor demand from foreign institutional investors. If the effect of this is a change in the characteristics of the marginal investor, the relevant marginal rate of substitution will change, and with it market valuations. Thus, Mehra suggests that the extension of the model to include foreign investors should be a major objective for future research.

Mehra's paper generated an active discussion that centered on the difficulties of accurately measuring some of the values, such as the rate of technological change and real interest rates, required to calibrate the model to India's situation. Several commentators also emphasized the important role of foreign investors. Others pointed to the difficulties of applying a model based on equilibrium conditions to the highly transitional nature of the Indian economy.

In "Why India Choked when Lehman Broke," Ila Patnaik and Ajay Shah analyze the rapid transmission of the impact of the Lehman bankruptcy into Indian financial markets. The authors propose an explanation that revolves around the treasury operations of Indian multinational corporations (MNCs). Such MNCs are less subject to the capital controls imposed on purely domestic Indian companies.

The developments that emerged within Indian financial markets in September and October following the bankruptcy of Lehman Brothers on September 14, 2008 were quite extraordinary. First, there was a sudden change in conditions in the money market. Call money rates shot up immediately after September 15. Despite swift action by the Reserve Bank of India (RBI), the tightness persisted through the month of October. The operating procedures of monetary policy broke down in unprecedented fashion and interest rates were persistently above the target range of the Reserve Bank of India (RBI). The call rate consistently breached the 9 percent ceiling for the repo rate and attained values beyond 15 percent. There was a huge amount of borrowing from the RBI. On some days, the RBI lent an unprecedented Rs 90,000 crore through repos. These events are surprising given the extent of India's *de jure* capital controls that were expected to isolate its financial markets from global developments. Greater understanding of crisis transmission, the effectiveness of capital controls, and India's *de facto* openness could be achieved by carefully investigating this episode and identifying explanations.

The main hypothesis of this paper is that many Indian firms (financial and non-financial) had been using the global money market before the crisis to avoid India's capital controls. This was done by locating global money market operations in offshore subsidiaries. When the global money market collapsed upon the demise of Lehman, these firms were suddenly short of dollar liquidity. They then borrowed in the rupee money market, converting rupees to US dollars, to meet obligations abroad.

The result was strong pressure on the currency market, and the rupee depreciated sharply. The RBI attempted to limit rupee depreciation by selling dollars. It sold $18.6 billion in the foreign exchange market in October alone. Ordinarily, one might have expected depreciation of the exchange rate in both the spot and the forward markets. However, instead of the forward premium rising in response to the pressure on the rupee to depreciate, it crashed sharply. The authors' hypothesis is that some Indian MNCs that were taking dollars out of India planned to return the funds within a few weeks. To lock in the price at which they would bring that money back, they sold dollars forward. Thus, the one month forward premium fell sharply into negative territory.

Balance of payments data shows outbound FDI was the largest element of outflows in the "sudden stop" of capital flows to India of the last quarter of 2008. This supports the aforementioned hypothesis. During this time there was no significant merger and acquisitions activity taking place owing to the banking and money market crisis around the world. The explanation for

the large FDI outflow when money market conditions in India and the world were among the worst seen in decades, could lie in the offshore money market operations of Indian MNCs. Finally, the authors analyze stock market data, finding that Indian MNCs were more exposed to conditions in international money markets as compared to non-MNCs.

This paper's main contribution lies in showing that Indian MNCs are now an important channel through which India is financially integrated into the world economy. This raises questions about the effectiveness of India's capital controls, which inhibit short-dated borrowing by firms. This restriction appears to have been bypassed to a substantial extent by Indian MNCs. This phenomenon contributes to a larger understanding of the gap that exists between India's highly restrictive *de jure* capital controls and its *de facto* openness.

De jure capital controls have not made India as closed to global financial markets as expected. The expectation that a global financial market crisis would not hit India owing to these controls was proved to be incorrect when the financial crisis was transmitted to India with unprecedented speed. This evidence of India's integration with global capital markets will influence the future discussion of its *de facto* capital account convertibility.

Climate change and the mitigation of greenhouse gas (GHG) emissions have moved to the forefront of international discussion and negotiations. While global warming may have adverse effects on Indian society, there are also concerns that efforts to mitigate emissions within India could seriously impair future economic growth and poverty alleviation. These concerns are the focus of the paper, "Climate Change and India: Implications and Policy Options" by Arvind Panagariya.

The basic perspective is that India's current per capita carbon emissions are very small, only one-fourth those of China and one-twentieth those of the United States; and given the strong association between income and emissions, the capping of emissions at current levels would make it impossible for India to sustain the growth required to match Chinese income levels, much less narrow the gap with the developed economies. Panagariya argues that India should resist making binding emission commitments for several decades, or until it has made greater progress in poverty alleviation.

The paper begins with a discussion of various uncertainties relating to the response of temperatures to GHG emissions, and in turn, the impact of any temperature changes on rainfall and various forms of extreme weather. There is further uncertainty about the effects of those weather changes on productivity and GDP growth. The author discusses the changes in

temperatures and rain patterns specific to India during the last century, as well as their impact if any on sea levels, glacier melting, and natural disasters such as drought and cyclones.

The paper then explores the question of optimal mitigation and instruments to achieve it. A key conclusion is that, absent any uncertainties, either a uniform worldwide carbon tax or a fully internationally system of tradable pollution permits should be employed to reach the optimal solution. A more complicated issue relates to the distribution of the costs of mitigation. Efficiency dictates that countries in which the marginal loss of output per ton of carbon mitigated is the lowest should mitigate more. But absent any international transfers, this may lead to an inequitable distribution of costs of mitigation. An additional question arises with respect to past emis-sions for which the responsibility largely rests with developed countries. A case can be made that if countries are asked to pay a carbon tax for future emissions, they should also pay for the past emissions. This is especially relevant since big emitters of tomorrow are likely to be different from big emitters of yesterday.

Panagariya argues that these distributional conflicts are the primary explanation of why countries have found it so difficult to arrive at a co-operative solution. Developing countries argue that since developed countries are responsible for the bulk of the past emissions and are also among the largest current emitters, they should undertake much of the mitigation. In turn, the United States has responded by raising the specter of trade sanctions against countries that do not participate in the mitigation efforts. The paper discusses whether such trade sanctions are compatible with the existing World Trade Organization (WTO) rules. It argues that the legality of the trade sanctions is far from guaranteed although the ultimate answer will only be known after the specific measures are tested in the WTO Dispute Settlement Body.

Turning to the specific situation of India, Panagariya argues that it should resist accepting specific mitigation obligations until 2030 or even 2040. The case for an exemption from mitigation for the next two or three decades is justified by the fact that India is a relatively small emitter in absolute as well as per capita terms. Based on 2006 data, it accounts for only 4.4 percent of global emissions, and in per capita terms it ranks 137th worldwide. This is in contrast to China, with which it is often paired. China currently emits the most carbon in the world in absolute terms, and as much as one-fourth of the United States in per capita terms. In addition, Panagariya argues that India needs to give priority to the reduction of poverty.

Given the situation of India and other poor countries, how can an international agreement to combat global warming be reached? Panagariya proposes first that significant progress can be made through agreements on the financing of investments devoted to the discovery of green sources of energy and new mitigation technologies. He believes that private firms will under-invest in such technologies due to the inherent uncertainties. Thus, he argues for establishing a substantial fund financed by contributions from the developed countries and using it to finance research by private firms with the proviso that the fruits of such research would be made available free of charge to all countries. Second, he argues that there is still considerable work to be done in completing an agenda of near-term actions. If developed countries are serious about the necessity of developing countries undertaking mitigation targets beginning some time in the near future, they need to lead by example and accept substantial mitigation obligations by 2020. Finally, he believes that mitigation targets for the developing countries should be stated in terms of emissions per capita or per unit of GDP.

The paper generated a lively exchange among participants on both the effects of climate change and on how India should participate in the international policy discussion. Some thought that Panagariya underestimated the costs to India of climate change, but most of the discussion centered on the development of an appropriate Indian policy response.

Beginning with the major 1991 reform, India has systematically phased out investment and import licensing. Progressive movement toward pro-market policies accompanying this phasing out of controls was expected to bring about major shifts in India's industrial structure. Partly because the opening up itself was uneven across sectors and partly because responses to liberalizing reforms were bound to differ across sectors and firms, it was expected that the changes would be highly variable.

"India Transformed? Insights from the Firm Level 1988–2005" by Laura Alfaro and Anusha Chari, sets out to study the responses of firms and sectors accompanying the ongoing transformation of India's microeconomic industrial structure. Relying on firm-level data, collected by the Center for Monitoring the Indian Economy from company balance sheets and income statements, they study the changes in firm activity from 1988 to 2005. They highlight the differing responses to reforms across sectors, private versus public sector firms, and incumbent versus new firms.

The authors define liberalization as consisting of trade and entry liberalization, regulatory reform and privatization that lead to increased domestic and foreign competition. They present a series of stylized facts relating to the evolution of firms and sectors accompanying and following

liberalization. The database covers both unlisted and publicly listed firms from a wide cross-section of manufacturing, services, utilities, and financial industries. Approximately one-third of the firms in the database are publicly listed and the remaining two-thirds are unlisted. The companies covered account for more than 70 percent of industrial output, 75 percent of corporate taxes, and more than 95 percent of excise taxes collected by the Government of India.

Detailed balance sheet and ownership information permits the authors to analyze a range of variables such as sales, profitability, and assets for approximately 15,500 firms classified across 109 three digit industries encompassing agriculture, manufacturing, and services. Therefore, in contrast to most existing firm level studies that focus on manufacturers, the authors are able to study the firms in the services and agriculture sectors as well. The data also permit distinction according to ownership categories such as state-owned, business groups, private stand-alone firms, and foreign firms. The authors divide the years from 1988 to 2005 into five sub-periods: 1988–90, 1991–94, 1995–98, 1999–2002, and 2003–05. This division into sub-periods is intended to capture the effects of various reforms taking place over time.

The authors present detailed information on the average number of firms, firm size, as measured by assets and sales, and profitability as measured by operating profits and the return on assets. The information is presented by sector as well as by category of firm: state-owned enterprises, private firms incorporated before 1985 (old private firms), private firms incorporated after 1985 (new private firms), and foreign firms for the five sub-periods. Sales, entry, profitability, and overall firm activity are interpreted as disaggregated measures of economic growth and proxies for efficiency; and thus, they provide an understanding of the effectiveness of reforms. The authors also look at market dynamics with regard to promotion of competition in order to understand the efficiency of resource allocations. They also examine the evolution of industrial concentration over time.

Alfaro and Chari find some evidence of a dynamic response among foreign and private firms as reflected in the expansion of their numbers as well as growth in assets, sales, and profits. But overall, they find that the sectors and economy continue to be dominated by the incumbent state-owned firms and to a lesser extent traditional private firms that were incorporated before 1985. Sectors dominated by state-owned and traditional private firms prior to 1988–90, where dominance is defined by 50 percent or larger share in assets, sales, and profits, generally remain so in 2005. Interestingly, rates of return remain remarkably stable over time and show low dispersion

across sectors and across ownership groups within sectors. Not only is concentration high, but there is persistence in terms of which firms account for the concentration.

The exception to this broad pattern is the growing importance of new and large private firms in the services industries in the last ten years. In particular, the assets and sales shares of new private firms in business and IT services, communications services and media, health, and other services have expanded at a rapid pace. These changes coincide with the reform measures that took place in the services sectors after the mid-1990s, and they are also consistent with the growth in services documented in the aggregate data.

According to Joseph Schumpeter (1942), creative destruction, defined as the replacement of old firms by new firms and of old capital by new capital, happens in waves. A system-wide reform or deregulation such as the one implemented in India may have been the shock that prompted the creative destruction wave. Creation in India seems to have been driven by new entrants in the private sector and foreign firms forcing the incumbent firms to shape up as well. Outside of the services sectors noted in the previous paragraph, and especially in many manufacturing sectors, transformation seems not to have gone through an industrial shakeout phase in which incumbent firms are replaced by new ones. In many of these sectors, state-owned enterprises and private business groups have continued to dominate despite many liberalization measures.

Different explanations may account for these findings. In part, continued dominance of public sector firms in certain sectors may reflect the high barriers to exit that not only impede destruction of marginal firms but also discourage new firms from entry. On the one hand, potential entrants know that exit of public sector firms is unlikely; on the other hand, they may fear paying high exit costs in case they fail to find a foothold. An additional explanation, perhaps not sufficiently stressed in the debate, is the possibility that entrenched public sector and business group firms subvert true liberalization in sectors in which they dominate. The authors find, for example, that both industry concentration and state ownership are inversely correlated with measures associated with liberalization.

Recent literature highlights the idea that economic growth may be impeded not simply by a lack of resources such as capital and skilled labor, but also by a misallocation of available resources. The high levels of state ownership and ownership by traditional private firms in India raise the question of whether significant gains could be made simply through the allocation of existing resources from less efficient to more efficient firms.

In "Land Reforms, Poverty Reduction, and Economic Growth: Evidence from India," Klaus Deininger and Hari K. Nagarajan consider the important but relatively neglected issues of land market policies and institutions. They focus attention on three issues: the role of rental markets in land, the contribution of land sales to the promotion of efficiency, and the potential benefits of better land ownership records and the award of land titles. The authors posit that well-functioning rental and sales markets lead to superior outcomes by raising productivity and providing improved access to land. On an average, these markets shift land toward more efficient farmers, thus contributing to poverty alleviation. The paper also brings into question the long-held view that land sales markets are dominated by distress sales whereby poor farmers facing credit constraints are forced to sell their land for below-market prices to their creditors.

In evaluating the impact of rental markets, the authors test three hypotheses:

1. Whether a household becomes a lessor or a lessee should be a function of the household's agricultural ability. Efficient but land-poor households would rent additional land to cultivate while inefficient and land-abundant households should rent out their land for cultivation by other more efficient households. In this manner, well-functioning rental markets in land enhance productivity and improve factor use in the economy.
2. The presence of high transactions costs inhibits households from participation in rental markets. These costs may force households to withdraw from rental transactions altogether and undermine productivity.
3. Participation in rental markets is crucially impacted by wage rates offered in the market. Increases in wage rates will prompt households with low ability to manage their land to rent their land to other households. The resulting increase in the supply of land to the rental markets leads to lower rental rates.

Using survey data, the authors test these various hypotheses. They show that rental markets improve productivity of land use by transferring land to more efficient producers. The results suggest that the probability for the most productive household in the sample to rent additional land is more than double that of the average household. The paper also shows that higher land and lower labor endowments increase the propensity of households to supply land to the rental market. By transferring land to labor-rich but

land-poor households, markets allow gainful employment of rural labor. The current policies have severely curtailed rental and have therefore retarded advancement of efficiency and equity in rural India.

The authors next turn to markets for land sales. They examine the impact of a well-functioning land sales market on land access. The long-held view has been that land sales are primarily motivated by adverse exogenous shocks. To the contrary, the authors find that such markets have helped more productive and more labor-abundant farmers to gain access to land. The authors also show that land sales markets exhibit greater activity in the presence of higher economic growth. This suggests that if other factor market imperfections are removed, the role of sales markets in promoting equity and efficiency will be expanded. Finally, identifying the source of shocks leading to distress sales and adopting policies that directly address these shocks can ameliorate the adverse effects of such sales in otherwise well-functioning land sales markets.

The last issue addressed in the paper concerns the importance of land administration for the promotion of efficient rental and sales markets. In India, there exist multiple institutions governing land records, registration, and transactions. This situation has led to a duplication of land records, leading to confusion and conflicts over ownership. It also creates a general sense of insecurity of tenure. The authors argue that the computerization of land records can help alleviate these problems. They cite Karnataka and Andhra Pradesh as examples of this experience. They note that the computerization of records can reduce petty corruption, ease access to land records, and possibly increase the probability of land becoming acceptable as collateral to obtain credit.

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Indian Equity Markets: Measures of Fundamental Value

Summary

In this paper, we take a critical look at the relationship between the value of capital stock in the Indian corporate sector and the valuation of claims to this capital stock in capital markets. We address the question of whether Indian equity valuations over the period 1991–2008 are consistent with three key market fundamentals: corporate capital stock, after-tax corporate cash flows, and net corporate debt. Our analysis extends the neo-classical growth model to include intangible capital and key features of the tax code. Unlike the standard partial equilibrium valuation framework, our paradigm allows us to explicitly capture the interaction between the growth in per capita consumption and interest rates, which fundamentally changes the role of the present value of growth opportunities in explaining a run up in equity prices. In a general equilibrium model with production, growth per se will not increase the value of equity relative to GDP. A second advantage is that it allows us to examine dividends and stock prices relative to GDP. These series are themselves non-stationary; however, they appear to be co-integrated with GDP. Examining these aggregate values relative to GDP induces stationarity and is a natural normalization that eliminates the need for adjustments due to inflation. Finally, it provides a framework to evaluate policy changes, such as altering dividend taxation on stock prices.

We specify the price per share of corporate equity as a function of tax rates and capital stocks and define an equilibrium relationship between the market value of equity and the reproduction value of the tangible and

* I thank Surjit S. Bhalla, Barry Bosworth, Ajay Shah, and the participants of the India Policy Forum for their helpful comments; Ellen McGrattan, Edward Prescott, and especially John Donaldson for many helpful discussions; and Viral Shah for his excellent research assistance. The usual caveat applies.

intangible capital, to which the equity represents claim. Next, we estimate the intangible capital stock in India and use this to develop estimates for equilibrium equity valuations. The challenge in estimating equity valuation is that we do not have readily available measures for the intangible capital stock in India. We estimate this stock of intangible capital for the two periods 1991–2004 and 2005–08 using three different techniques. We have chosen these periods to capture a structural break in the data. Indian equity valuations as a fraction of GDP were fairly constant over the period 1991–2004, rising sharply starting in 2005.

We begin by using the methodology in McGrattan and Prescott (2005). Next, we use the measures in Corrado et al. (2005) for the US economy to infer the corresponding capital stock levels in India. We conclude by constructing our own measures using actual investment data for India.

The McGrattan and Prescott approach uses data on corporate profits and assumes that after-tax returns to both tangible and intangible capital are equal. This facilitates an estimate of the stock of intangible capital. An advantage of this approach is that it does not require any knowledge of the rate of depreciation of intangible capital. Corrado et al. (2006) provide estimates for the value of various forms of intangible capital in the US based on investment data. Since we did not have access to a dataset for India that details the investment in intangible capital for all the categories considered in Corrado et al. (2005), we tease out information from their data to estimate the stock of intangible capital in India. Working with investment data for innovative property and brand equity and assuming that depreciation rates for tangible capital are similar in the US and India, we use the transformation rates for flows into stocks implied by their data for our estimation.

Further, using India-specific investment data on Innovative Property, which includes R&D and Technical knowledge and Brand Equity, we construct direct measures of the stock of these types of intangible capital and compare them with our earlier estimates derived using the Corrado et al. (2006) data. While these estimates for the intangible capital stock are similar to each other, they are lower than the estimates using the McGrattan–Prescott methodology. One reason is the high depreciation rates used by Corrado et al. (2006); another possibility is that organizational capital, in particular investment in learning-by-doing, is probably underestimated in their analysis.

We relate the price earnings ratio and Tobin's q, defined as the ratio of the market value of equity and net debt to tangible capital at replacement cost, to the quantities identified in our model formulation. In the absence of intangible

capital, the equilibrium value of q is 1. Unfortunately, in an economy with changing tax rates and significant intangible capital the usefulness of q_t is limited. In a setting with corporate taxes, distribution taxes (that is, taxes on dividends and capital gains) and subsidies to investment (for example, investment tax credits) not only is its equilibrium value not 1, but it is significantly impacted by changes in the tax code, particularly those changes in the tax rates on corporate distributions which have varied considerably in India from year to year. Thus q_t may differ from 1 either because of over- or undervaluation in capital markets or simply as a result of changes in the tax rates—the ratio per se does not distinguish between the two.

A measure closely related to q is the price earnings (P/E) ratio—the ratio of the stock price to earnings per share, or in the aggregate the value of equity normalized by its after-tax corporate profits. We parse its mechanics and usefulness for Indian equity markets and conclude that both q and P/E ratios, which implicitly abstract from tax rates and intangible capital, offer inadequate measures of under- and overvaluation of capital markets. In particular, for economies with sizable secular growth in intangible capital, as has been observed in India over the last 15–20 years, these metrics offer limited analytical utility.

Our analysis suggests that an optimistic estimate of the fundamental value of the current Indian equity market is about 1.2, considerably lower than the 1.6 value observed in 2008. One effect that we have not accounted for is demand from foreign institutional investors. If the effect of this is to change the marginal investor, the relevant marginal rate of substitution will change, and with it valuations as well. These are issues that we plan to pursue in subsequent research.

Introduction

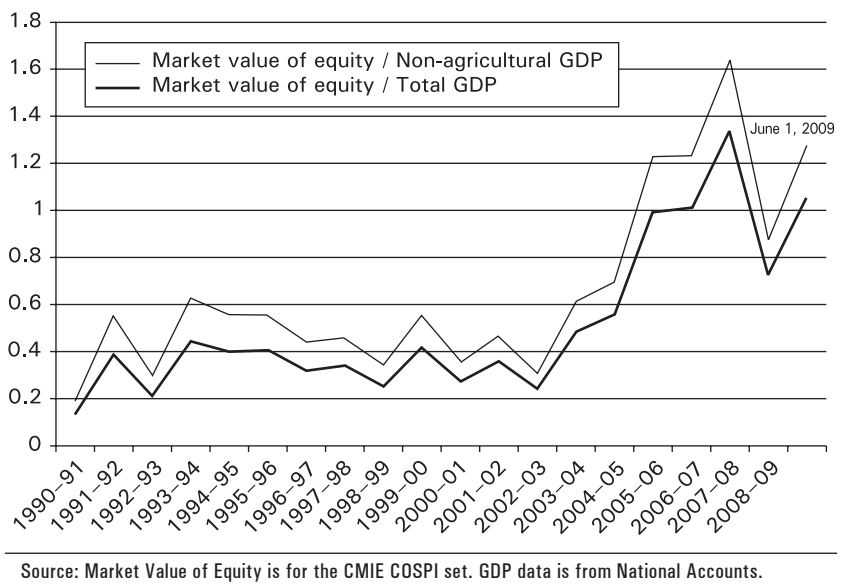
Indian equity markets had their inception in the early 1830s with trading in shares of banks and cotton mills.[1] The first organized exchange—the Native Share and Stock Brokers' Association (forerunner of the Bombay Stock Exchange)—was established in 1887, making it the oldest in Asia (Bajpai, 2004). By India's independence in 1947, the number of exchanges

1. The market experienced its first crash in 1865. The run up in stock prices prior to the crash was a consequence of the increased demand for Indian cotton precipitated by the disruption of cotton supplies from America due to the American Civil War.

had increased to seven and the market capitalization of listed companies was approximately Rs 10 billion (0.11 GDP).[2] In the subsequent forty odd years, however, equity markets languished, and by 1990, although market capitalization of equity had increased to Rs 697.16 billion in nominal terms, its relative value was only 0.135 GDP (Figure 1).

Following economic reforms instituted after the balance of payments crisis in 1991, equity valuations increased sharply. By 1993, equity values had risen to about 0.4 GDP and remained at approximately that level for almost 12 years.[3] Beginning in 2005, Indian equities went through a period of exponential growth culminating in a peak value of Rs 67.46 trillion (1.56 GDP) in early 2008. This propelled India into the "trillion-dollar club"

FIGURE 1. Market Value of Equity / GDP



Source: Market Value of Equity is for the CMIE COSPI set. GDP data is from National Accounts.
Note: The top line plots market value of equity as a multiple of non-agricultural GDP. The bottom line plots market value of equity as a multiple of GDP.

2. In the section "An Equilibrium Valuation Model," we argue that in the case of India, a more accurate representation is obtained if we normalize valuations with respect to non-agricultural GDP (NAGDP) rather than GDP.

3. Since real GDP growth over this period was 8 percent a year, the near constancy of the market value of equity/GDP ratio implies that equity markets also appreciated at this rate, doubling every 9 years.

and the Bombay Stock Exchange (BSE) became a "top ten" exchange in terms of market capitalization. However, by the end of 2008, Indian equity valuations had dropped to around 0.83 GDP and by March 2009 even further to 0.7 GDP. India had exited the "trillion-dollar club."[4]

These large swings in equity valuation were not limited to India alone. Starting in the mid-1990s, there was a considerable increase in US equity prices to an extent that prompted then Federal Reserve Chairman, Alan Greenspan, to characterize the run up as "irrational exuberance."

These dramatic changes in valuation suggest the possibility that at least part of this fluctuation was a response to changes in determinants other than the underlying factors of production or technology. Largely as a consequence of this run up, the possibility of departures of stock price valuations from "equilibrium or fundamental values" has gained center stage in academic research. In the 1970s and 1980s, the halcyon days of the efficient market hypothesis, the prevailing paradigm was that stock prices were an unbiased estimate of some underlying "fundamental" or "intrinsic" value. If at any point in time, the observed price of an asset is a fair indicator of its intrinsic worth, over- and undervaluation become meaningless constructs. What these underlying fundamental values actually were, was left unspecified and for good reason: there was no explicit theoretical framework linking the value of the capital stock to prices of claims to this capital stock—debt and equity—prevailing in the capital markets.[5] The first models (Brock, 1982; Cox et al., 1985; Donaldson and Mehra, 1984; Prescott and Mehra, 1980) to make these connections appeared in the early 1980s; however, they were ill suited to the task of quantifying over- and undervaluation in capital markets, as they abstracted from two key ingredients: intangible capital[6] and taxes. The equilibrium conditions in these models required that the value of the claims to the capital stock be equal to the tangible capital of the firm or, equivalently, that their ratio (Tobin's q) be 1. This was not empirically observed; together with the models' inability to address the equity premium

4. By early June 2009, the market capitalization of Indian equities was again US$ 1 trillion.

5. See Bosworth (1975) for an early empirical study linking stock prices to economic activity.

6. Unlike tangible capital, intangible capital cannot be measured directly: it includes brand names, scientific and technical knowledge, patents, and organizational capital. As an example, consider the difference between owning a thousand trucks (tangible capital) and running a trucking company that owns a thousand trucks. The difference in the value of the trucking business and the thousand trucks is a measure of intangible capital. I thank Ajay Shah for this example.

puzzle, this cast doubt on the models' usefulness as measurement tools to provide a benchmark for capital markets valuations. In 2005, McGrattan and Prescott (2005) extended the standard growth model to incorporate both intangible capital and taxes. In doing so, they were able to account for the secular movements in the value of US equity relative to GDP. The extended standard growth model can serve as a reference for over- and undervaluation in capital markets. Their analysis highlights the importance of the role that intangible capital and distribution taxes play in explaining variations in equity valuation.

In this paper, we take a critical look at the relationship between the value of the capital stock in the Indian corporate sector and the valuation of claims to this capital stock in capital markets. We address the question of whether Indian equity valuations over the period 1991–2008 are consistent with three key market fundamentals: corporate capital stock, after-tax corporate cash flows, and net corporate debt. Our analysis extends the neoclassical growth model[7] to include intangible capital and key features of the tax code. This paradigm has several advantages. Unlike the standard partial equilibrium valuation framework,[8] it allows us to capture explicitly the interaction between the growth in per capita consumption and interest rates. This interaction fundamentally changes the role of the present value of growth opportunities (PVGO) in explaining a run up in equity prices. In a general equilibrium model with production, growth per se will not increase the value of equity relative to GDP.[9] A second advantage is that it allows us to examine dividends and stock prices relative to GDP. These series are themselves nonstationary; however, they appear to be co-integrated with GDP. Examining these aggregate values relative to GDP induces stationarity and is a natural normalization in this theoretical setting. It also eliminates the need for adjustments due to inflation. Finally, it provides a framework to evaluate policy changes such as the effect of changes in dividend taxation on stock prices.

7. This model and its stochastic variants are a central construct in contemporary finance, public finance, and business cycle theory. It is the basis for much of our economic intuition and has been used extensively by, among others, Abel et al. (1989), Auerbach and Kotlikoff (1987), Barro and Becker (1988), Brock (1979), Cox et al. (1985), Donaldson and Mehra (1984), Lucas (1988), Kydland and Prescott (1982), McGrattan and Prescott (2005), and Merton (1971).

8. See, for example, Fama and Miller (1972).

9. For an elaboration, see Kiley (2004).

Although our framework is well suited to examining secular movements in the value of equity relative to GDP, it is not a suitable framework to address high frequency price movements in the stock market. In fact, we know of no framework that can satisfactorily account for these movements in terms of the underlying fundamentals. High frequency volatility remains a puzzle.[10]

This paper is organized as follows: in the second section, we derive an equilibrium relationship between the value of equity and net debt and the value of tangible and intangible corporate capital. Corporate tax rates and tax rates on distributions to equity and debt holders figure prominently in these relationships. We calibrate the economy in the third section. In the fourth section, using firm level investment data on intangible capital from CMIE, we estimate the intangible capital stock. In the fifth section, we use the relationships developed in the second section to obtain estimates of Indian equity valuation. In doing so, we are able to provide a theoretically grounded sense of market efficiency. In the next section, we take a critical look at two popular valuation metrics, Tobin's q and the P/E ratio and examine their appropriateness in light of the theory developed in the second section. The final section concludes the paper.

An Equilibrium Valuation Model

Overview

We extend standard growth theory by incorporating intangible capital and use it to value the Indian equity market.[11] Our model is similar to that

10. The "volatility puzzle" has its origins in the important early work of Shiller (1981) and LeRoy and Porter (1981), which found evidence of excessive volatility of stock prices relative to the underlying dividend/earnings process. These studies use a constant interest rate, an assumption subsequently relaxed by Grossman and Shiller (1981) who addressed the issue of varying interest rates. They concluded that although this reduced the excess volatility, Shiller's conclusion could not be overturned for reasonable values of the coefficient of relative risk aversion.

11. The importance of intangible capital, both for growth accounting and corporate valuation has received considerable attention. See papers by Bond and Cummins (2000), Corrado et al. (2005), McGrattan and Prescott (2001, 2005), Hall et al. (2000), Hall (2001), and the volume by Corrado et al. (2005). Bond and Cummins stress the importance of brand names for valuing corporations like Coca-Cola. Hall stresses the importance of "e-capital," for valuing high-tech companies.

analyzed by McGrattan and Prescott (2005) and our exposition closely follows their paper. One implication of the model is that the value of corporate equity and debt should be equal to the value of the productive assets in the corporate sector. The challenge is to find the value of these assets in terms of the consumption good. Table 1 classifies the components of corporate capital stock and the claims to this capital stock. In the model, in the absence of all taxes, the equilibrium relationship specifying the price of equity (p_t) and net debt (b_t) as a function of corporate capital stocks is

$$p_t + b_t = k_{m,t+1} + k_{u,t+1} \tag{1}$$

where $k_{m,t}$ and $k_{u,t}$ are, respectively, the tangible (measured) and intangible (unmeasured) capital stock.

TABLE 1. Basic Balance Sheet

Corporate capital stock	*Claims to corporate capital*
Tangible capital k_m	**Equity p**
Fixed corporate capital	**Net debt b**
Inventory stocks	
Corporate land	
Intangible capital k_u	
Brand names	
Patents	
Organizational capital	

Source: Author.

In Table 1, capital stocks are measured or estimated in terms of their reproduction cost, while the values of debt and equity are market values. The empirical counterpart of tangible corporate capital is the sum of fixed corporate capital stocks, inventory stocks, and the value of corporate-owned land. Intangible capital includes brand names, patents, and forms of organizational capital. Intangible capital is not measured directly and as Indian National Accounts do not report its value, it must be estimated. One approach to estimate the value of intangible corporate assets is to attribute the return on capital used in the corporate sector to both tangible and intangible capital and assume that the after-tax returns to both types of capital are equal. We detail this and other estimation procedures in the fourth section.

Model Formulation

To derive an equilibrium relationship between the value of productive capital and the market value of corporations, we initially assume that all the firms are equity financed.[12] Following McGrattan and Prescott (2005), we also abstract from uncertainty, as it is an unimportant feature for our results. We take note of the findings in Bosworth et al. (2007) who point out the heterogeneity in the contribution of different sectors of the economy to India's growth rate. The large agriculture sector in India has a very low capital labor ratio and little of its capital is publicly traded. Since the focus of this paper is on capital valuation in securities markets, we exclude the agriculture sector from our analysis and only model the non-agricultural sector.[13] One implication of our approach is that when we normalize capital valuations relative to GDP, we will use only the contribution to GDP of the non-agricultural sector (NAGDP). Within the non-agricultural sector, we introduce a dichotomy between workers and shareholders (Danthine et al., 2008; Mankiw and Zeldes, 1991). This distinction is particularly germane to the Indian context as workers generally do not hold equity either directly or indirectly and hence may have different future marginal rates of substitution compared to stockholders as their consumption growth rates may differ. In valuing equity, we use the marginal rates of substitution of the stockholders.

In light of the discussion earlier, we model the economy as one with two agents, workers and shareholders who take prices as given. There is also one firm that maximizes its value taking prices as given. These single entities, the workers, shareholders, and the firm are respectively "stand in" representatives of a continuum of such agents distributed on the unit interval. We abstract from population growth in the analysis later, as it does not change the valuation relation we derive but simplifies the notation and allows us to use per capita and aggregate quantities interchangeably. We will re-introduce it when we calibrate the model.[14]

12. We relax this assumption when we discuss our results.

13. Equivalently, the reader may view the Indian economy as being split into two disjoint sectors, one of them being the agriculture sector. For a balanced growth model with integrated agricultural, services, and manufacturing sectors, see Kongsamut et al. (2001). Their model features a rapidly declining agricultural sector which is beginning to be observed in India.

14. In the absence of intangible capital, tax rates, and subsidies our model reduces to the standard decentralized growth model. Thus setting these quantities to zero in the fifth section gives us the equilibrium valuation implied by the standard model.

The Worker

The representative worker supplies labor (n_t^w) inelastically and consumes his aggregate wages ($w_t n_t^w$). The worker does not trade securities and thus does not borrow or save. He maximizes the present value of his present and future utility of consumption (c_t^w):

$$\max_{\{c_t^w,\ n_t\}} \sum_{t=0}^{\infty} \beta^t v(c_t^w) \tag{P1}$$

subject to

$$c_t^w \le w_t n_t^w \quad \text{and} \quad n_t^w \le 1$$

The solution to this problem is $c_t^w = w_t$ and $n_t^w = 1$ since there is no presumed disutility of work.

The Shareholder

The shareholder owns all the securities (z_t) in the economy and consumes the aggregate dividends (d_t). There is one perfectly divisible equity share outstanding. Shareholders do not supply any labor. The representative shareholder also maximizes the present value of his utility of consumption (c_t^s):

$$\max_{\{c_t^s,\ z_t\}} \sum_{t=0}^{\infty} \beta^t u(c_t^s) \tag{P2}$$

subject to

$$c_t^s + p_t z_{t+1} \le (p_t + d_t(1-\tau_d))z_t + \pi_t \quad \text{and} \quad 0 \le z_t \le 1$$

where p_t is the price per share, τ_d is the tax on dividends or share buy backs and π_t is the value of taxes rebated back to the shareholder in lump sum form. The budget of the shareholder specifies that his consumption plus the value of shares that he carries over to the next period be less than or equal to the value of the portfolio at the beginning of the period plus government transfers.

The Firm

The firm uses labor and capital (tangible and intangible) to produce output y_t. It is characterized by a constant returns to scale production function $y_t = f(k_{m,t},\ k_{u,t},\ \lambda_t n_t^f)$ with productivity growth rate γ so that

$$\lambda_{t+1} = (1 + \gamma)\lambda_t$$

Firms act competitively to maximize shareholder value using the marginal rate of substitution provided by the representative shareholder. It solves:

$$\max_{\{x_{u,t}, x_{m,t}, n_t^f\}} p_t + d_t = \max_{\{x_{u,t}, x_{m,t}, n_t^f\}} \sum_{j=0}^{\infty} \frac{\beta^j u_1(c_{t+j}^s)}{u_1(c_t^s)} d_{t+j} \tag{P3}$$

subject to

$$d_t = f(k_{m,t}, k_{u,t}, \lambda_t n_t^f) - w_t n_t^f - x_{m,t} - x_{u,t} - \text{taxes} + \text{subsidies}$$

$$k_{u,t+1} = (1-\delta_u)k_{u,t} + x_{u,t})$$
$$k_{m,t+1} = (1-\delta_m)k_{m,t} + x_{m,t})$$

$$\text{taxes} = \tau_c(f(k_{m,t}, k_{u,t}, \lambda_t n_t^f) - w_t n_t^f - k_{m,t}\delta_m - x_{u,t})$$

$$\text{Subsidies} = \tau_s x_{m,t}$$

where τ_s is the subsidy for investment in tangible capital (such as an investment tax credit), τ_c is the corporate tax rate, $x_{m,t}$ and $x_{u,t}$ represent tangible and intangible investment at time t and δ_u and δ_m are the depreciation rates for these capital stocks respectively. n_t^f is the per capita labor demanded by the firm.

In (P3) the first constraint defines the dividend as output net of wages, investments, taxes, and subsidies. The second and third are the standard laws of motion of capital stock, both tangible and intangible. The constraint on taxes recognizes that wages, intangible investment, and depreciation of tangible capital are tax-deductible expenses. The final constraint defines the subsidy to capital investment.

The rate of return, defined by the marginal rate of substitution of the stockholders in this economy, is:

$$1 + r_{t+1} = \frac{u_1(c_t^s)}{\beta u_1(c_{t+1}^s)}$$

Equilibrium in this economy is defined by per capita sequences of consumption (c_t^s, c_t^w), investment ($x_{m,t}$, $x_{u,t}$), and labor (n_t^w, n_t^f) that simultaneously satisfy:

(*a*) the necessary and sufficient first order conditions for the firm's problem

$$(1+r_{t+1}) = \frac{(1-\tau_c)[f_1(k_{m,t},\, k_{u,t},\, \lambda_t n_t^f) - d_m]}{(1-\tau_s)} + 1 \tag{2}$$

$$(1+r_{t+1}) = f_2(k_{m,t},\, k_{u,t},\, \lambda_t n_t^f) - d_u + 1 \tag{3}$$

$$w_t = f_3(k_{m,t},\, k_{u,t},\, \lambda_t n_t^f) \tag{4}$$

(*b*) the necessary and sufficient first order conditions for the shareholders problem:

$$u_1(c_t^s)p_t = \beta u_1(c_{t+1}^s)(p_{t+1} + d_{t+1}(1-\tau_d)) \tag{5}$$

(*c*) market clearing conditions:

$$z_t = 1$$

$$n_t^w = n_t^f = 1$$

$$c_t^w + c_t^s = f(k_{m,t},\, k_{u,t},\, \lambda_t n_t^f) - x_{m,t} - x_{u,t} + \pi_t$$

where π_t = taxes – subsidies

Equations (2) and (3) equate the marginal return on tangible and intangible capital to the marginal rate of substitution of the shareholders while equation (4) defines the wage rate. It follows from (2), (3), and (5) that the equilibrium relation specifying the price per share of corporate equity as a function of tax rates and capital stocks is

$$p_t = (1-\tau_d)[(1-\tau_s)k_{m,t+1} + (1-\tau_c)k_{u,t+1}] \tag{6}$$

which is also the total equity value.

Equation (6) represents the equilibrium, full information, rational valuation relationship between the market value of equity, and the reproduction value of the tangible and intangible capital, to which the equity represents claim. In the next section, we estimate the intangible capital stock in India and then use (6) in the fourth section to develop estimates for equilibrium equity valuations. In the fifth section, we will use (6) to evaluate the theoretical appropriateness of other commonly used valuation techniques.

Calibration

In the following analysis (Table 2), we have split the time period 1991–2008 into two sub-periods 1991–2004 and 2005–08 since 2005 marked the beginning of a substantial run up in the equity markets.[15]

TABLE 2. Calibration

Parameter	*1991–2004*	*2005–08*
Population growth rate of shareholders (ζ)	0.015	0.015
Growth rate of technology (γ)	0.052	0.088
Growth of real NAGDP ($\gamma + \eta$)	0.067	0.103
Growth of real consumption (ν) Estimated over the period 1991–2008	0.049	0.049
Discount factor (β)	0.96	0.96
Elasticity of intertemporal substitution (η)	0.33	0.33
Real interest rate implied by model parameters (r_f)	0.141	0.141
Effective corporate tax rate on PBDIT (τ_c)	0.098	0.159
Distribution tax rate (τ_d)	0.10	0.125
Investment tax credit (τ_s)	0	0
Growth of real NAGDP ($\gamma + \zeta$)	0.067	0.103
Profits before interest and taxes (CP)	0.156	0.192
Corporate tangible capital (k_m)	0.783	0.939

The parameters that need to be "calibrated" are those related to the shareholders $\{\beta, \zeta, u(.)\}$; the firm $\{\delta_m, \gamma, x_m, k_m$, after tax cash flows $(CF)\}$ and the policy parameters $\{\tau_c, \tau_d, \tau_s\}$. Some of these parameters are well documented in the literature; others are not. Table 2 details the parameter values that we use for the Indian economy. We explain next the motivation for choosing these values.

We choose ζ to match the population growth of the shareholders. The population growth rate for this group, we believe, is lower than the general population growth rate (1.7 percent) or for the working age population (2 percent). We calibrate the growth rate of productivity γ by matching $\gamma + \zeta$ to the average real growth rate of output from the non-agricultural sector (NAGDP). As discussed earlier, we use this growth rate rather than

15. The theory that we have developed is meant to deal with low frequency movements in the underlying factors of production and technology and averaging over the 2005–08 period assumes that this trend will continue.

the growth rate of GDP as agriculture in India uses very little capital, and is likely to have a markedly different aggregate production function than the one that characterizes the non-agricultural sector. We choose $\beta = 0.96$ as it is a standard value for the discount factor in much of the macroeconomic literature. Our theory requires that the tax τ_c, be the effective tax rate faced by the suppliers of capital to the firm. Since interest payments are tax deductible this effective rate is much lower than the marginal corporate tax rate. Each year we estimate the effective corporate tax rate from data on corporate taxes paid and profits before interest and taxes and then take the appropriate averages: τ_c = actual corporate taxes paid/ profits before interest and taxes. We calibrate τ_d to the marginal tax rate. We note that the tax rate on dividends has changed frequently and we will revisit this issue when we discuss our results. We fix $\tau_s = 0$, as there is no investment tax credit in India. To calibrate the interest rate, we use Constant Relative Risk Aversion (CRRA) preferences with elasticity of intertemporal substitution $\eta = \frac{1}{3}$ and calculate the marginal rate of substitution of the shareholders. We use the average growth rate of per capita consumption over the entire period 1991–2008 for this calibration.

$$r \approx \frac{1}{\beta} + \nu / \zeta - 1$$

It is well known that the real interest rate implied by the growth model is counterfactually high in economies with high growth rates and this is probably the case in our model.[16]

We use data on net private stock of corporations to estimate k_m. It is expressed as a fraction of the non-agricultural output. We estimate the after-tax cash flow to debt and equity holders (net of depreciation of tangible capital and investment in intangible capital), CF by making appropriate adjustments to corporate profits before depreciation, interest, and taxes. It is also expressed relative to NAGDP. We assume that the economic depreciation rate is equal to the accounting depreciation rate, which averages 5 percent when measured relative to k_m. The depreciation rates allowed by the Indian tax code are far more generous; net of inflation they average to around 5 percent, which is what is reported in the Indian National Accounts.

16. High growth rates that characterize developing economies are unlikely to continue indefinitely and hence are not likely to be observed in steady state. For example, a growth rate of 6 percent implies a doubling in standard of living every twelve years compared to a doubling every 36 years in the US.

Methodology for Estimating Intangible Capital Stock

The challenge in using the relationship developed in equation (6) for equity valuation is that we do not have readily available measures for the intangible capital stock in India. We estimate the intangible capital stock using three different techniques. We begin by using the methodology in McGrattan and Prescott (2005). Next, we use the measures in Corrado et al. (2005) for the US economy to infer the corresponding capital stock levels in India. We conclude by constructing our own measures using actual investment data for India.

The McGrattan and Prescott Methodology

McGrattan and Prescott start by using data on corporate profits and assume that after-tax returns to both tangible and intangible capital are equal. This enables them to estimate the stock of intangible capital. An advantage of their approach is that it does not require knowledge of the rate of depreciation of intangible capital.

We illustrate their approach in a world without taxes. The accounting concept that corresponds to the model counterpart of pre tax corporate profits is profits before interest and taxes (PBIT) and can be written as

$$\text{PBIT} = y_t - w_t n_t^f - x_{u,t} - \delta_m k_{m,t}$$

Using the first order conditions (2) and (3) and the fact that the production function displays constant returns to scale that is,

$$f_1(k_{m,t}, k_{u,t}, \lambda_t n_t^f)k_{m,t} + f_2(k_{m,t}, k_{u,t}, \lambda_t n_t^f)k_{u,t} + w_t n_t^f = y_t$$

we can re write (PBIT) as

$$\text{PBIT} = r_t k_{m,t} + (\delta_u + r_t)k_{u,t} - x_{u,t}$$

Finally using the fact that on a balanced growth path

$$x_{u,t} = (\gamma + \eta + \delta_u)k_{u,t}$$
$$\text{PBIT} = r_t k_{m,t} + (r_t - \gamma - \eta)k_{u,t}$$

In the presence of taxes this expression is modified to

$$\text{PBIT} = \frac{r_t}{1-\tau_c} k_{m,t} + (r_t - \gamma - \eta)k_{u,t} \tag{7}$$

where we remind the reader that τ_c is defined as

$$\tau_c = \frac{\text{corporate taxes paid}}{\text{PBIT}}$$

It is the average tax rate on PBIT, not the marginal corporate tax rate.

The intangible capital stock can thus be estimated from equation (7) in terms of the observed parameters of the economy. We note that in deriving (7) we have assumed that the economy is (approximately) on a balanced growth trajectory, a condition that may not have been true in India in the early 1990s.

Using values in Table 2, we can estimate the average value of the intangible capital for the two periods 1991–2004 and 2005–08. As mentioned earlier, we have chosen these periods to capture a structural break in 2005. Indian equity valuations as a fraction of GDP were fairly constant over the period 1991–2004, rising sharply starting in 2005. Our estimates are presented in Table 3.

TABLE 3. Average Values Measured as a Fraction of Non-agricultural GDP

	1991–2004	*2005–08*
After-tax cash flows	0.1754	0.1991
Estimate of intangible capital	0.447	0.883

Alternative Estimates of Intangible Capital in India—1

Corrado et al. (2006) provide estimates for the value of various forms of intangible capital in the US based on investment data. The investment data is presented in Table 4 and the corresponding estimates of intangible capital in Table 5.

TABLE 4. Intangible Investment (US 2000–03 annual average)

	Billions of dollars	*Percentage of GDP*
Intangible investment	1,226	11.19
Computerized information	173	1.58
Innovative property	468	4.27
R&D (Scientific)	231	2.11
Non-scientific	237	2.16
Economic competencies	586	5.35
Brand equity	161	1.47
Firm-specific resources	425	3.88

Source: From Corrado et al. (2006), Table 2.

TABLE 5. Estimate of Intangible Capital Stock (US 2003)

	Billions of dollars	*Percentage of GDP*
Intangible capital stock	3,636	33.18
Computerized information	512	4.67
Innovative property	1,786	16.30
R&D (Scientific)	922	8.41
Non-scientific	864	7.88
Economic competencies	1,338	12.21
Brand equity	272	2.48
Firm-specific resources	1,066	9.73

Source: From Corrado et al. (2006), Table 3.

Corrado et al. (2006) report that for the period 2000–03, the aggregate US investment in intangible assets averaged 11.19 percent of GDP and estimate that these investment levels translate into a stock of intangible capital valued at 33.18 percent of GDP. As Tables A-1 and A-2 show (see the Appendix), due to differing depreciation rates the rate of transformation of investment flows into capital stock vary considerably.

Unfortunately, we do not have access to a dataset for India that details the investment in intangible capital for all the categories considered by Corrado et al. (2006). We can, however, tease out information from their data (Tables 4 and 5) to estimate the stock of intangible capital in India. Since, we have investment data for innovative property (both scientific and non-scientific) and brand equity (Table 6), if we assume that depreciation rates for tangible capital are similar in the US and India, we can use the transformation rates for flows into stocks implied by their data for our estimation. Our capital stock estimates are reported in Table 7.

Alternative Estimates of Intangible Capital in India—2

Since we have investment data on Innovative Property, which includes R&D and technical knowledge and brand equity, we can also construct direct

TABLE 6. Intangible Investment (India 2004–08 annual average)

	Billions of INR	*Percentage of NAGDP*
Intangible investment		
Computerized information		
Innovative property	393	1.11
R&D (Scientific)	99	0.28
Non-scientific	294	0.83
Economic competencies		
Brand equity	286	0.81
Firm-specific resources		

TABLE 7. India 2008: Estimate of Intangible Capital Stock Using Corrado et al. (2006)

	Billions of INR	*Percentage of NAGDP*
Intangible capital stock		
Computerized information		
Innovative property	1,467	4.15
R&D (Scientific)	394	1.11
Non-scientific	1,073	3.03
Economic competencies		
Brand equity	482	1.36
Firm-specific resources		

measures of the stock of these types of intangible capital and compare them with our earlier estimates derived using the Corrado et al. (2006) data. To do so, we use the law of motion for capital stock relative to non-agricultural GDP

$$\frac{k_{t+1}}{y_{t+1}} = \left[\frac{k_t}{y_t}(1-\delta) + \frac{x_t}{y_t}\right]\frac{1}{(1+\gamma+\eta)}$$
$$\frac{k_0}{y_0} : \text{given} \tag{8}$$

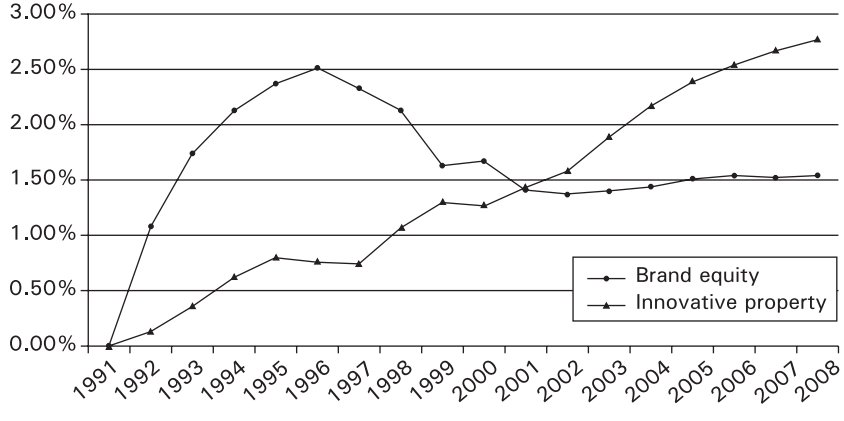
For a given initial capital stock, the future capital stock at any date *t* can be calculated by recursively using equation (8). We initialize the capital stock to zero in 1990 and use a variety of depreciation rates for our estimates. Given that depreciation rates for intangible capital are high (Corrado et al. [2006] report rates as high as 60 percent) the initialization assumption is innocuous. The contribution of an investment to the stock of the asset is only 25 percent after two half-lives so investments made prior to 1990 have little effect on the capital stock levels in the late 1990s. A depreciation rate of 20 percent implies a half-life of less than 3.5 years while a rate of 30 percent reduces the half-life of the investment to 2.3 years. We report our estimates in Table 8 for the depreciation rates used by Corrado et al. (2006). Capital stock levels for alternate depreciation rates are shown in Tables A-1 and A-2 in the Appendix.

It is comforting to note that the estimates that we get from the Corrado et al. (2006) measures are similar to those using investment data and their depreciation rates. One advantage of using investment flows is that it explicitly allows us to vary the depreciation rate and examine its effect on the capital stock. In Figure 2 we show the evolution of the stock of brand equity (advertising and marketing) and innovative property. We also observe

TABLE 8. India 2008: Estimate of Intangible Capital Stock Using Investment Data

	Billions of INR	*Percentage of GDP*
Intangible capital stock		
Computerized information		
Innovative property	1,295	3.66
R&D (Scientific)	315	0.89
Royalties, technical knowledge	980	2.77
Economic competencies		
Brand equity	545	1.54
Firm-specific resources		

FIGURE 2. Intangible Capital



Source: Investment in advertising and marketing from CMIE BB.

that while intangible capital associated with advertising and marketing has stabilized as a fraction of GDP, innovative property capital is still increasing. This leads us to conclude that Indian equity valuations relative to GDP will continue to rise as the stock of intangible capital approaches its steady state value.

Finally, we use the estimates in Tables 7 and 8 to construct estimates of the entire intangible capital stock in India. We report this in Table 9. In constructing Table 9, we have assumed that investments in firm-specific resources in India mimic those in the US. Although we do not have investment data for this category we feel that investment in human and organizational capital is likely to be similar in India especially for large firms. In addition, we use the estimates of intangible capital from the Indian National Accounts for the category of Computerized Information.

TABLE 9. Estimate of Intangible Capital Stock (India 2008)

	Following Corrado et al. (2006)		*Using investment data*	
	Rs (billion)	*% GDP*	*Rs (billion)*	*% GDP*
Intangible capital stock	5,724	16.17	5,947	16.81
Computerized information	296	0.84	296	0.84
Innovative property	1,463	4.13	1,295	3.66
R&D (Scientific)	394	1.11	315	0.89
Royalties, technical knowledge	1,069	3.02	980	2.77
Economic competencies	3,893	11.00	3,988	11.27
Brand equity	450	1.27	545	1.54
Firm-specific resources	3,443	9.73	3,443	9.73
Other intangibles (from accountants)	368	1.04	368	1.04

While these estimates for the intangible capital stock are similar to each other, they are lower than the estimates that we obtain using the McGrattan–Prescott methodology. One reason is the high depreciation rates used by Corrado et al. (2006), another possibility is that organizational capital, in particular investment in learning by doing, is probably underestimated in their analysis.[17]

Equilibrium Equity Values

In this section, we use the theoretical framework developed earlier and our estimates of intangible capital to compute equilibrium values for corporate securities in India and compare these to observed values. We begin by documenting the average observed values for both debt and equity in Table 10 and predicted fundamental values in Table 11.

Although we have abstracted from debt in deriving our valuation relationship equation (6) the empirical counterpart of claims to the corporate

TABLE 10. Average Observed Corporate Values for India

	1991–2004	*2005–08*
Corporate equities	0.452	1.200
Net corporate debt	0.335	0.268
Total relative to NAGDP	0.787	1.468
Total relative to earnings	17.378	18.272

17. The reader is referred to McGrattan and Prescott (2005) and the commentary by Edward Prescott at the end of the chapter by Corrado et al. (2005) for a discussion on organizational capital.

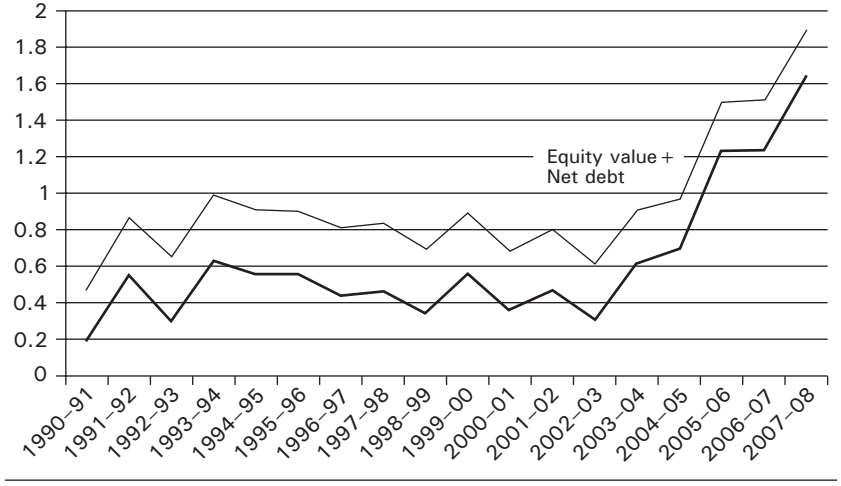
TABLE 11. Predicted Fundamental Corporate Values for India

	1991–2004	*2005–08*
McGrattan–Prescott		
Contribution of domestic tangible capital *	0.701	0.821
Contribution of domestic intangible capital **	0.362	0.650
Foreign capital	0.000	0.000
Total relative to NAGDP	1.063	1.471
Corrado et al.		
Domestic tangible capital		0.774
Domestic intangible capital		0.152
Foreign capital		0.000
Total relative to NAGDP		0.926
Using investment data		
Domestic tangible capital		0.774
Domestic intangible capital		0.168
Foreign capital		0.000
Total relative to NAGDP		0.942

Notes: $^{*}k_m(1-\tau_d)$; $^{**}k_u(1-\tau_c)(1-\tau_d)$.

capital stock is the market value of the corporate sector, which includes both equity and net debt. The total market value of the corporate sector is plotted in Figure 3.

FIGURE 3. Total Value / NAGDP

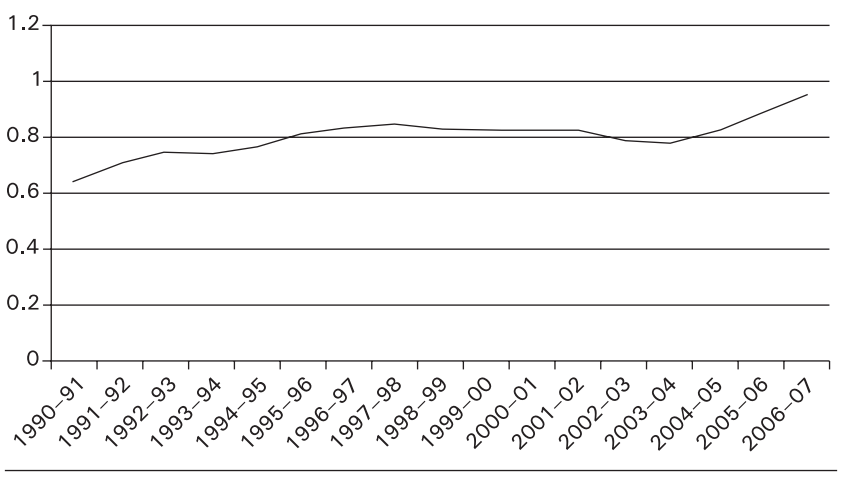


Source: Market Value of Equity is for the CMIE COSPI set. Net Corporate Debt is for all non-financial firms from CMIE BB. GDP data is from National Accounts.

The top line plots market value of equity and net debt as a multiple of NAGDP. The bottom line plots market value of equity as a multiple of NAGDP.

We observe that for the 1991–2004 period the ratio of total corporate value to NAGDP has been relatively constant with a mean value of 0.787. The predicted equilibrium value for the same time period is 1.09 (Table 11). If we use our model as a benchmark, the conclusion is that the Indian market was not overvalued during most of the 1991–2004 period—certainly not on average. In fact, tangible assets alone account for over 95 percent of the value[18] of the entire market—a point reinforced by Figure 4, which plots corporate capital as a multiple of NAGDP.

FIGURE 4. Corporate Capital / NAGDP



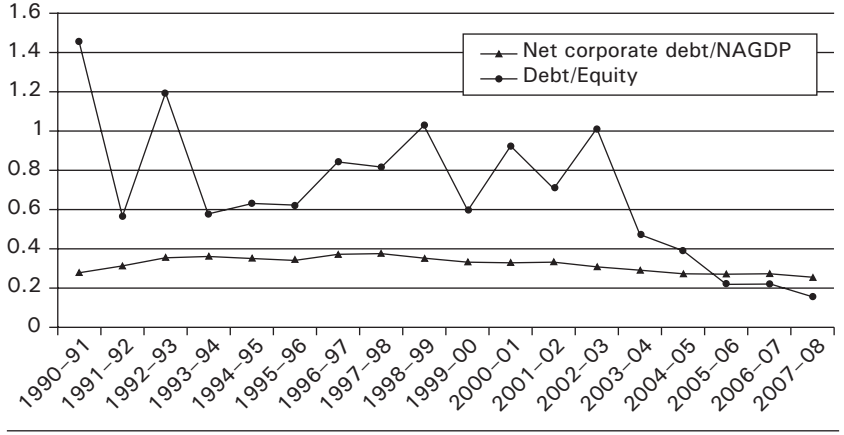
Source: National Accounts.

The Indian experience during 1991–2004, where both capital output and corporate valuations relative to GDP were constant, contrasts greatly with the US experience, in which the capital–output ratio is fairly constant but corporate valuations relative to GDP have moved considerably. McGrattan and Prescott (2005) attribute this to changes in the tax and regulatory framework.

18. The effective distribution tax rate over this period was 4.9 percent. Note that from equation (6) the contribution of tangible capital stock to corporate valuation is $k_m(1 - \tau_d)$.

Next, we examine the 2005–08 period. One explanation for the run up in equity values relative to GDP is that there was a change in the capital structure of firms. If there were debt equity swaps,[19] equity values relative to GDP would increase. To see if this was the case in India, we examine the net corporate debt relative to GDP and the debt equity ratio (Figure 5).

FIGURE 5. Net Corporate Debt / NAGDP and Debt / Equity



Source: Net Corporate Debt is for all non-financial firms in CMIE BB. GDP data is from the Indian National Accounts.

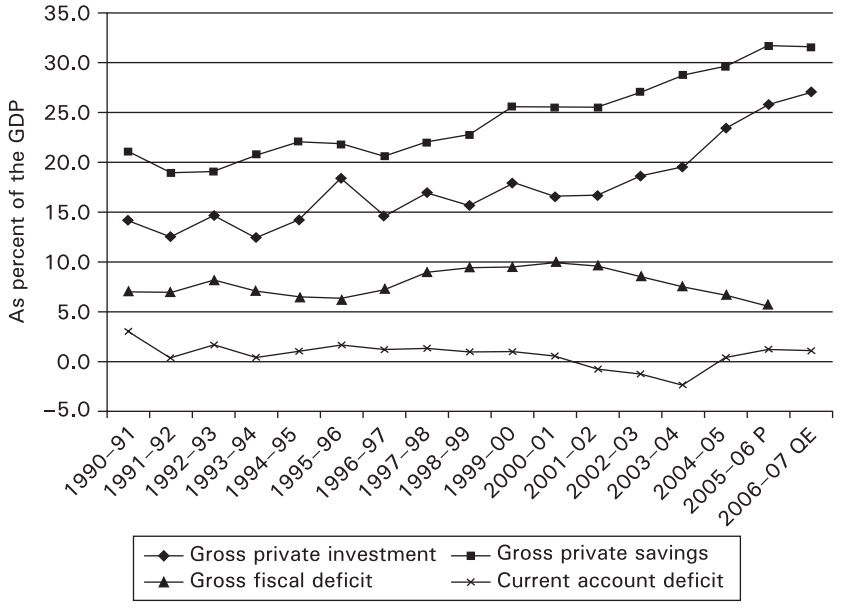
Looking at Figure 5, we see a gradual decline in debt financing starting in 1998 but nothing significant in the 2005–08 period. Hence, this is an unlikely explanation for the precipitous decline in the debt equity ratio in Figure 5, which seems to be the result of an increase in equity valuation.

Is this increase in corporate valuations consistent with changes in the underlying corporate capital stock? The average observed value over this period was 1.468, which is almost exactly equal to our high estimate of 1.471 but over 50 percent more than the low estimate for the fundamental value. The conclusion that market valuations should increase is apparent from Figure 4. We should have expected a 20–25 percent increase in valuations, based solely on the increase in tangible capital. This increase in the tangible capital stock is consistent with the increase in gross private investment over

19. With corporations buying back debt and issuing equity or changing the debt equity mix in financing new investments.

this period. This rate, which averaged 16.51 percent during 1991–2004, jumped to 25.5 percent during 2005–08 (Figure 6).

FIGURE 6. Investment, Saving, and Deficit



Source: Panagariya (2008).

However, this increase in the savings rate does not imply the valuations observed at the end of 2008. Our analysis suggests that an optimistic estimate of fundamental value of the current Indian equity market is about 1.2 (since debt is about 0.25). This is considerably lower than the 1.6 value observed in 2008. One effect that we have not accounted for is the demand from foreign institutional investors. In 2007, Foreign Institutional Investment was valued at 300 billion dollars (versus a low of 60 billion) and this fact may have important implications in valuing Indian stock markets.[20] If the effect of this demand is to change the marginal investor, the relevant marginal rate of substitution will change, affecting market valuations as well. These are issues that we plan to persue in subsequent research.

In closing, we revisit Figure 2, which suggests that intangible capital in India is still increasing in some sectors. This will lead to a future increase

20. I thank Surjit S. Bhalla for this insight.

in the equilibrium value of the Indian equity markets relative to GDP. If cross country data is any guide, we expect these markets to stabilize at around 1.5 GDP once intangible capital reaches steady state levels.

Valuation Ratios

In this section, we relate the price earnings ratio and Tobin's q, to quantities identified in the model developed in the second section. Both these ratios are widely used as measures of over- and undervaluation of equity. James Tobin introduced q, defined as the ratio of the market value of equity and net debt to tangible capital at replacement cost:

$$q_t = \frac{p_t + b_t}{k_{m,t+1}} \tag{9}$$

In the absence of intangible capital, equation (1) implies that the equilibrium value of $q_t = 1$. Persistent departures from $q_t = 1$[21] are interpreted as an indication of the over- or undervaluation of capital markets. Unfortunately, in an economy with changing tax rates and significant intangible capital the usefulness of q_t is limited. As was shown in the second section, in a setting with corporate taxes, distribution taxes (that is, taxes on dividends and capital gains), and subsidies to investment (for example, investment tax credits), the equilibrium relation specifying the price of corporate equity and capital stocks is:[22]

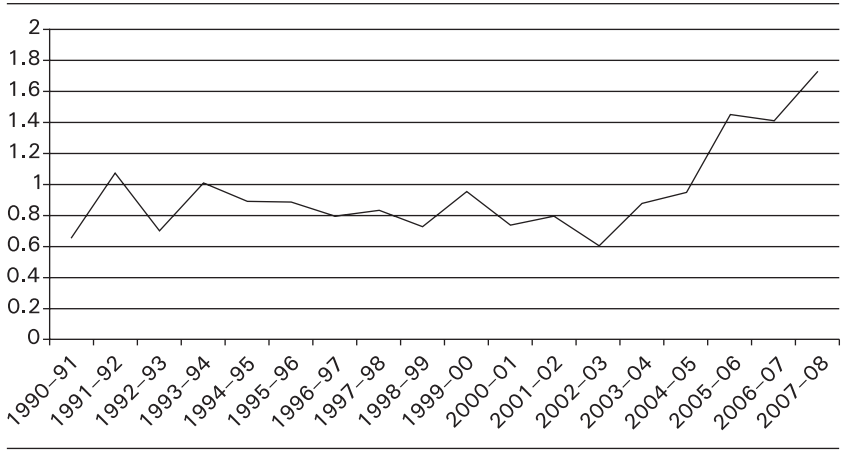
$$p_t = (1 - \tau_d)[(1 - \tau_s)k_{m,t+1} + (1 - \tau_c)k_{u,t+1}] \tag{10}$$

In this general setting if we define $q_t = p_t/k_{m,t+1}$ it is readily seen that not only is its equilibrium value not 1 but that it will change with changes in the tax code. In particular, it will change with changes in the tax rates on corporate distributions (dividends and buybacks) and these rates have varied considerably in India from year to year. Thus q_t may differ from 1 either because of over- or undervaluation in capital markets, or simply as a result of changes in the tax rates; the ratio per se does not distinguish between the two effects. For the time period 1991–2008, q_t is plotted in Figure 7.

21. Sometimes the historical average value of q is used as an ad hoc benchmark instead of $q = 1$. See Smithers and Wright (2000).

22. We remind the reader that in deriving equation (5) we have abstracted from net corporate debt. Empirically this is a small relative to equity.

FIGURE 7. Tobin's q



Source: Total value data is market value of CMIE COSPI firms and Net Corp debt of all non-financial firms. Total assets is for all non-financial firms from CMIE BB.

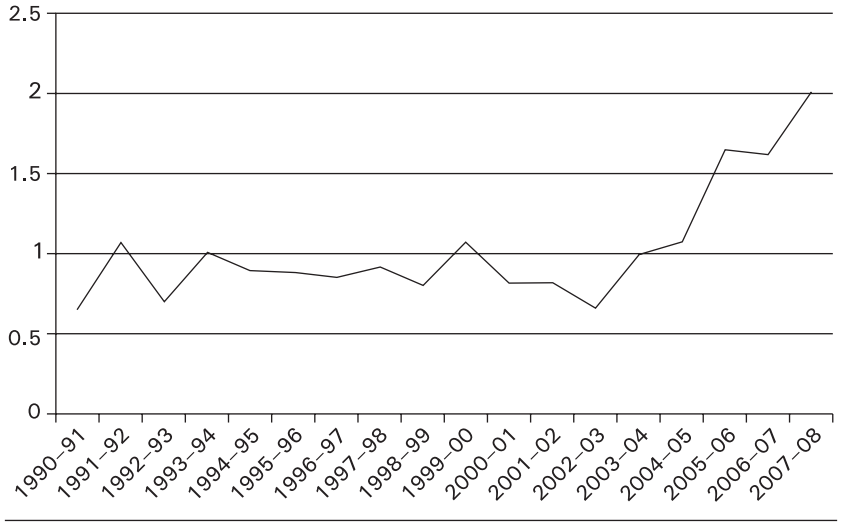
To eliminate the variations in q_t due to changes in distribution taxes one can define a tax adjusted q_t^{τ} as

$$q_t^{\tau} = \frac{p_t}{(1 - \tau_d)k_{m,t+1}}$$

The advantage of this measure is that it abstracts from the high frequency variation in dividend taxation characteristic of India. If corporate tax rates and investment tax rates are relatively stable, then the historical average value of q_t^{τ} provides a benchmark for relative valuation. q_t^{τ} is plotted in Figure 8. In the presence of intangible capital and changing tax rates, it is apparent that changes q_t^{τ} do not necessarily represent periods of over or undervaluation of equity markets.

With these caveats in mind, we examine the behavior of q_t^{τ}. From 1991 to 2004, the value was fairly constant with a mean of 0.88. In the absence of intangible capital, theory predicts that this value should be $(1 - \tau_s)$. Since τ_s was negligible in India over this period, the average estimated value is slightly below the equilibrium value, leading one to conclude that over the period 1991–2004 the Indian equity market was not overvalued. Starting in 2005, q has increased at an average rate of 23 percent per year. Since there was no change in τ_s, one can only conclude that either the amount of intangible capital dramatically increased or that the market was overvalued

FIGURE 8. Tobin's q Adjusted for Distribution Taxes



Source: Total value data is market value of CMIE COSPI firms and Net Corp debt of all non-financial firms. Total assets is for all non-financial firms from CMIE BB.

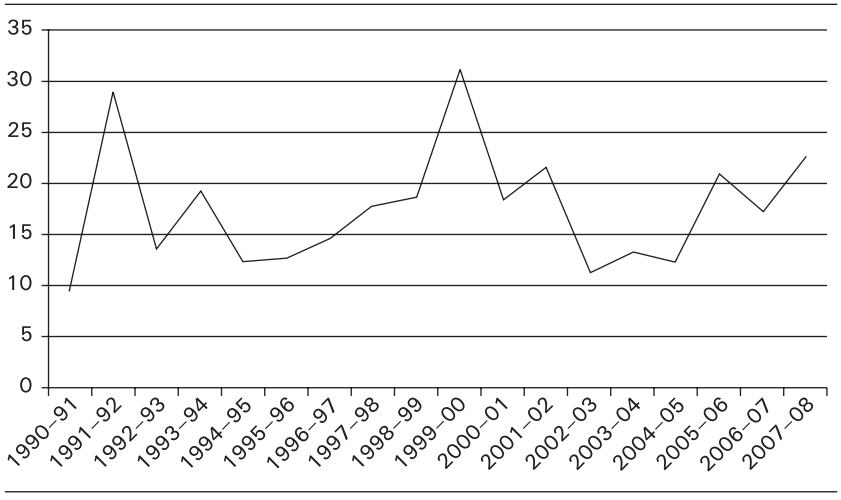
relative to its fundamentals.

A measure closely related to q is the price earnings (P/E) ratio.[23] It is the ratio of the stock price to earnings per share or, at the aggregate level, the value of equity normalized by after-tax corporate profits. It is widely used by financial analysts, and in recent years has been popularized by academics (Campbell and Shiller, 2001; Shiller, 2000). The P/E ratio for the Indian equity markets is plotted in Figure 9.

As expected, the P/E has fluctuated considerably over the period 1991–2008 with a low of 10, a high of 30 and a mean value of 17.6. The mean value of the P/E ratio in India is about that same as the historical average for the S&P 500, which is 18. Many practitioners consider the market overvalued when the actual value exceeds 24 or 27 (corresponding to a 33 percent or 50 percent increase over historical norms). Using this criterion, we conclude that except for a brief period in 1999–2000 the Indian

23. In a deterministic world an equilibrium relation is P/E = q/r, where r is the discount rate. Under uncertainty, variations in r will make P/E more variable than q. The reader is referred to Smithers and Wright (2000) for a detailed comparison of the relative merits of q and the P/E.

FIGURE 9. Price Earnings Ratio



Source: Price data is for the CMIE COSPI set. Earnings data is for all non-financial firms from CMIE BB.

equity market was fairly priced.

In conclusion, we reiterate that *q* and P/E ratios, which implicitly abstract from both tax rates and intangible capital, offer inadequate measures of under- and overvaluation of capital markets. In particular, for economies that exhibit sizable secular growth in intangible capital, as has been observed in India over the last 15–20 years, these metrics offer limited analytical utility.

Concluding Comments

In this paper, we take a critical look at the relationship between the value of capital stock in the Indian corporate sector and the valuation of claims to this capital stock in capital markets. We address the question of whether Indian equity valuations over the period 1991–2008 are consistent with three key market fundamentals: corporate capital stock, after-tax corporate cash flows, and net corporate debt. Our analysis extends the neo-classical growth model to include intangible capital and key features of the tax code and uses national account statistics to estimate the equilibrium value of corporate equity relative to GDP. Our framework can provide policy-makers with a benchmark to identify deviations in equity markets relative to those implied by economic fundamentals. In addition, it facilitates a quantitative assessment of policy changes such as, changes in dividend taxation on stock

prices. We caution the reader that although our framework is well suited to examining secular movements in the value of equity relative to GDP, it is not suitable to address high frequency price movements in the stock market. In fact, we know of no framework that can satisfactorily account for these movements in terms of the underlying fundamentals. High frequency volatility remains a puzzle.

Based on our analysis, we conclude that in a large measure, Indian equity markets were fairly priced over the 1991–2008 period.

APPENDIX

TABLE A-1. Capital Stock of Innovative Property (GDP)

	Depreciation rates (Half-life)			
Year	*10% (6.9 years)*	*20% (3.5 years)*	*30% (2.3 years)*	*CHS (20%) (3.5 years)*
1991	0.00%	0.00%	0.00%	0.00%
1992	0.16%	0.16%	0.16%	0.16%
1993	0.46%	0.45%	0.43%	0.45%
1994	0.86%	0.80%	0.75%	0.80%
1995	1.17%	1.04%	0.94%	1.04%
1996	1.28%	1.09%	0.92%	1.09%
1997	1.43%	1.17%	0.95%	1.17%
1998	1.93%	1.60%	1.35%	1.60%
1999	2.29%	1.86%	1.55%	1.86%
2000	2.45%	1.92%	1.54%	1.92%
2001	2.69%	2.07%	1.64%	2.07%
2002	2.91%	2.20%	1.73%	2.20%
2003	3.32%	2.51%	2.01%	2.51%
2004	3.72%	2.80%	2.24%	2.80%
2005	4.11%	3.09%	2.46%	3.09%
2006	4.44%	3.29%	2.59%	3.29%
2007	4.76%	3.49%	2.74%	3.49%
2008	5.03%	3.65%	2.82%	3.65%

TABLE A-2. Capital Stock of Brand Equity (GDP)

	Depreciation rates (Half-life)			
Year	*10% (6.9 years)*	*20% (3.5 years)*	*30% (2.3 years)*	*CHS (60%) (1.2 years)*
1991	0.00%	0.00%	0.00%	0.00%
1992	1.08%	1.08%	1.08%	1.08%
1993	2.25%	2.15%	2.05%	1.74%

(*Table A-2 continued*)

(*Table A-2 continued*)

	Depreciation rates (Half-life)			
Year	*10% (6.9 years)*	*20% (3.5 years)*	*30% (2.3 years)*	*CHS (60%) (1.2 years)*
1994	3.36%	3.08%	2.81%	2.13%
1995	4.39%	3.87%	3.41%	2.37%
1996	5.30%	4.50%	3.84%	2.51%
1997	5.83%	4.75%	3.90%	2.33%
1998	6.15%	4.80%	3.80%	2.13%
1999	5.99%	4.41%	3.32%	1.63%
2000	6.08%	4.35%	3.22%	1.67%
2001	5.87%	4.02%	2.88%	1.41%
2002	5.76%	3.84%	2.72%	1.37%
2003	5.71%	3.75%	2.66%	1.40%
2004	5.70%	3.70%	2.65%	1.44%
2005	5.75%	3.73%	2.70%	1.51%
2006	5.78%	3.75%	2.73%	1.54%
2007	5.79%	3.74%	2.73%	1.52%
2008	5.83%	3.76%	2.75%	1.54%

Comments and Discussion

Ajay Shah: The Question—A large part of the success of financial economics has been the simple idea that if there are two routes to the same risk, they should have the same price. This is about the *relative* pricing of two assets that have the same risk.

Finance has been much less effective in making *absolute* statements about the value of an asset. As an example, we know relatively little about what the P/E of Nifty "ought" to be. The paper explores two difficult questions:

- Can we make some statements about the valuation of the stock market?
- Can we do this in the context of an optimizing model, grounded in fundamentals?

If this can be done well, it is important in three ways. First, it would give us a framework to think about an important question. Second, it gives us a model to help us think about the world—for example, we could talk about the impact on the market P/E when the taxation of dividends is changed. Third, a methodology which fares well at this daunting problem could potentially have other interesting applications. And of course, along the way, the journey might throw up some interesting surprises and unexpected insights even if the main quest is unsuccessful.

The model employed in the paper is a dynamic general equilibrium model drawing on growth theory. Nothing is random—which comes as a surprise when we think that finance is almost entirely about how human beings behave around randomness. In the RBC tradition, the DGE model is calibrated using Indian NAS and Centre for Monitoring Indian Economy (CMIE) data.

Intangible Capital

The paper emphasizes the problem of intangible capital. This is organizational capital, scientific knowledge, brand value, patents. It argues that intangible capital is of essence in thinking about the problem. I am quite sympathetic

to this idea. As an example, it is easy to buy 10,000 trucks. But it is very difficult to build a trucking company with pan-India operations. The fleet of 10,000 trucks is the hard, physical capital. But the breath of life that convert these into a working company is the incredibly complex combination of information and incentives which overcome principal–agent problems across the perhaps 25,000 workers across the country who would turn it into a trucking company. So I am fully supportive of the idea that intangible capital is of first order importance in thinking about what is a firm.

Once we start thinking about intangible capital, it changes our views on notions of Tobin's *q*. If we see the stock market value a company with physical assets of 10,000 trucks at twice or thrice the accounting value of the trucks, then we should not be surprised. Similarly, the market value of a hospital company with 10,000 beds should be much bigger than the replacement cost—as measured by an accountant—of setting up the hardware of buildings and medical equipment. We could classify this as one of the unexpected insights obtained in the journey.

When I think of the complexity of firms in India, I expect intangible capital to play a big role. The numerical estimates that are in the paper are rather small and came as a surprise to me.

By and large, the model does fairly well at telling us something about the valuation of the equity market. It suggests that there is no first order mispricing in the stock market. It reminds us of the immense importance of tax treatment of capital, and underlines the "modern macro consensus" about the desirability of low taxation of capital.

The paper would have been more interesting if it had first done a Mark 1 model without intangible capital, identified weaknesses in it, then introduced intangible capital, and we would have been able to see how this new feature of the model helped change matters.

Depreciation

A key concern is the choice of a depreciation rate. Should Hulten/Wykoff depreciation rates be used? Or something different? It is, of course, best to do ground-up research on measuring the appropriate depreciation rate for large Indian companies. But in the absence of that, I have two perspectives on why higher depreciation rates are appropriate in India.

The first issue is about the impact of trade liberalization on capital stock. When a country opens up to international trade, a lot of existing physical capital and intangible capital gets destroyed. Companies in India who were producing things like computer hardware simply went bankrupt when India

opened up. A much bigger scale of capital destruction took place in places like the USSR, where the wedge between domestic prices and world prices was even bigger than that found in socialist India. Trade reforms destroy a lot of capital. Another way to say this is that depreciation rates are high when trade barriers are changing more.

This intuition has many interesting implications. As an example, the standard estimation strategies say that Total Factor Productivity (TFP) growth in India was not strong after the early 1990s. But if we think that a lot of *K* got destroyed from 1991 to 2001, then TFP growth was stronger than we think.

The second issue is about repeated obsolescence in a developing country with high rates of growth. At any point in time, the *K*/*L* ratio that an optimizing firm would choose in India would be different from that at the world frontier, given low wages and expensive capital in India. And in a few years, rapid GDP growth would make these technological choices obsolete and necessitate capital destruction. Since we cannot jump to the frontier, we have to build many times and destroy the intermediate stages on our path to the frontier. This argument also suggests that depreciation rates in India should be high.

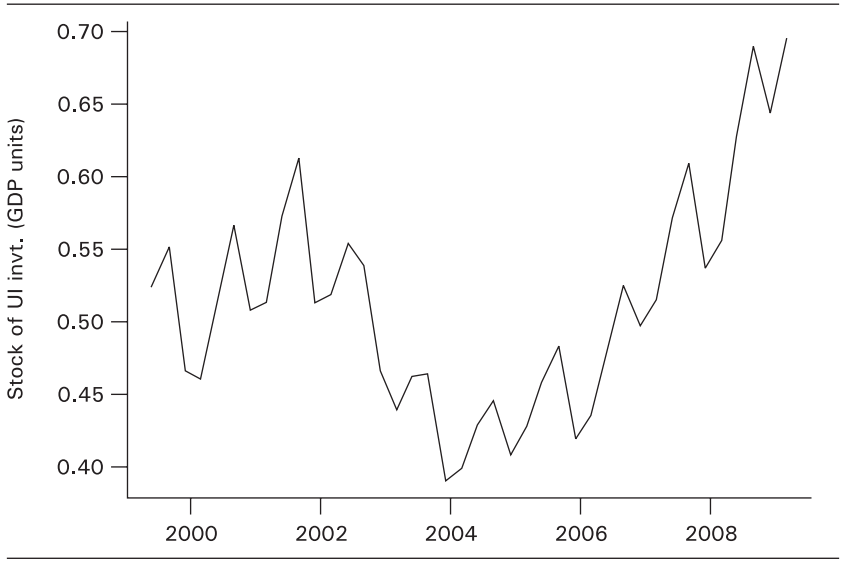
It should be noted that this argument requires a combination of (*a*) a very different ratio of prices of capital to labor and (*b*) high growth rates. In socialist India, the second condition did not obtain, so factories would have worked for a longer period of time without encountering obsolescence.

Interpreting the Post-2002 Events

A key figure in the paper suggests that after March 2002, *q* went up sharply, after adjusting for intangible capital and changes in taxation.

It would be interesting to ask: How does this prediction compare when faced with investment data? The CMIE Capex database is a quarterly inventory of all projects that are at hand. I focus on the projects classified as being "under implementation" by CMIE.

This time-series (in the figure on p. 34) shows that the investment boom came a bit later, after the March 2002 turning point in the time-series of *q*. It is interesting to ask why there is such a disagreement between these two dates. One possibility could be a simple time-to-build explanation: of the time taken in India to carry an investment idea through to the point where it can be classified as "under implementation." This would be a benign explanation, consistent with the story of the paper. There could be others.



Surjit S. Bhalla: Mehra's paper on the Indian stock market is timely, and informative. The question addressed by Mehra is whether the Indian stock market has been fairly valued over the post-reform period 1991–2008. There is a large interest in this question; a question raised by market participants and central bankers (is there a bubble?). For the record, the Indian stock market (at 16,000) is up roughly four times from the average 1996 level and three times from the 2004 level.

The paper is in the best traditions of IPF. It provides a historic and comparative overview of the subject. Using straightforward models, Mehra reaches the controversial conclusion that over the long period 1991–2008, the Indian stock market has been fairly valued. I want to give a few reasons why Mehra's conclusion is likely to be correct.

A lot has happened over the last 20 years. But in the main, the following factors stand out: First, this was an economic reform period, with most of the reforms bunched in the early years, but nevertheless, continuing. Second, the savings rate has doubled to the mid-30s range. Third, the middle class, one of the prime buyers of stocks, has risen from about 8 percent of the population in the early 1990s to above 40 percent today. Fourth, and finally, foreign institutional investors (FIIs) have been a major source of demand.

All these factors suggest that the share of market capitalization as a fraction of GDP should rise, and therefore the rate of growth of stock prices

should outpace per capita income growth; however, overvaluation means an *excessive* rise. What is the evidence that the stock price increase in India has *not* been excessive? Most striking, perhaps, has been the behavior of one of the largest investors in the Indian stock market, the FIIs. During the great meltdown of 2008/09, when the stock market declined to nearly a third of the peak reached in January 2008, the FII holdings in Indian stocks dropped from $300 billion to only $60 billion. This was a decline of $240 billion in assets. The total remittances or sales by FIIs were a paltry $13 billion, or less than 6 percent of total pre-decline assets. The remainder was all valuation loss. In other words, the FIIs clearly did not feel that the decline had to do with overvaluation; if they did, they would have redeemed more.

The middle class and savings rate issue is related, but what it does mean is that there has been a structural increase in the demand for stocks—hence, a structural increase in the fair valuation price level. Mehra presents, in Table 3, an estimate of the increase in the (intangible) capital stock—it has risen from 0.45 percent of GDP (1991–2004) to almost double that level 0.88 (2005–08). Investments in intangible capital stock during the recent 5-year period have been upwards of 3 percent; using this investment data, Mehra finds that the estimate of intangible capital stock is upwards of 3 percent (one estimation method yields an estimate close to 6 percent). As a comparator, in the US, intangible capital stock is a third of GDP, and investment in intangible stock about a tenth.

During 1991–2004, the average value of the Sensex was 3600; during 2005–08, the average level was 12200. The price level (GDP deflator) in the latter period was 55 percent higher. So the simplest back of the envelope calculation suggests that a "fair" Sensex level during the 2005–08 period would be three times higher than the 1991–2004 level: a doubling from the increase in the capital stock, and a 54 percent increase on the doubling because of the increase in the price level. This yields an average Sensex level around 11000—not very far from the observed value of 12220. Given that the estimate of capital stock is likely to be considerably higher than the 0.88 percent Table 3 estimate, it is likely that the Indian stock market is not only not overvalued, it very likely is undervalued, and by a not insignificant amount.

General Discussion

Most of the general discussion focused on the calibration of the model to India's situation. Urjit Patel suggested that it might be useful to separate

the data between companies that are subject to normal corporate taxation and those that operate under the alternative minimum tax. The separation might provide a means of measuring the effect of taxes on corporate valuations. Poonam Gupta suggested a separation by economic sectors, such as manufacturing versus IT.

Kaushik Basu raised questions about the meaning of depreciation for intangibles capital. How can it be measured? It does not seem subject to the same wear and tear as tangible capital. Others emphasized the role of obsolescence as the primary meaning of depreciation in the context of intangibles, but Basu noted that workers often learn to use the intangible capital more efficiently over time, and that learning-by-doing could be interpreted as negative depreciation in the context of constructing a stock of intangibles.

Arvind Virmani also believed that there would be problems with measuring physical capital because the magnitude of the 1991 reforms would induce an initial surge of obsolescence of the existing capital stock. He believed that the reforms had induced a j-curve effect, initially inducing a decline in output that was followed by a growth acceleration.

Abhijit Banerjee raised concerns about the magnitudes of the real interest rate and total factor productivity growth that needed to be assumed to make the model consistent for the observed equity valuations. He did not believe that the rate of TFP growth could be as high as 8.8 percent and noted that a real interest rate of 14 percent was far from the value observed in the market. He thought they suggested problems with applying the model in the Indian context. In particular he pointed to all of the distortions and other constraints that made individuals' internal rates of return far higher than market interest rates. These aspects are not captured in the model. Similarly, Dilip Mookherjee wondered how the model would account for the sharp increases in rates of saving and investment that have occurred in recent years. They are far from the steady-state values and would be difficult to incorporate in the calibration of the model.

Guillermo Calvo pointed out that the cycles in equity markets are often highly correlated across a large number of emerging markets. He wondered how that correlation could be accounted for in models, such as that of the current paper, that are country-specific. He thought it could be useful to conduct some cross-country studies of the correlations on equity markets.

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Why India Choked when Lehman Broke

Introduction

De jure measures of capital account liberalization suggest that India's capital account is quite closed. *De facto* integration has risen sharply in recent years, but India still remains fairly closed. The rapid transmission of the impact of the Lehman bankruptcy into Indian financial markets was consequently unexpected. In this paper, we propose an explanation involving the treasury operations of Indian multinationals (MNCs). These MNCs are less subject to the capital controls imposed on Indian companies.

The developments in Indian financial markets in September and October following the death of Lehman Brothers in New York on September 14, 2008 were quite unprecedented. First, there was the sudden change in conditions in the money market. Call money rates shot up immediately after September 15. Despite swift action by the Reserve Bank of India (RBI), the tightness persisted through the month of October. The operating procedure of monetary policy broke down in unprecedented fashion. Rates were persistently above RBI's policy rate corridor. The call rate consistently breached the ceiling of the repo rate, of 9 percent, and attained values beyond 15 percent. There was a huge amount of borrowing from RBI. On some days, RBI lent an unprecedented Rs 90,000 crores through repos.

These events are surprising given the apparent scale of India's *de jure* capital controls. Our understanding of crisis transmission, the effectiveness of capital controls, and India's *de facto* openness would be enhanced by carefully investigating this episode and identifying explanations.

The main hypothesis of this paper is that many Indian firms (financial and non-financial) had been using the global money market before the crisis, avoiding India's capital controls by locating global money market operations

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in offshore subsidiaries. When the global money market collapsed after the failure of Lehman, these firms were suddenly short of dollar liquidity. They borrowed in the rupee money market, converted rupees to US$, to meet obligations abroad.

This led to pressure on the currency market. The rupee depreciated sharply. RBI attempted to reduce rupee depreciation by selling dollars. It sold $18.6 billion in the foreign exchange market in October alone. Ordinarily, we may have expected depreciation of the exchange rate on both the spot and the forward markets. However, instead of the forward premium going up when there was pressure on the rupee to depreciate, or remaining the same, it crashed sharply. Our hypothesis is that some Indian MNCs, who were taking dollars out of India, planned to bring the money back to India in a few weeks. To lock in the price at which they would bring money back after a month, they sold dollars forward. The one month forward premium fell sharply into negative territory.

Balance of payments (BOP) data shows outbound foreign direct investment (FDI) was the largest element of outflows in the "sudden stop" of capital flows to India of the last quarter of 2008. This supports this hypothesis. This was not a time when there was significant merger and acquisitions activity going on owing to the banking and money market crisis around the world. The explanation for the large FDI outflow when financial market conditions in India and the world were among the worst in many decades could lie in the offshore money market operations of Indian MNCs.

Finally, we analyze stock market data, and find that Indian MNCs were more exposed to conditions in international money markets as compared with non-MNCs.

The contribution of this paper lies in showing that Indian MNCs are now an important channel through which India is financially integrated into the world economy. This raises questions about the effectiveness of India's capital controls which inhibit short-dated borrowing by firms. This restriction appears to be sidestepped to a substantial extent by Indian MNCs. This evidence fits into the larger understanding about the gap between India's highly restrictive *de jure* capital controls but yet substantial *de facto* openness.

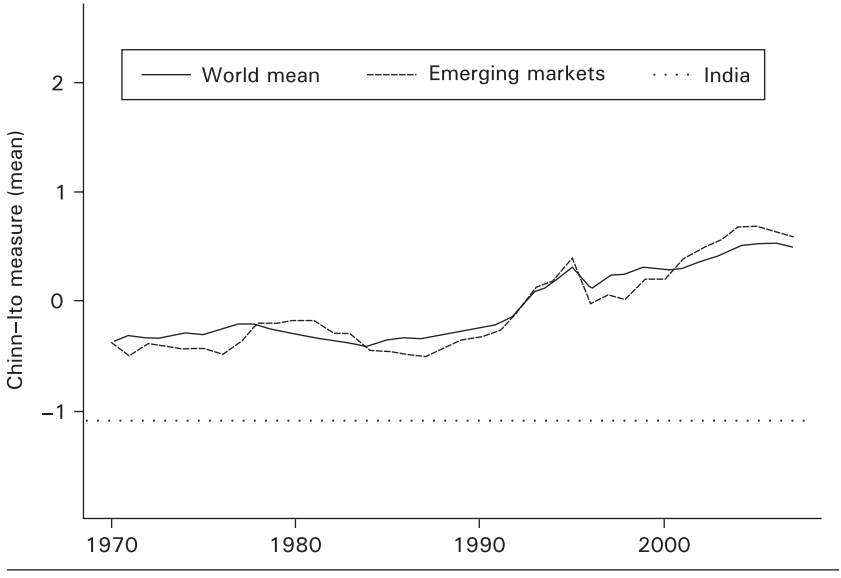
What Happened in India when Lehman Broke

India's Capital Account Liberalization

The extent of capital account integration is usefully examined in terms of the apparent rules in place (*de jure* integration) as opposed to the effective ground reality (*de facto* integration).

One important database with cross-country evidence about *de jure* capital controls has been created by Chinn and Ito (2008). Figure 1 shows the time-series of the Chinn–Ito measure from 1970 till 2007 for India, for the world average and the emerging markets average. The Indian value of the score has been at –1.1 all through, which highlights the limited progress that India has made in terms of removing *de jure* capital controls. The world mean went up from –0.38 in 1970 to 0.495 in 2007. The average for emerging markets went up from –0.375 in 1970 to 0.59 in 2007. Thus, regardless of whether India is compared against the world average or emerging markets, in both 1970 and 2007, its capital account has been significantly more closed, *de jure*.[1]

FIGURE 1. *De Jure* Capital Controls

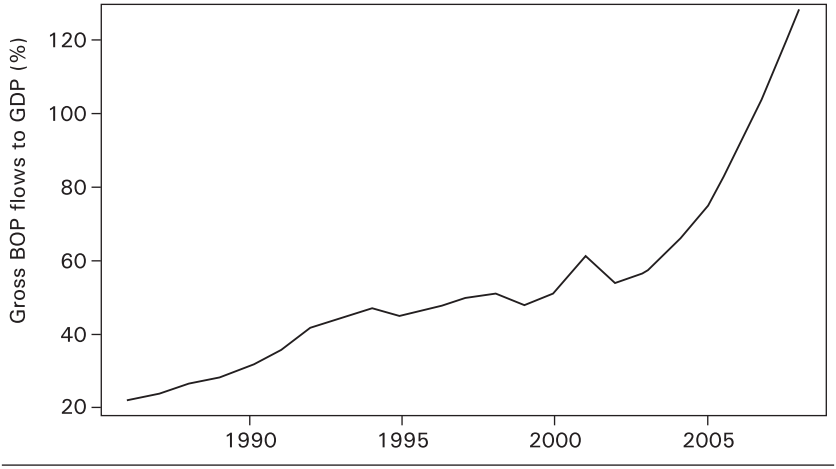


Source: Chinn and Ito (2008).

In terms of *de facto* measures, there are two important approaches to measurement. The first involves a simple examination of the gross flows on the balance of payments, expressed as percent of GDP. This extends the intuition of the trade/GDP ratio. Figure 2 shows that gross flows have risen

1. The measurement of intensity of capital controls is itself a field where standard methodologies have not yet been fully established. Another measurement effort, Edwards (2007), finds that Indian *de jure* capital controls have eased significantly in the recent decade.

FIGURE 2. Gross Flows to GDP



Source: *Business Beacon*, CMIE.

dramatically in recent decades, growing from roughly 20 percent to roughly 125 percent. Of particular interest is the doubling which took place in the period after 2002, which suggests an accelerated pace of capital account integration in these years.

The second strategy for measuring *de facto* integration lies in arriving at estimates of the *stock* of external assets and liabilities, as has been done by Lane and Milesi-Ferretti (2007). Their database shows that India has been rapidly opening up. At the same time, as Prasad (2009) notes, on a cross-country comparison and relative to its size, India appears to have been one of the least financially open economies in the world.

The Events of September 2008

When the global financial crisis erupted, at first it was believed that India would experience little turbulence, given a relatively closed economy and domestic financial system. The events went against these expectations (Aziz et al., 2008). Table 1 juxtaposes three time-series, observed at a daily frequency. The "TED Spread" measures financial distress in London.[2]

2. This is the spread between the three-month US$ LIBOR and the 90 day US treasury bill (UST). This measures the extent to which financial firms mistrust each other. Under normal circumstances, this is near zero.

TABLE 1. Turmoil in the Money Market: From London to India

Date	*TED spread*	*Call money rate*	*RBI repo (Rs crore)*
(Monday) 8 September	1.13	8.83	1,025
09/September	1.19	8.3	3,025
10/September	1.2	8.94	12,985
11/September	1.24	8.88	15,195
12/September	1.36	6.15	14,400
(Monday) 15 September	1.79	9.84	51,815
16/September	2.04	10.59	57,565
17/September	3.03	13.07	59,480

Source: Author's calculations based on data in Datastream and *Business Beacon*, CMIE.

This is compared against two measures of money market tightness in India: the call money interest rate and the quantity borrowed from RBI by the banking system.

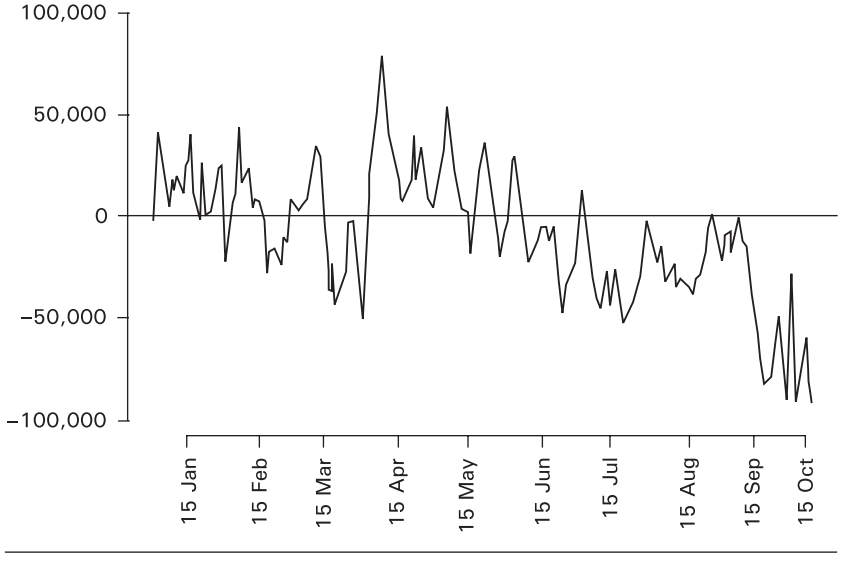
The last pre-crisis day was September 12, 2008, which was a Friday. On this day, the call money rate was 6.15 percent and the banking system had borrowed Rs 14,400 crores from RBI. Over the weekend, Lehman Brothers filed for bankruptcy. On Monday, the money market in Bombay opened in turmoil, even though this opens 5.5 hours before the money market in London. By September 17 (Wednesday), the quantity borrowed by banks from RBI had jumped to Rs 59,400 crores. The call money rate had risen to 13.07 percent.

Some of the Indian money market tightening was caused by the advance tax payment of September 15 and the unfortunate timing of a government-bond auction. However, tightness in liquidity owing to such events typically subsides rapidly. In this episode, money market tightness did not subside rapidly. On October 7, the call rate closed at over 16 percent. In a similar vein, the RBI repo operations surged from Rs 1,025 crores on September 8 to Rs 57,565 crores on September 16 and then to Rs 90,000 crores on September 29.

Figure 3 shows the status of RBI's "liquidity adjustment facility" (LAF) operations. The numerical values seen here are an inadequate depiction of the liquidity squeeze, since access to borrowing from RBI is restricted to a few financial firms and requires certain kinds of collateral. A lot more borrowing would have taken place if the rules would have permitted it. A better picture of liquidity conditions is obtained from observing interest rates.

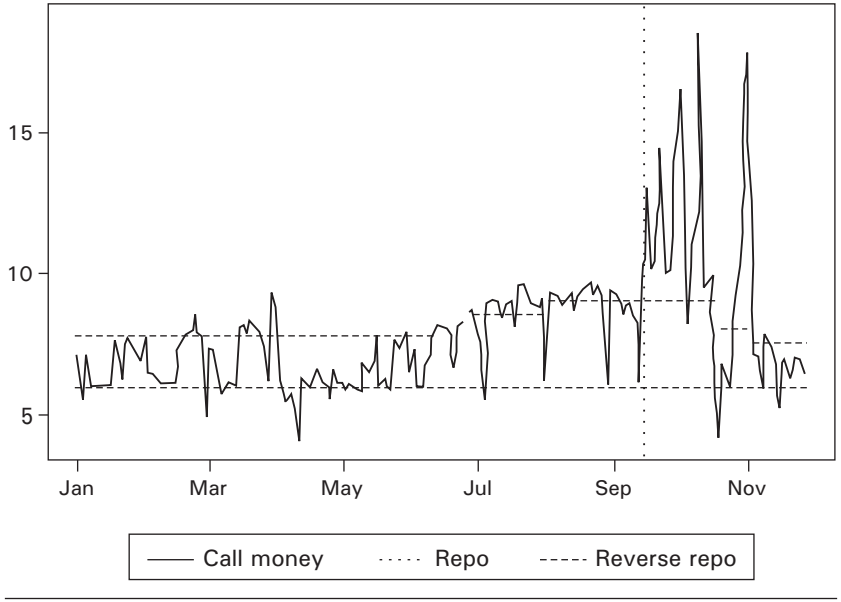
Figure 4 shows the time-series of the call money rate juxtaposed against the "corridor" defined by RBI's repo and reverse repo rates. For a while, the call money rate was closer to the top of the corridor. In the weeks following the Lehman bankruptcy, the call money rate consistently breached the ceiling

FIGURE 3. Outstanding Position of RBI LAF Operations (Rs Crore)



Source: *Business Beacon*, CMIE.

FIGURE 4. The Call Money Rate vs. RBI's "Corridor"



Source: *Business Beacon*, CMIE.

of 9 percent, often attaining values of above 15 percent. The operating procedure of monetary policy broke down in unprecedented fashion.

The Question

Indian capital controls are a maze of rules, restrictions, quantitative controls, and outright bans. For instance, restrictions on external commercial borrowing prevent firms from borrowing short term (less than 3 years) in international money markets or to utilize the money borrowed for uses other than those specified such as capital goods imports and infrastructure. The total borrowing by India has a cap and every firm needs approval from RBI for such borrowing. India is one of the more closed economies in the world in terms of *de jure* controls. On the weekend of September 13/14, 2008, there was a near-universal consensus in India that the turmoil in global markets caused by the failure of Lehman Brothers was not going to affect India. Yet, in the week starting September 15, the Indian money market fell into turmoil. These events merit an exploration.

These events suggest a gap between *de jure* controls and the extent to which they bind. The international evidence suggests that over time, and particularly when given a sophisticated financial system, capital controls lose effectiveness as economic agents learn ways to get around these controls. This motivates the question: What were the aspects of the capital account which enabled substantial *de facto* integration despite the burden of *de jure* controls? In this paper, we argue that the new phenomenon of Indian MNCs is important to understanding these events.

A Proposed Explanation: Offshore Operations of Indian MNCs

Our main argument involves the global treasuries of Indian MNCs.

The domestic operations of all Indian firms—MNCs and others—are subject to the same regime of capital controls concerning offshore borrowing. It is reasonable to expect MNCs to be no more effective at obtaining foreign borrowing, when compared with non-MNCs. However, MNCs are able to borrow in their overseas subsidiaries in a way that domestic firms cannot. In an environment where RBI enforced quantitative restrictions upon overseas access to debt capital for firms operating in India, MNCs could have done borrowing in their offshore subsidiaries.

When the global money market became illiquid on September 13/14, these firms were faced with dollar shortages associated with liabilities which could not be rolled over. It would be efficient for these firms to respond to this situation by borrowing in rupees in India, moving this money abroad, and thus discharging their dollar liabilities.

If this explanation is on track, then it has significant implications for the extent to which India will be able to maintain meaningful capital controls in the face of the rise of Indian MNCs. It is hence interesting to investigate this hypothesis further.

Information from within Indian MNCs which would directly resolve this question is not available. Hence, in this paper, we focus on three predictions that follow from this proposed explanation.

Prediction about the Currency Market

Some of the MNCs taking capital out of the country in the week of September 15 would be anticipating the return of this money into India in the future. They could choose to hedge their currency risk by locking in the INR/US$ exchange rate at which the capital would come back at a future date. The Indian currency derivatives market is fairly illiquid and inefficient; shocks to the order flow influence prices. Hence, if significant capital left the country in meeting short-term money market obligations, and if many firms chose to hedge the return of this capital into India at a future date, then an unusual decline in the INR/US$ forward premium would be observed.

Prediction about Quarterly BOP Data

Late 2008 was a difficult period in the Indian economy and the world economy. Ordinarily, outward FDI flows would be muted in this period. However, if Indian MNCs wanted to take money out of the country in order to meet obligations on the money market abroad, one path which they could use is RBI rules about outbound FDI. Hence, we would expect to see an unusual upsurge in outbound FDI in that quarter.

Prediction about Stock Market Price Fluctuations

Offshore borrowing by Indian firms is constrained by capital controls. If Indian MNCs were evading these controls by borrowing through offshore subsidiaries, then their stock prices should be significantly exposed to fluctuations of the offshore credit spread relevant for emerging market corporations.

The Rise of Indian MNCs

In recent years, there has been an upsurge of outward FDI from India (Demirbas et al., 2009; Pradhan, 2004). Hundreds of large Indian firms are now MNCs, and the most outwardly oriented of these increasingly have over 50 percent of their assets outside the country.

The literature on capital account openess or cross-border flows has focussed on portfolio, debt or FDI flows rather than on the internal flows and treasury operations of MNCs. However, there is a literature on how MNCs organise themselves, which suggests that MNCs make decisions about utilizing financial markets in different countries based on costs of financing. As an example, Desai et al. (2004) examine the ways in which firms use internal capital markets opportunistically to complement external financing opportunities when external finance is costly and when there are tax arbitrage opportunities.

In a world where MNCs run global treasuries, maximize the tax efficiency of their operations, and source capital at the cheapest price across multiple locations, it is reasonable to think that MNCs would also optimally exploit opportunities for engaging in cross-border finance, based on a sophisticated understanding of a given set of capital controls.

Another dimension is the explicit evasion of capital controls. MNCs engage in substantial intra-firm trade. These transactions can be used for transfer pricing, so as to recognize profits at low-tax locations, and to move capital across the world in ways that are not permitted by capital controls. There is thus a link between the rise of MNCs and the long-understood issues of misinvoicing as a mechanism for obtaining *de facto* capital account openness (Patnaik et al., 2009; Patnaik and Vasudevan, 2000).

Data Description

We draw firm level data from the CMIE Prowess database, using data for firms in the CMIE COSPI index, which is a set of 2,500 companies with high stock market liquidity and good disclosure. This includes both financial and non-financial firms. Of these, the 2,162 companies which had full data availability for 2007–08 were included in the dataset for our analysis.

A firm is defined as a multinational if it holds more than 1 percent of total assets outside India. This emphasizes the abrupt transition which takes place when a firm becomes an MNC. When a firm is not an MNC, it is fully subject to RBI's capital controls. Once a firm establishes overseas

operations, a new set of techniques for doing corporate finance become available. This transition is about becoming an MNC, and not about the magnitude of foreign assets.

Symmetrically, we also define a firm as an exporting firm if it derives more than 1 percent of sales from exports. Table 2 shows the breakdown of firms based on their exporting status and their MNC status. Of the 2,162 firms in the database, there are 332 MNCs, of which 288 are exporters and 44 are not.

We use the terminology "D" for firms which only produce for domestic customers, "DX" for firms that export, "DXI" for firms that export and have FDI outside India, and "DI" for firms which are multinationals but do not export. Table 3 shows summary statistics about the four groups for the

TABLE 2. Exporters and MNCs in the CMIE Cospi Firms

	Not MNC	*MNC*	*Sum*
Not exporter	827	44	871
Exporter	1,003	288	1,291
Sum	1,830	332	2,162

Source: Author's calculations based on data in *Prowess*, CMIE.

TABLE 3. Summary Statistics about Four Kinds of Firms

Variable	*Units*	*D*	*DI*	*DX*	*DXI*	*All*
Age	Years	21	19.5	23	21	22
IQR		15	45.5	21	13	18
Total assets	Rs crore	131.48	577.78	226.82	615.2	214.07
IQR		490.51	1,765.42	501.7	1,678.96	631.35
Sales	Rs crore	92.25	257.94	202.76	352.59	174.55
IQR		354.88	1,517.58	472.51	1,075.8	523.26
Employees	Number	131.16	509.72	382.71	912.5	296
IQR		516.69	3,384.52	1,058.28	2,318.45	1,060
Market capitalization	Rs crore	68.18	686.83	98.93	551.8	111.79
IQR		368.27	3,889.4	387.28	2,128.44	591.54
Turnover ratio	Percent	80.8	97.88	77.27	92.77	80.51
IQR		139.07	127.05	111.26	151.65	126.31
Exports/Sales	Percent	0	0	15.18	40.17	3.53
IQR		0	0.15	33.36	69.88	25.18
OFDI/Assets	Percent	0	3.19	0	8.34	0
IQR		0	7	0	17.26	0.01
Size	Log Rs crore	4.8	5.95	5.41	6.22	5.34
IQR		2.67	2.65	1.88	2.31	2.3
Leverage	Times	2.1	2.2	2.48	1.91	2.26
IQR		1.99	2.48	1.71	1.32	1.78
Number of observations	Number	827	44	1,003	288	2,162

Source: Author's calculations based on data in *Prowess*, CMIE.

accounting year 2007–08. For each group of firms, for each variable of interest, the median and the inter-quartile range (IQR) is shown. Here, we define "size" as log([sales + assets]/2).

Table 3 shows sharp differences between the firm characteristics of these four groups. In particular, multinationals who are also exporters (the DXI group) have a median value for total assets and number of employees which is almost three times larger than that computed for the full dataset. They have a median value for market capitalization that is more than four times bigger than that seen for the full dataset. They are also much more export oriented with an export/sales ratio of 40.17 percent—when compared even with exporting firms which are not multinationals who have an export/sales ratio of just 15.18 percent. In terms of financing, multinationals have somewhat *less* leverage when compared with others.

Table 4 shows the industry distribution of the MNCs. The biggest single industry is information technology. At the same time, some multinationals are found in all the top-level industries. While financial firms are represented in this data, only 14 of the 332 multinationals are financial firms.

TABLE 4. Industry Distribution of the Multinationals

Industry	*Number of firms*
Chemicals	69
Diversified	2
Electricity	2
Food	14
Machinery	26
Metals	16
Mining	3
Miscellaneous manufacturing	4
Non-metallic minerals	18
Textiles	13
Transport equipment	16
Services (Construction)	7
Services (Finance)	14
Services (IT)	96
Services (Other)	32
Total	332

Source: Author's calculations based on data in *Prowess*, CMIE.

In this paper, we suggest that the microeconomic phenomenon of some firms becoming multinationals helps us understand a macroeconomic phenomenon—the crisis on the money market and the collapse of the operating procedures of monetary policy in India after Lehman Brothers failed. For this claim to be tenable, the size of multinationals (in the aggregate) has to be large enough to matter to macroeconomics.

In order to assess these issues, Table 5 sums up financial data for the 332 multinationals in our dataset, and compares them against the total for the full dataset of 2,162 firms. While the MNCs only account for 15.36 percent of the firms by number, they make up between 22 and 38 percent of the dataset when viewed through certain variables of interest. The sales of these 332 MNCs works out to 11.7 percent of GDP, and their total assets works out to 35.2 percent of GDP.

TABLE 5. How Big are the Multinationals?

Variable	*Units*	*Not MNC*	*MNC*	*All*	*Share of MNCs (Percent)*
Sales	Rs crore	2,112,181	586,082	2,698,263	21.72
Total assets	Rs crore	4,948,705	1,760,003	6,708,709	26.23
Market capitalization	Rs crore	3,408,303	1,517,651	4,925,955	30.81
Exports	Rs crore	264,906	159,761	424,668	37.62
Number of observations	Number	1,830	332	2,162	15.36

Source: Author's calculations based on data in *Prowess*, CMIE.

If, hypothetically, these 332 MNCs were financing 5 percent of their balance sheet through the money market in London, this translates to a sum of Rs 88,000 crore, which is of the same order of magnitude as the sudden increase in borrowing from RBI's lending window depicted in Figure 3.

This suggests that this set of 332 multinationals is large enough to matter to macroeconomics. To the extent that our dataset is incomplete, that is, to the extent that some MNCs exist which are not captured in our dataset, the influence of MNCs upon macroeconomic outcomes would be correspondingly larger.

Evidence from the Foreign Exchange Market

A sudden stop of capital flows or an outflow from the capital account would put downward pressure on the exchange rate. Evidence of this is seen partly in the depreciation of the rupee, and partly in the sudden and large sale of dollars by RBI. The normal reaction to a sudden jump in the exchange market pressure on the rupee would have been a rise in the forward premium as people would expect further depreciation. Even if the premium did not rise, it would remain the same. In fact, the reverse happened.

Under ordinary circumstances, currency forward pricing is done through covered interest parity (CIP). As a consequence, in most situations, the

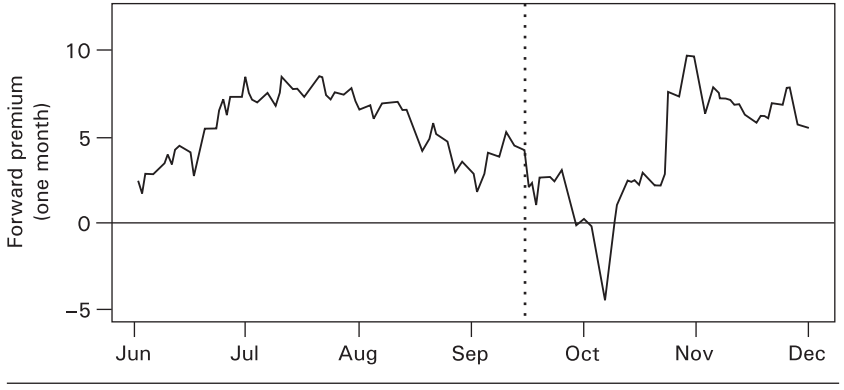
forward price is uninformative since it merely reflects CIP arbitrage. India is a rare situation in that CIP arbitrage is blocked by RBI (Shah and Patnaik, 2007). As a consequence, the price of the forward is disconnected from the spot exchange rate. Therefore, fluctuations of the order flow influence the forward price. This makes the forward price uniquely informative.

If MNCs were taking money out of the country in order to address a short-term exigency, they are likely to want to bring this money back at a future date. Some of them could choose to hedge this conversion of dollars to rupees at a future date by selling dollars forward. In particular, the rules for banks require that these short-term movements of capital be fully hedged.

Hence, the period where capital was leaving the country in response to the money market crisis worldwide would be a period where dollars were being sold forward. As a consequence, the forward premium would drop.

Figure 5 shows the time-series of the one-month rupee-dollar forward premium. The selling pressure on the forward market in the days after September 15 yielded an unprecedented crash in the forward premium. When the forward premium is negative, it means that a dollar at a future date is traded at a lower price than the spot price, which is an unusual configuration.

FIGURE 5. The One-Month Forward Premium



Source: *Business Beacon*, CMIE.

In the period from September 29 to October 8, negative forward premia were repeatedly seen on the one-month, three-month, and six-month forward markets. The most extreme value seen was a premium of –4.5 percent for the one-month forward premium on October 7. These events are consistent with our arguments about the global treasuries of Indian MNCs as the mechanism

through which money market difficulties in London were transferred to India. If the problem on the domestic money market was merely one of a withdrawal of foreign capital, these dramatic changes in forward premia would not have taken place.

Evidence from the Balance of Payments

The balance of payment data, shown in Table 6, also provides important insights into what was happening in this period.[3] In this period, India experienced a sudden stop in capital inflows, with net capital flows going from an inflow of $33.155 billion in the July/August/September 2007 quarter to an outflow of $3.7 billion in the October/November/December 2008 quarter.

TABLE 6. What Happened in the Sudden Stop?

	Million US$ per quarter					
	09/07	*12/07*	*03/08*	*06/08*	*09/08*	*12/08*
Loans	9,305	10,942	12,527	4,228	3,561	1,733
Banking capital	6,643	207	5,826	2,696	2,131	–4,956
Investment	13,027	16,892	4,760	4,778	4,254	–5,000
FDI in India	4,709	7,873	14,197	11,891	8,782	6,684
FDI by India	–2,581	–5,832	–5,701	–2,902	–3,218	–5,864
Portfolio investment	10,917	14,751	–3,764	–4,178	–1,301	–5,787
Others	4,180	2,976	2,916	–579	–2,094	4,540
Net capital inflows	33,155	31,017	26,029	11,123	7,852	–3,683

Source: *Business Beacon*, CMIE.

A striking fact in the balance of payment data for October–December 2008 is not that foreign capital flowed out, as it did from many emerging economies. The dominant story of the outflow in this quarter is capital being taken out by Indian companies. Capital leaving India through banks ("banking capital") and through non-bank corporations ("FDI by India") added up to $10.8 billion which was bigger than the overall net capital outflow of $3.7 billion. In comparison, the net capital outflow through portfolio investors was only $5.78 billion.

Indian banks with overseas operations were under stress much like banks worldwide were facing stress when the global money market was

3. The phrase "sudden stop" was brought to prominence by Calvo (1998).

disrupted. Collateral requirements for outstanding CDS positions went up. When Indian non-financial firms faced shortages of dollar liquidity in the money market outside India, they often turned to Indian banks who lent them dollars outside India.

Turning to "FDI by India," in the pre-crisis period, many large Indian firms were in the process of turning themselves into MNCs. This required sending capital out of the country for the purpose of acquiring companies, setting up global distribution systems, etc. This process was critically linked to (*a*) optimism about the outlook for the world economy and (*b*) benign conditions for access to equity and debt capital. In the quarter of October/November/December 2007, $5.8 billion left the country in this fashion.

After December 2007, optimism about the world economy and financing conditions both turned relatively somber. Outbound FDI flows declined to $2.9 billion in the quarter of April/May/June 2008. Ordinarily, one might expect that from July to December 2008, conditions *worsened* in terms of optimism on the outlook for the world economy and in terms of access to equity or debt financing. However, FDI by India *rose* to $3.2 billion in the July/August/September 2008 quarter and further to $5.9 billion in the October/November/December 2008 quarter. We would conjecture that these large values were not about Indian companies buying assets or building a business overseas. They were perhaps about Indian companies transferring capital to overseas subsidiaries, which had been using the global money market, and were now short of dollar liquidity.

Apart from the official flows through the permitted mechanism of FDI by Indian companies, there is a possibility of Indian firms transferring capital out of the country through transfer pricing with their own subsidiaries. Prior research has shown that India has substantial capital flows in both directions through trade misinvoicing. However, it is not possible to identify these flows in the crisis period of late 2008 using the available data.

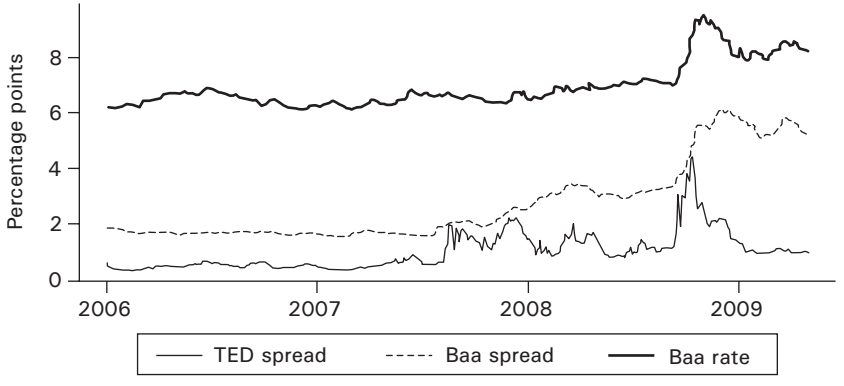
Evidence from the Stock Market

In the period of crisis, did the firms with treasury operations abroad do worse than those without? It would be useful to examine how the stock market sees the share price of Indian MNCs. If a firm got into trouble in its global money market operations, its share price would do badly.

The most important measure of financing conditions for Indian firms outside the country is the Moody's Baa spread. This is the spread between the Moody's Baa bond and the 10-year US government bond. This measures

the credit risk of bonds that are roughly comparable to those issued by the best Indian firms. Figure 6 juxtaposes recent values of the TED spread, which measures the credit risk of large global financial firms, with the cost of borrowing for Baa firms and the Baa spread. The relevent question is: did the share prices of Indian MNCs get adversely affected with a change in the Baa spread?

FIGURE 6. The Moody's Baa Spread



Source: Author's calculations based on data from Datastream.

Empirical Strategy

The simplest empirical strategy would involve examining how the stock prices of MNCs fluctuated in relation to the changing values of the Moody's Baa spread. There are three difficulties with this approach:

1. Individual stock prices contain substantial idiosyncratic risk. The signal (of the extent to which Indian MNCs are influenced by the Moody's Baa spread) would be weak when compared with the noise (of idiosyncratic stock price fluctuations).[4]

4. There is a small literature that argues that in many emerging markets, a substantial proportion of stock price volatility is explained by the overall market index. However, in the Indian case, the market model of the CMIE Cospi companies ranges from a median value of 0.273 in the top decile by size to 0.023 in the bottom decile (Table 4.14 of Shah et al. [2008]). The extent of idiosyncratic risk in India is hence broadly comparable with that seen in Organization for Economic Cooperation and Development (OECD) countries.

2. It could be argued that MNCs are firms with significant international exposure. When business cycle conditions in the world economy worsen, stock prices of Indian MNCs would do badly. Since the Moody's Baa spread is correlated with global business cycle conditions, there would be a bias in favor of finding that the Moody's Baa spread is linked to the stock price fluctuations of Indian MNCs.
3. It could be argued that MNCs tend to be large firms with more leverage. As a consequence, they are more exposed to credit market conditions. Indian firms do borrow abroad, though constrained by quantitative restrictions. All large leveraged Indian firms are likely to have some borrowing abroad, and would be adversely affected when the Moody's Baa spread rises. Interpreting this as a consequence of outbound FDI would be incorrect.

To address these problems, we resort to analysis of a special portfolio constructed through a matching procedure. We make two lists of firms: one of Indian MNCs, and another of exporting firms who are not MNCs. Each MNC is matched to a partner firm with similar size and leverage. We then form a portfolio which holds long positions in the MNCs along with holding short positions in their exporting partners. The performance of the portfolio shows the ways in which MNCs are different from companies in India which have not embarked on outbound FDI. This empirical strategy addresses the three problems described above:

1. *Idiosyncratic risk*: Idiosyncratic risk would be diversified away since the analysis only involves the returns on portfolios.
2. *Exposure to the world economy*: MNCs and exporting firms would both be exposed to the world economy. Hence, mere business cycle considerations would affect both the exporters portfolio and the MNC portfolio.
3. *MNCs tend to be large leveraged firms*: The matching procedure identifies exporting non-MNC firms which have similar size and leverage when compared with the MNCs. Credit market conditions onshore and offshore would influence both portfolios equally, since both kinds of firms operate under the identical capital controls onshore.

Matching Procedure

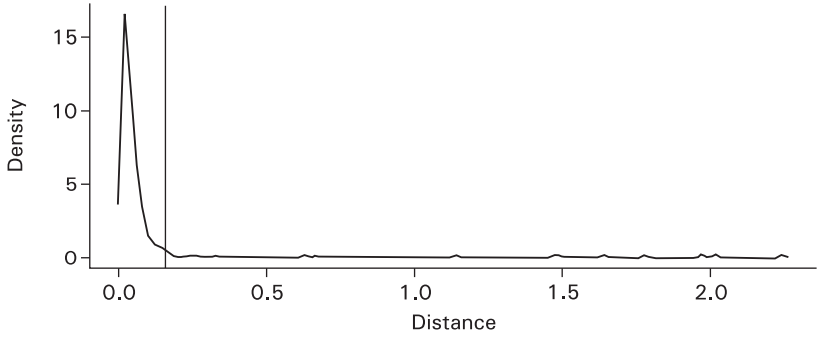
For the matching procedure, size is defined as the log([sales + assets]/2). Variables are standardized, but in the interest of robustness, the sample median is used instead of the sample mean and the inter-quartile range is used instead of the sample standard deviation.

Each firm i is a point $z_i = (z_{1i}, z_{2i})$, where z_{1i} is the standardized size and z_{2i} is the standardized leverage. Let E be the set of exporting, non-MNC firms. For each MNC i, the matching procedure involves finding the firm i^* such that:

$$i^* = \arg\min_{j \in E} \| z_i - z_j \|$$

We define $Q_i = \| z_i - z_{i*} \|$. In order to improve the quality of matching, the worst 5 percent of firms in terms of the values of were deleted from the dataset. This corresponds to deleting the 17 firms with poor matching, leaving a dataset of 315 MNCs and their matched partners. This corresponded to deletion of firms where $Q_i > 0.16$. Figure 7 shows the kernel density plot of the match quality seen across all the firms. The 25th and 75th percentile of Q_i prove to be 0.02 and 0.06, which suggests that for most firms, excellent matches were obtained. After deletion of the 5 percent of firms with poor matching, the 25th and 75th percentile of Q_i works out to 0.021 and 0.056.

FIGURE 7. Distribution of Quality of Match



Source: Authors' calculations.

Some examples of matching are shown in Table 7. The firms in the left column are MNCs; they are matched against non-MNC exporting firms in the right column. As an example, Infosys is matched against Sterlite.

TABLE 7. Examples of Matching Procedure

	Standardized			*Standardized*		
Firm	*Size*	*Leverage*	*Best match*	*Size*	*Leverage*	*Distance*
Info-drive Software	3.24	1.16	Intellvisions Software	3.21	1.16	0.0122
Infosys	9.71	1.28	Sterlite	9.68	1.41	0.0752
Infotech Enterprises	6.38	1.19	Mahindra L. Devp.	6.37	1.16	0.0171
IPCA Labs	7.1	2.1	Kalyani Steels	7.06	2.2	0.0541
J B Chemicals	6.49	1.61	Jagatjit Industries	6.56	1.56	0.0402

Source: *Prowess*, CMIE.

Infosys has a standardized size of 9.71, while Sterlite is at 9.68. Infosys has a standardized leverage of 1.28 and Sterlite is at 1.41. Thus, Sterlite is a company with size and leverage much like Infosys. In this case, Q_i works out to 0.0752. In the table, the numerical values seen for distance are small, which is consistent with the distribution of seen in Figure 7.

Table 8 shows a broad array of summary statistics about the 315 MNCs where matching was successful, and the partner firms identified.

TABLE 8. Summary Statistics about MNCs and Matched Partners

Variable	*Units*	*MNC*	*Partner*
Age	Years	21	25
IQR		14	29
Total assets	Rs crore	581.82	458.45
IQR		1,415.24	1,272.55
Sales	Rs crore	328.69	437.92
IQR		1,004.61	1,022.98
Employees	Number	790.33	726
IQR		2,296.71	1,862.82
Market capitalization	Rs crore	536.11	352.63
IQR		1,850.24	1,272.48
Turnover ratio	Percent	92.77	71.35
IQR		151.44	106.73
Exports/Sales	Percent	31.36	11.59
IQR		68.73	28.8
OFDI/Assets	Percent	7.71	0
IQR		15.17	0
Size	Log Rs crore	6.15	6.12
IQR		2.17	2.2
Leverage	Times	1.91	1.95
IQR		1.29	1.27
Number of observations	Number	315	315

Source: Authors' calculations based on *Prowess*, CMIE.

Some rows merely constitute validation of the matching procedure. Partners were required to be exporting firms with no outbound FDI (OFDI).

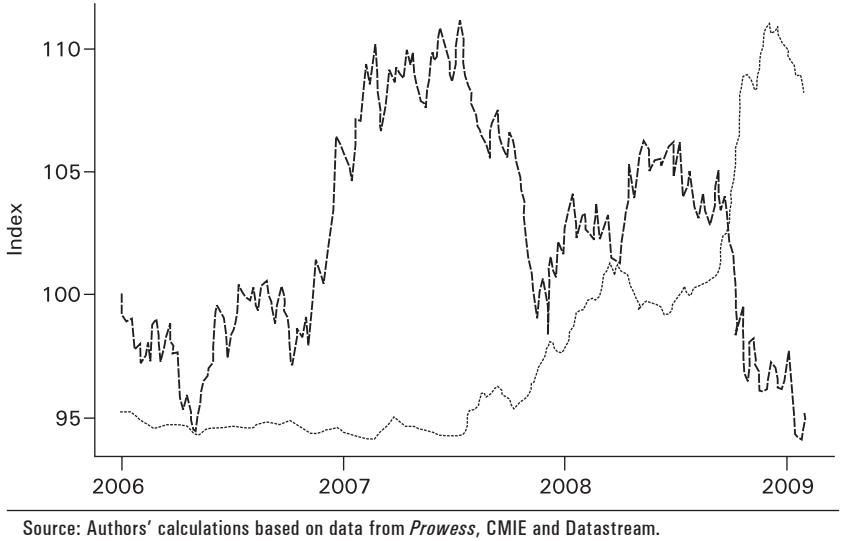
Hence, the OFDI/Assets ratio for partners is 0. Partners were chosen to match the size and leverage of MNCs. Hence, the median size of the partners, at 6.12, is similar to the median size of MNCs, at 6.15. Similarly, the median leverage of the partners, at 1.95 times, is similar to the median leverage of the MCNs, at 1.91 times.

In other respects, the partners inevitably differ from the MNCs. There is surprising correspondence in some respects (for example, number of employees) but not in others (for example, sales or turnover ratio). A key fact, which influences the estimation strategy of the paper, concerns the export/sales ratio: this averages to 31.36 percent for MNCs but only 11.59 percent for the non-MNC exporters.

Alternative Explanations, and Estimation Strategy

In this fashion, we compute the returns on this portfolio, which is long MNCs and short a matched portfolio of exporters who are not MNCs. Figure 8 shows the time-series of the value of this portfolio, which is indexed to start

FIGURE 8. Long MNC + Short Exporter Portfolio, against the Moody's Baa Spread



Source: Authors' calculations based on data from *Prowess*, CMIE and Datastream.

from 100. The time-series of the Moody's Baa spread, is also shown on this graph. Both these series are in levels in the graph. The notation $H_t^{I/DX}$ denotes the daily *returns* of the hedged portfolio which is long MNCs and short non-MNC exporters.

An alternative explanation that limits the interpretation of these results concerns exposure to global business cycle conditions. While the portfolio that has been formed is long MNCs and short non-MNC exporters, both of which should have a trade exposure to the world economy, MNCs are more exposed to international trade.[5] The 315 MNCs where good matches were found have an average value for the exports/sales ratio of 31.36 percent. On average, the exporting non-MNC partner had an export/sales ratio of 11.59 percent. Hence, the impact of the Moody's Baa spread upon the hedged portfolio could merely reflect the bigger trade exposure of MNCs.

In order to address this concern, we construct a daily time-series which represents the Indian stock market implications of international trade exposure. We break the non-MNC exporting firms into two groups: the firms with an above-median exports/sales ratio and the firms with a below-median export/sales ratio. The same matching procedure is used to match all above-median exporting firms with a below-median exporting firm while mimicking the size and leverage. This gives us the returns series on another hedged portfolio: long high exports + short low exports. We interpret the returns series on this portfolio as reflecting pure trade exposure to the world economy, mapped into the Indian stock market returns. We use the notation $H_t^{Xhi/Xlo}$ for the daily returns of the hedged portfolio which is long high-export non-MNCs and short low-export non-MNCs.

The natural estimation strategy is a regression explaining *returns* on these long/short portfolios using *changes* in the Moody's Baa spread. This is done using a daily time-series that runs from the start of the crisis (June 2007) till end-January 2009, which has 414 observations. To recapitulate, notation $H_t^{I/DX}$ is the daily returns of the hedged portfolio which is long MNCs and short non-MNC exporters; $H_t^{Xhi/Xlo}$ is the daily returns of the hedged portfolio

5. The exports/sales ratio is observed for all firms, so in principle, matching could be done to find firms with similar size, leverage, and the exports/sales ratio. The difficulty with this path is that for MNCs, sales outside India are tantamount to serving foreign customers by other means and induce trade exposure to global economic conditions. A fuller definition of sales to foreign customers (whether through exports or through outbound FDI) is not measured in the CMIE database.

which is long high-export non-MNCs and short low-export non-MNCs; S_t is the level of the Moody's Baa spread on date t. The simplest model[6] is:

$$H_t^{I/DX} = a_0 + a_2(1-L)S_t + e_{1t} \quad (1)$$

This model suffers from the problem that MNCs have a greater trade exposure to the world economy than non-MNC exporters. As a consequence, part of what is seen in $\hat{a}_2$ is just the greater trade exposure of MNCs; $\hat{a}_2$ cannot be interpreted as being only about offshore borrowing by MNCs. This motivates:

$$H_t^{I/DX} = a_0 + a_1 H_t^{Xhi/Xlo} + a_2(1-L)S_t + e_{2t} \quad (2)$$

The coefficient a_1 would pickup the extent to which $H_t^{I/DX}$ does well when global trade conditions improve. If it is the case that MNCs have greater trade exposure to the world economy when compared with non-MNC exporters with similar size and leverage, then we will observe $\hat{a}_1 > 0$.

A concern about these models lies in the extent to which shocks to $(1 - L)S_t$ influence Indian stock prices immediately. If there are weaknesses in information processing by the stock market, this information processing could take many days. To address this, we estimate models of the form:

$$H_t^{I/DX} = a_0 + a_1 H_t^{Xhi/Xlo} + \sum_{j=0}^{10} b_j(1-L)S_{t-j} + e_{3t} \quad (3)$$

where lagged values of $(1 - L)S_t$ are allowed to influence $H^{I/DX}$ at time t.

6. When estimating models explaining stock market returns on a portfolio, the overall stock market index is often useful as an explanatory variable, to reflect overall market fluctuations. That is inappropriate here for two reasons. First, the hedged portfolio is long MNCs and short non-MNC exporters. Both groups of firms have similar leverage and are spread across all kinds of industries. Hence, the overall exposure of to the stock market index should be zero.

Further, the typical market-capitalization weighted stock market index attaches considerable importance to MNCs, who tend to be big companies with a bigger weightage in the index. For example, a disproportionate number of the big components of the Nifty index are likely to be multinationals. Hence, the typical market-capitalization weighted stock market index is likely to be contaminated with exposure to the very MNCness that we are trying to identify.

Results

These results are shown in Table 9. Model 1, corresponding to equation (1), explains returns on the hedged portfolio (long MNC + short non-MNC exporters) using first differences of the Moody's Baa spread. This proves to be statistically significant at a 95 percent level, and economically significant with a coefficient of –1.5. In other words, a 100 bps rise in the Moody's Baa spread induces a negative stock market return for Indian MNCs of –1.5 percent. The time profile of information disclosure here involves data emanating from the US about the Baa spread in the Indian night, which is impounded into Indian stock prices in the day.

TABLE 9. Does the Moody's Baa Spread Matter in Explaining Stock Market Returns of Indian MNCs?

	M1	*M2*	*M1 with lags*	*M2 with lags*
(Intercept)	–0.02	–0.02	–0.01	–0.01
	(0.02)	(0.02)	(0.02)	(0.02)
$H_t^{Xhi/Xlo}$		0.15*		0.15*
		(0.06)		(0.06)
dBaa.spread	–1.50*	–1.47*	–1.32*	–1.31*
	(0.43)	(0.43)	(0.46)	(0.46)
dBaa.spread lag 1			0.22	0.29
			(0.45)	(0.45)
dBaa.spread lag 2			0.62	0.65
			(0.45)	(0.45)
dBaa.spread lag 3			–0.11	–0.13
			(0.46)	(0.45)
dBaa.spread lag 4			–0.15	–0.11
			(0.45)	(0.45)
dBaa.spread lag 5			–0.60	–0.63
			(0.47)	(0.47)
dBaa.spread lag 6			0.18	0.11
			(0.46)	(0.46)
dBaa.spread lag 7			–0.32	–0.22
			(0.46)	(0.45)
dBaa.spread lag 8			–0.38	–0.48
			(0.45)	(0.45)
dBaa.spread lag 9			–0.17	–0.14
			(0.48)	(0.48)
dBaa.spread lag 10			–0.62	–0.52
			(0.46)	(0.46)
N	413	413	403	403
R-squared	0.03	0.04	0.05	0.06
Adj. R-squared	0.03	0.04	0.02	0.03

Source: Author's estimation and results from the research.

Notes: Standard errors in parentheses.

* indicates significance at $p < 0.05$.

Model M2 reflects equation 2, augmenting Model M1 with an additional explanatory variable. This measures the Indian stock market impact of trade exposure to the world economy. This coefficient is statistically significant and has a value of 0.15. On average, when $H_t^{Xhi/Xlo}$ is +1 percent, the portfolio $H_t^{I/DX}$ gains 0.15 percent. This suggests that in the hedged portfolio $H_t^{I/DX}$, the MNCs have more trade exposure to the world economy than their matched partners with similar size and leverage. At the same time, after controlling for this, the Moody's Baa spread coefficient is essentially unchanged at –1.47. This shows that our main result is robust to the problem of MNCs having greater trade exposure than non-MNCs.

Two additional specifications are shown, which utilize lagged values of the Moody's Baa spread. These investigate the idea that the Indian stock market is not fast enough in understanding these things, that the process of domestic price discovery is not able to understand the implications of last night's value of the Moody's Baa spread for the valuation of hundreds of Indian MNCs. This conjecture is not substantiated. Ten days of lagged values are not significant, the adjusted actually declines, and the basic results stand. This suggests that stock market speculators are quite aware of the implications of fluctuations of credit conditions in the US for valuation of Indian MNCs.

The interpretation of these results is as follows. All firms—MNCs or otherwise—face the same capital controls that inhibit foreign borrowing and prohibit short-dated foreign borrowing. It is reasonable to think that MNCs and non-MNCs of similar size and leverage would have the identical incentives to engage in foreign borrowing (within the constraints of the capital controls). In both cases, capital controls that blocked short-dated borrowing should have implied that turmoil on the money market in London was not so important to Indian firms who were supposed to not have money market operations. Yet, we find that Indian MNCs had a credit exposure to the Moody's Baa spread over and beyond what non-MNC exporters with a similar size and leverage had. This suggests that there is something about MNCness which induces a bigger exposure to the Moody's Baa spread.

Conclusion

De jure capital controls have not made India as closed to global financial markets as expected. The expectation that a global financial market crisis would not hit India owing to these controls proved to be incorrect when the financial crisis was transmitted to India with unprecedented speed.

In this paper we have explored one element of India's capital account which answers some of the puzzles about the speed of transmission and behavior of domestic financial markets. With a large presence outside India, Indian MNCs appear to have escaped the capital controls that are imposed on Indian companies. As a result, they are exposed to the global money market. Since they are the large firms, who are significant players in the Indian economy, their operations on money markets, foreign exchange markets, and India's balance of payments are large and important. This dimension of India's integration with global capital markets gives a new insight into India's *de facto* capital account convertibility.

Comments and Discussion

Eswar Prasad: This paper by Patnaik and Shah is a very useful contribution to the debate on capital controls, a debate that has become especially topical in the aftermath of the global financial crisis. As the panic resulting from the crisis has subsided, there has been a pullback of international investors from the safe haven of the dollar and money is once again flowing toward the major emerging markets, which have to deal with the mixed blessings of such inflows. While many of these economies can certainly use foreign capital, surges in inflows bring with them the pain associated with exchange rate appreciation, which hurts export competitiveness, and the risks of asset market bubbles. In response, economies such as Brazil and Taiwan have already imposed taxes on certain types of inflows, China has tightened up its controls on inflows and many other emerging markets including India are considering the imposition of various types of controls.

This is of course a sharp turnaround from the period around the height of the crisis when international investors were pulling capital out of emerging markets and rushing to the safe shores of the US Treasury bond market. At that time, emerging markets were concerned about the deleterious effects of sudden stops or reversals of capital flows. And some of these countries were contemplating controls on outflows.

While the effects of surges in inflows or sudden stops are quite different, the instinctive reaction of policy-makers to use capital controls to deal with the volatility of capital flows is one common thread between these two types of episodes. And this is where the study by Patnaik and Shah sheds some light on an important element of the debate on capital controls.

A key question is whether capital controls are in fact effective in managing capital flows. As noted by authors such as Kose et al. (2009), there is a widening chasm between *de jure* capital account openness and *de facto* financial openness. Rising trade flows provide a conduit for disguising capital flows through misinvoicing of trade transactions. Increasingly sophisticated financial players can easily circumvent capital controls by disguising flows among their subsidiaries or branches in different countries. Even when capital controls are effective, evidence shows that this effectiveness is ephemeral as investors and other market participants quickly find ways to evade controls if the incentives for such evasion are strong enough.

Patnaik and Shah provide a case study of the effects of the collapse of Lehman Brothers on Indian money markets. Their contribution is to trace out, using a variety of different pieces of evidence, how Indian MNCs reacted to the worldwide dollar shortage in September 2009 and use the evidence they muster to make the broader point that multinationals are now making a major contribution to increasing the *de facto* openness of India's capital account, irrespective of the *de jure* controls in place.

Suggestions

This is a competent study that pulls together different strands of evidence to tell a plausible story about how Indian MNCs are able to effectively move capital across borders. While the data are limited and it is difficult to construct persuasive counterfactuals to some of the authors' propositions, they are quite creative about using the available data to tease out some of the implications of their hypotheses. My main suggestions are to increase the value of the paper by increasing its descriptive content, which would provide a better context for understanding its results and thereby make it more self-contained.

The authors use a number of benchmarks in evaluating the effects of the collapse of Lehman on Indian money markets. One of their points is that India experienced a fair amount of turbulence in its money markets despite the expectation that, given its relatively closed economy and financial system, it would not be vulnerable. However, this was a truly global shock that reverberated around the world and virtually every significant financial market, whether in an advanced or developing economy, experienced turmoil around that period. It would have been useful to explore in some detail whether India experienced a larger effect than other countries with similar levels of *de jure* capital account openness.

The authors interpret the evolution of the one-month premium on the rupee-dollar forward market as evidence that Indian MNCs anticipated that their need for capital to meet dollar obligations abroad would be a temporary exigency. It is not obvious if and why only Indian MNCs saw this as a temporary problem and that they anticipated bringing capital back to India once the crisis passed. Some additional evidence to bolster this assertion would be useful.

Given the importance of disentangling the *de jure* controls on Indian MNCs versus what they were actually able to accomplish through their

cross-border operations, the paper would have benefited from a more detailed description of controls that these corporations are subject to, in terms of both inflows and outflows, and how these controls have evolved in terms of both legal tightness and enforcement intensity over time. Some other details that would be useful include how important the MNCs are in terms of Indian markets, along with their shares in exports, capital flows, and other indicators. Such indicators would provide better context for the interesting points made by the authors.

Implications

The bottom line is that the paper makes an interesting contribution to the debate on capital controls by providing an excellent case study of the experience of the Indian money markets around the time of extreme global financial stress induced by the events surrounding the fall of Lehman Brothers.

The implication of the study and others in its genre is that rising global integration of trade, finance, and supply chains are making *de jure* capitals increasingly ineffectual as a policy tool. These results do not necessarily imply that these countries should throw up their hands and open up their capital accounts at one shot. Rather, it suggests that emerging markets should move forward on strengthening their financial systems and macroeconomic policy frameworks to better cope with volatile inflows rather than relying on the crutch of capital controls. They could also consider opportunistically opening up their capital accounts in a measured manner in order to deal with some of the pressures of inflows or outflows, as the case may be (see Prasad and Rajan, 2008). There are no easy answers to the question of what emerging markets should do to deal with the vagaries of fickle international capital flows. The research program that this study is part of, at least shows that a knee-jerk resort to capital controls is probably not the right answer.

Abhijit V. Banerjee: The thesis of this very nice paper is that Indian MNCs might be using the ability to export long-term capital to undertake short-term movements of capital. This has the important implication that by permitting Indian MNCs to invest abroad, the Reserve Bank of India's ability to keep the market for short-term capital closed.

The evidence they present starts with the observation that Indian money market rates spiked when Lehman closed even though Indian money markets are supposed to be closed. This was followed by large capital outflow after

the Lehman episode, ostensibly in the form of FDI, even though this was hardly the most upbeat time for the world economy and in general there were not a lot of new businesses created. Moreover while the rupee tanked, futures rates predicted recovery, suggesting future inflows had been planned. Finally Indian MNCs lost value relative to non-MNC firms that had a similar export profile when the relevant US money market rate spiked.

This is an interesting story engagingly told; it marshals data carefully and uses a clever indirect strategy to get around the lack of direct evidence. My comments are in two parts:

- Do these facts necessarily mean that the Indian firms were borrowing short-term abroad?
- Do they have to mean that capital markets are *de facto* open?

Starting with alternative interpretations, I think the fact that Indian short rates spiked is certainly not surprising in itself. After all there was a massive increase in perceived risk in the global economy and many Indian firms were exposed to it, and not just through credit relations. There were exporting firms that were worried whether they will be paid for their last shipment by the foreign buyers and importing firms that felt that they may be required to pay cash right away for their current purchase rather being able to get some trade credit, because their suppliers are cash strapped. This, in turn must have affected the banking sector's confidence in its own liquidity—what happens if the exporters started to delay payments because they had no cash? All of this would inevitably raise short rates.

In addition there was some concern that a number of the banks had invested in global toxic assets and may now be required by the regulator to scale down lending to meet the prudential rules. In general, it seems clear that both banks and firms were trying to judge their own vulnerability, and the option value of cash was going up and the supply of even secured money was upward sloping—this why the RBI bands get breached.

What would be the alternative explanations for the capital outflows? Suppose, for example, my firm's global profits were supposed to repay my foreign currency long-term bonds that were maturing in December 2008. Or just pay wages in my foreign subsidiary. Suddenly demand crashes. Profits vanish. Bond markets freeze-up. Stock markets tank. What am I supposed to do? It makes sense that I would export capital to replace the profits that I no longer have. It would also interesting finding out if there was any real FDI—was there some fire sale FDI? Clearly more information about debt structure of the major MNCs would help here, as will as a sense of their non-debt liabilities (how much was wages as fraction of profits, etc.).

How about what happened to the futures premium? The sudden rise of the dollar against all currencies was mysterious given the billowing deficit in the US (it was described as a flight to "quality," bizarrely enough). Many expected a turn around, which eventually happened. So may be people were simply speculating against an irrational movement in the dollar. It may be worth checking whether this same pattern also shows up in other countries that were much more open (from the capital market point of view) or in only in countries that allow FDI but not short-term capital movements.

Finally what about the relatively fall in MNC value? The authors discuss the possibility that export market exposure may have differed for MNCs versus other firms and try to deal with it. My sense is that the biggest exposure for many of these MNCs was foreign currency risk given that they were holding long-term foreign currency debt, their foreign holdings were having teething problems and the rupee was tanking. There was even speculation about Tata's having to restructure the debt used to acquire Jaguar. There needs to controls for the ratio of export earnings to the part of long-term debt that was maturing to really nail this and given the non-linear nature of debt, we probably should introduce this control non-linearly.

Turning to the second question that they try to answer: what does all this say about the RBI's regulation? Clearly there are limits to how well the RBI controls the margin between short- and long-term capital movements. But a part of that is less a statement about the cupidity of Indian firms or the competence of the RBI than a recognition of the essential incompleteness of concepts like long-term capital. How is the RBI supposed to know whether a particular investment is long term or short term: For example, if you pay wages for the workers who are setting up your plant, is that short term or long term? Presumably the RBI uses some information about what the specific projects are combined with some guess-work to regulate these flows. This will never be perfect, even if everyone tries their best and there is no malfeasance.

However it is worth emphasizing that the RBI was not just using the regulation margin. It was also making the monetary supply curves steeper—this is why the call market rate went outside the promised band. I don't want to argue that this is the best way to regulate—it may well be less than optimal in many ways—but there is also no evidence that the combination of these instruments did not effectively protect the markets from something worse. More generally, I am not convinced that the RBI has lost control over capital markets, though it may be possible to improve upon their particular model of regulation.

General Discussion

Shankar Acharya commented that the explanations provided by the authors regarding the spike in call rates, and other economic occurrences in India after the fall of Lehman were actually somewhat different from those being discussed in policy circles at the time of the actual crisis. While he did allow for the fact that some of those previous explanations may have been incorrect, he felt that there were four or five of them that needed to be taken into account by the paper, to at least justify if they actually mattered.

The first factor that he described was that of the sharp squeeze in trade credit from both foreign bankers, distressed by the events at Lehman, and (to a lesser extent) Indian banks. The second factor revolves around the sharp and almost sudden outflow of FII money in the wake of Lehman's collapse (September 15). The third relates to the stress present on the liability side amongst the foreign branches of many Indian firms in New York, London, etc. These branches contributed to the additional demand for short-term money in the Indian market, as they turned to their headquarter banks for money as a result of the aforementioned stress they faced. Lastly, Acharya talked about the role played by Indian MNCs involved in foreign acquisitions. These firms eventually took bridging loans, often from foreign lenders, which helped transmit the shock in Western markets to the Indian market.

Surjit S. Bhalla disagreed with the second factor presented by Acharya. In his opinion, FII outflow could not have played a role in the events discussed by the paper, due to its relatively stable value between September and December 2008.

On a different note, Bhalla agreed with the authors' use of the matching method (in their analysis), claiming that it probably told the story of the events that affected Indian MNCs better than any other procedure. He was though somewhat uncertain as to why there had been a lack of emphasis, in the paper, on the regulatory framework being run by the RBI. Elucidating on this framework, he offered an alternative explanation of the events that took place in the Indian MNCs after the collapse of Lehman. Taking advantage of the high interest rates placed on foreign borrowings, Indian MNCs brought money from abroad hoping to gain benefits through the expected appreciation of the rupee. This process seemed to be working, especially after March 2007 when the RBI relaxed some of its controls on the exchange rate, leading to an appreciation of the currency. However, the aftermath of Lehman's collapse provided a different scenario, one in which the currency depreciation exceeded, to a great extent, any difference in

interest rates. This provoked MNCs to take their capital out of the country, which created the post-Lehman mess. While this was his own explanation, Bhalla stressed that it was one that was consistent with the majority of the authors' work.

On a related note, Dilip Mookherjee claimed that Bhalla's argument was only a slight variation to the one proposed by the authors. He also brought up the idea of capital convertibility, and how the cost of capital for Indian companies is different from foreign companies and MNCs. In regards to this, he queried whether there exists an appropriate measure of the extent of capital convertibility.

There were also some questions regarding the more technical aspects of the study. In her comments, Anusha Chari chose to discuss aspects regarding the forward premium and its components, specifically the effects on the forward rate due to the limitations in the CIP arbitrage. She suggested that the paper tackle the possibility that the CIP crash might have been caused by downward pressure in the spot market, or by interest rate differentials. Rajnish Mehra suggested that it would have been interesting to differentiate the MNCs with American Depository Receipts (ADRs) outside India from those without ADRs, and see whether a loss in value in both types of firms was because they were in the same model.

Suman Bery felt that there were three clarifications that needed to be made by the authors; firstly the main focus of the paper, was it a paper on capital controls or a paper on multinationals in India? Settling on one of these topics, he felt, would lend greater weight to the arguments put forward by the paper. Second, and echoing Shankar Acharya, why was the role played by banks in creating the post-Lehman economic climate in India not mentioned? Lastly, were the authors more interested in (*a*) capital inflows, (*b*) capital outflows, (*c*) the porous nature of the total inflows, or (*d*) leakages on the outflow side? Apart from these three queries, Bery also thought it would be interesting for the authors to explore how the capital controls of the RBI worked in non-crisis scenarios, or in essence whether there was some kind of policy story to be told.

In his response to the questions put forward, Ajay Shah first addressed the points raised by Shankar Acharya, specifically the four factors mentioned by the latter in connection with the post-Lehman effect on India. Regarding the first of these, Shah agreed that the trade credit squeeze could well have caused money market tightness, however he felt that it was not the paper's intention to quantify the sources of such tightness in Indian markets. Shah did not buy the FII argument, as he believed that FII going out of the country had no impact on the money market per se. Shah responded to the last two

points by highlighting the fact that Indian banks with operations and assets abroad were part of the dataset, as they are considered to be multinationals. In fact, Shah went on to state that the last two factors were, in essence, the focus of the paper.

In response to the point raised by Anusha Chari on the CIP arbitrage, Shah stated that further details on that subject's components would be provided in the revised form of the paper, which would include improved graphs and perhaps one on CPI deviation. On the suggestion of using ADRs given by Rajnish Mehra, Shah contended that the dataset would be too small, as there exist only eleven Indian MNCs with ADRs.

Regarding the questions raised by Suman Bery, Shah described the policy story of the paper to be one whose basis lies in the fact that the Indian MNCs reacted very differently after the fall of Lehman from what many people expected. The crisis showed these companies to be fairly open—and more tellingly, open to foreign shock, and not closed as believed by many (including the authors) due to the presence of capital controls. Shah explained that in terms of policy, this new openness of the MNCs has to be taken into account in any future fiscal, financial or monetary policy conducted in the country.

The discussion culminated with a brief comment by the Chair, Guillermo Calvo, who suggested to the authors that a comparison of India's current situation in terms of capital controls with that of Latin America's would perhaps be of interest, due to the presence there, once upon a time, of similar capital regimes. He took the example of Chile, and explained how controls were once levied on capital inflow, only to be suddenly dispensed with after a certain point. At that point the government in Chile took it upon itself to learn the ways in which companies had bypassed the previous capital controls (akin to the Indian MNCs of today). If such a scenario presented itself to India, then the Reserve Bank would do well to follow such a procedure.

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Climate Change and India: Implications and Policy Options

> Action on Climate Change must enhance, not diminish the prospects for development. It must not sharpen the division of the world between an affluent North and an impoverished South, and justify this with a green label. What we require is a collaborative spirit which acknowledges the pervasive threat of Climate Change to humanity and seeks to find answers that enhance, not diminish the prospects of development, particularly of developing countries. All members of our common global family should have equal entitlement to the fruits of prosperity.
>
> —Government of India, 2009

Introduction

Despite recent rapid growth, India remains an extremely poor country. Its per capita income in current dollars at $1,016 in 2008 is less than one-third that of China, itself a country with substantial pockets of poverty. Based on the National Sample Survey of 2004–05, 300 million Indians live in abject poverty. In the same vein, going by 2001 Census, nearly 400 million Indians are without an electricity connection. If India is to provide a humane existence to all its citizens, it must sustain its current rapid growth for some decades to come.

Perhaps the greatest challenge to India's ambition to stamp out poverty and give its citizens a decent living standard comes from international pressures to accept targets for mitigation of greenhouse gas (GHG) emissions in the near future, say, beginning 2020. Based on the data for 2006, the latest year for which detailed reliable data are available, China's total carbon emissions from fossil fuels are 4.7 times those of India. Even making the generous assumption that China could cut its current emissions by 25 percent by

* The author thanks Barry Bosworth for helpful suggestions on an earlier draft that led to substantive changes in this version.

adopting more efficient technologies without sacrificing any income, its total emissions would remain 3.5 times those of India. The inevitable implication is that barring major breakthroughs in green technologies, India cannot reach even the current Chinese total income without a significant increase in its carbon emissions.[1] Any restrictions on carbon dioxide (CO_2) and other GHG emissions beginning in the near future would greatly undermine India's poverty alleviation objective. It is this context that makes India's policy choices with respect to GHG mitigation a far more daunting task than that of the rich countries.

In this paper, I offer a detailed analysis of India's options on GHG emissions in the context of the mitigation efforts being made by various countries individually at the national level and jointly at the international level. At the outset, this analysis must recognize at least four major complications.

First, accepting that global warming is real and that GHG emissions have contributed to it, policy analysis must take into account uncertainty at three different levels:[2] (*i*) precise future response of temperatures and rainfall to GHG emissions; (*ii*) precise quantitative effect of rising temperatures ("global warming") on glacier melting, sea levels, and extreme events such as heat waves, drought, floods, and cyclones; and (*iii*) quantitative response of agricultural productivity, GDP (gross domestic product) growth, health, volume, and pattern of migration and poverty to GHG emissions directly as well as through global warming and the changes in rainfall, glacier melting, sea levels, and extreme events. Each analyst must form some expectation with respect to these relationships before he can make a recommendation with respect to regulatory policy toward GHG emissions, that is, mitigation.

The second complication arises from the fact that the benefits of GHG emissions in the form of extra output and growth accrue to emitting countries while the costs in terms of global warming and more frequent and severe extreme events fall on the entire world. Therefore, on its own, a country will underestimate the cost-benefit ratio associated with emissions and undertake too little mitigation relative to what is globally optimal. Optimal mitigation requires cooperation by all major emitters.

1. I hasten to add that by the time India reaches the current Chinese total income, its population will cross that of the latter. Therefore, achieving the current Chinese total income will still not grant India the current Chinese per capita income.

2. As discussed in the second section, there still remain disagreements within the scientific community regarding whether there exists a warming trend in the temperatures. As such, in principle, we could add yet one more uncertainty to the list of uncertainties in the text: that regarding the existence of a global-warming trend.

Third, given that the GHGs stay in the atmosphere for up to 100 years, whereas the benefits of GHG emissions largely accrue to the generation responsible for them, costs fall disproportionately on the future generations. Because individuals value present consumption more than future consumption, with the present value of a consumption basket declining the farther into the future it becomes available, agreement on a policy that curbs present consumption in favor of larger future consumption is difficult. This problem is exacerbated by the uncertainties associated with the effects of GHG emissions: whereas the output gains from GHG emissions are here and known, the precise form and timing of costs are uncertain.

The final complication arises from the fact that while GHG emissions have been concentrated heavily in the developed countries, according to most analysts their costs will fall disproportionately on the developing countries. Approximately 71 percent of the carbon emissions from 1850 to 2000 were accounted for by the United States, EU, Russia, Japan, and Canada alone. Although China has recently emerged as the largest carbon emitter, according to 2006 emission data, Canada, US, Europe, Eurasia, and Japan together account for more than 50 percent of the current emissions. When it comes to the regions most likely to be subject to the adverse effects, South Asia and Africa end up at the top of most experts' lists. This geographical patter of winners and losers naturally generates tension along the traditional North–South fault line.

Against this background, the present paper asks how India should approach its policies toward adaptation and mitigation, where the former refers to improved capability to protect against and respond to extreme natural events that occur and the latter to efforts aimed at capping the increases in the frequency and severity of the events themselves. For a poor country like India, mitigation imposes two sets of costs by undermining sustained rapid growth. First, it compromises poverty alleviation and the ability to provide basic amenities such as electricity and water to the citizenry. Second, it also undermines the ability to adapt against extreme events that will visit the country even if emissions were eliminated altogether worldwide. Sustained rapid growth gives the citizens access to shelter that better protects them against heat, cold, rain, and floods. It also speeds up transportation and communication thereby enhancing the ability of the citizens to rapidly evacuate in case of natural disasters. Furthermore, sustained rapid growth places more resources into the hands of the government enabling it to move the population from coastal regions or build dikes in response to rising sea levels and to develop water resources to combat droughts. In deciding upon mitigation policy, India must weigh these costs against the expected

benefits of capping the escalation in the frequency and severity of extreme events in the light of mitigation efforts by other countries.

I begin in the second section with a broad discussion of some of the uncertainties mentioned earlier. In the third section, I discuss the changes in temperatures and rain patterns in India during the last century, as well as their impact if any on sea levels, glacier melting, and the natural disasters such as drought, and cyclones. The fourth section details the predictions of temperature and rainfall changes in the 21st century India and how they might impact the frequency and severity of drought, floods, and cyclones on the one hand and agriculture, health, migration patterns, and poverty on the other. The fifth section constructs a simple analytic model to derive optimal levels of mitigation worldwide and in individual countries and the associated instruments to implement the solution. In the sixth section, I turn to the distributional issue: who should pay for the costs of mitigation? The seventh section discusses mitigation in practice at both national and international levels. In the last substantive section, the eighth section, I finally come to a frontal discussion of India's options going forward. The ninth section concludes the paper.

The Uncertainties

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2007a), the warming of the climate system in the second half of the 20th century is unequivocal and this change is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Although the available *statistical tests* of a rising trend in temperatures between 1979 and 1993 contradict this proposition, policymakers around the world now generally accept it.[3] Accepting the existence of

3. Santer et al. (2000) test whether the linear trend in the deep-layer temperature data from 1979 to 1993 is significantly different from zero. They conclude, "Using this [preferred] test, we find that none of the individual 1979–93 trends in deep-layer temperatures is significantly different from zero. This result holds for virtually all datasets and atmospheric regions that we consider. In all datasets, individual (cooling) trends in lower-stratospheric temperatures become significant if volcanic effects are first removed from the time series." There also exist a controversy within the scientific community around differences in warming trends of earth's surface temperatures as recorded by thermometers and the lower troposphere temperatures as monitored by satellites. The trend rate in the former dataset shows greater warming than the latter. While the IPCC (2007a) has argued that the differences can be reconciled around the surface temperature readings, Klotzbach et al. (2009) conclude that the IPCC reported temperature trends carry an upward bias of 30 percent.

global warming and GHG emissions as its principal cause, there still remain significant uncertainties with respect to the precise nature of temperature increases as also what thy imply for rains, floods, droughts, and storms.

At the broadest level, there inevitably remains uncertainty with respect to the magnitude of the change in the mean temperature that would accompany different levels of GHG emissions during the course of the 21st century. Predictions based on the experience to-date are uncertain because the response of temperature changes to GHG emissions, which has itself been highly variable over time, may not repeat itself in the future.[4] Even ignoring this problem, the temperature change is going to vary across regions, over different parts of the year and during different parts of any given day. The annual mean temperature is a highly aggregative measure consistent with a variety of distributions. A given increase in the mean temperature in any given year in any specific location may result from a uniform increase in the temperature at all points in time in the year, increase in the number of hot days, decrease in the number of cold days, increase in the temperature during the summer or during the winter, increase in the maximum or minimum temperature, and so on.[5]

Greater uncertainties are associated with the consequences of global warming for other natural phenomena. Rainfall may increase or decrease on average with differential impact across seasons and across regions. A rise in mean rainfall may represent an increased intensity of rains, increased frequency, expanded rainy season or the emergence of new rainy days outside the rainy season. One further uncertainty relates to the presence of factors other than GHG emissions contributing to warming.[6] If such factors are present and significant, changes in them may reinforce or counteract the effects of GHG emissions.

4. For example, even though GHG emissions have accumulated steadily during the past century, surface air temperatures have risen in two phases: 1910 to 1945 and 1976 to-date. The period from 1945 to 1975 exhibited no trend change in the average annual temperatures around the globe.

5. Surprisingly, in the case of India, we encounter disagreement on even the *actual* change in the average temperature. While the Intergovernmental Panel on Climate Change (IPCC, 2007c) states that the average temperature in India has been increasing at the rate of 0.68°C per century, the World Bank (2009a: 162) states, "There have been no significant increases in temperatures observed over the country."

6. IPCC leaves the door open to this possibility when it states in its Fourth Assessment, "Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations." [Italics in the original.] In principle, natural phenomena such as El Niño and La Niña can explain some of the short-term shifts in temperatures and extreme weather events.

Scientific evidence on the link between global warming and extreme events such as hurricanes is far less definitive. In Pielke et al. (2005: 1574), an interdisciplinary team of researchers surveyed the peer-reviewed literature on the relationships between global warming and the frequency and severity of hurricanes. They concluded thus,

> To summarize, claims of linkages between global warming and hurricane impacts are premature for three reasons. First, no connection has been established between greenhouse gas emissions and the observed behavior of hurricanes (Houghton et al., 2001; Walsh, 2004). Emanuel (2005) is suggestive of such a connection, but is by no means definitive. Second, the peer-reviewed literature reflects that a scientific consensus exists that any future changes in hurricane intensities will likely be small in the context of observed variability (Knutson and Tuleya, 2004; Henderson-Sellers et al., 1998), while the scientific problem of tropical cyclogenesis is so far from being solved that little can be said about possible changes in frequency. And third, under the assumptions of the IPCC, expected future damages to society of its projected changes in the behavior of hurricanes are dwarfed by the influence of its own projections of growing wealth and population (Pielke et al., 2000). While future research or experience may yet overturn these conclusions, the state of the peer-reviewed knowledge today is such that there are good reasons to expect that any conclusive connection between global warming and hurricanes or their impacts will not be made in the near term.

China's top climatologist has also expressed reservations on the predictions of calamities. In a recent story in the *Guardian*, Jonathan Watt (2009) writes, "A 2°C rise in global temperatures will not necessarily result in the calamity predicted by the IPCC, China's most senior climatologist has told the Guardian." Watt goes on to add, "Despite growing evidence that storms in China are getting fiercer, droughts longer, and typhoons more deadly, Xiao Ziniu, the director general of the Beijing Climate Center, said it was too early to determine the level of risk posed by global warming."

Policy analysis is further complicated by the fact that virtually all predictions of large changes attributable to GHG emissions are back loaded. At least until 2030, no dramatic impacts with or without mitigation are predicted. On the other hand, predictions beyond 2030 remain subject to revision based on what will be observed between now and 2030 in the same way that the current predictions have been greatly influenced by the events of the past 15 years.

The IPCC predictions on changes in temperatures, rainfall, and related natural phenomena are derived using simulation models of the climate system. Few models in economics and meteorology consistently forecast with

accuracy even over a short time horizon, let alone 100 years. Fred Pearce (2008) graphically described the uncertainty associated with the forecasts of the climate change models in an article published in the *Guardian*. Pearce, himself no skeptic on global warming, states

> Now, a skeptic might say that if the modelers are only just learning about the importance of natural cycles to climate forecasts, why should we believe their predictions at all? Fair point. In their desire to persuade us about the big picture of global warming, scientists have sometimes got cocky about coloring in the detail.
>
> Recently I attended a conference in Reading where some of the world's top experts discussed their failings. How their much-vaunted models of the world's climate system can't reproduce El Niños, or the "blocking highs" that bring heat waves to Europe—or even the ice ages. How their statistical mimics of tropical climate are "laughable," in the words of the official report.
>
> This sudden humility was not unconnected with their end-of-conference call for the world to spend a billion dollars on a global centre for climate modeling. A "Manhattan project for the 21st century," as someone put it.
>
> Even so, scientists are concerned that many of their predictions about how climate change will play out in different parts of the world are little better than guesses. But whatever the local wrinkles and whatever natural cycles may intervene, man-made global warming is real, current and matters a great deal.

Suppose we take the IPCC predictions of global warming and the associated natural phenomena at face value. Even then the formulation of well-informed mitigation policy over a time horizon extending all the way to the end of the 21st century requires predictions of innovations of clean technologies and green sources of energy. As the information technology revolution that swept the world in the 1990s and beyond illustrates, such predictions are highly uncertain as well.

This discussion suggests that any analysis of optimal mitigation policies is likely to carry a significant speculative element in it. This is particularly true of *quantitative* estimates of costs and benefits of mitigation. Therefore, references to such estimates must be taken with a heavy dose of skepticism. Indeed, where possible, I will try to rely on qualitative and conceptual analysis turning to numbers only when they are useful for clarifying a point.

Climate Change in India during the Past Century

Let us now turn to a brief consideration of global warming-related developments in India. India is a peninsular country with a coastline of approximately

6,000 kilometers along the mainland and an additional 1,500 kilometers around the islands of Lakshadweep and Andaman and Nicobar. The Tropic of Cancer divides the country into two halves with the northern half being temperate and southern half tropical. Variations in temperatures in the peninsular region are smaller and rains heavier than in the inner continent. In the inner continent, temperatures range from near-freezing levels in the winter to 40°C or more during the summer. The Himalayan states in the northernmost part of the country experience sub-freezing temperatures during the winter with elevated regions in those states receiving sustained snow.

In *India's Initial National Communication to the United Nations Framework Convention on Climate Change*, the Government of India (2004) identifies four seasons during a year: winter from December to February; pre-monsoon season from March to May; southwest or summer monsoon from June to September; and post monsoon from October to November.[7] The precise timing of these seasons exhibits some variation across regions. A major variation relates to the northeast monsoon that occurs in October and November. The states of Tamil Nadu, Karnataka, and Kerala receive most of their rainfall from the northeast monsoon during November and December. The Himalayan states experience two additional seasons: autumn and spring.

The primary points of impact of GHG emissions are air temperature and rainfall.[8] These changes in turn impact the rates at which glaciers melt, sea levels and the occurrences of extreme weather events such as the frequency and intensity of droughts, cyclones, and floods. In the following, I briefly discuss the changes in the temperatures and rainfall, melting of glaciers and sea levels, and the pattern of extreme weather events in the last century.

Temperatures

Three different figures for the increase in the mean temperature in India during the 20th century have been reported. The World Bank (2009a: 162) reports no change, the Government of India (2004: 62) notes a 0.4 percent increase and the IPCC (2007b, Table 10.2: 475) observes a

7. The ancient Hindu calendar divides a year into six seasons with each season lasting approximately two months. The six seasons are: spring (*vasanta* in Sanskrit), summer (*grīsma*), monsoon (*varsā*), early autumn (*śarada*), late autumn (*hemanta*), and winter (*śiśira*).

8. Air temperature, also termed surface temperature in meteorology, refers to the ambient temperature indicated by a thermometer exposed to the air but sheltered from direct solar radiation and kept 1.5 to 2 meters above ground.

0.68 percent increase.[9] Because these sources neither refer to each other nor explain details of methodologies used to compute the temperature change, the sources of the differences cannot be explained.

The Government of India (2004: 62) further notes,

> On a seasonal scale, the warming in the annual mean temperatures is mainly contributed by the post-monsoon and winter seasons. Also, data analyzed in terms of daytime and nighttime temperatures indicate that the warming was predominantly due to an increase in the maximum temperatures, while the minimum temperatures remained practically constant during the past century. The seasonal/annual mean temperatures during 1901–2000 are based on data from 31 stations, while the annual mean maximum and minimum temperature during 1901–90 are based on data from 121 stations. Spatially, a significant warming trend has been observed along the west coast, in central India, the interior peninsula and over north-east India, while a cooling trend has been observed in north-west India and a pocket in southern India.[10]

Figure 1, in Lal (2003: 8), shows that temperatures in India have recently increased in two phases: the first half of the 20th century and the period since the mid-1970s. The average annual temperature during the approximate quarter century between 1950 and 1975 exhibited no trend. As just noted, the warming in India is concentrated in the post-monsoon and winter seasons and in the maximum daytime temperatures rather than nighttime minimum temperatures. In the monsoon season, temperatures exhibit a *declining* trend in northwest India and no trend in the rest of the country. Increases in surface air temperatures relative to climatologically normal temperatures have been observed at most of the locations in India.

Rainfall

With respect to rainfall, the Government of India (2004: 61) notes,

> Although the monsoon rainfall at the all-India level does not show any trend and seems mainly random in nature over a long period of time, the presence of pockets of significant long-term changes in rainfall have been recorded. Areas of increasing trend in the monsoon seasonal rainfall are found along the west coast, north Andhra Pradesh and north-west India (+10 to +12 percent of normal/100 years) and

9. These changes are in contrast to 2–3°C increases in North Asia, the region subject to most global warming within Asia.

10. IPCC evidently relies on Lal (2003: 8) who states that "an analysis of seasonal and annual surface air temperatures, using data from 1880 to 2000 for 25 or more stations, showed a significant annual mean warming of 0.68°C per 100 years."

> those of decreasing trend over east Madhya Pradesh and adjoining areas, north-east India and parts of Gujarat and Kerala (–6 to –8 percent of normal/100 years).

This assessment is consistent with that in Lal (2003, Figure 2), which reports no change in the trend on either the annual or seasonal basis during 1871–2000 in all-India rainfall.

Glacier Melting

According to NASA, although certain types of glaciers—for example, surge glaciers and tidewater glaciers—have been expanding, the vast majority are shrinking. The Glacier National Park in North America had 147 glaciers 150 years ago. Today, only 37 remain.[11] In India, glaciers in the Himalayas are in decline. According to Naithani et al. (2001), at 30.2 kilometers long and between 0.5 and 2.5 kilometers wide, Gangotri glacier in the Uttarkashi district of Garhwal Himalaya is one of the largest Himalayan glaciers. It has been receding since scientists began to keep its measurement in 1780. Data between 1936 and 1996 show that 1,147 meters of the glacier melted away during the 61 years. This works out to a rate of 19 meters per year. Data for 1975 to 1999 show the glacier has receded 850 meters during these 25 years. At 34 meters per year, the rate at which the glacier is melting has accelerated over that observed in the prior years. The account in Naithani et al. (2001) is at odds with that in the Government of India (2004, Box 3.5: 79), however. The latter notes, "The rate of retreat of the snout of Gangotri glacier demonstrated a sharp rise in the first half of the 20th century. This trend continued up to around the 1970s, and subsequently there has been a gradual decline in its rate of retreat." The fact that Gangotri glacier has been receding since 1780 raises some doubt about the link between GHG emissions and glacier melting. And if the Government of India (2004) accounts on the speed of melting during various periods in the 20th century are correct, GHG emissions and the melting of Gangotri glacier would seems to be unrelated.

Over 1 percent of water in the Ganges and Indus basins is currently due to runoff from wasting of permanent ice from glaciers. This water flow will first rise and then decline as the Glacier becomes smaller and smaller. In assessing the cost of the glacier retreat, we must take into account two benefits as well: it is currently helping ameliorate the rate at which water availability per person is declining due to rising population and as the glacier recedes, land underneath becomes available for use.

11. See http://earthobservatory.nasa.gov/IOTD/view.php?id=4594 (accessed on May 13, 2010).

Sea Level

The average of the sea level along India's coastline is reported to be rising at 1 mm per year on the average. According to the Government of India (2004: ix), at 0.4 to 2.0 mm per year, the rise is the highest along the Gulf of Kutchh in Gujarat and the coast of West Bengal. Along the Karnataka coast, there is a relative decrease in the sea level. Much of the rise in the sea levels has been due warming of seawater that increases its volume rather than the accelerated inflow of water.

Extreme Weather Events

Although numerous accounts of increased risk of extreme weather events can be found, the available historical data on the incidence of extreme weather events—heat waves, droughts, floods, cyclones, and tidal waves—are equivocal.[12] De et al. (2005) compile data spanning over approximately the entire 20th century from various sources. Assuming the data are comparable, the incidence of heat waves declined in Uttar Pradesh, Madhya Pradesh, and Gujarat during 1978–99 relative to 1911–67 but rose in Rajasthan, West Bengal, and Maharashtra between the two time periods. Major cyclones over the North Indian Ocean numbered four in the 1940s, 1960s, and 1990s and three in the 1970s. Frequency of rainfall of 30 inches or more in one day also does not show a clear pattern.

The bottom line with respect to droughts and floods offered by the Government of India (2004: 63) is consistent with these observations:

> Instrumental records over the past 130 years do not indicate any marked long-term trend in the frequencies of large-scale droughts or floods in the summer monsoon season. The only slow change discernible is the alternating sequence of multi-decadal periods of more frequent droughts, followed by periods of less frequent droughts. This feature is part of the well-known epochal behavior of the summer monsoon.

Regarding cyclones, the report points to nuances not noticeable in the data in De et al. (2005). It notes (p. 63),

12. For example, Lal (2003: 8) states, "The frequency of extreme weather events in India—for example, heat waves, droughts and floods—has increased over the past two decades." While Lal discusses *examples* of droughts and floods from Orissa, Maharashtra, and other states during the1990s and early 2000s, he does not compile complete comparative data necessary to reach the conclusion just noted. Surprisingly, IPCC (2007b) echoes Lal without additional data.

> In the northern Indian Ocean, about 16 cyclonic disturbances occur each year, of which about six develop into cyclonic storms. The annual number of severe cyclonic storms with hurricane force winds averages to about 1.3 over the period 1891–90. During the recent period 1965–1990, the number was 2.3. No clear variability pattern appears to be associated with the occurrence of tropical cyclones. While the total frequency of cyclonic storms that form over the Bay of Bengal has remained almost constant over the period 1887–1997, an increase in the frequency of severe cyclonic storms appears to have taken place in recent decades (Figure 3.7). Whether this is real, or a product of recently enhanced monitoring technology is, however, not clear.

Predicted Changes

Given the difficulties and uncertainty in accurately measuring even the past *observed* shifts in temperatures and rainfall, it should be no surprise that predicting the future shifts in them is bound to be subject to extremely large errors. The predictions on changes in temperatures, rainfall, and related natural phenomena are derived using simulation models of the climate system. As I noted earlier in the second section, few models of climate change forecast with any degree of accuracy over the long horizon under discussion.

This uncertainty in predictions makes the assessment of vulnerabilities resulting from future climate change-related events extremely difficult. To complicate matters further, significant climate change impacts are predicted to occur well after 2030 and possibly closer to the end of the 21st century. In the interim, new products and production processes that allow drastic cuts in GHG emissions at very low cost and counteract the effects of climate change-related impacts may emerge. The upshot is that predicted changes below must be taken with a grain of salt.

I divide the discussion into impacts on physical and economic phenomena. In the latter case, I also touch on India's prospects for adaptation to GHG-induced changes.

Physical Phenomena

GHG emissions may impact natural phenomena through temperatures and rainfalls; extremes in rainfalls, droughts, floods, and storms; and the rise in sea levels.

Temperatures and Rainfall

In Table 1, I reproduce the predictions of average temperature and rainfall changes during the 21st century in South Asia and North Asia reported in

TABLE 1. Predicted Changes in Temperatures and Precipitation (Baseline: 1961–90)

	Temperature (°C)		*Precipitation (%)*		*Temperature (°C)*		*Precipitation (%)*	
	A1FI	*B1*	*A1FI*	*B1*	*A1FI*	*B1*	*A1FI*	*B1*
Months	*South Asia*				*North Asia*			
2010 to 2039								
DJF	1.17	1.11	–3	4	2.94	2.69	16	14
MAM	1.18	1.07	7	8	1.69	2.02	10	10
JJA	0.54	0.55	5	7	1.69	1.88	4	6
SON	0.78	0.83	1	3	2.24	2.15	7	7
2040 to 2069								
DJF	3.16	1.97	0	0	6.65	4.25	35	22
MAM	2.97	1.81	26	24	4.96	3.54	25	19
JJA	1.71	0.88	13	11	4.2	3.13	9	8
SON	2.41	1.49	8	6	5.3	3.68	14	11
2070 to 2099								
DJF	5.44	2.93	–16	–6	10.45	5.99	59	29
MAM	5.22	2.71	31	20	8.32	4.69	43	25
JJA	3.14	1.56	26	15	6.94	4	15	10
SON	4.19	2.17	26	10	8.29	4.98	25	15

Source: IPCC Fourth Assessment Report, Working Group II, Chapter 10.

Note: Months "DJF" stand for December, January, and February. Other symbols for the months are similarly defined. Scenario A1FI refers to the highest future GHG emission trajectory considered in the simulations by the IPCC Fourth Assessment Report and B1 to the lowest emission trajectory.

IPCC (2007b). The predictions are derived from Atmosphere-Ocean General Circulation Models (AOGCM). The table reports the results of simulations based on two sets of assumptions with respect to GHG emissions: scenario A1FI assumes the highest future emission trajectory and B1 the lowest emission trajectory. Therefore, the two scenarios give the upper and lower limits of predicted changes. The changes are recorded relative to the baseline period of 1961–90.

Two points follow from Table 1. First, the variation in predictions across regions is large. In North Asia, the region with the greatest climate change impact within Asia, the predicted temperature increase in the winter months (December, January, and February) ranges from 6 to 10.5°C during 2070–99 relative to the baseline period 1961–90. That is to say, even if strong measures to contain emissions around the globe are taken, the temperature rise in North Asia would be as much as 6°C during the winter months by the end of the 21st century. The temperature change in South Asia in the winter months during 2070–99 is predicted to be between 3 and 5.5°C in South Asia. The maximum rainfall increase in North Asia is predicted to be

in the winter months and in the range of 29–59 percent of the rainfall in the baseline period. In South Asia, the largest rainfall increase during 2070–99 is predicted to be in the summer months of March, April, and May and in the range 20–31 percent of the average rainfall in the baseline period. During the winter months (December, January, and February), rainfall is predicted to fall between 6 and 16 percent. The magnitudes of predicted changes in temperatures are larger during the winter months and become smaller as we move away from those months. The pattern of rainfall predictions across seasons is less clear-cut.

Second, the predicted changes in nearer term are smaller than those in the longer term but still larger than those observed during the last entire century. For example, the temperature increases in South Asia during 2010–39 are predicted to range between 1.1°C and 1.2°C during the winter months and 0.78–0.83°C in the post-monsoon months. Rainfall increase is predicted to range between –3 and 4 percent in the winter months, and 1 and 3 percent in the summer months.

The Government of India (2004) reports the results from a set of General Circulation Models with regional details under the assumption that GHG forcing is increased at the compound rate of 1 percent per year during 1990–2099. Like the IPCC Fourth Assessment, these simulations predict marked increase in temperatures and rainfall by the end of the 21st century. The increase in the average temperature ranges from 3 to 6°C and that in rainfall from 15 to 40 percent over the 1961–90 baseline. The models predict increased precipitation during the monsoon season especially in the northwestern part of the country. State-wise projected increases show wide variation across models, however. The Government of India (2004) cautions that projections based on the models are subject to very substantial uncertainty:

> Regionally, there are large differences among different GCMs [General Circulation Models], especially in precipitation-change patterns over the Indian subcontinent. Most GCM models project enhanced precipitation during the monsoon season, particularly over the northwestern parts of India. However, the magnitudes of projected change differ considerably from one model to the other. Uncertainties exist in the projections of climate models specifically concerning their spatial resolutions. The GCMs are robust in projecting temperature changes rather than rainfall changes.

Extremes in Rainfall, Droughts, and Floods

According to model simulation results reported in the Government of India (2004: 70) the number of rainy days in western and central parts of India would decline by 15 or more and those in the foothill of Himalayas and

northeast India would rise by 5 to 10 days in the 2050s.[13] Rainfall intensity is predicted to rise by 1 to 4 millimeters per day except in small areas in northwestern India where it would decline by 1 millimeter per day. The highest one-day rainfall per day over a major part of the country could rise by as much as 8 inches per day while that in some parts of northwestern India could decline by 4 inches per day. With respect to droughts and floods, the report (p. 78) notes, "The preliminary assessment has revealed that under the GHG scenario, the severity of droughts and intensity of floods in various parts of India is projected to increase. Further, there is a general reduction in the quantity of the available run-off under the GHG scenario."

Sea Level Rise, Cyclones, and Effects on Coastal Zones

According to the census of 2001, there are 65 coastal districts out of a total of 593 districts countrywide. These districts are spread over nine different states. According to the Government of India (2004), as per the long-term trend, sea level along the Indian coast has been rising 1 inch per 25 years. More recent data suggest a rising trend of 2.5 inches per 25 years. Model simulations suggest that the oceanic region adjoining the Indian subcontinent will warm at its surface by about 1.5–2°C by 2050 and by about 2.5–3.5°C by 2100. This would lead to sea-level rise between 6 and 15 inches by 2050 and 18 and 24 inches by 2100. It is estimated that a 40 inch rise in sea level would displace approximately 7.1 million people in India and cause a loss of approximately 2,224 square miles of land. Climate change may add to risks by increasing the frequency of cyclones though no evidence that this would happen is so far available.[14]

Economic Phenomena

GHG emissions will impact various economic activities directly as well as indirectly through impact on a variety of natural phenomena. Among the aspects likely to be impacted most are water supply, agriculture, migration, and poverty. The effects raise the issue of adaptation on which I touch toward the end of this section.

13. The India Meteorological Department defines a rainy day as a day with a rainfall of 2.5 millimeter or more. The mean annual number of rainy days varies from less than 20 days in northwestern India (west Rajasthan and Kutchh region of Gujarat) to more than 180 days in the northeastern part of the country (Meghalaya). Northeastern India and the southern parts of the west coast are major areas of relatively high mean annual number of rainy days (approximately 140 days).

14. For more details, see Government of India (2004: 108–13).

Water Supply

India has 16 percent of the world's population but only 4 percent of its water. Rising population has been continuously lowering the availability of water per capita. The current availability of utilizable surface and ground water stands at 1,122 billion cubic meters (Government of India, 2004: 72). Given India's population of 1.15 billion, this works out to approximately 1,000 cubic meters per capita. Conventionally, utilizable water below 1,700 cubic meters per capita per year is associated with "stress" in water availability and that below 1,000 cubic meters per capita per year with chronic water "scarcity." The Government of India (2004, Table 3.1) estimates actual total water consumption in 2010 to be 200 billion cubic meters. With the expected population of 1.2 billion in 2010, this works out to approximately 165 cubic meters per capita per year. This consumption is comparable to that in some of the developed countries though considerably below many others.[15] Irrigation accounts for more than 80 percent of water consumption in India.[16]

Looking ahead, per capita water availability is expected to decline due to rising population. According to some estimates, population is expected to stabilize around 1.6 billion in 2050. Assuming no change in water availability, this would place per capita water availability at approximately 700 cubic meters per year. In the light of the current consumption levels, this may seem adequate but such a conclusion is unwarranted. Surface water accounts for only 60 percent of the available supply and 40 percent of it is concentrated in the Ganges–Brahmaputra–Meghna system. This has meant that water usage in the majority of the river basins is already between 50 and 95 percent of the available supply. In addition, variation in the availability across seasons can also add to scarcity in certain parts of the year.

Climate change can impact water availability through several channels. Increased rains by themselves would add to the availability of surface water. More rapid melting of glaciers will also add to the availability of utilizable water initially though this channel will dry up as glaciers disappear. Increased temperatures that lead to increased evaporation and transpiration cause the

15. This availability level is distinct from actual consumption level. Interestingly, the consumption levels vary vastly across countries. Based on 2002 (or latest available) data, annual per capita water consumption in the OECD countries ranged from 130 cubic meters in Denmark to 1,730 cubic meters in the United States. All OECD countries except Portugal, Australia, Canada, and the United States have water consumption below 1,000 cubic meters.

16. In the United States, industrial, agricultural, and domestic consumption account for approximately 65, 27, and 8 percent of the total consumption.

availability of utilizable surface water to shrink. Estimates reported in the Government of India (2004, Table 3.2) show the net effect to be positive for some rivers and negative for others.

Climate change can further impact water availability through its influence on droughts and floods. Water shortages in specific regions can occur if drought conditions become more severe, prolonged, and frequent. According to the Government of India (2004: 78), areas served by river Luni, which occupies about one-fourth of the area of Gujarat and three-fifths of the area of Rajasthan, are likely to experience acute physical water scarcity conditions. Increased frequency and severity of floods can also temporarily create a shortage of utilizable water.

From the policy perspective, climate induced changes require more intense pursuit of measures to conserve and develop water resources that India must undertake even absent climate change. These include more prudent utilization of surface and ground water through proper pricing as well as training, harvesting of rainwater, building of dams, development of distribution networks, and re-forestation to help replenish ground water. The government can also exercise the option to import of food grains to conserve water utilization in agriculture.

Agriculture

From an economic standpoint, climate change is likely to have its most pronounced effects in the area of agriculture. Approximately 70 percent of India's population lives in rural areas and 55–60 percent of its workforce is engaged in agriculture. On the other hand, the share of agriculture (including forestry and fishing) in the GDP has declined from 29.3 percent in 1990–91 to only 17.8 percent in 2007–08. Already, three-fifths of the workforce lives on less than one-fifth of the GDP.

Very low productivity growth in Indian agriculture is a well-recognized problem. Future prospects also look bleak. The sector is likely to face progressive scarcity of water. Ground water level has been progressively declining and the supply of river water may also shrink over time. Progressive division of land holdings over last several generations has led to extremely low size of land holdings: In 2002–03, 70 percent of land holdings were less than 1 ha (2.47 acres) and the average land holding was 1.06 ha. Land leasing laws in various states result in vast volumes of land being left uncultivated in some states while leading to highly inefficient methods of farming in virtually all states.

Against this background, how do we assess the impact of climate change? There are several possible channels. Increased droughts and floods can

lead to partial destruction of crops with greater frequency. Compression of the monsoon season and increased intensity of rains may also impact agricultural productivity. Increased sea levels can reduce the availability of arable land. Rising maximum temperatures in drought-prone areas lead to reduced productivity while those in cooler areas raise productivity. Increased carbon dioxide levels in the air lead to increased productivity in many major crops. According to the World Bank (2009a, Box on p. 76), C3 crops, which include rice, wheat, soybeans, fine grains, legumes, and most trees, benefit significantly from such a change while C4 crops, which include maize, millet, sorghum, and sugarcane, benefit less.

A number of studies try to estimate the effects of rising temperatures, increased or reduced rain, increased carbon dioxide levels and other climate related changes on yields in different crops and regions. Table 7.3 in World Bank (2009a) summarizes the results of many studies. The effects vary widely according to crops, specific climate changes assumed and region. For example, Aggarwal and Mall (2002) simulate various IPCC climate change scenarios for parts of northern, eastern, southern, and western India and predict gains in rice yields ranging from 1.3 percent by 2010 to 25.7 percent by 2070. On the other hand, assuming increases of 2°C in maximum and 4°C in minimum temperature, 5 percent reduction in the rainy days, 10 percent reduction in monsoon rains and an increase in carbon dioxide levels to 550 ppm (parts per million) from 430 ppm, World Bank (2006) predicts 9 percent reduction in rice yields and 2, 3, 10, and 3 percent increases in yields of groundnut, jowar, sunflower, and maize, respectively.

There are very serious problems with these studies. First, they use past information to predict future outcomes going almost 100 years into the future. Surely, technology will change during this period. New seeds, products, and cultivation methods would emerge. This means any response coefficients based on the past data are unlikely to correctly predict the outcomes this far into the future. Second, the use of IPCC predictions of average changes in temperatures and rainfall to predict the changes in future outputs is rather heroic. The changes across regions of India and across seasons within the same region greatly differ. In the case of rainfall, it is expected to rise in some regions and seasons and fall in others. Temperature increases would be above average in some regions and seasons and below average in others. Third, related to the previous points, responses to temperatures, rainfall, and carbon dioxide would themselves differ across regions and seasons. Fourth, as far as the overall agricultural output and income are concerned, the impact would be cushioned by substitution out of crops with larger adverse effect into those with smaller adverse or positive effect. Finally, some studies

consider the effects of predicted changes in temperatures and rainfall only. But one cannot accurately assess even the direction of the change without taking into account to favorable impact of carbon dioxide emissions on some of the key crops. Given these flaws, most of which are insurmountable, one wonders if the predictions going beyond even 2020 can be taken any more seriously than those by astrologers relating to one's life.

Health

In general, the relationship between climate change and health outcomes is complex. Therefore, as in other areas, we can only speak in terms of possible outcomes. If temperatures rise in warmer parts of the country and on the maximum end of the spectrum, heat waves may become more intense and longer lived. That would result in increased incidence of heat stroke and related diseases. Heatstroke related deaths might rise as well. Warmer climate also makes air pollution more harmful and contributes to airborne diseases with greater potency. Increased dampness and water pollution accompanying floods are likely to increase the risk of spread of diseases such as malaria. Water contamination that may accompany floods and droughts may also lead to increased incidence of intestinal diseases such as diarrhea. On the other hand, warming in colder regions, during winter season and in minimum temperatures may reduce health risks associated with cold waves. Increased rains in currently dry regions may also reduce the risk of heat waves.

To the extent that climate change is expected to be associated with increased health problems, the change represents an intensification of some of the existing public health problems in India. My detailed analysis of the heath sector (Panagariya 2008, Chapter 19) shows that the government is already behind the curve in addressing these problems. The possibilities outlined above call for renewed vigor in implementing major policy reforms in the sector. India needs to accelerate medical education at all levels to ensure access to trained medical personnel. It also needs to improve access to medicines. And, of course, it needs to take a variety of public health measures to combat the spread of infectious diseases by ensuring proper drainage and supply of clean drinking water.

Migration

Intensification of urban–rural and inter-state migration may be another area of impact of climate change. To begin with, given diverse rates of growth across states and between urban and rural areas, migration is likely to accelerate even independently of climate change. Demographic changes are likely to reinforce this phenomenon: whereas all four southern states (Andhra Pradesh, Kerala, Tamil Nadu, and Karnataka) have reached the

replacement levels of fertility rates, many of the poorer states in the north such as Bihar, Uttar Pradesh, Madhya Pradesh, and Rajasthan have high population growth rates. This would likely lead to increased migration from the latter set of states to the former.

Climate change can further add to complications in migration patterns. For example, as previously discussed, rising sea levels may displace a part of the population currently living in the coastal zones. More frequent cyclones, droughts, and floods may also lead to increased migration. Finally, it is commonly suggested that climate-related events may lead to massive migration from Bangladesh into India. These sources of migration are bound to interact with other sources and, very importantly, the ongoing process of urbanization. Other than noting these possibilities, it is not clear what precise policy prescriptions can be offered in anticipation of what are at this stage guesses with high degree of uncertainty. While migration may generate some social stress, in so far as it involves the movement of people from low-income to high-income areas and leads to urbanization and modernization, it is to be welcome.

Poverty

Climate change may impact poverty at two levels: it may increase the number of poor by impoverishing those with incomes just above the poverty line and it may be accompanied by the burden of some of the accelerated and more intense extreme events falling disproportionately on the poor.

The proportion of the poor living below the poverty line may rise due to reduced incomes of farmers many of whom may be living just above the poverty line. But it must be acknowledged that this effect may also go the other way if the net effect of climate change is to increase rather than reduce agricultural productivity. An increase in poverty may also result from reduced opportunities for the bottom deciles elsewhere in the economy and reduced revenues available to the government to carry out anti-poverty programs. Whether or not the effect would be large depends how large climate-related changes in temperatures, floods, cyclones, and droughts are and how close the connections between these changes and reduced farm incomes, shrunken opportunities elsewhere in the economy, and decline in government revenues are.

Turning to climate change-related extreme events such as floods, cyclones, and droughts, a prima facie case can be made that they would asymmetrically hurt the poor. The poor are more exposed to floods. Disproportionately large number of them being landless workers or marginal farmers, they also bear the greatest burden of droughts. Natural calamities are also likely to adversely

impact indigenous populations that are less able to shelter themselves. Floods and heavy rains are also likely to asymmetrically damage the urban poor who live in dwellings that readily collapse under heavy downpour.

One way to pose the poverty question in the context of climate change is where we expect poverty levels to be in 2030 absent any climate-related effects and where it will be taking the latter into account. We may then ask how the strategy to combat poverty ought to be different. The same may be said of necessary protection against the vagaries of droughts and floods. These are ongoing phenomena that are predicted to become more frequent and more intense. The question then is how best to modify flood and drought relief policies in anticipation of climate-related changes.

Here we must not shy away from raising the issue of priorities: Given that the government has limited resources and, indeed, very limited capacity to deliver services, how much importance should it give to combating the adverse effects of climate change relative to other priorities such as the provision of education and health, helping sustain a high rate of growth, and attending to localized environmental concerns ranging from pollution of river waters to indoor air pollution associated with cooking with solid fuels such as dung, wood, crop waste, or coal.

An argument can be made that rapid growth currently under way will better prepare the population to cope with vagaries of future climate changes. If the current near-double-digit growth were sustained for two to three decades—an entirely feasible proposition—the country would almost entirely be free of extreme poverty. With proper shelters and substantially improved purchasing power, people will themselves be better prepared to adapt to climate change effects in two decades.[17] This line of reasoning argues for minimizing the commitments for mitigation of GHG emissions in the next two to three decades that might compromise growth. This is not a recommendation for irresponsible behavior but simply for negotiating an agreement whereby India's mitigation commitments are back-loaded. I will return to this theme more frontally in the eighth section.

In concluding this section, let me note that my assessment of the prospects for India's ability to adapt to climate-related changes that will occur even

17. My assessment in this regard is consistent with India's National Action Plan on Climate Change released on June 30, 2008. The plan rightly emphasizes the overriding priority of maintaining high economic growth rates to raise living standards and focuses on identifyng "measures that promote our development objectives while also yielding co-benefits for addressing climate change effectively."

after actions for mitigation are taken are less apocalyptical than some others who describe them as potentially "calamitous." For instance, on the authority of Nordhaus and Boyer (2000), Mendelsohn et al. (2006), and IMF (2008), Joshi and Patel (2010: 4) express the urgency for India to negotiate an agreement in these terms:

> India is more vulnerable to climate change than the US, China, Russia and indeed most other parts of the world (apart from Africa). The losses would be particularly severe, possibly calamitous, if contingencies such as drying up of North Indian rivers and disruption of Monsoon rains came to pass. Consequently, India has a strong national interest in helping to secure a climate deal.

While India faces a severe water shortage problem in large part due to poor management even absent any climate change effects, claims of "calamitous" losses *on account of global warming* are difficult to reconcile with the predictions of the impact of GHG emissions on temperatures, rains, evaporation, and transpiration in India discussed earlier. Rains are almost uniformly predicted to rise and the impact of temperature increase on evaporation and transpiration is not expected to be large enough to significantly change the net availability of surface water. For their part, Joshi and Patel or the sources they cite provide no evidence supporting the hypothesis of calamitous losses due to GHG emissions.

Mitigation: Optimality with No International Transfers Permitted

While the uncertainties discussed earlier are naturally important for the choice of action, there is currently general agreement that an effort needs to be made to bring down GHG emissions to help slowdown global warming and the harmful effects accompanying it. Therefore, in this section, I turn to a consideration of the optimal choice of GHG emissions and the instrument to achieve it.

The first point to note is that GHG emissions are accompanied by a global externality: emissions by one firm impact individuals living everywhere on the globe. Therefore, the optimal solution requires action at the global level. If there was a sufficiently powerful and efficient global government, it could implement the optimal solution by maximizing a global social welfare function that takes into account the expected damage from GHG emissions subject to country-wise resource constraints and production technologies allowing for GHG emissions as an input (see later).

Among other things, such a solution would yield optimal country-specific GHG emissions as well as lump-sum distributions of income across individuals (and therefore nations) necessary to achieve individual welfare levels consistent with the maximized value of the social welfare function. Therefore, to achieve the fully optimized solution, efficiency and distribution problems would be simultaneously solved.

In practice, we do not have a global government with a well-defined global social welfare function and the power to redistribute income internationally. Therefore, as a starting though not ending point, we may consider the optimal solution under the assumption that no international transfers are permitted. Such a solution would exploit any benefits available to each country without affecting any international transfers. This solution can only be implemented, however, if all governments cooperate rather than act strategically. In practice this is unlikely to happen since each individual government will find that since the cost of GHG emissions partially spills over to other countries, it can improve upon its fate by choosing to expand its GHG emissions. But if all governments play this game, the result would be a strategic rather than cooperative equilibrium in which each country would be left worse off.[18]

Realistically, given that GHG emissions stay in the atmosphere for up to 100 years and their costs accrue at points in time different from when such emissions add to output (with costs even falling on generations different from those benefiting from it), the problem is properly formulated in a dynamic framework. Such an ambitious exercise being outside the scope of this paper, I take a short cut by defining the period of analysis to be sufficiently long that we may think of the benefits and costs as accruing in the same period. For example, we may think of the entire 21st century as a single period during which extra output from emissions and the damage they incur would both be realized.

A One-Country Model

For simplicity, I begin with a one-country world. The essential features of the problem within this framework can be captured using a one-good model. Therefore, denoting the output of this aggregate good by X, capital by K, labor by L, and GHG emission by Z, technology for the production of

18. For example, if individual country governments choose to independently maximize their welfare taking the emission choices of other governments as given, we would end up in the standard Cournot equilibrium, which is inferior to the cooperative equilibrium to be considered immediately below.

X can be represented by a conventional constant-returns-to-scale production function F(.).

$$X = F(K, L, Z) \tag{1}$$

The social welfare function to be maximized is written

$$W = U(X, Z) \tag{2}$$

U(.) is rising in X and declining in Z and satisfies the usual properties of a utility function.[19] We take K and L as given. Therefore, the optimization problem is to choose Z (and therefore X as well) to maximize utility. Using a subscript to denote a partial derivative, the solution is given by:

$$F_Z(.) = -U_Z(.) / U_X(.) \tag{3}$$

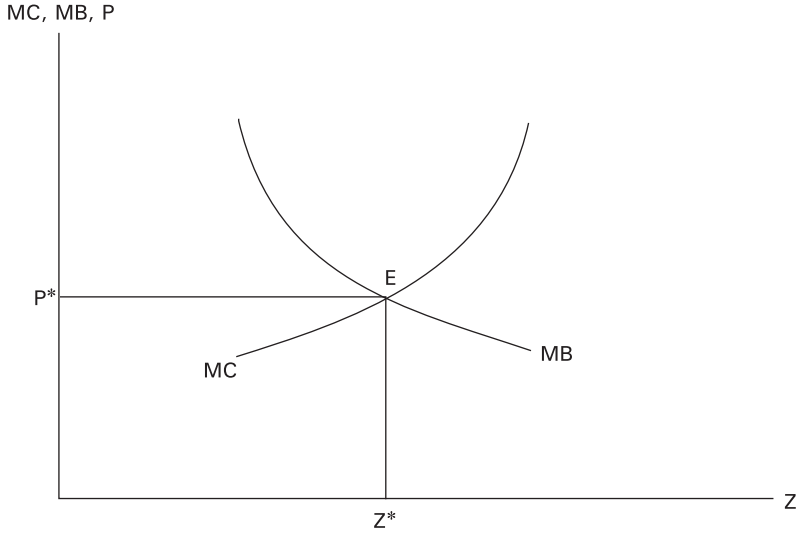
The left-hand side of this equation represents the extra X attributable to the last unit of GHG emission and may be viewed as the marginal benefit of Z. The right-hand side represents the absolute value of social cost imposed by the last unit of GHG emitted, where the cost is measured in terms of units of X. The right-hand side thus represents the marginal social cost of Z.

In Figure 1, I measure Z on the horizontal axis and its marginal benefit, marginal cost and "price," in terms of X, on the vertical axis. Remembering $F_{ZZ} < 0$ by concavity of the production function, the left-hand side of equation (3) can be represented by the downward-sloped marginal benefit curve labeled MB. Likewise, we can represent the right-hand side by the marginal cost curve labeled MC. A sufficient but not necessary condition for MC to be upward sloped is that the marginal utility of X decline with a rise in Z ($U_{XZ} < 0$). In words, the latter condition says that an extra unit of consumption of X gives less pleasure in a more polluted environment. In the rest of the paper, the conditions necessary for the MC curve to be upward sloped have been assumed to be satisfied.

The optimal solution in Figure 1 is given by point E. One way to achieve this solution is to fix the price of Z at P*. This is equivalent to the imposition

19. Under certain assumptions, this social welfare function may be derived from individual utility functions. Under this interpretation, the government must also affect the necessary redistribution of income across individuals in a lump-sum fashion to achieve the maximized value of the social welfare function.

FIGURE 1. Optimal Choice of Emissions



Source: Author.

of a pollution tax at rate P* (measured in terms of X) per unit of pollution. Given P* as the price, firms will use up Z up to the point where the marginal product of Z = P* or F_Z = P*. Recalling that the MB curve represents nothing but F_Z, we immediately obtain Z* as the equilibrium value of Z.

Alternatively, we could fix the quantity of Z at Z*. The instrument to ensure this would be the tradable pollution permit. The government would issue pollution permits for Z* units and auction them competitively. The firms would keep bidding for the permits until the marginal product of Z exceeds the price of the permit. Therefore, if the auction is perfectly competitive, the price of the permit will settle at P*. If the price is any lower, there will be firms with higher marginal product and an excess demand for permits would exist. If it is any higher, some permits will go unsold pushing the auction price down. Therefore, the price (tax) and quantity (pollution permits) solutions are exactly identical.

A Two-Country Model

We may now extend the model depicted in Figure 1 to explicitly allow for a two-country world consisting of a rich northern country and a poor southern

country. I use upper-case letters to denote variables associated with the northern country and lower-case letters those associated with the southern country. I also introduce past emissions explicitly denoting the stock of pollutants in the environment from past emissions by ζ_0. The simple model above is now replaced by

$$X = F(K, L, Z), \quad x = f(k, l, z) \tag{4}$$

$$W = U(X, \zeta), \quad w = u(x, \zeta) \tag{5}$$

$$\zeta = \zeta_0 + Z + z \tag{6}$$

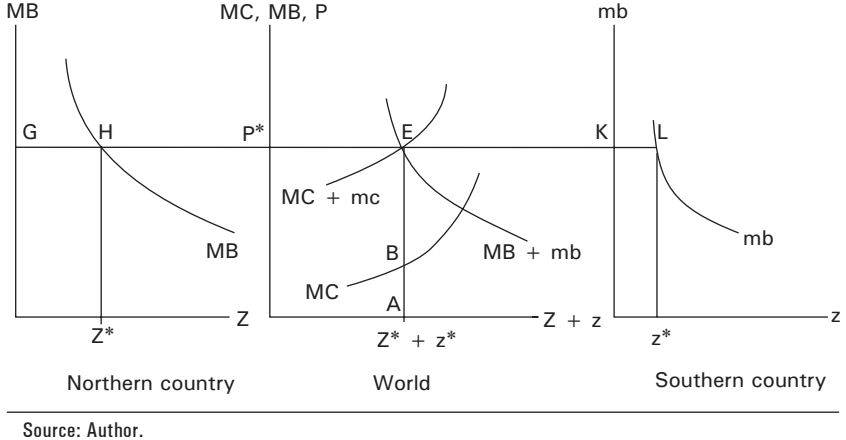
The modification through the introduction of ζ_0 denoting the stock of past emissions in the environment makes explicit the proposition that the social cost of emissions depends on not just current but past emissions as well. The optimal levels of z and Z are now given by

$$(U_\zeta + u_\zeta) / u_x = (U_\zeta + u_\zeta) / U_X = F_Z = f_z \tag{7}$$

This is the usual solution to the public good ("public bad" in the present case) problem: global welfare is maximized by equating the sum of the costs imposed on the two countries by the last unit of emission to the benefit produced by it in either country.

Figure 2 depicts this solution graphically. The marginal products of GHG emissions in the northern and southern countries are depicted by curves labeled MB and mb in the first and last panels, respectively. In the

FIGURE 2. Optimal Emission in a Two-Country Model



Source: Author.

middle panel, MB + mb is derived by horizontally summing the MB and mb curves. Curve labeled MC in the middle panel depicts the marginal cost of worldwide GHG emissions (inclusive of the past emissions) in the northern country. Stacking the marginal cost in the southern country for each value of the worldwide GHG emissions vertically above MC, we obtain MC + mc curve as showing the global marginal costs of worldwide emissions.

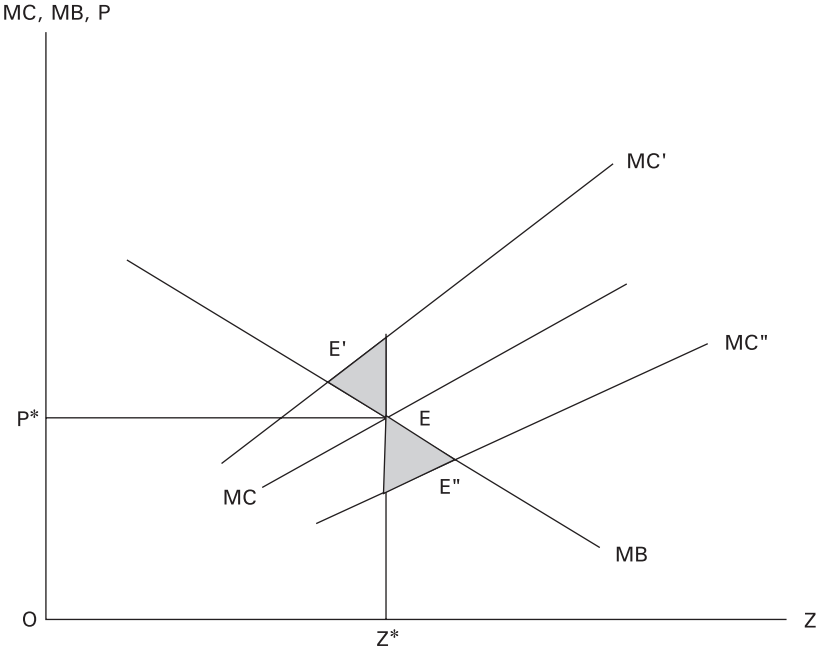
Point E where the global marginal benefit and cost curves intersect yields the optimal level of global GHG emissions, Z* + z*. Setting the price of (tax on) emissions at P*, the northern country firms chooses Z* and the southern country firms z*. Alternatively, if globally tradable permits in the amount Z* + z* are issued and competitively auctioned, permits will be priced at P*, with the northern country firms buying Z* and southern country firms z* worth of permits. The globally efficient solution will be reached.

As drawn, Figure 2 shows that the southern country pollutes much less than the northern country. This feature derives from its smaller economic size mainly captured by smaller resource base and perhaps lower productivity. Given these features, emission levels of the southern country turn out to be small in relation to the northern country. Figure 2 also shows that in equilibrium, the southern country bears the bulk of the cost of emissions: the marginal cost absorbed by the southern country, EB, is significantly bigger than that absorbed by the northern country, AB. As drawn, a comparison of the total costs in the northern country measured by the area under the MC and above the horizontal axis up to emission level Z* + z* and that for the southern country measured by the area below mc curve and above MC curve up to the same emission level shows higher total costs to the latter than the former. This feature is intended to represent the greater vulnerability of the southern countries to climate change that many analysts emphasize, though given the uncertainties previously noted, the truth of this feature is difficult to judge.

Carbon Tax versus Emission Permits

How does the presence of uncertainty with respect to the cost of GHG emissions impact this analysis? Surprisingly, at least under risk-neutral behavior, the equivalence of price and quantity instruments is entirely preserved. The point is readily made using the simpler, one-country model of Figure 1. I reproduce this model in Figure 3 with the modification that the location of the MC curve is known only probabilistically. Specifically, marginal costs may turn out to be high or low each with a probability of 0.5. These are respectively represented by MC′ and MC″ in Figure 3.

FIGURE 3. Uncertainty and the Optimal Instrument



Source: Author.

For simplicity, I make all curves linear. MC represents the expected (or mean) value of the marginal cost for various levels of Z. The objective now is to maximize the expected net benefit from Z. This is achieved at point E with Z = Z*. Given MC shows the mean value of the marginal cost, the shaded triangles are equal in area. If the cost curve ends up being MC′, Z is overshot with a deadweight loss of the upper shaded triangle relative to the ex post optimum E′. If the cost curve turns out to be MC″, Z undershoots with the lower shaded triangle representing unexploited benefits relative to the ex post optimum E″. Any other value of Z will lead to lower expected net benefits.

In view of the fact that the marginal benefits are not uncertain, outcome E can be reached by either setting the price of Z at P* or issuing pollution permits for Z* quantity and auctioning them competitively. In the former case, firms will buy Z until $P^* = F_Z$, which leads to Z* as the solution and P*Z* as revenue. If permits are auctioned competitively, firms are willing to pay a price equal to the marginal benefit, which equals P*. Once again, the same solution is obtained with revenues equaling P*Z*.

This result will not hold in general. A more comprehensive analysis of prices versus quantities as the right policy instrument in the presence of uncertainty can be found in Weitzman (1974). The thrust of Weitzman's analysis is that uncertainty in costs leads to a presumption in favor of quantity as the superior instrument, though this is by no means inevitable.

In practice, the bigger difference between the price (tax) and quantity (permits) instruments is likely to result from the political economy accompanying them. A tax will work more transparently since the revenue collected will be like any other tax revenue and will become a part of general revenues. But a decision to go with permits is likely to allow firms responsible for emissions to lobby for their free distribution. This is amply illustrated by the recent US experience with the "cap and trade" legislation aimed at regulating domestic emissions of US firms. The US Congress opted for permits, which immediately led firms in carbon-intensive sectors to begin lobbying for their free distribution. The outcome has been a decision to distribute 85 percent of the permits freely. To justify this action, the US Congress now plans to hold down the price charged by electricity suppliers, the largest beneficiaries of the give away. This clearly violates the efficiency principle. On the political economy and transparency counts, a tax on GHG emissions is likely to be superior.

From Optimality to Efficiency

Up to this point, the analysis has been overly simple along one dimension but overly complex along another. Taking the former first, I have analyzed the problem of optimal choice within a static framework. As previously noted, there is a time dimension to the problem. We must derive the optimal target levels of emissions based on expected costs and benefits for each period, which may be defined as one year or longer. In general, the optimal tax or number of permits would vary across periods depending on how the expected costs and benefits are phased.

While realism, thus, requires explicit introduction of time into the analysis, it also forces us to take a short cut along the cost dimension. The second, third, and fourth sections of this paper have emphasized the vast uncertainties concerning the timing, object, and value—when, where, and how much—of the costs associated with GHG emissions. Any expectation that such costs can be incorporated into a formal analysis to determine mitigation targets in different years is unrealistic.

The solution to these problems is likely to emerge partly from the scientific evidence and partly from practical (political?) considerations. Scientific evidence, as reported by the IPCC (2007a), gives us guidance on global

emission targets for benchmark years. More detailed, annual emission targets must then be devised based on what is practical and politically achievable. Once these targets are set, our analysis in the pervious sections tells us that the least costly way to achieve them is either a globally uniform tax per tone of emissions or globally tradable permits. It must be remembered, however, that this approach does not give us the optimal solution by any means since the emission targets themselves are chosen in an ad hoc manner—all we can claim for a common emission tax or globally tradable permits now is efficiency in achieving the specified targets.

Additional Considerations

Two additional practical considerations in the implementation of an efficient mitigation policy may be noted. First, in a strict sense, efficiency of a uniform emission tax or tradable permits requires participation by all countries. Exclusions would result in the emission in the exempted countries being pushed to the point where it produces less value than the emission tax (or permit price) and, thus, violating the efficiency principle. Yet, few proposals under consideration extend to all countries in the world. Instead, the set of included countries varies from all developed countries that are not transition economies to all developed and major developing countries. Those proposing the latter such as Cooper (2008) defend their position not on efficiency grounds but the assertion that the grant of exemption to major developing countries such as China and India would lead to leakages: dirty industries and firms would simply relocate themselves from regulated to unregulated countries. But the argument has two serious limitations: (*i*) the vast majority of emissions in the rich countries take place in non-traded sectors that cannot migrate, and (*ii*) environmental regulation being only one of the many factors determining the location of industries, leakages are capped even in traded goods sectors. With respect to the latter point, the Environmental Protection Agency of the United States estimates that the US emissions leakage rates under Lieberman-Warner legislation would be approximately 11 percent in 2030 and 8 percent in 2050.[20]

The second implementation issue relating to the efficient solution is the need for monitoring and therefore, a monitoring agency. Again, Cooper (2008) argues that this is not a problem since the International Monetary Fund (IMF)

20. EPA Analysis of the Lieberman-Warner Climate Security Act of 2008. *S. 2191 in 110th Congress*, March 14, 2008.

is well equipped to fulfill this function. But if one simultaneously insists on requiring the developing countries such as China and India to participate in mitigation, acceptability of the IMF to them is far from obvious in view of their near lack of voice in the institution's governance. It is unlikely that these countries will accept surveillance by an institution heavily dominated by many tiny European countries that would themselves make limited contribution to the alleviation of global warming.

A Serious Limitation of the Efficient Solution

An extremely important limitation of the globally uniform emission tax or its equivalent, the globally tradable permits system, as the efficient solution is the presence of prior direct or indirect taxes (or subsidies) at different rates on carbon use in almost all countries. For example, if the United States has a 10 percent sales tax on gasoline and India 20 percent, adding a uniform carbon tax to these will not equalize the marginal social benefit from mitigation between the two countries, a necessary condition of efficiency. If a uniform carbon tax is to be truly efficient, it should replace all other direct and indirect carbon taxes and be set at a level that delivers the targeted global emission absent all other direct and indirect taxes on emission.

A related point is that an initially efficient carbon tax or tradable permits system can be readily subverted by countervailing actions. For instance, if tradable permits are given out free of charge to firms in certain sectors, the firms in those sectors will have an incentive to expand output beyond the (efficient) level obtained when they are required to buy such permits because higher output allows them to obtain more free permits that command a positive price in the marketplace. The result would be a movement away from the efficient solution.

Mitigation: The Distributional Issue

So far, I have entirely sidestepped the contentious distributional implications of mitigation. A uniform carbon tax or globally tradable permit system may yield an efficient solution but absent income transfers across countries is also accompanied by a specific distribution of burden that may be politically or ethically unacceptable. That these considerations directly or indirectly influence even the most ardent advocates of the "efficiency only" view is illustrated by the fact that no one to-date has suggested subjecting

the countries in Africa to carbon tax or emission permits.[21] Indeed, most principles of moral philosophy would give some consideration to protecting the interests of those living in abject poverty.

Conceptually, we identify two sources of distributive inequity associated with the use of the common environmental resource: that arising out of free use of the environment in the past and that associated with its use in the future. Bhagwati (2006) refers to the former as "stock" problem since it refers to the cost of the existing stock of emission and to the latter as "flow" problem since it relates to future flows of emissions. Consider each of these problems in turn.

The "Stock" Problem

Carbon emissions stay in the environment for approximately 100 years. Therefore, the damage to the environment is due as much to the past emissions as from the future ones. Bhagwati (2006) argues that if future emitters are to be held responsible for their acts, so must be past emitters. While countries such as China and India are becoming substantial contributors (with India still very far behind China) to the flow problem, they have contributed very little to the stock problem.

According to the Pew Center on Global Climate Change, the United States contributed 30 percent of the cumulative CO_2 emissions between 1850 and 2000; EU-25 together 27 percent (Germany 7 percent, UK 6 percent, France 3 percent, and each of Poland and Italy 2 percent); Russia 8 percent; China 7 percent; Japan 4 percent; and Ukraine, Canada, and India 2 percent each.[22] In other words, approximately 71 percent of the emissions from 1850 to 2000 were accounted for by the United States, EU, Russia, Japan, and Canada alone. As Table 3 shows, with 4.4 percent of the global CO_2 emissions in 2006, the latest year for which data exist, India is now the fifth largest contributor to the flow problem with China (20.6 percent), United States (20.2 percent), EU (14.8 percent), and Russia (5.8 percent) accounting for the top four emitters. Quite apart from the fact that the gap between the current top three emitters and India is very large, the latter's contribution to the stock problem at 2 percent is tiny. Under any reasonable equity principle,

21. Small economic size of these countries is not sufficient to explain the omission. Some African countries are comparable in economic size to some of the tiny but richer countries that the authors propose to cover under the carbon tax.

22. These data are taken from website http://www.pewclimate.org/facts-and-figures/international/cumulative (accessed on May 13, 2010).

TABLE 3. CO_2 Emissions from the Consumption and Flaring of Fossil Fuels, 2006

Serial number	*Country*	*Total emissions (Million metric tons of CO_2)*	*Percent of world*	*Per capita emissions (Tons/capita)*
1	China	6,017.69	20.6	4.58
2	United States	5,902.75	20.2	19.78
3	European Union	4,331.97	14.84	7.99
4	Russia	1,704.36	5.8	12
5	India	1,293.17	4.4	1.16
6	Japan	1,246.76	4.3	9.78
7	Germany	857.6	2.9	10.4
8	Canada	614.33	2.1	18.81
9	United Kingdom	585.71	2.0	9.66
10	South Korea	514.53	1.8	10.53
11	Iran	471.48	1.6	7.25
12	Italy	468.19	1.6	8.05
13	South Africa	443.58	1.5	10.04
14	Mexico	435.6	1.5	4.05
15	Saudi Arabia	424.08	1.5	15.7
16	France	417.75	1.4	6.6
17	Australia	417.06	1.4	20.58
18	Brazil	377.24	1.3	2.01
19	Spain	372.61	1.3	9.22
20	Ukraine	328.72	1.1	7.05
21	Poland	303.42	1.0	7.87
22	World	29,195.42	100	4.48

Source: Energy Information Agency, United States Department of Energy.

it cannot be expected to become a part of an agreement that addresses only the flow problem.

Coming from the opposite viewpoint and drawing on the work of Mueller et al. (2007), Cooper (2008) categorically rejects the case for compensation by rich countries for the past emissions. His principal argument is that past emitters did not know the harmful consequences of their actions at the time they undertook those actions. Moreover, present generations cannot be held responsible for the actions of their forefathers.[23]

Bhagwati counters, however, that compensation by a future generation for a harmful act that its ancestors committed without knowing the associated harmful effects is not unusual. Americans who practiced slavery in the

23. Drawing on the literature on distributive justice, Beckerman and Pasek (1995) have challenged the role for equity in determining the allocation of costs of future mitigation and questioned the validity of compensation for the damage resulting from past emissions.

19th century acted according to the prevailing social norms; they did not know their actions would cause harm to the future generations of African Americans. Yet, once it came to be recognized that those acts had inflicted harm, the affirmative action program was put in place.

There is also an important precedent from within the environmental area in the United States for compensation against past damage. The United States Comprehensive Environmental Response, Compensation and Liability Act of 1980, commonly called the Superfund, allows the Environmental Protection Agency (EPA) to compel parties responsible for dumping toxic waste in the 1970s in rivers, canals, and other sites to perform clean-ups or reimburse the government for clean-ups. The US law also permits individuals adversely impacted by toxic waste sites to sue the offending companies for damages.

If it is agreed that polluter pay principle must be applied to past emissions, how is it to be implemented? Bhagwati (2006) suggests creating a substantial global warming superfund to which developed countries contribute for no less than 25 years. Unlike in the case of the Superfund, there is no toxic waste to be cleaned up in this case. Therefore, the funds could be made available to the developing countries such as India and China to promote clean technologies including wind and solar energy. Given that developed country companies are likely to develop a significant part of these technologies, the fund would also benefit them.

Flow Emissions

The equity issue arises not just with respect to the past stock of damages but the future-flow emissions as well. Given their high levels of current emissions, rich countries will remain substantial emitters in the years to come. Their large demand for emissions would result in relatively high carbon prices in any mitigation scheme. In turn, that would have an adverse effect on growth and development prospects of the developing countries. Adding to this factor are the predictions that developing countries will be damaged disproportionately by emissions already in place.

The obvious instrument for redistribution in the context of future mitigation is the revenue collected through the emission tax or that associated with emission permits. If the mitigation instrument is emission tax, the revenue raised from it could be redistributed in favor of the developing countries. And if emission permits are used, they could be allocated disproportionately to the latter allowing them to raise revenue by selling the bulk of them in the marketplace for cash.

Recognizing this equivalence between the tax and permit systems, I cast the remainder of the discussion in this section in terms of the latter. We can describe some illustrative redistribution schemes in terms of the initial allocation of permits. Assuming a known global cap on emissions, some possibilities are:

- Each country is given permits in proportion to the emissions in an initial base year. This scheme would give the developed countries, which account for the bulk of the current emissions, the lion's share of the revenues and is unlikely to be acceptable to the developing countries, especially absent any compensation for the past emissions.
- Each country is allocated permits equal to its actual emissions in the globally efficient equilibrium. Under an emission tax, this would allow each country the revenue it collects from its firms. Under the permit system, a global body would auction permits to firms around the world, collect the revenue, and then return it to the countries in proportion to permit purchases by firms within their respective jurisdictions. This scheme, favored by Cooper (2008), involves no redistribution of revenues at all.
- Permits are distributed in proportion to each country's population. This scheme awards equal permits per capita across the globe. This is justified on the ground that environment is a common resource with each individual having an equal claim to it. This is the allocation favored by India in its representations but the developed countries oppose it. It may be noted that if the objective is full equity, this allocation still falls short of full egalitarian distribution for two reasons: the stock problem still remains, since the rights to past emissions were not equally distributed and the damage from emissions will still be unevenly distributed across individuals and countries.
- A related scheme would be to distribute permits in inverse proportion to each country's per capita income.[24] Given, the bulk of the population is concentrated in the low-income countries, this criterion would closely track the previous one with the qualification that within developing countries, it would result in smaller allocations for China and within developed countries, for the United States. This scheme would also lack support in the developed countries.

24. Letting y_i denote per capita income of country i, the share of country r according to this criterion would be $(1/y_r)/\sum_i(1/y_i)$.

- Developing countries below a specified per capita income are not subjected to mitigation commitments. They join the mitigation effort as they cross the threshold level of per capita income with liberal allocations of permits in the initial years that eventually decline to their actual emission levels. This alternative allows the poor countries full flexibility to pursue their development goals until they reach a minimum per capita income.

Flow Emissions: Numerical Applications

Many authors have simulated the implications of different allocation schemes for the costs and benefits to various countries. In this section, I discuss the results of one of these studies—Jacoby et al. (2008)—which, in my view, provides a nice illustration of how the developed and developing country interests clash under distribution of revenues associated with emissions (that is, allocation of permits). The basic strategy of the simulations is straightforward. Rather than explicitly model the costs of emission represented by the marginal cost curves in Figures 1–3 and optimally determine the level of emissions, they fix the global emission target exogenously. Permits for the targeted level are then allocated among countries according to a pre-specified scheme. Because permits are tradable, actual emissions at the national level are determined endogenously. Free tradability of permits establishes a single price of emission per unit and thus equalizes the marginal benefits of emissions across countries along the lines of Figure 2 and ensures efficiency in limiting emission to a pre-specified level. Any output losses relative to the scenario in which no restrictions on emissions are imposed, commonly called business-as-usual (BAU), determines the economic cost of mitigation. Permit trading generates financial flows from countries that are initially allocated fewer permits than their firms use to those that have more of them than their use. The scenarios are mainly distinguished according to the rules governing the allocation of emission permits across countries.

In the simple model I considered above and illustrated in Figures 1–3, I packed all production activity into a single aggregate good. The simulations in Jacoby et al. (2008) replace this aggregate good by a full-blown multi-good, multi-factor, and multi-country general-equilibrium model with all major GHG emissions endogenously chosen and free international trade in goods permitted. The model has seven developed and eight developing countries and the rest of the world as an aggregate. Emissions caps are applied to all GHG emission and are defined relative to 2000 emission levels. All simulations bring the global emissions down by 50 percent relative to their

2000 levels in 2050, linearly falling beginning in 2015. The authors consider seven different scenarios of which four suffice to bring out the source of conflict between developed and developing countries:

1. Allocations fall linearly such that developed countries receive permits equaling 30 percent and developing countries 70 percent of their respective 2000 emissions in 2050. Together, these terminal-year allocations yield an exactly 50 percent reduction in 2050 over 2000 emissions.
2. Allocations follow 2000 population shares. That is to say, permits are allocated equally on a per capita basis according to 2000 populations of countries.
3. Allocations are based on inverse share of per capita GDP in year 2000.
4. Developing countries are fully compensated for the costs of mitigation with developed country allocations of the remaining permits determined according to their year 2000 emissions.

Table 2 reports the allocations of emission permits, the welfare changes, and financial flows implied by the purchase or sale of permits in years 2020 and 2050 for the United States and India. Because the results for other countries are not central to the present paper, I suppress them. In the first case, the allocation of permits is 80 percent of 2000 emission levels for the United States and 98 percent for India as shown in the top rows. By 2050,

TABLE 2. Simulated Implications of Alternative Permit Allocation Schemes

	Declining proportion of 2000 emissions		*Equal per capita allocations*		*Allocations in inverse proportion of per capita GDP*		*Full compensation to developing countries*	
	2020	*2050*	*2020*	*2050*	*2020*	*2050*	*2020*	*2050*
Allocations as % of 2000 emissions								
USA	80	30	20.5	11.4	1.7	0.9	49.3	–8.3
India	98	70	265.4	147.1	405.2	224.6	127.6	93.3
Welfare (% change from reference level)								
USA	–0.1	2.6	–2.8	–5.5	–3.7	–7.2	–1.3	–7.4
India	–4.9	–11.4	20.9	21	39	48.9	0	0
Net financial transfers (2000 US$ billion)								
USA	–30.3	–179.6	–368.7	–668.8	–483.5	–1024	–196.7	–1239.4
India	10.1	14.7	232.7	513.9	439.7	1056.3	51.8	176.4

Source: Constructed from simulation results in Jacoby et al. (2008).

these fall to 30 and 70 percent, respectively. On the surface, this may seem like a good deal for India but the catch is that India's emissions in 2000 are very low, relative to where they would be in 2050 absent mitigation. Therefore, India suffers income losses on account of mitigation. This is reflected in the welfare cost shown in the middle rows: by 2050, India suffers a welfare loss of 11.4 percent relative to the level it would achieve absent mitigation. This occurs due to the rather high price of permits with India choosing to sell a part of its allocation to the rest of the world. This last fact can be gleaned from the last set of numbers that show a positive financial flow into India. In comparison, the United States does well in this scenario: in 2050, it experiences a welfare gain of 2.6 percent despite having to buy permits worth $179.6 billion.

As expected, the scenarios 2 and 3 turn out to be good for India as expected. In these cases, India ends up receiving permits several times its emissions in 2000. For instance, under the equal per capita distribution rule, it receives 2.7 times and 1.5 times its 2000 emissions in 2020 and 2050, respectively. This naturally proves a good deal for India: its welfare gain over the business as usual scenario turns out to be 21 percent higher in both 2020 and 2050. The United States takes a major hit: its welfare falls 5.5 percent in 2050. The contrast is even starker in the third case when allocations are done according to inverse per capita income.

In the last case, permit allocations are determined by fixing the welfare of the developing countries at business as usual welfare level. Therefore, by definition, the welfare of India is unchanged throughout relative to the business as usual equilibrium. What is interesting, however, is that by 2050, the United States not only receives zero permit allocation but also must effectively purchase permits worth 8.3 percent of its 2000 emissions in the market and give them away to the developing countries. The result is a whopping 7.4 percent decline in its welfare.

Joshi and Patel (2009) favor this last scenario and present it as their preferred proposal; indeed, they even christened it as the "Joshi–Patel" proposal. While attractive, two limitations of the program not recognized by Joshi and Patel must be noted. First, the scenario does not account for the damage resulting from past emissions in terms of increased frequency and severity of extreme events. The manner in which Jacoby et al. (2008) set up the model, the damage inflicted by emissions is entirely outside the analysis. Mitigation would help arrest the damage but would not make it go away. Second, per capita incomes excluding the transfers in this scenario are below those achieved under business as usual scenario. This implies that unless the transfers to the developing countries are maintained beyond 2050 and,

indeed, in perpetuity—an extremely unlikely scenario—they would end up worse off as soon as the compensating transfers end.

Despite these weaknesses, the last three of the numerical examples of Jacoby et al. just presented illustrate why the negotiations for mitigation are so complex and difficult. The uncertainties associated with the implications of global warming for individual countries in the absence of any action, different levels of development and growth trajectories, and different perceptions of equity held by different nations greatly add to this complexity. Unsurprisingly, substantive action so far has been difficult, as we will see below from a brief discussion of the efforts to-date.

Policy Action: The Current State of the Play

Given the free-rider problem externalities generated and the uncertainties associated with the costs and benefits of mitigation, it should be no surprise that action on the latter has been difficult. Efforts have been made at both national and international levels but with extremely limited success. Internationally, the United Nations Framework Convention on Climate Change (UNFCCC) provides the overarching institutional framework, though efforts have also been made at forums other than the UNFCCC. At the national level, countries have taken various steps to promote clean technologies and develop green sources of energy. Recently, the United States House of Representatives also passed a "cap and trade" legislation, known as the Waxman–Markey Bill after its sponsors Representatives Henry Waxman and Edward Markey, though it must also be approved by the Senate to become law.

Action at the International Level

The United Nations Conference on Trade and Environment (UNCED) held in Rio de Janeiro in June 1992 and popularly called the Earth Summit produced the international treaty UNFCCC. The aim of the treaty is to stabilize GHG concentrations to avoid "dangerous anthropogenic interference" with the climate system. In its original form, the treaty contains no enforceable limits on GHG emissions but provides for updates called "protocols" setting such limits. The Kyoto Protocol (see later) is such an update.

The UNFCCC entered into force on March 21, 1994 and has been signed by as many as 192 countries to-date. The members are divided into three categories: Annex I countries, Annex II countries, and Non-Annex

or developing countries. Annex I countries consist of all industrialized countries. Annex II countries are a subset of Annex I countries and include all OECD countries in that annex that were not "transition economies" in 1992.

Annex I countries are expected to reduce their GHG emissions to levels to be negotiated within the UNFCCC framework. They may do this by allocating the agreed upon emission targets among the major operators within their borders. The operators must then buy offsets to exceed their limits. Under UNFCCC, developing countries are not expected to limit their GHG emissions unless Annex II developed countries supply enough funding and technology. The signatories have agreed under "common but differentiated responsibilities" that the largest share of historical and current GHG emissions originated in the developed countries; per capita emissions in the developing countries are still low; and the share of developing countries in the global GHG emissions will grow to meet social and development needs.

The signatories to the UNFCCC have been meeting once a year in the Conference of the Parties (COP) beginning 1995. To-date, fifteen COPs have taken place and the sixteenth is scheduled to take place in Copenhagen from December 7 to December 18, 2009. Two of the most visible COP meetings were those in Kyoto in 1997 and Bali in 2007.

The Kyoto conference set out to establish a legally binding international agreement on GHG emissions. The result was the Kyoto Protocol, under which developed (Annex I) countries agreed to bring down GHG emissions 5.2 percent below their 1990 levels with varying limits across countries. For example, the EU15 committed to lowering its emissions by 8 percent of the 1990 levels (with varying targets for different EU members), the United States by 7 percent (though it eventually chose not to ratify the protocol), Japan by 6 percent, and Russia by 0 percent. The protocol permitted Australia and Iceland, both Annex I countries, to increase their GHG emissions by 8 and 10 percent of 1990 levels, respectively.

The Kyoto Protocol required that it could only come into force after 55 or more countries covering 55 percent of the 1990 emissions ratified it. Accordingly, it came into force on February 16, 2005. As of January 2009, 183 countries had ratified the protocol. Neither the Clinton nor Bush administration sent the protocol for ratification to the Congress. George W. Bush explicitly rejected it in 2001.

The signatory countries are to undertake emission reductions between 2008 and 2012. The protocol provides three mechanisms to facilitate implementation: (*i*) Emission trading, (*ii*) Clean development mechanism (CDM),

and (*iii*) Joint implementation (JI). Under emission trading, countries that manage to lower their emissions below the assigned target can sell their leftover rights (permits) to other countries that fail to lower theirs down to the assigned target. Under CDM, countries subject to reductions can meet their targets partially by undertaking emission-reduction projects in developing countries. The project earns the country a saleable certified emission reduction (CER) credit, each equivalent to one tonne of CO_2. Under JI, a country with an emission reduction commitment under the Kyoto Protocol (Annex B party) can earn emission reduction units (ERU) from an emission-reduction project in another Annex I party, each equivalent to one tonne of CO_2. The ERU can be counted toward meeting its Kyoto target.

The current status of intentions of countries on the implementation of targeted emission reductions is variable. Canada has stated that it will not be able to meet its obligations. Within the EU, Greece was excluded from the Kyoto Protocol on April 22, 2008 due to an unfulfilled commitment to create adequate mechanisms of monitoring and reporting emissions but the country was reinstated seven months later. Bigger European countries such as France and Germany will meet their targets. The EU15 achieved a reduction of 2.7 percent and EU27 of 7.7 percent by 2006. The Economist Intelligence Unit (EIU) (2009) estimates that if the EU15 implement all planned measures, they will reduce emissions by 11 percent by 2010.

After generally sluggish progress for nearly a decade, the thirteenth UNFCCC COP held in Bali in December 2007 tried to bring the negotiating process back on track. After spending an extra day over what had been planned, it concluded with the "Bali Action Plan," which together with a number of important decisions, formed the Bali roadmap. The Bali roadmap sets out the timing, main elements of and steps in the negotiations leading to a successor climate regime to the Kyoto Protocol. An ad hoc working group was appointed at Bali to complete the work by the fifteenth COP to be held in Copenhagen. The group was entrusted with the responsibility to discuss "mitigation commitments or actions" by all developed countries and "mitigation actions" by developing countries. The negotiations at Copenhagen are to be held on the four building blocks of the UNFCCC process: mitigation, adaptation, technology, and financing.

The success of Bali COP was limited, however. Specifically, it failed to produce an agreement on the future level of ambition on mitigation and ended up vaguely calling for "deep cuts in global emissions." Greater success in setting up the ambition level with respect to mitigation was achieved in the parallel but separate negotiations under the Kyoto Protocol mainly because the United States was not a party to them. The EU, which has been a strong

supporter of mitigation, largely drove the process in these negotiations. The parties under the Kyoto Protocol noted in their final statement the need for emissions to peak within 10–15 years and for emissions to be brought well below half of the 2000 level. They also recognized that Annex I parties needed to reduce their emissions in the range of 25–40 percent to reach the lowest stabilization scenarios assessed by the IPCC in its Fourth Assessment Report.

Three additional processes outside the UNFCCC have been at work to promote action on climate change: Gleneagles Dialogue kicked off by the 2005 G8 plus five meeting; Asia Pacific Partnership (AP6) consisting of Australia, China, India, Japan, South Korea, and the United States; and the United States Major Economies Meeting (MEM). Of these, the first one has had the most substantive impact on progress.[25] The 2005 G8 meeting brought five major developing countries—Brazil, China, India, Mexico, and South Africa—to participate and issued the Gleneagles Communiqué and Plan of Action on Climate Change, Clean Energy and Sustainable Development. It initiated the Gleneagles Dialog that came to consist of 20 countries. This dialog concluded at the 2008 G8 Summit in Toyako, Japan, with the G8 leaders expressing strong need to consider and adopt a global Long-Term Goal of a reduction in emissions of at least 50 percent by 2050 in their final statement.[26] The G8 leaders also signaled their intention to agree to a global international climate change framework when the fifteenth UNFCCC COP meets in Copenhagen in 2009.

Under President Bush, the United States had been opposed to participation in an international treaty for mitigation such as the Kyoto Protocol. The US position under President Obama has undergone a drastic change. He has already created the position of a "global warming czar" under the title "White House coordinator of energy and climate policy" and appointed the former EPA Administrator Carol Browner to the task. But the conversion of the US President to the cause is only the necessary step toward a comprehensive agreement. The United States Congress remains steadfastly opposed to an agreement that does not require China and India to undertake binding mitigation commitments. For their part, China and India have stated in no uncertain terms that consistent with the UNFCCC,

25. For details on the other two processes, see European Parliament (2008). This publication offers an excellent overview of the Bali conference.

26. I am unable to ascertain whether this 50 percent reduction is relative to emission levels prevailing in 1990, 2000, or another year.

as developing countries, they have no intention of compromising their development and poverty alleviation programs by undertaking emission reduction obligations. Therefore, the negotiations at Copenhagen promise to be highly contentious.

Action at the National Level

There are several programs under way at the national level in many countries to address global warming. The EU 20:20:20 initiative whereby it plans to reduce GHG emissions by 20 percent, increase the share of renewable energy by 20 percent and curb energy consumption by 20 percent by 2020 is one such program. The United States and China have similarly introduced a number of programs aimed at curbing energy consumption. India has also announced its National Action Plan on Climate Change (Government of India, 2008). Within this plan, India is to launch eight separate missions. According to an August 24, 2009 Government of India press release, the second of these missions, National Mission on Enhanced Energy Efficiency, has just been approved. Announcing the approval, the Prime Minister stated, "This Mission will enable about Rs 75,000 crores [approximately $15 billion] worth of transactions in energy efficiency. In doing so, it will, by 2015, help save about 5% of our annual energy consumption, and nearly 100 million tons of carbon dioxide every year."[27]

While the reader can find summaries of the initiatives taken at the national level by a number of countries in the EIU (2009), it is important to briefly discuss here the implications of the Waxman-Markey "cap and trade" legislation, which has yet to pass the Senate, for India. This legislation proposes to cut the CO_2 emissions to 97 percent of 2005 levels by 2012, 80 percent by 2020, 58 percent by 2030, and 17 percent by 2050. Firms would be required to hold pollution permits for their CO_2 emissions. The current proposal is to distribute 85 percent of the permits for allowable emissions to the firms free of charge and auction 15 percent of them competitively. Once in private hands, permits will be freely tradable in the market. The proportion of freely distributed permits would decline over time dropping to nil in 2030.

A threat facing India and other countries lacking similar cap and trade or equivalent programs is that the United States may subject its goods entering

27. The quotation can be found at http://pib.nic.in/release/release.asp?relid=52092&kwd (accessed on September 9, 2009).

into the United States to similar requirements. Importers of a product from India may be required to buy pollution permits to cover its carbon content or pay a tax equal to the allowance price. The issue then would be whether the World Trade Organization (WTO) dispute settlement body would uphold such a measure under its rules.

In a carefully argued paper, Bordoff (2008) takes the view that though we will know the truth of WTO compatibility of such a measure only when it is challenged in the dispute settlement body and the latter gives its ruling, the case for an affirmative ruling is rather weak. Rather than reproduce various legal arguments made by Bordoff in detail, it suffices to report his broad points here. The United States will have to justify the imposition of a domestic environmental regulation or tax on imports under either the "national treatment" provision of Article III of the General Agreement on Tariffs and Trade (GATT) or the environmental exception allowed under Article XX of the latter. There are problems with justifications under both provisions.

GATT Article III requires that once a product has crossed the border, it be accorded the same national treatment as domestically produced "like" products. In defining like products, the process and production method (PPM) cannot be considered as product characteristics.[28] This would rule out distinguishing imported products from domestically produced ones based on GHG content. An additional problem will arise with respect to the Most Favored Nation (MFN) treatment required under Article I of GATT. So far as many European countries do have cap and trade programs in place, imports from them will have to be exempted from any GHG related charges. This would introduce discrimination based on the origin of imports. A final complication would be that under the current proposals, the United States proposes to hand out 85 percent of the permits free of charge, which is likely to be interpreted as subsidy under the WTO rules.[29]

In all likelihood, the United States will have to justify any effective carbon taxes on imports under the environmental exception permitted in Article XX of the GATT. Under Article XX, discrimination is permitted but the United States will need to persuasively argue that the measure is

28. Some analysts argue that the recent EU Asbestos case opens the door to the inclusion of the PPM as characteristics defining the product. But this is misleading since the ruling in this case explicitly relies on physical differentiation between products made from asbestos laden fibers and others.

29. Bordoff (2008) provides a systematic analysis of the circumstances under which the WTO may or may not rule the subsidy as actionable.

required to reduce the overall leakage. This is a tough sell, given leakage is itself a small proportion of the emissions, and subjecting imports to permit requirements would do little to plug that leakage.[30] Based on the Appellate Body report in the shrimp-turtle case, Bordoff (2008) further argues that the WTO may also consider the differences in the conditions of the United States and developing countries in reaching a decision. To quote him,

> Fourth, the US program must take into consideration "different conditions which may occur" in different countries. Failure to do so may constitute "arbitrary discrimination," according to the Appellate Body. In that regard, the WTO might consider the relevance of developed countries' greater historical responsibility for cumulative carbon emissions and higher current emissions per capita. In that case, there is a possibility the WTO would find that even a border adjustment [through the requirement of permit purchase] applied equally to domestic and imported goods is noncompliant.

In taking action against India, politically, the United States also runs a different risk. Other developed countries, notably in Europe, have emission reduction programs that possibly go farther than the United States program under Waxman-Markey legislation. Therefore, any action by the United States will make it vulnerable to similar actions by other developed countries with tougher mitigation programs.

In sum, while India cannot rule out the possibility that the WTO might approve of the United States effort to "level the playing field" through an effective pollution tax equivalent to that borne by the US firms under the proposed cap and trade system, it is by no means a foregone conclusion.

India's Options

We are now in a position to consider the key question of this paper: What should India do going forward? I divide the answer into three parts: what is in India's best interest, what it can do to contribute to mitigation without compromising its own national interest, and how it should respond to pressures, originating principally in the United States, for undertaking internationally sanctioned mitigation obligations beginning in the near future, say 2020.

30. It is easy to envision countries reshuffling their trade to avoid the charge associated with the permits. For example, the US might import more from Europe, which will not be subject to buying the US permits, and less from India and other developing countries, which will export more to Europe.

India's Interests

Many analysts based predominantly though not exclusively in the West argue that India is so vulnerable to the harmful effects of climate change that it should actively seek a post-Kyoto climate change treaty at the Copenhagen conference in December 2009. They argue that the acceptance of internationally mandated restrictions on GHG emissions by India in the near future, say beginning in 2020, is in its own national interest.

I disagree with this proposition. The foremost objective India must pursue in the forthcoming decades is to provide its citizens with a humane existence with adequate access to basic amenities such as shelter, water, and electricity. Given that 300 million Indians still live in abject poverty and 400 million are without access to electricity, achieving this objective requires sustained rapid growth complemented by well-crafted social programs for some decades to come. The question then is whether such growth is feasible while implementing mitigation targets beginning in the near future, say, 2020.

As I stated in the introduction to this paper, even if India were to aspire to the *current* Chinese living standards, its carbon emissions will have to rise to at least three-and-a-half times their current levels. Achieving the standards currently enjoyed by South Korea and Singapore would mean far greater expansion of the emissions. Based on 2006 data, the latest available, India ranks 137th in terms of per capita carbon emissions. China, South Korea, and Singapore respectively emit as much as 4, 9, and 27 times the emissions by India on per capita basis. Even the world average is 3.8 times that of Indian per capita carbon emissions. Barring the appearance of dramatically cleaner technologies and green sources of energy within a short period of time, acceptance of even modest mitigation commitments beginning in 2020 would condemn a significant number of Indians to an inhuman existence in perpetuity.

A key argument mitigation advocates offer is that by refusing to accept mitigation obligations as a part of a Copenhagen treaty, India makes matters worse for itself by making future catastrophes more likely. They say that being among the most vulnerable to catastrophic events such as cyclones and floods in its coastal regions, India stands to gain the most from joining the mitigation effort. There are at least four objections to this argument.

First, as discussed in greater detail in the second section, while the facts of global warming and GHG emissions as its cause are widely accepted, scientific evidence linking GHG emissions to increased frequency or intensification of catastrophic events such as floods, hurricanes, and cyclones is lacking. To remind, reporting on a careful survey of peer-reviewed

literature on the relationships between global warming and the frequency and severity of hurricanes in the *Bulletin of American Meteorological Society of America*, Pielke et al. (2005) concluded that "claims of linkages between global warming and hurricane impacts are premature." They went on to add, "the peer-reviewed literature reflects that a scientific consensus exists that any future changes in hurricane intensities will likely be small in the context of observed variability." Evidence linking global warming and glacier melting is similarly weak: the Gangotri glacier has been receding since scientists began to keep its measurement in 1780.

Second, assuming a connection between GHG emissions and increased severity and frequency of rains, floods, heat waves, and even cyclones and hurricanes exists, mitigation by India in the next two or three decades is neither necessary nor sufficient to arrest global warming and its consequences. The richer world consisting of the US, Europe, Japan, Canada, and Eurasia account for slightly more than 50 percent of the current carbon emissions. Adding China brings the proportion over 70 percent. In contrast, India accounts for only 4.4 percent of global carbon emissions.

If the big and largely rich emitters of today were to take mitigation in the immediate future seriously, they could achieve emission cuts commensurate with the IPCC recommendations without denying the poor in India (and Africa) the prospects of a humane existence. With abject poverty eliminated and electricity and water provided to all, India could join the mitigation effort two to three decades from now. At that point, it would ease the future burden of the countries taking on mitigation obligations in the early decades. The argument that mitigation is not feasible without participation by India, thus, appears to be a political one. Perhaps itself less than fully convinced of the extreme long-run effects of GHG emissions but politically cornered, the United States Congress has taken the expedient if not altogether cynical position that it will not accept internationally mandated emission obligations unless India accepts them beginning in 2020 as well. The Waxman-Markey legislation, which proposes action through purely domestic mechanisms, likewise, faces uphill battle in the Senate.

Third, the stock of carbon in the atmosphere in the next two to three decades would continue to be dominated by the emissions accumulated over the past century. Therefore, in so far as the impact of human activity on global warming, rains, floods, sea levels, and hurricanes in the next two to three decades is concerned, the die is already cast. If India accepts mitigation commitments early on, it will remain woefully inadequately prepared to face the vagaries of nature that would visit it even absent any additional GHG emissions. But if it manages to postpone the commitments

for two to three decades and stay course on growth and poverty alleviation, it would be able to provide significantly improved protection against the adverse natural events in the future.

With higher incomes, India will be better able to adapt itself to GHG emission related changes in the climate in the next two to three decades that future mitigation cannot prevent. With better shelters, individuals will be better able to protect themselves against heat, rains, floods, and even cyclones. With access to world-class vehicles on land, sea, and air, good highways, ports and airports, and the state of the art means of communication, they would be better prepared to react to emergencies arising out of natural calamities. At higher incomes, the citizens will also be better able to access modern medicines and healthcare. In a similar vein, the government will have more resources to assist citizens against emergencies arising out of various natural disasters. It will be in a much stronger position to move people away from coastal areas and build dikes as water levels rise. It will also have more resources to alleviate water shortages that threaten India in the forthcoming decades even if mitigation proceeds according to the IPCC recommendations.

Finally, GHG induced effects on extreme events are only one of the many challenges India faces in its quest for the provision of humane existence for all. Nutrition, health, education, urban infrastructure, and local pollution problems are among some of the most pressing problems with which India must grapple. Accepting mitigation obligations in the near future to avert possible rise in the frequency and severity of extreme natural events must be weighed against a compromise along all these pressing problems in the near future.

India has grown a little above 6 percent in per capita terms during the last 6 years. If this average growth rate can be sustained, its per capita income of $1,016 in 2008 (in 2008 dollars) would rise to $3,260 in 2028 and to $5,835 in 2038. At these per capita income levels, India would have essentially conquered abject poverty and would be in a position to fully join the mitigation effort.

Voluntary Mitigation

While internationally mandated mitigation commitments beginning in the near future would compromise its national interest, India can still contribute to mitigation efforts by adopting "green" measures that are consistent with its growth and poverty alleviation objectives. For example, the adoption of certain "green" technologies such as replacing "green" bulbs for the

conventional ones cannot only lower carbon emissions but is also less costly in the long run. Likewise, fighting urban pollution that causes lung diseases, replacing dirty sources of energy such as wood by clean sources such as gas in domestic cooking, pricing of electricity to reflect scarcity and reforestation can promote domestic developmental objectives while helping mitigation. India should also welcome the adoption and development of clean technologies when developed countries are willing to provide them free of charge under programs such as the clean development mechanism of the Kyoto Protocol.

Acceleration of policy reform in the electricity sector is of particular importance. Giving free electricity to farmers leads to its economically wasteful use and also contributes to global warming. Large distribution losses due to poor management have the same implications. When struggling to bring electricity to all households, India can ill afford its wasteful disposal.

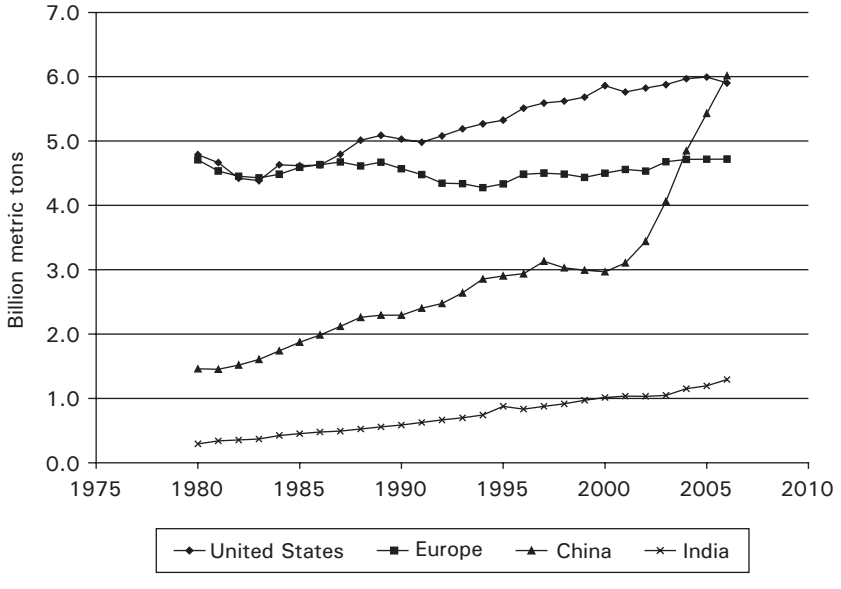
Questioning the Legitimacy of the US Pressure

The United States has been pressuring India to accept internationally mandated mitigation commitments in the near future as a part of a post-Kyoto climate change treaty to be negotiated in Copenhagen. Such pressure would be understandable had the United States been a shining example of mitigation. But this is not the case. The price of gasoline in the United States is among the lowest in the world. The country has also taken few tough steps to curb the inefficiencies in the use of electricity, lighting, heating, and cooling in its building sector. It even refused to ratify the Kyoto Protocol that it had signed and subsequently went on to significantly expand its carbon emissions.

Belatedly, the United States House of Representatives did pass the Waxman-Markey bill providing for a "cap and trade" system aimed at cutting emissions. But this bill too back loads mitigation. It replaces the base year for mitigation targets from 1990 in the Kyoto Protocol to 2005. Given the emission level in the latter year was much higher, the target of 17 percent reduction by 2020 in the Waxman-Markey bill turns out to be 6.4 percent above the target the United States had accepted for the year 2012 in the Kyoto Protocol. Alternatively, the Waxman-Markey target is only 3 percent below the 1990 emission. The bill also gives away 85 percent of the permits free of charge to politically influential and major emitter industries. Finally, the bill, as passed by the House, subjects countries without a similar "cap and trade" system to trade sanctions. Even so, it faces an uphill battle in the Senate.

In comparison, India scarcely qualifies as a big-league emitter. As previously noted, on a per capita basis, it ranks 137th in carbon emissions. While Western analysts routinely club India with China to give credibility to the claim that it is a gigantic emitter, few of them are perhaps aware that India accounts for less than 5 percent of the world's emissions compared with 21 percent of China. The country is, thus, not in the same league as China, United States, and the Europe Union even in terms of absolute emissions. Figure 4 graphically conveys this message. Super-high growth in China has led it to more than double its carbon emissions in less than a decade. But India's emissions have grown only at a modest rate and remain far below those of the United States, Europe, and China despite its second largest population in the world.

FIGURE 4. Total CO_2 Emissions from the Consumption and Flaring of Fossil Fuels, 1980–2006



Source: Based on data from Energy Information Agency, United States Department of Energy.

In view of these facts, the assumption of the high moral ground by the United States and exhortations that India, which bears little responsibility for the existing global warming, join active mitigation even at the cost of condemning a significant part of its citizenry to perpetual poverty borders on hypocrisy.

Exploring the Ways Forward

Before exploring possible avenues to progress, let me express serious reservations about the tactics employed recently by the Western press and politicians to threaten developing countries into accepting mitigation obligations.

The French President Nicolas Sarkozy recently stated, "We need to impose a carbon tax at [Europe's] borders. I will lead that battle."[31] Soon after, the United States climate negotiator Todd Stern joined Sarkozy in the intimidation game. According to a report entitled "China and India Warned to Co-operate Over CO_2 Emissions" in the *Financial Times* (September 16, 2009, p. 4),[32] Stern "warned countries such as China and India that they run greater risk of protectionist measures in the US Congress if they do not cooperate on the international steps to hold down carbon emissions." The Waxman-Markey legislation, still awaiting passage in the Senate, proposes to translate the threat into reality.

Of course, the legality of these tariffs under the WTO agreements has been questioned. Even then, countries such as China and India are large enough to credibly retaliate against such tariffs using WTO-legal instruments. Moreover, they can ill-afford to capitulate to the threat for the simple reason that the injury the carbon tariffs would inflict on them is minuscule in relation to the cost of accepting mitigation obligations.

Consider India. In view of the growth rate of 8.5 percent per year during the last 6 years, it is reasonable to assume that absent mitigation commitments the country can grow at the annual rate of 8 percent until 2030. A further reasonable assumption is that the acceptance of substantive mitigation obligations relative to business-as-usual emissions beginning with, say, 2020 will cut the growth rate of the country by at least 1 percentage point.

At 8 percent rate of growth, India's GDP would rise from $1.2 trillion in 2008 to $3.0 trillion in 2020. From then on, mitigation would take effect. At a 1 percentage point cut in the growth rate, the lost GDP would be a modest $30 billion in 2021. But this figure will rise sharply each successive year, reaching $575 billion in 2030. At a discount rate of 3 percent per year, the stream of losses during the 10-year period would sum to $2.1 trillion in net present value terms in 2020. Add to this the fact that the loss of $575 billion

31. This quotation is taken from the *Financial Times* (September 10, 2009) story titled "Sarkozy Calls for Carbon Tax on Imports." Available online at http://www.ft.com/cms/s/0/a5fb6084-9e32-11de-b0aa-00144feabdc0.html (accessed on May 13, 2010).

32. Available online at http://www.ft.com/cms/s/0/9f0bc6c2-a258-11de-9caa-00144feabdc0.html (accessed on May 13, 2010).

or more would accrue in perpetuity after 2030. The choice between this loss and the cost imposed by carbon tariffs is a no-brainer.

Yet another common threat routinely issued to impress upon China and India, the urgency of acceptance of mitigation obligations is that their refusal to do so will result in a failure to forge a post-Kyoto mitigation agreement at Copenhagen. In turn, the failure will lead to sinking of Shanghai, Mumbai, and Calcutta into the ocean by the end of the 21st century. Once again, such threats are not compelling. Having access to the same research as developed countries, one knows that Miami, New York, London, and Amsterdam face the same risk of ending up under water as Shanghai, Mumbai, and Calcutta by the end of the 21st century. A failure to reach an equitable agreement at Copenhagen is therefore at least as damaging to the United States and some European countries including France as to India and China.

Indeed, it may be argued that relative to their rich counterparts, poor countries may find it perfectly rational to trade a slightly higher risk of rising water level around their coastal cities for faster growth. That choice allows these countries to better prepare against not just the vagaries of global warming but other natural disasters such as earthquakes and ongoing hardships as well.

In arriving at a menu of constructive efforts for progress at Copenhagen, the United States and EU should confront two facts. First, recognizing the likelihood that they will remain among the largest emitters despite significant mitigation they might undertake in the coming decades, they need to convince the developing countries of their sincerity and seriousness in addressing global warming. This will require making significant financial commitments as well as undertaking substantial mitigation obligations. Second, the leaders of developed countries need to promote an environment of cooperation and harmony eschewing threats that are not credible and also certain to lead to acrimony. In particular, they must acknowledge that any acceptance of mitigation obligation by developing countries amounts to sacrifice and is their contribution to safeguarding the future of the planet. Most developing countries understand that sooner or later they have to be a part of the solution to the global warming problem and that this will require sacrifice on their part.

Against this background, efforts at tackling global warming at the international level may proceed along three fronts. First, an agreement may be reached toward giving developing countries credit for voluntary measures that contribute to reduction in GHG emissions. Indeed, for the vast numbers of poor developing countries, these voluntary measures should suffice with mandatory mitigation targets left for negotiation on unspecified future dates.

One important measure in this category could be re-forestation and reduced deforestation. For some developing countries, most prominently China and India, re-forestation is a part of their current development agenda. The adoption of green technologies such as replacement of the conventional bulbs by "green" bulbs is another such example. Yet another example is the effort to curb urban pollution that causes lung diseases as well as the replacement of kerosene and wood as cooking fuels by gas to combat domestic pollution. All these measures are in the interest of the developing countries purely from a national viewpoint but also contribute to combating global warming.

Second, an agreement may be reached to vigorously promote technological solutions at the international level. Schelling (2007) offers a rich discussion of technologies that are unlikely to be developed by private entrepreneurs and ideally require multi-government cooperation. One such example relates to technologies that would allow CO_2 generated in power plants to be captured, transported, and injected into an appropriate underground location. Research and development required for these technologies including sites suitable for permanent storage are unlikely to be undertaken by the private sector. The same holds for research in the area of geo-engineering aimed at finding novel ways to reflect away sunlight thereby counteracting the global warming caused by GHG emissions.

To promote this form of research and development, a substantial fund could be created through contributions by developed countries. The rationale for such contributions can be easily found: it can be seen as a tort payment for the past damage along the Superfund idea of Bhagwati (2006). The United States has long accepted the tort principle for past damage to the environment in the context of domestic pollution. Politically, such a fund may find support in the developed countries on the ground that, by and large, their own researchers and firms, who are currently ahead of the environmental-research curve, will be the principal beneficiaries of the expenditures from it, regardless of the precise modalities chosen to spend the moneys.

Finally, on the core issue of mitigation, there is need for a more relaxed attitude in general and toward developing countries with substantial pockets of poverty in particular. Given the vast amount of uncertainty on how much global warming will result from a given volume of GHG emissions and how global warming will impact the frequency and severity of natural disasters, it is a bit far-fetched to suggest that any specific mitigation target such as the IPCC-recommended 50 percent reduction in the 1990 levels of emission by 2050 is "optimal" in any meaningful sense. Schelling (2007: 4) makes this point forcefully:

> Deciding now, through some multinational diplomatic process, what the ultimate ceiling on greenhouse gas concentrations must be to prevent, in the immortal words of the Framework Agreement, "dangerous anthropogenic interference with the climate system," as a basis for allotting quotas to participating nations, is in contradiction to the acknowledged uncertainty about the "climate sensitivity" parameter, with its factor of three in the range of uncertainty.

Rather than pretend to work toward a grand optimal target far into a future year such as 2050, it surely makes more sense for Annex I countries to agree on targets going no farther than 2020. They, along with other UNFCCC signatories, can then return some time in the late 2010s to evaluate the further scientific evidence that would become available in the interim and decide upon the next step.

If developed countries are keen on bringing the developing countries on board to undertake mitigation obligations, it is important that they themselves agree to sufficiently ambitious targets within the context of the current knowledge on global warming. As noted earlier, at present, there remains suspicion on the part of the developing countries that developed countries themselves are avoiding taking on to their share of responsibility. They are acutely aware that many developed countries have not implemented the Kyoto targets to which they had agreed and have instead added to rather than subtracted from their 1990 emission levels. They also note with dismay that the United States is now proposing a shift in the base year from 1990 to 2005, which sets back the process.[33]

Apart from the provision for giving them credit for voluntary measures such as re-forestation and reduction of deforestation, which will encourage them to take more of such actions, a key concession the developed countries

33. For example, Jairam Ramesh, the Environment Minister of India, recently stated that India and China would "respond very positively" if rich nations such as the US agreed to a goal of cutting emissions 40 percent from 1990 levels by 2020. "That's a game changer," Ramesh said. "It would be very difficult for me, as an Indian minister, not to respond if developed countries accept this proposal. The fat would be in the fire, our bluff would be called." On the one hand, this statement may be dismissed as political rhetoric but on the other hand, a relatively ambitious target that challenges Ramesh is not out of reach. In a January 2009 communication to the European Parliament, the European Commission (2009: 2) has stated, "The EU is willing to go further [than its current commitment] and sign up to a 30% reduction target [relative to 1990 emission levels] in the context of a sufficiently ambitious and comprehensive international agreement that provides for comparable reductions by other developed countries, and appropriate actions by developing countries." If developed countries were to agree on 30 percent reduction in emissions relative to 1990 levels, a lack of response by India would bring Ramesh's credibility in question.

will need to give to bring the developing countries on board on mitigation is an agreement to set emission norms according to criteria that address the equity issue. Two such criteria would rely on the GDP and population. If GDP alone is taken as the basis, the cap for the developing countries will be set in terms of emission per-unit of GDP. If population is chosen as the basis, it will be set in terms of emissions per capita. A combination will effectively bring per capita GDP as a basis. A GDP-based norm gives the developing countries flexibility in maintaining high growth since it allows absolute emissions to rise with the GDP. The same can be said of per capita emissions cap though it will not lead to mitigation until the cap becomes binding.

In short, we now have constructive ideas on the table that can define the contours of an eventual agreement. Copenhagen provides an opportunity that should not be buried in the acrimony of threats from the leaders of the developed countries. Instead, it must be utilized to set us on the path to an equitable and efficient agreement aimed at coping expeditiously with the existential challenge of climate change.

Concluding Remarks

In this paper, I began by noting that that estimates of how much climate change has impacted India in the last century and predictions of how much it will impact the country in the current century are subject to vast amounts of errors. This uncertainly calls for sufficient preparation for adaptation to possible extreme weather change effects. This makes sustaining high rates of growth and poverty alleviation even more urgent.

Using a simple model, I have shown that the efficient solution to mitigation can be achieved through either a carbon tax or internationally tradable emission permits. A key point is that efficiency requires setting a single mitigation target at the global level or a single carbon tax worldwide with individual country-level mitigations endogenously determined. In contrast to this efficiency principle, international negotiations have sought to set mitigation targets by countries.

A key factor undermining the efficiency of a global mitigation target achieved through a uniform carbon tax or globally tradable permits, quite important in practice, is the presence of differential direct or indirect taxes on carbon in the initial equilibrium. For example, countries have different sales or value added taxes on gasoline in the initial equilibrium. The super-imposition of a uniform carbon tax on these taxes to achieve a given level of mitigation will fail to minimize the social cost of mitigation.

In practice, efforts toward mitigation are greatly hampered by their asymmetric distributional implications. I discuss these implications at length, dividing them into stock and flow counterparts, following Bhagwati (2006). I argue that at least in principle there is a strong case for the developed countries, which bear the bulk of the responsibility for the past emissions, to compensate the developing countries. Regarding the flow problem, I argue that there is an important equity issue here as well. Developed countries and China are responsible for the bulk of the current emissions. Even if these countries were to undertake significant mitigation obligations, they will remain the largest emitters. Most developing countries are small emitters on a per capita basis. Any agreement that attempts to extend mitigation obligations to these countries will have to address the equity issue.

I have provided a detailed discussion in the paper of the current state of play of mitigation policy at both national and international levels. At the international level, the negotiations for mitigation commitments at the fifteenth UNFCCC COP at Copenhagen are likely to be contentious as the developed countries try to get reluctant India and China to accept binding commitments. At the national level, the United States is poised to introducing a cap and trade program, which may pose some challenge to imports from countries such as India that do not have similar programs. If the United States eventually decides to subject the imports from the countries without cap and trade programs to its domestic permit requirements, a battle at the WTO on the legality of such extension is almost guaranteed. And if the WTO rules in favor of the US measure, countries such as China and India will have no option but to retaliate in a WTO consistent fashion.

Finally, the Copenhagen conference could try to make progress through cooperation in the promotion of research and development that satisfies the property of global public good and setting up mitigation agenda in the near term. Regarding the former, the paper suggests setting up a substantial fund financed by contributions from the developed countries. Regarding the latter, I argue that if developed countries are serious about the necessity of developing countries undertaking mitigation targets beginning some time in the near future, they need to lead by example. To be credible to the developing countries, they themselves need to first accept substantial mitigation obligations by 2020 relative to their 1990 levels. In addition, they will need to address the equity issue by agreeing to set the mitigation targets of the developing countries in either per capita or per-unit GDP terms. In the near term, except in the case of China, they may also have to settle for good-faith voluntary efforts by the developing countries.

Comments and Discussion

Vijay Joshi: Arvind Panagariya has written an excellent paper (hereafter the Paper) on the climate change problem in relation to India. In what follows, I shall focus not on its virtues but on what I consider to be its main shortcomings. Some of the points made below are also discussed explicitly or implicitly in my joint papers with Urjit Patel (Joshi and Patel, 2009, 2010).

The earlier sections of the paper discuss the scientific projections of the impact of climate change on the world and on India in particular. The tone of these sections is skeptical; the uncertainties in climate projections receive a great deal of emphasis. In my opinion, the paper significantly underplays the dangers of climate change. But I shall not discuss this aspect of the paper because I lack the expertise to do so competently. I will only point out that in the last couple of years since the publication of the 4th Intergovernmental Panel on Climate Change (IPCC) Report (IPCC, 2007c), scientists have become even more pessimistic about the impact of climate change than they used to be.

Collective Action

The paper is rather cavalier about the importance of India's contribution to the global mitigation effort. Indeed it goes so far as to imply that it would not much matter if India stood aside from the global mitigation effort until 2040, since the country accounts for only 4 percent of global emissions. There are two things wrong with this. First, to assess India's importance we must consider not its share in emissions now but its share in emissions in a future BAU scenario. This would be significantly higher than 4 percent. Second, even with a 4 percent share, India's total emissions are the fifth highest in the world. There are about 200 countries; if every country, from 5 to 200, took the paper's line, the global mitigation effort would fail. (The same stricture applies to the claim, sometimes heard, that the climate change problem can be solved by the advanced countries [ACs], without help from the developing countries [DCs]. The fact is that DCs are expected

to account for two-thirds of incremental emissions from now until the end of the century on a BAU basis.) I do not think the paper shows proper appreciation of the fact that climate change is a collective action problem and that the DCs must share in combating it. Of course, this does not imply that they should pay for the cost of their mitigation policies. Who should mitigate is a different question from who should bear the cost of mitigation.

Carbon Tax versus Cap-and-Trade

The paper's discussion of the choice between a carbon tax and cap-and-trade is not entirely satisfactory. On certain simple assumptions, the two are equally efficient but there is an important political-economy consideration that tells in favor of the latter, when equity is brought into the picture. In a cap-and-trade system, carbon trading would ensure that *any* initial allocation of permits to countries would lead to an efficient solution. This extra degree of freedom means that the allocation can be chosen to deliver equity and/or to offer inducements for compliance and participation. The implied financial transfers would take place automatically as part and parcel of the working of the market in carbon permits. With a carbon tax, a uniform international tax would have to be agreed—difficult enough but only half the battle. Equity could only be achieved by explicit, visible, budgetary transfers, which may be impossible politically to deliver. The only feasible way of combining efficiency and equity may be to distribute carbon permits from the start on an equitable basis. In the rest of my comment, I shall assume that the instrument of mitigation is cap-and-trade. But that is not essential to my argument.

Equity and "Historic Responsibility"

Fair burden-sharing is obviously critical to DCs', and in particular India's, willingness to be part of a climate deal. The paper distinguishes two separate equity considerations that need to be addressed. The first concerns the ACs' historic responsibility for the accumulated stock of carbon. The ACs have used up a large part of the safe carbon-absorbing capacity of the atmosphere and should therefore compensate the DCs for this expropriation. This is a persuasive claim but it runs up against some powerful moral intuitions. The ACs did not expropriate knowingly. They acted in the belief, universally held until quite recently, that the atmosphere was an infinite resource. Moreover, the expropriators are mostly dead and gone. Their descendants,

even if they could be identified, cannot be held responsible for actions they did not themselves commit. These points do not entirely overturn "historic responsibility" since ACs benefit hugely from their past carbon-intensive industrialization. Even so, the extenuating factors mentioned earlier surely count to reduce the fair liability of the ACs. The paper does not say how the fair liability of the ACs should be assessed. It does appear to commend, however, the suggestion that a global fund should be set up by the ACs to compensate the DCs for the "stock aspect" of the climate problem. But the need for this is not at all clear. The equity issue could be handled by structuring the distribution of permits to regulate the permissible flow of future emissions. If it were agreed that the ACs must pay for the damage caused by the stock of carbon, DCs could be given more permits annually to allow for that.

Equity, Permit Distribution, and Negotiation

The second equity consideration concerns the distribution of the burden of reducing the future flow of global emissions. If the reduction is to be achieved by a global cap on tradable permits, the critical issue is how to allocate them. On this matter, the paper largely follows Jacoby et al. (2008) in comparing different options. It should be noted that the latter paper is almost wholly a simulation exercise and does not discuss the ethical or political-economy aspects of different allocation criteria, nor does it propose any particular criterion. The paper rightly rejects on equity grounds the criterion currently in play in international negotiations, namely, a phased reduction of AC and DC emissions to 70 and 30 percent respectively of their 2000 levels by 2050. The other alternatives discussed are to distribute permits to countries on the basis of (*a*) population, (*b*) per capita income, and (*c*) zero welfare cost of mitigation for DCs, until a target date. The paper does not advocate any of these criteria or indeed any well-defined criterion. It argues instead that, given its development compulsions, India (and presumably many other DCs) should refuse to take on any quantitative targets until 2040. In my judgment, this would be a mistake. India should adopt a bolder strategy that is consonant with its status as a responsible future global power. It should offer to join a mitigation treaty on fair terms, such as criterion (*c*) above, viz. the "zero welfare cost" criterion.

Ideal fairness is a highly contentious concept and philosophers have argued about it for centuries. Progress in climate change negotiations will require the adoption of a non-ideal but acceptable notion of fairness that can

bridge differences in entrenched positions. The population and per capita income criteria fall in the "ideal" category. The rationale of the former is rights-based: each human being has an equal right to use the remaining global carbon space. The rationale of the latter is egalitarian: permits should be given to the very poor because they are very poor. Either way, the above principles imply that most of the permits should be given to DCs. This is because they contain most of the world's people as well as most of the world's poor. The trouble is that such a radical extension of human rights or of egalitarian values would be internationally unacceptable. There is no agreement that natural resources should be equally shared. Why should the atmosphere be any different? Nor is there any enthusiasm for stringent international egalitarian obligations: foreign aid has consistently failed to reach even half the UN target of seven-tenths of 1 percent of ACs' gross national product.

The way forward is to focus on a principle that is widely accepted as a minimal requirement of fairness. The principle is simply, "Do no harm." In the climate change context, this plausibly translates into criterion (*c*) above: DCs should be enabled to reduce their welfare cost of mitigation to zero until they have eliminated abject poverty. In practical terms this would mean allocating enough tradable carbon permits to DCs to allow them to maintain the growth of their living standards along the BAU path, say for the next two decades. (Two decades is an average that may be suitable for India. The time-horizon would be shorter for China, longer for Africa.) After that time, DCs' permit allocations would be progressively reduced. Climate models, of which Jacoby et al. (2008) is an example, are capable of calculating the requisite time path of permit allocations.

This no-harm approach to burden-sharing would have many desirable features. It takes some account of "historic responsibility." This because the damage inflicted by the accumulated stock of carbon consists mainly of raising the cost of future mitigation for all countries. In the no-harm scheme, however, DCs' mitigation costs would be covered for an agreed period. The scheme also takes some account of rights-based and egalitarian arguments by skewing the allocation of permits toward the DCs, which would result in a significant financial transfer to them, unlike an allocation of permits based on current emissions, which would strongly favor the ACs. But the transfer to the DCs would not go beyond offsetting the welfare cost of their mitigation policies for a defined length of time. This would be more acceptable to the governments and citizens of the ACs than distributing permits on a population or per capita income basis, which would result in much larger financial transfers to DCs, several times larger than foreign aid flows today.

The paper takes the view that India should not accept any quantitative targets for three decades. Why not, if India can negotiate compensation for the welfare loss from undertaking mitigation policies? The paper provides no satisfactory answer to this question. A fair treaty would give India enough permits to follow a BAU welfare path for a couple of decades. There would be other advantages in joining a carbon treaty besides a significant inward financial transfer. It would give India some share in controlling the progress of the global climate negotiations. It would also forestall the risks of having trade restrictions imposed against the country as a treaty non-participant. In addition, as a first-mover among DCs, India may be able to negotiate other things it wants as the price of joining a treaty, for example a seat on the UN Security Council. (Note that the Western countries agreed to facilitate Russia's accession to the WTO in return for its joining the Kyoto treaty.)

In sum, the Panagariya paper is a highly sophisticated defense of the Government of India's current stand in climate change negotiations. My view, in contrast, is that India should regard a climate change treaty with quantitative targets as a diplomatic challenge of getting the right terms, not as a bugbear to be feared and shunned.

Devesh Kapur: Thank you. Following up from Vijay who has pretty much said what I wanted to say. But anyway, I would go at it. I shall first briefly summarize my take on what I thought the paper says. It basically says that there are climate changes, not much of a problem for India. Insofar as it is a problem, the cause is the industrialized countries. Therefore, India should not do anything in the near future, at least anything that might restrict its growth path. The author firmly believes that if climate change has any impact and adaptations are required, growth is the best way to adapt. Any additional cost for adaptation, when it is additional to growth, should be paid by financial and technology transfers from industrialized countries. As is usual, there is a very clear argument that there is no justification. One thing that is unusual from other things that I have read by him is that it actually very very strongly supports the GOI's policy. Usually Arvind disagrees with the GOI but in this paper, in summary he is more catalytic. That shows how open-minded you are.

The first point I think he is skeptical about is scientific evidence. I would not go into that as Jessica will be taking on that, but at least my reading would be rather different. I think one thing that is fair, is not explicit, and I think it is around in Delhi policy circles more generally, is that these scientific studies are a bit of scare tactic. The scare tactic, the scare mongering

look that India will be the worst affected, etc. etc., is basically to stampede us into agreement that is not really in our long-term interest. This is a bit of thing that these things have somewhat overblown. So, I think the paper says, and think by and large we all agree, that there is considerable uncertainty with the scientific evidence. But I think it is also true that each successive report by the various scientific publications on this is that the trend has been almost pretty unequivocal, each successive year the report has become more and more pessimistic about the way the things are going. I think on that you can be reasonably sure that if you look at all the reports from 1990 scientific evidence, almost everything, from the glacial melt to sea temperatures, all of these seem to show on that. I think we have now resided about the uncertainty about its specific impacts on India per se as opposed to climate change as a global phenomenon.

Well, I think as Vijay said, if there is this large uncertainty—especially I think if at least some of these studies seem to suggest very strongly that there could be non-linearity so that these changes could accelerate if not done now—I think that is what the Urjit Patel and Vijay Joshi paper had that it could have very very strong implications for India if that happens. So, if that happens, then the precautionary principle would ask what the insurance premium that the industrial society pays is. That insurance premium can either come through being part of a global effort, which is mitigation, to some extent, and that is a cost, but that cost is like an insurance premium. Or it could be that you say, look, we are not going to be part of anything international and we will pay the cost through greater expenditure, efforts, and adaptation. Either way there will be a cost that is, in a sense, the insurance premium that you are paying. The question is, how should we think through an appropriate insurance premium given this considerable uncertainty?

Then we step back a little bit about and think about environmental policy in India per se. At least my reading is that much of what happens to the environment by way of policy is out of compulsion, not out of conviction. And the compulsions have largely come from activists, from co-tooling. The Ministry of Environment felt very lucky that the Supreme Court passed an order that every project above Rs 50 crore needs a clearance from the Ministry of Environment, and my understanding is that it became a tremendous source for rent seeking in the Ministry, which is why one particular party that some of you might know, insisted that it always keeps that Ministry which was dead for the better part of the last decade. So, if you see the most recent statement in the Budget Speech, in which the new Minister of Environment

states, and I quote: "We have already started implementing the National Action Plan on Climate Change which has eight major Missions and 24 critical initiatives." This is the sort of thing. The National Action Plan on Climate Change was done a month before the Indian Prime Minister is going to attend the Copenhagen Summit. He had to show something, so, we came up with the Plan which was formed by a few people with very very little widespread consultation, and that was the plan. The basic thing is that we are doing everything and more, by and large, if you read that. When I read this, I called some friend in the Ministry of Finance. I just asked that in the budget how much money had been allocated to eight major Missions and 24 critical initiatives. Well, it so happens that they could not find. Of these Missions, five—Solar, Water, Energy Efficiency, Sustainable Agriculture, and Sustainable Habitat—will apparently be launched at the end of the year. So, forget money; they have not officially. But we are saying that we are doing all this. The budgetary allocation is the only one that I have been able to find and I would be corrected, it is for something called the National…. And Lake Conservation Plan for which Rs 562 crore has been allocated. So, that is the one you put your money into. This is one thing.

What surprised me about the paper is and you said it really thumbs up, with India's position more as a center of entitlement. It is not really about a bargaining approach to international agreement. What are the second best options given that especially when you begin to see what the other side's constraints are and what the other side implies to do? We all began with Kyoto and I think one thing which I see Kyoto to quote is the lovely title of the paper. If someone sees the CPR on India's foreign policy, it was called "Aim low and hit lower." I do not have to get into Indian foreign policy but Kyoto I think was a very classical example of that. It aimed low, it hit lower and now we also realize the problem is much much bigger than what are we going to do about this. I think there is one very significant difference between the climate for international agreements which have occurred in the past, frankly 50 years, and what is going to happen in the next few decades and I think that for the first time it sensed that the West is no longer hegemonic. I think we really underestimate how that is going to change the entire bargaining climate. Prior to this, whether you liked it or not, a few dominant powers got together for hegemonic stability or whatever you want to call it, and they basically came up with an agreement which served their interests and, by and large, the other countries were made to sign it. So, this was the story. That is not going to happen. When that is going to change, you might believe that the agreements will be fairer, but

the agreements will be much more difficult to reach. I think the atmosphere in which the West, whether out of things about guilt and responsibility or foreign policy objectives, you name it, all these complex reasons that drive motivations behind agreement, that is going to be much much less. For instance, if you think of a thing optimally the carbon tax, the idea that the US is going to have a tax, of which the money will be transferred to China, which I think is as unlikely as my becoming the Prime Minister of India. I mean, it is simply not on the cards. I think that is the sort of difference that we are going to see that there are many things that could have taken place when Asia was a rising power. And we cannot have it both ways that we want to be treated as equals but then we immediately take precaution on our commitment and say, Oh, we are really very very small players. So, when we want to be big players in the Security Council, we want to see the IMF and all of that, rightfully so I think, then we have this problem that when it comes to other things, we say we are really very very tiny and pitiful and things like that. Obviously, every side that is going to have its negotiating position, puts its best. So, as a negotiating position, this is fine, but I am just reading the lead down the line that international agreements are going to be much much more difficult to reach on these things.

Then, the questions that India faces are basically three—(*a*) Do you have an agreement where you are prepared to sit it out? (*b*) Do you have an agreement where you pay some price instead of mitigation? or (*c*) Are you prepared to seek no agreement at all? These are the three likely scenarios. I think it would be nice to hear from Arvind and perhaps in this paper about what he thinks would be the different costs and benefits. I mean, how should one think through this? I am not sure myself about which of these three scenarios in likelihood and the different implications for India. I think my sense of belief is that an agreement which at all binds India to any binding commitment is the worst scenario for India and it is better for India to set it out. But I would like to hear even more on that in the paper.

These are few of the points. One is on the adaptation side. I think he has a very firm belief that growth is the best form of adaptation and I think there are very good reasons, good historical reasons, and so on and so forth. But I wonder if we really do want to make the same mistakes as the West made or, for instance, something that China, I believe, is making now in this part of the globe, and whether you would not want to think of qualifying that how—after all, there are different growth strategies, not all growth strategies have same implications—and what are the different forms you see that this might indeed be an opportunity? For instance, we had lamented a lot that India had not done much in manufacturing compared to China, it should

have done more. But may that now be a strength because generally services are less polluting as compared to manufacturing. Could that actually be a strength and should that be a more feasible viable growth path, given what we now know about climate change? The second is, I am a bit more hesitant than what the paper says about these very critical links between rapid growth and lower environmental cost. I think the state in India which has had the most rapid growth has been Gujarat and what I have gathered now is that the environmental cost in Gujarat has been really quite high. That has not to do with climate change; it is much more local environmental cost, especially from the chemical industry. But all I am saying is that there are probably more qualifiers. Perhaps one should add that there is nothing automatic. At least I do not see that automatic as perhaps you see.

I will end with the following thoughts. One is that I think that the harder questions India will face are not just external but also internal. There is going to be a range of very tough institutional changes that India will have to think through because the distributional conflicts of this are not just international but are also intra-national. Some work which we have seen shows that inter-state variation in carbon emissions or GHG emissions is actually as large as the difference in emissions between India and the US. So, inequalities within India on this are also extremely high. That is not part of your external bargaining policy, but it is something that I think we cannot avoid that these will have to be part of internal bargaining. If you take institutions, like for watering. If we are going to have, and I think lightly, water shortages and distributional conflicts around waters, you can see what followed from the Cauvery River dispute. That is an example. These are going to multiply manifold. And to add to that, much of India's water comes from China or at least the head waters are from China for our major rivers, and I think there are already several reports that what happens if China faces these problems and diverts these waters northwards? What exactly is India going to do then? If you think of that, frankly it is not clear what India can do. These are some of the issues. I think there is a very recent nice paper by Nirvikar Singh which looks at that and the possible options. But I think these are the possible institutional changes that India will have to think of.

Finally, which I will just end with, I think it is very clear that these debates and thinking on climate change are just actually beginning and given the fact that they are going to involve and have effect on so many people in virtually every just society, I think it is urgent for India to really begin to involve much more wider sectors of society in these debates because that is really going to impact us. Thank you.

Jessica Wallack: The paper's main argument is that India could and should delay commitments to emissions reduction in order to maintain its growth rate and improve its future mitigation and adaptation ability. This conclusion is partly based on a model of trade-offs between growth and emissions cuts over time, although the author acknowledges that it is difficult to derive optimal target levels of emissions based on expected costs and benefits in each period given the uncertainties surrounding the trajectory of emissions and effect of emissions on global and regional climate. The second section, through the fourth, outlines these uncertainties in detail.

My comments raise questions about the treatment of uncertainty about the costs and benefits of emissions reduction now versus later. I argue that Panagariya under-represents the potential costs of climate change and omits key findings regarding the possibility of sudden, irreversible, disruptive environmental change. What we know about the probability distribution of uncertainty about climate change suggests we may be better off thinking about mitigation as insurance rather than consumption-smoothing. The paper also overstates (or too confidently assumes) the benefits of growth for poverty reduction and mitigation/adaptation capacity and ignores the possibility that retrofitting infrastructure and industry may be more expensive than advance planning that would be provoked by commitments now.

The additional evidence I present does not necessarily reverse Panagariya's main conclusion that India should not agree to binding commitments to limit emissions, but it does strengthen the global case for action and make it more difficult to maintain that India should not participate in some way.

The final section of my comments questions Panagariya's choice of title and argues that it should be more circumspect: this paper is about India's options for addressing carbon dioxide emissions (CO_2) and (implicitly) other greenhouse gases, not about India's policy options for addressing climate change. It overlooks emerging evidence about the role of air pollution, particularly ozone and its precursors, black carbon, and sulphates in regional and global climate change. India has distinct interests and policy options for addressing these contributors to climate change. This discussion is probably beyond the scope of this already long and comprehensive paper, but it is a significant omission in paper titled "Climate Change and India: Implications and Policy Options."

I leave discussions of the efficiency of various instruments for mitigating carbon as well as the overview of the international state of play to the other discussants.

Climate Change and its Consequences may be Worse than Portrayed

Panagariya is correct to emphasize the significant uncertainties about the costs of climate change. Climate sensitivity (the relationship between emissions and temperature changes) is the most important source of uncertainty in predicting climate change, but even if this is removed, there is still a 3C range of uncertainty about temperatures at the end of the century under business as usual scenarios due to uncertainty about demographics and social change (von Below and Persson, 2008). Hof et al.'s (2008) analysis of the importance of uncertainties about costs of climate change and costs of abatement finds that a wide range of emissions pathways can be justified by cost-benefit analysis using reasonable parameters. Choices about abatement costs, damage costs, and discount rates—as much value choices as scientific choices given the uncertainty about predicting future trajectories—drive the results.

Panagariya's portrayal of the uncertainties is misleading, however, in that it overemphasizes the reasons for skepticism and neglects to mention several aspects of the nature of uncertainty that are relevant for incorporating the uncertainty into optimal policy design.

The evidence for an upward trend in temperatures is not as weak as he portrays it to be. The only paper on trends cited, Santer et al. (2000), analyzes just 17 years of data. Their primary purpose is to comment on the validity of statistical methods used to estimate trends and adjust for temporal autocorrelation of the data. The authors explicitly state that they do not consider underlying causes of the trends or whether trends are stochastic or deterministic due to the short time series and lack of understanding about how climate forcing may affect natural variability in temperature among other reasons. Both of these factors would work against finding a statistically significant trend even if climate change models were correct. Also, it is important to remember that a finding of lack of statistical significance simply means that the confidence interval includes zero as well as the model-predicted trend assuming anthropogenic warming effects.

Panagariya also neglects to mention the generally accepted scientific argument that observed temperature changes are muted because some types of air pollution have "masked" about a quarter of the warming and oceans' thermal inertia has slowed the manifestation of another quarter of the warming that current levels of CO_2 have already committed us to. Current levels of CO_2 suggest that we should have seen about 2.4°C of warming with a 90 percent

confidence interval of 1.4°C to 4.3°C given various assumptions about climate sensitivity.[1] Evidence of relatively greater warming in areas that have reduced emissions of the "masking" air pollution is consistent with this argument (Philipona et al., 2009).

The connection between emissions and temperature change is not as tenuous as Panagariya implies. The Intergovernmental Panel on Climate Change's (2007c) verdict on the evidence is not as wavering as implied by footnote six's statement that the panel "leaves the door open" to doubt about whether GHGs cause warming by stating that anthropogenic greenhouse gas emissions are only "very likely" to be linked to observed temperature increase. The statement "very likely" has a defined meaning of over 90 percent probability and the fact that it is italicized in the original is not for emphasis on the uncertainty, it is for emphasis on the fact that this is a defined term. The fact that a large group of scientists from around the world, interacting and writing a report at least in tacit recognition of policy-makers' preferences, can agree that anthropogenic causation of temperature change is at least 90 percent likely is striking. The door is open to doubt, but it is not open very wide.

Finally, Panagariya downplays the potential impact of climate change on weather and associated economic outcomes. The section on temperature change makes the point that there does not seem to be an overall trend and that temperatures in some areas in some seasons are actually declining. Italics emphasize the word declining, in apparent counterpoint to perceptions of global warming as the problem. However, this point is irrelevant for estimating the impact of regional changes in temperature and its variability on crop yields. Any temperature change, increase or decrease, can be disruptive for crops, and an increase in variability particularly problematic.[2] And the data are not good enough to say anything in particular—reassuring or not—about the extent of change or its impact on farmers. The fact that the government's report is on mean temperature changes is based on 31 stations and that for minimum/maximum from 121 stations in a country of 3,287,590 square kilometers is one indication of the problem.

1. Ramanathan and Feng (2008) use Intergovernmental Panel on Climate Change (IPCC) estimates of greenhouse forcing and climate sensitivity to calculate committed warming of 2.4°C with a 90 percent confidence interval of 1.4°C to 4.3°C.

2. The impact of temperature changes on farm incomes also depends on farmers' ability to adapt by changing crop varieties or farming practices. Adaption ability appears to be low for small farmers, given limited plot size for experimentation, access to agricultural extension information, seeds and inputs, and market infrastructure.

Similarly, the section on rainfall mentions some regional changes in rainfall, but concludes by citing evidence that there has been "no change in the trend on either the annual or seasonal basis" over the past century and a half. The all-India findings, however, are not as relevant as the changes in the location of rainfall, which, again, is not adequately measured.

On glaciers, the author's conclusion that while glaciers may be melting, the decline is unrelated to climate change is similarly unfounded. Glacier monitoring in India is notoriously incomplete and time series data are rarely comparable enough to justify calculations or comparisons of the rate of change. Measuring the snout of the glacier as discussed here is misleading because glaciers that are actually losing mass can appear to grow if they are slipping due to water melting at the base.[3] There are only two glaciers where mass balance—a better measure of glacial health—has been tracked for more than a few years.[4]

Panagariya's discussion of the impacts of climate change also neglects to mention that the worldwide evidence seems to look worse as uncertainties are resolved and we understand the risks in more detail.[5] The past decade of scientific evidence on links between temperature changes and "reasons for concern" such as risks to threatened and unique systems, risk of extreme weather events, and risk of large-scale discontinuities suggests greater environmental change at lower temperatures than had previously been estimated in the 2001 IPCC Assessment (Smith et al., 2009). The widely cited Stern report, which advocated early action on emissions cuts to avoid substantially greater costs of adjusting to climate change later, is now considered too conservative by the main author.[6]

More importantly, Panagariya overlooks two commonly accepted findings that are relevant for incorporating uncertainty into policy analysis:

3. The comparability of long historical time series on the snout of the glacier is also questionable. While satellite imagery can pinpoint the snout accurately and comparably over time for the past 40 years, previous measurements could be misleading if collected at different times in the seasonal ebb and flow and geo-location was also less precise.

4. Personal communication with Michele Koppes, Assistant Professor, University of British Columbia.

5. Uncertainty (knowledge of the possibility of various outcomes without a sense of these outcomes' relative probabilities) becomes risks as we are better able to assign a probability distribution to the possible outcomes.

6. Nicholas Stern's 2008 statement to a Reuters interviewer, "Emissions are growing much faster than we'd thought, the absorptive capacity of the planet is less than we'd thought, the risks of greenhouse gases are potentially bigger than more cautious estimates, and the speed of climate change seems to be faster," was widely quoted in the blogosphere. Hepburn and Stern (2008) reiterate the point.

the significant probability of outcomes that are worse that the mid-range scenarios and the finding that environmental change is non-linear and potentially irreversible on human time scales.

Climate sensitivity, the most significant source of uncertainty in calculations of the effects of emissions, has a "fat tailed" distribution (Roe and Baker, 2007). The probability that outcomes on the higher range of climate sensitivity (which imply higher temperatures for a given concentration of CO_2) does not decline to zero in the limit. This means that cost-benefit analyses that approximate risk using the normal distribution (for which the probability of extreme outcomes does go to zero in the limit) or otherwise truncates the distribution of extreme outcomes, understates risk. Weitzman (2009) highlights the difference that such a "fat tail" can make for analysis of climate policy: it points to mitigation now being the optimal solution.[7] He argues in a related paper (Weitzman, 2007) that under these circumstances we should think of the question of mitigation as "how much insurance to buy," rather than as a question of consumption smoothing.

The fact that environmental change may also be sudden and irreversible reinforces the importance of thinking about mitigation policy as insurance rather than consumption smoothing. Lenton et al. (2008) identify a series of "tipping points," or environmental thresholds that trigger a rapid transition to a new state. If the Arctic Sea ice melted, for example, the darker ocean surface that would be exposed would accelerate warming by absorbing more radiation. The Western Antarctic Ice Sheet's melting (and contribution to sea level rise) would accelerate if ocean water undercut its foundation on the bedrock. Similarly, freshwater from melting ice entering the North Atlantic could halt the North Atlantic Deep Water formation and cause significant regional cooling in Europe and elsewhere. The IPCC (2007c) report discusses the risks of these events and finds them to be generally relatively low-probability, but Lenton et al.'s (2008) paper includes additional evidence that reinforces that these are real possibilities. Their conclusion is that "society may be lulled into a false sense of security by smooth projections of climate change" (Lenton et al., 2008: 1792). Many of these changes will be irreversible on a human time scale (Solomon et al., 2009).

Finally, CO_2 remains in the atmosphere for centuries to millennia, leaving a long lag between emissions and the outcomes that they in some sense

7. In more exact terms: it "makes the expected present discounted disutility [due to climate change] very large."

pre-determine. Although some decision-theoretic approaches suggest delaying action in order to resolve uncertainty or better learn about the appropriate actions to tackle a challenge, the net benefits of waiting to learn depend on how quickly the problem grows in the meantime (Summers and Zeckhauser, 2008). We may only learn about these irreversible climate changes too late to make midcourse corrections.

Emissions Do Not Automatically Buy Growth, Development, or Adaptation Capacity

Panagariya's discussion of uncertainties related to the costs of emissions is extensive and detailed. His discussion of the benefits of emissions, however, is cursory. There is substantial variation in how much growth emissions buy as well as how much poverty reduction and adaptation or mitigation capacity results from growth. The paper does not discuss uncertainty about how much return on emissions India will be able to achieve, although there is reason to doubt that it will achieve the maximum development returns without policy and institutional reform. These priorities—the actions India needs to take to have its emission be justified ex post by actual development returns rather than ex ante by potential returns—are not discussed.

Output per kilogram of CO_2 emissions (reported as CO_2 emissions per dollar of GDP) is a crude measure of the "return" on emissions, but it is widely available. These figures highlight the fact that the relationship between emissions and output, and presumably then emissions and growth, varies widely across countries and over time from 0.12 or 0.13 to 6 kg per dollar of GDP.[8] Figure 1 shows the emissions per unit of output for selected countries. Note that China, the example Panagariya uses to show that additional emissions will be required to achieve improved living standards, has dramatically decreased its emissions per unit of output over the 1980s.

The extent of poverty reduction and mitigation or adaptation capacity per unit of growth also varies. Ferreira and Ravallion's (2008) review of the global evidence on growth, poverty, and inequality finds that while poverty tends to be lower in countries with higher per capita income, there is "considerable heterogeneity" around this relationship. The effect of poverty

8. Based on figures from the World Bank (2009b).

reduction on growth is similarly varied: the 95 percent confidence interval of the effect of growth on poverty implies that a 2 percent increase in growth could bring anything from a 1 percent to a 7 percent reduction in poverty. Brazil, for example, achieved more rapid poverty reduction than did India with less growth (Ravallion, 2009).

The elasticity of adaptation and mitigation capacity to growth is harder to judge, but performance on infrastructure provision is a plausible proxy. Panagariya's argument is that the additional growth enabled by CO_2 emissions will improve access to shelter, transport, communications, and water management infrastructure among other support for adaptation to and mitigation of some of the effects of climate change. Here too, income does not assure performance. Figures 2a and 2b plot road density against size of the economy for two measures of the size of the economy. There is a wide variation in outcomes; India performs relatively well in terms of current US$, but not as well considering purchasing power parity. Figures 3a and 3b focus on paved roads only—the kind less likely to wash out during rains and floods. India's achievements are relatively poor for both measures of the size of the economy. Scatter plots for other infrastructure such as water and sanitation show similar "clouds" suggesting a loose relationship between income and infrastructure provision.

There is undoubtedly a relationship between emissions, growth, and development that increases peoples' and states' ability to adjust to environmental change. My point is that the development returns on emissions have varied in the past and are thus not guaranteed in the future without a concerted effort to build state capacity to deliver infrastructure, services, and emergency response.

"Climate Change Policy" Requires Attention to More than Just CO_2

Panagariya's paper focuses on greenhouse gases, and in particular on CO_2. While CO_2 is an important contributor to climate change, it is only responsible for about half of global warming.

The significant contribution of air pollution, specifically black carbon, tropospheric ozone and some of its precursors, and sulphates, to regional and global climate change is increasingly well documented. Black carbon, the dark part of soot produced by diesel engines, power plants, and household and small industry burning of solid fuels and biofuels (wood, coal, cow dung, crop waste), is estimated to have about 55 percent of the warming impact

of CO_2.[9] Ozone, which forms from a combination of components found in transport emissions and emissions from biomass burning, has long been a known contributor to global warming with about 20 percent of the impact of CO_2.[10] Ozone precursors oxides of nitrogen (NO_x) and sulphates affect climate change in a more complex way as they interact with better-recognized greenhouse gases to affect their warming effect. These two pollutants can increase the potency of methane, a gas widely seen as second to CO_2 in impact, by 30 percent.[11]

Air pollution also contributes to some of the most devastating regional environmental changes. Black carbon depositions on the Himalayan glaciers are accelerating their melting, while black carbon carried to the Arctic is one of the leading causes of accelerating melting of the ice caps there (Flanner et al. 2007, 2008). The so-called "Atmospheric Brown Cloud," a transcontinental plume of air pollution affecting much of the earth, has been linked to changes in rainfall and monsoon patterns in India as well as dimming of the sunlight that affects crop productivity.[12]

Panagariya mentions the development reasons to limit black carbon, but the regional benefits of regional reducing air pollution are worth reiterating in more detail. Indoor air pollution—in large part black carbon—is second only to unclean water as an environmental cause of illness and premature death, while ozone affects asthma, allergies, and cardiac illness.

The benefits of additional CO_2 for crops (which Panagariya mentions) are likely to be more than offset by the effects of ozone, which interferes with photosynthesis and damages plant cells, on crop yields. Present day global relative yield losses due to ozone are estimated to range between 7 percent and 12 percent for wheat, between 6 percent and 16 percent for soybean, between 3 percent and 4 percent for rice, and between 3 percent and 5 percent for maize. The cumulative economic effect is estimated to be US$14–26 billion annually at 2000 prices—far greater than estimates of the impact of climate change on agriculture. These estimates are likely to be conservative, as they use European crop-response functions without accounting for the

9. As measured by comparing radiative forcing (RF). Ozone estimate is as given by IPCC (2007c), black carbon from Ramanathan and Carmichael (2008).

10. Based on the radiative forcing measures provided in IPCC (2007c).

11. Drew T. Shindell, Greg Faluvegi, Dorothy M. Koch, Gavin A. Schmidt, Nadine Unger, and Susanne E. Bauer. 2009. "Improved Attribution of Climate Forcing to Emissions." *Science* 326: 716–18.

12. UNEP (2008) summarizes the evidence. Ramanathan and Feng (2008) provide an overview of air pollution–climate links including the evolution of the science.

water scarcity or other plant stressors. The global situation is expected to deteriorate mainly for wheat (additional 2–6 percent loss globally) and rice (additional 1–2 percent loss globally). India, under a business as usual scenario, would account for half of this additional yield loss over the next two decades (Van Dingenen et al., 2009).

It is not enough to simply mention air pollution as a development policy aimed at public health. The climate co-benefits of addressing these development challenges supports the argument for increasing state capacity and allocating public resources to tighten regulation on air quality as well as provide enabling infrastructure to make cleaner, more efficient technologies available for more of India. Acknowledging and discussing the climate benefits of improving air quality also helps complete a full cost-benefit analysis. Cleaning up urban air pollution in order to reduce ozone might not pass a cost-benefit analysis focused only on public health benefits. Doing so in order to protect crop yields implies redistribution between rural and urban constituents. Adding in the overall climate benefits of air pollution control could tip the balance.

Air pollution control, particularly ozone and black carbon, is also emerging as a topic in international discussions of mitigation. Existent international efforts to reduce air pollution have mostly been regional emissions commitments (such as the UN Economic Commission for Europe Convention on Long Range Transboundary Air Pollution Agreement) or based on voluntary collaboration across international networks (such as the Clean Air Initiative for Asia's Cities). How, if at all, air pollution should be integrated with ongoing climate change discussions is one question to be included in any comprehensive overview of the "state of play" that affects India's interests?[13]

Conclusion

All this said, Panagariya's basic point that India and the developing world can ill afford a tax on development is true. Whether early mitigation of emissions or uncontrolled climate change will be a bigger tax on development given

13. I argue elsewhere (Wallack and Ramanathan, 2009) that air pollution should be addressed through regional agreements, since these can be crafted to cover an area large enough to internalize at least a large portion of the international externalities while also preserving the flexibility of small groups and underpinning of stronger regional diplomatic ties that are necessary to address a complex policy challenge guided by science that is still evolving.

the varied opportunity cost of forgone emissions and the worrying risks of costly environmental change is another question and the debate should not obscure the underlying common goal.

General Discussion

The paper and formal discussant comments generated a lively discussion of the implications of climate change and India's role in the international policy negotiations.

Ester Duflo pointed out that there were several historical studies looking at the effects of temperature change in agriculture and health in India; and in contrast to the United States and Europe, the implications were quite uniformly negative. She thought that the paper disregarded too much of the evidence suggesting that higher temperatures could impose substantial costs on India.

Abhijit Banerjee expressed skepticism that India would be able to manage a cap and trade system. He argued that the Indian government does not have a track record in executing past programs that would make its commitment to a complex international agreement credible.

Surjit Bhalla argued that it was a mistake to put India and China together in any discussion because they were really quite far apart, both in their level of economic development, and the magnitude of their emissions. Additionally, reference to India as a poor country is not relevant to the time period under discussion that stretches out to 2040. He thought that India should participate in the international discussion on the basis of where it would be in 2040—not in terms of its present economic position.

Robert Lawrence also emphasized the advantages of early and active participation in the international negotiations. The costs of mitigation would be far lower if India acted before its capital stock had been put in place. This could be a major advantage compared to many of the advanced economies who would be faced with large obsolete capital stocks. He thought that India could influence the negotiations to a much greater extent by participating from the beginning rather than staying on the outside. He agreed with Vijay Joshi that a cap-and-trade system was much different from a tax because it had greater flexibility in dealing with the distributional issues.

Madhav Raghavan thought that an international agreement would be very difficult to negotiate, and that greater attention should be given to policies that India could enact unilaterally (for example, clean technology developments) and to policies aimed at adapting to the climate change.

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India Transformed? Insights from the Firm Level 1988–2005

Using firm-level data, this paper analyzes the transformation of India's economic structure following the implementation of economic reforms. The focus of the study is on publicly-listed and unlisted firms from across a wide spectrum of manufacturing and services industries and ownership structures such as state-owned firms, business groups, private and foreign firms. Detailed balance sheet and ownership information permit an investigation of a range of variables such as sales, profitability, and assets. Here we analyze firm characteristics shown by industry before and after liberalization and investigate how industrial concentration, the number, and size of firms of the ownership type evolved between 1988 and 2005. We find great dynamism displayed by foreign and private firms as reflected in the growth in their numbers, assets, sales, and profits. Yet, closer scrutiny reveals no dramatic transformation in the wake of liberalization. The story rather is one of an economy still dominated by the incumbents (state-owned firms) and to a lesser extent, traditional private firms (firms incorporated before 1985). Sectors dominated by state-owned and traditional private firms before 1988–90, with assets, sales, and profits representing shares higher than 50 percent, generally remained so in 2005. The exception to this broad pattern is the growing importance of new and large private firms in the services sector. Rates of return also have remained stable over time and show low dispersion across sectors and across ownership groups within sectors.

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Introduction

> *Is there some action a government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? If so, what exactly? If not, what is it about the "nature of India" that makes it so?*
>
> —R. E. Lucas Jr. (1985)

According to World Bank estimates, between 1960 and 1980, India's growth rate remained at an unspectacular average of 3.5 percent per annum. It was in the mid-1980s that it began accelerating, culminating in a rate of over 9 percent per annum by 2005. In fact, India's average growth rate over the entire period between 1986 and 2005 surpassed those of both Indonesia and Egypt (see Appendix Table A-1).

Numerous views are put forth about the driving forces behind the transformation of India's growth landscape (Bosworth et at., 2007; Kochar et al., 2006; Panagariya, 2008; Rodrik and Subramanian, 2005). While Rodrik and Subramanian (2005) point out that growth initially accelerated during the 1980s, and attribute it to the role of "pro-business" reforms that began in the early 1980s, Bosworth et at. (2007) argue that the emphasis on the services sector as the driving force behind the expansion of the Indian economy is perhaps exaggerated as it represents only a small share of the country's overall employment level. Panagariya (2004) argues that piecemeal external liberalization, along with small spurts of domestic deregulation on a variety of margins and expansionary policies, combined to produce a small shift in the growth rate in the 1980s.[1] He also contends that the systemic reforms in the 1990s and 2000s were essential to both sustaining and accelerating the growth rate. Srinivasan and Tendulkar (2003), on the other hand, view fiscal expansion and excessive foreign borrowing that precipitated the balance of payments crisis in 1991 as the primary cause of the shift in the growth rate in the 1980s but also note that this growth rate would have been unsustainable without the subsequent reforms.

The debate is far from settled. Thus far the extensive empirical literature has focused on characterizing India's aggregate economic performance. However, aggregate data do not shed light on the channels through which

1. At 1999–2000 prices, the annual growth rate shifted from 3.2 percent between 1965–66 and 1980–81 to 4.6 percent between 1981–82 and 1987–88 with end-point years included in the calculations (Panagariya, 2004).

policy reform can transform the economy at the micro-level. Data at the firm or plant level would offer an opportunity to do so. This paper takes a step in this direction by documenting detailed stylized facts about the evolution of India's microeconomic industrial structure against the backdrop of the reforms that began in the mid-1980s.[2]

The end of the license raj and implementation of pro-market reforms had far-reaching implications for changes in India's industrial structure. Significant sectors of the economy were opened up for private participation. India began to integrate into the world economy: import licensing was abolished in many sectors, import duties were sharply reduced, and many restrictions on foreign direct investment (FDI) were lifted.[3] Investment increased from 23 percent of gross domestic product (GDP) in 1985 to 38 percent in 2005. During the 1980s, total FDI inflows barely reached one billion dollars. In contrast, India attracted more than $70 billion in FDI between 2000 and 2005, the bulk of which was concentrated in the services, computer software and hardware, construction, and telecommunications sectors. New firms emerged and many Indian firms established an international presence. The economy transitioned from being mainly dependent on agriculture and manufacturing to a services-oriented one over the 1990s.[4]

Liberalizations, broadly defined to include trade and entry liberalization, regulatory reform, and privatization, are believed to transform economies via more competition (domestic and foreign), the removal of distortions in relative prices and access to finance. The effects of liberalization processes, however, may not be uniform.[5] Some industries may be better equipped to

2. The reform process, albeit piecemeal in nature, began in the mid-1980s. Data limitations prevent us from describing changes in firm-activity for the period before 1988.

3. The third section describes the main industrial reforms which include privatization, trade, and FDI deregulation, and de-licensing or domestic deregulation; financial reforms include banking sector deregulation allowing foreign bank entry, stock market liberalization, exchange rate deregulation, and capital account liberalization; corporate governance reforms including setting up of a regulatory body (SEBI), regulations concerning listing requirements, insider trading laws, protection of minority shareholders, board membership rules, executive compensation rules, etc.

4. Manufacturing as a share of GDP had increased only marginally over the past three decades, from 22 percent in 1980 to 27 percent in 2006. Restrictive labor laws, and moderate corporate investment hampered this sector.

5. As Alesina et al. (2005) note, the theoretical effects of regulatory reform (entry liberalization and privatization) are ambiguous. Reforms that imply reduction in entry barriers and in the markup are likely to lead to an increase in investment; aspects of deregulation that remove binding constraints on rates of return may determine a reduction of investment. Similarly, the effects of privatization are also ambiguous.

change than others. Within industries, new entrants may gain market share, while incumbents go bankrupt. Restrictions may linger in some sectors, and for some firms.

Until recently, studies about firm-activity in the context of policy reform have predominantly focused on developed rather than developing economies—data availability being an obvious constraint (see Tybout, 2000).[6] Firms in developing countries often face a variety of constraints such as over-regulation and the underdevelopment of financial markets. These are glaring constraints affecting the ease with which resources can be reallocated across sectors and within firms. Liberalization policies in many developing countries have relaxed some of these constraints and changed the environment in which firms operate. These reforms provide an ideal backdrop against which to investigate the firm-level response to a changing economic environment.

The aim of this paper is to describe the evolution of India's sectoral composition by focusing on the micro-foundations of its productive structure. How has India's industrial structure evolved at the firm level as a result of the reforms? What was the industrial composition by ownership before and after reforms? Has the influence of traditional incumbents such as state-owned firms changed? If so, what is the emerging role of private, domestic, and foreign firms? What has happened to firm size and industry concentration following liberalization?

We present a series of detailed stylized facts about the characteristics of firms evidenced by industry before and after the reforms of 1991.[7] We use firm-level data from the Prowess database collected by the Centre for Monitoring the Indian Economy from company balance sheets and income statements. Prowess covers both publicly-listed and unlisted firms from a wide cross-section of manufacturing, services, utilities, and financial industries from 1988 until 2005. About one-third of the firms in Prowess are publicly-listed firms. The companies covered account for more than 70 percent of industrial output, 75 percent of corporate taxes, and more than 95 percent of excise taxes collected by the Government of India (Centre for Monitoring the Indian Economy). Prowess covers firms in the organized sector, which refers to registered companies that submit financial statements.[8]

6. Bertrand and Francis (2002), for example, study the expansion decisions of French retailers following new zoning regulations in France. Black and Strahan (2002) and Guiso et al. (2004) find that competition in the banking sector and financial development fosters firm-entry in the US and Italy.

7. Formal econometric analysis establishing causal linkages is left to future work.

8. The fourth section describes in detail the advantages and shortcomings of the dataset.

The main advantage of firm-level data is that detailed balance sheet and ownership information permit an investigation of a range of variables such as sales, profitability, and assets for an average of more than 15,500 firms across our sample period. Firms are classified across 109 3-digit industries covering agriculture, manufacturing, and services, which is an additional advantage of our data over existing work focusing only on the manufacturing sector.[9] The data are also classified by ownership categories such as state-owned, private business-group-affiliated firms, private stand-alone firms and foreign firms. Note that private refers to firms in the private as opposed to the public sector, and many firms in the private sector are publicly traded. We study five sub-periods 1988–90, 1991–94, 1995–98, 1999–2002, and 2003–05.[10] These periods broadly match the different liberalization waves explained in detail in the text.

We present, specifically, information in detail about the average number of firms, firm size (assets, sale), and profitability (profit before interest depreciation and taxes and return on assets) for all firms in our sample by sector as well as by category of firm: state-owned enterprises, private firms incorporated before 1985 (old private firms), private firms incorporated after 1985 (new private firms), and foreign firms for the five sub-periods. Sales, size, entry, profitability, and overall firm-activity are disaggregated measures of economic growth and proxies of efficiency, and thus provide an understanding of the effectiveness of reforms. We also look at market dynamics with regard to promotion of competition in order to understand the efficient allocation of resources. We measure the degree of competition (consolidation) as a measure of competitive efficiency to examine how industrial concentration has evolved over time.

The data show great dynamism on the part of foreign and new private firms (incorporated after 1985) as reflected in their growth, that is, in numbers, assets, sales, and profits. However, on closer examination, what emerges is not a story of dramatic transformation in India's microeconomic structure following liberalization. Rather, the data suggest an economy still dominated by the incumbents, state-owned firms, and to a lesser extent, the traditional

9. As Goldberg et al. (2009) note, unlike the Annual Survey of Industries (ASI), the Prowess data is a panel of firms, rather than a repeated cross-section, and therefore, particularly well suited for understanding how firms adjust over time and how their responses may be related to policy changes.

10. Although the liberalization process has been gradual, and the pattern of foreign-entry liberalizations (and more general reforms) driven by private interests (see Chari and Gupta, 2008), this does not preclude the analysis of the effects of reducing these constraints on the evolution of the firm-size distribution.

private firms, that is, those firms that existed before the first wave of reforms. We find evidence of continuing incumbent control in terms of shares of assets, sales, and profits accounted for by state-owned and traditional private firms. In sectors dominated by state-owned and traditional firms before liberalization (with shares higher than 50 percent), these incumbents remain the dominant ownership group following liberalization. Interestingly, rates of return remain remarkably stable over time and show low dispersion across sectors and across ownership groups within sectors.

The exception to the pattern of incumbent firm dominance is seen in the growth of private firms in the services industries. In particular, the assets and sales shares of private new firms in business and IT services, communications services and media, health, and other services show a substantial increase in growth and in shares over this period. This fact coincides with the reform measures that took place in the services sectors after the mid-1990s and is also consistent with the growth in services documented in the aggregate data.[11]

Schumpeter (1942) argued that creative destruction, the replacement of old firms by new firms, and of old capital by new capita, happens in waves. A system-wide reform or deregulation, such as the one implemented in India, may be the shock that prompts the creative destruction wave. Creation in India seems to have been driven by new entrants in the private sector and foreign firms. The sectoral transformation in India does not, however, seem to have gone through an industrial shake-out phase in which incumbent firms are replaced by new ones.[12] Sectors in which state-owned enterprises and older private firms dominated activity prior to liberalization continue to do so even twenty years after the reforms began.

Our findings are consistent with the observation in Topalova (2004), that there seems to be very little exit at the firm level in India's industry, with Goldberg et al.'s (2008) finding that net product creation following trade liberalization was almost exclusively driven by product addition as opposed to discontinuation of product lines, and with arguments in Panagariya (2008) about the slow transformation of the country following

11. In the case of information technology, pharmaceuticals, and telecom, some new and very large players have emerged. Khanna and Palepu (2005) document the dynamism in the software industry.

12. Interestingly, many of the older firms (pre-independence) have by and large remained untouched by the reforms (not considering sectoral composition effects); see Table 8.

reforms.[13] Different explanations may account for these findings such as lingering restrictions and regulation constraining firm flexibility to adjust and inefficiencies in the financial sector among others.[14] However, one additional explanation, perhaps not sufficiently stressed in the debate, may be the important remaining role of incumbent (such as state-owned firms and firms incorporated before the reforms began). As emphasized in the political economy literature, entrenched incumbents firms may have incentives to oppose the liberalization efforts (Rajan and Zingales, 2003a, 2003b). In fact, we find both industry concentration and state-ownership to be inversely correlated with the probability of liberalization. These results are consistent with the findings in Chari and Gupta (2008) focusing on FDI liberalization. Our conclusions suggest that trade liberalization in India was also inversely correlated with industry concentration.

Our work contributes to the literature that focuses on the study of different aspects of the recent evolution of the Indian economy, by analyzing in detail the evolution of firm activity by ownership, sector, and industry.[15] In addition, it relates, more generally, to literature that emphasizes the effects of policy in the allocation of resources across establishments, by studying the effects of liberalization, particularly those that use firm-level data.[16]

The paper is organized as follows. The second section presents a review of the related literature. The third section describes the liberalization process in India. The fourth section describes the data while the fifth section presents the main empirical results. The next, sixth section carries the conclusion.

13. Goldberg et al. (2008) find little evidence of "creative destruction" and no link between declines in tariffs on final goods induced by India's 1991 trade reform and product dropping.

14. Banerjee (2006) notes that the banking sector in India, dominated by public sector-managed banks, fails to pull the plug on firms that ought to have been long shut down, and refers to practices of "ever-greening" of loans in the Indian banking system. Bloom and Van Reenen (2007) and Bloom et al. (2007) find that decision-making in Indian firms is highly centralized and management practices do not provide strong incentives for good performance. See also Khanna and Palepu (1999) for explanations put forth for the lack of product dropping in case studies on the product scope of Indian conglomerates.

15. Other recent work examines the effects of India's 1990s liberalization with an emphasis on employment (see, for example, Aghion et al., 2008; Besley and Burgess, 2004), bank lending (Cole, 2009), product-mix and imported intermediate inputs (Goldberg et al., 2008, 2009). These papers shed light on some of the impediments to the transformation of the economy (labor regulation, bank regulation, tariffs, and so on).

16. See Goldberg and Pavcnik (2004), Alfaro and Rodríguez-Clare (2004), and Harrison and Rodríguez-Clare (2009) for recent overviews of the studies on the effects of trade and FDI and Kose et al. (2006) and Henry (2007) for the effects of liberalization on foreign capital.

The Lens of Firm-Level Data—Theory and Evidence from Related Literature

This study is related to different strands of research analyzing the recent performance of the Indian economy as well as the broad literature analyzing the impact of liberalization on investment, changes in the allocation of resources, and economic growth. A thorough review of these large and diverse studies is clearly beyond the scope of this paper. We limit our attention to a few examples that particularly motivate our work.

Reforms and Firm-Activity

Theories emphasizing the role of "creative destruction" emphasize rapid output and input reallocation, product obsolescence and changes in productivity levels as necessary ingredients for the pace of reallocation playing an important role in aggregate productivity growth. Schumpeter (1942: 83) describes "creative destruction" thus:

> The fundamental impulse that keeps the capital engine in motion comes from the new consumers' goods, the new methods of production and transportation, the new markets...[The process] incessantly revolutionizes from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact of capitalism. It is what capitalism consists in and what every capitalist concern has got to live in…

In addition to technological change, a system-wide reform or deregulation may prompt the creative destruction wave. Industries then go through a shake-out phase during which the number of producers decline in the industry, as incumbents and new entrants replace the firms that exit (Caballero and Hammour, 1996). Restructuring is one manifestation of creative destruction, by which the production structure weeds out unproductive segments, upgrades its technology, processes and output mix, and adjusts to the evolving regulatory and global environment.

In the case of India, theory suggests that the number of firms operating within industries can change through entry and exit in the face of deregulation. Therefore we expect that the ownership composition between incumbents and new entrants may change especially if unproductive incumbents are weeded out during an industrial shake-out phase and efficient new players enter the market. Theory also suggests a greater variability in observed rates of return and a decline in importance of unproductive incumbents (for example, declining market shares, assets, sales, and profits).

Trade Liberalization and Firm-Activity

Recent work in trade using dynamic models with heterogeneous firms highlights the point that opening up trade leads to reallocations of resources across firms within an industry. Melitz (2003) provides a framework of monopolistic competition with heterogeneous firms that have become the cornerstone of a growing literature, as the model yields rich predictions that can be confronted with the data. With exogenously determined levels of firm-productivity, the model predicts that opening up trade leads to changes in firm-composition within industries along with improvements in aggregate industry productivity: that low-productivity firms exit; that intermediate productivity firms which survive contract; and that high productivity firms enter export markets and expand.[17]

Additionally, in a world of variable markets, import competition could have differential effects on firms of different productivities and procompetitive effects through endogenous changes in variable markups (Melitz and Ottaviano, 2008).[18] More generally, changes in tariff and non-tariff barriers may affect the availability of foreign products on domestic markets and, hence, the elasticity of demand for domestic goods. Therefore we expect that in sectors liberalized to trade, incumbent firms may contract or exit the market. Moreover, only those new firms that are able to withstand competition from imports will enter and/or remain in the market. Examining concentration ratios and coefficients of variation in firm-size in industries that were liberalized to trade will allow us to examine this hypothesis.

Several studies have also focused on the effects of trade liberalization on indigenous firms and have uncovered substantial heterogeneity in firm performance within narrowly defined industries in both developed and developing countries (see Goldberg and Pavcnik, 2004). Trade liberalization has been found to have a positive effect in terms of efficient allocation of resources, that is, higher output and productivity in manufacturing industries. In the case of India, Krishna and Mitra (1998) find that low-productivity plants contract and industry-level productivity increases following liberalization. Similar results are shown in Sivadasan (2006) and Topalova (2004)

17. In the standard version of the model, there is firm selection into export markets but no feedback from exporting to firm productivity. See Bustos (2009) and Lileeva and Trefler (2007) for work in this direction.

18. Trade liberalization is widely believed to have pro-competitive effects that are ruled out by assumption in most models (constant elasticity of substitution preferences implying constant markups). In contrast, in a world of variable markets, import competition could have differential effects on firms of different productivities through endogenous changes in markups.

following trade liberalization, while Arnold et al. (2008) find positive productivity effects from India's policy reform in services.

Industrial De-licensing, Domestic Deregulation, and Firm-Activity

Theoretical predictions about firm activity from macro models of entry liberalization and deregulation are ambiguous (see Alesina et al., 2009; Blanchard and Giavazzi, 2003).[19] Reducing entry barriers and reforms that imply a reduction in price markups in excess of marginal cost are likely to lead to an increase in the number of firms and investment. Regulatory reform can also influence the desired capital stock and number of firms via, for example, reduction in the red tape. On the other hand, for certain firms, removing constraints on rates of returns (especially removing ceilings restrictions) could lead to a reduction in investment.[20]

Most theoretical models, however, assume that firms are able to efficiently allocate resources within the firm and that factor markets are frictionless. Goldberg et al. (2009) argue that remnants of industrial regulation still affect the operation of Indian firms and may constrain their flexibility to adjust to new economic conditions.[21] In India, there is evidence to suggest this, despite the extensive industrial deregulation in the early 1990s. Along with lengthy, cumbersome liquidation procedures, this factor often hinders firms from eliminating unprofitable product lines.[22] As noted by Panagariya (2008), "India operates in a world with virtually no exit doors." India's bankruptcy rate was, according to the World Bank (2005), of 4 per 10,000 firms, compared with 15 in Thailand and 350 in the United States. If the pattern in firm-entry and exit is consistent with these observations, we expect industrial de-licensing to be accompanied by dynamism in firm-entry but little incumbent firm-exit.

19. Blanchard and Giavazzi (2003) develop a model of both labor market and product market regulation and their interconnection. Alesina et al. (2009) analyze a monopolistic competition model and show that deregulation of product market has a positive effect on capital accumulation if it generates a reduction in the markup of prices over marginal costs (for instance, through a reduction in entry barriers) or if it lowers costs of adjusting the capital stock.

20. In some network industries, such as utilities and telecommunications, reforms entailing service liberalization and price rules for accessing networks can have conflicting influences on investment.

21. Some of their results also suggest that declines in tariffs are associated with somewhat bigger changes in the product scope of firms in industries, which are no longer subject to licenses at the onset of the 1991 reform as compared to regulated industries.

22. For example, an All-India Amendment to Industrial Disputes Act (1947) in 1982 required firms with more than 100 employees to seek government approval to dismiss workers (Kochhar et al., 2006).

Privatization and Firm-Activity

Similarly, the effects of privatization stemming from agency problems and political mandates are ambiguous. For example, deregulation, through a reduction in markups and in the availability of internal funds, may have a negative effect on investment if there is imperfect substitutability between internal and external sources of finance. This effect may be more relevant for firms severely affected by informational asymmetries and with limited collateral, such as small and young firms. On the other hand, if privatization reduces the influence of state-owned firms in the economy allowing new firms to enter, it can lead to an increase in investment.[23] While the theoretical predictions about the impact of privatization on firm-activity are ambiguous, we are particularly interested in examining the role of state-owned firms in the Indian economy—the most influential incumbents before the reforms began. The next sub-section elaborates on this subject.

Reforms and the Role of Incumbent Firms

Somewhat missing from, or perhaps not emphasized in, many papers in this literature, are political economy considerations and in particular the role of incumbent-firm ownership. As emphasized by Stigler (1971), incumbent firms in profitable, concentrated sectors have a greater incentive to prevent entry.[24] Theory predicts that successful reforms will lead to a decline in industry concentration in liberalized industries and greater competition as signaled by greater variation in rates of return and coefficients of variation in firm-size.

The widespread privatizations of the 1980s and 1990s around the world generated a large empirical literature focused on understanding the effects of ownership on firm performance.[25] As reported by Chong and Lopez-de-Silanes (2004), between 1984 and 1996, the participation of state-owned

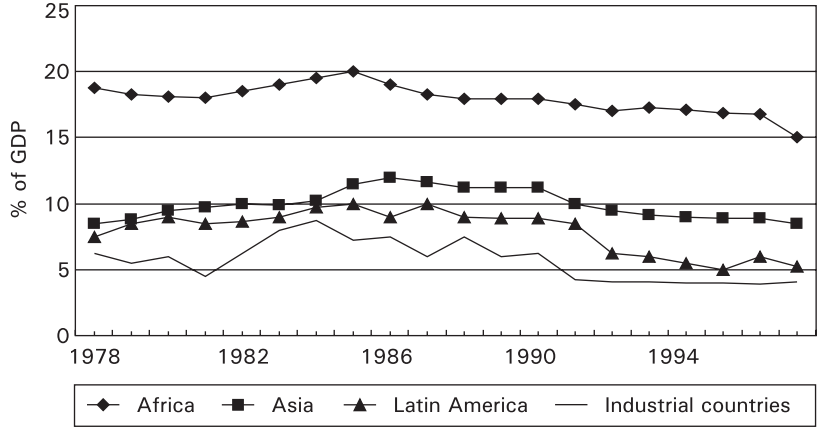
23. Alesina et al. (2009) find that regulatory reforms in the OECD have been associated with increases in investment. The authors find both, entry into liberalization and privatization, to have had substantial effect on investment. There is also evidence to show that the marginal effect of deregulation on investment is greater when the policy reform is large and when changes occur, starting from already lower levels of regulation. In other words, small changes in a heavy regulated environment are not likely to produce any noteworthy effect.

24. Chari and Gupta (2008) find that reforms may be captured by powerful interests, particularly firms in profitable, concentrated industries and in industries with substantial state-owned firm presence. Given the deadweight loss associated with industry concentration, selective liberalization may inhibit economic growth.

25. Megginson and Netter (2001), surveying the literature, find that most studies reveal a positive impact of privatization on profitability and efficiency of firms.

enterprises in industrial countries declined from 8.5 percent of GDP to 5 percent (see Figure 1).[26] In middle-income countries it fell from 11 percent of GDP in 1980 to 5 percent in 1997 and from 15 percent to 3 percent in low-income economies. Employment dropped from 13 percent to 2 percent in middle income and 20 percent to 9 percent in low-income countries.[27] For India, our data suggest that between 2001 and 2005 state-owned firms accounted for 59 percent, 42 percent, and 50 percent of total assets, sales, and profits.

FIGURE 1. Economic Activity of State-owned Enterprises, 1978–97 (Percentage of GDP)



Source: World Bank (2001a) taken from Chong and Lopez-de-Silanes (2004).
Note: Weighted average.

Gupta (2005) studies the effects of partial privatization of state-owned enterprises in India and finds a positive impact on profitability, productivity, and investment. Her results also suggest that partial privatization does not cause the government to abandon the political objective of maintaining employment. This paper finds that the fractions of sales, assets, and profits

26. Reviewing the evidence in Latin America, Chong and Lopez-de-Silanes (2004) note that most privatization led to higher profitability, output and productivity growth, fiscal benefits, and quality improvements. The authors also highlight many instances of failure, which may be understood within the political framework (state participation in opaque processes, poor contract design, inadequate regulation or deregulation).

27. These averages, however, mask huge variations. In Africa, state ownership remains higher than 15 percent of the GDP; in China the government still has control over important sectors of the economy.

accounted for by state-owned firms have remained substantial in India for nearly two decades since liberalization and are substantially higher than in other countries, including the transition economies of Eastern Europe.

Liberalization in India: The Reforms

Liberalization in India encompassed a series of reforms including foreign entry and trade liberalization, industrial de-licensing and de-reservation measures, and services liberalization. In this section, we provide a broad overview of the reforms and refer the reader to studies that provide in-depth detail about specific reform measures.

Topalova (2004) provides a detailed overview of trade policy reform following the conditionalities imposed by the 1991 IMF Program. Benchmarks set forth under these conditions included a reduction in the level and dispersion of tariffs, a removal of quantitative restrictions on imported inputs and capital goods for export production, and elimination of public-sector monopoly on imports of almost all items.

It is important to note that the most significant initial trade reform was the removal of import licensing for capital and intermediate goods. However, tariff rates remained extremely high in the initial reform period. For example, the top tariff (while reduced) was brought down from 350 percent to 150 percent. Moreover, the 22 percent devaluation of the rupee further shielded the domestic industry from import competition, at least temporarily (Panagariya, 2008).

The government's export–import policy plan (1992–97), however, dramatically reduced the use of quantitative restrictions. The share of products subject to quantitative restrictions decreased from 87 percent in 1987–88 to 45 percent in 1994–95; all 26 import-licensing lists were eliminated and a "negative" list was established. Restrictions on exports were also relaxed, with the number of restricted items falling from 439 in 1990 to 210 in 1994 (Topalova, 2004).

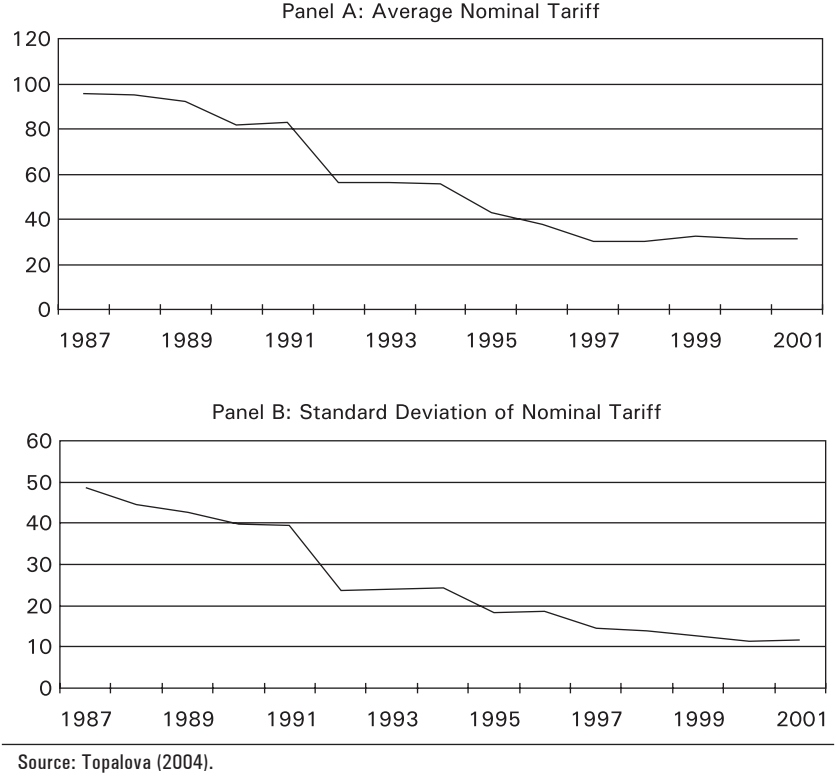
Tariff reductions took place in 77 industrial categories and tariffs across a wide range of industries fell from a simple average of about 85 percent in 1990 to a value of approximately 12 percent in 2007 (Panagariya, 2008).[28]

28. The top tariff dropped from 50 percent in 1995–96 to 40 percent in 1997–98, 35 percent in 2000–01, 30 percent in 2002–03, 25 percent in 2003–04, 20 percent in 2004–05, 15 percent in 2005–06, 12.5 percent in 2006–07, and 10 percent in 2007–08. Some tariff peaks being outside the top rate, the simple average of tariffs on industrial goods in 2007 was approximately 12 percent. Custom duty collection in 2005–06 as a proportion of merchandise imports was just 4.9 percent (Panagariya, 2008).

Topalova (2004) also notes that the standard deviation of tariffs dropped by approximately 63 percent during the period between 1987 and 2001 (Figure 2, Panel A).[29] At the industry level, although there was variation across industries, the sharpest drop in tariffs took place between 1991 and 1992.

We note that the trend toward de-licensing and de-reservation began with the industrial policy statements in 1985 that outlined many liberalization measures including not restricting business houses to Appendix 1 industries as long as they moved to industrially backward regions and raised the minimum asset limit defining business houses. The pace of these policy trends accelerated with the New Industrial Policy outlined in the Industrial Policy Resolution of 1991.

FIGURE 2. Trade Reform in India, 1987–2001



Source: Topalova (2004).

29. Data for Figure 2 were generously provided by Petia Topalova.

Compulsory industrial licensing was abolished for all except eighteen industries. Large companies no longer needed MRTP approval for capacity expansions. The number of industries reserved for the public sector in Schedule A (IPR 1951) were cut from seventeen to eight,[30] Schedule B, which listed industries open to the private sector but with increasing involvement from the state particularly for new establishments, was abolished altogether.[31] Importantly, limits on foreign equity holdings were raised from 40 to 51 percent (for industries listed in Annexure III of the Statement of Industrial Policy in 1991) under the "automatic approval route." The Industrial Policy Resolution of 1991 (Office of the Economic Advisor, 2001) provides information about the list of manufacturing industries in which the state liberalized foreign entry and also a list of industries where domestic entry restrictions continued to be in effect.

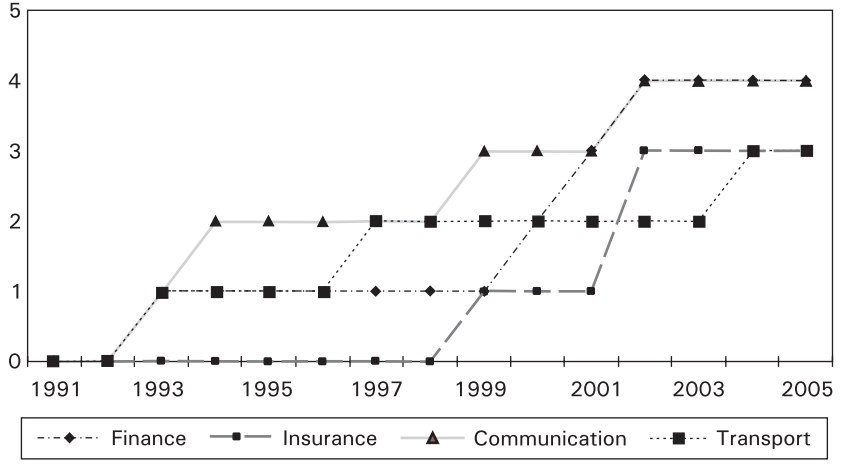
Services reforms while rapid in the 1990s, varied across sectors. Appendix A in Arnold et al. (2008) provides an excellent and detailed survey of the services liberalization reforms by sector between 1991 and 2005. Their paper carefully examines major policy changes enacted between 1991 and 2003. The first significant changes in financial services (banking and insurance), telecommunications, and transport are recorded as early as the 1993–94 fiscal year. The authors highlight some of the major policy changes they recorded for four services sectors, and then describe a strategy for quantifying this information into a services reform index. In order to make the services policy information amenable to quantitative analysis, we translated the policy changes into a sector-specific reform index, taking values from 0 to 5. We reproduce Figure 1 from their paper that provides a graphic illustration of the variation contained in the services reform index across four services sectors (see Figure 3).[32]

30. According to the Industrial Policy Resolution (1948), Schedule A comprised among others (*i*) industries exclusively reserved for the State (atomic energy, arms and ammunition, and railways), and (*ii*) basic industries where the State would have the exclusive right to undertake new investments (iron and steel, mineral oils, coal, shipbuilding, aircraft production, and telecommunications equipment). Other categories included eighteen industries of national importance regulated and licensed in cooperation with state governments and industries open to private sector participation. The Industrial Policy Resolution (1956) included the nine industries in categories (*i*) and (*ii*) of IPR 1948 and added eight additional industries including mining sectors, air transportation, and some heavy industries.

31. These industries included minerals, aluminum, and other non-ferrous metals not listed in Schedule A, machine tools, basic intermediate products required by the chemicals industries, antibiotics and other essential drugs, synthetic rubber, fertilizers, and road and sea transport.

32. We are grateful to the authors for permission to use their figures.

FIGURE 3. Service Liberalization, 1991–2005



Notes: Taken from Arnold et al. (2008). Index values: 0: Almost no reform, the public sector is either the only relevant provider of services or has a strong grip on private providers. 1: some scope for private sector participation and some liberalization of operational decisions, combined with very limited scope for foreign participation (limited, for example, by low FDI ceilings or announced only as intentions). 2: limited degree of interference in operational decisions by public authorities, substantial price liberalization, and clear scope for foreign participation even if only in narrowly defined segments and as minority participations. However, the state remains a dominant actor in the sector. 3: significant scope for private providers, including foreign ones, a noticeable competitive pressure from new entrants on the public incumbents, and explicit possibilities for foreign equity participation. 4: little public intervention into the freedom of operation of private providers, the possibility of majority foreign ownership, and the dominance of private sector entities. 5: would be equal treatment of foreign and domestic providers, full convergence of regulation with international standards and unrestricted entry into the sector.

Following the description in the second section, we would expect a transformation of India's microeconomic structure following this broad and wide-ranging reform process: new firms entering and expanding production, increased competition from new entry as well as imports, and exit by unproductive incumbents that are unable to adapt to the changing economic environment. Most theoretical work on the effects of liberalization analyzes static effects. India experienced high growth during our period of analysis, in particular, toward the end, suggesting additional effects on entry, exit, and expansion in addition to those implied by the standard models (confounding further the overall effects at the macro level). Alternatively, as mentioned earlier, the reform process has been slow, and piecemeal in nature. Moreover, while we might expect to see dynamism in firm-entry, particularly by private and foreign firms following liberalization, lingering restrictions may imply little incumbent firm-exit.

The Prowess Data

We use firm-level data from the Prowess database. The sample period is from the year of inception of dataset, 1988–2005.[33] The data are collected by the Centre for Monitoring the Indian Economy (CMIE) from company balance sheets and income statements and covers both publicly-listed and unlisted firms from a wide cross-section of manufacturing, services, utilities, and financial industries. About one-third of the firms in Prowess are publicly listed firms. The companies covered account for more than 70 percent of industrial output, 75 percent of corporate taxes, and more than 95 percent of excise taxes collected by the Government of India (CMIE).

Prowess covers firms in the organized sector, which refers to registered companies that submit financial statements. According to the government, "The organized sector comprises enterprises for which the statistics are available from the budget documents or reports, etc. On the other hand the unorganized sector refers to those enterprises whose activities or collection of data is not regulated under any legal provision or do not maintain any regular accounts" (Government of India, 2000: 2). Indian firms are required by the 1956 Companies Act to disclose information on capacities, production, and sales in their annual reports. All listed companies are included in the database regardless of whether financials are available or not.[34]

The Indian National Industrial Classification (NIC) (1998) system is used to classify firms in the Prowess dataset into industries. The data include firms from a wide range of industries including mining, basic manufacturing, financial and real estate services, and energy distribution.

The main advantage of firm-level data is that detailed balance sheet and ownership information permit an investigation of whether the presence of certain types of incumbent firms in an industry affects the evolution of industry and firm characteristics, as also the responses to policy changes such as liberalization. In contrast, industry-level databases usually do not provide information about sales, assets, profits, and employment under

33. The Prowess database has now been used in several studies including Bertrand et al. (2002), Khanna and Palepu (1999), Fisman and Khanna (2004), Khanna and Palepu (2005), Topalova (2004), Dinç and Gupta (2009), Chari and Gupta (2008), and Goldberg et al. (2008, 2009).

34. Unlisted companies are not required to disclose its financials. CMIE asks their permission, but if they refuse, it cannot include these companies in Prowess.

different ownership categories.[35] The firms in the data belong to three main ownership categories: state-owned firms, private firms, and foreign firms. Private firms include family-owned business groups and unaffiliated private firms. Appendix Table A-2 provides a description of variables used in the data analysis.

One concern with the data may be related to new entrants versus improvements in the data coverage by CMIE. However, for all firms that Prowess decides to cover, regardless of when the decision is made, financial data from 1989 onwards, wherever available, is added to the database. That is, even if coverage for a firm begins only in 1995, CMIE goes back and gets data from at least 1989, if not earlier. Hence, for the sample that we consider, the entry numbers are not distorted by changing coverage (except, of course, from firms that are actually incorporated in that period). Nevertheless, we are cautious when interpreting the results.

A point regarding data coverage of foreign firms is worth highlighting. Firms are classified as domestic or foreign depending on the incorporation location. For example, in the case of Jet Airways, the holding company is incorporated overseas and therefore classified as a foreign firm. Also, as in the case of unlisted domestic firms, data on unlisted foreign firms is available only if the firm chooses to disclose its financial information. CMIE requests unlisted foreign firms for permission, but if they refuse (as for example, McDonald's and Coca Cola have done) then the firms are not included in Prowess.

Chari and Gupta (2008) compare the Prowess data with the ASI conducted by the Government of India. The ASI is a survey collected on a sampling basis of factories employing 100 or more workers.[36] Although the overlap in the list of industries covered by the two datasets is not perfect, the ASI data nevertheless provide a useful cross-industry benchmark for the coverage in Prowess. For instance, the ASI data focus exclusively on the manufacturing sector, whereas Prowess covers several additional service sectors including defense, restaurants, hotels, and IT services. The authors find that in forty-one of the fifty-one 3-digit industries covered by both

35. Since firms are not required to report employment in their annual reports, we observe employment data for only a more restricted sample of firms. Financial services are the only industry that is mandated by law to disclose employment information. Since the sample of firms that report employment is small, we do not focus on these numbers.

36. The sampling design is outlined in detail in items number 9–11 at http://www.mospi.nic.in/stat_act_t3.htm (accessed on May 14, 2010).

databases, total industry sales in Prowess is an average of 77 percent of the value of total sales for the same industry in the ASI.

Goldberg et al. (2009) argue that the Prowess dataset is not a manufacturing census, and therefore may not be ideal for studying firm-entry and exit, given that it includes only larger firms for which entry and exit are not important margins of adjustment. However, it is pertinent to note that unlike the ASI, which is a survey of manufacturing, the Prowess data is a panel of firms, rather than a repeated cross-section. Prowess is therefore particularly well suited to examining how firm-characteristics including entry and exit evolve over time and may respond to policy changes. (For instance, Goldberg et al. [2009] use the Prowess dataset to examine how firms adjust their product-mix over time.) Firms that no longer report sales or assets are assumed to have exited. We also classify firms that do not report data because of mergers and acquisitions as firms that exit the data due to consolidation.

Finally, the predominant emphasis of the extant literature using firm-level data on India has been on the manufacturing sector. An important advantage of Prowess is its coverage of firms in the services sector widely credited for India's growth miracle. The next section documents stylized facts about the evolution of India's industrial composition and firm activity against the backdrop of these broad-sweeping reforms.

The Evidence

We study five sub-periods: 1988–90, 1991–94, 1994–98, 1999–2002, and 2003–05. These periods broadly match the different waves of liberalization. Our objective is to provide the reader with an overview of the evolution of India's industrial composition in the last 20 years. We present deflated data using the GDP deflator from World Bank, World Development Indicators. For expositional purposes, the tables collapse the sectors in ten: agricultural, mining, and extraction; food, textile, and paper manufacturing; chemical and plastics manufacturing; metals and industrial manufacturing; utilities, construction, and retail; transport; hospitality, tourism, media, health, and other services; financial services and real estate; business, computer, and communication services; and miscellaneous diversified. Appendix Table A-3 presents detailed information on the industries included in each sector and the number of firms by sector.

Tables 1 to 5 present detailed information on the number of firms, firm size (assets, sale), and profitability (profit before interest depreciation and taxes and return on assets) for all firms in our sample by sector as well as by category of firm: state-owned enterprises, foreign firms, private firms incorporated before 1985 (also referred to as traditional firms), and private firms incorporated after 1985 (also referred to as new private firms). Table 6 presents information on the dispersion of returns. Table 7 describes the composition of number of firms, firm size, and profitability as a percentage of the total (by ownership group and sector). Table 8 presents additional information by year of incorporation, and Tables 9 and 10 describe the evolution of firm size and concentration.

Reforms and Dynamism?

The columns in Table 1 present data on the average number of firms by type of ownership and sector. The table shows information for the full sample across all sectors by type of ownership, followed by information for each of the different sectors by type of ownership and finally, data consolidated by sector.

Consistent with the rapid growth observed in India after the mid-1980s (as documented in Table A-1) overall firm activity as proxied by the number of firms grew substantially relative to the beginning of the sample period. There is, however, heterogeneity in ownership type. The average number of state-owned firms increased from 645 in the 1988–90 to 693 in 1995–98 ending in 617 by 2003–05. The number of firms incorporated before 1985 decreased in this period from 7,551 in 1988–90 to 5,685 in 2003–05. These numbers are in contrast to the growth rates in the average number of new private firms: up from 3,031 in 1988–90 to close to 8,864 at the end of the period. The number of foreign firms increased from an average of 533 in 1988–90 to 748 by 2003–05.

While one cannot infer causality from our results, following the different wave of reforms in the mid-1980s and early 1990s, the increasing number not just of private but also of foreign firms suggests that the liberalization measures enacted to allow domestic entry through de-licensing and de-reservation, combined with the liberalization of FDI, promoted greater dynamism in new entry by firms other than the incumbents of the pre-reform period (state-owned and traditional private firms incorporated before 1985). Indeed, the doubling of the average number of foreign firms in this period is suggestive of substantial foreign entry albeit from very low levels in the pre-reform period.

TABLE 1. Industrial Composition—Average Number of Firms, 1988–2005

Owner/Period	I 1988–90	II 1991–94	III 1995–98	IV 1999–2002	V 2003–05
Full sample					
State	645	665	693	684	617
Private (Inc. pre-1985)	7,551	7,413	6,903	6,317	5,685
Private (Inc. post-1985)	3,031	6,381	9,233	9,616	8,864
Foreign	533	678	856	850	748
Agriculture, mining, extraction					
State	42	44	43	41	39
Private (Inc. pre-1985)	145	143	134	126	112
Private (Inc. post-1985)	99	221	289	279	255
Foreign	6	8	13	14	13
Food, textile, and paper mfg.					
State	83	77	73	66	56
Private (Inc. pre-1985)	1,328	1,284	1,171	1,049	907
Private (Inc. post-1985)	504	1,048	1,293	1,269	1,109
Foreign	68	85	101	89	73
Chemicals and plastics mfg.					
State	56	57	56	49	46
Private (Inc. pre-1985)	1,150	1,121	1,025	910	816
Private (Inc. post-1985)	527	929	1,081	1,030	916
Foreign	120	135	147	139	123
Hospitality, tourism, media, health, and other services					
State	16	17	17	17	16
Private (Inc. pre-1985)	198	198	194	186	173
Private (Inc. post-1985)	104	206	341	411	404
Foreign	18	20	25	28	26
Financial services, real estate					
State	185	202	220	212	197
Private (Inc. pre-1985)	1,861	1,858	1,779	1,669	1,538
Private (Inc. post-1985)	656	1,652	2,566	2,561	2,404
Foreign	80	117	157	148	129
Business, computer, and communication services					
State	24	28	30	32	28
Private (Inc. pre-1985)	266	265	260	248	225
Private (Inc. post-1985)	133	360	711	923	875
Foreign	34	56	93	117	98
Misc. diversified					
State	5	4	4	6	6
Private (Inc. pre-1985)	156	153	150	145	134
Private (Inc. post-1985)	78	173	338	391	392
Foreign	7	9	15	17	16

(*Table 1 continued*)

(*Table 1 continued*)

Owner/Period	*I* 1988–90	*II* 1991–94	*III* 1995–98	*IV* 1999–2002	*V* 2003–05
Metals and industrial mfg.					
State	97	97	94	83	73
Private (Inc. pre-1985)	1,450	1,406	1,264	1,115	995
Private (Inc. post-1985)	521	916	1,198	1,166	1,045
Foreign	135	159	191	181	160
Utilities, construction, retail					
State	103	105	116	135	124
Private (Inc. pre-1985)	892	882	828	775	702
Private (Inc. post-1985)	370	796	1,279	1,415	1,293
Foreign	55	75	92	97	89
Transport					
State	33	36	40	42	34
Private (Inc. pre-1985)	104	104	99	95	87
Private (Inc. post-1985)	40	80	138	171	174
Foreign	9	16	21	21	22

Owner/Period	*I* 1988–90	*II* 1991–94	*III* 1995–98	*IV* 1999–2002	*V* 2003–05
	Full sample				
Industry/Period	*I*	*II*	*III*	*IV*	*V*
Agri., mining, extrac.	292	416	479	460	419
Food, text., pap. mfg	1,983	2,494	2,637	2,473	2,144
Chem., plastics mfg.	1,853	2,242	2,309	2,128	1,901
Metals, ind. mfg	2,204	2,578	2,747	2,545	2,272
Utilities, construction, retail	1,421	1,857	2,315	2,422	2,207
Transport	186	236	298	329	316
Hospitality, tourism, and other	336	441	578	642	618
Finance, real estate	2,782	3,828	4,722	4,590	4,267
Business, computers, and communication services	456	709	1,094	1,321	1,225
Miscellaneous diversified	246	338	506	559	547

Source: Prowess dataset.

Note: See Appendix Tables A-1 and A-2 for detailed explanation of variables.

These patterns are broadly mimicked within sectors. Agriculture, for example, is characterized by a relatively stable average number of state-owned firms and increasing activity by private and foreign firms (again the former from a relatively low base). The average number of traditional private firms in this sector decreased from 145 in 1988–90 to 112 by 2003–05.

In food, textiles and paper manufacturing, chemicals and plastic manufacturing, and metals and industrial manufacturing, the average number of state-owned firms decreased from 83, 56, and 97 respectively in 1988–90 to a corresponding 56, 46, and 73 in 2003–05. The number of traditional private firms shows somewhat similar patterns: the average numbers went from 1,328, 1,150, and 1,450 respectively in 1988–90 to a corresponding 907, 816, and 995 by 2003–05. In contrast, the number of private and foreign firms has increased substantially between 1988 and 2005.

Similarly, we observe high growth in the number of private and foreign firms in sectors such as utilities, construction, and retail; hospitality, tourism, and media; financial services and real estate; and business, computer and computer communications, and others. In these same sectors, there was an increase in the number of state-owned firms while there were slight reductions in the number of traditional private firms.

Business, computer and communication services, and financial service and real state by far show the highest growth rates for all type of firms, but again, private and foreign firms show substantial activity in terms of number of firms. Panagariya (2008) hails the success story in the telecommunication sector as the triumph of reforms. As the last panel in Table 1 shows, there was an overwhelming increase in the number of firms in this sector.[37]

Overall, Table 1 presents a picture of a dynamic economy driven by private and foreign firms and the transformation of the Indian economy. In fact the data suggests that 1988–90 was already a period of great activity in terms of the number of firms. We examined within-period growth in the number of firms for this period and found it to be substantial ranging from 35 percent for foreign firms and 115 percent for new private firms. As mentioned, while our data precludes comparisons with the pre-1985 period, the evidence is consistent with arguments in Panagariya (2008: 18–19) that the reforms of the 1980s opened the door to wider entry by new firms. Consistent with previous evidence, the data also suggest that the regime shift in India's growth path began in the mid-1980s.

37. See Appendix Table A-2 for activities included in each classification.

We note that there was acceleration in entry in the period following 1991 that continued through the rest of the decade. Further, our findings corroborate observation of lingering exit restrictions. While the data presents clear evidence on dynamism in firm-entry particularly by private and foreign firms, we observe little incumbent firm-exit (notwithstanding methodological issues in the collection of the data).

Table 2 presents information on average assets of ownership type and sector (in constant rupees crore). Average assets have also grown in the last two decades particularly for new private firms and firms in the foreign sector, although the initial values of assets under foreign ownership and private firms incorporated after 1985 were very low (the latter by construction). The table shows high accumulation of assets in private and foreign firms in all sectors of the economy but particularly in agriculture, mining and extraction, food, textile and paper manufacturing, transports, utilities, construction and retail, business and IT services, financial services, and other services (hospitality, tourism, media, health, and others). Foreign firms also show increased participation in recent periods and particularly in sectors such as transportation, media, health, and other services. While one cannot infer causality, greater foreign firm access did not seem to come at the expense of the overall significance of private domestic firms (see Alfaro et al. [2009] for similar results for a broad sample of countries).

The lower panel in Table 2 shows asset accumulation across sectors suggesting an increasing role in service-related activities. The growth of assets is far more dramatic in financial services and real estate, business, computer and communication services, utilities, construction and retail, transport, construction, and media.

Table 3 presents similar detailed information on sales (in constant rupees crore), where much the same pattern emerges. Although there is substantial growth across all forms of ownerships and sectors, the data suggest higher activity in terms of sales growth by foreign and new private firms and in growth in the services sectors. In sales by new private firms, growth was particularly strong in transport, hospitality, tourism media and health, while foreign firm growth was high in transport, business, computer, and communication services. As in previous patterns, there was noticeably high growth in sales of new private firms in agriculture in the period 1991–94 versus 1988–90.

Table 4 shows profits (profits before depreciation, interest payments, and rents of firms in constant terms) by ownership and sector. New private firms stand out in terms of the growth rate in their average profits. However, all

TABLE 2. Industrial Composition—Average Total Assets, 1988–2005 (Constant Rs Crore)

Owner/Period	I 1988–90	II 1991–94	III 1995–98	IV 1999–2002	V 2003–05
Full sample					
State	198,288	384,355	551,184	808,408	969,039
Private (Inc. pre-1985)	73,013	134,655	224,185	246,071	269,427
Private (Inc. post-1985)	3,079	24,090	82,517	167,759	244,100
Foreign	14,547	36,319	68,390	99,833	117,171
Agriculture, mining, extraction					
State	8,523	24,821	29,117	36,988	49,479
Private (Inc. pre-1985)	297	644	1,053	1,176	1,571
Private (Inc. post-1985)	36	600	1,567	2,684	2,874
Foreign	46	231	288	352	452
Food, textile, and paper mfg.					
State	15,080	17,540	30,602	43,080	47,737
Private (Inc. pre-1985)	12,512	21,842	34,255	43,580	50,666
Private (Inc. post-1985)	372	4,444	15,980	18,749	20,381
Foreign	2,259	3,816	5,203	6,258	7,644
Chemicals and plastics mfg.					
State	7,119	7,197	8,166	7,310	6,479
Private (Inc. pre-1985)	20,127	30,528	43,591	44,016	45,664
Private (Inc. post-1985)	806	4,832	11,033	14,251	18,938
Foreign	4,336	5,473	9,357	12,733	13,795
Hospitality, tourism, media, health, and other services					
State	40	153	246	257	341
Private (Inc. pre-1985)	730	1,258	3,133	6,129	5,672
Private (Inc. post-1985)	18	250	1,084	2,878	4,526
Foreign	32	120	305	527	510
Financial services, real estate					
State	115,481	239,529	376,073	535,430	633,167
Private (Inc. pre-1985)	5,963	25,834	59,802	66,747	70,690
Private (Inc. post-1985)	380	5,295	23,429	69,535	110,035
Foreign	2,546	18,287	34,660	51,801	63,953
Business, computer, and communication services					
State	3,329	5,717	6,847	38,517	43,438
Private (Inc. pre-1985)	460	796	1,866	4,490	6,555
Private (Inc. post-1985)	333	1,308	7,204	19,674	28,885
Foreign	53	197	1,285	4,337	5,987
Misc. diversified					
State	532	348	404	386	382
Private (Inc. pre-1985)	3,392	4,588	5,212	4,491	4,608
Private (Inc. post-1985)	152	638	1,242	1,436	1,842
Foreign	189	165	154	167	235

(*Table 2 continued*)

(*Table 2 continued*)

Owner/Period	*I* *1988–90*	*II* *1991–94*	*III* *1995–98*	*IV* *1999–2002*	*V* *2003–05*
Metals and industrial mfg.					
State	27,872	32,737	31,148	27,140	32,028
Private (Inc. pre-1985)	21,130	33,715	51,047	50,570	56,805
Private (Inc. post-1985)	692	4,747	12,556	20,358	23,987
Foreign	4,770	7,490	14,461	17,893	19,694
Utilities, construction, retail					
State	19,047	48,894	59,622	107,182	143,278
Private (Inc. pre-1985)	7,256	13,227	21,425	21,926	23,496
Private (Inc. post-1985)	241	1,704	7,560	14,900	28,475
Foreign	305	454	1,980	3,574	2,331
Transport					
State	1,265	7,420	8,960	12,118	12,710
Private (Inc. pre-1985)	1,146	2,224	2,800	2,946	3,702
Private (Inc. post-1985)	48	273	863	3,296	4,156
Foreign	10	86	698	2,190	2,570

Owner/Period	*I* *1988–90*	*II* *1991–94*	*III* *1995–98*	*IV* *1999–2002*	*V* *2003–05*
	Full sample				
Industry/Period	*I*	*II*	*III*	*IV*	*V*
Agri., mining, extrac.	8,903	26,296	32,025	41,200	54,375
Food, text., pap. mfg	30,223	47,641	86,040	111,666	126,429
Chem., plastics mfg.	32,388	48,031	72,148	78,310	84,876
Metals, ind. mfg	54,464	78,688	109,212	115,961	132,514
Util., construct., retail	26,849	64,279	90,586	147,582	197,580
Transport	2,469	10,003	13,320	20,550	23,138
Hosp., tour., and other	820	1,781	4,768	9,791	11,049
Financ., real estate	124,370	288,944	493,963	723,513	877,845
Bus., comp., and comm.	4,176	8,017	17,202	67,018	84,865
Misc. diversified	4,264	5,739	7,012	6,480	7,067

Source: Prowess dataset.

Note: See Appendix Tables A-2 and A-3 for detailed explanation of variables.

TABLE 3. Industrial Composition—Average Gross Sales, 1988–2005 (Constant Rs Crore)

Owner/Period	*I* *1988–90*	*II* *1991–94*	*III* *1995–98*	*IV* *1999–2002*	*V* *2003–05*
Full sample					
State	67,121	90,617	129,745	203,605	256,972
Private (Inc. pre-1985)	72,047	96,737	128,494	150,568	187,815
Private (Inc. post-1985)	2,566	13,094	38,155	72,986	103,229
Foreign	17,748	22,774	35,473	47,240	59,091
Agriculture, mining, extraction					
State	5,486	10,462	16,098	20,974	26,712
Private (Inc. pre-1985)	253	477	830	857	1,307
Private (Inc. post-1985)	22	276	955	1,869	2,470
Foreign	81	173	181	209	465
Food, textile, and paper mfg.					
State	29,059	31,898	52,401	88,011	103,620
Private (Inc. pre-1985)	14,795	20,236	26,214	39,253	46,606
Private (Inc. post-1985)	483	3,182	9,124	18,631	18,808
Foreign	4,086	5,669	7,149	8,518	9,003
Chemicals and plastics mfg.					
State	4,729	5,104	5,405	6,056	6,208
Private (Inc. pre-1985)	19,989	26,667	34,097	35,660	41,531
Private (Inc. post-1985)	629	2,815	7,041	11,082	15,295
Foreign	6,647	7,834	11,753	14,474	14,804
Hospitality, tourism, media, health, and other services					
State	29	123	226	181	185
Private (Inc. pre-1985)	367	616	1,175	1,405	1,678
Private (Inc. post-1985)	3	64	280	941	1,495
Foreign	17	58	147	205	297
Financial services, real estate					
State	195	364	538	407	414
Private (Inc. pre-1985)	2,280	2,568	3,597	4,797	4,429
Private (Inc. post-1985)	42	179	390	466	898
Foreign	40	44	56	22	76
Business, computer, and communication services					
State	996	1,526	2,180	9,987	12,739
Private (Inc. pre-1985)	565	813	1,683	3,639	5,576
Private (Inc. post-1985)	185	1,287	4,046	7,822	12,958
Foreign	29	140	566	2,405	4,029
Misc. diversified					
State	680	341	372	343	381
Private (Inc. pre-1985)	3,253	3,902	3,936	3,454	4,176
Private (Inc. post-1985)	288	619	1,031	1,058	1,401
Foreign	582	427	291	394	486

(*Table 3 continued*)

(*Table 3 continued*)

Owner/Period	*I* 1988–90	*II* 1991–94	*III* 1995–98	*IV* 1999–2002	*V* 2003–05
Metals and industrial mfg.					
State	14,492	15,981	16,046	16,407	21,394
Private (Inc. pre-1985)	23,583	30,563	41,587	43,286	59,202
Private (Inc. post-1985)	639	3,230	9,172	17,908	26,992
Foreign	5,499	7,406	13,128	16,890	25,225
Utilities, construction, retail					
State	10,615	21,984	31,645	54,346	77,522
Private (Inc. pre-1985)	6,313	9,846	13,980	16,243	20,770
Private (Inc. post-1985)	262	1,281	5,637	12,080	21,236
Foreign	751	984	1,642	2,893	3,006
cont.					
Transport					
State	840	2,834	4,835	6,892	7,798
Private (Inc. pre-1985)	649	1,049	1,397	1,974	2,540
Private (Inc. post-1985)	13	159	480	1,130	1,675
Foreign	15	39	561	1,230	1,699

Industry/Period	*I* 1988–90	*II* 1991–94	*III* 1995–98	*IV* 1999–2002	*V* 2003–05
	Full sample				
Agri., mining, extrac.	5,842	11,387	18,064	23,908	30,954
Food, text., pap. mfg	48,423	60,984	94,887	154,413	178,038
Chem., plastics mfg.	31,994	42,419	58,296	67,272	77,837
Metals, ind. mfg	44,212	57,181	79,932	94,491	132,813
Util., construct., retail	17,942	34,095	52,904	85,562	122,535
Transport	1,518	4,082	7,273	11,226	13,713
Hosp, tour., and other	416	862	1,829	2,732	3,656
Financ., real estate	2,558	3,155	4,580	5,693	5,817
Bus., comp., and comm.	1,774	3,767	8,474	23,852	35,302
Misc. diversified	4,803	5,289	5,630	5,250	6,444

Source: Prowess dataset.

Note: See Appendix Tables A-2 and A-3 for detailed explanation of variables.

TABLE 4. Industrial Composition—Average Profits (PBDIT), 1988–2005 (Constant Rs Crore)

Owner/Period	*I* *1988–90*	*II* *1991–94*	*III* *1995–98*	*IV* *1999–2002*	*V* *2003–05*
Full sample					
State	15,421	32,029	50,140	72,050	82,753
Private (Inc. pre-1985)	10,032	17,326	25,484	25,893	33,252
Private (Inc. post-1985)	402	2,552	6,693	13,213	19,562
Foreign	2,130	4,196	7,783	10,371	12,886
Agriculture, mining, extraction					
State	767	3,731	4,905	7,031	10,571
Private (Inc. pre-1985)	38	88	110	111	369
Private (Inc. post-1985)	7	67	143	254	356
Foreign	9	33	30	26	143
Food, textile, and paper mfg.					
State	2,089	2,123	3,406	5,376	7,395
Private (Inc. pre-1985)	1,847	2,959	3,841	5,341	6,848
Private (Inc. post-1985)	49	401	948	1,666	1,557
Foreign	442	720	923	1,195	1,504
Chemicals and plastics mfg.					
State	608	824	707	390	580
Private (Inc. pre-1985)	2,909	4,343	5,269	5,090	6,120
Private (Inc. post-1985)	76	472	934	1,441	1,968
Foreign	754	1,029	1,573	2,313	2,584
Hospitality, tourism, media, health, and other services					
State	3	21	36	11	12
Private (Inc. pre-1985)	95	197	459	448	506
Private (Inc. post-1985)	1	23	72	178	283
Foreign	6	23	42	45	62
Financial services, real estate					
State	7,709	16,874	29,855	40,125	37,802
Private (Inc. pre-1985)	714	2,935	6,724	5,909	5,791
Private (Inc. post-1985)	49	565	2,026	4,295	6,480
Foreign	210	1,338	3,224	4,059	3,669
Business, computer, and communication services					
State	436	819	1,347	5,160	6,876
Private (Inc. pre-1985)	67	127	332	1,022	1,559
Private (Inc. post-1985)	81	276	914	2,113	3,228
Foreign	3	34	115	594	1,202
Misc. diversified					
State	57	34	33	11	8
Private (Inc. pre-1985)	365	555	521	350	569
Private (Inc. post-1985)	23	84	112	114	161
Foreign	40	41	28	51	58

(*Table 4 continued*)

(*Table 4 continued*)

Owner/Period	*I* *1988–90*	*II* *1991–94*	*III* *1995–98*	*IV* *1999–2002*	*V* *2003–05*
Metals and industrial mfg.					
State	2,204	2,508	2,598	1,944	5,118
Private (Inc. pre-1985)	2,955	4,277	5,847	5,265	8,535
Private (Inc. post-1985)	77	480	981	1,707	2,771
Foreign	640	914	1,570	1,576	3,005
Utilities, construction, retail					
State	1,374	4,446	6,440	10,661	12,796
Private (Inc. pre-1985)	812	1,462	2,037	1,944	2,271
Private (Inc. post-1985)	35	156	482	1,061	2,297
Foreign	26	54	204	332	216
Transport					
State	172	649	814	1,341	1,596
Private (Inc. pre-1985)	231	382	344	412	684
Private (Inc. post-1985)	5	27	80	384	461
Foreign	0	9	73	180	442

Owner/Period	*I* *1988–90*	*II* *1991–94*	*III* *1995–98*	*IV* *1999–2002*	*V* *2003–05*
	Full sample				
Industry/Period	*I*	*II*	*III*	*IV*	*V*
Agri., mining, extrac.	820	3,920	5,188	7,422	11,440
Food, text., pap. mfg	4,428	6,204	9,118	13,578	17,304
Chem., plastics mfg.	4,347	6,668	8,484	9,235	11,252
Metals, ind. mfg	5,876	8,179	10,996	10,493	19,430
Util., construct., retail	2,247	6,118	9,162	13,998	17,580
Transport	408	1,067	1,311	2,318	3,184
Hosp, tour., and other	105	264	609	682	862
Financ., real estate	8,682	21,712	41,829	54,388	53,741
Bus., comp., and comm.	587	1,256	2,708	8,888	12,865
Misc. diversified	485	713	695	526	796

Source: Prowess dataset.

Note: See Appendix Tables A-2 and A-3 for detailed explanation of variables.

type of firms, state-owned, traditional and new private firms and foreign firms also show high rates of growth in the average level of their profits. For foreign firms, financial services and business and computer-related activities witnessed the highest rates of growth in average profits. It is also worth noting that across economic activities, sectors in the services (such as utilities, construction and retail, hospitality, tourism, media, health, and financial services) dominated those activities in the manufacturing sector (such as food, textile and paper manufacturing, and chemicals and plastics) for profit growth. It is also worth highlighting the high growth in profits in agriculture and mining by traditional private firms in the period 1991–94 versus 1988–90.

Table 5 shows a more subtle picture emerging, which reflects the return on assets. In the early period of 1988–90, for the full sample, traditional private businesses display the highest average rate of return (13.53 percent) followed by new private firms (12.93 percent) and then foreign firms (12.36 percent). State-owned firms come last with an average rate of return of 8.90 percent during this period. After 1991, the picture changes. Traditional private firms and new private firms experience a decline in the return of assets reaching 10.66 percent and 8.11 percent, respectively, in 1999–2002 to increase to 12.39 percent and 8.54 percent, respectively, during 2003–05. State-owned firms, in contrast, experienced an increase in the return on assets with a figure of 10.61 percent in 2003–05 from 8.90 percent in 1988–90.[38] Foreign firms also experience an increase in the return on assets with a 14.94 percent return for the 2003–05 period compared to 12.36 percent in 1988–90. It is interesting to note that the dispersion in rates of return remained almost the same from 1988–90 (at 4.63 percent) until 1999–2002 (at 4.38 percent) to increase to 6.39 percent in 2003–05 across ownership group. The coefficient of variation in returns across ownership increased from 0.17 in 1988–90 to 0.23 in 2003–05.

For state-owned firms, the highest rate of return was in agriculture, mining and extraction (21.27 percent) followed by business, computer, and communication services (15.85 percent); metals and industrial manufacturing (15.74 percent); and food, textile, and paper management (15.63 percent) in 2003–05. The sectors with the highest rates of return for traditional private firms were business, computer, and communication services (23.65 percent) and agriculture, mining and extraction (22.91 percent). For new private firms, the highest rate of return was agriculture, mining

38. Bai et al. (2006) estimate the aggregate marginal product of capital in China to be around 20 percent, down from 25 percent in the pre-reform period.

TABLE 5. Industrial Composition—Average Return on Assets, 1988–2005

Owner/Period	*I* 1988–90	*II* 1991–94	*III* 1995–98	*IV* 1999–2002	*V* 2003–05
Full sample					
State	8.90	9.54	10.26	9.21	10.61
Private (Inc. pre-1985)	13.53	12.78	11.54	10.66	12.39
Private (Inc. post-1985)	12.93	11.81	8.35	8.11	8.54
Foreign	12.36	14.18	12.44	12.50	14.94
Agriculture, mining, extraction					
State	8.81	15.29	16.82	18.75	21.27
Private (Inc. pre-1985)	13.39	13.48	10.51	9.40	22.91
Private (Inc. post-1985)	19.77	11.02	9.27	9.48	12.38
Foreign	18.93	15.21	10.39	7.60	30.04
Food, textile, and paper mfg.					
State	13.97	12.14	11.16	12.41	15.63
Private (Inc. pre-1985)	14.68	13.58	11.23	12.28	13.50
Private (Inc. post-1985)	12.62	9.69	6.23	8.67	7.64
Foreign	19.41	19.06	17.70	19.11	19.69
Chemicals and plastics mfg.					
State	8.54	11.46	8.67	5.47	8.96
Private (Inc. pre-1985)	14.44	14.19	12.15	11.57	13.40
Private (Inc. post-1985)	9.39	9.98	8.49	10.05	10.40
Foreign	17.36	18.95	16.88	18.14	18.73
Hospitality, tourism, media, health, and other services					
State	2.82	13.32	14.29	0.70	3.42
Private (Inc. pre-1985)	13.16	15.59	16.06	7.33	8.90
Private (Inc. post-1985)	2.06	8.51	6.65	6.22	6.23
Foreign	17.95	19.45	14.22	8.50	12.09
Financial services, real estate					
State	6.55	7.08	7.93	7.50	6.00
Private (Inc. pre-1985)	12.77	11.30	11.30	8.88	8.19
Private (Inc. post-1985)	12.77	12.04	9.00	6.30	5.92
Foreign	8.37	7.60	9.37	7.84	5.76
Business, computer, and communication services					
State	13.27	14.18	19.67	13.23	15.85
Private (Inc. pre-1985)	14.59	16.00	17.33	23.01	23.65
Private (Inc. post-1985)	16.29	22.13	13.15	11.42	11.07
Foreign	5.28	16.42	9.74	13.79	20.09
Misc. diversified					
State	11.02	9.83	8.19	2.83	2.03
Private (Inc. pre-1985)	10.69	12.05	9.82	7.76	12.33
Private (Inc. post-1985)	14.34	13.70	9.30	7.89	8.73
Foreign	22.48	25.16	18.18	30.67	24.79

Metals and industrial mfg.					
State	7.99	7.66	8.36	7.10	15.74
Private (Inc. pre-1985)	13.97	12.73	11.51	10.39	14.97
Private (Inc. post-1985)	11.14	10.41	7.87	8.37	11.48
Foreign	13.40	12.24	11.24	8.81	15.22
Utilities, construction, retail					
State	6.97	9.05	10.77	10.07	8.95
Private (Inc. pre-1985)	11.21	11.11	9.54	8.88	9.66
Private (Inc. post-1985)	14.92	10.34	6.36	7.05	8.11
Foreign	8.35	11.73	9.38	9.51	9.24
Transport					
State	15.20	8.94	9.08	11.07	12.56
Private (Inc. pre-1985)	19.79	17.14	12.38	14.00	18.30
Private (Inc. post-1985)	11.19	10.44	9.14	11.60	11.09
Foreign	–0.70	7.96	11.53	8.56	17.04

	Full sample				
Industry/Period	*I*	*II*	*III*	*IV*	*V*
Agri., mining, extrac.	17.31	12.07	10.20	10.14	16.14
Food, text., pap. mfg	13.78	11.75	8.92	10.69	10.80
Chem., plastics mfg.	12.02	12.37	10.58	11.10	12.16
Metals, ind. mfg	12.45	11.48	9.73	9.26	13.42
Util., construct., retail	13.07	10.56	7.71	7.88	8.68
Transport	13.16	11.82	10.13	11.96	13.54
Hosp., tour., and other	5.69	10.93	9.64	6.43	7.07
Financ., real estate	12.35	11.42	9.78	7.32	6.73
Bus., comp., and comm.	16.39	20.36	13.80	13.71	14.15
Misc. diversified	13.70	13.58	9.64	8.39	9.81

Source: Prowess dataset.

Note: See Appendix Tables A-2 and A-3 for detailed explanation of variables.

and extraction (12.38 percent), transport (11.09 percent), and business, computer, and communication services (11.09 percent). It is important to highlight that in agriculture, mining and extraction, food, textile, and paper manufacturing, chemicals and plastics manufacturing, transport, hospitality, tourism, media, health, and other service and miscellaneous diversified activities, foreign firms earned the highest rates of return across ownership groups. For the full sample, the highest rate of return was in agriculture, mining and extraction (17.31 percent) and the lowest in hospitality, tourism, media, and health (8.15 percent) in 1988–1990. In 2003–05, the highest rate of return was in transport (13.54 percent) and the lowest in financial services (6.73 percent).

Table 6 presents data on the sectoral variance of return on assets measured by dispersion in the top panel and by the coefficient of variation[39] in the second one. As seen in Table 6, in 1988–90, the dispersion in returns across ownership groups within a sector was the highest in transport (20.49 percent) and the lowest in metals and industrial manufacturing (5.97 percent) and financial services (7.22 percent). In the period 2003–05, the dispersion in returns ranged from 22.76 percent in miscellaneous to 1.55 percent in utilities, construction, and retail. Interestingly, the dispersion in returns across sectors fell from 11.62 percent in the early period to 9.41 percent in the most recent period.

The coefficient of variation within sectors across ownership groups was 0.19 in food, textile, and paper manufacturing and 0.77 in transport in 1988–90 and ranged from 0.07 in utilities, construction, and retail to 0.80 in miscellaneous diversified production in 2003–05. The coefficient of variation in returns across sectors went from 0.24 in 1988–90 to 0.28 in 2003–05.

In sum, the panels in Tables 5 and 6 tell an analogous story. The rate of return is remarkably stable for the full sample across time with an average return on assets of 11.93 percent in 1988–90 to 11.62 percent in 2003–05. While there is cross-sectional variation in rates of return across ownership groups and sectors, there is relatively little dispersion in the rates of return as seen in the tight range of returns and the low coefficient of variation within sectors by ownership groups and across sectors (see Figure 4). The patterns in the return on assets are striking when compared to the large variations

39. The coefficient of variation is a normalized measure of the dispersion of a probability distribution. It is defined as the ratio of the standard deviation to the mean. For examples, distributions with coefficient of variation less than one are considered low variance and higher than one high variance.

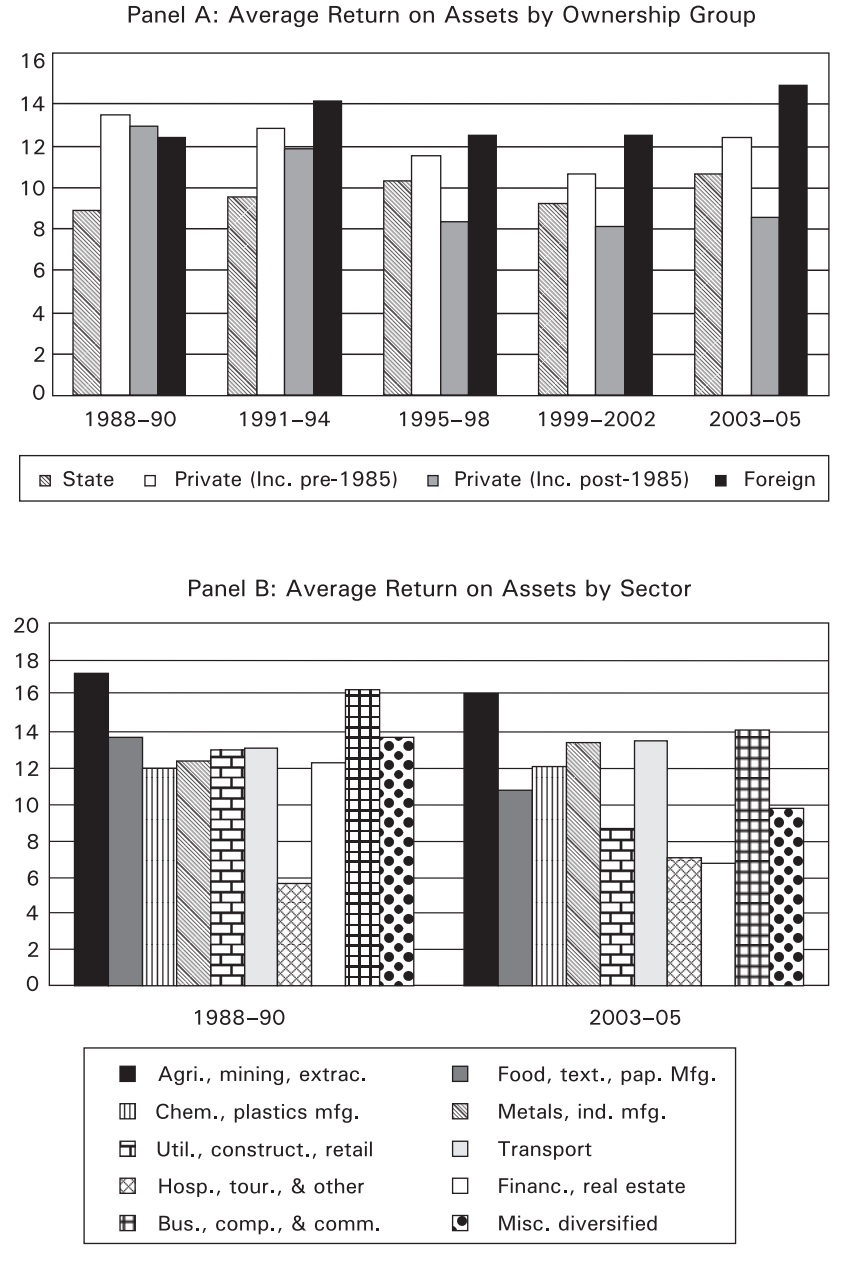
TABLE 6. Return on Assets—Cross-Sectional Variance, 1988–2005

Industry/Period	*I* *1988–90*	*II* *1991–94*	*III* *1995–98*	*IV* *1999–2002*	*V* *2003–05*
Return on assets (%): Dispersion					
Full sample (across owners)	4.63	4.64	4.09	4.38	6.39
Agriculture, mining, extraction	10.96	4.27	7.55	11.15	17.66
Food, textile, and paper mfg.	6.79	9.37	11.46	10.44	12.05
Chemicals and plastics mfg.	8.83	8.97	8.38	12.67	9.78
Metals and industrial mfg.	5.97	5.06	3.64	3.28	4.26
Utilities, construction, retail	7.95	2.68	4.41	3.02	1.55
Transport	20.49	9.18	3.30	5.44	7.21
Hospitality, tourism, media, health, and other services	15.89	10.94	9.41	7.80	8.66
Financial services, real estate	6.22	4.96	3.37	2.58	2.44
Business, computer, and communication services	11.01	7.95	9.92	11.59	12.58
Misc. diversified	11.79	15.32	9.99	27.84	22.76
Full sample (across industries)	11.62	9.80	6.09	7.27	9.41
Return on asset: Coefficient of variation					
Full sample (across owners)	0.17	0.16	0.17	0.19	0.23
Agriculture, mining, extraction	0.34	0.15	0.29	0.45	0.34
Food, textile, and paper mfg.	0.19	0.29	0.41	0.33	0.36
Chemicals and plastics mfg.	0.34	0.29	0.34	0.46	0.34
Metals and industrial mfg.	0.23	0.21	0.19	0.16	0.14
Utilities, construction, retail	0.34	0.11	0.21	0.15	0.07
Transport	0.77	0.37	0.16	0.20	0.24
Hospitality, tourism, media, health, and other services	0.87	0.32	0.33	0.61	0.48
Financial services, real estate	0.31	0.27	0.15	0.14	0.18
Business, computer, and communication services	0.39	0.20	0.29	0.34	0.31
Misc. diversified	0.37	0.45	0.40	1.02	0.80
Full sample (across industries)	0.24	0.22	0.15	0.23	0.28

Source: Prowess dataset.

Note: See Appendix Tables A-2 and A-3 for detailed explanation of variables.

FIGURE 4. Average Return on Assets



Source: Prowess dataset.

we see in terms of new firm—entry by foreign and private firms and in the growth of their assets, sales, and profits in comparison to the lower rates of entry by state-owned and business group-affiliated firms.

A growing literature argues that the differential effects of policies and institutions on the investment climate broadly defined might significantly influence the allocation of resources across establishments. The working hypothesis in this literature is that not only the level of factor accumulation, but also how these factors are allocated across heterogeneous production units, matters in trying to understand income differences (see Alfaro et al., 2009; Hsieh and Klenow, 2009; Restuccia and Rogerson, 2008). That is, the great divide between rich and poor countries may not just be explained by lack of capital and skilled labor but also by the consequence of the misallocation or misuse of available resources.

For India, Hsieh and Klenow (2009) use plant-level information from the Indian manufacturing census data to measure dispersion in the marginal products of capital and labor within 4-digit manufacturing sectors. When capital and labor are hypothetically reallocated to equalize marginal products to the extent observed in the United States, the authors find efficiency gains of 50–60 percent in India.[40] As noted by Klenow (2008), the importance of allocative efficiency has been motivated by the fact that the growth took off in India in the wake of a series of policy reforms. In this paper, we show that the coefficient of variation in the rate of return on assets is relatively low across both industries and owners. A further point to observe is that state-owned firms earn substantial profits. It is not clear whether these returns stem from monopoly power in concentrated industries or because they are efficient. If it is the former, further privatization may serve to raise returns even higher, notwithstanding the caveat that private monopolies do not replace state-owned monopolies.

Or, Is It Continuing Incumbent Control?

Table 7 presents information about the shares of the number of firms, assets, sales, and profits by ownership groups and sectors. Although the table carries substantial information, some clear, interesting but conflicting, patterns emerge. Overall, what appears is not a story of dramatic transformation in India's microeconomic structure following liberalization. Rather, it is one

40. Hsieh and Klenow (2009) use manufacturing data from India's Annual Survey of Industries (ASI) from 1987–88 through 1994–95.

TABLE 7. Industrial Composition—Fraction of Average Number of Firms, Assets, Sales, and Profits, 1998–2005

Number of firm						*Total assets*						*Total sales*						*Profits (PBDIT)*					
Owner/ Period	*I 1988–90*	*II 1991–94*	*III 1995–98*	*IV 1999–2002*	*V 2003–05*	*Owner/ period*	*I 1988–90*	*II 1991–94*	*III 1995–98*	*IV 1999–2002*	*V 2003–05*	*Owner/ period*	*I 1988–90*	*II 1991–94*	*III 1995–98*	*IV 1999–2002*	*V 2003–05*	*Owner/ period*	*I 1988–90*	*II 1991–94*	*III 1995–98*	*IV 1999–2002*	*V 2003–05*
Full sample						**Full sample**						**Full sample**						**Full sample**					
State	5%	4%	4%	4%	4%	State	69%	66%	60%	61%	61%	State	42%	41%	39%	43%	42%	State	55%	57%	56%	59%	56%
Pr. Pre-85	64%	49%	39%	36%	36%	Pr. Pre-85	25%	23%	24%	19%	17%	Pr. Pre-85	45%	43%	39%	32%	31%	Pr. Pre-85	36%	31%	28%	21%	22%
Pr. Post-85	26%	42%	52%	55%	56%	Pr. Post-85	1%	4%	9%	13%	15%	Pr. Post-85	2%	6%	11%	15%	17%	Pr. Post-85	1%	5%	7%	11%	13%
Foreign	5%	4%	5%	5%	5%	Foreign	5%	6%	7%	8%	7%	Foreign	11%	10%	11%	10%	10%	Foreign	8%	7%	9%	9%	9%
Agric., mining, extraction						**Agric., mining, extraction**						**Agric., Mining, extraction**						**Agric., mining, extraction**					
State	14%	10%	9%	9%	9%	State	96%	94%	91%	90%	91%	State	94%	92%	89%	88%	86%	State	94%	95%	95%	95%	92%
Pr. Pre-85	50%	34%	28%	27%	27%	Pr. Pre-85	3%	2%	3%	3%	3%	Pr. Pre-85	4%	4%	5%	4%	4%	Pr. Pre-85	5%	2%	2%	2%	3%
Pr. Post-85	34%	53%	60%	61%	61%	Pr. Post-85	0%	2%	5%	7%	5%	Pr. Post-85	0%	2%	5%	8%	8%	Pr. Post-85	1%	2%	3%	3%	3%
Foreign	2%	2%	3%	3%	3%	Foreign	1%	1%	1%	1%	1%	Foreign	1%	2%	1%	1%	2%	Foreign	1%	1%	1%	0%	1%
Food, textile, and paper mfg.						**Food, textile, and paper mfg.**						**Food, textile, and paper mfg.**						**Food, textile, and paper mfg.**					
State	4%	3%	3%	3%	3%	State	50%	37%	36%	39%	38%	State	60%	52%	55%	57%	58%	State	47%	34%	37%	40%	43%
Pr. Pre-85	67%	51%	44%	42%	42%	Pr. Pre-85	41%	46%	40%	39%	40%	Pr. Pre-85	31%	33%	28%	25%	26%	Pr. Pre-85	42%	48%	42%	39%	40%
Pr. Post-85	25%	42%	49%	51%	52%	Pr. Post-85	1%	9%	19%	17%	16%	Pr. Post-85	1%	5%	10%	12%	11%	Pr. Post-85	1%	6%	10%	12%	9%
Foreign	3%	3%	4%	4%	3%	Foreign	7%	8%	6%	6%	6%	Foreign	8%	9%	8%	6%	5%	Foreign	10%	12%	10%	9%	9%
Chemicals and plastics mfg.						**Chemicals and plastics mfg.**						**Chemicals and plastics mfg.**						**Chemicals and plastics mfg.**					
State	3%	3%	2%	2%	2%	State	22%	15%	11%	9%	8%	State	15%	12%	9%	9%	8%	State	14%	12%	8%	4%	5%
Pr. Pre-85	62%	50%	44%	43%	43%	Pr. Pre-85	62%	64%	60%	56%	54%	Pr. Pre-85	62%	63%	58%	53%	53%	Pr. Pre-85	67%	65%	62%	55%	54%
Pr. Post-85	28%	41%	47%	48%	48%	Pr. Post-85	2%	10%	15%	18%	22%	Pr. Post-85	2%	7%	12%	16%	20%	Pr. Post-85	2%	7%	11%	16%	17%
Foreign	6%	6%	6%	7%	6%	Foreign	13%	11%	13%	16%	16%	Foreign	21%	18%	20%	22%	19%	Foreign	17%	15%	19%	25%	23%
Metals and industrial mfg.						**Metals and industrial mfg.**						**Metals and industrial mfg.**						**Metals and industrial mfg.**					
State	4%	4%	3%	3%	3%	State	51%	42%	29%	23%	24%	State	33%	28%	20%	17%	16%	State	38%	31%	24%	19%	26%
Pr. Pre-85	66%	55%	46%	44%	44%	Pr. Pre-85	39%	43%	47%	44%	43%	Pr. Pre-85	53%	53%	52%	46%	45%	Pr. Pre-85	50%	52%	53%	50%	44%
Pr. Post-85	24%	36%	44%	46%	46%	Pr. Post-85	1%	6%	11%	18%	18%	Pr. Post-85	1%	6%	11%	19%	20%	Pr. Post-85	1%	6%	9%	16%	14%
Foreign	6%	6%	7%	7%	7%	Foreign	9%	10%	13%	15%	15%	Foreign	12%	13%	16%	18%	19%	Foreign	11%	11%	14%	15%	15%

Utilities, construc., retail					
State	7%	6%	5%	6%	6%
Pr. Pre-85	63%	47%	36%	32%	32%
Pr. Post-85	26%	43%	55%	58%	59%
Foreign	4%	4%	4%	4%	4%

Transport					
State	18%	15%	14%	13%	11%
Pr. Pre-85	56%	44%	33%	29%	27%
Pr. Post-85	21%	34%	46%	52%	55%
Foreign	5%	7%	7%	6%	7%

Hospitality, tour., media, health, and other					
State	5%	4%	3%	3%	3%
Pr. Pre-85	59%	45%	34%	29%	28%
Pr. Post-85	31%	47%	59%	64%	65%
Foreign	5%	4%	4%	4%	4%

Financial services, real estate					
State	7%	5%	5%	5%	5%
Pr. Pre-85	67%	49%	38%	36%	36%
Pr. Post-85	24%	43%	54%	56%	56%
Foreign	3%	3%	3%	3%	3%

Business, comp., and comm. services					
State	5%	4%	3%	2%	2%
Pr. Pre-85	58%	37%	24%	19%	18%
Pr. Post-85	29%	51%	65%	70%	71%
Foreign	7%	8%	9%	9%	8%

Utilities, construc., retail					
State	71%	76%	66%	73%	73%
Pr. Pre-85	27%	21%	24%	15%	12%
Pr. Post-85	1%	3%	8%	10%	14%
Foreign	1%	1%	2%	2%	1%

Transport					
State	51%	74%	67%	59%	55%
Bus. G.	46%	22%	21%	14%	16%
Private	2%	3%	6%	16%	18%
Foreign	0%	1%	5%	11%	11%

Hospitality, tour., media, health, and other					
State	5%	9%	5%	3%	3%
Bus. G.	89%	71%	66%	63%	51%
Private	2%	14%	23%	29%	41%
Foreign	4%	7%	6%	5%	5%

Financial services, real estate					
State	93%	83%	76%	74%	72%
Bus. G.	5%	9%	12%	9%	8%
Private	0%	2%	5%	10%	13%
Foreign	2%	6%	7%	7%	7%

Business, comp., and comm. services					
State	80%	71%	40%	57%	51%
Bus. G.	11%	10%	11%	7%	8%
Private	8%	16%	42%	29%	34%
Foreign	1%	2%	7%	6%	7%

Utilities, construc., retail					
State	59%	64%	60%	64%	63%
Pr. Pre-85	35%	29%	26%	19%	17%
Pr. Post-85	1%	4%	11%	14%	17%
Foreign	4%	3%	3%	3%	2%

Transport					
State	55%	69%	66%	61%	57%
Bus. G.	43%	26%	19%	18%	19%
Private	1%	4%	7%	10%	12%
Foreign	1%	1%	8%	11%	12%

Hospitality, tour., nedia, health, and other					
State	7%	14%	12%	7%	5%
Bus. G.	88%	71%	64%	51%	46%
Private	1%	7%	15%	34%	41%
Foreign	4%	7%	8%	7%	8%

Financial services, real estate					
State	8%	12%	12%	7%	7%
Bus. G.	89%	81%	79%	84%	76%
Private	2%	6%	9%	8%	15%
Foreign	2%	1%	1%	0%	1%

Business, comp., and comm. services					
State	56%	41%	26%	42%	36%
Bus. G.	32%	22%	20%	15%	16%
Private	10%	34%	48%	33%	37%
Foreign	2%	4%	7%	10%	11%

Utilities, construc., retail					
State	61%	73%	70%	76%	73%
Pr. Pre-85	36%	24%	22%	14%	13%
Pr. Post-85	2%	3%	5%	8%	13%
Foreign	1%	1%	2%	2%	1%

Transport					
State	42%	61%	62%	58%	50%
Bus. G.	57%	36%	26%	18%	21%
Private	1%	3%	6%	17%	14%
Foreign	0%	1%	6%	8%	14%

Hospitality, tour., media, health, and other					
State	3%	8%	6%	2%	1%
Bus. G.	90%	75%	75%	66%	59%
Private	1%	9%	12%	26%	33%
Foreign	6%	9%	7%	7%	7%

Financial services, real estate					
State	89%	78%	71%	74%	70%
Bus. G.	8%	14%	16%	11%	11%
Private	1%	3%	5%	8%	12%
Foreign	2%	6%	8%	7%	7%

Business, comp., and comm. services					
State	74%	65%	50%	58%	53%
Bus. G.	11%	10%	12%	11%	12%
Private	14%	22%	34%	24%	25%
Foreign	0%	3%	4%	7%	9%

(*Table 7 continued*)

(*Table 7 continued*)

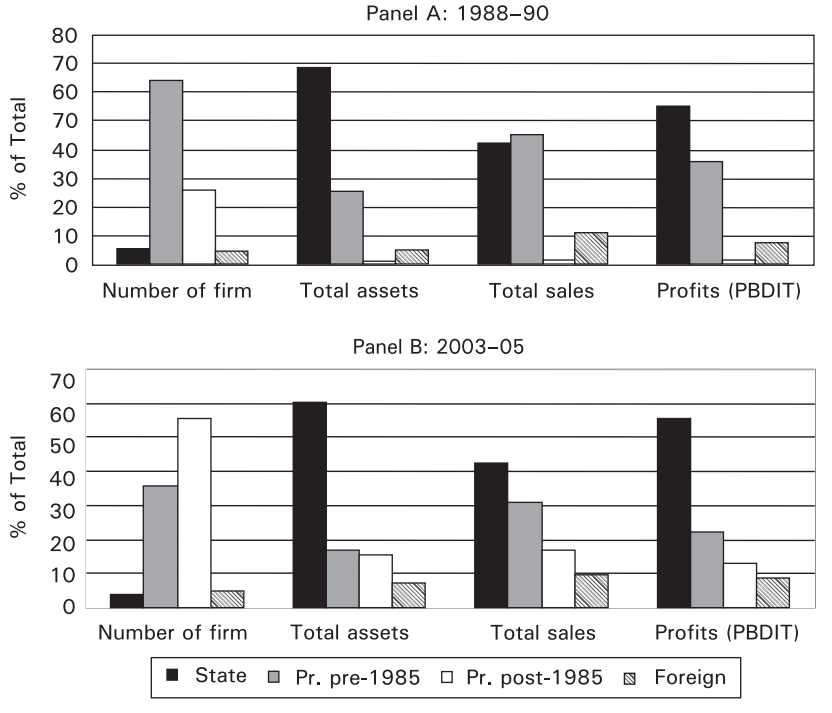
Number of firm						*Total assets*						*Total sales*						*Profits (PBDIT)*					
Owner/ Period	*I 1988–90*	*II 1991–94*	*III 1995–98*	*IV 1999–2002*	*V 2003–05*	*Owner/ period*	*I 1988–90*	*II 1991–94*	*III 1995–98*	*IV 1999–2002*	*V 2003–05*	*Owner/ period*	*I 1988–90*	*II 1991–94*	*III 1995–98*	*IV 1999–2002*	*V 2003–05*	*Owner/ period*	*I 1988–90*	*II 1991–94*	*III 1995–98*	*IV 1999–2002*	*V 2003–05*
Misc. diversified						**Misc. diversified**						**Misc. diversified**						**Misc. diversified**					
State	2%	1%	1%	1%	1%	State		6%	6%	6%	5%	State	14%	6%	7%	7%	6%	State	12%	5%	5%	2%	1%
Pr. Pre-85	63%	45%	30%	26%	24%	Bus. G.	80%	80%	74%	69%	65%	Bus. G.	68%	74%	70%	66%	65%	Bus. G.	75%	78%	75%	67%	71%
Pr. Post-85	32%	51%	67%	70%	72%	Private	4%	11%	18%	22%	26%	Private	6%	12%	18%	20%	22%	Private	5%	12%	16%	22%	20%
Foreign	3%	3%	3%	3%	3%	Foreign	4%	3%	2%	3%	3%	Foreign	12%	8%	5%	8%	8%	Foreign	8%	6%	4%	10%	7%
Full sample: All industries						**Full sample: All industries**						**Full sample: All industries**						**Full sample: All industries**					
Agri., min.	2%	3%	3%	3%	3%	Agri., min.	3%	5%	3%	3%	3%	Agri., min.	4%	5%	5%	5%	5%	Agri., min.	3%	7%	6%	6%	8%
Food, text.	17%	16%	15%	14%	13%	Food,text.	10%	8%	9%	8%	8%	Food, text.	30%	27%	29%	33%	29%	Food,text.	16%	11%	10%	11%	12%
Chem.R	16%	15%	13%	12%	12%	Chem.R	11%	8%	8%	6%	5%	Chem.R	20%	19%	18%	14%	13%	Chem.R	16%	12%	9%	8%	8%
Metals	19%	17%	16%	15%	14%	Metals	19%	14%	12%	9%	8%	Metals	28%	26%	24%	20%	22%	Metals	21%	15%	12%	9%	13%
Util., cons.	12%	12%	13%	14%	14%	Util., cons.	9%	11%	10%	11%	12%	Util., cons.	11%	15%	16%	18%	20%	Util., cons.	8%	11%	10%	12%	12%
Trans.	2%	2%	2%	2%	2%	Trans.	1%	2%	1%	2%	1%	Trans.	1%	2%	2%	2%	2%	Trans.	1%	2%	1%	2%	2%
Hosp.	3%	3%	3%	4%	4%	Hosp.	0%	0%	1%	1%	1%	Hosp.	0%	0%	1%	1%	1%	Hosp.	0%	0%	1%	1%	1%
Finan.	24%	25%	27%	26%	27%	Finan.	43%	50%	53%	55%	55%	Finan.	2%	1%	1%	1%	1%	Finan.	31%	39%	46%	45%	36%
Bus. comp.	4%	5%	6%	8%	8%	Bus. comp.	1%	1%	2%	5%	5%	Bus. comp.	1%	2%	3%	5%	6%	Bus. comp.	2%	2%	3%	7%	9%
Misc.	2%	2%	3%	3%	3%	Misc.	1%	1%	1%	0.5%	0.4%	Misc.	3%	2%	2%	1%	1%	Misc.	2%	1%	1%	0%	1%

Source: Prowess dataset.

Note: See Appendix Tables A-2 and A-3 for detailed explanation of variables.

of an economy still dominated by the incumbents (state-owned firms and traditional private firms) and the sectors of the pre-reform period (see Figure 5). The evidence corroborates the arguments in Panagariya (2008).[41]

FIGURE 5. Number of Firms, Assets, Sales, and Profits by Ownership Group (Share of Total)



Source: Prowees dataset.

Despite low shares in the number of firms, India's formal sector continues to be dominated by state-owned enterprises and to a lesser extent by traditional private firms in terms of shares of assets, sales, and profits. Between 1988 and 1990, on an average, new private and foreign firms accounted for 26 percent and 5 percent of the total number of firms, respectively, while state-owned firms and traditional private firms accounted for 5 percent and 64 percent of the total number of firms, respectively. Between 2003 and 2005, on an average, the number of new private firms accounted for 56 percent of all firms, while the number of traditional private firms was 36 percent of the total number of firms. The share of the number of state-owned firms

41. The evidence is consistent with a slow and gradual reform process.

and foreign firms remained virtually unchanged at 4 percent and 5 percent respectively. The 60–40 split in the number of firms between the shares of private and foreign firms and the shares of state-owned and traditional private firms is replicated across sectors. The exceptions are business, computer, and communication, where the split is 80–20, which reflects the even higher number of new private firms.

In striking contrast, state-owned and traditional private firms overshadow the shares of assets, sales, and profits. Between 1988 and 1990, state-owned and traditional firms accounted for 94 percent, 87 percent, and 91 percent of total assets, sales, and profits. Between 2003 and 2005, these fractions stood at 77 percent, 73 percent, and 78 percent, respectively. While the rising importance of foreign and private firm activity is evident from the data, it appears that the incumbents from the pre-reform period control nearly three-quarters of the economy in broad terms: state-owned firms and traditional private firms. It is worth pointing out, however, that although the shares of assets, sales, and profits appear largely under the control of incumbent firms, given that the number of private and foreign firms has been increasing across sectors, competition at the margins is probably intensifying alongside of competition from imports in sectors that were liberalized to trade.

The importance of the state-owned firms has remained extraordinarily high suggesting perhaps insufficient reform. Privatization efforts were abandoned after a short spell in the early 2000s and sectors such as manufacturing and financial services remain largely under state control. For example, average total assets of state-owned firms represented close to 70 percent of total assets in 1988–90, and stood at over 60 percent by 2005. Given virtually no privatization, however, we note that while this is not an inconsequential shift, the extent of state control makes India an outlier in the world economy (with the exception of China, of course) (Chong and Lopez-de-Silanes, 2004). Average share of total assets owned by traditional private firms remained relatively constant at 25 percent between 1988 and 1998 while falling to 17 percent by 2005. New private firms' average share of assets in contrast rose from of 1 percent in 1988–90 reaching 15 percent at the end of the period. The share of assets under foreign firms has remained relatively constant throughout the period moving from 5 percent in 1988–90 to a mere 7 percent in 2003–05.

Average sales by state-owned firms remained at close to 40 percent of total sales throughout the sample period, while the average share of traditional firms dipped from 45 percent to 31 percent and that of new private firms rose from 2 percent to 17 percent. Foreign firms represent close to 10 percent of total sales on average remaining relatively stable throughout the period.

Profit shares also remained relatively stable throughout the period for state-owned firms, representing close to 55 percent, and for foreign firms at 9 percent. Traditional private firms and new private firms marked a shift from 36 percent and 1 percent respectively at the beginning of the sample period to 22 percent and 13 percent respectively in 2003–05.

Although there is considerable variation in assets, sales, and profit shares across sectors, an interesting pattern emerges. Sectors dominated by state-owned firms before liberalization (with fractions higher than 50 percent to 60 percent) remain the dominant ownership groups following liberalization. For example, in agriculture, state-owned firms represented close to 95 percent of all assets, sales, and profits in the period 1988–90. By 2003–05, state-owned firms still represented close to 90 percent of assets, sales, and profits. Similarly, in utilities, construction and retail and transport state-owned firms accounted for more than 70 percent and 50 percent of assets respectively in the period 1988–90 and in 2003–05, with similar shares for sales and profits. Traditional private firms led chemicals and plastic manufacturing, metals and industrial manufacturing, and activities in the miscellaneous diversified groups.

Interestingly, while in all sectors the share of new private and foreign firms has remained low, they have gained importance in recent years. In particular, an important exception to state and traditional private-firm dominance is seen in business and business, computer, and communication where new private firms accounted for close to 40 percent of asset shares in 2003–05. Shares of total sales and profits display a similar pattern. These activities therefore represent not only growth in terms of numbers of firms but also in terms of importance in assets, sales, and profit shares. The firm-level evidence in these industries mirrors the services growth in the aggregate data, especially after 2000.

Activities in manufacturing such as food and textile and paper manufacturing, chemical and plastics manufacturing, and metals and industrial manufacturing still dominate sales. While these sectors still represent a high share of assets, it is the financial service and real estate activities that dominate assets. In food and textile and paper manufacturing, and metals and industrial manufacturing, state-owned firms account for 38 percent and 24 percent of assets; 58 percent and 16 percent of sales and 43 percent and 25 percent of profits in the current period down from 50 percent and 51 percent of assets; 60 percent and 33 percent of sales and 47 percent and 38 percent of profits. Chemicals and plastics manufacturing, however, remains dominated by traditional private firms which still account for more than 50 percent of assets, sales, and profits. The combined role of private and

foreign firms in assets, sales, and even profits peaked at close to 40 percent in recent years in chemicals and metals and close to 20 percent in food and textile. Overall, for activities in the manufacturing sector, the picture remains one of a sector dominated by incumbents (state-owned firms and traditional private firms).

In the financial services sector, state-owned and traditional private firms accounted for 97 percent of total assets, sales, and profits in 1988–90. These shares stood at 80 percent, 83 percent, and 81 percent, respectively, in 2001–05.

Table 8 presents information by year of incorporation (between 1947–77, 1977–90, and 1991–05) for number of firms, firm size, assets, sales, employment, profitability, and rate of return and their evolution in the different periods of study.[42] The oldest firm in the sample (Howrah Mills Company Ltd) was incorporated in 1825, and the sample begins with over 1,200 firms

TABLE 8. Year of Incorporation

Incorporation/Period	*I 1988–90*	*II 1991–95*	*III 1996–98*	*IV 1999–2002*	*V 2003–07*
Pre-independence					
Number of firms	1,018	1,002	950	883	785
Assets (Rs crore)	162	285	367	436	445
Sales (Rs crore)	91	67	79	73	67
PBDIT (Rs crore)	15	23	32	36	33
ROA	11	11	10	5	–1
c1947–85					
Number of firms	1,177	1,159	1,098	1,022	912
Assets (Rs crore)	135	102	120	126	122
Sales (Rs crore)	80	48	58	61	65
PBDITA (Rs crore)	13	10	13	12	13
ROA	13	12	9	5	6
c1985–2007					
Number of firms	365	827	1,293	1,357	1,268
Assets (Rs crore)	101	27	34	52	48
Sales (Rs crore)	25	7	11	19	18
PBDIT (Rs crore)	10	3	3	5	4
ROA	10	8	6	2	–1

Source: Prowess dataset.
Note: See Appendix Tables A-1 and A-2 for detailed explanation of variables.

42. A point about firm-exit is worth noting. The dataset contains a code for firms that exited the data via mergers and acquisitions. However, the data do not contain a flag for firms shutting down versus discontinued coverage. Therefore, when we no longer observe data for a firm, we assume firm-exit. But again, this may also reflect discontinued coverage by Prowess or the failure of unlisted firms to provide data about their operations. Results should, hence, be interpreted with caution.

that were incorporated before independence. From this group 91 firms exit the sample through mergers. Many of these older firms (pre-independence), however, remain in operation following the reforms.[43] An industrial shake-out perhaps characteristic of a creative destructive wave following widespread reform is not manifest in the data.

Overall, the facts presented in the section "Evidence," the low number of state-owned and business group-affiliated firms combined with their dominant shares of assets, sales, and profits, is suggestive of high industry concentration by incumbents.

Using data on product lines, Goldberg et al. (2009) find the contribution of the net product margin to total output growth, following liberalization in India, to be driven almost exclusively by product additions, and not by discontinuation of product lines that have become obsolete.[44] The authors argue that product churning or "creative destruction" along the product dimension did not happen in India in the 1990s, despite the fact that firms were undergoing major trade and other structural reforms during this period.[45] In relation to these findings, our results suggest that creative destruction in firm-entry and exit, where new entrants replace incumbent firms, does not appear to characterize firm-activity in the Indian context following liberalization. Consistent with the addition of product lines in Goldberg et al. (2009), there was substantial firm-entry across all sectors and in particular in the services sectors. However, it does not appear that firm-entry was also accompanied by a decline in the importance of incumbent firms. This may simply be because the incumbent firms restructured and became competitive. In industries such as airlines, banking, and telecommunications, incumbent firms have restructured with a significant rise in their productivity.

43. The data also suggest that the profitability of older firms (incorporated before 1985) surpasses that of newer firms (incorporated after 1985). This finding may in part reflect survivorship bias (surviving older firms) and the fact that young firms may have lower returns in their early years.

44. For recent theoretical models that focus on the relationship between trade costs and product-mix predict that firms adjust to a decline in trade costs through product dropping, see Bernard et al. (2006, 2010).

45. Goldberg et al. (2008, 2009) examine whether Indian firms change their extensive product margin in response to India's large-scale tariff liberalization during the 1990s. Their analysis suggests that despite the regulatory constraints, changes in firms' product-mix made a noticeable contribution to growth; on net, they account for approximately 25 percent of the increase in Indian manufacturing output during our sample period. However, in contrast to the US, only 30 percent of Indian firms show a change in their product-mix over a 5-year period. Firms in India infrequently drop a product or simultaneously add and drop a product. See Bernard et al. (2006, 2010) for evidence in US.

Alternatively, incumbent firms, especially state-owned firms, may continue to operate because they remain heavily subsidized by the state.

The next section examines the evolution of industry concentration and firm size across industries and ownership shares and the impact of various liberalization measures enacted in 1991.

Maintaining Control: Market Share and Concentration

In order to understand the efficient allocation of resources, we look at market dynamics with regard to promotion of competition. We measure the degree of competition (consolidation) as a measure of competitive efficiency to examine how industrial concentration has evolved over time.

Table 9 includes information on industry concentration (the Herfindahl index)[46] and dispersion measures (coefficient of variation calculated by assets and sales). Underlying average market share values are calculated for a given firm across the years in a sub-period and then the Herfindahl index is calculated by industry for a given sub-period. It may be noted that the Prowess database provides four-and-five-digit industry classifications for most firms. However, because the liberalization policies were enacted at the 3-digit level, industry concentration accordingly is computed at the 3-digit level. We present data for the full sample first and then by the different forms of ownership.

For the overall economy, Table 9 shows a reduction in market concentration for the average firm throughout the sample period. The Herfindahl indices suggest an increased degree of competition among firms in India. This finding is consistent with the earlier evidence on increased firm-activity and overall higher dynamism in the economy. However, despite the evidence about increased levels of competition, even for 2001–05, the concentration measures remain high. Chari and Gupta (2008) compare the industrial structure in India with that of the United States (taken as a benchmark of a country with fewer regulations and more developed financial markets). They find that in 1990, a year before the reforms, the average Herfindahl index in India was significantly higher (40 percent) than in the United States (24 percent) for the same 3-digit SIC industries, while concentration in industries that remained protected was significantly higher than their US counterparts (54 percent versus 22 percent).

46. The Herfindahl index is an indicator of the degree of competition among firms in an industry. It is defined as the square of the market shares of each firm in an industry. The value of the Herfindahl index can range from zero in perfectly competitive industries to one in single-producer monopolies). All data are first expressed in constant rupees crore.

TABLE 9. The Evolution of Firm Size and Market Concentration (Constant Rs Crore)

	1989–90	*1991–95*	*1996–98*	*1999–2002*	*2003–07*
			Full sample		
Herfindahl index	0.43	0.38	0.33	0.32	0.31
Firm profits	13.39	12.21	11.88	12.21	10.85
Firm size (assets Rs crore)	137.66	126.20	118.23	132.55	116.65
Firm size (sales Rs crore)	85.62	49.79	43.41	47.10	43.34
Coefficient of variation of firm size (assets)	2.09	2.77	3.71	4.17	4.78
Coefficient of variation of firm size (sales)	1.99	3.55	5.51	6.24	9.83
Number of firms	11,394	14,608	17,544	17,767	16,318
Number of industries	115	116	119	122	121
			State-owned firms		
Coefficient of variation of firm size (assets)	2.02	2.63	3.39	3.78	4.21
Coefficient of variation of firm size (sales)	1.89	3.55	5.67	5.97	8.59
Number of firms	645	661	691	692	636
Number of industries	81	82	85	85	84
			Private firms (before 1985)		
Coefficient of variation of firm size (assets)	2.19	2.88	3.83	4.28	4.82
Coefficient of variation of firm size (sales)	2.08	3.67	5.61	6.38	10.12
Number of firms	7,564	7,436	7,035	6,552	5,843
Number of industries	111	111	111	111	111
			Private firms (after 1985)		
Coefficient of variation of firm size (assets)	2.04	2.73	3.71	4.18	4.86
Coefficient of variation of firm size (sales)	1.94	3.52	5.51	6.27	9.97
Number of firms	2,664	5,858	8,983	9,646	9,069
Number of industries	103	110	115	118	118
			Foreign firms		
Coefficient of variation of firm size (assets)	1.91	2.45	3.13	3.44	3.96
Coefficient of variation of firm size (sales)	1.85	3.06	4.65	5.01	7.00
Number of firms	521	654	835	877	771
Number of industries	76	81	89	90	88

Source: Prowess dataset.

Note: See Appendix Tables A-1 and A-2 for detailed explanation of variables.

The coefficient of variation (for both sales and assets) indicates increased dispersion. Overall, consistent with theory, what emerges is a picture of the average firm in India growing bigger, in terms of assets, sales, and profits, perhaps with some gaining more than others as heterogeneity increased substantially in the period. The finding also suggests a decline in the traditional dominance of small firms in India.

In terms of the different ownership groups, for the average state-owned firm, dispersion has also increased. Overall, the average state-owned firm has grown bigger, more profitable and somewhat more dissimilar. This may largely reflect greater involvement of the state in the commanding heights of the industry and its monopoly in certain sectors. The share here refers to the fraction of assets (sales) owned by state-owned firms relative to the total assets (sales) in a particular industry. For traditional private firms, dispersion also increased during the period. In sum, the average traditional private firm has become more profitable, bigger, and more disperse (particularly during the last sub-periods of the data). For new private firms, there is a substantial increase in heterogeneity in this group, which characterizes a great many firms. As for foreign firms, they too show increased dispersion.

The previous discussion portrays the evolution of firms in India from 1988–2005, a period characterized by substantial reforms. These reforms took many forms (liberalization of FDI, trade, domestic markets, etc.) at different times as different sectors were liberalized each at a difference pace. Although a formal causal analysis of the effect of these policies is beyond the scope of this paper, Tables 10a–10c describe how firms evolved before and after in industries that enacted specific reforms: liberalization of foreign direct investment, trade liberalization, and domestic market deregulation.[47]

Table 10a shows measures of industry concentration, and dispersion averaged across sectors that were for the period before FDI liberalization in the first column and after FDI liberalization in the second one. The FDI reforms in 1991 reduced barriers to foreign entry in a subset of industries. Specifically, according to the Industrial Policy Resolution of 1991, automatic approval was granted for foreign direct investment of up to 51 percent in 46 of 96 3-digit industrial categories (Office of the Economic Advisor, 2001). In the remaining 50 industries, the state continued to require that foreign investors obtain approval for entry. The top panel of the table shows the results for the whole sample and the lower ones by ownership group.

47. Variations in the number of industries in Table 10a before and after liberalization reflect entry or exit by different owner categories into industries that were liberalized. The number of industries in the results for the full sample gives the maximum number of liberalized industries.

TABLE 10a. The Evolution of Firm Size and Market Concentration—FDI Deregulation (Constant Rs Crore)

	Before FDI deregulation	*After FDI deregulation*
	Full sample	
Herfindahl index	0.26	0.20
Coefficient of variation of firm size (assets)	1.95	2.32
Coefficient of variation of firm size (sales)	1.86	2.36
Number of firms	5,241	6,434
Number of industries	43	43
	State-owned firms	
Coefficient of variation of firm size (assets)	2.02	2.36
Coefficient of variation of firm size (sales)	1.91	2.35
Number of firms	198	193
Number of industries	33	33
	Private (Inc. pre-1985)	
Coefficient of variation of firm size (assets)	2.05	2.39
Coefficient of variation of firm size (sales)	1.94	2.38
Number of firms	3,495	3,402
Number of industries	43	43
	Private (Inc. post-1985)	
Coefficient of variation of firm size (assets)	1.88	2.27
Coefficient of variation of firm size (sales)	1.80	2.35
Number of firms	1,228	2,458
Number of industries	40	42
	Foreign firms	
Coefficient of variation of firm size (assets)	1.84	2.23
Coefficient of variation of firm size (sales)	1.83	2.32
Number of firms	321	381
Number of industries	35	37

Source: Prowess dataset.

Note: See Appendix Tables A-1 and A-2 for detailed explanation of variables. This table provides descriptive statistics of the "before–after" effect of foreign direct investment liberalization on the market share and profitability of firms and concentration ratios in liberalized industries. The sample is restricted to industries that deregulated foreign investment and to two years before (1989–90) and two years after (1992–93) the policy was implemented in 1991.

The sample is restricted to industries that deregulated foreign investment, to 2 years before (1989–90) and to 5 years after (1991–95) the policy was implemented in 1991.

For the average firm, industry concentration declined significantly following the policy change from 0.26 to 0.20 in liberalized industries. Dispersion (both in terms of assets and sales) also increased following the reforms. Industries that were liberalized had lower concentration ratios before liberalization than non-liberalized economies. Concentration falls below the Herfindahl index for the full sample after liberalization suggesting that non-liberalizing industries had and continue to have substantially higher levels of concentration. These results are consistent with findings in Chari and Gupta (2008).

Closer examination reveals substantial heterogeneity across groups. The data shows a significant increase in dispersion across state-owned firms. In the case of traditional private firms as well, dispersion seems to have increased considerably. FDI liberalization (of up to 51 percent ownership stake) in many instances necessitated a local partner. As such, many local business groups stood to gain by the liberalization process (as they were the obvious partner to take in many instances). Similarly, the results show that for new private firms and foreign firms, increase in dispersion was substantial.

Table 10b presents similar results for trade liberalization. First, it is important to note that trade liberalization in 1991 was inversely related to

TABLE 10b. The Evolution of Firm Size and Market Concentration—Trade Liberalization (Constant Rs Crore)

	Before trade liberalization	*After trade liberalization*
	Full sample	
Herfindahl index	0.32	0.28
Coefficient of variation of firm size (assets)	2.27	2.57
Coefficient of variation of firm size (sales)	2.09	2.48
Number of firms	4,255	5,110
Number of industries	35	35
	State-owned firms	
Coefficient of variation of firm size (assets)	2.23	2.55
Coefficient of variation of firm size (sales)	2.06	2.44
Number of firms	182	181
Number of industries	28	28
	Private (Inc. pre-1985)	
Coefficient of variation of firm size (assets)	2.32	2.61
Coefficient of variation of firm size (sales)	2.13	2.50
Number of firms	2,784	2,701
Number of industries	34	34
	Private (Inc. post-1985)	
Coefficient of variation of firm size (assets)	2.24	2.54
Coefficient of variation of firm size (sales)	2.05	2.47
Number of firms	1,055	1,959
Number of industries	32	34
	Foreign firms	
Coefficient of variation of firm size (assets)	2.18	2.48
Coefficient of variation of firm size (sales)	2.10	2.49
Number of firms	234	270
Number of industries	28	29

Source: Prowess dataset.

Note: See Appendix Tables A-1 and A-2 for detailed explanation of variables. This table provides descriptive statistics of the "before–after" effect of foreign direct investment liberalization on the market share and profitability of firms and concentration ratios in liberalized industries. The sample is restricted to industries that deregulated foreign investment and to two years before (1989–90) and two years after (1992–93) the policy was implemented in 1991.

industry concentration before 1991. Second, following trade liberalization, the industry concentration of the average firm in the economy declined significantly five years following the policy change. Third, dispersion also increased following trade liberalization. Looking across ownership types, we find substantial heterogeneity.

Finally, Table 10c shows similar summary statistics for pre- and post-domestic market deregulation. The trends also display substantial heterogeneity across groups. One interesting pattern is that market concentration seems to have diminished for the liberalizing industries more dramatically, following domestic market regulation, than FDI deregulation and in

TABLE 10c. The Evolution of Firm Size and Market Concentration—Domestic Delicensing (Constant Rs Crore)

	Before domestic delicensing	*After domestic delicensing*
	Full sample	
Herfindahl index	0.35	0.24
Coefficient of variation of firm size (assets)	1.57	2.03
Coefficient of variation of firm size (sales)	1.54	1.93
Number of firms	3,158	3,789
Number of industries	24	24
	State-owned firms	
Coefficient of variation of firm size (assets)	1.73	2.11
Coefficient of variation of firm size (sales)	1.63	1.94
Number of firms	131	124
Number of industries	16	16
	Private (Inc. pre-1985)	
Coefficient of variation of firm size (assets)	1.60	2.03
Coefficient of variation of firm size (sales)	1.59	1.94
Number of firms	2,139	2,083
Number of industries	24	24
	Private (Inc. post-1985)	
Coefficient of variation of firm size (assets)	1.54	2.03
Coefficient of variation of firm size (sales)	1.48	1.90
Number of firms	705	1,374
Number of industries	32	34
	Foreign firms	
Coefficient of variation of firm size (assets)	1.49	1.89
Coefficient of variation of firm size (sales)	1.58	2.07
Number of firms	181	204
Number of industries	17	18

Source: Prowess dataset.

Note: See Appendix Tables A-1 and A-2 for detailed explanation of variables. This table provides descriptive statistics of the "before–after" effect of foreign direct investment liberalization on the market share and profitability of firms and concentration ratios in liberalized industries. The sample is restricted to industries that deregulated foreign investment and to two years before (1989–90) and two years after (1992–93) the policy was implemented in 1991.

particular trade liberalization (perhaps not very surprising, given the extent of regulation and lingering restrictions).

Overall, preliminary findings suggest that industry concentration and average market shares decline in industries that experienced either de-licensing or FDI and/or trade liberalization. The coefficient of variation in average firm sales and assets increased suggesting that there is greater dispersion in firm size within liberalized industries. Our future endeavor will be to disentangle the precise mechanisms through which specific reforms affect firm activity in liberalized industries.

Conclusion

Between 1986 and 2005, Indian growth put to rest the concern that there was something about the "nature of India" that made rapid growth difficult. Following broad-ranging reforms in the mid-1980s and early 1990s, the state deregulated entry, both domestic and foreign, in many industries and also hugely reduced barriers to trade. While liberalizations are believed to transform economies through competition and the removal of distortions, the effects of liberalization may not be uniform. Some industries may be better equipped for change while others are not. Within industries, new entrants may gain market share, while incumbents go bankrupt. Restrictions may linger in some sectors, and for some firms.

In this paper we analyze the evolution of India's industrial composition by focusing on the micro-foundations of its productive structure: we examine the evolution of India's industrial structure at the firm level following reforms. In addition to changes in the industrial composition, we examine whether entry took place and if so, whether at the expense of traditional incumbents such as state-owned and traditional private firms. Finally, we examine the evolution of firm size, market share, and industry concentration over time and in industries that were liberalized to either domestic or foreign entry or trade.

Using firm-level data, we document dynamism and change in the productive structure following the implementation of economic reforms. Substantial new entry by foreign and private firms went along with high growth in their assets, sales, and profits. In recent years, for example, some new and important private players have emerged in sectors such as information technology services (IT), pharmaceuticals, and telecom. However, despite the substantial increase in the number of private and foreign firms, the overall

pattern that emerges after close to two decades of reforms is one of continued incumbent dominance in terms of assets, sales, and profits: state-owned firms and traditional private firms. In sectors dominated by state-owned and traditional private firms before liberalization (with assets, sales, and profits representing 50 percent or higher shares), these firms remain the dominant ownership group following liberalization. Further, rates of return remain stable over time and show low dispersion across sectors and across ownership groups within sectors.

Certainly, the welfare implications of our findings are not clear-cut, especially in the light of the current international financial crisis and the increased role of the state in private enterprise in the US and other developed countries. It may, however, be hard to justify the extent of state-owned presence that we continue to see in India. Of course it is not clear whether ownership per se matters or whether exposure to competition through liberalization is a sufficient condition for improvements in efficiency.[48]

Recent literature highlights the idea that economic growth may be impeded not simply because of a lack of resources such as capital, skilled labor, and entrepreneurship but also because available resources are misallocated. The high levels of state ownership and ownership by traditional private firms in India raise the question of whether existing resources could be allocated more efficiently and whether remaining barriers to competition jeopardize the effectiveness of reform measures that have been put in place. While rates of return across ownership groups do not display significant dispersion, it is not clear whether the rates of return for the incumbent groups are being driven by monopoly power that comes with high industry concentration, or through inherent efficiency. A related issue that also arises is whether privatization in the context of high industry concentration may simply replace state-owned monopolies with private ones as it has done in the case of many countries in Latin America.

48. One might well argue that the slow/uneven reform process and the small private sector could still be setting "marginal incentives." As Schumpeter (1942) notes,

> [Monopolistic] competition of the kind we now have in mind acts not only when in being but also when it is merely an ever-present threat. It disciplines before it attacks. The businessman feels himself to be in a competitive situation even if he is alone in his field or if, though not alone, he holds a position such that investigating government experts fail to see any effective competition between him and any other firms in the same or a neighboring field and in consequence conclude that his talk, under examination, about his competitive sorrows is all make-believe.

As discussed in the paper, the macroeconomic effects of deregulation are theoretically ambiguous. Further empirical work is needed before we can reach definitive conclusions on the impact of deregulation on the overall dynamic efficiency of the economy.[49] An assessment of the optimality of market reforms requires a full welfare analysis that goes beyond the scope of this paper and will be the subject of our future research.

APPENDIX

TABLE A-1. Egypt, India, and Indonesia—Economic Growth (1975–2005)

	1975–85	*1986–95*	*1996–2005*
		Real GDP growth rates*	
India	4.1%	6.0%	6.3%
Egypt	8.3%	4.2%	4.3%
Indonesia	6.8%	4.9%	2.8%
		Real per capita GDP growth rates*	
India	1.9%	4.3%	4.6%
Egypt	5.8%	2.3%	2.4%
Indonesia	4.6%	3.4%	0.8%

Source: *World Development Indicators*, World Bank.
Note: *Average growth rate of GDP and GDP per capita (constant 2000 US$).

TABLE A-2. Description of Variables

Variables	*Definition*
State-Owned (SOE)	Firms majority-owned by the federal and state governments.
Traditional Private Firms	Includes firms majority-owned by a business group and private firms not affiliated to a group incorporated before 1985. Indian business groups or family-owned firms are groups of companies that are controlled by the same shareholders, usually all members of a family.
New Private Firms	Includes firms majority-owned by a business group and private firms not affiliated to a group incorporated after 1985.
Foreign Firms	Firms incorporated overseas.
Sales	Sales generated by a firm from its main business activity measured by charges to customers for goods supplied and services rendered. Excludes income from activities not related to main business, such as dividends, interest, and rents in the case of industrial firms, as well as non-recurring income. Data in constant Rs crore (deflated by GDP deflator from World Bank, WDI).

(*Table A-2 continued*)

49. It is also worth emphasizing that this work does not speak to other welfare and efficiency-improving effects of liberalization linked to improved quality and variety of products, or international risk-sharing.

(*Table A-2 continued*)

Variables	*Definition*
Assets	Gross fixed assets of a firm, which includes movable and immovable assets as well as assets which are in the process of being installed. Data in constant Rs crore (deflated by GDP deflator from World Bank, WDI).
PBITDA	Excess of income over all expenditures except tax, depreciation, interest payments, and rents in a firm. Data in constant Rs crore (deflated by GDP deflator from World Bank, WDI).
Return on Assets	Ratio of *PBITDA* to *Assets* in a firm, averaged across firms in that industry.
Firm Size (Assets and Sales) and Profits	Average firm assets, sales, and profits in an industry. For the full sample, the industry-level averages are averaged across industries. Data in constant Rs crore (deflated by GDP deflator from World Bank, WDI).
SOE Share	The ratio of total sales, assets, profits produced by state-owned firms in an industry to *Industry Sales*, *Industry Assets, Industry Profits* in that industry.
Traditional Firms Share	The ratio of total sales, assets, profits produced by private firms incorporated before 1985 in an industry to *Industry Sales*, *Industry Assets, Industry Profits* in that industry.
New Private Firms Share	The ratio of total sales, assets, profits produced by private firms incorporated after 1985 in an industry to *Industry Sales*, *Industry Assets, Industry Profits* in that industry.
Foreign Share	The ratio of total sales, assets, profits produced by foreign firms in an industry to *Industry Sales*, *Industry Assets, Industry Profits* in that industry.
Herfindahl Index	Sum of the squares of the *Market Share* of all firms in an industry in each 3-digit industrial category.
Coefficient of Variation	Ratio of standard deviation to mean of assets, sales, return on assets at the industry level.
Trade Liberalization Measure	Percentage decrease in tariffs at the three-digit industry level between 1986–90 and 1991–95.
NIC Code	3-digit industry code includes manufacturing, financial, and service sectors.

Source: Authors' definitions.

TABLE A-3. Industry Classifications

Industry name	*3-digit NIC code*	*No. of firms*
1. Agriculture, mining, extraction		
Coal and lignite	101, 102	16
Cotton and blended yarn	11, 14	6
Crude oil and natural gas	111	9
Floriculture	11	27
Granite	141	46
Minerals	101, 103, 120, 131, 132, 141, 142	81
Other agricultural products	11, 12, 14, 20, 142	149
Other construction and allied activities	112	12
Other textiles	11	2
Poultry and meat products	11, 12	16
Processed/packaged foods	11	22
Rubber and rubber products	11	11
Tobacco products	11	5
Vegetable oils and products	11	0
Wood	20	6
2. Food, textile, and paper manufacturing		
Bakery products	154	21
Beer and alcohol	155	95
Books and cards	210, 221, 222	60
Cloth	171	148
Coal and lignite	231	11
Cocoa products and confectionery	154	9
Coffee	154	19
Comp., and storage devices	221	1
Cotton and blended yarn	171	336
Dairy products	152, 154	46
Footwear	192	47
Lubricants, etc.	232	46
Marine foods	151	71
Media-print	221	35
Milling products	153, 155	59
Misc. manufactured articles	232	1
Other agricultural products	155	2
Other industrial machinery	172	1
Other leather products	191	36
Other recreational services	223	2
Other storage and distribution	232	5
Other textiles	171, 172, 173, 181	189
Paper	210	154
Paper products	210	46
Poultry and meat products	151, 154	14
Processed/packaged foods	151, 153, 154, 155	81
Readymade garments	181	120
Refinery	232	12
Starches	153	9
Sugar	154	99

(*Table A-3 continued*)

(*Table A-3 continued*)

Industry name	*3-digit NIC code*	*No. of firms*
Synthetic textiles	171, 172	19
Tea	154	173
Textile processing	171	68
Tobacco products	155, 160	20
Vegetable oils and products	151, 152, 153	224
Wood	201, 202	41
3. Chemicals and plastics manufacturing		
Abrasives	269	11
Alkalies	241	13
Cement	269	113
Ceramic tiles	269	44
Comp., and storage devices	252	2
Cosm., toiletries, soaps, and detergents	242	86
Drugs and pharmaceuticals	242	442
Dyes and pigments	241, 242	73
Fertilizers	241	60
Glass and glassware	261	48
Inorganic chemicals	241, 242	86
Misc. electrical machinery	269	3
Organic chemicals	241	134
Other chemicals	241, 242	124
Other non-metallic mineral products	269	29
Other recreational services	252	4
Other textiles	252	1
Paints and varnishes	242	34
Pesticides	241, 242	86
Plastic films	252	40
Plastic packaging goods	252	105
Plastic tubes and sheets, other	252	162
Polymers	241	55
Prod., distribution and exhib. of films	242	0
Refractories	269	32
Rubber and rubber products	241, 251	82
Synthetic textiles	243	100
Textile processing	243	57
Tyres and tubes	251	34
4. Metals and industrial manufacturing		
Air-conditioners and refrigerators	291, 293	16
Aluminum and aluminum products	272	53
Automobile ancillaries	343	307
Castings and forgings	273, 289	123
Commercial vehicles	341	5
Communication equipment	319, 322, 331	45
Computers and peripherals	300	46
Construction equipment	291, 292	39
Consumer electronics	300, 321, 323	34
Copper and copper products	272	30

(*Table A-3 continued*)

(*Table A-3 continued*)

Industry name	*3-digit NIC code*	*No. of firms*
Domestic electrical appliances	289, 292, 293, 315	52
Dry cells	314	5
Gems and jewelry	369	84
General purpose machinery	291	84
Generators, transf. and switchgears	319	111
Industrial machinery	291, 292, 300	137
Machine tools	292	60
Metal products	271, 281, 289, 361	218
Misc. electrical machinery	291, 292, 312, 319	44
Misc. manufactured articles	369	68
Other electronics	314, 319, 321, 322	194
Other industrial machinery	291, 292	24
Other non-ferrous metals	272	30
Other transports equipment	351, 352, 353, 359	38
Passenger cars and multi-utility vehicles	341	8
Pig iron	271	10
Prime movers	281, 291	24
Sponge iron	271	21
Steel	271	327
Steel tubes and pipes	271	85
Storage batteries	314	8
Tobacco products	369	4
Tractors	292	9
Trading	293	1
Two and three wheelers	359	16
Wires and cables	313	80
5. Utilities, construction, retail		
Copper and copper products	511	1
Electricity distribution	401	21
Electricity generation	401	116
Housing construction	452	118
Industrial construction	452	105
Infrastructural construction	452	56
Irrigation	410	3
LNG storage and distribution	402	4
Other construction and allied activities	452, 453	83
Other misc. services	502, 519, 521, 526	180
Other storage and distribution	402	7
Retail trading	521, 523	15
Trading	514, 515, 519	1,293
6. Transport		
Air transport infrastructure services	630	3
Air transport services	621	19
Other storage and distribution	603, 630	30
Railway transport services	601	4

(*Table A-3 continued*)

(*Table A-3 continued*)

Industry name	*3-digit NIC code*	*No. of firms*
Road transport infrastructure services	630	10
Road transport services	602	48
Shipping transport infrastructure services	611, 612, 630	10
Shipping transport services	611, 612	63
Tourism	630	19
Transport logistics services	602, 630	63
7. Hospitality, tourism, media, health, and other services		
Animation content provider	924	4
Exhibition of films	924	12
Health services	851	74
Hotels and restaurants	551, 552	203
Media-broadcasting	922	28
Media-content	924	23
Other financial services	753	1
Other misc. services	809, 851, 911, 919	91
Other recreational services	921, 924	46
Production, distribution, and exhibition of films	921	22
Tourism	552	9
8. Financial services, real estate		
Banking services	651	164
Brokers	659, 671	72
Business consultancy	671	21
Commercial complexes	701, 702	167
Computer software	701	5
Drugs and pharmaceuticals	701	0
Financial institutions	659	44
Housing finance services	659	49
Non-banking financial cos. (NBFCs)	659	374
Other financial services	659, 660	1,697
Readymade garments	701	1
Securities and stock traders	659	1,395
9. Business, computer, and communication services		
Business consultancy	743, 749	342
Computer software	722	451
Courier services	641	10
ITES	722	50
Other const. and allied activities	742	5
Other misc. services	731, 741	9
Telecommunication services	642	74
10. Misc. diversified		
Diversified	970	52
Misc. manufactured articles	970	382

Comments and Discussion

Robert Z. Lawrence: This paper gives us an interesting description of a large firm database that reports on the performance of Indian firms along a number of dimensions during a period in which there was both economic reform and considerable economic growth. The aim is obtain deeper insights into how the reform process affects firm behavior to generate that growth.

What the paper actually shows is that the Indian growth acceleration has been associated with less "creative destruction" than one might have imagined and perhaps some might have hoped for. It reveals an Indian economy that is dynamic at the margin, but also, particularly with respect to key corporate players, is rather stable at its core. There is, to be sure, some evidence that accords with expectations about a dynamic transformation: There has been considerable new entry of both domestic and foreign firms and over time markets have become less concentrated. And about a quarter of the firms that were incorporated prior to 1985 and appeared in the data for 1988–90 were not present in the data for 2003–05, presumably because they either merged or went out of business.

Nonetheless, the traditional asset-intensive incumbents remain dominant in the economy. This is true both of those that are state owned and those that were already around in 1985. In addition, "rates of returns are stable over time and show low dispersion across sectors and across ownership groups within sectors." Given their high profits, one is led to speculate that without policy changes, the dominant role of both state-owned firms and those that existed in 1985 is likely to persist. On the other hand, while new foreign investors have done particularly well, domestic private newcomers are by and large a group whose average returns have been low and declining.

The strength of the paper is that the authors are modest about what they have found and do not make exaggerated claims for what they have accomplished, but the weakness is that as a reader one still remains uncertain about what exactly to make of the findings. Indeed, for the paper to be useful for policy we need lots more work. In particular, what strikes me about the findings is that in their current state they could be used to support some very different viewpoints.

For example, take the finding that Indian growth has been associated with a dominant role played by incumbents. One interpretation is that since

India was able to grow so fast with relatively little creative destruction, perhaps the merits of creative destruction have been oversold. Maybe the Indian model with large incumbents and state-owned firms at its core is actually a good one. Maybe the high and steady profits of the state-owned enterprises indicates they are efficient and have successfully engaged in activities the private sector might not have been able to undertake. Maybe the similar rates of profits across sectors and firms within sectors indicate that resource allocation is actually quite efficient. Maybe the regime, prior to reform, actually constrained large and more efficient firms, and the success of the reforms was not in destroying the large firms but allowing them to realize their potential. Similarly, perhaps creative destruction, particularly if it involved exit and entry could be oversold and the very stability of Indian firms has allowed them to invest and innovate.

On the other hand, you could say that if India has been able to grow that fast without serious structural changes, with state-owned and other large firms exercising monopoly control and reform only tinkering at the edges, imagine how much faster it might grow with more extensive reforms and even more intense competition. The extent and pervasiveness of state-owned firms in India certainly is surprising. If the high profits earned by state enterprises reflect monopoly power that also limits growth, accelerating privatization might be the answer. Similarly, a much higher dispersion in profit rates should be expected if resources are transferred to uses with larger payoffs. Certainly India's most dynamic sector, that of business, computer, and communications services has been associated with minimal state ownership, major shifts in market shares from old to new firms, and very volatile rates of return. Perhaps it is the exception that proves the rule.

My hunch though is that before we get close to drawing broad conclusions, this data should be exploited to investigate some narrow questions that can be answered with greater confidence. For example, the paper takes a very tentative first step at trying to explore the effects of specific reforms such as liberalizing FDI, reducing tariffs and eliminating licensing on corporate behavior. But they have only scratched the surface by reporting on how affected industries behaved before and after these reforms were implemented. Obviously, a regression analysis is really required to provide better controls in order to isolate the marginal impact of these policies. It would also be interesting to match these data with measures of firm productivity. That might allow us to determine, for example, if the relatively high profitability of state-owned and foreign owned firms reflects market power or greater efficiency.

As told therefore, the authors have done us a service by highlighting the existence of this valuable Dataset, but they have only scratched the surface of what they and others could do in helping us understand the sources of Indian growth, and its policy implications.

Shashanka Bhide: I would like to thank the organizers of IPF for giving me this opportunity to comment on the very interesting paper by L. Alfaro and A. Chari. The paper has two parts, one on the nature of India and then on the transitions in the industrial sector. The paper points to much less churn in the industry on a variety of indicators in a period of economic reforms than what is usually assumed.

The paper looks at the period from 1988 onwards and if one were to think of changes in the economy leading up to the large-scale reforms of the 1990s, we may have to look at the period covering a few more years before 1988. Although the choice of the period of analysis is limited by the available data, there is a need to examine the previous few years even if based on other studies. Mookherjee (1995) provides a good summary of industrial policy and trends leading up to the economic and industrial reforms. One important reason for looking at a year before 1988 to place the significant changes in the economy is to mark the changes marked by the noticeable rise in the manufactured consumer products produced by the industry.

There have been changes in the economy that may have significance to the changes in the industrial structure. I would like to point to some of these transformations.

The percentage share of agriculture in gross fixed capital formation dropped from about 45 percent in 1951 to 25 percent in 1981. It dropped to 20 percent in 1991 and 15 percent in 1999. There has been a drop of 5 percentage points in each decade in the 1980s and 1990s but actually a faster drop in the previous three decades. The pace of industrialization, therefore, was not slower in the early years.

The share of industry has been a mirror image of agriculture, its rise actually a little more spectacular than agriculture's decline.

One may argues that at the aggregate level, the reforms of the 1980s and 1990s have essentially taken the transformation forward. The sources of overall growth remain the same: services and industry rather than agriculture.

However, there are important differences at the disaggregate level.

One difference is in the case of the role of public sector. The share of public sector (including government) in gross fixed capital formation

(nominal) first rose from about 27 percent in 1951 to 50 percent in 1965 reaching the commanding heights, dropped, and rose again steadily back to 50 percent in 1981. It then dropped to 46 percent by 1987–88, 40 percent in 1990, and to 25 percent in 2001–02. The decline in the share of public sector had begun in the early 1980s. What is of interest is that the GCF in private sector was rising steadily throughout this period.

The public sector could not keep up its role in the transformation of the economy from an essentially agrarian structure to industrial, once the policy regime began to turn more liberal. The private sector was able to play the role as much under the restricted regime of planning as under the reforms.

It is, therefore, not surprising that with the delicensing and liberalization of other economic policies, the firms in the private sector became more dynamic and private sector became more dynamic. The much lamented "industrial sickness" sort of dropped off the radar of research starting from the late 1990s. Mookherji volume has the influential piece by Anant and Goswami (1995) pointing to the reasons for stagnation in markets.

If the result of the reforms of the 1990s—more dynamic markets—was any different, it would have been quite startling. But I would like to note that the reasons for outcome are not limited to industrial policy. The liberalization of capital markets, credit market, and better fiscal policies were equally important.

The paper provides an interesting description of changes in the organized sector of the economy, the sector which has delivered high growth in the recent two decades.

The paper has examined the evolution of India's industrial structure with respect to composition (ownership), entry of firms, and whether the entry of new firms is at the expense of the incumbents: state or business groups. It examines the evolution of firm size, market share, and industry concentration.

It finds substantial new entry by foreign and private firms; high growth of assets, sales, and profits. However, even after two decades of reforms, there is continued dominance of traditional incumbents. In each of the sectors, there are state enterprises and in each case, their number has increased. The "transformation" has indeed been by stealth and appears to have been designed to be non-destabilizing.

The share of private sector in terms of numbers has generally been about 70 percent throughout the period of analysis and their share of assets is about 8 percent. This raises the question, how different are the results across ownership groups of firms? Only in the case of Business services and IT, the share of private sector in assets is touching 30 percent.

There is an interesting table on the characteristics of firms by year of incorporation. Are the reform era firms any different from their immediately earlier generation? They appear to be of about the same size in terms of assets and sales. The distinct thing seems to be that they employ less labor and they earn negative returns on assets.

I would like to point out some results of analysis based on one of my analysis of the ASI data (Bhide and Kalirajan, 2004).

1. Decomposition of growth in employment in organized manufacturing: Average annual growth rates (percent):

Period	*No. of factories*	*Output per factory*
1973–80	2.20	6.77
1980–90	5.86	1.23
1990–98	5.18	2.50
1993–98	6.95	2.06
1973–98	4.72	3.04

   - The growth in the number of factories was very high in the decade of 1970s. The post-reform period did see a faster growth in the number of factories as compared to the period of 1980s.
   - The output per factory was very rapid in the period after the 1970s, both pre-reform and post-reform. It may have accelerated slightly in the period after the 1993–94.
   - Both the scale (output per factory) and spread (number of factories) effects of the reforms appear to be significant. But the scale effect is stronger.

2. Determinants of output per factory and number of factories: A regression analysis suggests that

   - The output per factory is more sensitive to overall growth (GDP) (positive) and (trade/GDP) ratio (negative).
   - The number of factories is not statistically significantly affected by overall growth and (trade/GDP) ratio. The dynamics is really in the size of factory rather than entry and exit.

I will point to another strand of analysis which provides a decomposition of output growth in terms of number of firms, input growth per firm, and improvements in technical efficiency and technical progress. Perhaps growth is needed in all three components to sustain the growth momentum. The

mere growth in the size of firms may only tell us that there are constraints to the entry and exit.

One final point. Actually for quite some time after the industrial reforms, there was a great concern that the industrial sector actually did not respond to any of these reforms, especially in terms of pace of growth of industrial output. The performance was pretty much "in the nature of India." The immediate post-1991 period, the years in which the reforms were launched, was also a period of weak performance particularly for the manufacturing sector. Some of this is attributed to the impact of competition arising from trade reforms. India saw very small improvement in the UNIDO Industrial Competitiveness Index between 1985 and 2002 while China's numbers surged.

The paper makes a very important contribution to our understanding of the behavior of the firms during the period of reforms.

General Discussion

Pranab Bardhan raised three issues. First, the decline in the value of the Herfindahl index observed by the authors is surprising since a study by the OECD a couple of years back using the ASI data found no change in the value of the index. Second, there is some doubt about the claim in the paper that the firms in the Dataset represented 70 percent of the industrial output. Even the ASI data, which include all firms in the organized sector, do not represent 70 percent of industrial output. Finally, the authors refer to a political-economy factor whereby incumbent firms oppose liberalization. But surely, incumbent firms also want access to foreign inputs and capital goods at cheaper prices. This factor would work in favor of liberalization unless the incumbent firms are fully vertically integrated. It is doubtful that business groups like Tata and Reliance are against liberalization.

Arvind Panagariya followed Bardhan with three points of his own. For Panagariya, the broad message of the paper seemed to be that little transformation has happened in terms of industry structure. However, in his opinion, this conclusion did not meet the "smell" test. He stated that even a casual look at some of the industries that were subject to clear and systematic liberalization, would provide evidence of major transformation. One of the examples he highlighted was that of the airline industry. Panagariya described how the entry of private airlines (upon receiving the go-ahead from the government) significantly transformed the airline industry, into one with a multitude of players and options for flyers. Telecommunications

was another area subject to a similar transformation. Panagariya noted how, following the entry of private operators, there had been a surge in the number of phones, from a lowly three per hundred in 1999–2000, to the current figure, which exceeds forty. A similar change was seen in the auto industry, abetted mainly by the dismantling of the license raj and the entry of foreign firms. Information technology, banking, construction, and pharmaceuticals likewise, experienced major transformation. Panagariya's second point expressed the importance in distinguishing between reformed and unreformed sectors. He stated that a contrast had to be made between products subject to small-scale industries (SSI) reservation and others. Panagariya stated that the dismantling of the SSI reservation did not begin until 1998, and that even after this dismantling, labor laws probably remained a barrier to the entry of new large firms. Finally, Panagariya referred on trade data disaggregated down to six-digits within the harmonized system, which showed a vast number of new products appearing on both the export and import side. This to him suggested a major transformation of the economy and he concluded his comments by expressing the view that the idea that there was little industrial transformation in an economy growing at 8–9 percent a year went against basic intuition.

Kaushik Basu urged the authors to look into breaking up time periods differently. He noted that period 1991–95 could not be viewed as representing the post-reform period since the reforms were largely implemented in 1992 and in the immediately following years the economy was still recovering from the crisis that had hit. The impact of reforms was more likely to be captured in the data during 1994–97 when economic growth did accelerate.

Picking on Basu's point, Isher Ahluwalia stated that the use of terms pre-liberalization and post-liberalization is a tricky affair. Recall that licensing on consumer goods did not go away until as late as 2001. Even though many policy changes had been made during the 1990s, investors perhaps remained unconvinced that the changes will stick until almost the turn of the century. They perhaps also held out for strategic reasons, seeking more concessions from the government in terms of devaluation, building of infrastructure, and the like. It was only around 2001 that reforms became credible and real action on investment began. Even so, different states have played their complementary roles differently so that Punjab is not the same as Karnataka, Andhra Pradesh, Maharashtra, and Gujarat.

Surjit S. Bhalla stated that the turn around in India at the turn of the century was rooted in a major reduction in the real interest rates that began in 1999. By 2004, this reduction had cumulated to 6 percentage points. Bhalla also

noted that if one went by the turnover in the ownership of top twenty firms, India ranks second only to the United States. By this measure, suggested by Tarun Khanna who studied ownership of top twenty firms in years 1939, 1969, and 1999, there is great dynamism in the Indian economy.

Sugata Marjit suggested that it might be worthwhile to relate the entry and exit to trade orientation of industries. One would not expect much exit in exportable sectors while importable sectors would have both entry and exit. These asymmetries may be reflected in the movements in the concentration ratios as well.

Poonam Gupta noted that the CMIE data has the major limitation that firm coverage in the earlier years is poor relative to later years. Madhav Raghavan replied that when new firms are added, CMIE does go back up to 1988 or 1989 to fill whatever information gaps can be filed based on the available balance sheets for prior years. Rohini Somanathan echoed Poonam Gupta, however, saying that when she used the CMIE data, she found lots of gaps in information for many firms. On a different subject, Somanathan noted that she was struck by the variance in the performance of public sector firms: while the public sector player in steel has done phenomenally well, one in the airline industry has done very poorly.

Suman Bery made three points. First, he drew a contrast between lobbying power of public sector units (PSUs) in India and China. According to the OECD, PSUs in China have suffered the brunt of the adjustment policies through privatization or liquidation. In contrast, in India, as in the recent case of Air India, PSUs are successfully able to lobby for themselves. It needs to be investigated why PSUs in India are so successful at lobbying. Second, how do we think about continued dominance of Chaebols (conglomerates) in South Korea? There is a lot of dynamism in terms of product innovation and growth but it is always within that the sources remain the same Chaebols. Under such circumstances, what kind of smell test does one employ to find out whether true competition has set in or monopoly is reappearing under a different guise each time. Finally, India is placing a lot of faith in public–private partnerships. But given the chilling portrait of what went on in the United States that Robert Z. Lawrence has painted, is this the right way to go?

Robert Z. Lawrence responded that what turned absolutely toxic in the United States was the combination of public ownership and no regulation of publicly owned entities such as the Fannie Mae and Freddie Mac. This combination allowed the firms to engage in all kinds of uncontrolled "innovation" with implicit government guarantee against losses and eventual bankruptcy. Because they had this guarantee, their cost of capital was lower than their

private sector counterparts. They used the advantage to maximize profits by investing into riskier and riskier assets. In retrospect, such a guarantee must come with regulation against moving into riskier and riskier ventures. I think this is the broader lesson of the 1930s and how the United States got deposit insurance for banks on the one hand, which gave banks certain advantages in raising capital, and bank regulation on the other. So, when we talk about private–public partnership, the real challenge is how the government structures them and what incentive systems it sets up. As economists, we know if you do not allow the incentives appropriately and you provide the private players an opportunity to take advantage of the public guarantee, you are going to get into deep trouble. There is a lot of advantage in private participation but it is very important to be very careful about the incentive system under which they operate.

In her response, Anusha Chari selectively answered a few of the questions raised by formal discussants and during the general discussion. She began by stating that this was the first stab at the data by her and her co-authors and that they tried to put together a set of stylized facts that can provide a basis for informed discussion. How we divide data into different time periods and how data are average of all issues open to discussion and debate. Chari appreciated Robert Z. Lawrence's suggestion regarding an analytical framework as also conducting comparison over time in terms of real rather than nominal magnitudes. She also noted that the paper emphasizes variation across industries. In particular, it finds considerable dynamism in many services sectors. In these sectors, we do observe greater fractions of sales and assets being accounted for by private and foreign firms. Finally, responding to a point made by Shashank Bhide, Chari noted that consistent with what he said, Tables 9 and 10 of the paper showed an increase in the average size of the firms.

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Land Reforms, Poverty Reduction, and Economic Growth: Evidence from India

Motivation and Background

With about three-fifth of India's workforce still in agriculture, operation of rural factor markets, in particular those for land rental, will be essential to allow movement of labor out of agriculture and the expansion of the non-agricultural sector that will be needed to sustainably reduce poverty in rural areas (Panagariya, 2008). It will also be critical to counter a trend of increasing fragmentation of land and holding sizes through subdivision by facilitating consolidation of land into larger operational farm sizes that will be important if incomes in the rural sector are to keep up with the rest of the economy. Finally, the scope for greater agricultural productivity and diversification through movement toward higher-value commodities will critically depend on farmers having scope for entering into contracts to realize economies of scale in production (for example, adherence to phyto-sanitary standards) and marketing.

However, many states continue to outlaw land leasing or other forms of contractual arrangements, thereby restricting the operation of markets for key factors (land, labor, credit) in numerous ways. This policy is widely perceived as detrimental not only to investment incentives and the effective utilization of scarce resources but, by preventing land access by the landless, may also impose considerable losses on the poor. Many of the relevant policy initiatives have their origin in efforts at land reform that were adopted with

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the explicit goal of dealing with the inherited inequality of land ownership by facilitating redistribution of land to the poor. Two problems with this stand out. On the one hand, inability to implement such legislation in many states, a failure to provide full ownership rights to beneficiaries in cases where they did receive land, and the impact such laws have on the willingness of landlords to rent out land, all pose a danger of the unintended consequences of land reform policies ending up directly hurting the poor. On the other hand, such policy restrictions will make it very difficult, if not impossible, to achieve the agricultural growth rates of 4.5 percent targeted by the Planning Commission (Government of India, 2008).

Beyond the functioning of rural land markets, broader concerns relate to the fact that, in many respects, India's system of land administration fails to deliver the level of tenure security and operational efficiency needed in a modern economy to encourage land-related investment, improve governance, and reduce informality as well as land-related conflict far beyond the rural sector. Reasons for such failure can be found in incomplete and overlapping records, as well as, institutional overlap and inefficiency all of which can be traced to the original objectives of land administration in India. Recent efforts to computerize land records and registration in some states have led to some progress but a large number of obstacles, most notably relating to spatial records, remain to be addressed (World Bank, 2007). In fact, it is often argued that only a drastic move toward conclusive title along the lines of Australia's Torrens system will provide the modernization of land administration that is needed in India (Wadhwa, 1989).

This paper examines empirical evidence from India in light of international best practice to provide guidance on these issues that is grounded in representative data rather than anecdotal information. The second section provides a historical account of the emergence of land-related policies and institutions over time to provide the backdrop for our analysis and allow formulation of hypotheses that are subject to empirical testing. The third section develops a conceptual model of the operation of rural rental markets and then uses a unique panel dataset at the household-level to provide evidence on the functioning of land rental markets. The goal of doing so is not only to assess the extent to which such markets contribute to productivity and improved land access but also to provide quantitative evidence on the impact of restrictions to the operation of such markets that continue to be widespread in India. Indeed, our results suggest that the way in which rental markets operate has changed over time and that there is little justification to maintaining these restrictions which reduce productivity, by preventing more productive producers from accessing land, as well as equity, by putting

land out of the reach of the landless and poor whose welfare could be most improved through land access.

The fourth section applies a similar empirical framework to the operation of land sales markets to test whether, as often alleged by policy-makers, operation of such markets in an environment characterized by multiple market imperfections, will give rise to undesirable outcomes. The main concern is that, with less than full insurance due to credit market imperfections, exogenous shocks (for example, droughts) may lead to accumulation of land by the wealthy who, in an environment where land leasing is subject to transaction costs, will not be able to make the most productive use of it. Empirical evidence suggests that, while such shocks are indeed of relevance, they did not prevent the transfer of land to more productive producers although, as one would expect, sales markets were less effective than rental markets in transferring land to the poor.

The fifth section focuses on land administration in India more generally in three specific respects. First, we assess the extent to which computerization of land records as well as registration in select states holds lessons for institutional reform of India's land administration system more generally. In addition to having had success at improving governance and transaction costs of registering land, such measures also provide opportunities to increase tenure security by moving toward a more unified institutional structure, making it easier to search the chain of previous transactions, and allowing officials to conduct basic checks before a transaction is registered. Second, we discuss reasons for the lack of comparable progress with respect to spatial data and use this to identify technical and institutional options to improve the spatial information in India's land administration system. Finally, we debate the extent to which a transition from a registration system based on deeds to one based on titles is realistic. In doing so, we explain key differences between the two systems, identify ways in which deeds systems can be improved, and draw on the experience of other countries to describe mechanisms for making the transition between the two and the implications for recent attempts in a number of Indian states to create the legal framework that would allow making such a transition.

Policy Context and Historical Background

With ill-defined or incomplete property rights, those holding land need to spend resources to defend their rights. As such expenditures (guards and fences) often have little direct social or productive value, they lead to

dissipation of rents and divert resources from more productive uses. The privately optimal amount of spending on protection can be excessive from a social point of view (De Meza and Gould, 1992; Feder and Feeny, 1991; Malik and Schwab, 1991). Enforcement of property rights by the state realizes economies of scale and has benefits that are non-rival (that is, one person's enjoyment does not reduce others' benefits), although some of them allow exclusion of others, characteristics generally associated with a club good (Lueck and Miceli, 2006; Shavell, 2003). If property rights are secure, well-defined, and publicly enforced, land owners need to spend less time and resources guarding them. By reducing the risk of expropriation, secure property rights assure land users of the ability to enjoy the fruits of their labor, thus encouraging them to make long-term land-related investments and manage land sustainably (Besley, 1995). Also, ability to verify boundaries at low-cost and legal measures to minimize land-related conflicts reduces transaction costs in a number of ways. Systems to document and verification of land ownership are public interventions to enhance tenure security. The magnitude of net private and social gains will depend on the extent to which a land registration system induces higher levels of tenure security and the nature, magnitude, and opportunity cost of the resources thus freed up, compared to the cost of the apparatus needed for administration and enforcement of property rights.[1]

Also, provision of credit is risky because uncertainty and asymmetric information lead to credit rationing in equilibrium and reduced lending volumes compared to a world of perfect information (Stiglitz and Weiss, 1981). The use of collateral is a universal practice to reduce the extent of credit rationing and improve welfare. Its immobility and relative indestructibility make land ideal collateral. However, banks' ability to use it for this purpose on a large scale is contingent on a formal and low-cost way to unambiguously identify land ownership. In the absence of other obstacles to the operation of financial markets and if land rights can be exercised, a

1. While much of the literature relies on a unitary household model, women's ability to own land is often constrained by social practice. Even if constitutions outlaw gender discrimination, females can often access land only through male relatives and their ability to inherit land or hold on to it in case of widowhood or divorce is limited. This can affect their intra-household bargaining power, the allocation of household spending among alternative uses, efficiency of land use (Udry, 1996), and participation in non-farm opportunities (Quisumbing and Maluccio, 2003). Legal changes and land registration programs that take into account local realities and enforcement capacity can contribute to women's social and economic empowerment (Deininger and Castagnini, 2006; Joireman, 2008).

reliable land registry can thus help to increase credit access. As this will allow borrowers to obtain funding for projects the true risk of which is less than what lenders would assume without collateral, this would increase the level of investment and improve economic efficiency. In such situations, formalizing land tenure can encourage financial market development and use of financial instruments that draw on the abstract representation of property through formal documents (de Soto, 2000).

However, rather than documenting and securing rights, the main goal of India's land administration system in colonial days was to obtain government revenue. The *de facto* award of land rights to revenue collectors (*zamindar*s) in large parts of the country had consequences that affect development to this day (Banerjee and Iyer, 2005). This has two types of implications. Rather than aiming to establish a system of land administration that would provide low-cost means to secure and transfer rights, the system inherited from the British was adopted without critical examination or major modifications. Instead, immediate post-independence efforts focused on establishing a more equitable land ownership-distribution through abolition of rent-collecting intermediaries and broader agrarian reform. In fact, abolition of intermediaries was tackled swiftly and successfully virtually everywhere after independence. Land reform consisted of three main elements. The first one was tenancy reform which aimed to limiting the rent to be paid for land by tenants and increasing their security, in particular by prohibiting tenant evictions. The second policy was ceiling legislation, which aimed to legislate a maximum land holding and require owners to dispose of all that was owned beyond this limit. The third element was securing land ownership by those who did not have land, partly through distribution of ceiling land.

The fact was that in the constitution legislative and implementation responsibility was assigned to states led to considerable diversity in timing, nature, and speed of implementation. At the same time, it is fair to say that even in the most progressive states, implementation of these policies was variable at best non-existent in many cases, and far below the potential virtually everywhere.[2] It took until the 1970s for serious efforts at

2. The fact that implementation of ceiling reforms and tenancy restrictions started in earnest only after 1972 allowed landlords to "prepare" by resuming self-cultivation, evicting tenants or transforming them into wage workers, or implement spurious subdivisions. Using census figures, Appu (1996) estimates that, to avoid having to give rights to tenants, landlords evicted about 30 million tenants or about one-third of the total agriculturally active population, similar to evidence from other countries with similar policies (Deininger, 2003).

implementation to materialize. After the late 1980s, efforts waned again; in fact between 1995/96 and 2003/04, that is, for almost a decade, progress almost completely halted.[3] While land reforms overall are still credited with the transfer of almost 10 mn ha, 2.5 mn ha via ceiling surplus redistribution, and 7.35 mn ha via tenancy legislation (Kaushik, 2005),[4] there is now widespread concern that the policies to bring such reform about could, by preventing landlords from supplying land to the market and instead encouraging them to leave it fallow, have significant negative impact on efficiency as well as equity.

Especially in view of the fact that India's land administration system is widely viewed as having difficulty delivering the public goods it was designed to provide, the continued adequacy of such policies has been questioned. Even at the high point, implementation was lackluster at best. Moreover, most of the relevant policies were put in place long time ago and high levels of economic growth continue to profoundly transform India's economic landscape. This puts new demands on land policy to facilitate development of the non-agricultural sector while also creating new opportunities for poverty reduction. In particular, growth and safety nets may have helped to attenuate many of the market imperfections that historically provided the main justification for government intervention in the functioning of land markets, implying that it would be better for government to focus its effort on providing a well-functioning system of land rights rather than to try and implement policies which have not only encountered widespread resistance but which may also cause undesired side effects for the very groups who are expected to benefit from them. Exploring the impact of such intervention and its continued justification would thus be of interest.

3. The increment in ceiling surplus land transferred during the period amounted to only 10,800 ha which is only about one-tenth of the land declared ceiling surplus which had not been distributed. The fact that all the remainder remains tied up in litigation suggests that further progress in achieving redistribution of ceiling land could be slow—it would take almost 90 years to dispose of remaining ceiling surplus cases if the current pace is maintained—and that, by clogging up the court system and preventing it from quickly dispensing justice in other urgent matters, the ceiling legislation may impose external effects beyond land rental markets (Moog, 1997).

4. The amount of land involved is much larger than what was redistributed in other Asian land reforms such as Japan (2 mn ha), Korea (0.58 mn ha), and Taiwan (0.24 mn ha). In terms of total area distributed, this puts India on par with Mexico which, in a much more land-abundant setting, and starting in 1917, managed to distribute slightly more than 13 mn ha (Deininger, 2003).

Land Leasing

This section focuses on the empirical analysis of contemporary land lease markets in India. Following a description of the traditional rationale for restrictions on land leasing and the prevalence of such policies across different states, it develops a framework that allows us to make predictions on the impact of such restrictions. This is followed by an empirical test of the extent to which predictions are supported by household panel data for 1982 and 1999. The evidence from this is then used to draw policy conclusions.

Nature and Potential Impact of Land Leasing Restrictions

Although empirical evidence on the impact of rent ceilings and other forms of tenancy control in rural areas is limited, the issue has been analyzed in urban contexts where rent control is a textbook example for policies that transfer resources from landlords to sitting tenants in the short term but that will be associated with inefficiencies in the medium to long run (Arnott, 2003). The key reason is that, by fixing rents below their equilibrium level, controls reduce the supply of new housing (or maintenance of existing stock) due to artificially reduced prices (Gyourko and Linneman, 1990), thus making access to rental more difficult thereafter (Basu and Emerson, 2000). With a constant or decreasing number of beneficiaries and an increasing number of new entrants who need to access to land in distorted markets, social cost of maintaining land rental restrictions will increase over time (Glaeser, 2002). Identifying other policies that can be better targeted and have fewer undesirable side-effects are thus desirable (Munch and Svarer, 2002).

The impact of rental restrictions may be equally severe in rural areas. Landlords affected by tenancy legislation may have an incentive to revert to self-cultivation for fear of losing it permanently although this may be associated with less efficiently cultivation (Appu, 1996). In fact, descriptive data from NCAER's 2006 ARIS-REDS survey suggest that, in states where rental is outlawed, such as Karnataka or Kerala, 30 percent or more of the cultivable land remains fallow even in the main cropping season. Even if inefficiency is less directly visible, cultivation based on wage labor is significantly less efficient than owner-cultivation based on family labor (Binswanger et al., 1995). Also, the rights given to tenants under land reform legislation provide tenants with heritable security against eviction but not ownership, are non-transferable, and still require rent payment to the landlord. This is likely to reduce both parties' incentives for land-related investments and undermines the scope to increase allocative efficiency

through sub-leasing. Thus, although they can provide benefits by increasing tenants' tenure security (though stopping short of full land ownership), such measures are likely to negatively affect supply of land to the leasing market. In doing so, they may make it more difficult for productive farmers to access land and for bad farmers to migrate or join the non-agricultural economy.

In fact, none of the Indian states permit sub-leasing of lands to which tenants had received permanent rights in the course of land reform and most states also restrict transfers of land that had been received through land reform. Therefore, these two variables measure restrictions on the operation of land rental markets that is exogenous to households' decisions. Variations in legislation across states thus provide scope for analyzing the impact of such policies on outcomes. To do so, we use the share of households who benefited from key land reform policies as an indicator for policy-induced constraints to the operation of rental markets. Specifically, we construct for each state the share of households who were awarded tenancy rights and the share of ceiling surplus area that was actually transferred to beneficiaries.[5]

Conceptual Framework

To explore the impact of such restrictions on rental markets, we use a simple model where a key rationale for producers to enter land markets is the desire to adjust for differences in their existing endowments of land and effective family labor (Deininger et al., 2008). Let household i be endowed with fixed amounts of labor ($\bar{L}_i$) and land ($\bar{A}_i$), and agricultural ability (α_i). Agricultural production follows a production function $f(\alpha_i, l_{i,a}, A_i)$ with standard properties, that is, $f' > 0$, $f'' < 0$ with respect to all arguments and the cross-derivative with respect to labor and land being positive. Relative land scarcity, together with the cost of supervising labor (Frisvold, 1994) makes wage-labor based cultivation undesirable in equilibrium (Binswanger et al., 1995), implying that households allocate their labor endowment between farming their own land ($l_{i,a}$) and off-farm employment ($l_{i,o}$) at an exogenous wage (w_i). Renting of land incurs transaction costs TC^{in} for renting-in and TC^{out} for renting-out because of the need to obtain information on

5. We use area rather than beneficiaries because in some cases ceiling surplus land was distributed to a collective entity such as a cooperative so that the number of beneficiaries would be misleading. Also, the existence of large discrepancies between the amount of land expropriated and actually distributed—which is due to the fact that in some cases land that had been distributed could not occupied by beneficiaries or was taken back after some time—led us to focus on land actually distributed.

market conditions, to negotiate and enforce payments, and the presence of regulations that restrict transferability or completely outlaw certain contract types. Transaction costs are assumed to be proportional to the size of land transferred. With households able to structure rental contracts in a way that allows those lacking liquidity to enter into arrangements,[6] thus allowing to defer rental payments until the harvest, household i's decision problem is to choose A_i, $l_{i,a}$, and $l_{i,o}$ to solve

$$\underset{l_{i,a}, l_{i,o}, A_i}{\text{Max}} \; pf(\alpha_i, l_{i,a}, A_i) + wl_{i,o} - I^{in}[(A_i - \bar{A}_i)(r + TC^{in})] + I^{out}[(\bar{A} - A_i)(r - TC^{out})] \tag{1a}$$

$$\text{s.t.} \quad l_{i,a} + l_{i,o} \leq \bar{L} \tag{1b}$$

$$l_{i,a}, l_{i,o}, A_i \geq 0 \tag{1c}$$

where p is the price of agricultural goods, r is the rental rate, A_i is the operational land size, I^{in} is a indicator variable for rent-in (=1 for rent-in, 0 otherwise), I^{out} is an indicator for rent-out (=1 for rent-out, and 0 otherwise), TC^{in} and TC^{out} are transaction costs, and all other variables are as defined above. From the first order conditions, we can derive three propositions that can be tested empirically.[7]

Proposition 1: The amount of land rented in (out) is strictly increasing (decreasing) in households' agricultural ability, α_i, and strictly decreasing (increasing) in the land endowment $\bar{A}_i$. Land rental will transfer land to efficient, but land-poor producers, thereby contributing to higher levels of productivity and more efficient factor use in the economy.

Proposition 2: The presence of transaction costs defines two critical ability levels $\alpha_l(TC^{out}, \ldots)$ and $\alpha_u(TC^{in}, \ldots)$ such that households with ability $\alpha_i \in [\alpha_l, \alpha_u]$ will remain in autarky. Any increase in TC^{in} or TC^{out} will expand the autarky range, thus reducing the number of producers participating in rental markets and the number of efficiency-enhancing land transactions. Compared to a situation with no transaction cost, this will decrease productivity and social welfare.

6. As we have data on overall leasing but not the specific contractual form, we couch our discussion in general terms rather than a specific rental arrangement.

7. For a more detailed derivation, see Deininger and Jin (2007).

Proposition 3: Increases of the exogenously given wage for off-farm employment will imply that higher amounts of land are transacted in rental markets as households with low agricultural ability who join the off-farm labor market will supply more land. With an appropriate model closure (see Deininger et al., 2008 for details), this leads to a decrease in the equilibrium rental rate which will prompt high-ability workers to rent in more land and specialize in agricultural production.

Estimation Strategy

Equations (2a, 2b, 2c) indicate that producers' decision to enter land rental markets depends on their marginal productivity in autarky, $MP(\bar{A})$ as compared to the rental rate to be paid $r(TC^{in})$ or received $r(TC^{out})$ which is a function of transaction costs. Formally, the three regimes are characterized by

$$\text{Rent-out regime } (A_i^* > \bar{A}_i): MP(\bar{A}) + \varepsilon_i < r(TC^{out}) \tag{2a}$$

$$\text{Autarky regime } (A_i^* = \bar{A}_i): r(TC^{out}) < MP(\bar{A}) + \varepsilon_i < r(TC^{in}) \tag{2b}$$

$$\text{Rent-in regime } (A_i^* < \bar{A}_i): MP(\bar{A}) + \varepsilon_i > r(TC^{in}) \tag{2c}$$

A producer's marginal product $MP(\bar{A})$, will depend on his or her ability (α), endowment with land ($\bar{A}$), family labor ($\bar{L}$), assets (K), and the opportunity cost of labor which will be affected by the level of education (E) and the presence of opportunities in the local off-farm labor market (O). Defining a well-behaved net earning function $g(\alpha, \bar{A}, \bar{L}, K, E, O)$ with first derivative $g'(.)$, we can write a linear version of the latter as $MP(\bar{A}) = g'(\alpha, \bar{A}, \bar{L}, K, E, O) = \beta_0 + \beta_1\alpha + \beta_2\bar{A} + \beta_3\bar{L} + \beta_4 K + \beta_5 E + \beta_6 O$. Transaction costs are expected to depend on policy variables S, household characteristics Z, and a dummy D^{99} for 1999. With linear versions of the transaction cost functions denoted by $r(TC^{out}) = \eta_0 + \eta_1 S + \eta_2 Z + \eta_3 D^{99}$ and $r(TC^{in}) = \delta_0 + \delta_1 S + \delta_2 Z + \delta_3 D^{99}$ and defining an index variable y_i such that $y_i = 1$ if $A^* < \bar{A}$; $y_i = 2$ if $A^* = \bar{A}$; $y_i = 3$ if $A^* > \bar{A}$, we can rewrite the system of equations (2a, 2b, 2c) as an ordered probit model that can be estimated using maximum likelihood methods.

$$\begin{aligned}\text{Prob}(y_i = 1) = \Phi\{\varepsilon_i < \eta_0 + \eta_1 S + \eta_2 Z + \eta_3 D^{99} - \beta_0 - \beta_1\alpha \\ - \beta_2\bar{A} - \beta_3\bar{L} - \beta_4 K - \beta_5 E - \beta_6 O\}\end{aligned} \tag{3a}$$

$$\begin{aligned}\text{Prob}(y_i = 2) = \Phi\{ & \eta_0 + \eta_1 S + \eta_2 Z + \eta_3 D^{99} - \beta_0 - \beta_1 \alpha - \beta_2 \bar{A} - \beta_3 \bar{L} \\ & - \beta_4 K - \beta_5 E - \beta_6 O < \varepsilon_i < \delta_0 + \delta_1 S + \delta_2 Z + \delta_3 D^{99} \\ & - \beta_0 - \beta_1 \alpha - \beta_2 \bar{A} - \beta_3 \bar{L} - \beta_4 K - \beta_5 E - \beta_6 O\} \end{aligned} \tag{3b}$$

$$\begin{aligned}\text{Prob}(y_i = 3_i) = \Phi\{ & \varepsilon_i > \delta_0 + \delta_1 S + \delta_2 Z + \delta_3 D^{99} - \beta_0 - \beta_1 \alpha \\ & - \beta_2 \bar{A} - \beta_3 \bar{L} - \beta_4 K - \beta_5 E - \beta_6 O\} \end{aligned} \tag{3c}$$

Variables we expect to affect marginal productivity are agricultural ability (α), the derivation of which will be discussed below, a dummy for landlessness and the log of the land endowment to represent $\bar{A}$, the number of members in the 14–60 and below 14-year age group to represent $\bar{L}$, the value of assets and the share of agricultural assets (livestock, implements, and agricultural structures) for K, the head's age (as a proxy for experience) and a dummy for primary education to represent human capital E, and mean village income O to represent wage labor opportunities in off-farm labor markets. Transaction cost of land rental participation are affected by producer's caste status (Z), a time dummy (D^{99}), and land policy (S) which is proxied by either the share of households who were recognized under tenancy reform, the share of area distributed under ceiling legislation, or the number of tenancy laws enacted as discussed earlier.

The propositions from our model allow making predictions on the signs of individual coefficients. The factor equalization from proposition 1 implies that rental markets will transfer land to more productive producers ($\beta_1 > 0$) with lower levels of land endowments ($\beta_2 < 0$) and more family labor ($\beta_3 > 0$). The hypothesis of wealth bias in rental markets, possibly due to credit market imperfections, translates into $\beta_4 > 0$. Diversification effects implied by proposition 3 suggest that producers with higher levels of education have better off-farm opportunities and will be less likely to rent in land ($\beta_5 < 0$) and that higher levels of non-agricultural wages, proxied by O, will make renting in less likely ($\beta_6 < 0$).

Proposition 2 implies that, by moving the cut-off points where producers shift from renting out to autarky and from autarky to renting in, respectively, rental market restrictions expand the range of autarky but do not affect producers' marginal product due to the fixed wage rate. We thus expect $\eta_1 < 0$ and $\delta_1 > 0$, respectively. By the same logic, higher transaction costs for producers from scheduled and backward castes imply $\eta_2 < 0$, and $\delta_2 > 0$ while a reduction over time in transaction costs due to better access to information implies $\eta_3 > 0$ and $\delta_3 < 0$.

A key element of the above regressions is households' agricultural ability α. As the data available are a panel of households and their offspring who were observed in 1982 and again in 1999, we can recover this parameter from a panel production function using household (or dynasty) fixed effects to proxy for ability (Deininger and Jin, 2008). Let technology be represented by the Cobb-Douglas production function

$$Q_{ijt} = \exp(\alpha_i + \alpha_j) A_{ijt}^{\theta_1} L_{ijt}^{\theta_2} K_{ijt}^{\theta_3} X_{ijt}^{\theta_4} \exp(\phi t) \tag{4}$$

where Q_{ijt} is the value of agricultural output produced by household i in village j in year t; A_{ijt}, L_{ijt} and K_{ijt}, X_{ijt} are total cultivated area, labor for crop production, value of agricultural assets, and amounts of chemical fertilizer, organic manure, pesticides, and seeds, θ_1, θ_2, θ_3, and θ_4 are technical coefficients, α_j is a time invariant village level parameter reflecting, among others, access to markets, infrastructure, and other time invariant factors such as climate, α_i is the time invariant household fixed effect which we use to measure of ability, and t is a time dummy so that $\exp(\phi t)$ measures productivity changes over time. To estimate this, we let $\alpha_{ij} = \alpha_i + \alpha_j$, take logarithms of both sides, and add an iid error term to obtain

$$q_{ijt} = \alpha_{ij} + \theta_1 a_{ijt} + \theta_2 l_{ijt} + \theta_3 k_{ijt} + \theta_4 x_{ijt} + \phi t + \varepsilon_{ijt} \tag{5}$$

where lower case letters are in logarithms. With multiple observations per household, we can subtract means

$$q_{ijt} - \bar{q}_{ij} = \alpha_{ij} - \bar{\alpha}_{ij} + \theta(\mathbf{Z_{ijt}} - \bar{Z}_{ij}) + \phi(t - \bar{t}) + \varepsilon_{ijt} - \bar{\varepsilon}_{ij} \tag{6}$$

where $\mathbf{Z_{ijt}}$ is a vector including a, l, k, x with coefficient θ. As $\alpha_{ij} - \bar{\alpha}_{ij} = 0$, this can be simplified to

$$q_{ijt} - \bar{q}_{ij} = \theta(\mathbf{Z_{ijt}} - \bar{Z}_{ij}) + \phi(t - \bar{t}) + \varepsilon_{ijt} - \bar{\varepsilon}_{ij} \tag{7}$$

This can be used to obtain $\hat{\alpha}_{ij}$, composed of a producer's idiosyncratic ability α_i and unobserved village attributes α_j. Letting the latter be the average of household fixed effect in the village $\hat{\alpha}_j = \left(\sum_i \alpha_{ij} \right) \Big/ n_j$ (Mundlak, 1961) allows to obtain $\hat{\alpha}_i$, the producer-specific effect by subtracting $\hat{\alpha}_j$ from $\hat{\alpha}_{ij}$.

An alternative approach to determine producers' level of technical efficiency in each of the periods is to use a stochastic frontier production function. This assumes that the disturbance term is composed of two additive components v_i and u_i where v_i is pure white noise and $u_i \sim N + (0, \delta_u^2)$ captures

producers' level of technical inefficiency $TE_i = \exp(-u_i)$ (Coelli, 1995). While the strong distributional assumption and the fact that u_i will capture other shocks imply that this approach is inferior to the one based on panel data, it does not require us to drop the large number of households who were included only in the second period. We therefore use it as a robustness check for our results below without reporting detailed results.

Data Sources and Descriptive Evidence

The data used here and below come from two rounds of NCAER's ARIS/REDS survey conducted in 1982 and 1999, respectively. This survey, the first rounds of which were implemented in 1968–71 covers all of India's major states. The 1982 sample includes some 5,000 households (Foster and Rosenzweig, 1996) and adding replacements and splits yields about 7,500 households which are located in 242 villages in 104 districts and 17 states in 1999 (Foster and Rosenzweig, 2004).[8] Table 1 presents household characteristics by rental participation status (rent-in, rent-out, or autarkic). It points toward an increase in the level of land market activity over the period; from 5.3 percent and 2 percent for renting out and renting in, respectively, in 1982, the share of market participants has increased to 10.7 percent and 4.1 percent in 1999.[9] This suggests that rental markets functioned better in the second, as compared to the first period. Comparing the per capita land endowment for land owners who either remained in autarky (0.51 ha and 0.36 ha in 1982 and 1999, respectively), rented in (0.28 ha and 0.20 ha), or rented out (0.68 ha and 0.64 ha) illustrates that, in both periods, rental provided opportunities for land-scarce and labor-abundant households to gain access to land. Land markets transferred land from households with more educated and female heads to male headed ones with less education. The share of landless who had gained access to land through rental markets increased from 12 percent in the first to 37 percent in the second period, suggesting an expansion of outreach toward this group over time. Noting

8. Sample states include Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal.

9. While this is a large change, the level of rental market activity increased more rapidly, and in a shorter period, in other Asian countries such as China or Vietnam, despite the fact that the more egalitarian land ownership distribution in these countries would put greater limits on the potential of land markets to equalize operational holdings than in India. In Vietnam, the share of households renting has increased from 3.8 percent to 15.8 percent in the 5-year period between 1993 and 1998 (Deininger and Jin, 2008). In China, the same figure increased from 2.3 percent in 1996 to 9.4 percent in 2001 (Deininger and Jin, 2005).

TABLE 1. Key Household Characteristics by Rental Market Participation Status in 1982 and 1999

	1982			*1999*		
	Rent-in	*Autarkic*	*Rent-out*	*Rent-in*	*Autarkic*	*Rent-out*
Basic characteristics						
Household size	8.15	6.92	5.34	6.91	6.04	5.54
Members aged below 14	2.75	2.38	1.83	2.38	1.87	1.53
Members aged 14–60	4.90	4.20	3.10	4.17	3.77	3.45
Members older than 60	0.49	0.34	0.41	0.36	0.40	0.56
Land endowment (ha)	2.31	3.34	2.93	1.27	2.02	2.87
Per capita land endowment	0.28	0.51	0.68	0.20	0.36	0.64
Landless dummy (%)	11.83	23.76	0.00	37.34	26.29	0.00
Head's age	51.85	49.97	51.71	47.41	48.98	51.65
Female head dummy (%)	2.15	6.67	12.03	3.30	6.54	8.90
Head with primary or above (%)	29.03	25.34	35.71	49.50	48.51	61.53
Consumption and asset ownership						
Per capita consumption expenditure (Rs)	1,426.98	1,280.42	1,697.84	1,346.19	1,549.19	2,213.63
Value of all assets (Rs)	34,783	17,215	20,333	33,839	46,568	62,466
Financial and off-farm (%)	19.48	26.47	34.20	19.23	22.69	27.16
Farming and livestock (%)	32.12	15.70	7.69	21.67	20.91	13.26
House and consumer durables (%)	48.40	57.83	58.10	59.10	56.41	59.58
Participation in activities (%)						
Crop production	100.00	72.60	19.17	100.00	66.12	23.07
Livestock production	97.85	78.66	61.65	81.82	63.57	49.88
Non-farm self-employment	5.38	11.30	13.91	14.61	9.9	17.96
Salaried employment	18.28	16.84	28.2	10.71	15.98	30.05
Wage employment	26.88	38.82	19.92	59.74	44.93	23.94
Number of observations	93	4,621	266	308	6,366	802

Source: Own computation from 1982 and 1999 ARIS/REDS surveys.
All values are in 1982 Rs; 1999 values are deflated by state level deflators.

that our sample represents about 130 million rural households, in 1999 about 15 million households—a quarter of them landless—used markets as a means to get access to land. While econometric analysis will be required to identify the underlying factors, it is clear that policies affecting land leasing could have far-reaching impacts for many households.

Comparing levels of consumption and assets for households according to the nature of their land market participation reinforces the notion that rental provides opportunities for poor segments of the population to access productive resources and thereby improve their well-being but also points toward structural changes. For example, while land rental seems to have transferred land to those with higher levels of assets in 1982, the opposite was true in 1999. The value of all assets owned by households renting in 1999 was, with Rs 33,839, some 25 percent below the average, compared

to autarkic households who had assets equivalent to the mean of the sample and those renting out whose asset endowment was significantly above the average (by about 33 percent). This not only supports the notion that it is now the asset-poor who benefit from land access provided by rental markets but also suggests that, over time, wealth became less important for agricultural production and more relevant for non-agricultural activity.[10] At the same time, a narrowing gap between rent-in and average households with respect to per capita expenditure is consistent with the hypothesis of land markets making a positive contribution to participants' livelihood. The high share of renters engaging in (agricultural) wage employment suggests that land rental provides wage laborers with ways to earn additional income. The fact that, in contrast to 1982, non-farm self-employment is much higher among rent-in households than either the mean or those who remained in autarky suggests that land rental is not an obstacle to participation in the rural non-farm economy.

Econometric Results

To obtain a measure of households' agricultural ability, a production function, coefficients for which are reported in Table 2, was estimated. Although a significant number of households for whom production is observed only in one of the periods are dropped, the specification fit the data well with an R^2 of 0.76 for the fixed effect estimation, and of 0.83 for OLS with coefficient estimates from both being close to each other. Concerning the individual variables, land is estimated to be by far the most important input for crop production; doubling cultivated land area alone would lead to a 50 percent to 58 percent increase in total crop production. This is followed by seed expenditures and labor use with an estimated elasticity of 13 percent to 17 percent each. Compared to these, returns to fertilizer, pesticides, irrigation, and assets are more moderate with elasticities of about 5 percent, 2–3 percent, 1–2 percent, and 4 percent for expenditure on fertilizer, pesticides, irrigation, and others. While neither education nor the gender of the household head are significant, land quality matters and doubling land values, which we use as a proxy for land quality, would increase total output by 11–12 percent. Significant variation of ability across households could imply that, even without a strong pull from non-agricultural employment opportunities, the scope for market-mediated transfers to bring about efficiency gains could be

10. Finding significant differences in the composition of the asset portfolio between rent-in and rent-out households, with the former having relatively more of their wealth in farming and livestock, and the latter in off-farm and financial assets, is not too surprising.

TABLE 2. Coefficient Estimates for the Cobb-Douglass Production Function

	OLS 1982 and 1999 pooled	*Panel fixed effect*	*Stochastic frontier*
Log of total crop area	0.499***	0.578***	0.513***
	(41.32)	(30.33)	(53.60)
Log of total labor use	0.173***	0.128***	0.172***
	(16.11)	(9.19)	(20.27)
Log of seed expenditure	0.174***	0.129***	0.148***
	(22.72)	(12.43)	(25.23)
Log of fertilizer expenditure	0.051***	0.047***	0.046***
	(12.32)	(8.66)	(14.43)
Log of pesticide expenditure	0.031***	0.019***	0.030***
	(9.41)	(4.16)	(10.79)
Log of irrigation and other expenditures	0.017***	0.012**	0.019***
	(4.65)	(2.48)	(6.75)
Log of agricultural assets value	0.039***	0.036***	0.036***
	(11.83)	(8.65)	(13.31)
Head's age	0.000	0.001*	0.001
	(0.83)	(1.75)	(1.53)
Head with primary education	–0.017	–0.030	–0.005
	(1.13)	(1.35)	(0.41)
Female headed	–0.036	–0.028	–0.033
	(1.09)	(0.60)	(1.26)
Log of land value	0.114***	0.119***	0.110***
	(12.66)	(9.27)	(14.61)
1999 dummy	0.141***	0.244***	0.116***
	(4.97)	(6.55)	(5.06)
Observations	5,215	5,215	8,816
R-squared	0.83	0.76	

Note: Absolute value of *t* statistics in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%; regional dummies were included in the OLS regression but not reported.

large. The estimated size of technological change between the two periods is between 14 and 24 percent and the fact that coefficients for the frontier production function are very similar to those obtained using OLS and the panel increases confidence in the robustness of the results.

Results from ordered probit estimation of the rental market participation equation using the pooled sample for 1982 and 1999 and with and without ability which, in the panel approach, is defined only for those observed in both periods, are reported in Table 3.[11] The pairs of columns correspond to policy

11. Results using the stochastic frontier production function are similar and available from the authors upon request.

TABLE 3. Determinants of Land Rental Market Participation

	Policy measure in the upper/lower bound equations			
	Tenants recognized		*Ceiling land redistributed*	
Main equation				
Cultivation ability		0.208**		0.226***
		(2.50)		(2.68)
Landless dummy	0.623***	0.574***	0.626***	0.611***
	(18.09)	(7.00)	(17.81)	(7.06)
Land endowment (acres)	–0.012***	–0.024***	–0.013***	–0.024***
	(4.63)	(6.42)	(5.14)	(6.50)
Members below 14 years	0.054***	0.040***	0.055***	0.043***
	(6.22)	(3.17)	(6.18)	(3.32)
Members aged 14–60 years	0.063***	0.056***	0.062***	0.057***
	(7.97)	(5.28)	(7.74)	(5.28)
Head's age	0.021***	0.031***	0.022***	0.032***
	(3.44)	(3.18)	(3.62)	(3.22)
Head's age squared/100	–0.025***	–0.031***	–0.025***	–0.032***
	(4.34)	(3.36)	(4.36)	(3.34)
Head has primary or above	–0.148***	–0.116**	–0.153***	–0.114**
	(4.59)	(2.45)	(4.77)	(2.42)
Mean village income (log)	–0.090***	–0.037	–0.077***	–0.007
	(3.42)	(0.96)	(2.91)	(0.18)
Total assets (log)	0.010	–0.008	0.008	–0.024
	(0.59)	(0.30)	(0.50)	(0.86)
Off-farm share in total assets	–1.194***	–1.249***	–1.180***	–1.230***
	(5.43)	(2.85)	(5.24)	(2.83)
Lower bound (rent-out to autarky)				
Policy variable	–12.300***	–13.652***	–1.502**	–1.329
	(6.50)	(3.17)	(2.53)	(1.40)
ST/SC dummy	–0.200***	–0.112	–0.178***	–0.134
	(3.85)	(1.26)	(3.38)	(1.52)
OBC dummy	–0.105**	–0.068	–0.104**	–0.068
	(2.49)	(1.04)	(2.42)	(1.02)
1999 dummy	0.527***	0.778***	0.454***	0.719***
	(8.73)	(6.80)	(7.49)	(6.38)
Upper bound (autarky to rent-in)				
Policy variable	12.697***	24.871***	2.551***	6.829***
	(4.18)	(3.96)	(2.71)	(3.86)
ST/SC dummy	0.166**	0.255**	0.148**	0.313***
	(2.52)	(2.43)	(2.24)	(2.89)
OBC dummy	0.148**	0.223***	0.116*	0.194**
	(2.42)	(2.79)	(1.87)	(2.39)
1999 dummy	–0.239***	–0.074	–0.245***	–0.113
	(3.41)	(0.71)	(3.43)	(1.10)
Observations	11,331	5,303	11,147	5,303
Log likelihood	–4564.94	–1985.13	–4450.96	–1986.69

Note: Robust *z* statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constants and regional dummies included throughout but not reported.

variables, that is, recognition of tenants and distribution of above-ceiling land. To interpret these, recall the coding of 1 for rent-out, 2 for autarky, and 3 for rent-in regimes, implying that positive coefficients increase the probability of renting out.

The highly significant coefficient on ability implies that, as expected, rental markets improve productivity of land use by transferring land from less to more efficient producers. The magnitude is large; according to the estimates, the probability for the most efficient household in the sample to rent-in is more than double that for the average household.[12] There is also a strong factor equalization effect. Higher land and lower labor endowments—especially for 14–60-year olds—increase the propensity to supply land to the rental market. This suggests that, by transferring land to labor-rich but land-poor households, markets allow gainful employment of rural labor. The large significant coefficient of the landless dummy implies that rental is important for landless households to access land. Landless producer's propensity to rent is, at 5.4–8.6 points, almost double that of land owners. Lack of significance for the coefficient on total assets suggests that rental markets are not biased in favor of the wealthy. In line with descriptive statistics reported earlier, this would imply that the importance of tenant wealth, for example, to reduce moral hazard, is no longer a very significant issue as wealth bias that had characterized such markets earlier was reduced with diversification of the economy.[13] The response of rental markets to economic growth is visible from the fact that completion of primary education by the head increases (decreases) the propensity to rent out (in) land, by about 2.1 percent and 1.1 percent, respectively. Mean village income increases the tendency to rent out as well, implying that, as the level of income increases, households will be more likely to move out of agriculture, supply land to the rental market, and allow those remaining behind to increase their holdings and income levels, as is also observed in other countries, for example, China.

Regarding the lower bound equation, regressions suggest that policy restrictions will lead to a significant and quantitatively large reduction of land

12. While lack of data on profits before and after rental participation makes it difficult to assess the net impact on productivity, evidence from China, where rental helped increase productivity gains by some 60 percent (Deininger and Jin, 2007), suggest that these can be large.

13. Inclusion of an interaction between the time dummy and asset ownership (not reported) suggests that land rental markets had been biased in favor of the wealthy in 1982 but that, presumably due to better credit market access in the study areas, this bias had disappeared by 1999.

supply to rental markets. Estimated effects are strongest for recognition of tenants (first and second column), consistent with the notion that landlords will be less willing to rent out if doing so can attenuate their property rights or if there are limits on their ability to negotiate rents. This is consistent with expectations that ceiling legislation poses less of a threat than tenancy regulation—as the latter applies to all market participants irrespective of their holding size—and enforcing it is more politically controversial and administratively complex than implementing tenancy legislation. The 1999 dummy illustrates that, over time, land rental supply increased significantly.

Turning to the (upper) bound between autarky and renting in, positive coefficients on all policy variables suggests that rental restrictions also depressed demand, making it more difficult for households to obtain land through rental. In most equations, coefficients are bigger for the upper as compared to the lower bound, suggesting that the impact of policy-induced restrictions may be larger on the demand than the supply-side. Backward and scheduled castes are more likely to remain in autarky and over time, the size of the autarky area has decreased, that is, land rental markets have become more active.

Policy Implications

In rural India, there is an increasing recognition of the importance of land rental markets to bring land to more productive uses while at the same time providing a basis for development of the rural non-farm economy. Although the continued need for restrictions on the operation of land rental markets has been debated in case studies, quantitative evidence of its impact has been scant, giving rise to a debate that is highly ideological in nature. Contrary to what is often assumed, our data suggest that, by allowing higher ability individuals to access land and equalizing factor ratios, rental markets improve overall productivity and equity. Interacting policy variables with producers' estimated productive efficiency (not reported) allows more detailed exploration of rental restrictions' impact on efficiency with results reinforcing the notion that rental restrictions significantly curtail efficiency of land use by preventing land access by the most efficient producers and slowing growth of the non-agricultural economy.

To quantify the impact of policy restrictions we compute, for every household, the predicted probability to rent out with actual values for all right hand side variables and with the tenancy restriction variable taking a value of zero. Taking the difference between these two values as a measure for the impact

of tenancy restrictions suggests that their removal could lead to a considerable increase in renting out, by between 40 percent and 70 percent. Removal of tenancy restriction is even more important for potential tenants as it could more than double access to land by those renting in. While significant time trends in both upper and lower bound equations suggest that the combined effect of higher overall growth and non-agricultural activity may reduce the undesirable impacts of rental regulation over time, estimated coefficients are small and not always significant; their magnitude implies that almost a century will be required to offset the effects of rental restrictions. Indeed, the government has recognized the importance of taking action on legalizing land leasing and eliminating rental market restrictions in the context of a broader regulatory framework for land market operation (Government of India, 2008).

Land Sales Markets

Although less restricted than land rental, it is often argued that land sales can lead to outcomes that are undesirable from an equity and an efficiency point of view due to imperfections in other markets. In addition to reviewing the underlying arguments, we provide empirical evidence to assess the extent to which this is true. Results suggest that, even though exogenous shocks have an impact on land sales, this does not imply that their operation would reduce efficiency; to the contrary, they helped more productive but land-poor and labor-abundant farmers gain access to land.

Motivation and Conceptual Framework

While theoretical models that put land sales markets into the general context of a household's choice of an optimum asset portfolio can generate widely divergent predictions, empirical evidence to assess the extent to which these correspond to actual outcomes—and key underlying factors—is often scant. In fact, as land sales markets are normally very thin, large or sufficiently long samples will be required to be able to observe causes and consequences of land market participation. Existing studies are often based on comparatively small samples (Lanjouw and Stern, 1998; Sarap, 1995) or rely on retrospective information (Baland et al., 2007). The implied selectivity and lack of initial characteristics makes it in many cases difficult for analysis to go beyond simple descriptive statistics or transition matrices with little scope

to help identify underlying factors and thus provide much-needed insight to enlighten the policy debate.

If households do not face subsistence or borrowing constraints that would otherwise prevent them from fully insuring against risk, everybody has access to the same set of information, and switching transaction partners is costless, the market for land sales will not be different from that for land rental. Demand for land would be determined by producers' ability to make best use of the land in farming and relative land endowments and market transactions will enhance social welfare by allowing small producers with higher levels of productivity to bid land away from large and less productive land owners (Zimmerman and Carter, 1999). Land prices would equal the net present value of the stream of profits from the best available land use, and potential buyers would be indifferent between renting land and purchasing it.

Policy-makers' concern about land sales leading to outcomes that may not be desirable from a social or economic perspective originates in three observations, namely that (*i*) imperfections in markets for credit and insurance will affect participation in land markets, and that subsistence constraints can force households to take decisions based on short-term requirements that are inconsistent with maximization of welfare in the long term; (*ii*) differences in producers' access to information will lead to variation in transaction costs; and (*iii*) with positive transaction cost, acquisition of land for speculative purposes unrelated to its use in agricultural production will lead to sub-optimal production outcomes.

Households' decision problem can be illustrated by considering the option of holding two assets, one, for example, land, with high returns but that is also risky and illiquid, and another one, for example, grain, with lower returns but less risk and higher liquidity. At every point in time, households choose a combination between these two assets to maximize utility over the entire lifetime and subject to limits for borrowing and an overall budget constraint. While an analytical solution to this problem is impossible unless more structure is imposed, numerical simulations show that credit market imperfections and risk, households' need to satisfy basic subsistence needs can give rise to land being supplied to the market by producers who are forced to sell under duress in bad years, often to individuals with access to non-covariate income streams outside the local rural economy or large amounts of assets (Zimmerman and Carter, 1999).

In high-risk environments, this may lead the poor to rationally prefer assets with a lower but more stable return to land even if transaction costs were modest and they had access to credit to acquire it. With imperfect

credit markets, some households will be able to buy and accumulate land not because they would be more productive but due to their ability to better overcome such market imperfections (Carter and Salgado, 2001; Zimmerman and Carter, 2003). Similarly, others may be forced to sell use land markets to sell land in exchange for less risky assets to minimize their exposure to risk even though they would be able to make more productive use of the land than those who acquire it (Rosenzweig and Binswanger, 1993). In addition to these factors, macroeconomic instability, expectations of future land price hikes and transaction costs in lease markets, lack of sufficiently attractive alternative assets, policies, and the valuation of land for non-productive reasons, all will affect households' participation in land sales markets independently from their innate productivity. We model these two sets of factors that will affect land markets in a rather independent manner in our ordered probit estimation as discussed below. A direct consequence of this is that the productivity and equity impact of land sales market operation will depend on the extent to which other markets function and net effects of land sales markets are ambiguous *a priori* and will have to be decided empirically depending on whether or not risk is high.

With India's highly unequal distribution of land, distress sales had historically played a major role (Kranton and Swamy, 1999). Evidence suggests that households' access to insurance substitutes allowing them to buffer consumption during crisis had a significant impact on whether land sales markets helped to equalize endowments or contributed to further dis-equalization (Cain, 1981). To halt these tendencies, virtually all states implemented, during the 1960s and 1970s, different types of land reform measures, mainly in the form of ceilings for land ownership and security against eviction as well as rent ceilings for tenants.[14] In addition to these, legislation in virtually all states prohibits land transfers from tribals to non-tribals. Transaction costs are further increased by stamp duty which has to be paid upon registration of a sale and which in most cases amounts to more than 10 percent of land value (Alm et al., 2004).

14. Ceilings on the amount of land that could be held by an individual or household although implementation effort varied widely and generally, was much delayed until the early 1970s. Contrary to Korea, where land owners' anticipation of such ceilings led to a tremendous increase in land sales market transactions that transferred income to former tenants and increased productivity (Jeon and Kim, 2000), they were largely evaded by spurious subdivisions (Kaushik, 2005). Where, as in West Bengal, implementation of land reform legislation was effective, ceilings are still credited with having led to greater land sales market activity (Bardhan and Mookherjee, 2006).

Estimation Strategy

Based on the discussion earlier, we build on Deininger et al. (2009) to explore three issues, namely (*i*) whether land sales promote efficiency of land use by transferring it to households with higher levels of ability; (*ii*) the extent to which land sales contribute to equalization of endowments, that is, transfer land from labor-poor and land-rich to labor-rich and land-poor households; and (*iii*) whether shocks and policies affect the outcomes observed in land sales markets. Further, we are interested to see how land sales compare to non-market transfers. We distinguish factors that affect households' or dynasties' latent demand for land due to their level of productivity from other factors, unrelated to productivity, that may prevent them from exercising this demand or force them to sell even if doing so runs counter to long-term maximization of productivity using an ordered probit model with variable upper and lower thresholds for land market participation. Latent demand is determined by their current and expected future ability to make productive use of the land. Actual participation decisions will, in addition, be affected by factors unrelated to productivity such as transaction costs and shocks. Formally, we assume that latent demand for land depends on long-term productivity which can be expressed as a reduced form equation

$$f(\alpha, \bar{A}, L, K, O) = \beta_0 + \beta_1 \alpha + \beta_2 \bar{A} + \beta_3 K + \beta_4 L + \beta_5 N \qquad (8)$$

Thresholds for the transition between sales and autarky and autarky and purchase are defined as follows:

$$p^S(T) = \eta_0 + \eta_1 S + \eta_2 C + \eta_3 G + \eta_4 (C \times S) + \eta_5 (G \times S) + \eta_6 \mathbf{Z} \qquad (9)$$

$$p^B(T) = \delta_0 + \delta_1 S + \delta_2 C + \delta_3 G + \delta_4 (C \times S) + \delta_5 (G \times S) + \delta_6 \mathbf{Z} \qquad (10)$$

where S denotes whether or not the household experienced a weather shock, defined as a level of rain below the average for two consecutive growing seasons, C denotes credit access, G local availability of mechanisms for risk coping, in particular the employment guarantee scheme, $\mathbf{Z}$ is a vector of other characteristics, and the βs, δs, and ηs are parameters to be estimated.

Factors affecting the extent of participation in the main equation are the level of ability and the dynasty's endowment with land, labor, and assets, the length of the households' independent existence in 1999, and the position in the life cycle which are represented empirically by a dummy for whether a household is from a landless dynasty and the dynasty's land endowment to represent A and initial asset endowments and levels of per capita

consumption to proxy for K. To proxy for life cycle events and concerns about inter-generational transmission (L), we use the number of unmarried sons aged between 5 and 25 years in 1981. We expect $\beta_1 > 0$ and $\beta_2 < 0$ as high levels of agricultural ability increase producers' marginal product and thus their competitiveness in land markets while standard assumptions for the production function imply a negative relationship between land endowment and marginal product. In other words, higher agricultural ability or lower land endowment will increase a household's likely propensity to shift from autarkic to land purchase and less likely to move away from autarkic to land sale. As, with imperfections in credit and labor markets, higher levels of wealth or family labor will increase a household's marginal productivity, we expect $\beta_3 > 0$, $\beta_4 > 0$, and $\beta_5 > 0$.

Concerning the variables in the threshold equations, note that $\boldsymbol{Z}$ includes policy constraints on tribals' land market participation, the inequality of land holdings in the village that will affect transaction costs in the land market, and the growth rate of village income to proxy for non-farm opportunities. We expect negative weather shocks to increase the supply of land to the market through (distress) sales and safety nets to reduce it as they improve poor people's ability to cope with unanticipated shocks, thus $\eta_1 > 0$, and $\eta_3 < 0$. While presence of banks also improves the ability to cope with shocks, it will also provide greater liquidity that would increase land market activity, making the sign of η_2 indeterminate. As safety nets and banks improve the ability to cope with shocks, we expect $\eta_4 < 0$ and $\eta_5 < 0$.

On the supply side, we expect shocks (village employment schemes) to increase (decrease) land supply to the market, hence $\delta_1 < 0$, and $\delta_3 > 0$. By the same liquidity argument as above, we expect that $\delta_3 < 0$. If access to banks and safety nets reduces the supply of land to markets through distress sales and less supply would reduce the number of those being able to buy land, we expect $\delta_4 > 0$ and $\delta_5 > 0$. Finally, the presence of constraints on market participation by tribals leads us to expect a negative (positive) sign on the coefficient for STs/SCs in the upper (lower) threshold equation. On the other hand, by increasing the scope for productivity-enhancing land transactions, economic growth at the village level is expected to increase land market activity, thus we expect the coefficient on this variable to be positive (negative) in the upper and lower threshold equations, respectively.

To compare effects of market transactions to those of non-market transactions (that is, inheritance, gift, dowry, etc.), we run an ordered probit model that identifies key determinants for non-market land transfers with some modifications of the variables to be included in the ordered probit model. For example, the entire argument of transaction costs associated

with land sale and land purchase will not be relevant to inheritance and gift exchange. Correspondingly, we treat the two thresholds in the ordered probit model as constant. As discussed earlier in the estimation strategy section, we treated the lower and upper bounds of the ordered probit model as constant because the transaction costs are unlikely to be relevant to non-market transactions.

Descriptive Statistics

With 15 percent and 8 percent (or 0.88 percent and 0.47 percent annually) of the population and 9 percent and 5 percent of the land involved in purchasing or selling land, respectively, the level of land sales market activity in the data compares to what has been reported by other Indian studies in similar time periods (Dreze et al., 1997; Mani and Gandhi, 1994; 1997; Rawal, 2001).[15] There are clear regional differences, with land purchase markets being quite inactive in the North (6 percent of population and 3 percent of land) but relatively active in the South (25 percent and 18 percent of population and land). Even in the most active areas, land sales and purchase markets are much less active than those for rental in which 15 percent and 9 percent participated in 1999 alone (Deininger et al., 2008).

Table 4 summarizes initial characteristics in the top panel and changes in key variables between the two survey periods in the bottom panel for the whole sample (column 1) and for households who sold, bought, and remained in autarky (columns 2, 3, and 4, respectively) over the period.[16] The top panel allows three main conclusions. First, data point to land sales equalizing factor endowments; land sellers had significantly smaller initial adult populations and per capita landholdings than purchasers (3.8 versus 4.4 persons aged 14–60 and 2 versus 1.3 ha per capita, respectively). Fifteen percent of buyers came from a landless dynasty, that is, more than 60 percent of those who started out landless acquired land through the market.[17] Initial non-land assets or levels of per capita income are equal for purchasers, sellers, and autarkic households although the two former

15. Rawal (2001) reports a number of studies from India that find that in most cases the share of land transacted annually was below 0.5 percent. Part of the reason for this low figure may be the fact that in the studies quoted, the denominator was total village land rather than the land owned by survey respondents.

16. The results of *t*-tests for the significance of differences between the group transferring land and those remaining in autarky are indicated by stars as explained in the table.

17. At the same time 2 percent of the sample who were landless in 1982 managed to acquire land but had sold it by the end of the period.

TABLE 4. Household Characteristics by Sales Market Participation Status

	Total sample	*Sale*	*Autarkic*	*Purchase*
		1982		
Household characteristics				
Household size	6.97	6.56**	6.95	7.32**
Number of individuals between 14 and 60	4.15	3.84***	4.15	4.36***
Number of unmarried sons (5–25 years)	0.80	0.88**	0.73	1.08***
Number of unmarried daughters (5–25 years)	0.56	0.68***	0.51	0.78***
SC share	9.74	4.57***	10.87	6.61***
ST share	7.55	5.01**	7.92	6.95
Assets, income, and consumption				
Per capita land endowment of the dynasty (ha)	1.47	2.00***	1.45	1.30*
Share of households from landless dynasty	20.99	2.41***	24.18	14.87***
Value of all assets	15,906	16,408	15,866	15,820
Per capita income (Rs)	1,514	1,607	1,492	1,566
Per capita consumption expenditure (Rs)	1,275	1,376	1,255	1,318*
Income sources				
Agricultural production	59.50	63.67**	59.48	57.31*
Salary and self-employment	19.59	18.55	19.20	21.99*
Wage income	17.90	14.39**	18.82	15.44**
Number of observations (dynasties)	3,816	329	2,885	602
		Change 1982–99		
Assets, income, and consumption				
Per capita land endowment of household (ha)	–0.70	–1.18*	–0.75	–0.20**
Value of all assets	45,035.18	41,949.04	40,357.47	70,646.30**
Per capita income	1241.17	835.83	1038.29	2491.63**
Per capita consumption expenditure (Rs)	409.65	369.36	376.88	598.69**
Income shares (%)				
Agricultural production	–10.99	–18.38*	–12.84	2.26**
Salary and self-employment	–0.41	3.14**	–0.55	–1.55**
Wage income	9.93	12.86*	11.69	–0.53**
Number of observations (including splits)	5,932	459	4,581	892

Source: Own computation from NCAER ARIS/REDS survey data.

Notes: (*a*) The 1982 figures for this item refers to those at the time when the current household head became head. (*b*) All values are in 1982 Rs with 1999 values deflated by state level deflators.

*, **, *** significantly different from the sample mean at 10%, 5%, and 1%, respectively.

had slightly higher initial levels of consumption. Second, the fact that the number of unmarried sons and daughters for sellers (1.08 and 0.78) and buyers (0.88 and 0.68) is markedly above that of those in autarky (0.73 and 0.51) suggests links between land market participation and life cycle events. Finally, the share of scheduled caste (SC) and tribe (ST) households who sold (4.6 percent and 5 percent) and that of SCs—but not STs—who bought land (6.6 percent and 7 percent, respectively) is significantly below their population share (9.7 percent for SCs and 7.55 percent for STs), possibly due to policies restricting land sales by STs (World Bank, 2007).

Shifting to changes over time in the bottom panel suggests that, while sellers did not become appreciably worse off, land purchasers experienced considerable welfare gains with large increases in asset ownership (Rs 70,646 versus 41,949 and 40,357), per capita income (Rs 2,491 versus 1,038 and 836), and expenditure (598 versus 369 and 376), were significantly above those for sellers and non-participants, respectively. While for the whole sample, wages were substituted for income from agricultural production, purchasers increased the share of income derived from agricultural production. Land purchasers moved to the top of the three groups in terms of per capita land endowment. Although population growth implied that all households saw their per capita land endowment decline, the magnitude was smaller for purchasers than the rest (–0.2 ha p.c. versus –0.8 and –1.2 for autarkic and sellers). The extent to which such performance was underpinned by higher levels of productivity will have to be explored through econometric analysis.

Econometric Evidence

Coefficients for the main equation and participation cut-offs in the ordered probit are reported in Table 5 where column 2 also includes an interaction between shocks and bank access.[18] A productivity-enhancing impact of land markets is highlighted by the positive coefficient on initial ability which suggests that sales transferred land to those who had been more efficient producers in 1982. Interestingly, imperfections in credit market, to the extent that they did exist, were not strong enough to overcome this tendency.[19]

18. Recall the coding of 1 for sale, 2 for autarky, and 3 for purchase.

19. As agricultural ability is not available for those whose dynasty did not cultivate land in 1982, estimation of the ordered probit model without farming ability increases the sample by about 1,400. Results, which are available upon request, are generally consistent with those reported here. To interpret the results, recall that the coding 1 is for sale, 2 is for autarky, and 3 is for renting in, that is, a positive coefficient implies that the variable under concern increases the probability of land purchase and reduces that of a land sale.

TABLE 5. Determinants of Participation in Land Purchase and Land Sale (Ordered Probit)

	Specification	
	(1)	*(2)*
Agricultural ability (technical efficiency)	0.162**	0.161**
	(2.26)	(2.24)
Household size in 1982	0.007	0.008
	(1.56)	(1.57)
Number of unmarried sons below 25 in 1981	0.067***	0.067***
	(3.75)	(3.77)
Dynasty land endowment	–0.004***	–0.004***
	(3.72)	(3.76)
Landless dynasty dummy	0.127***	0.126***
	(2.94)	(2.91)
Total asset value (log)	0.029	0.029
	(1.47)	(1.47)
Years of independence in 1999	0.007**	0.007**
	(2.37)	(2.35)
Lower bound equation (sale to autarky)		
Number of climatic shocks	0.106***	0.172***
	(3.69)	(4.16)
Bank access 1982	0.167***	0.383***
	(2.63)	(3.43)
Bank access in 1982 × climatic shocks		–0.079**
		(2.24)
Mean income growth in village 1982–99	1.247*	1.322*
	(1.80)	(1.88)
Village land Gini	0.986***	0.980***
	(5.04)	(4.99)
ST dummy	–0.381***	–0.371***
	(3.48)	(3.40)
SC dummy	–0.462***	–0.454***
	(4.29)	(4.21)
Upper bound equation (autarky to purchase)		
Number of climatic shocks	–0.126***	–0.160***
	(4.49)	(4.29)
Bank access 1982	–0.130***	–0.242***
	(2.58)	(2.69)
Bank access in 1982 × climatic shocks		0.043
		(1.42)
Mean income growth in village 1982–99	–2.011***	–2.040***
	(3.36)	(3.37)
Village land Gini	0.090	0.088
	(0.62)	(0.60)

(*Table 5 continued*)

(*Table 5 continued*)

	Specification	
	(1)	*(2)*
ST dummy	0.093	0.089
	(1.13)	(1.09)
SC dummy	0.296***	0.291***
	(3.90)	(3.83)
Observations	5,930	5,930

Note: Robust *z* statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Regional dummies included throughout but not reported. Regional dummies are jointly significantly different from zero.

Compared to the least efficient dynasty in the sample, a member of the most productive would have a probability of purchasing land (over the whole period) that is higher by about 3.8 percentage points (or 25 percent). The main equation also supports the hypothesis of sales markets contributing to factor equalization as is visible from the negative coefficient on the dynasty land endowment and the positive and highly significant coefficient on whether or not a household came from a landless dynasty.[20] According to the regression, members of a landless dynasty were 15 percentage points more likely to buy land than those with the highest land endowment in the sample. Data also support the life-cycle hypothesis, suggesting that those with unmarried sons in 1982 were significantly more likely to purchase land.[21] Also, households that have been in existence independently for longer were more likely to participate in land markets. Finally, the insignificant sign on household's non-land assets suggests that, once other factors are controlled for, ownership of other assets did not make it easier to purchase or sell land. This suggests that speculative motives by households with large amounts of non-covariate income are not a factor that drives the observed patterns of land transactions in India over the period studied.

Results from the lower bound between land sales and autarky and the upper bound between autarky and purchase highlight a number of interesting results: The positive (negative) sign of climatic shocks in the lower

20. To check whether it was access to salaried income or earnings from non-agricultural self-employed that enabled the landless to purchase land, we include an interaction between the landless dummy and the share of non-farm income. The fact that this coefficient is consistently insignificant (not reported) suggests that this concern is not substantiated by the data.

21. As presence of sons in the relevant age range is highly correlated with that of daughters ($\rho = 0.4$), we include only the former.

(upper) bound equations suggests that droughts or floods in consecutive seasons significantly increase the odds of a household selling land, thus also expanding the quantity of land available on the market. The positive coefficient on bank access suggests that having a bank available increases activity in land markets overall. As local economic growth, which could be correlated with banks' location choice, is controlled for, the better liquidity afforded by bank presence is likely at the root of this. The negative coefficient on the interaction of this variable with the number of shocks implies that availability of banks can help offset somewhat less than half of the effect of shocks, for example, by providing credit and insurance substitutes that reduces the need for distress sales.

The significant and negative sign on the coefficient for dummies of SCs and STs in the lower bound equation suggests that both are less likely to sell land while that in the upper bound implies that SCs—but not STs—are also less likely to purchase land.[22] Higher growth at the village level is estimated to shift the upper bound down, that is, to encourage land purchases, without affecting the boundary between sales and autarky. The finding that a more unequal land distribution (proxied by the Gini) at the village level shifts the boundary between sales and autarky upwards while leaving the upper bound unaffected could suggest that the threat of ceiling legislation being implemented prompted land owners to sell off land in anticipation of such policies (Bardhan and Mookherjee, 2006).

Policy Implications

The most important finding relates to the productivity and equity impacts of land sales market operation. Although they are, as expected, much less active than rental markets, land sales transferred land to better cultivators, thereby contributing to net gains in productivity. At the same time, and despite imperfections in other factor markets that could, in principle, lead

22. The negative coefficient on STs in the lower bound could be explained as a consequence of legal restrictions on land sales by tribals. However, the fact that the point estimate for the coefficient on SCs is even larger than (though not significantly different from) the coefficient on STs casts doubt on the validity of this interpretation, consistent with widespread reports about violations of this regulation (World Bank, 2007). The positive and significant coefficient on the SC dummy, compared to lack of significance of the ST dummy, suggests that, at least in our sample, discrimination in the land market against STs is not prevalent. In fact, we can reject equality of the two coefficients at the 1 percent level. As this is contrary to what had been found in other studies (Thorat et al., 2008), detailed study of this issue in a specifically tribal context would be desirable.

to adverse outcomes, they also contributed to equity by equalizing factor ratios and allowing relatively land-poor and labor-abundant households to improve their levels of asset ownership and welfare without making sellers worse off. Second, and in addition to performing much better than non-market alternatives, land sales markets were significantly more active where overall economic growth was higher, suggesting that as the economy develops and other obstacles and factor market imperfections are gradually dealt with, they are likely to perform an even more important role. Finally, producers' propensity to participate in land sales markets was significantly increased by the number of times they experienced an unfavorable shock, suggesting that credit market imperfections and subsistence constraints continue to be an important determinant of land sales. At the same time, ways to mitigate such shocks, if interacted with the frequency of shocks, helped counteract such negative impacts, suggesting that rather than trying to prevent land sales through administrative fiat, it may be preferable to explore mechanisms which those affected can use to better cope with risks to avoid undesirable land sales arising from distress. Attempts to prevent such sales by administrative fiat will be difficult to enforce and have often backfired by worsening the terms of the transaction instead of preventing them (Deininger, 2003).

Other Land Policy Issues

A first area relates to the need to reduce transaction costs (and increase governance) by clarifying the institutional framework for land administration, including the setting of reasonable tax rates. In the Indian context, a number of factors, including duplication of institutions and high fees, limited coverage of the system and low reliability of the information it contains make it costly to obtain reliable information on land ownership or to transfer it. This can cause growing informality where owners see little gain in registering land transactions, thus eroding the reliability and value of the land administration system.

Reducing Transaction Costs of Land Transactions

Modern land administration deals with the recording, processing, and dissemination of information about ownership, value, and use of land and the resources associated to it. This includes determination and (public) documentation of property rights and attributes such as boundaries of the land.

India's land administration system was established by the British with the goal of collecting land tax (revenue) on agricultural lands, rather than securing rights. Although the contribution of land revenue to government income has shrunk from about 60 percent in the mid-19th century to less than 1 percent today and the revenue department being loaded with a host of administrative functions,[23] the basic institutional structure was maintained largely without change though there are, of course, some variations across states.

Instead of having one institution dealing with land matters in an authoritative and conclusive manner, responsibilities are split between four main institutions all of whom only provide presumptive evidence. The land *revenue* department maintains the textual database for land records, collects land revenue, in addition to its regular administrative functions. The *survey and settlement* department is responsible for maintaining spatial data, mapping and demarcating boundaries, and executing surveys for sub-division on demand. The department of *stamps and registration* is responsible for registering deeds, as well as, other instruments and collects stamp duty, the magnitude of which has long eclipsed that of land revenue, on these transactions. Finally, as land records cover agricultural areas only, *local bodies* such as municipal corporations or panchayats maintain property tax registers and in some cases also maps, layout plans, or city surveys in areas that have not been covered by original surveys. The problems arising from this are three-fold, namely (*i*) duplication of records that increases transaction costs and reduces transparency; (*ii*) lack of unambiguous ownership; records and maps in many areas, especially peri-urban ones fostering conflict; and (*iii*) complete absence of land administration structures in marginal areas reducing tenure security and incentives for sustainable management of natural resources.

First, records are not routinely shared between revenue and registration departments or updated (mutated) in case a transaction occurs; in fact high

23. The duties of revenue official include the conduct of general elections, issuance of certificates, implementation and monitoring development schemes, and provision of relief in natural calamities. A study in Andhra Pradesh showed that revenue officials spent 32 percent of their time on administration of welfare programs, 25 percent on judicial and magisterial functions, 25 percent on developmental activities and implementation of schemes, 10 percent on general administration, and only 8 percent on land administration (Agrawal, 2006). With no change in the way land records were to be maintained, this must have affected the quality with which this tasks was performed. More importantly, as this shift reduced the emphasis on land records in the curriculum for public servants, many may no longer be familiar with the details of the associated documents, something that would, over time, lead to further decline in land record maintenance.

fees encourage informal transactions. This implies that records are often seriously out of date, raising both transaction cost and the potential for dispute. High stamp duties, a need to comply with complex regulations and the time and money spent in duplicative and inefficient procedures made the cost of registering property in India one of the highest in the world. According to the World Bank's 2004 "Doing Business" study, India ranked 123 out of 140 countries (World Bank, 2004).[24] Overlapping institutional mandates and ill-defined processes, together with appreciating land values, provide ample opportunities for corruption. An independent study highlights that administration is considered the least transparent and the second most corrupt public service in the country, at par with the police and the lower judiciary. Of the households interacting with land records or registration departments, 48 percent had to pay a bribe, with the total amount of bribes paid each year estimated at Rs 3,126 crore (Transparency International India, 2005).

Second, rural areas at the urban fringe have increasingly become subject to urbanization. Although this increased land values, thereby increasing the benefits from fixing boundaries more precisely, in many states urbanization led to the lapse of the survey department's responsibility for maintaining an accurate spatial record. Responsibility for this was, instead, transferred to municipal corporations which often lacked technical competence and were interested in records for tax purposes. Even where they have adjusted to the new requirements, maps are not part of the ownership record. This is a main reason for high levels of land-related conflict which, in a pilot study was found to affect 28 percent of parcels in peri-urban areas (Agrawal, 2006) and be responsible for some 40 percent of all court cases in state high courts (Debroy, 2000).

Finally, forest, as well as, revenue lands that had previously been waste and thus were never subject to a settlement survey have increasingly been brought under agricultural cultivation. Inability by the relevant institutions to carry out the required actions implies that numerous households in marginal areas remain without rights to the land they may have used for very long periods of time. This reduces their incentives to invest and manage land sustainably and implies that, if land is needed for other purposes such as infrastructure or public investment, they may not be entitled to compensation. The areas involved are large; for example, 74 percent of land in scheduled

24. Given the reduction in stamp duties affected in Maharashtra and the fact that the World Bank's indicator for the whole country is based only on the major commercial city (in this case Mumbai), this indicator decreased somewhat after 2004.

areas of Orissa is categorized as (unsurveyed) state land, with 26 percent and 48 percent being revenue and forest land, respectively (Kumar et al., 2006). Given the concentration of poverty in these areas, surveying and settling these areas is of great relevance for poverty reduction. To address these issues, states have started to computerize land records or registration.

In such situations, computerizing records can bring three-fold benefit. First, it has simplified the system and significantly reduced petty corruption that was traditionally involved in getting access to land records. A survey from Karnataka estimates that computerization in this state saved Rs 80 crore of bribes and Rs 6.6 crore in waiting time per year, in addition to non-quantifiable impacts on villagers' attitude to officials (Lobo and Balakrishnan, 2002). Second, where it is fully operational, computerization improved the quality of government service delivery and is generating surpluses from user fees that can be ploughed back to expand and improve the system (for example, through village-level access). Third, computerization helped to improve credit access in some cases and a number of states demonstrate that computerized records can be used as a springboard to integrate revenue records with the registry and even spatial data. This can be achieved by automating the back-end of the process, by ensuring that surveys be done before mutation, and by providing registry officials with access to the land records database before registering a document.

Success in computerization of land records was based on three principles: First, manual records were abolished so as to ensure that computerized records are routinely used so as to avoid duplication and confusion. Second, all of the computerized system are financially self-sufficient and in fact generate considerable surplus income, thus allowing outsourcing of tasks where public sector capacity is insufficient and reducing political influence. Third, to ensure confidence in the system, transparent processes were adopted, for example, through verification of records involving active participation by land owners, integrity of data was ensured through centralized state data centers with appropriate security features and audit trails, and publicity, that is, making information available on the internet to help de-mystify the process and to cross-check data. "Best practice" in computerizing land registration was similarly based on three factors. First, there was some re-engineering of the underlying business practices, for example, involving standardization and simplification of deeds, the development of a process to automate market valuation, and the setting of clear performance standards. Second, roll-out plans were adopted to proceed from offices with high volume of transaction to those with limited land market activity and uniform

fee schedules were adopted to have areas with high land values implicitly provide a cross-subsidy to more remote ones. Finally, outsourcing to the private sector was key from the very beginning.

The impact of computerization of registration has been tremendous, in a number of respects. First, in a number of states, computerization has led to a significant increase in the number of registered land transfers and increased revenue from duties even though duty rates had been substantially reduced. This suggests that more transparent processes for registration and property valuation increased the usefulness of services to customers and that demand for such services exists. Second, the fact that in some states encumbrance certificates for a significant length of time are available helps to increase tenure security. Being able to obtain these electronically via the internet implies a significant reduction in the transaction costs for sellers and purchasers as well as banks, although evidence regarding its impact on credit market activity is still limited. Finally, computerizing registry data created the preconditions for a functional integration between registration and records that will have to be a key element of any effort to make the land administration system more conclusive, thereby reducing transaction costs and insecurity involved in dealing with land.

From a technical perspective, computerizing land registration is straightforward and the main source of resistance is likely to be political, often from people in the system whose ability to obtain rents would be negatively affected. Still, a number of policy issues need to be addressed to maximize its impact. First, even though some states have moved to reduce high levels of stamp duty that tended to drive transactions into informality, the taxes levied on property transfers in India, in contrast to land taxes, remain among the highest in the world. Unless they are reduced, even the best technical solutions for improving land records are unlikely to be sustainable. Options to partially replace stamp duty with higher land taxes—levied on market values and ideally shared between local bodies and states—would be more in line with international best practice and need to be explored urgently. Second, it will be important to ensure completeness of registry records and their consistency with the data maintained by the land revenue department. This will require regulatory changes to ensure that mutations, for example, through succession, that did not need to be registered in the past, will be registered automatically and free of charge, something that will be easy once systems are computerized. Third, computerized systems make it easy to increase officials' accountability and thus increase the value of certificates as a proof of land ownership. Simple ways of doing so are to give them

access to the information (for example, encumbrance certificates) needed to perform basic checks on transactions that register, to automate mutations, and to adopt uniform parcel identifiers. Some states' requirement to lodge an approved survey before a transaction can be registered goes further in the same direction.

Table 6 illustrates that, although uneven across states, progress has been considerable. For example, computerized records are now fully or partly operational in Karnataka, Gujrat, Rajasthan, Madhya Pradesh, Maharashtra, Uttar Pradesh, and Tamil Nadu and registration is (almost) fully computerized in Andhra Pradesh, Rajasthan, Maharashtra, Karnataka, and Tamil Nadu. To facilitate further change and to provide incentives for states to expand surveying activity, the Indian government has in late 2008 approved the National Land Records Modernization Program (NLRMP), a centrally sponsored scheme with an initial endowment of Rs 2,000 crore, that integrates previous programs and, in particular by conducting pilots in one district per state, aims to eventually facilitate the transition to conclusive title rather than just a deeds system (Government of India, 2008).

Improving Spatial Records

There is little doubt that establishment of a comprehensive, reasonably accurate, and cost-effective spatial framework will be a key element of any strategy to improve India's land administration system. Without such a system, it will be impossible to identify gaps or overlaps and thus have a system that guarantees tenure security comprehensively and on a broad basis. However, long neglect and gaps in institutional responsibilities imply that quality and reliability of existing spatial data are much inferior to that of textual ones. It is recognized that, instead of conducting revisional surveys every 30 years, as done by the British in colonial times, a self-sustaining system that is updated whenever a transaction occurs will be required. While existing spatial records can be used as a basis in some cases, their generally outdated nature implies that simple computerization with some field checking, as was done for textual records, will be insufficient. There is thus an urgent need for viable and replicable models to improve and maintain spatial records. This is difficult due to the specialized nature and high cost of surveying, the presence of strong vested interests pushing for technically sophisticated rather than economically viable options, and the fact that costs increase exponentially with precision. A spatially differentiated approach will be needed that chooses strategies based on maximum use of existing records, heavy use of remote sensing technology with appropriate ground

TABLE 6. Comparative Status in Modernization of Land Administration across States

State	*Registry computerized?*	*Computerization of land records*	*Digitization of village maps/FMBs*	*Town and habitation surveys/property cards*
Andhra Pradesh	Completed	Not operational.	< 10% of VM vectorized. FMBs scanned.	Data not satisfactory, thus little activity.
Bihar	Piloting	Data entry	No activity.	No activity.
Gujarat	Roll-out	Fully operational, manual records banned.	< 10% of VMs vectorized.	Roll-out for computerization of property cards starting. 0.9 million surveys (out of 2.3 million cards) in progress; GIS support planned.
Himachal Pradesh	Piloting	Roll-out; manual records not banned anywhere.	No activity.	No information.
Karnataka	Completed	Fully operational, manual records banned.	50% village maps vectorized, FMB scanning in pilot phase.	Limited coverage of city surveys with survey started in 48 cities. No computerization.
Kerala	No, only indexes operational	Data entry stage.	No activity for village maps. Piloting digitization of FMBs.	No information.
Maharashtra	Completed	Fully operational, manual records not banned.	All VMs scanned, vectorized, and geo-referenced. Scanning of FMBs ongoing.	Survey nearing completion. All property cards computerized and available via PCIS.
Madhya Pradesh	Only indexes operational	Operational, manual records not banned.	VM digitization at pilot stage, problems with area.	Survey for one-third of cities ongoing since 1964; majority completed. No information on PCs.
Orissa	Piloting	Data entry and piloting.	Piloting of digitization of VMs and scanning of FMBs.	
Punjab	Piloting	Data entry.	Limited piloting.	No survey for urban centers. No property cards.
Rajasthan	Near completion	Fully operational, manual records banned.	No activity.	
Tamil Nadu	Roll-out	Fully operational in all taluks, manual records banned.	VMs scanned; not vectorized. Piloting digitization of FMBs.	*Natham* survey almost complete. Survey done in corporations; roll-out in municipal towns.
Uttar Pradesh	Piloting	Fully operational in all taluks, manual records banned.	No activity.	
West Bengal	Piloting	Limited pilots.	Limited piloting of both.	No information (only Kolkata is urban).

Source: World Bank (2007).

truthing, and an overall cost that is in line with land values and beneficiaries' ability and willingness to pay. Drawing on India's capabilities to combine satellite imagery with existing village maps and other readily available spatial products to generate a basic cadastral index map would be a low cost option to provide a comprehensive framework, identify gaps, and on this basis establish criteria for ways to address spatial data problems in a step-wise and affordable manner. This would be particularly important for poverty reduction as recognition of group rights by very poor and marginal groups who were left out of the traditional system is possible at low cost using satellite imagery and could significantly increase incentives for sustainable land management and reduce dangers of land alienation.

Putting in practice a spatial system that responds to these needs will require that (*i*) public sector activity focus on broad provision of clear public goods, that is, comprehensive coverage with a low precision cadastral index map that can be generated at modest cost by combining satellite imagery with existing village and tax maps, instead of establishing islands of high quality spatial data in an ocean that remains largely uncharted; (*ii*) pilots focus on developing integrated, scalable, and cost-effective ways to generate spatial data and link them to textual records applicable to archetypical situations (for example, unrecorded subdivisions, complete change in land use patterns, loss of spatial data, or complete lack of survey); (*iii*) lessons from pilots be translated into regulations and guidelines for private actors; (*iv*) an effort to expand capacity and increase the role of the private sector (with structures for accountability) in areas where willingness and capacity to pay exist a state monopoly on surveying as is still the case in most Indian states;[25] (*v*) providing a regulatory framework for application of a range of survey methods with defined precision requirements; (*vi*) strengthening capacity in the private and the public sector; and (*vii*) revamping survey processes, for example, shifting from paper-based to electronic ones to reduce cost and make survey more affordable.

Is There a Need to Move toward a Title Registration System?

It has long been noted that, partly because they are fiscal in nature and presumptive in character, and partly because of their incompleteness, the value of current land records in India as a proof of ownership, and thus a basis for

25. There is no argument about the government having to verify the authenticity of the work but this does not mean that outsourcing is not possible, as illustrated by Eastern European countries.

transactions or credit, is extremely limited (Wadhwa, 2002).[26] To change this, it has often been argued that India needs to make the transition from a system based on deeds to one based on title where the state guarantees property rights. In fact, the states of Andhra Pradesh, Rajasthan, and Delhi are discussing legislative changes that would allow establishment of a title registration system.

To understand the associated issue, it is important to understand differences and common elements between the two. A *deeds registration* system is a public repository where documents evidencing transactions with land can be lodged, numbered and dated, indexed, and archived. Recording of the document will give public notice of the transaction, serve as evidence for it, and may assign priority to the right claimed in that document with registered deeds normally taking priority over unregistered ones, or any deeds registered subsequently. However, registration of a deed does not imply any inference about the legal validity of the transaction or that the parties were legally entitled to carry out the transaction. As discussed earlier, the registration office will, in principle, register anything and in practice in India, officers often invest more time in ensuring the identity of the parties to the transaction than the physical location and attributes of the land. Under *registration of titles*, the register itself serves as the primary evidence of ownership. It is commonly identified by three attributes, namely (*i*) the mirror principle indicating that the situation in the registry is an exact reflection of reality; (*ii*) the curtain principle, implying that anybody interested in inquiring about the title status of a given property will not have to engage in a lengthy search of documents but can rely on the evidence from the title registry being definitive; and (*iii*) the assurance principle according to which the government will indemnify for damages incurred as a consequence of errors in the registry.

Thus, while deeds and title registration systems intend to put rights in land on public record, a deed provides only evidence of an isolated transaction and says little about the validity of this transaction.[27] Simply put,

26. …a deed does not in itself prove title, it is merely a record of an isolated transaction. It shows that a particular transaction took place, but it does not prove that the parties to the transaction were legally entitled to carry out the transaction and therefore it does not prove the validity of the transaction. It is left exclusively to the person entering into a transaction concerning an immovable property to investigate himself about the soundness of the title to that property of the person. (Wadhwa, 2002)

27. To illustrate, if, under title registration, A fraudulently sells a piece of land (which actually belongs to C) to B who purchases in good faith, B becomes the rightful owner and any claims by C are extinguished as soon as the sale is registered. The only recourse open to C

under a deeds system potential purchasers will need to expend resources to investigate whether the seller's title is genuine whereas under a title system this is not needed as the validity of such claims has already been checked for them by the registry system. This implies that the entry in the registry is definitive and that the state is willing and able to indemnify any person who suffers material loss, for example, due to disputes that arise out of a duly registered transaction. Of course, either the state or any private insurer will be able to offer such a guarantee only if the risk of disputes surfacing is low. This risk is a function of the completeness of the information in the registry, the ease of searching it; and its reliability. To minimize risks, modern deeds systems have taken measures including (*i*) compulsory registration; (*ii*) parcel-based indexing; (*iii*) computerization and standardization; and (*iv*) examination of documents at the point of registration to ensure compliance with applicable laws and regulations.[28]

First, compulsory registration may be made a condition of the validity of the deed by providing in the law that unregistered deeds may not be admitted in court as evidence of title. Documents which are not registered can then be safely ignored and searching the deeds register, which can be automated by having encumbrance certificates computerized, will enable anybody dealing in land to make sure that no material factor has been overlooked, thereby affording significant protection against concealed conveyancing. Second, while basic deeds registration systems are normally filed and indexed under the names of parties, rather than a unique parcel identifier, and do

would be to demand compensation, but not restitution of the property, from the state which in turn has the option to sue A. The need to ensure that the responsibility taken up by the state can be met is one of the reasons why title registration systems are normally associated with a guarantee fund to facilitate payment of such compensation. By contrast, under a deeds system, it is B's responsibility to investigate the veracity of A's ownership claims and C will be able to demand restitution of the property from B, implying that B will incur the loss. Put simply, under a deeds system, the cost of acquiring information about the ownership status of a particular piece of land have to be incurred by the purchaser (something that may lead to a less than optimum amount of land market activity) while under a title system the state guarantees this information. However, note that, despite a common misconception to the contrary, even a Torrens system of title registration does not guarantees boundaries or areas of parcels. In fact no title registration legislation expressly supports that notion, and no case law supports it. Many more modern title registration statutes expressly provide that indefeasiblity does not extend to the lengths, bearing, and areas of registered parcels.

28. A number of countries, including the Netherlands, South Africa, and the USA use these techniques to run highly effective deeds systems that offer levels of protection that are equivalent, or even higher, than those found in title systems where, due to low quality of the underlying information, a government guarantee is not possible.

not include or require cadastral maps, these elements are required in more advanced systems. This then allows computerization of title abstracts as well as the links to cadastral maps, parcel based indices, and examination of documents described earlier can greatly improve the quality of information provided by deeds registries and reduce the cost of searching them. Finally, the risks that a deed is not properly drawn can be minimized by requiring officials to check compliance with essential rules and making the registry liable for any damages incurred as a consequence of negligence or even insurance. Insurance against defects in title for a property being transferred is a common arrangement in most states of the USA where title insurance companies have developed private deeds registers and will insure purchasers against losses as a result of defective title.

If, as a consequence of these steps having taken, regular operation of the registry is satisfactory, options for conversion from deeds to title registration may be considered. The main types are a conversion that is entirely voluntary, a compulsory transaction-based conversion, or a systematic process whereby specific areas are declared "conversion" areas to allow systematic determination of all immovable property rights and following issuance of title documents (possibly qualified with a provision to mature into full titles if no counter-claims surface within a specified period of time). Under voluntary conversion, owners of land may apply to convert their land from deeds to title registration but experience in Australia has shown that this process alone will not achieve full conversion.[29] Compulsory transaction-based conversion offers the advantage of converting land whenever it is subject of a transaction, for example, by requiring that the party lodging the deed for registration is required to produce proof of a good title which will then be examined by the registry. This approach, which was taken in England and Scotland is cheap but slow and will also not achieve full conversion, but has the advantage that valuable land will enter into the title registration system first. Systematic conversion, though much more expensive, may thus be necessary if maintaining a dual system for an extended period of time is considered undesirable and has been adopted even in England and Scotland to complete the process. Legislation to establish the legal basis

29. In the States of Victoria and New South Wales, Australia voluntary conversion was the only conversion process for around 100 years, with the result that there were still large amounts of unregistered land. There was insufficient incentive for land owners to go to the cost and trouble of applying for title registration unless a large-scale development was planned. It was finally concluded that there needed to be some element of compulsion or automatic conversion for the change to take place within a finite time.

for land titles as currently under discussion in Andhra Pradesh and Delhi relies on systematic conversion while the recently adopted Land Title Act in Rajasthan uses voluntary conversion by peri-urban land owners. Success of all of these pieces of legislation will depend critically on the ability to establish and maintain the needed institutional infrastructure which differs significantly from what is in place currently. A further success factor is in the type of rights that can be registered (and the cost of doing so) as well as the mechanisms used to adjudicate property rights in the process of a systematic field survey. Unless they comprehensively account for a wide range of potential evidence and reach conclusive and accepted conclusions regarding ownership rights for the vast majority of parcels so as to quickly establish an information base that is reliable, complete, and of high quality and for which a state guarantee can be offered, the credibility of the process as well as the end-product may suffer and could be undermined.

Conclusion and Policy Implications

Although land administration and policy in India are complex subjects with considerable variation across states, our analysis allows us to derive a number of key messages for policy and specific program. First, there is little justification for maintaining restrictions on land leasing that have been inherited from earlier land reform efforts. To the contrary, such restrictions undermine productivity and equity by preventing land access by more productive producers, as well as, development of the non-farm economy. Second, even though there is clear evidence of land sales being affected by credit market imperfections that make it difficult for households to fully insure themselves, land sales in the Indian regions covered by our survey, and within the current policy environment, are shown to contribute to greater productivity while at the same time equalizing factor ratios. Finally, government efforts to improve effectiveness of land administration through computerization of land records and registration provide a basis for further advances that can help to either significantly improve tenure security within an improved system of deeds registration or to make the transition toward a title registration system where reliability of information is guaranteed by the state or private insurers. Further progress along this path will depend on the ability to address not only technical issues but also develop a field-based adjudication process that is comprehensive and robust enough and the scope for establishing an efficient and streamlined institutional structure to ensure reliability of information and reduce the transaction cost of registering land transfers.

Comments and Discussion

Pranab Bardhan: I largely agree with some of the main conclusions of the paper, particularly those pointing to unintended consequences of much of land legislation, the benefits of land transfer (either through tenancy or sales) from the landed to the land-poor but more productive producers, and the value of computerized land records and registration.

Let me here focus only on cases where I have some differences or my emphasis may be somewhat different.

- That prohibition of land lease is inefficient and inequitable has been recognized in the literature for quite some time. But when the authors argue against land rental restrictions, which presumably include restrictions that ensure security of tenure (at a reasonable rent) for pre-existing tenants (hitherto working on an oral lease), they should be aware of a trade-off in such cases: on the one hand, such restrictions may discourage landlords from leasing-out (which the authors focus on); on the other hand, security of tenure and rent ceilings may encourage long-term investments on land by the tenants. There is a substantial theoretical literature on the latter issue, but the authors should at least refer to the empirical literature—for recent examples, see Banerjee et al. (2002) and Bardhan and Mookherjee (2008), where it is shown that such security of tenure enhancing land reform has significantly improved farm productivity in West Bengal.
- A proxy used for rental restrictions is "no. of tenancy laws." I think counting the no. of laws as a measure of land reform (as has been done in part of the empirical literature) is problematic.
- Transaction costs in land lease:
  - I do not quite understand why transaction costs are necessarily higher for scheduled and backward castes (most cultivators today belong to these castes—their social network may even yield some advantages in transactions among cultivators), except may be in terms of legal processes.
  - In the theoretical literature on tenancy, transaction costs include costs of monitoring (moral hazard in unobservable use of effort

and other variable inputs). The authors' theoretical set-up does not seem to include them. If it did then in the context of "limited liability" it is possible to generate the phenomenon of "tenancy ladders" (landlords prefer leasing out to wealthier tenants)—for a demonstration of this, see Bardhan and Udry (1999), Chapter 6. But in the empirical results of this paper assets seem to be insignificant in land-lease decisions, which is surprising. The land-poor may "demand" more land-lease, but the landlords may prefer "supplying" leases to better-off tenants—the resulting equilibrium is not captured in the authors' estimating equations.

- In the rental equation one should include the possession of bullocks as an important determinant of land rental. A landless person, not owning a bullock, would not try to lease in land, as the bullock rental market is often weak (largely on account of moral hazard reasons).
- In the section "Estimation Strategy", mean village income is taken to represent non-farm wage labor opportunities, but the latter may also depend on mean income in other villages or towns nearby.
- In different parts of India one hears about increasing incidence of "reverse tenancy" (small farmers leasing out to the rich), as in recent years cultivation has become more costly and more dependent on market-purchased inputs. Do the authors' data for 1999 counter this?
- National Council of Applied Economic Research (NCAER) data seem to suggest a large increase in tenancy over time, which contradicts the finding of tenancy decline from NSS data (according to which percentage of operational land area leased-in was 10.6 percent in 1970–71, 7.2 percent in 1981–82, and 6.5 percent in 2002–03). One would like to know why NCAER data show such a diverging trend compared to NSS data (the latter based on a sample of more than 52 thousand households in the latest round, many times the sample size in NCAER data).
- In the empirical equation for determining land sales/purchase, it is important to correct for land quality, as the data are for households across the whole of India (this has been an important issue in the old literature on agricultural production functions).
- In the same equation the landless include professionals (like school teachers or traders) as well as agricultural laborers. For the purpose of interpretation it may be useful to separate out the occupational categories.

Surjit S. Bhalla: I also have a story about being informed late but I shall just end with the fact that I do not have a PowerPoint presentation. First, I shall give some general comments and some comments on data, and then some specifics on the paper.

First and foremost, I think the REDS data is an extremely rich source of data for answering several questions, including the ones that Deininger and Nagarajan have done. One suggestion here is that I think it is time now that the NSS and National Council of Applied Economic Research (NCAER) talked to each other when they write the papers and, therefore, a paper which has NCAER data should also have NSS data, and I shall tell you how it will actually enrich your paper quite considerably. And I think the opposite with the NSS people who work only on NSS, should be able to refer to and use the NCAER data. This obviously involves that the NCAER data be now publicly available for sale, etc., just like the NSS's, and I hope that this is the beginning of that or that this could lead to that.

As far as the paper goes, the topic investigated, the evidence provided, policy conclusions, I think the work is extremely server and I have very little to question on it. There are a couple of points that I have. One is on the measurement of ability and the second, on the differential trends with NCAER, with NSS—Pranab has already mentioned to that. So, the comments that I have will pertain to additions to the paper that I think will make it "better." They are not really additions. One thing I should mention that these are actually two papers. Therefore, you have a lot of material or you have done two papers. "Land Administration" part is a paper in itself. So, when I say that these are additions, it may be a bit of cut-and-paste and a bit of additions.

Coming to the data, the topic is both controversial and interesting and I think one of the first questions one wants to know is what is the land distribution in India? Now, the NSS data has land distribution data, unit level data going back to 1983, just to try and show what is the distribution of land. You have one reference in the paper where it says it is highly unequal and this is where you can show unequal with respect to whom. The related point on that is that you have got very interesting set of results and statistics in other countries and I shall suggest that you have it in a table where it can be much better, much more prominently displayed so that the reader can actually see where other countries have faced similar problems and how they have tackled. So, you do mention it, do write it, you have it in footnotes, and I shall give it a lot more prominence.

On land reform, there is one question that I think Pranab perhaps indirectly eluded to but springs up to any reader. You have data from 1969–1970–1971, then 1982 and then 1999, while the one measure land reform that occurred in India was in West Bengal and that happened, I think, in the late 1970s or early 1980s. What are the results of that? I know you will face small sample problems, but this is where with a bit of marrying of the NSS data and your own data, try and relate some of the questions on productivity, etc., with this one major land reform that occurred and to try and answer the question, did it work? This is before we get to tenancy and other considerations which I shall come to. Before we get to that stage, *we know* that land reform not only works, but works spectacularly. We have the example of China. Well, let us see the good old-fashioned example from India, particularly from West Bengal to see what has happened.

Now, to some more specific comments on your paper. You know you have a throwaway line which I would give a lot of prominence. The editors may not have that line survive at the time of printing but the throwaway line refers to ideological prejudice. We, at IPF and other places, do not believe that ideology has anything to do with either research or economics or policy, but I would really give it a lot of attention. You do have in the case of land sales but you have much less in the case of tenancy. As to why are these policies there, why were they initially there, who are they supposed to benefit and who they are actually benefiting. So, it is just a tabular form. Now, how does tenancy hurt? I am taking a naïve and I do not think it hurts. Clearly, there must be evidence that it has hurt people and hurt people more than it has helped them, etc. etc., so that this was a good policy to initiate, let alone to follow now in 2007. So, I think in a tabular form upfront, these were the reasons. Some history as to whether these reasons were valid when they were first initiated, in other words by valid meaning non-ideological, and whether they are still valid today, and I shall give some examples of some of the things.

Let me start off with the SEZs, which Pranab also alluded to, and whether the government should be involved in the sale of land. There are theoretical arguments as to why something might happen but you have actually got empirical data. So, first, rather than go into theory, we can all construct theoretical models which will show whichever result one wants. Really, the ultimate test is, does it hold in practice? Therefore, one example of the SEZs is that have the poor benefited and/or whether the state should intervene? There is an interesting example that all the places where there has been trouble on the SEZs, have been places where the government is directly involved in purchasing the land and then selling to SEZ developer.

All the states like Haryana where the state is not being involved, where the buyer is directly in contact with the seller, as you are alluding to, there is no problem. So, I would bring that discussion in because it is very pertinent to your conclusion. Now, what is the reason indeed in the case of Orissa where there is a large multinational developer called PASCO and the state wants to come in and say, no, we shall buy it and we shall sell it to PASCO, obviously with a large differential and PASCO saying, listen, we want to be transparent; we shall go out to the marketplace and we shall pay and let us see who the seller prefers? So, I think this is very relevant to your conclusions. Second, it is also the ideological prejudice, and this pertains to some of the discussion that we have had in the last couple of days, on education. The Planning Commission—please correct me if I am wrong—in its draft for the 11th Five-Year Plan had a whole section there as to how education vouchers should be introduced as a way for both equity and efficiency and the final draft of the plan document does not contain any reference to vouchers and indeed there is some flak of a better word, camouflage of the whole original idea. This has to do with ideological prejudice, this has to do with perhaps some facts that one covered as to how can a student of poor family lose when he is given the option of whatever school he has to go to and given the money to attend the school. I am yet to understand. One argument is, well, no school will be there or no schools are there. If no schools are there, it does not affect either way and the poor person is better off because he is getting an equivalent amount of money. So, how somebody loses out by having the option of both going to a government school and going to a private school, I would like to know, and I think this underlines some of the discussion particularly about land rentals as to what is the logic of restricting land rentals and all kinds of things. You might want to refer to the urban land rental laws which made investment in housing completely impossible. Not only tenants had rights but their grand children had rights and their dogs and cats had rights to the house. So, there was no investment in housing at all until the reform came in that you could rent only for eleven months at a time and, therefore, not be subject to any tenancy laws. And lo and behold! There has been an absolute boom in land rentals and efficiency in the entire land market in the urban sector.

One other aspect is, now you have some calculations of how much productivity will go up. Klaus, you have mentioned a little bit in your presentation. I am just trying to reinforce that. There is a big debate, as you know, in India, which was mentioned by the Finance Ministry yesterday as to whether agriculture can grow at four percent and this needed to grow. You have calculations as to how much terminal productivity will

increase, distribute that over a few years if these policies are enacted and just give illustrative numbers as to what will happen to Indian agricultural growth, and in a comparative sense what will happen or what has happened with China.

Another aspect is, you mentioned as to how about 18 percent of the people were involved in land sales and SCs/STs, you state, was a very small fraction, somewhere around 10 or 13 percent. I was quite surprised, given the common presumption which I also had that there was a huge amount of discrimination and SCs/STs just could not participate in land sales to find this large number.

One other aspect that I think needs a bit more discussion is—it comes out in your appendix but even there it is indirect, but I think there are other papers from the REDS that demonstrate this; you can use also the NSS in an indirect fashion to come up to the same—as to what is happening to non-farm income in the rural areas?

Last two points. One is on the results. They are very very suggestive of everybody moving up the ladder in terms of who is now participating in the land rental market, who is benefiting, etc. If that is indeed the case, just to go further into it, just to show that listen, you could do it by dossals, etc., a sort of a transition matrix as to who is benefiting and who is losing, and you can do it in relative and absolute terms.

One other statistics which you may want to bear in mind and which should appear somewhere is that since 1993, there has been practically zero growth in the absolute number of cultivators and agricultural workers in India. So, clearly refraction has come down considerably but there is no growth. It may be 0.1 percent per annum. I think this needs to be set in into the entire debate about what is happening in agriculture on the equity side, whether the poor are becoming worse off, etc. etc. You are finding that the same amount of output, or 5 or 10 percent higher output is now being produced by the same number of people, and this is related to whether you are moving up the ladder or not.

To conclude, the argument which I would like is that the arguments for the policies India has enacted in land as well as in tenancy should clearly state what the original rationales was, whether there was justification for the original rationale from the data in the 1950s and 1960s when these things were enacted, and today what the situation is, how it has changed, what your results suggest, and whether there is any rationale for these policies today.

General Discussion

T. N. Srinivasan raised a number of questions. First, he questioned the authors' approach of treating all tenancy as if it was a fixed rent cash tenancy. In reality, there are diverse tenancy markets including sharecropping with various shares to input sharing with output sharing. Second, variation in land quality has important implications for the analysis of issues such as inequality. The proportion of poor-quality land is higher on large land holdings. This means measured inequality will be higher than if we adjust for quality. Third, the analytic separation of land rental market from land sales market done by the authors poses the problem that the two markets are connected. The implicit value of a piece of land an individual wants to sell is closely related to the net present value of rent he or she can earn through renting it out. Fourth, in practice, land rental market is much thicker than land sales market. It is unlikely that land sales market is competitive to the same degree as land rental market. Finally, there is the issue of titles versus deed that did not get discussed. Since deed—and not title—is all the seller of land has, treatment of land sale as if it was like any other asset with properly defined ownership is misleading.

Devesh Kapur questioned the proposition by Pranab Bardhan that the government had to be necessarily involved in land acquisition to protect the rights of the farmer. He cited an example from Jharkhand whereby logging in forests was forbidden on the assumption that this would be to the benefit of contractors and detriment of tribal people. In reality, large-scale illegal logging took place with state functionaries pocketing a good part of the profit. But then logging was made legal and it turned out that logging rate went down and tribal people made good money as well. Kapur asked how much more evidence was needed before we would be convinced that the state intervention at every stage is not the solution for the protection of the poor and vulnerable. It is one thing to argue that people should have the option of either selling through the state if they so desire but quite another to insist on the monopoly by the state when we have overwhelming evidence that in reality implementation by the state invariably enriches functionaries of the state.

Anjini Kochar raised a number of questions with respect to estimation method and variables used in regressions. First, she hypothesized that what the authors called ability was actually land quality. The residual in the production function is likely to represent land quality. Second, the authors appear to be measuring the impact of differences in legislation as the

state-specific effect. If so, this is likely to contain not just legislative but all state-specific effects. Finally, while the paper makes much of credit constraints, in the empirical work, credit constraints are not taken into account.

Kirit Parikh referred to a 2002 article on land title by Wadhwa and stated that all land titles in India are presumptive. Wadhwa had looked at the issue in the 1980s and suggested a path to issuing titles but government after government has refused to follow up. This statement led Rajnish Mehra to ask how land ownership was enforced in the absence of any guarantee by the government. Arvind Panagariya responded that the enforcement was through the courts. An individual has the ownership right until someone challenges that right in a court of law. And when that happens, the court decides who the true owner is.

Parmod Kumar from NCAER commented that he had studied data from northern and eastern India and found that in prosperous states, small farmers were leasing their land to large farmers (the phenomenon of "reverse tenancy") while in poorer states the opposite was the dominant practice. Since the data set Deininger and Nagarajan use has data for two separate years that are very far apart, they may find a switch from conventional tenancy (by large farmers to small farmers and the landless) to reverse tenancy. A second evolving phenomenon is that over time, agricultural development has led to the replacement of share cropping by fixed-rent tenancy. This phenomenon may also be captured in the data the authors have employed.

Hari Nagarajan responded to several of the questions raised. He questioned Bardhan on the importance of land tenure security on the ground that all available evidence has been drawn from West Bengal and the provision of tenure security took place under peculiar political atmosphere that is non-comparable across rest of the country. Regarding legislative differences across states, the variable used is the number of legislations in the state as the proxy for seriousness of land reform. Addressing one of the questions raised by Srinivasan, Nagarajan said there was no obvious way to treat sales and rental markets for land as interconnected markets. Addressing some other questions, he noted that reverse tenancy was marginal in their data; the paper cannot do very much about land quality because data on it are not available; and, likewise, the paper cannot deal with the issue of how land should be acquired.

Klaus Deininger added to the responses provided by Nagarajan. He noted that their regressions control for land value, which must partially capture land quality. He said the regressions include regional dummies, which means the measure of policy restrictions is at the state rather than village or household level. On land acquisition, Deininger expressed fear that India may be making

a mistake of adopting the Chinese model whereby the government acquires land and then passes it on to private entrepreneurs. Establishing government monopoly over land acquisition is something India might want to avoid. Finally, on land title issue, Deininger said that the revenue record in rural areas was essentially equivalent to title even if it is not called that. Banks do accept registration records as collateral for short-term borrowing though not for long-term borrowing. Computerization of records can help further since the government is not just recording current occupancy but also all encumbrances levied in the preceding 20 years. This will further pave the way for the banks to accept land as collateral.

Pranab Bardhan repeated his belief in the importance of security of tenure citing various works. He agreed that all this work related to the experience in West Bengal but added that international evidence pointed in the same direction. Bardhan also reiterated his conviction that the government needed to be an active participant in land acquisition though this conviction did not derive from a faith in the efficacy of bureaucratic functionaries. If bureaucratic functionaries have been responsible for the horrors described by Devesh Kapur, leaving matters to the market have also led to horrors. Bardhan concluded by noting that in his view, bureaucratic functionaries and private market were not the only two alternatives. Local panchayat governments and independent commissions consisting of NGOs, agents of real estate developer, and local groups could also play a role.

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