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INDIA
POLICY FORUM
2006|07

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PURPOSE

India Policy Forum 2006–07 comprises papers and highlights of the discussions from the third India Policy Forum (IPF) conference, held on July 31–August 1, 2006, 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 continuing generous support of Tata Sons, State Bank of India, Citigroup and HDFC 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.

CORRESPONDENCE

Correspondence regarding papers in this issue should be addressed to the authors. Manuscripts are not accepted for review because this journal is devoted exclusively to invited contributions. Feedback on the journal may be sent to NCAER, Parisila Bhawan, 11, I.P. Estate, New Delhi 110 002 or at ipf@ncaer.org.

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Editors' Summary

This is the third volume of the *India Policy Forum*. The journal is jointly promoted by the National Council for Applied Economic Research (NCAER) in New Delhi and the Brookings Institution in Washington, D.C., with the objective of presenting high-quality empirical research on the major economic policy issues that confront contemporary India. The forum is supported by a distinguished advisory panel and a group of active researchers who participate in the review and discussion process and offer suggestions to the editors and the authors. Our objective is to make the policy discussion accessible to a broad nonspecialist audience inside and outside India. We also hope that it will assist in the development of a global network of scholars interested in India's economic transformation.

The five individual papers included in this volume were selected by the editors and presented at a conference in Delhi on July 31 and August 1, 2006. In addition to the working sessions, Pranab Bardhan, a member of the advisory panel, gave a public address on the topic of "Governance Matters in Economic Reform." The papers cover a diverse set of macro and micro-economic topics of relevance to policymakers. The first two papers focus on India's economic growth performance over the past quarter century and the impact of trade liberalization on the distribution of income and poverty. The third paper highlights the distressingly poor performance of India's elementary schools. The fourth paper examines the role of economic factors on the decline of the Indian birth rate. The last paper explores the link between economic growth and environmental change by assessing the interaction between local living standards and forest degradation in the Indian mid-Himalayas.

During the first three decades of its development, the Indian economy grew at the so-called Hindu rate of growth of 3 to 4 percent. But India has now turned a corner, growing at a much higher rate of 6 to 7 percent during the last two decades. How has this transition been achieved and what implications does it have for the future transformation from a primarily rural and agricultural economy to a more modern one? These are the key questions Bosworth, Collins, and Virmani address in their paper.

Bosworth et al. observe that answering these questions requires analyses of both the evolution of productivity in the three key sectors—agriculture, industry and services—and the implications for aggregate productivity

growth of the reallocation of resources out of agriculture to more productive activities in industry and services. Consequently, they use a growth accounting framework to examine empirically the acceleration in economic growth that India has achieved over the past two decades. The analysis focuses on two dimensions in which India's experience differs from that of China and other parts of Asia. First, instead of strong growth in the manufacturing sector and in exports, India's success reflects rapid expansion of service-producing industries. Second, it has been associated with relatively modest levels of human and physical capital accumulation.

The authors construct accounts at the sectoral level, and identify the residual gains from resource reallocation across sectors. They then undertake further analysis of the role of capital accumulation—providing estimates of the returns to schooling for human capital, and reporting on trends in sectoral saving and investment in physical capital. The paper concludes with a discussion of some of the important issues for India's growth experience and prospects for the future.

Throughout the analysis, the authors focus on the quality of the available data. The updated growth accounts incorporate recent data revisions, some of which are quite large. Extensive examination of the relevant underlying data series helps to clarify a number of issues related to how the data are constructed. In particular, the discussion highlights challenges faced by the Indian statistical agencies in preparing measures of output and employment, primarily because much of the non-agricultural workforce operates outside of standard reporting programs. Thus, India's national accounts depend on quinquennial surveys (conducted in 1973, 1983, 1987, 1993, 1999, and 2004) for information on households and small enterprises. Researchers should have a reasonable degree of confidence in the GDP estimates for benchmark years that incorporate results from the surveys. However, for non-benchmark years, annual output data are based on interpolation and extrapolation of the labor input data required to construct output measures for India's large unorganized sector. The lack of reliable annual series makes it impossible to pin down the precise timing of India's growth acceleration.

A key finding of the paper is that services have shown very substantial productivity growth since the early 1980s—a result in sharp contrast to that obtained for other countries at a similar stage of development. Productivity gains in agriculture and industry have been modest, which is consistent with both the findings of prior studies of India and those for other comparable countries such as Korea and Taiwan in the 1960s and 1970s. What distinguishes the Indian case is the relatively small *output*

growth in industry: the sector has not played a major role in reallocating workers out of agriculture where they are underutilized.

Considerable attention has been focused on the role of services—especially high-tech services—as the source of India's growth. The growth accounts attribute 1.3 percentage points of the 3.8 percent per annum growth in GDP per worker during 1980–2004 to growth in total services productivity (versus 0.7 percentage points each to agriculture and industry and 1 percent to reallocation).

However, the authors argue that the frequent emphasis on business services as the driving force behind India's economic expansion may be overblown. Despite its extraordinary growth, the industry comprises only a small share of India's GDP and employment. Business services provide jobs primarily for the relatively small proportion of the workforce that is highly educated, and recent increases in the returns to higher education suggest that high-skill services industries are encountering labor shortages. Furthermore, the strong gains in service sector TFP are puzzling. One might expect this in sub-sectors such as finance and business services, but these sectors remain small—just 17 percent of total services output in 2004. In fact, the growth acceleration is quite widely dispersed across service sub-sectors and rapid productivity growth seems unlikely in the biggest, which are trade, transportation and community services. Though difficult to verify, the authors express concern that an underestimate of services price inflation, particularly in the more traditional sectors, may imply an overestimate of output growth. The available measures of employment suggest a less dramatic acceleration of overall growth and a somewhat smaller focus on services.

In any case, India's growth expansion is not creating adequate job growth for the bulk of the population that is not particularly well-educated. Thus, it is important that India broaden the base of the current expansion by promoting programs that would increase India's attractiveness as a source of manufactured goods for the world market. Growth of the manufacturing sector would also provide a strong match for the skills of India's workforce.

The paper also offers additional discussion of education and physical investment, both of which have an important bearing on growth and productivity. The accounting decomposition finds that the growth contribution from increases in education has been quite modest. The paper also examines the evolution of India's saving behavior. The authors conclude that saving is not constraining India's growth. However, there is room for increased public and foreign savings.

Pulling together the findings of their analysis, the authors draw a number of implications for India's growth in the coming decade. A key message is that India needs to broaden the base of its economic growth through the expansion of the industrial sector—especially manufacturing. In this context, China provides a useful model, in its emphasis on exports of manufactured goods as a primary driver of growth.

To accomplish this, India needs to create a more attractive economic environment for doing business—a location able to compete effectively with China. This will require strengthening its infrastructure—including a weak and unreliable power system, and poor land transportation in many states. However, India already enjoys relatively good institutions and is strong in the areas of finance and business services.

The liberalization of the international trade regime is believed to reduce poverty through its impact on both efficiency and distribution. Expansion of trade lowers the cost of goods and services consumed by the poor and freer trade should lead to an increased demand for and higher returns to unskilled labor in poor countries. However, those gains may not emerge if workers are not able to move to the sectors and areas of expanding demand. Thus, the ultimate effect of trade expansion on poverty is ambiguous and must be determined empirically.

In their paper, Hasan, Mitra, and Ural examine the impact of India's trade liberalization on poverty reduction using state and regional level data from the National Sample Survey (NSS) of households. Their measure of trade policy includes changes in both tariffs and non-tariff barriers (NTBs). They weight tariffs (and alternatively NTBs) by sectoral employment to arrive at a state-level measure of the trade exposure of the labor force, and they construct a second version that is based on a principal-components aggregation of the two policy instruments. They then allow the impact of trade policy on poverty to differ across states according to the flexibility of labor-market institutions. The classification of states with flexible and inflexible labor markets is based largely on a prior study by Besley and Burgess. To obtain a clearer picture of the effects on poverty, they also investigate the impact of another important, complementary component of economic reforms, namely product market deregulation, and look also at its interaction with labor-market institutions.

The measures of poverty are drawn from the NSS surveys of 1987–88, 1993–94, and 1999–2000, and are largely based on a methodology developed by Deaton and Drèze and their approach for adjusting the poverty estimates for a change in the design of the household survey in 1999–2000.

However, Hasan et al. also check the robustness of their results with two alternative measures: one based on the official Government of India (GOI) estimates of poverty, and a longer time series of state-level poverty rates created by Ozler, Datt, and Ravallion. Another innovation in the paper is that they allow the transmission of changes in protection rates to domestic prices to vary across states since distance and the quality of the transportation system should influence the extent of change in local prices.

Their principal finding is that states whose workers are more exposed to foreign competition tend to have lower rural, urban and overall poverty rates (and poverty gaps), and this beneficial effect of greater trade openness is more pronounced in states that have more flexible labor market institutions. Trade liberalization has led to poverty reduction to a greater degree in states that are more exposed to foreign competition by virtue of their industrial composition. The results hold, at varying strengths and significance, for overall, urban and rural poverty.

For example, controlling for state as well as time fixed effects, they conclude that the reduction in tariff rates over the 1990s was associated with a reduction in poverty rates ranging from 16 percent to 40 percent. Reductions in tariff rates also were associated with a decline of about 15 percent in urban poverty in states with flexible labor market institutions relative to other states. They find some evidence that industrial delicensing has had a more beneficial impact on poverty reduction in states with flexible labor institutions.

Hasan et al. contrast their evidence on the linkages between trade and poverty with a prior study by Petia Topalova, whose investigation utilized district-level data. Topalova concluded that trade liberalization slowed the pace of poverty reduction in rural districts, with the strength of this effect being inversely related to the flexibility of labor-market institutions. She found that the linkage between trade liberalization and poverty reduction was also negative in urban areas, but that result was not statistically significant. The authors provide some reasons for the differences. First, Topalova restricted her analysis to one measure of employment-weighted tariffs. The current paper includes NTBs and a principal-components aggregate of tariffs and NTBs. Second, there are significant differences between the two studies in the methods used to construct the overall employment-weighted indexes of average tariffs. Topalova included nontradable goods industries, which are explicitly excluded from the measures used in the current study. Third, the Topalova paper did not allow for the effects of changes in trade protection on domestic prices to vary across districts. Finally, the authors explored the robustness of their own results

by incorporating a greater variety of poverty measures and by extending the analysis to the regional level.

India's public elementary education system faces enormous problems. Although enrollments have increased, a recent survey of rural areas found shockingly low levels of learning achievement, confirming the cumulating evidence of a dysfunctional system. There are many other indicators of distress—high levels of dissatisfaction of parents and students with teachers, the massive and on-going shift into private schooling, and the unhappiness of the public sector teachers themselves.

In their paper, Pritchett and Murgai argue that the current system of teacher compensation in the public sector is at the heart of many of these problems. They argue that the system of compensation within any high performance organization should be designed to attract, retain and motivate workers who, on a day-to-day basis, pursue the goals of the organization. All four elements of a system of compensation (*durability of the employment relationship, structure of pay across states of the world, assignment of workers to tasks,* and *cash versus benefits)* should work together towards this goal.

Their paper highlights the extraordinary extent to which India's system of teacher compensation departs from this norm. While there are many variations across states, the current system can aptly be described as a combination of *high pay and zero accountability*. The paper documents four facts about the system of teacher compensation: (1) there is little or no ability to terminate the employment of teachers—for any cause; (2) the average pay of public sector teachers is very high relative to alternatives (both private teaching and other private sector jobs); (3) the degree of overpayment is *higher* for public sector teachers at the early stages of a career; and (4) the pay of public sector teachers has very little variance even potentially related to performance—much less than either private sector teachers or other private sector salaried workers.

Each of these elements of the system of compensation reinforces the lack of accountability. There is nothing in the present system to attract people well matched to teaching, to retain the best and most committed teachers, or to motivate performance of good teachers (for that matter, prevent good teachers from becoming disillusioned, cynical, and embittered and yet stay until they are 60 years old). Moreover, the institutional context of basic schooling—all the other relationships of accountability—is also weak.

Pritchett and Murgai argue that this system of compensation plays a large role in producing the current "perfect storm" in public schooling:

(a) the learning achievement of students is low, (b) absenteeism of teachers is very high, (c) the treatment by teachers of students is often abysmal, (d) parents and students are dissatisfied with government schools, and (e) families are voting with their feet and pocketbooks to move their children into private schools. Perhaps worst of all, the potentially good teachers within the public system are disenchanted, overburdened, and feel disrespected by parents and managements. The authors argue that any reform of teacher compensation needs to be *pro-teacher* in contrast with the current system which is dramatically *anti-teacher*.

In one study of schools in New Delhi, teachers in government schools were compensated at a rate seven times of that of teachers in unregistered schools, they were present less than half the time, and their students consistently scored far below those of students in the unregistered schools in all subject areas. Parents and students expressed higher levels of displeasure with teacher performance in the public schools. Even so, government teachers were dissatisfied with nearly every element of their jobs.

While accepting the common view that there is no possibility of significant reform of the compensation system under the present circumstances, Pritchett and Murgai argue that the devolution of education to Panchayati Raj Institutions (PRIs) provides a unique opportunity to restructure the system to be consistent with an accountable and performance-oriented public sector. Decentralization to PRIs, if done well, has the potential to break the political impetus behind business as usual by combining a reallocation of functions across tiers of government (states and PRIs) with allowing PRIs to develop systems of compensation that are aligned with the realities of public employment and the particularities of the practice of teaching.

Pritchett and Murgai suggest that the development of a future cadre of teachers should take place within a new system under district control. They propose a system with three phases for teachers' careers, ranging from an initial apprentice phase up to a masters level, with each stage corresponding to increased pay and prestige. Promotion from one phase to another would be based on performance reviews with input from the local school, peers, and technical reviews. The objective is to develop a professional teacher cadre at the district level, but to leave control of school administration and the actual hiring of teachers from the eligible pool with the local authorities.

Fast growth of the population has been a central concern of policy makers in the developing countries with large populations such as India and China. Reductions in fertility have been seen as an important means to achieve

rapid and sustained economic growth. And, many countries have adopted policies ranging from offering incentives for fertility reduction to outright restrictions on the size of the families. The advocates of such direct measures to reduce fertility are skeptical that economic growth alone can deliver the necessary reduction in fertility without at least a major expansion of education among women.

At one level, the controversy over the positive role of economic growth in driving down fertility would seem surprising. After all, richer, more developed economies have uniformly lower fertility rates than do poorer, less developed ones. Over time many formerly poor countries have become richer and simultaneously achieved sustained fertility declines.

But there also exist examples and patterns supporting the view that fertility responds to declining mortality and a transition in cultural perspective that need not be related to growth. For example, we have countries such as Cuba, Costa Rica, and Sri Lanka with traditionally high levels of education and health and correspondingly low levels of fertility. Likewise, China has lowered fertility through direct intervention at a relatively low level of income. There also exists evidence that the timing of a first sustained decline in fertility is not connected to a particular threshold level of economic development.

In their paper, Andrew Foster and Mark Rosenzweig employ a newly available panel data set to assess the impact of economic factors on fertility. The data set offers a representative sample of rural India over the period 1971–99, and it allows an examination of the main factors responsible for the rural fertility decline that occurred in India in the 1980s and 1990s. The authors first construct a simple dynamic model of fertility choice that incorporates the opportunity cost of time, the trade-off between investments in the human capital of children and family size (the so-called quality-quantity trade-off), and increased access to health and family planning services as determinants of fertility. The model yields testable hypotheses relating the fertility decision to its various determinants.

The authors then go on to use the data set to test the hypotheses so derived. A key feature of the data is that it links the households across different rounds of the survey. This permits the elimination of the influence of time-persistent cultural and preference differences across Indian states and households that may be correlated with economic change. When these cultural and preference differences are ignored, the empirical results lead to the conclusion that neither agricultural productivity growth nor changes in the value of time matter for fertility change. Cross-sectional variations in

fertility decisions depend only on the spatial differences in maternal education. This analysis supports the advocates of direct intervention to influence fertility decisions.

But once the authors take the cultural and preference differences into account, the results change dramatically. The corrected results show that increases in the opportunity cost of women's time, as reflected in female wages and increased investments in child schooling, explain the lion's share of the fertility decline. The results leave very little role for parental schooling, male or female.

The results show that the areas of high agricultural productivity growth not only experience declines in fertility but also increases in the schooling of children and in the time devoted by married women to non-household work. The quantitative estimates suggest that aggregate wage changes, dominated by increases in the value of female wages, explain 15 percent of the decline in fertility over the 1982–99 period. In combination, changes in agricultural productivity and agricultural wage rates explain fully 61 percent of the fertility decline. Health centers are found to have had a significant effect on fertility as well, but the aggregate increases in the diffusion of health centers in villages only explains 3.4 percent of the fall because during the period there was little change in the distribution of such centers. The results thus suggest that the process of economic growth has had a major impact on fertility in India over the last two decades. The authors conclude that given sustained economic growth that continues to raise wages and increase returns to human capital, the fall in fertility in India will continue for the foreseeable future.

Given their enormous populations, the rapid, sustained growth of India and China has heightened concerns on the environmental consequences of such growth. Yet there is no accepted professional consensus on the nature and intensity of these links. For some economists, growth is seen as continuing to raise the demand for the earth's energy resources. For others poverty is seen as the root cause, implying that growth is itself at least part of the solution. The so-called 'environmental Kuznets curve' hypothesis represents an intermediate view: economic development may initially aggravate environmental problems, but beyond a threshold of economic development environmental conditions improve. Yet another viewpoint stresses the importance of local institutions such as monitoring systems and community property rights. Particularly where deforestation is concerned it is argued that assigning local communities effective control of forest resources would substantially reduce environmental pressures, leaving little need for external policy interventions.

Despite these different perspectives, there is remarkably little systematic micro-empirical evidence on their relative validity. Efforts to test these hypotheses have been cast mainly on the basis of macro cross-country regressions, with only a few recent efforts to use micro evidence concerning behavior of households and local institutions governing use of environmental resources. The paper by Baland and others attempts to fill this gap through a careful analysis of the determinants of firewood and fodder collection, the chief causes of forest degradation in the mid-Himalayan region of India. The study seeks to predict the deforestation implications of future growth in the region, assess the likely impact on future livelihoods of local residents, and evaluate some specific policies to arrest forest degradation.

The analysis is based on a stratified random sample of 3,291 households in 165 mid-Himalayan villages in the Indian states of Uttaranchal (recently renamed Uttarakhand) and Himachal Pradesh, complemented by detailed measurement of forest conditions in surrounding areas used for collection of firewood and for livestock grazing. Prior accounts of the state of these forests suggest significant externality problems at both local and transnational levels. The local externality problem arises from the dependence of the livelihood of local inhabitants on neighbouring forests. The forests are important for the collection of firewood (the principal source of household energy), fodder for livestock rearing, leaf-litter for generation of organic manure, timber for house construction, and collection of herbs and vegetables. Sustainability of the Himalayan forest stock also has significant implications for the overall ecological balance of the South Asian region. The Himalayan range is amongst the most unstable of the world's mountains and therefore inherently susceptible to natural calamities. There is evidence that deforestation aggravates the ravaging effects of regular earthquakes, and induces more landslides and floods. This affects the Ganges and Brahmaputra river basins, contributing to siltation and floods as far away as Bangladesh.

On the basis of contemporary recall the paper finds considerable evidence of forest degradation (though not deforestation) over the last quarter century in forest areas accessed by villagers. Such degradation is evident in the presence of over-lopped trees and low rates of forest regeneration, and a 60 percent increase in the average time needed to collect a bundle of firewood—approximately six additional hours per week per household. Against this background, the first part of the paper assesses the likely impact of growth in **household incomes and assets** on firewood collection. Such growth both gives rise to wealth effects (which raise collections by increasing household energy demand) and substitution effects (which lower

collections by raising the value of time of households; almost all firewood is directly collected by consuming households with negligible amounts purchased in markets). The econometric analysis shows that the substitution and wealth effects offset each other, so that firewood and fodder collection is inelastic with respect to improvements in living standards. The paper finds no evidence for any effects of poverty or growth on forest pressure, nor any Kuznets-curve patterns.

In contrast, the effects of growth in **population** are likely to be adverse: rising population will cause a proportional rise in collections at the level of the village, while leaving per capita collections almost unchanged. To the extent that household fragmentation induces a shift to smaller household sizes, the resulting loss of economies of scale within households will raise per capita collections even further. Hence anthropogenic pressures on forests are likely to be aggravated by demographic changes, rather than economic growth. Unless there is substantial migration out of the Himalayan villages, the pressure on forests is likely to continue to grow in the future.

The paper next estimates the effect of such further projected forest degradation on the future livelihoods of affected villagers, mainly via a further increase in collection times for firewood. This is done by estimating the effects of increased collection times by one hour, which is a plausible estimate for the next decade or two. The welfare impact of this externality turns out to be surprisingly low: the effect is less than 1 percent loss in household income across the entire spectrum of households. Moreover, there are no significant effects on child labor, nor on the total labor hours worked by adults. This indicates that the magnitude of the local externality involved in use of the forests is negligible, providing a possible explanation for lack of effort among local communities to conserve neighboring forests. The argument for external policy interventions then rests on the larger ecological effects of forest degradation, which are beyond the scope of the paper.

Should the ecological effects demand corrective action, the paper surveys the available policy options. The authors find that the principal fuel alternative to firewood, somewhat surprisingly, is LPG (liquefied petroleum gas); kerosene and electricity are still secondary (despite the region's enormous abundance of hydropower reserves). Household firewood use exhibited considerable substitution with respect to the price and accessibility of LPG cylinders, suggesting the scope for LPG subsidies as a policy which could be used to induce households to reduce their dependence on forests for firewood. The authors estimate the effectiveness and cost of a Rs 100 and a Rs 200 subsidy for each gas cylinder. The latter is expected to induce a rise in households using LPG from 7 percent to 78 percent, reduce

firewood use by 44 percent, and cost Rs 120,000 per village annually (about 4 percent of annual consumption expenditure). A Rs 100 subsidy per cylinder would be half as effective in reducing wood consumption, but would have a substantially lower fiscal cost (Rs 17,000 per village annually, approximately 0.5 percent of annual consumption).

The econometric estimates also show that firewood use was moderated when local forests were managed by the local community (*van panchayat*s) in Uttaranchal. However, this effect is limited to those community-managed forests that were judged by local villagers to be moderately or fairly effectively administered, which constituted only half of all (*van panchayat*) forests. It is not clear how the government can induce local communities to take the initiative to organize themselves to manage the neighboring forests effectively, when they have not done so in the past. Moreover, the authors conclude that, even if all state-protected forests could be converted to van panchayat forests, firewood use would fall by only 20 percent, which is comparable to the effect of a Rs 100 subsidy per LPG cylinder.

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Sources of Growth in the Indian Economy

Optimism about the potential for India's economic growth has grown steadily in recent years. In part, this is fueled by China's example of strong sustained growth, raising the obvious question of why India cannot do as well. However, the optimism also reflects the fact that India's growth has accelerated over the past two decades. And while still well below the growth rate in China, this favorable performance contrasts with growth slowdowns in other regions. It has also enabled the emergence of a significant middle class in India. Interestingly, India's economic performance has differed from that of China and other parts of Asia in at least two dimensions. First, India's success has not been based on strong growth in the manufacturing sector and in exports. Instead, it has reflected very rapid expansion of the service-producing industries. Second, it has been associated with relatively modest levels of investment. Even incorporating recent data revisions, India's physical capital accumulation has not been impressive. And despite substantial increases in the number of Indians attaining higher education, illiteracy rates remain high.

In this paper, we build on a growth accounting framework to empirically examine these dimensions of India's recent growth. How has the growth been distributed among agriculture, industry, and the service-producing sectors? What are the major contributors to that growth: increased employment, physical capital, educational attainment, or improvements in the basic efficiency of resource use (total factor productivity)? We are particularly interested in the sources of growth in the service-producing industries. Is it sustainable or should India place greater emphasis on the manufacturing sector and the promotion of rapid growth in export markets? Throughout the analysis, we are concerned about the quality of the available statistical data.

We seek to contribute to the existing literature in a variety of ways. The growth accounting framework, combined with our emphasis on data issues, pulls together concerns that have typically been treated separately, and that do not appear to have been consistently recognized. Our updated growth accounts are based on extensive examination of the relevant underlying data series, enabling us to clarify a number of issues related to how the data are constructed. The updated accounts incorporate recent data revisions, some of which are quite large. They also provide new estimates for the contributions to overall growth from changes in labor productivity within major economic sectors versus the gains from reallocating labor and capital among the sectors. Furthermore, we have examined a variety of additional data in our analysis of the role of capital accumulation—providing estimates of the returns to schooling for human capital, and reporting on trends in sectoral saving and investment in physical capital.

The existing literature on productivity in India focuses either on the performance of the aggregate economy or manufacturing, the latter at the industry or firm level. But understanding India's evolving transformation from a primarily rural and agricultural economy to a more modern one requires analysis of both the evolution of productivity in all three key sectors—agriculture, industry and services—and the implications for aggregate productivity growth of the reallocation of resources out of agriculture to more productive activities in industry and services. This is particularly essential for India where, in contrast with the typical pattern in East Asia (including China), the primary driver for growth has been services, not industry.

Our paper fills this important gap by separating aggregate productivity growth into growth for each of the major sectors of the economy and by providing an estimate of the growth effects of factor reallocation among sectors. A key finding of the paper is that services have shown very substantial productivity growth since the early 1980s—a result in sharp contrast to that obtained for other countries at a similar stage of development. Productivity gains in agriculture and industry have been modest, which is consistent with both the findings of prior studies of India and those for other comparable countries such as Korea and Taiwan in the 1960s and 1970s. What distinguishes the Indian case is the relatively small *output* growth in industry. As a result, the sector has not played a major role in reallocating workers out of agriculture where they are underutilized.

We argue that the emphasis on business services as the driving force behind the expansion of the Indian economy is frequently overstated. Despite its extraordinary growth, the industry comprises only a small share of India's GDP and overall employment. In addition, business services

provide jobs primarily for the relatively small proportion of the workforce that is highly educated. We find some evidence that the current emphasis on high-skill services is already encountering some shortages—a bidding up of the relative wage rate for secondary and university-level graduates. Furthermore, high rates of total factor productivity (TFP) growth in the overall services sector, which includes such industries as trade, transportation and education where we would not expect to observe rapid TFP growth, raise concerns that growth of the sector may be overstated in the statistics.

In any case, India's growth expansion is not creating adequate job growth for the bulk of the population that is not particularly well-educated. Thus, it is important that India broaden the base of the current expansion by promoting programs that would increase India's attractiveness as a source of manufactured goods for the world market. The growth of the manufacturing sector would provide a strong match for the skills of the Indian workforce.

The paper also offers a discussion of two additional subjects that have an important bearing on growth and productivity: education and physical investment. On the former, we provide an empirical analysis of the returns to different levels of schooling in India. While we do find a high average return, our results suggest that returns are relatively low at the elementary levels. This is surprising compared to the results for other developing countries, and a cause for concern, given the large share of the population with little education. As we illustrate, the Indian workforce is not particularly well-educated. Illiteracy rates are high by international standards, even among the young, and we find evidence of shortages among the group of highly-educated workers (university graduates) who have done so well in recent years. India also faces significant challenges in the quality of the educational system. Thus, India needs to expand the supply of well-educated workers at the same time that it increases the demand for workers with more modest skills.

On savings and investment, we assess the quality of various estimates offered by the Central Statistical Organization (CSO) and argue that the overall rate of saving has expanded substantially in recent years. Furthermore, we conclude that the supply of private saving in India is adequate to support a significantly higher rate of growth in future years. From the perspective of physical capital formation, the problems are more concentrated in the extreme dissaving of the public sector and the apparent weakness of investment incentives on the demand side.

There is already an extensive empirical literature—often using growth accounts—that examine India's past economic growth. Many of the studies address one or more of the following topics. First, a number of analysts

have focused on characterizing India's economic performance at the most aggregate level. While there is concurrence on the fact that the growth improved during the past quarter century, researchers have reached varying conclusions on some issues such as the timing and precise magnitude of this acceleration, and the relative importance of changes in domestic policy. For example, Virmani (1997), Rodrik and Subramanian (2005) and Kohli (2006a and b) point out that growth initially accelerated during the 1980s, predating the reforms that followed the crisis of the early 1990s. Within this context, Rodrik-Subramanian and Kohli both stress the role of what they term "pro-business" reforms that began in the early 1980s. In contrast, Srinivasan (2003b) and Panagariya (2004) argue that India's growth did accelerate prior to the more substantial liberalizations in the 1990s, but that this was concentrated in 1988–91 following some initial liberalizations and furthermore, that it was driven by unsustainable increases in public expenditures and excessive foreign borrowing, thus culminating in the balance of payments crisis of 1991. There are on-going discussions over the extent to which the current growth can be maintained and various means by which it might be increased.

Second, analysts have examined the behavior of particular sectors. A number of authors have studied productivity in manufacturing—reaching a wide range of conflicting conclusions. However, as explained in detail by Goldar and Mitra (2002), differences in the findings can be largely attributed to a variety of measurement issues, such as the use of single versus double deflation to construct estimates of real growth in manufacturing value added. Goldar (2004) provides a careful recent update showing that TFP growth in manufacturing appears to have slowed in the post reform period; raising additional puzzles discussed below.[1] However, due to difficulties in measuring employment within individual industries, our analysis focuses primarily on the broader industrial sector. Additional studies that focus on the performance of agriculture and India's services sector are discussed in later sections of this paper.

Thus, this paper is comprised of four remaining sections. The next section details the construction of growth accounts for India, with considerable attention paid to the quality of the underlying data. The section following it presents and discusses the results. Section three examines a range of issues related to the role of capital accumulation in India's growth experience. It focuses first on human capital and then turns to an analysis of investment

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1. Goldar and Mitra (2002) and Goldar (2004) provide extensive references to the prior research on manufacturing.

and saving behavior in India. Drawing from the preceding analyses, the final section discusses implications for Indian economic growth, going forward.

Construction of the Growth Accounts

Although empirical research on productivity growth has used a variety of methodologies, most of the analysis has evolved along two primary paths: growth accounting or direct econometric estimation. Both are based on the underlying concept of an aggregate production function. Growth accounting combines the production function with the assumption of competitive markets, leading to the use of income shares to measure the contribution of factor inputs. This method focuses on identifying contributions of individual factor inputs and a residual, typically called total factor productivity (TFP). In contrast, the econometric approach focuses on exploring alternative functional forms for the production function, and does not rely on any assumption that markets are competitive.

Most empirical studies have tended to emphasize what might be labeled the *proximate causes* of growth: measuring the quantity and quality of capital and labor inputs, and viewing the TFP residual as representing a combination of changes in efficiency and the production technology. More recently, some researchers have sought to go beyond proximate causes, so as to associate the fundamental sources of long-term differences in living standards with underlying differences in institutional and legal arrangements and geography. In these studies, TFP is perceived as the driving force behind growth. Accumulation of both physical capital and labor skills is taken to be largely endogenous—and ultimately induced by changes in TFP. From this perspective, developing a theory of TFP is a central objective.[2]

Basic Growth Accounting Framework

Building from the seminal work by Solow (1957), modern productivity analysis begins with the concept of an aggregate production function. As shown in equation (1), this relates output (Q) to contributions of factor inputs, capital (K) and labor (L), as well as a Hicks-neutral shift in the production function (A):

(1) $$Q_t = A_t F(K_t, L_t)$$

2. Examples of this literature are provided by Klenow and Rodriguez-Clare (1997) and Easterly and Levine (2001).

The next step is to combine the notion of a production function with the assumption of competitive markets in which factors are paid their marginal products. It is then straight-forward to derive a simple index number formulation relating growth in output to increases in factor inputs and a residual shift term, identified with TFP:

(2) $$d \ln Q = s_k d \ln (K) + s_l d \ln(L) + d \ln TFP,$$

where s_k and s_l are the shares of capital and labor income, respectively.[3]

As discussed more fully below, it is often difficult to obtain meaningful time series estimates of factor income shares. Thus, many studies adopt the more restricted Cobb-Douglas production function, which assumes the contribution of each factor to be constant:

(3) $$Q_t = A \left(K_t^{\alpha} L_t^{1-\alpha} \right)^{\gamma}.$$

Again, A represents TFP and γ measures the extent of returns to scale. In this restricted formulation, the s_k and s_l of equation (2) are replaced with constants. Many studies have also simply assumed returns to scale of unity. In the absence of an explicit allowance, returns to scale are subsumed within an overall residual of TFP. That is the approach used in this study.

It has become standard to adjust the factor inputs, particularly labor, to reflect changes in quality. Most of this research follows one of two common approaches. The first seeks to cross-classify the workforce by a number of differentiating characteristics, such as education, age, occupation and gender. Information on these characteristics is combined with data on wage rates, so to compute each subgroup's share of total compensation, v_i. An adjusted measure of the labor input is then computed as

(4) $$d \ln L^* = \sum_i v_i d \ln L_i.$$

However, this process is very data intensive. In addition, some analysts object that observed wage differentials may reflect factors other than productivity differences, such as gender or age discrimination.

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3. The use of income share weights is critical, because this makes it possible to avoid imposing restrictions on the possible functional forms of the production function. In empirical applications, the factor shares are replaced by average between period shares in a Tornqvist discrete time approximation. Thus s_k is replaced by $(s_{kt} + s_{kt-1})/2$. A summary of this literature is provided in Hulten (2001). OECD (2001) provides a detailed manual, elaborating on the major issues.

The alternative, which we follow here, is to adjust for skill differences using a simple index of educational attainment. For example, an index of the form:

$$(5) \qquad\qquad L^* = e^{as} L$$

assumes that each year of schooling, *s*, raises the average worker's productivity by a constant percentage, *a*. This formulation parallels the vast number of empirical studies that use "Mincer regressions" to measure the relationship between wages and years of schooling. Such studies have been carried out for different time periods and for a large number of countries around the world, typically finding a return to each additional year of education in the range of 7 to 12 percent.[4]

Finally, we would also like to adjust the measure of the capital input for variations in the flow of capital services associated with capital of different service lives. The rapid pace of innovation and economic obsolescence of high-tech capital makes this an issue of growing importance. Unfortunately, few countries have sufficiently detailed information to make these types of compositional adjustments to their capital inputs measure—and India is no exception. The data constraints are particularly acute at the level of individual industries. Instead, an estimate of the capital stock is commonly used as an index of the growth in capital services.[5]

Using this framework, we estimate a set of growth accounts over the period 1960–61 to 2004–05, for the total economy and the three major sectors—agriculture, industry and services—as well as for manufacturing.[6] We have excluded residential housing from services and the total economy because income from housing is based solely on imputations, and is all assigned to capital income. As described more fully below, the output and capital stock data are from the national accounts. These reflect the significant revisions associated with the adoption of the new 1999–2000 base. Estimates of employment are based on results from the quinquennial household surveys.

4. References to many of these international studies are available in Psacharopoulos and Patrinos (2004). We will discuss several specific studies of India in a later section.

5. The essential difference between the two is that the capital stock aggregate is constructed using purchase prices as the relevant weights, while the capital services aggregate would be constructed using rental prices as weights.

6. We follow the grouping traditionally used by the UN and other international organizations. Indian statistical agencies use the same grouping, but refer to them as the primary, secondary and tertiary sectors. The agricultural sector includes forestry and fishing. Industry is comprised of mining, manufacturing, construction and utilities. The services sector covers the remainder of the economy.

Data Sources

The Indian statistical agencies face substantial challenges in preparing measures of output and employment at both the aggregate and sector levels. The difficulties arise primarily because a large portion of the nonagricultural workforce operates outside of standard reporting programs. Furthermore, India's national accounts are highly dependent on a series of quinquennial surveys for information on households and small enterprises. Therefore, annual estimates of output and employment (as well as estimates at higher frequencies), are largely based on simple interpolations and extrapolations of underlying source data. We have relied heavily on the comprehensive analysis of Sivasubramonian (2004) for the development of the requisite data at the level of the total economy. We have extended his analysis by incorporating recent revisions of the national accounts and by developing comparable growth accounts for the major sub-sectors of the Indian economy (agriculture, industry, manufacturing, and services). We have also incorporated an alternative methodology, explained above, to estimate the contribution of improvements in the educational attainment of the workforce.

In the remainder of this section, we discuss the data used to construct growth accounts for India. Output measures are considered first, followed by each of the factor inputs and, finally, measures of factor shares. Along the way, we summarize key data concerns and their implications.

OUTPUT. India has a reasonably good statistical system for measuring output of the agricultural sector and output of non-agricultural enterprises that participate in government reporting programs, and are classified as part of the organized sector.[7] For example, this includes factories registered under the 1948 Factories Act, as well as large portions of mining, utilities, communications and finance. For these enterprises, it is possible to construct estimates of value added for national accounts, using either the production approach or the income approach. Furthermore, original source data are often available annually.

However, most workers are not included within the organized or formal sector of the economy. This point is clearly illustrated in table 1, which provides data for 1999–2000. Its first three columns show the distribution of

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7. A recent review of the Indian statistical system is provided in the 2001 Report of the National Statistical Commission, available at: http://mospi.nic.in/nscr/mp.htm. The commission identified some significant areas of deterioration in the quality of the agricultural and industry statistics, and it highlighted the dearth of information about service-producing industries.

TABLE 1. Measures of the Organized and Unorganized Sectors by Industry, 1999–2000

Percent

Industry	Distribution of GDP by sector	Percent of sector GDP		Percent of sector employment	
		Organized	Unorganized	Organized	Unorganized
Agriculture, forestry and fishering	25.3	3.1	—		99.1
Agriculture	23.2	3.2	—		99.2
Forestry and logging	1.1	5.6	—		98.3
Fishing	1.1	0.1	—		98.5
Industry	**25.4**	**62.5**	**37.5**		..
Mining and Quarrying	2.3	91.6	8.4		90.7
Manufacturing	14.7	60.8	39.2		97.9
Electricity, gas and water supply	2.5	93.8	6.2		90.1
Construction[1]	5.9	41.8	58.2		85.8
Services	**49.2**	**51.3**	**48.7**		..
Trade	12.9	18.1	81.9		84.7
Hotel and restaurants	1.2	41.2	58.8		90.7
Transport and storage	5.8	35.2	64.8		79.3
Communication	1.6	91.4	8.6		92.8
Banking and insurance	5.9	90.5	9.5		88.7
Real estate, ownership of dwellings and business services	7.1	18.6	81.4		89.9
Public admininistration and defence	6.7	100.0	0.0		0.4
Other services	8.1	69.5	30.5		87.4
Non-agricultural sector	**74.7**	**56.0**	**44.0**		**88.3**
Total[2]	**100.0**	**42.0**	**32.4**		**95.6**

Source: Saha, Kar and Baskaran (2004) and Government of India, Central Statistical Office (2006, February).
Notes: 1. Unorganized employment in construction includes casual laborers in the organized sector.
2. Classification of organized versus unorganized is not applied to agricultural sector and household employment.

GDP by major industry, as well as the share of output in each industry produced in the organized versus the unorganized sectors.[8] The final column shows the percent of employment that is unorganized in each sector.[9] Within the nonagricultural economy, for example, 44 percent of the GDP was in the unorganized sector, while it accounted for 88 percent of total employment.

For the unorganized sector, Indian measures of GDP are constructed using the labor input method. Thus, estimates of labor input at the industry level are combined with measures of value added per worker (VAPW) from a variety of enterprise surveys. Labor input in the unorganized sector is estimated as the residual difference between measures of total labor input and labor input in the organized sector. The latter is obtained from employer reports, while the total labor input measure is constructed from the quinquennial household survey. In this context, it is important to note that labor input is defined in terms of the number of jobs, not the number of workers. Since the objective is to obtain an employment measure equivalent to the one that employers would report (inclusive of multiple job holding), the number of workers reporting a principal employment activity over the prior year is added to the number of workers reporting a subsidiary employment activity. Each worker could be recorded as having up to two jobs. No adjustment is made for full versus part-time work for either primary or secondary jobs.[10]

The techniques described above should generate reasonably good estimates of output in the benchmark years for which survey data are available. However, India has no consistent source of information about employment in the unorganized sector for the years between the quinquennial surveys.

8. The unorganized sector is a bit broader than the related concept of the informal sector. For further discussion of the classification issues in the Indian context see Saha, Kar, and Baskaran (2004) and Kolli and Hazra (2005).

9. Note that the percent of employment in a particular industry that is unorganized may differ from the share of labor input to the unorganized sector. For example, labor inputs in the organized sector may include casual workers, who would be classified as "unorganized employment".

10. The methods used to compute the labor input have varied significantly over time, further restricting the comparability of the estimates of industry value added. The 1950, 1970, and 1980 benchmarks used census estimates, whereas the 1993–94 and 1999–2000 benchmarks used data from the quinquennial employment and unemployment surveys. The 1970 through 1990 census are known to have encountered severe problems in measuring the workforce (Visaria, 2002). Also the 1999–2000 benchmark adjusted for multiple jobs at the level of individual industries, whereas the 1993–94 estimates relied on common ratios from aggregate data. Additional details are available in CSO (2004).

Annual information on value added per worker is equally limited, since the value-added data are also updated on an approximate 5-year cycle. Therefore, detailed calculations of output using the labor input method can only be undertaken for benchmark years. Estimates of value added for the years between benchmarks are obtained by interpolation. Estimates for years since the most recent benchmark are obtained by extrapolating the labor inputs, based on growth between the two most recent benchmarks.

Table 2 provides a stark illustration of the problems created by the lack of underlying annual survey data for the unorganized portions of the economy. The first column shows the sector composition of GDP, using the 1993–94 benchmark revision. The next two columns show two estimates of 1993–94 GDP—one using the 1980–81 benchmark and the other from the revised data. Column 4 shows the percentage difference between the two. The revisions to 1993–94 GDP were substantial, raising the estimate of total GDP by fully 9 percent. In part, the sizable revisions that accompanied the shift to the 1993–94 base reflect the fact that it had been so many years since the introduction of the 1980–81 base. But it is important to point out that the revisions are quite small for those industries that are largely in the organized sector and for which annual sources of information are available. In contrast, the necessity of relying on the labor input methodology and past rates of change to extrapolate output resulted in particularly large output revisions in the service-producing industries (15 percent, on average). Output for the category that includes business services was revised upwards by 103 percent. The lack of good output data for the service industry is a problem in all countries. It is of particular importance for India because of the prominent role that services are expected to play in the country's future growth.

The second panel provides parallel information for the 1999–2000 base revision, comparing the estimate of 1999–2000 GDP using the 1993–94 benchmark, with that from the 1999–2000 benchmark.[11] The percentage revisions, shown in column 8, are much smaller than those associated with the 1993–94 revision—both because fewer years had elapsed and there had been fewer methodological changes. In addition, India adopted many elements of the 1993 Standard National Accounts, which contributed to some of the upward revisions of GDP. The revisions for agriculture and industry were minor, but output of the service-producing industries was increased

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11. Prior to the introduction of the 1993–94 base, GDP data were rebased to the decennial census with the last benchmark being 1980. The Central Statistical Office (CSO) has now shifted to a procedure that ties benchmark revisions to the quinquennial household surveys.

T A B L E 2 . National Accounts Revisions, Benchmark Years, 1993–94 and 1999–2000
Billions of rupees

Sector	1993–94 GDP by sector				1999–2000 GDP by sector			
	Share of total (1)	1980–81 series (2)	1993–94 series (3)	Percent change (4)	Share of total (5)	1993–94 series (6)	1999–2000 series (7)	Percent change (8)
Agriculture, forestry and fishing	**30.3**	**2,237**	**2,424**	**8.4**	**25.3**	**4,620**	**4,541**	**-1.7**
Agriculture	27.9	2,063	2,231	8.2	23.2	4,224	4,153	-1.7
Forestry and logging	1.3	98	102	3.9	1.1	196	195	-0.4
Fishing	1.1	75	91	20.2	1.1	200	192	-3.9
Industry	**25.8**	**2,040**	**2,058**	**0.9**	**25.4**	**4,556**	**4,556**	**0.0**
Mining and quarrying	2.5	168	197	17.1	2.3	413	416	0.7
Manufacturing	15.9	1,276	1,267	-0.7	14.7	2,667	2,641	-1.0
Rregistered	10.4	812	831	2.3	9.7	1,708	1,730	1.3
Unregistered	5.5	464	436	-6.0	5.1	959	911	-5.0
Electricity, gas and water supply	2.4	189	190	0.5	2.5	423	447	5.8
Construction	5.1	407	404	-0.7	5.9	1,053	1,051	-0.1
Services	**43.9**	**3,051**	**3,508**	**15.0**	**49.2**	**8,443**	**8,826**	**4.5**
Trade, hotels and restaurants	13.9	980	1,110	13.2	14.2	2,460	2,541	3.3
Trade	13.2	922	1,056	14.6	12.9	2,290	2,319	1.3
Hotel and restaurants	0.7	59	54	-7.5	1.2	170	223	30.7

Transport, storage and communication	7.3	561	580	3.4	1,243	1,318	6.0
Railways	1.2	96	96	0.0	156	195	24.8
Transport by other means	4.8	371	383	3.4	819	824	0.6
Storage	0.1	6	6	6.9	13	14	13.1
Communication	1.2	88	94	6.9	256	284	11.3
Finance, insurance, real estate and business services	11.2	671	896	33.4	2,206	2,328	5.5
Banking and insurance	5.2	436	417	−4.4	1,191	1,057	−11.3
Real estate and business services	6.0	236	479	103.3	1,015	1,271	25.2
Community, social and personal services	11.5	839	923	10.0	2,534	2,640	4.2
Public administration and defence	5.4	400	431	7.9	1,167	1,197	2.6
Other services	6.2	439	492	12.0	1,367	1,443	5.6
Total GDP at factor cost	**100.0**	**7,329**	**7,991**	**9.0**	**17,618**	**17,923**	**1.7**

Source: Central Statistical Organisation (2004, p.8), Central Statistical Organisation (2006, February, p.11), and authors' estimates.

by 4.5 percent, adding almost a percentage point to the annual growth rate. And once again, the revisions were quite large in some sub-sectors, such as the category that includes business services.

The problems with annual output estimates in non-benchmark years suggest that debates over the precise timing of changes in India's rate of GDP growth around episodes of economic reform should not be taken very seriously. Annual changes, based on extrapolations from the last benchmark, may be misleading. In contrast, the benchmark estimates themselves are constructed with considerable detail and a strong anchor in the quinquennial surveys. This provides a reasonable degree of confidence for focusing on those selected years to study India's economic performance.

In the past, the CSO has provided revised historical estimates of GDP and its components that are consistent with the latest benchmark. However, similar data have not yet been published following the introduction of the new 1999–2000 base. In the absence of published data, we have assumed that the 1999–2000 percentage revision reflected a drift in the annual estimates, and we distributed this discrepancy back to 1993–94 in a linear fashion. We continue to measure output in 1993–94 prices. The output data of 1993–94 and earlier years are assumed to be unchanged.[12]

CAPITAL STOCK ESTIMATES. Estimates of the capital stock by industry are available back to 1950. However, these are dependent on the underlying measures of investment by industry, and there is little direct information on capital service lives. The CSO compiles two separate estimates of capital investment. First, aggregate investment by asset type is based largely on a commodity-flow method. Second, investment by industry is compiled from establishment surveys, which do not have asset detail. The two estimates have differed substantially in some years. We have used the industry-based estimates because we need estimates of the capital stock by broad industry groups.

The annual estimates of investment are subject to uncertainties between benchmark years that are similar to those discussed above for output data. Again, the problems are most evident in the published revisions at the time a new base year is adopted. The 1993–94 benchmark revisions increased total investment of all industries by a relatively modest 9 percent.[13] Somewhat surprisingly, the changes associated with the shift to the 1999–2000

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12. This procedure closely follows the description by the CSO for its revisions of the historical data after the 1993–94 revisions.

13. At the sector level, the percentage adjustments were; 6 percent for agriculture, 18 percent for industry, and 4 percent for services (Central Statistical Office, 1999, pp. 39–40).

base are much more substantial—despite the passage of just 5 years since the prior benchmark. Total industry fixed investment in 1999–2000 has been increased by 33 percent, with revisions for agriculture, industry and services to 57, 17, and 46 percent respectively.[14]

The recent investment revisions are sufficiently large to have a major effect on estimates of capital stock growth since 1993–94. Since official capital stock revisions are not yet available, we have created new estimates for the major economic sectors, and for manufacturing, for the period of 1993–94 to 2004–05. As with output, we have phased in the investment revisions beginning in 1993–94. For the capital stocks, we created approximate measures using a fixed geometric rate of depreciation. These approximate measures were then recomputed for the period after 1993–94, using both the old and the revised estimates of investment. The percent adjustment for each year was applied to the corresponding official series to obtain our final revised capital stock series. For 2004–05, the last year of published data, our methodology implies that the revisions increased the overall capital stock by 15 percent, with even larger increases for agriculture and services.

LAND INPUT ESTIMATES. Our growth accounts include land as well as capital and labor as factor inputs to produce agriculture. An estimate of the volume of land used in agricultural production is available annually (Directorate of Economics and Statistics, 2005). However, there are no available estimates of current market value of the land that would enable us to construct measures of the annual flow of capital services. We use an estimate of total cropped land that adjusts for irrigated lands, sown more than once per year.

EMPLOYMENT. Difficulties also arise in the effort to construct reliable annual estimates of employment, and thus labor productivity. The censuses of 1971, 1981, and 1991 are believed to have produced solid estimates of the overall population, but to have grossly underestimated the worker-population ratio (WPR) and thus the size of the total workforce. Visaria (2002) discusses these problems and suggests the need for corrections on the order of 26 (1971), 15 (1981), and 12 (1991) percent to the reported figures.[15] In contrast, the quinquennial surveys appear to yield consistent

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14. CSO (2006), table 30, p. 53. The revisions to the commodity-flow estimates were much smaller, but the methodology was changed to bring the industry estimates into line with those based on the commodity flow method.

15. Provisional estimates of the WPRs are available for the 2001 census. The values appear to be much closer to the 1999–2000 quinquennial survey than in past censuses.

estimates of WPRs, but to underestimate the total population. Thus, estimates of India's labor force are typically generated by combining the survey-based estimates of the WPR for four component groups (rural men, rural women, urban men and urban women) with estimates of the corresponding populations, obtained by interpolating the census data. As a result, reliable estimates of the total workforce are limited to the years covered by the seven quinquennial household surveys that were conducted over the period 1972–73 to 2004–05. Annual estimates for the aggregate economy can only be obtained by interpolation of the results from those surveys.[16]

The NSSO surveys incorporate several distinct measures of the economic activities of the population. These are based on the prior year (usual status), the prior week (current weekly status) and each day of the reference week (daily status). They also distinguish between the principle activity status (plurality of time) and subsidiary status. Most researchers have relied on a count of persons with employment in usual status (either principle or subsidiary). However, unlike the national accounts their estimates are based on a count of persons, not a count of jobs. Visaria (2002) used estimates of worker participation rates from the quinquennial surveys and interpolated estimates of the populations of rural and urban males and females to produce estimates of the workforce. Sivasubramonian (2004) interpolated those estimates to obtain annual data for the aggregate economy.

We have updated the data of Visaria and Sivasubramonian using slightly different estimates of the WPRs by gender and sector from the NSSO surveys, and extended the estimates through 2004. We have also used information from the surveys to allocate employment among the sectors: agriculture, industry (and manufacturing), and services. The calculations are shown in appendix table A-1. The resulting estimates of employment apply to the seven years covered by surveys from 1973 to 2004. We combined those observations with estimates from the 1961 Census, and interpolated the data to obtain annual measures of employment by sector for the period from 1960–61 to 2004–05.

These employment surveys also provide information about the highest level of educational attainment for individuals in the workforce. These measures can be used to adjust the workforce for improvements in quality over time. Thus, for constructing the growth accounts, we computed average years of schooling for workers over age 15 in the three sectors of agriculture,

16. A recent evaluation of the potential usefulness of the smaller annual NSO surveys, which were undertaken in other years, is provided by Sundaram and Tendulkar (2005a). They concluded that the WPRs are not sufficiently comparable with those of the quinquennial surveys. Bhalla and Das (2006) reach a contrary conclusion.

industry, and services. We assumed a 7 percent return for each year of schooling in constructing an index of labor quality as in equation (5).[17] Estimates of earnings are also available for four micro data sets that cover the 38th, 50th, 55th, and 60th rounds that enable us to compute estimates of the returns to education over the 1983–2004 period. The analysis of the gains in educational attainment and their relationship to earnings are discussed more fully in a later section.

FACTOR INCOMES. The distribution of income payments between capital and labor is an important input into growth accounts because as discussed above, under conditions of competitive markets, income shares can be used to measure the contributions of each factor. However, such estimates are problematic for India (and most developing countries) because the self-employed play such a dominant role in total employment. Their earnings, which are labeled as mixed income in the national accounts, reflect a combination of income from capital and their own labor. In industrial countries, where the income of the self-employed is a small proportion of the total, it is common to impute a wage equal to that of their employees or a return on capital equal to that of the corporate sector. In India, however, mixed income accounted for fully 45 percent of NDP in 2002–03, and 79 percent of the income of the unorganized sector, which is a slowly declining share of the total economy (CSO, 2005, p. xlv). The importance of mixed income raises strong doubts about the validity of the imputation technique for such a large income component.[18]

We have used fixed factor shares in our analysis. That implies a more restrictive range of production functions, but the analysis of industrial countries—where information on factor income shares are available—suggests little variation in share weights over time. We have also assumed constant returns to scale in all three sectors—any such gains are allocated to the TFP residual. For agriculture, our assumed shares are 0.5, 0.25, and 0.25 for labor, capital, and land respectively.[19] For industry and services, we used a simple capital share of 0.4. For the aggregate economy, we

17. As discussed later, returns to schooling in India seem comparable to international experience, and the assumption of a 7 percent return is consistent with our estimates for other countries (Bosworth and Collins, 2003).

18. Sivasubramonian (2004) allocated mixed income between labor and capital on the basis of the distribution of income in the private organized sector. The result is a labor share that declines from 55–60 percent of GDP in the 1960s to 45–50 percent by the late 1990s.

19. See Evenson and others (1999, p. 40). The values are an average of their results for 1967, 1977, and 1987. They included a weight for fertilizer; but because our data are based on valued added, we scaled up the estimates for the other inputs. A similar procedure was used to compute agricultural TFP in Bhattarai and Narayanmoorthy (2003).

combined the factor shares of individual sectors, weighted by their share of total nominal nonresidential GDP. The share of agriculture, for example, declines from 52 percent of the total in 1960–61 to 23 percent in 2004–05. We also conducted some sensitivity analysis using different values for the factor shares. However, in the case of India, choice of specific shares has little impact on the analysis because, in general, there have been relatively small differences in the growth rates for the labor and capital inputs. Thus, the total contribution of the factor imputs and the estimats of TFP are only marginally affected.

India's Growth Accounts: Results and Discussion

In this section, we present our updated growth accounts—first for the total economy and then by major sector. The results reflect many of the now standard themes in the literature on India's economic development. However, some new findings emerge as well. Thus, drawing implications from our results, we build on the existing literature to discuss some of the key issues for India's growth experience and prospects for the future. The basic growth accounts are provided for the aggregate economy in table 3 and by sector in table 5, and we refer to these data throughout the discussion.

Aggregate Growth

We begin by looking at growth performance over the relatively long periods 1960–80 versus 1980–2004 (lines 1–3 of table 3). This split reflects the widespread view that the performance of the Indian economy changed

T A B L E 3 . Sources of Economic Growth, Total Economy, 1960–2005
Annual percentage rate of change

				Contribution of			
Period	Output	Employment	Output per worker	Physical capital	Land	Education	Factor productivity
1960–2004	4.7	2.1	2.6	1.2	−0.1	0.3	1.2
1960–80	3.4	2.2	1.3	1.0	−0.2	0.2	0.2
1980–2004	5.8	2.0	3.7	1.4	0.0	0.4	2.0
1960–73	3.3	2.0	1.3	1.1	−0.2	0.1	0.2
1973–83	4.2	2.4	1.8	0.9	−0.2	0.3	0.6
1983–87	4.0	1.6	2.4	1.2	0.0	0.3	0.9
1987–93	5.7	2.4	3.2	0.7	−0.1	0.4	2.2
1993–99	7.0	1.2	5.8	2.4	−0.1	0.4	2.8
1999–2004	6.0	2.8	3.2	1.1	0.1	0.4	1.7

Source: Authors' calculations as explained in text.

T A B L E 4 . **Sources of Growth, Regions, 1960–2003**

Region/Period	Output	Output per worker	Contribution of		
			Physical capital[a]	Education	Factor productivity
India					
1960–80	3.4	1.3	0.8	0.2	0.2
1980–04	5.8	3.7	1.4	0.4	2.0
China (1)					
1960–80	4.0	1.8	0.8	0.4	0.6
1980–03	9.5	7.8	2.8	0.4	4.5
South Asia (4)					
1960–80	3.6	1.4	1.0	0.3	0.3
1980–03	5.5	3.4	1.2	0.4	1.7
East Asia less China (7)					
1960–80	7.0	4.0	2.2	0.5	1.2
1980–03	6.1	3.7	2.2	0.5	0.9
Latin America (23)					
1960–80	5.7	2.7	1.0	0.3	1.4
1980–03	2.0	–0.6	0.1	0.4	–1.1
Africa (19)					
1960–80	4.4	1.9	1.0	0.1	0.8
1980–03	2.2	–0.6	–0.1	0.4	–0.9
Middle East (9)					
1960–80	5.4	3.2	1.8	0.4	1.0
1980–03	3.8	0.8	0.3	0.5	0.0
Industrial Countries (22)					
1960–80	4.2	2.9	1.2	0.4	1.3
1980–03	2.6	1.6	0.8	0.2	0.6

Source: Authors' calculations as explained in text and Bosworth and Collins (2003).
Note: a. For India, combines contribution of physical capital and land.

significantly after 1980. However, as discussed above, there is an on-going debate about the precise timing of the growth acceleration, the role of economic reforms and the relative importance of changes undertaken during the 1980s versus those undertaken after the 1991 economic crisis.

The more rapid GDP growth after 1980 is clearly evident, from an average of 3.4 percent per year during the period from 1960–80 to 5.8 percent during 1980–81 to 2004–05. It is noteworthy that nearly all of the output growth during the first period is associated with increases in factor inputs. However, the post-1980 acceleration is concentrated in improvements in the efficiency of factor use, TFP.[20] That the gains should be concentrated in

20. Previous studies have also concluded that growth in factor inputs accounted for most of the growth in output during the "pre-reform" period. For example, see Dholokia (2002), who defines this earlier period as 1960–85.

TFP seems reasonable in light of the fact that the growth gains are typically attributed to shifts in the policy regime beginning around 1980 that initiated an ongoing process of liberalization and opening up of the economy. The associated increases in reliance on markets and reductions in the role of government would be expected to result in improved economic efficiency.

However, there has been little or no net gain in the rate of job growth, and only a modest pickup in the rate of growth of both physical and human (education) capital per worker. At the level of the total economy, the lack of acceleration in employment is not a surprise since it is driven by population growth; but as other authors have noted, the lack of strong gains in capital is in striking contrast to the experience of East Asian economies. Their periods of rapid growth have been characterized by significant capital deepening and rapid increases in educational attainment.[21] We discuss India's experience with both human and physical capital accumulation in greater detail in a following section.

We can also examine shorter periods by focusing on the intervals between the quinquennial surveys. We argued above that data for these years are likely to be more reliable because the survey results are a primary input to the national accounts and provide the only direct measure of employment. As shown in table 3, growth in output per worker strengthened from just 1.8 percent per annum in 1973–83 to 2.4 percent in 1983–87, and 3.2 percent in 1987–93 before surging to 5.8 percent in 1993–99. These figures suggest a sustained improvement in the underlying trend. However, they do not enable us to pin down the precise timing of the growth acceleration. The decomposition shows that the contribution from TFP growth jumped after 1987 and has remained relatively high. Growth did slow over the 1999–04 period, but this appears largely due to a severe agricultural drought in 2003–04. Moreover, preliminary data for 2005–06 suggest a strong 8.4 percent annual growth rate, and a three-year average above 8 percent.

As discussed above, our measures of physical capital accumulation reflect significant upward revisions to investment in the 1999–2000 benchmark. We have phased these into our capital stock estimates beginning in 1993–94. The resulting contribution of increased capital per worker during 1993–99 of 2.4 percent per annum is similar to levels observed during East Asia's rapid growth periods. However, India's capital deepening slowed after 1999.

21. See Young (1995) and Bosworth and Collins (2003).

International Comparisons

Table 4 compares India's growth performance with that in China and other regions. As shown, in the 1960–80 period India was outperformed in terms of growth in total output as well as output per worker by all of the world's regions, as well as by China.

Although the contribution from increases in capital per worker in India were comparable to the averages for Latin America and Africa, the gains from TFP were considerably lower. In contrast, India's growth since 1980 exceeds that for all regions except East Asia, averaging more than 2 percent per year above the industrial country growth rate. While capital deepening, and especially TFP growth, accelerated in India, both collapsed in Latin America, Africa and the Middle East. Although the contribution of capital accumulation remained well below that for China and East Asia; India achieved impressive rates of TFP growth at the aggregate level. In the next sections, we decompose India's performance by sector to examine the features of the acceleration in greater detail.

Agriculture

The growth accounts for India's major sectors are shown in table 5. The first panel summarizes the growth performance of the agricultural sector. The contrast between the increase in output per worker in 1960–80 (growth of just 0.1 percent per annum) and 1980–2004 (1.7 percent per annum) highlights the role of the green revolution. The new technology began to be introduced in the late 1960s and early 1970s. Our decomposition shows TFP growth jumping from –0.2 percent per year during 1960–73 to 0.9 percent per year during 1973–83, and to an average of 1.2 percent during 1983–99 (though as shown, it was quite variable during sub-periods). This estimated acceleration in TFP growth is consistent with a number of recent studies focused on agriculture.[22] It also is coincident with other changes that expanded the role of private decision-makers. There has been some concern that the rate of improvement in agriculture has begun to moderate, possibly suggesting lower returns to the government's R&D and extension service expenditures on the sector. However, our results do not suggest a clear pattern—except for the most recent five year period which includes the drought. There is still considerable margin, judged by the performance in comparator countries, for improvements in agricultural yields.

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22. See, for example, Coelli and Rao (2003), Everson and others (1999), Foster and Rosenzweig (2004), and Janaiah et al. (2005).

T A B L E 5 . Sources of Economic Growth, Major Sectors, 1960–2005
Annual percentage rate of change

Period	Output	Employment	Output per worker	Contribution of			
				Physical capital	Land	Education	Factor productivity
Agriculture							
1960–2004	2.4	1.4	0.9	0.3	–0.1	0.2	0.6
1960–80	1.9	1.8	0.1	0.2	–0.2	0.1	–0.1
1980–2004	2.8	1.1	1.7	0.4	–0.1	0.3	1.1
1960–73	1.8	1.9	–0.2	0.2	–0.2	0.1	–0.2
1973–83	2.9	1.6	1.3	0.3	–0.1	0.2	0.9
1983–87	0.1	0.5	–0.5	0.3	0.0	0.2	–1.0
1987–93	4.8	2.0	2.8	0.1	–0.2	0.2	2.7
1993–99	2.6	0.2	2.4	0.7	0.1	0.3	1.3
1999–2004	1.8	1.4	0.4	0.8	–0.3	0.4	–0.4
Industry (Inclusive of Manufacturing)							
1960–2004	5.6	3.3	2.4	1.7		0.3	0.4
1960–80	4.7	3.1	1.6	1.8		0.3	–0.4
1980–2004	6.4	3.4	3.0	1.6		0.3	1.1
1960–73	4.7	2.3	2.4	2.3		0.2	–0.1
1973–83	5.2	4.5	0.7	1.2		0.4	–0.8
1983–87	6.0	4.6	1.4	1.0		0.3	0.2
1987–93	5.9	1.7	4.2	1.6		0.4	2.2
1993–99	6.9	2.4	4.5	3.0		0.4	1.1
1999–2004	6.4	5.0	1.4	0.1		0.2	1.2
Manufacturing							
1960–2004	5.7	2.7	3.1	1.8		0.3	0.9
1960–80	4.6	2.7	2.0	1.5		0.3	0.2
1980–2004	6.6	2.7	4.0	2.1		0.4	1.5
1960–73	4.9	1.6	3.4	2.1		0.2	1.0
1973–83	5.3	4.2	1.1	1.0		0.4	–0.3
1983–87	6.2	2.4	3.7	1.4		0.3	2.0
1987–93	5.8	1.8	4.0	1.3		0.4	2.2
1993–99	7.2	1.6	5.5	4.6		0.5	0.4
1999–2004	6.4	4.8	1.7	0.2		0.3	1.1
Services							
1960–2004	6.3	3.3	3.0	0.9		0.4	1.7
1960–80	4.9	2.8	2.0	1.1		0.5	0.4
1980–2004	7.6	3.8	3.8	0.7		0.4	2.7
1960–73	4.7	1.7	3.0	1.9		0.4	0.6
1973–83	5.3	4.5	0.8	–0.1		0.6	0.3
1983–87	6.9	3.3	3.5	0.5		0.3	2.7
1987–93	6.3	4.1	2.2	0.1		0.5	1.5
1993–99	10.2	3.1	7.0	1.5		0.4	5.0
1999–2004	7.8	4.4	3.4	0.5		0.4	2.5

Source: Authors' estimates as described in text.

One surprise is that agricultural employment continues to grow. The experience with similar stages of development in other countries has been that employment within agriculture tends to decline as underemployed workers are drawn out of agriculture into industry and services. In this context, India's experience is particularly notable because, as is well known, a relatively large share of India's employment remains in agriculture. However, the share of agriculture in value added is similar to that for other countries at similar income levels.[23]

Industry

The second panel of table 5 shows that industrial output growth also quickened after 1980. However, the magnitude of this increase was less than for the economy as a whole. Employment growth rose by about 0.3 percentage points, to 3.4 percent per annum, while the contribution of capital per worker remained low, and the gains in educational attainment of the workforce have been modest. Although all of the improvement in labor productivity can be traced to higher growth in TFP, this also remains low by international standards. Further, the figures in table 5 show TFP growth as most rapid during 1987–93, and then slowing, not accelerating, during the post reform period. The trend is disappointing in light of the attention that has been devoted to the on-going liberalization of the trade and regulatory regimes for goods production. These results parallel those of some other researchers, who also found somewhat disappointing performance of the industrial sector in recent decades.[24]

But a low rate of TFP growth in industry is not necessarily a surprise. First, it was a common feature of the early stages of growth in other Asian countries (Young, 1995). Certainly, the industrial base is likely to be inefficient initially, providing some room for productivity gains. But to the extent that developing country growth is a process of adopting the existing production technologies of more industrialized economies, longer-term gains in industrial sector TFP are likely to be minimal. In particular, suppose that the requisite capital and technology are purchased in global markets, and then combined with an advantage in low-cost labor to produce an output that is also sold in competitive global markets. This is not a process that is likely to generate large productivity residuals—or large economic rents. Any TFP gains would be more likely to be found in the production of goods for the domestic market, as inefficient producers decline in importance.

23. For example, see Virmani (2005) for a recent discussion of this point.
24. Recent discussions include Wallack (2003) and Kohli (2006b).

At the aggregate level under this scenario, gains in TFP will largely emerge from the shift of resources among the sectors.[25]

In any case, there remains considerable scope for growth of India's industrial sector, especially compared with industrial growth in Korea during the 1970s and China during the 1990s. In particular, India's employment share in industry remains surprisingly low given its development level. Raising living standards will require expansion of relatively labor-intensive activities, so as to productively employ the large pool of low-skilled workers who are currently under-employed in agriculture.[26] At its current stage of development, India's priority is to generate employment in industry. Less concern need be devoted to increases in sectoral TFP.

Because much of the discussion of India's economic growth has focused on manufacturing, we extracted it from the rest of the industrial sector and compiled a separate set of accounts. Our data include both the registered and unregistered portions of manufacturing.[27] Together they account for roughly half of the industrial sector, but only about 15 percent of overall GDP. As shown in the third panel of table 5 the general pattern of growth for manufacturing is similar to that for the total industry. However, while both show growth accelerations during the 1980s, the surge in manufacturing began earlier, during 1983–87. The investment boom of the mid-1990s and the subsequent collapse are also evident in the large change in the capital contribution before and after 1999–2000.

Manufacturing experienced a slowing of TFP growth after 1993 that was more severe than that reported for industry as a whole, but the improvement in the last 5 years is more pronounced. The early and mid-1990s were marked by major reductions in industrial tariffs that intensified the competitive pressures on domestic manufacturing and mining. Thus, we would expect some initial reduction in TFP, but a steady pickup of growth as the old capital depreciates and new technologies are adopted by an increasing proportion of the industry. The cycle appears to have been amplified by a significant buildup of excess capacity in the mid 1990s, leading to a sharp

25. To the extent that India used trade restrictions to limit the importation of low-cost capital machinery in favor of domestic producers, we would expect the performance to be even worse.

26. Many authors have made this point, including Banga (2005), Virmani (2005), and Krueger (2005). In this context, Foster and Rosenzweig (2004) highlight the role of increased non-agricultural activity in rural areas for raising rural incomes.

27. The registered portion has increased from 58 percent of the total in 1980 to about 65 percent today.

downturn in both output and capital accumulation at the end of the decade. That excess capacity has been largely eliminated in recent years.

It is notable that employment growth in manufacturing has been consistently slower than for industry overall, giving rise to somewhat faster rates of growth of both labor productivity and TFP. Paradoxically, this has also implied that the manufacturing sector has become more capital intensive. (see Kochhar et. al. 2006) However, the measure of TFP in manufacturing is sensitive to the precise factor share that is used to combine the inputs. This is the one case in which the growth rates of capital and labor differ by a significant amount in some periods.

The general pattern of our results for the post-1993 period is comparable to the results reported in Goldar (2004). However his study used data from the Annual Survey of Industries (ASI), and it related only to the registered portion of manufacturing. Goldar also found that TFP growth slowed somewhat after 1991, but the analysis could only cover the years up to 2001–02, the last year for which ASI data are available.

Services

The bottom panel of table 5 summarizes the growth performance of the service sector. As frequently noted, service-producing industries have been the primary source of India's growth surge, consistently outperforming industry/manufacturing.[28] Indeed, since 1980, output growth has exceeded the pre-1980 growth rate by 2.7 percent per year—and maintained an average annual growth of 7.6 percent. Furthermore, employment growth in the sector has averaged 3.8 percent per year, roughly comparable to that for industry. However, increases in capital per worker have made an even smaller contribution to growth of the services sector than for industry. The result is that gains in output per worker are dominated by high rates of improvement in TFP, averaging 2.7 percent annually. We also note that this sector has registered the largest improvements in the educational attainment of its workforce. Turning to the results for the shorter sub-periods, both output per worker and TFP growth accelerated during 1983–87, slowed somewhat and then took off after 1993.

28. Banga (2005) provides a recent overview of the issues associated with India's rapid growth in services. She highlights explanations for and implications of the so-called "job-less growth" in India's service sector whereby increases in the share of GDP have not been associated with equivalent increases in the share of employment. Banga and Goldar (2004) argue that services are increasingly important as an input to Indian manufacturing. See also Gordon and Gupta (2004). Srinivasan (2005) focuses specifically on the development of India's IT sector and its implications for growth.

Another perspective on the role of TFP in India's post-1980 growth is provided by figure 1, which displays annual TFP trends by sector and for the total economy. The dominance of the service-producing industries and the relatively weak performance of the goods producers are both very evident. The chart also shows that the growth of TFP in services has been remarkably consistent over the past quarter century and shows few signs of abating.

F I G U R E 1 .   **Growth in TFP by Major Sector, 1960–2004**
Index, 1960 = 1.0
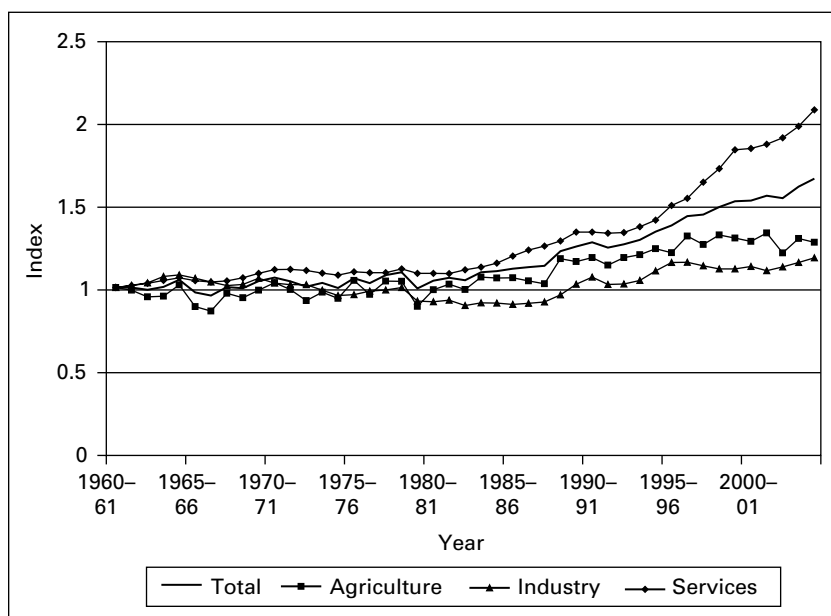
The source of such strong TFP growth in services, however, is puzzling. Information on employment is not available at a sufficient level of detail to compute productivity indexes; but greater detail is available for the output measures. Thus, table 6 reports growth in the component industries and their contribution to the growth of the total (defined to exclude housing). We have separated the sector into a modern component that includes communications, finance, business services, education and medical care, and a traditional sector of trade, transportation, public and personal services. Communication, finance and especially business services have received considerable attention as areas in which India has done well. The middle panel shows that these sub-sectors do indeed stand out, with high average rates of growth. Yet, business services account for just 5 percent of the overall

T A B L E 6. Growth in Component Service-Producing Industries, 1980–2004
Percentage

Period	Modern services					Traditional services				Services less dwellings
	Total	Communications	Finance	Business services	Education & medical	Total	Trade	Transportation	Other services	
Share of Total Output in Services										
1960–61	19	2	6	1	10	81	40	14	27	100
1980–81	22	3	7	1	11	78	37	16	24	100
1993–94	31	3	14	2	12	69	34	14	21	100
1999–2000	35	6	14	4	12	65	33	12	19	100
2004–05	40	11	12	5	11	60	33	11	16	100
Annual Percentage Rate of Change										
1960–80	5.7	6.9	5.9	3.4	5.5	4.6	4.5	5.6	4.3	4.9
1980–93	9.0	7.1	12.3	9.8	6.6	5.4	5.6	5.4	4.9	6.3
1993–99	12.6	20.3	9.3	28.0	10.6	8.9	9.8	7.5	8.6	10.1
1999–2004	10.5	23.8	5.7	11.4	7.1	6.5	7.9	5.7	4.3	8.0
Percentage Contribution to Total Services Growth										
1960–80	1.1	0.1	0.3	0.0	0.5	3.8	1.8	0.8	1.2	4.9
1980–93	2.0	0.2	0.9	0.1	0.7	4.2	2.1	0.9	1.2	6.3
1993–99	3.9	0.7	1.3	0.5	1.2	6.2	3.3	1.1	1.8	10.1
1999–2004	3.7	1.3	0.8	0.5	0.8	4.2	2.6	0.7	0.8	8.0

Source: authors' calculations from CSO (2006) and prior years.

sector's output, and the entire modern component accounted for less than half of the growth between 1980–81 and 2004–05.

Instead, the acceleration of the sector's growth has been very broadly based, including trade, transportation, and community and personal services. But these are not industries in which we would anticipate rapid productivity growth. As stressed by Baumol (1967) services are normally an area of limited productivity growth. That characterization is changing with respect to portions of what we have called modern services because IT capital greatly altered the production process. On the other hand, although services are a major IT user in the United States, the adoption of the capital has not been accompanied by supernormal returns that might spillover into TFP.[29] Education and government services are other large sectors in which we would not expect to observe significant productivity growth.

An alternative explanation is that increases in the price of services are being underestimated, leading to an overstatement of real growth. However, this hypothesis is difficult to verify. We can only note that, while inflation has averaged 7.5 percent overall since 1980, inflation has also been remarkably similar for agriculture, industry and services. During 1980–2005, the services price deflator rose at an average annual rate of 7.5 percent, compared with 7.4 percent in both agriculture and industry. It seems extremely unlikely that all three price deflators would grow at nearly identical rates over such a long period.

From an international perspective, the finding of large TFP gains in the service industries is atypical. Most countries, lacking measures of physical output, extrapolate the output of services with indexes of the inputs.[30] Thus by construction, they eliminate the possibility of reported productivity gains. This does not appear to be a common practice in the Indian national accounts. While up-to-date information on the methods used to adjust for price inflation is limited, it appears that the output of some service industries is adjusted only for general (CPI) inflation (CSO, 1989). In the case of trade, margins are assumed to be constant in real value and change in line with total sales. Furthermore, because so much of services lies outside the organized sector, the Indian statistical agencies have little

29. Triplett and Bosworth (2005).

30. The most common methods are to use an index of employment to represent real growth, or equivalently to deflate the nominal values by change in average wage rates. In recent years, the U.S. and some other OECD countries have moved away from this input-based valuation by developing explicit price indexes for services. However, the method is still used for government and education.

or no direct information on the output of services. To a large extent, they are forced to rely on extrapolation of the base year values.

In summary, the growth of the service sector has been sustained and very broadly based. However, the extent that it is concentrated in TFP and not employment does give us pause. In addition, the lack of employment data at a more detailed level prevents us from exploring the source of the TFP gains in greater detail.

Reallocation Effects

A potentially important source of growth comes from the reallocation of resources from less productive to more productive activities. Traditionally, this has been associated with a shift of labor from agriculture, where there is initially substantial under-employment, to industry and then services. Our data indicate that Indian value added per worker in industry and services is 4 to 5 times that in agriculture (table 7). Thus, employment shifts from agriculture to either of these sectors should contribute to substantial gains in productivity and average incomes. We have already seen (table 5) that employment has grown more rapidly in industry and services than in agriculture, and that these sectors have experienced greater capital deepening. Both of these trends have implied some sectoral reallocation of factors. However, as discussed above, there remains considerable scope for additional labor reallocation out of agriculture.

T A B L E   7 .   Growth in Output per Worker, 1960–2005, Sectoral Growth vs. Reallocation Effects
Annual percentage rate of change

Period	Total economy (1)	Weighted sectoral growth (2)	Reallocation effects (1)–(2)	Contribution of		
				Agricultural	Industry	Services
1960–80	1.3	0.9	0.4	0.04	0.3	0.5
1980–2004	3.7	2.8	1.0	0.7	0.8	1.3
1960–73	1.3	1.1	0.2	–0.1	0.4	0.8
1973–83	1.8	1.0	0.8	0.6	0.2	0.2
1983–93	2.9	2.3	0.6	0.6	0.8	0.9
1993–99	5.8	4.8	1.0	0.8	1.3	2.7
1999–2004	3.2	2.0	1.2	0.1	0.4	1.5
Memo: GDP/ Worker (2004, in Rupees)	32,596			11,964	51,364	66,323

Source: Tables 3 and 5 and authors' estimates as described in the text.

Table 7 and figure 2 provide an estimate of the contribution of factor reallocation to India's growth. For each period, we show the contribution to the total of growth in each of the three sectors, weighted by the sector shares. The data for total and sector growth are taken directly from tables 3 and 5. The contribution of resource reallocation is the difference between the economy-side increase in labor productivity and the sum of the individual sector contributions. Post-1980, our calculations show that this reallocation contributed roughly one percent per year to output growth. Our findings also suggest that this component has become increasingly important in recent years.[31]

F I G U R E 2 .   Growth in Output per Worker, 1960–2005, Sectoral Growth vs. Reallocation Effects
Annual percentage rate of change
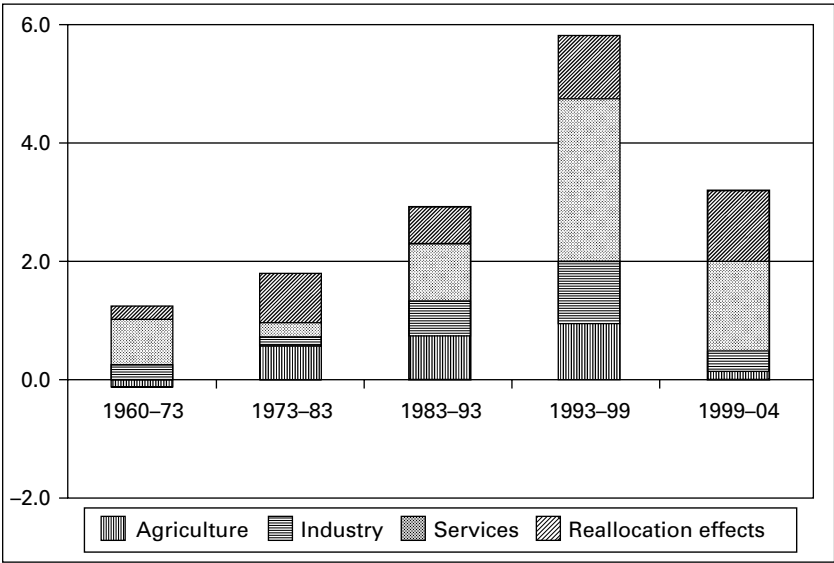
The Role of Capital Accumulation: Additional Perspectives

In recent years, controversy has surrounded the roles of physical capital and education (human capital) in the growth process. Young (1995) has shown the dominance of physical capital accumulation in the growth of the

31. See Bosworth (2005) for a similar calculation applied to Thailand. Using a different methodology, Wallock (2003) also concludes that much of India's post 1980s growth is attributable to resource movements.

East Asian economies. On the other hand, Klenow and Rodriguez-Clare (1997) argue that physical capital accumulation is largely induced by increases in TFP, a phenomenon that leads to an overstatement of the contribution of physical capital as an exogenous source of growth, and an understatement of the role of TFP.[32] Hulten and Srinivasan (1999) apply this argument to Indian manufacturing growth during 1973–92. Easterly and Levine (2001) argue that only a small percentage of the variation in growth across countries can be attributed to capital accumulation. Baier and others (2006) argue the opposite. Our own reading is that both capital accumulation and gains in TFP are important components of the growth process (Bosworth and Collins, 2003), although we agree that the precise magnitude of the role varies across countries. Capital accumulation is a necessary part of the process—regardless of whether it is an exogenous or induced factor. Furthermore, the investment underlying that capital accumulation must be financed through national or foreign saving.

The role of education has been equally controversial. Many studies, including our own, have relied on the strong microeconomic association between education and earning to adjust the workforce for improvements in educational attainment.[33] Again, rapid gains in educational attainment have been a particular feature of many of the fast-growing East Asian economies. Easterly (2001) and Pritchett (2001) question the relationship between education and growth at the aggregate level.

The growth accounts presented above imply that both human and physical capital have made relatively modest contributions to India's growth performance by international standards. We examine each of these areas in more detail below. Our examination of human capital first reviews the evolution of educational attainment. Using individual level data for selected years from 1983 to 2004, we then present new estimates of the extent to which Indian labor markets reward workers for various levels of additional schooling. This issue is of particular relevance, because increases in educational attainment have evolved somewhat differently in India than for other rapidly growing Asian economies—beginning with the push at tertiary levels, educating large numbers of engineers and scientists, and only since 1986 emphasizing primary education more broadly. Finally, the section turns to a discussion of investment and saving in India. While India's

32. Much of this debate revolves around the choice of the Harrodian, instead of the Hicksian approach to measuring TFP. The Harrodian formulation effectively assigns a larger role to TFP by assuming that a portion of the capital accumulation is endogenous and induced by an increase in TFP (Hulten, 1975).

33. See Bosworth and Collins (2003) for a discussion of the differing perspectives.

national saving rate has been rising and compares favorably to that for low income countries, it remains below that for high growth Asian economies. Is saving likely to act as a constraint for India's growth? We use the accounting identity linking investment to saving to frame our discussion, and explore the evolution over time as well as across sectors. Once again, a variety of issues arise, regarding the data available for measurement of both saving and investment.

The Contribution of Education

India is often cited as having a large cadre of well-educated university graduates. However, overall levels of educational attainment are low compared to the East Asian countries at similar stages of development.[34] An international comparison suggests that India has only now reached an average level of schooling comparable to that achieved in other Asian countries a quarter century earlier (table 8).

T A B L E 8 . Educational Attainment of the Total Population Aged 15 and Over, Selected Countries and Years
Percent

Country	Year	No schooling	Below middle	Middle	Secondary	Post secondary	Average years of school
India	1960	72.2	16.2	11.1	0.4	0.0	1.7
	1980	55.0	10.0	23.9	8.6	2.6	2.9
	2000	40.7	9.9	27.1	16.8	5.6	4.5
China	1960						
	1980	34.0	19.5	35.6	10.2	0.6	4.8
	2000	18.0	21.1	43.3	15.5	2.1	6.4
Thailand	1960	36.9	12.7	47.6	2.3	0.4	4.3
	1980	14.4	66.1	12.1	6.4	0.9	4.4
	2000	12.6	34.5	37.9	8.1	7.0	6.5
Malaysia	1960	49.7	25.0	20.5	3.6	1.1	2.9
	1980	26.8	22.2	41.0	8.8	1.1	5.1
	2000	16.2	16.4	48.7	15.8	2.9	6.8
Indonesia	1960	68.0	16.8	14.5	0.8	0.0	1.6
	1980	31.9	33.0	29.3	5.7	0.1	3.7
	2000	32.1	18.2	36.7	12.4	0.5	5.0

Source: Barro and Lee (2000), NSSO various years, and authors' calculations.
Note: Data for India in 1980 and 2000 come from the surveys conducted in 1983–84 and 1999–2000, respectively.

34. Primary education did not become a national policy priority in India until 1986. The National Program of Universal Elementary Education was launched in 2001. (For example, see Wu, Kaul, and Sankar [2005]).

Today, most East Asian countries, including China, maintain a substantial lead over India in terms of the average-years-of-schooling. Using results from the household surveys, table 9 provides a more detailed perspective on the changes in educational attainment of workers since 1960. The first row shows that there has been a substantial reduction in the proportion of the workforce that is illiterate—from 72 percent in the 1961 census. But illiteracy remains high, at about 40 percent currently. Those who have completed secondary schooling account for about 14 percent of workers, while an additional 6 percent have a university degree. Surprisingly, if we limit the analysis to those aged 24–34 in 2004, the proportion with a secondary education or better only rises to 25 percent compared to the 20 percent reported for the full population of working age. It implies a slow rate of educational improvement for younger age cohorts.

T A B L E   9 .   **Educational Attainment of Workers Aged 15–64**
Percent

Schooling level	1960	1983–84	1993–94	1999–2000	2004
Illiterate	72.2	56.6	48.5	43.5	39.4
Below Primary	16.2	11.1	12.0	11.0	9.1
Primary		12.8	11.9	11.7	14.5
Middle	11.1	9.6	11.8	14.1	17.1
Secondary	0.4	7.2	7.5	9.3	8.9
Higher Secondary			3.7	4.5	5.1
Graduate	0.0	2.7	4.5	5.9	6.0

Source: NSSO (various years), and authors' calculations.
Note: Data for 1960 reflect educational attainment of all persons 15+.

At the same time, education appears to earn a very good return in India, comparable to that of other strongly growing countries. We obtained the micro household data files of the 38th (1983), 50th (1993–94), 55th (1999–2000), and the 60th (2004) rounds of the NSSO employment surveys. These are large surveys that provide estimates of the earnings of workers (regular and laborers) as well as their educational attainment—measured, as in table 9, by the highest level completed. Regression estimates of the relationship between schooling and earning in each of the four surveys are shown in table 10.[35] A pattern of strongly increasing earnings at each level

35. Our results for the 1983 and 1993–94 surveys are very similar to those of Duraisamy (2000), who used the same two data sets. Dutta (2004) found somewhat lower returns. However, her analysis included other determinants that are likely to be correlated with educational attainment.

T A B L E 1 0 . **Regressions of Wages on Educational Attainment, 1983–2004**

Coefficient	Survey round			
	#38 (1983)	#50 (1993–94)	#55 (1999–2000)	#60 (2004)
Below Primary	0.19	0.21	0.22	0.24
Primary	0.31	0.33	0.35	0.34
Middle	0.55	0.52	0.52	0.54
Secondary	1.02	0.91	0.92	0.78
Higher Secondary		1.07	1.14	1.01
Diploma Certificate				1.32
Graduate	1.39	1.37	1.52	1.47
Tech Degree			0.51	0.51
Tech Certificate	0.29	0.27	0.30	0.25
Female	–0.53	–0.44	–0.44	–0.46
Rural	–0.44	–0.33	–0.41	–0.45
Constant	8.44	9.27	5.38	5.52
adj_R^2	0.50	0.40	0.54	0.50
RMSE	0.70	0.86	0.69	0.72
Sample size	87,769	81,038	88,430	42,501

Source: Government of India, National Sample Survey Organization, various years and authors' calculations.
Note: Sample includes all persons aged 15 to 64 who reported positive wages during the reference week. The dependent variable is the log of the weekly wage. Regressions also included categorical variables for sub-round and ten-year age brackets (not shown). The excluded education category is illiterates. All coefficients shown are significant at the.0001 probability level or higher.

of education is clearly evident. Except for some evidence of a decline in the return to a secondary education in the 2004 survey, the magnitudes of the estimated returns are highly stable across time.

We also explored an alternative formulation that replaced the categorical variables with a single index of years of schooling.[36] The estimation results imply an average rate of return that varies between 9.1 and 9.8 percent per year of schooling. For comparison, Psacharapoulus and Patrinos (2004) report an average return to additional schooling across countries of about 10 percent both overall and for the sub-group of Asian economies. However, the returns to schooling in India are not quite as uniform as the log-linear formulation would imply. Table 11 shows the annual marginal returns for different levels of schooling implied by the regression results in table 10.

36. Most states have adopted a system of five years for primary, three for middle school, and two each for secondary and higher secondary. We have treated a university degree as equivalent to three years, and added an additional two years of schooling for those with a technical degree or certificate.

T A B L E 1 1 .   **Implied Incremental Rates of Return by Schooling Level**
Percent

	Survey round			
Schooling level	#38 (1983)	#50 (1993–94)	#55 (1999–2000)	#60 (2004)
Below Primary	6.3	7.3	7.6	8.0
Primary	4.3	3.9	4.0	3.4
Middle	5.4	4.2	3.8	4.5
Secondary	10.5	14.9	15.4	9.2
Higher Secondary		4.0	5.5	6.2
Graduate	4.3	4.7	5.6	7.1

Source: Computed from the coefficients in table 9: the proportionate change in the coefficient of progressively higher levels of education expressed as an annual rate.

Interestingly, the incremental returns to primary education are significantly lower than the average returns, and there is a large jump in the return associated with completing the secondary level of schooling (10 or 12 years). The additional return to a university degree was low in the 1980s, but it has been rising rapidly in the latest surveys. This is consistent with the view that India may have over-invested in higher education in earlier decades for fields such as engineering, leading to the large diaspora of Indian engineers abroad. The rising return in recent years is reflective of the changed economic situation, and the potential emergence of a scarcity of highly-skilled workers.

These deviations in the return to schooling from a simple log-linear relationship contrast sharply with results for some other countries.[37] Psacharapoulus and Patrinos (2004) report a general global pattern in which the returns are highest for elementary education and decline slightly for higher levels of educational attainment. Those findings have been used to argue for shifting public resources toward primary education and reduction of illiteracy. However, our results would suggest that greater effort should be made to ensure that students complete the secondary education level. In part, the pattern of returns we find can be traced to strong gender effects in the relationship between education and earnings. Women are particularly disadvantaged at low levels of education, but do gain correspondingly

37. The analysis of similar surveys for Thailand found no significant deviation from a log-linear return of 10 percent (Bosworth, 2005). Also, our own analysis of U.S. data suggests a log-linear relationship is an adequate summary of the relationship between earnings and education.

more from secondary and tertiary education. In our analysis, the jump in incremental returns upon completion of the secondary level is particularly pronounced for women.

The finding of a relatively low return to an elementary education is consistent with several recent articles that have been critical of the quality of the primary education system.[38] There has also been a large move from public to private schools; but that may compound the problems as the poor are increasingly isolated and left behind in the process. Kapur and Mehta (2004) offer an even more critical perspective on the system of higher education. They argue that a crisis of governance in the public institutions is forcing students into private educational institutions and to enroll abroad. Such criticisms of India's education system stand in sharp contrast to a generally favorable foreign perspective on the Indian education system, perhaps because a large number of highly-educated persons emigrated. However, the critique raises challenges for a growth strategy that aims to build on economic activities with a large skill component.

Saving and Investment

The small contribution of capital per worker to economic growth evident in the growth accounts highlights important issues about the adequacy of Indian saving and capital accumulation for sustaining high growth in the future. However, several studies have pointed to strongly rising rates of saving and investment shown in the national accounts to argue that capital accumulation should not be a major constraint on future growth.[39] At the same time, the magnitude of recent revisions to the national accounts also raises questions about the reliability of the saving and investment data and the extent to which they reflect the underlying reality (Shetty, 2006). In this section, we address these issues, beginning once again with a discussion of the data available for analysis.

In the Indian national accounts, total national saving is the sum of three separately-compiled components: (1) public sector saving, (2) corporate saving and (3) household (including non-corporate enterprises) saving.

$$(6) \qquad\qquad S_T = S_{pub} + S_c + S_h.$$

38. See Kochar (2002), and Kremer and others (2005). Psacharapoulus and Patrinos (2004) also report a surprisingly low return to primary education of 3 percent. See also the paper by Pritchett and Mugai in this volume.

39. See, for example, Mühleisen (1997) and Rodrik and Subramanian (2004b).

The CSO can construct reasonably good estimates of public sector saving from budget records. Its measure of corporate saving is compiled from a sample of major corporations' income and balance sheets, maintained by the Reserve Bank of India. The difficult measurement issues are associated with saving of the household sector. Household saving consists of two independently-estimated components: physical saving, and net financial saving. Saving in physical assets is simply set equal to investment of the household sector, which is itself a residual estimate, as explained below. The estimate of household financial saving is constructed from flow-of-funds measures of the net addition to total financial assets less the net financial saving of the public and corporate sectors.

The overall national saving rate and its three components are shown as percentages of GDP for the period 1970–2004 in figure 3a. The overall saving rate has risen strongly, especially since the mid 1980s. Further, this increase is dominated by major gains in household saving. Public sector saving actually turned negative in the late 1990s, but it has improved in recent years. Corporate saving (retained earnings) grew substantially up to 1995, but has since remained in the range of 4–5 percent of GDP.

F I G U R E   3a. Gross National Saving by Sector, 1970–2004
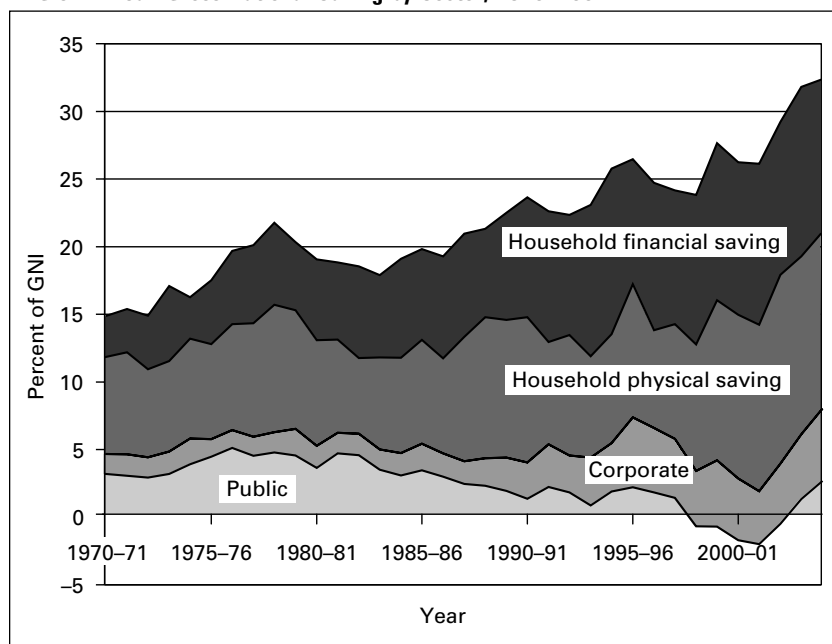
F I G U R E 3b. Capital Formation by Sector, 1970–2004
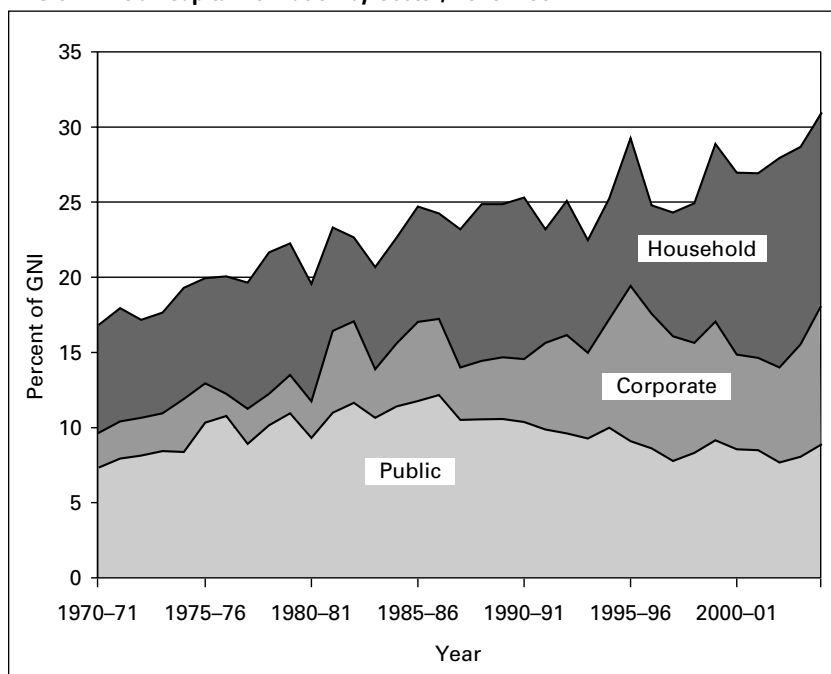
Thus, the expansion of saving is concentrated in the household sector. Total household saving has increased from a modest 10 percent of GDP in the early 1970s to 25 percent today. Furthermore, in the 1970s, over two-thirds of household saving was in physical saving, implying that it was dominated by housing and own-account construction, much of which never passed through financial institutions. (An unknown portion represents the investment of unincorporated business that are included as part of the household sector.) The most impressive growth has been in the category of financial saving, which increased from about 4 percent of GDP in the early 1970s to 12 percent in recent years and now represents half of household saving. These funds are available to finance investment in other sectors.

The estimates for 2004–05 and preliminary indicators for 2005–06 imply that household saving has recently declined slightly as a share of GDP. These data are subject to substantial revision, but the falloff is consistent with the rapid growth in consumer credit during the same period. It may be that this is a transitional response to the introduction of new consumer debt products, but it makes any projections of the future trend quite uncertain.

On the investment side, the CSO constructs two direct measures. The first is an estimate of *total* investment derived using the commodity flow method. Under that method, the total supply of goods by commodity line is estimated as the sum of domestic production and imports. It is then apportioned among intermediate inputs and the various components of final demand, such as consumption, exports, and investment. The process is similar to that utilized to construct input-output tables. Of necessity, many of the demand components and some of the elements of domestic production must be estimated using various fixed ratios. For both the public sector and private corporations, investment is derived from the same sources used to estimate their saving. Household investment is then obtained as a residual by subtracting public and corporate investment from the total. Thus, household investment (physical saving) reflects all of the potential for error in the estimation of total investment expenditures as well as the errors in the estimation of government and corporate saving. For example, it is alleged that many of the ratios used to allocate commodity output among the various expenditure components are seriously out of date.

A second direct estimate of capital accumulation is built up from individual industries, based largely on the expenditure approach in which information is obtained from buyers rather than producers. Measures of both fixed investment and inventory accumulation are constructed from a variety of sources, including surveys, public budget documents, and annual reports of public and private enterprises. Given the importance of the unorganized sector, this second set of estimates is particularly tenuous—but they provide the only information on the distribution of investment at the industry level.

Finally, by combining the estimate of national saving with the current account balance of the balance of payments (CA), the CSO can derive still a third indirect measure of total investment:

(7) $$I_T = S_T - CA.$$

Thus, the CSO actually has three alternative measures of aggregate capital accumulation that are semi-independent of one another. Prior to the last revision (1999–00 base), all three measures were published with their associated discrepancies. The CSO views the valuation from the saving side (equation 7) as the most reliable and emphasizes it in their publications. The various measures of investment and saving are shown for the period of 1960 to 2004 in appendix table A-2.

With the introduction of the 1999–2000 base, the CSO made several changes to its calculation and presentation of the alternative measures of capital formation. First, the definition of capital accumulation has been changed to include an estimate of net purchases of valuables, such as jewelry.[40] By 2004–05, these purchases represented 1.4 percent of GNI. However, no comparable change was made to include valuables on the saving side. Since the saving-side measure of capital accumulation has been the larger in recent years, this definitional change had the effect of sharply reducing the magnitude of the reported discrepancy between the saving and the commodity-flow measures of capital accumulation. However, we have retained the old treatment and excluded valuables from our measure of productive capital in the growth accounts.

Second, the CSO elected to eliminate the second discrepancy between the commodity-flow and industry-based estimates by distributing the discrepancy across the industry groups in proportion to their estimated levels of investment. The result was a dramatic upward adjustment of the industry-based investment of 30 percent for 1999–2000.[41] A previous pattern of a declining rate of investment—particularly within industry—was converted into a strongly rising trend. We integrated the new 1999–2000 and subsequent estimates of both saving and investment into the historical data by phasing the changes in between 1993–94 and 1999–2000, the same procedure that was used to link in the revisions to the other GDP data.

The composition of investment by institutional sector is shown in figure 3b. In a comparison with figure 3a, it is readily evident that the investment of both private corporations and the public sector is much larger than their own saving. The household sector has become an important source of finance for the rest of the economy. In addition, the growth of overall investment is concentrated in households and corporations, while public sector investment has been a consistently declining share of GDP. The increase in the household sector is largely due to the growing importance of private noncorporate enterprises. While there was a substantial upward revaluation of real estate investment (concentrated in the household sector) in the 1999–2000 revisions, the growth in household investment is substantially larger.[42]

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40. The accounts also adopted the suggestion of the 1993 SNA to include purchases of computer software, but the accounts do not include the development of own-account software and databases as investment.

41. The revision to the commodity-flow estimate was a more modest 12 percent.

42. As discussed in the section on growth accounts, the national accounts do not currently separate investment of the business services industry from that of real estate investment. That is unfortunate given the interest in the rapidly expanding business services industry.

Additional information on the role of the public sector is given in table 12. First, the historically low rate of public saving has primarily been due to the large dissaving in the administrative budget, not public enterprises. The shortfall of revenues relative to current outlays first emerged in the mid-1980s and then grew steadily over the years. After peaking in 2001–02 at 6.6 percent of GNI, the administrative budget deficit has been cut in half in recent years. Saving within public enterprises has increased over the past decade, so that total public sector saving turned positive in 2003–04.

T A B L E 1 2 . Saving and Investment of the Public Sector, 1970–2004
Percent of GNI

	1970–79	1980–84	1985–89	1990–94	1995–99	2000–04
Public sector saving	3.7	3.7	2.4	1.4	0.6	−0.3
Administration	2.0	1.4	−1.2	−2.0	−3.3	−5.1
Other public	1.7	2.3	3.6	3.4	3.9	4.8
Public sector investment	8.2	9.9	10.2	8.9	7.7	7.4
Administration	1.4	1.6	1.6	1.4	1.2	2.0
Other public	6.8	8.3	8.6	7.5	6.2	5.5
Puiblic sector net lending	−4.5	−6.2	−7.8	−7.5	−7.1	−7.7
Administration	0.6	−0.2	−2.8	−3.3	−4.5	−7.0
Other public	−5.1	−6.0	−5.0	−4.2	−2.3	−0.6
Addenda:						
Infrastructure investment	4.2	4.8	5.5	5.6	5.2	5.7

Source: appendix table A-2.
Note: Infrastucture investment includes investment of public utilities and the transportation and communication industries.

Investment of public enterprises did rise significantly in the 1980s—a point made by those who point to demand stimulus as a cause of the acceleration of growth in the 1980s.[43] However, enterprise investment was steadily cut back after the surge of the 1980s. Investment in the administrative budget has remained very low in recent years—between one and two percent of GNI. This reflects a longstanding lack of attention to infrastructure needs, particularly road building. Some other types of infrastructure investment are captured in the industry data for public utilities, transportation and communications, shown as an addendum to table 12. Again, this type of investment has also remained low as a share of GNI.

Some of the increase in the rate of gross investment that has taken place over the last quarter century has been offset by a rise in capital consumption allowances as a share of GDP, the result of a shift in investment toward

43. See Srinivasan (2003b) and Buiter and Patel (1992).

shorter lived machinery. During the latest 5-year period (2000–04), net investment has averaged 17 percent of GDP (appendix table A-2). At the same time, the aggregate capital-output ratio has also been a stable 2.5 times GDP, suggesting that the current rate of capital formation is sufficient to support a growth rate of 6–7 percent per annum.

Is saving constraining India's growth? To the contrary, we think the evidence suggests a higher potential growth rate should be quite feasible. First, the private saving rate appears to be rising over time.[44] Second, India should be able to support a significantly higher rate of foreign saving (current account deficit), particularly if this were financed by higher rates of FDI. Third, there continues to be substantial room for improving the saving performance of the public sector.[45]

As an additional reason for believing that current rates of saving are adequate to support future growth, we note that we can find little evidence of heightened competition for domestic capital. We constructed a lending rate by averaging the rates of four major lending institutions, as reported by the Reserve Bank of India (RBI). A real interest rate was computed on an annual basis using the ex-post realized rate of increase in the Wholesale Price Index. These data are summarized in table 13. While the real rate shows considerable fluctuation, there is little evidence of a secular rise. Although the rate rose in the late 1990s, it appears to have been a transitory response to a sharp decline in the inflation rate. Furthermore, a real interest rate in the range of 5–7 percent is not particularly high for a developing country.

T A B L E 1 3 . Nominal and Real Lending Rates, 1970–2004

Year	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04
Nominal lending rate	9.0	10.4	13.3	13.9	16.7	15.2	11.4
Inflation rate	15.3	4.7	9.3	6.7	11.0	5.3	5.2
Real interest rate	−4.9	5.9	3.9	6.8	5.2	9.4	5.9

Source: Reserve Bank of India (2006), tables 70 and 169.
Note: The nominal lending rate is an average of the rates for four major lending institutions. The inflation rate is measured by the annual rate of change in the wholesale price index for all commodities.

44. Several international studies of saving in developing countries conclude that there is a strong positive association with the level of income. For a discussion see Mühleisen (1997), and Loayza and others (2000). See Loayza and Shankar (2000) for a discussion of India's experience. Also, India's demographic trends support the notion of continued increases in private saving (Higgins and Williamson, 1997).

45. See Mitra (2006) for further discussion of these points.

Overall, this evidence suggests to us that the low contribution of capital accumulation to growth has largely been a product of weak incentives to undertake investment, rather than a saving constraint. Mary Hallward-Driemeier (2005) provides a recent overview of the literature on business climate and its implications for investment and private sector activity. Referring to the World Bank's survey based indicators—"Doing Business"—she finds that India ranks in the bottom 25 percent of countries. The survey highlights the firms' concerns, including poor access to electricity, and stringent labor regulations. The public sector, in particular, has not responded to obvious signs of insufficient infrastructure capital.

Implications for the Future

India is still a very poor economy, and increasing overall living standards is clearly the major priority. To achieve this, it will be necessary both to raise labor productivity, and to speed up the pace of job creation for those currently underemployed in rural agriculture. Our analysis in prior sections points to three implications for achieving this critical objective. While we are certainly not the first to highlight the issues below, we believe our analysis sheds additional light on the reasons for their importance.

First India must broaden the base of the economic expansion beyond the modern service sector, which, by itself, can not provide the requisite number of job opportunities. This point is cogently argued by Panagariya (2005) among others. Studies, such as Virmani (2005) and Kochhar et. al. (2006), have documented unusual features in India's development pattern to date, especially compared with other high growth Asian economies. These include a relatively low share of manufactures in GDP, a high share of employment in agriculture, and a somewhat surprising concentration of manufacturing (and services) in skill-intensive output. What is needed is a much more rapid expansion of the manufacturing sector, which will require strengthening India's infrastructure, raising private sector investment and adopting an aggressive approach to expanding India's export markets for goods.[46]

Second, India must accelerate the pace of improvements in the educational attainment of the population. As discussed above, this requires a

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46. Hulten, Bennathan and Srinivasan (2006) assess the importance of infrastructure for Indian manufacturing growth. Other relevant work includes World Bank (2002, 2004). Hallward-Driemeier (2006) and Dollar, Iarossi and Mengistae (2002) provide analyses of India's investment climate.

greater emphasis on increasing primary and secondary schooling, as well as expanding its already substantial pool of highly educated labor.

A third implication of our work is good news—India has strong prospects for increasing the saving necessary to finance the additional capital accumulation. It is true that the overall saving rate has not been as impressive as that of the high-growth East Asian economics. However, India's *private* saving rate has grown rapidly.[47] As incomes increase, experience elsewhere suggests that India's private saving should be expected to increase somewhat further. Equally important, India has considerable scope for raising foreign saving through increased FDI. To date India has received little of the very substantial global FDI flows to developing countries. Virmani (2005) notes that during 1980–2003, FDI flows averaged only 0.3 percent of India's GDP, putting India in the 7th percentile of his sample of 82 medium and large countries. Despite some recent liberalization, India's ranking remains near the bottom of such indicators. Estimates of the stock of FDI assets by country constructed by Philip Lane and Gian-Maria Milesi Ferretti show that as a share of GDP India's FDI stock is less than one fifth that for China.[48]

Concerns about the adequacy of national saving are centered on the behavior of the public sector. As discussed above, the public saving rate has fallen dramatically over the past twenty years. In part, this reflects a deteriorating situation within the public enterprises, requiring substantial subsidies and other transfers from the central administrative budget. In addition, central administrative budget deficits have become endemic.

Finally, the lack of reliable annual statistics on employment is a major limitation on efforts to evaluate current economic performance. Thus, we believe that India needs to undertake an ongoing household survey that would provide annual time-consistent measures of labor-market performance. The assessment of India's economic performance is made difficult by the lack of statistical coverage of large portions of the economy. In particular, there is no consistent information on employment between the quinquennial surveys. At a minimum, India needs an annual survey for the intervening years. The quality of the quinquennial surveys appears to be high, but the development of the sample frame for each survey is a major undertaking. In addition, by constructing a large portion of the sample frame as a new undertaking for each survey, the results have suffered from a lack of consistency over time. We believe that the maintenance and continued use of the

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47. For example, see Loayza and Shankar (2000).

48. Lane and Milesi-Ferretti (2006). Their data are available at http://www.ssc.wisc.edu/~cengel/CAConference/WP_External%20Wealth_final.pdf

sample frame from the quinquennial survey over the following five years would provide a relatively low cost means of obtaining time-consistent employment data.

Concluding Remarks

In this paper, we have revisited some of the key issues regarding India's economic growth performance and prospects. Our work updates previous studies and presents results based on analysis of new data. Our analysis focuses on the periods de-lineated by the quinquennial surveys, conducted in: 1973, 1983, 1987, 1993, 1999 and 2004. We have argued that researchers should have a reasonable degree of confidence in the GDP estimates for benchmark years. However, for non-benchmark years, annual output data are based on interpolation and extrapolation of the labor input data required to construct output measures for India's large unorganized sector. These estimates have been subject to substantial revisions. We conclude that the lack of reliable annual series make it impossible to pin down the precise timing of India's growth acceleration. Although it does seem clear that growth accelerated in the years after 1973, the precise timing and the triggering events remain topics of on-going debate.

It is clear, however, that India is enjoying a large and sustained acceleration of economic growth: from an average of about 3 percent per year in the years prior to 1973 to 6–7 percent over the past decade. Prior to 1973, growth was limited to increases in the factor inputs; but in subsequent decades, the contribution of improvements in the efficiency of input use, TFP, has grown in importance.

Considerable attention has been focused on the role of services—especially high-tech services—as the source of India's growth. Our growth accounts attribute 1.3 percentage points of the 3.8 percent per annum growth in GDP per worker during 1980–2004 to growth in total services productivity (versus 0.7 percentage points each to agriculture and industry and 1 percent to reallocation, respectively). However, the very strong gains in service sector TFP are also puzzling. One might expect such rapid productivity growth in sub-sectors such as finance and business services, but these sectors remain small—just 17 percent of total services output in 2004. In fact, the growth acceleration is quite widely dispersed across service sub-sectors. But rapid productivity growth seems unlikely in the biggest, which are trade, transportation and community services. Though difficult to verify,

we are concerned that output growth in services has been overstated, perhaps due to an underestimate of services price inflation, particularly in the more traditional sectors. The available measures of employment suggest a less dramatic acceleration of overall growth and a somewhat smaller focus on services.

The accounting decomposition finds that the growth contribution from increases in education has been quite modest. While India can boast a relatively large share of highly educated workers for its income level, average years of schooling and literacy rates among its population remain low, and the effort to achieve universal primary education is quite recent. Not only does India have a long way to go to catch up with competitors such as China, the rapid increase in school enrollments appears to have exacerbated concerns about educational quality—particularly in poorer regions. The growth accounts show that capital deepening has also made only a small contribution to growth—despite the recent data revisions that have substantially increased measured investment since 1993.

We also examine the evolution of India's saving behavior, to explore whether saving is likely to constrain India's investment. We argue that private saving in India has performed remarkably well. The rise is concentrated among households, who now save fully 25 percent of GDP. Further, nearly half of household saving is in the form of financial saving, available to fund corporate or public investment. However, public sector saving has been very low historically, turning negative during the late 1990s, before recovering somewhat more recently. We conclude that saving is not constraining India's growth. There is room for increased public saving, as well as a rise in foreign saving, particularly if financed through FDI which remains quite low in India.

Pulling together the findings of our analysis we draw a number of implications for India's growth in the coming decade. Our starting point is that improving living standards in India will require a combination of increasing employment and raising labor productivity. To date, accelerated output growth has been associated with a modest improvement in overall rates of job creation. And while agricultural output has fallen as a share of GDP, its share of total employment remains surprisingly high. We find that labor productivity in agriculture is just one-fifth that in either industry or services, implying significant productivity gains from further sectoral reallocation of labor.

Thus, India needs to broaden the base of its economic growth through greater efforts to promote the expansion of the industrial sector—especially manufacturing—and to emphasize the creation of jobs as well as gains in

TFP. In this context, China provides a useful model, in its emphasis on exports manufactured under foreign contract as a primary driver for growth. One key attraction to this strategy is that it provided rapidly expanding employment opportunities for relatively young, and low-skilled workers. A second is that it generated large feedback effects for the domestic economy—both in promoting linkages to the supplying industries (including services) and in developing local expertise for doing business in a global market.

To follow this strategy, India needs to create a more attractive economic environment for doing business—a location able to compete effectively with China. This will require strengthening its infrastructure—including a weak and unreliable power system, and poor land transportation in many states. However, compared with China, India already enjoys relatively good institutions and is strong in the areas of finance and business services.

Finally, we stress that successful implementation of this growth strategy should not be expected to generate rapid TFP growth within the growing sectors. Expansion of both industry and services will draw workers out of agriculture. This will generate gains in aggregate TFP from the reallocation of labor to higher productivity activities and from reduced labor redundancy in agriculture. Thus, reforms should be directed towards making it easier to expand domestic production, and creating a more attractive location for global business. We see strong prospects for sustaining this broad-based type of high growth in India.

A P P E N D I X

T A B L E   A - 1 .   Data Used to Compute Workforce, 1973–04

		Usually employed			
		Male		Female	
Round	Date	ps	all	ps	all
		Worker participation rates, per 1000 persons			
		Rural			
27	1-Apr-73		545		318
32	1-Jan-78	537	552	248	331
38	1-Jul-83	528	547	248	340
43	1-Jan-88	517	539	245	323
50	1-Jan-94	538	553	234	328
55	1-Jan-00	522	531	231	299
61	1-Jan-05	535	546	242	327

(Table A-1 continued)

(Table A-1 continued)

Round	Date	Usually employed			
		Male		Female	
		ps	*all*	*ps*	*all*
		Urban			
27	1-Apr-73		501		134
32	1-Jan-78	497	508	123	156
38	1-Jul-83	500	512	120	151
43	1-Jan-88	496	506	118	152
50	1-Jan-94	513	521	121	155
55	1-Jan-00	513	518	117	139
61	1-Jan-05	541	549	135	166
		Population (millions)			
		Rural		Urban	
		Male	Female	Male	Female
27	1-Apr-73	233.6	221.7	63.3	54.6
32	1-Jan-78	254.4	241.7	75.6	65.9
38	1-Jul-83	280.6	266.0	91.1	80.4
43	1-Jan-88	305.5	287.9	104.4	92.8
50	1-Jan-94	339.4	319.4	124.0	111.1
55	1-Jan-00	374.4	353.8	145.9	131.2
61	1-Jan-05	400.4	378.7	164.4	148.0
		Workforce (millions)			
		Rural		Urban	
	Mid round	Male	Female	Male	Female
27	1-Apr-73	127.3	70.5	31.7	7.3
32	1-Jan-78	140.4	80.0	38.4	10.3
38	1-Jul-83	153.5	90.5	46.6	12.1
43	1-Jan-88	164.7	93.0	52.8	14.1
50	1-Jan-94	187.7	104.8	64.6	17.2
55	1-Jan-00	198.8	105.8	75.6	18.2
61	1-Jan-05	218.6	123.8	90.2	24.6

Sources: Worker participation rates, NSSO (2006) table 5.1, p. 76; Population, 1973–88 data from Visaria (202), p13; later years from Sundaram and Tedulkar (2005a) table 1, 2005 from census projections. Workforce, computed by authors.

T A B L E   A - 2 .   Components of Saving and Invesment Balance, 1960–2004

Percent of GNI

Year	1960–69	1970–79	1980–84	1985–89	1990–94	1995–99	2000–04	2000–01	2001–02	2002–03	2003–04	2004–05
Gross domestic saving	12.7	17.6	18.5	20.5	23.3	25.3	28.9	26.0	25.9	29.0	31.6	32.1
Household Sector	8.5	12.3	13.2	16.2	18.7	19.9	24.6	23.4	24.2	25.3	25.7	24.3
Financial savings	2.7	4.6	6.4	7.3	10.2	10.5	11.7	11.3	11.9	11.3	12.5	11.4
Physical savings	5.7	7.7	6.8	8.9	8.6	9.3	12.9	12.1	12.3	13.9	13.2	13.0
Private corporate sector	1.5	1.6	1.6	2.0	3.1	4.7	4.6	4.6	3.9	4.5	4.8	5.3
Public Sector	2.8	3.7	3.7	2.4	1.4	0.6	-0.3	-1.9	-2.2	-0.7	1.1	2.5
Administration	1.4	2.0	1.4	-1.2	-2.0	-3.3	-5.1	-6.1	-6.6	-5.7	-4.0	-3.0
Other	1.4	1.7	2.3	3.6	3.4	3.9	4.8	4.1	4.4	5.0	5.1	5.4
External Investment (current account)	-2.0	-0.1	-1.4	-2.4	-1.5	-1.4	0.4	-0.7	0.7	1.3	1.8	-1.1
Total capital formation	14.8	17.7	19.8	22.9	24.8	26.6	28.5	26.7	25.2	27.7	29.8	33.2
Errors and Omissions	-0.7	-0.6	-1.0	-0.6	1.4	1.1	1.2	0.6	-0.8	0.7	2.0	3.2
Unadjusted capital formation	15.5	18.3	20.9	23.5	23.3	25.5	27.4	26.0	26.0	27.0	27.8	30.0
Public sector	7.0	8.2	9.9	10.2	8.9	7.7	7.4	7.6	7.6	6.8	7.1	8.0
Administration	1.4	1.4	1.6	1.6	1.4	1.2	2.0	1.8	1.6	1.9	2.1	2.4
Other public	5.6	6.8	8.3	8.6	7.5	6.2	5.5	5.9	6.0	4.8	5.0	5.6
Private crporate sector	2.8	2.4	4.1	4.4	5.9	8.6	7.1	6.3	6.1	6.3	7.5	9.1
Household sector	5.7	7.7	6.8	8.9	8.6	9.3	12.9	12.1	12.3	13.9	13.2	13.0
Valuables					0.1	0.4	0.9	0.8	0.7	0.6	1.0	1.4

(Table A-2 continued)

(Table A-2 continued)

Year	1960–69	1970–79	1980–84	1985–89	1990–94	1995–99	2000–04	2000–01	2001–02	2002–03	2003–04	2004–05
Industry basis	**15.8**	**18.8**	**22.6**	**23.8**	**22.1**	**27.3**	**27.4**	**26.0**	**26.0**	**27.0**	**27.8**	**30.0**
Ariculture	2.0	2.7	2.6	2.2	2.0	2.4	2.6	2.4	2.9	2.8	2.6	2.4
Industry	7.1	8.9	11.9	12.7	11.9	14.4	11.3	10.6	8.9	10.5	12.4	13.9
Services	6.7	7.2	8.1	8.9	9.5	11.1	13.5	13.0	14.2	13.7	12.8	13.7
Real estate	1.4	1.4	2.0	2.1	2.5	3.7	4.5	3.9	5.2	5.3	4.3	3.8
Capital consumption allowances	6.0	7.3	8.9	9.7	9.9	10.4	10.5	10.6	10.6	10.5	10.2	10.4
Infrastucture Investment	4.0	4.2	4.8	5.5	5.6	5.2	5.7	6.1	5.2	5.5	5.4	6.2
Fixed Investment - asset	14.1	15.9	19.1	21.6	22.6	24.6	26.5	25.1	25.4	26.3	27.0	28.6
Fixed investment - industry	14.4	16.3	20.8	22.0	22.6	26.6	26.5	25.1	25.4	26.3	27.0	28.6

Source: CSO (2006) and prior years.
Data include the revisions publised in the 1999–2000 base year revisions, but total capital formation redefined to exclude valuables.

Comments and Discussion

Shankar Acharya: This is an interesting paper, which covers a lot of ground and raises some important empirical and policy issues. I broadly agree with the major themes and findings of the paper. Precisely because it covers a lot of ground (some of it well-trodden) it might have been helpful if the authors had focused a little more on delineating more clearly their fresh contributions and comparing them with earlier work. My comments focus on the parts of the paper which interested me most.

Sources of Growth Analysis

I welcome the paper's constructive criticisms of Indian economic data, especially those relating to national income and employment. One wishes that more analysts spent as much time and effort in assessing the basic data deployed in their analyses. The underlying infirmities in the available data lead Bosworth-Collins-Virmani (henceforth, BCV) to give special weight to the (approximately) quinquennial "benchmark years", for which detailed surveys are available for applying the "labour input" method of estimating unorganized sector output and value added. That is why in the sub-periodization for their sources of growth analysis they prefer to deploy the benchmark years as "bookends" for their chosen sub-periods.

There is certainly appealing logic to their approach. But it does distract attention from alternative schemes of sub-periodization based on different criteria, such as policy regimes. For example, in some earlier work we (Acharya-Ahluwalia-Krishna-Patnaik, 2003) had divided up India's half century of growth experience (1950–2000) into four sub-periods (1950–66, 1967–80, 1980s and 1990s) on a prior identification of major policy shifts and major shocks. On that basis we found somewhat different trends in total factor productivity from those estimated here by BCV (their table 3). They find continuously rising TFPG rates between 1960 and 1999, whereas we found that TFPG first fell (in 1967–80) and then rebounded strongly in the next two decades. It would have been interesting to benefit from BCV's comment on such differing productivity trends.

More generally, I welcome the attention and space the authors devote to disaggregating the rise in productivity due to reallocation of labor and capital across sectors, specifically from low-productivity agriculture to higher productivity industry and services. It is standard stuff but too often neglected. The authors are to be congratulated for not doing so.

Services: Growth and Productivity

I warmly welcome BCV's focus on and cautionary remarks about growth of services in India and related issues of data reliability and sustainability. This is especially important given the unusually high and rising share of services in India's GDP and its growth. For the past five years or so I have been a somewhat lonely voice pointing to the unusual (and possibly unlikely) pace and pattern of services growth in India. For example, Acharya (2002, p. 1516), commenting on India's growth pre and post the 1991 crisis, noted:

"In both the pre-crisis decade and the post-crisis quinquennium services accounted for a little under half of GDP growth. For the full nine years, post-crisis, the growth-contributing role of services was almost 60 percent. Even more remarkably, the proportion rose to nearly 70 percent in the last four years. Without wishing to be labeled as a commodity-fetishist, this kind of numbers surely raises genuine issues of both plausibility and sustainability."

It's good to have BCV join one's corner in this ongoing debate, although they are surely mistaken in dating the services sector surge as beginning in 1980. It's much more a post-1996/7 phenomenon. BCV's own analysis shows this, when they are rightly skeptical of their findings of labor productivity growth of 7 percent per year and TFP growth of nearly 5 percent in services in the latter part of the 1990s. They go on to hypothesize over-estimation of services real value added (in the official data) for some reason including, possibly, under-estimation of inflation in many traditional service activities such as trade, transportation and community services.

Let me draw BCV's attention to some cross-country data to reinforce their skepticism. Some years ago I looked at comparative growth performance of developing countries over a longish, 35 year period, 1965–2000. It was interesting to find that in not one of the seven fastest growing economies of that period did services grow faster than industry (see Acharya (2003), especially chapters 3 and 5). This was in marked contrast to post-1996/7 growth in India, especially during the Ninth Plan period 1997–2002,

when services growth averaged 8.2 percent and industry grew much slower at 4.4 percent. This kind of anomaly had led me to two conclusions, which BCV appear to share: possible over-estimation of services value added and growth in recent years; and the more important policy lesson that if India wants long-term rapid economic growth, industry and agriculture also have to grow fast.

Policies for the Future

BCV's general policy advice for sustaining rapid growth is unexceptional and easy to agree with: "India needs to broaden the base of its economic growth through greater efforts to promote the expansion of the industrial sector—especially manufacturing—and to emphasize the creation of jobs as well as gains in TFP." That's pretty well accepted here in India. The issue is how to set about it. BCV do not go beyond recommending better infrastructure and a more attractive investment climate. Given the empirical focus of their paper, this is perhaps fair enough.

In fact, the menu of desirable policy reforms to serve the broad objective is well-known (see, for example, Acharya (2006) and Panagariya (2006)). It includes: reform of labour laws, abolition of small-scale industry "reservations", further trade policy reforms, fiscal discipline, revitalization of a sluggish agricultural sector and privatization of government enterprises in energy, banking, transport and communications. The difficult task ahead is to get these reforms implemented.

Rajnish Mehra: I specially thank Jean Pierre Danthine, John Donaldson, Marek Kapicka, Krishna Kumar and Edward Prescott for their insightful comments, many of which are incorporated in this discussion. I am also grateful to the participants of the India Policy Forum Conference for a stimulating discussion. I remain responsible for any errors.

Introduction

In this thought-provoking paper, the authors raise several interesting issues regarding the empirics of growth in India. Their analysis builds on their earlier work and on the study by Sivasubramonian (2004). I want to use this discussion to highlight some of the issues raised in the paper.

The paper is an exercise in Growth Accounting—a task that is challenging to undertake in India due to a large informal sector, major statistical revisions and a lack of systematic annual surveys. The paper brings quantitative rigor to bear upon assertions that have heretofore been part of conventional wisdom. Its basic conclusions are:

a. India's success has not been based on strong growth in the manu-facturing sector.
b. The success is a result of a rapid expansion in service producing industries.
c. Physical capital accumulation has not been impressive.
d. Illiteracy remains high.

The paper is agnostic in identifying the takeoff year for Indian economy. Given the major revisions that have been undertaken to the National Accounts, I believe that this is the correct perspective.[1]

Methodological Issues

The paper starts out by presenting a general production formulation with time varying shares. However, the framework for analysis that is ultimately used is standard Cobb-Douglas with fixed shares and constant returns to scale. For example, for the agricultural sector the functional form used is:

$$y_A = A k_1^{\alpha_1} k_2^{\alpha_2} l^{\alpha_3}$$
$$k_1 \ : \ \text{capital}$$
$$k_2 \ : \ \text{land}$$
$$l \ \ : \ \text{labor}$$

with shares $\alpha_1 = 0.25$, $\alpha_2 = 0.25$, and $\alpha_3 = 0.5$. For the industrial and service sector the shares are $\alpha_1 = 0.4$, $\alpha_2 = 0$, and $\alpha_3 = 0.6$.

I have some reservations regarding the authors' methodology. They use fixed factor shares, which may be appropriate for analyzing advanced industrial economies (which presumably are in "steady state") but this mode of analysis does not readily translate to an economy in transition. Further, abstracting from returns to scale very likely overstates TFP.

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1. These revisions are probably responsible for the current debate between Rodrik and Subramanian (2005) and others.

There is a well-established literature documenting the importance of taxes as a factor in investment and labor supply decisions. Thus, it is surprising to see no analysis regarding the role of taxes and other distortions, in this paper.[2]

From the perspective of neoclassical growth theory, one can analyze economic growth and identify anomalies by undertaking two related, but in principle distinct, exercises. The first examines whether changes in employment, investment or capital accumulation are consistent with a given TFP growth rate while the second is an analysis of the TFP growth rate itself. The distinction is important, because each has a different methodology and different results. The paper would have benefited from drawing a distinction between these two exercises. For example, to analyze the problem of changes in employment, investment or capital stock, one should compute the growth model for a given time path of TFP. Conclusions such as "India's priority is to generate employment in industry" could be misleading because industry employment may in fact be optimal, *given the TFP in industry*.

Similarly, the conclusion that "(it is a) surprise that agricultural employment continues to grow" may be misleading. Hayashi and Prescott (2006) found a similar pattern of agricultural growth in Japan prior to the Second World War.[3] They attributed this to the sizeable transaction costs of moving from agriculture to other sectors. It would be interesting to compare results and see, for instance, whether the implied transaction costs in pre-war Japan and current day India are of similar magnitudes. This issue may be related to the problem of low educational attainment. If, for example, the transaction costs of moving from agriculture are high, there are fewer incentives to invest in education.

In the absence of a well-established theory of TFP, one typically needs to resort to anecdotal evidence to do the second exercise and identify puzzles in TFP growth. For example, I would expect the liberalization reforms in the 1980's and 1990's to be related to increases in TFP. The authors compare changes in services across various East Asian countries and conclude that the TFP growth in services is puzzlingly high. It would make sense to likewise compare TFP growth rates across East Asian countries.

Meaningful price level deflators are a crucial parameter input for growth accounting. The lack of a comprehensive price index in India that adjusts

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2. See the section on 'A Puzzle' in this discussion.
3. I thank Marek Kapicka for bringing this to my attention.

for quality and technical innovation is a major impediment in this context. The authors do not discuss this important issue in any substantive way. Typically, the inflation rate for different sectors varies, often considerably. This could potentially bias reported growth rates; in particular, the growth rate for the service sector may be overstated. This is especially likely to be the case in a sub-period where there was a substantial pay increase for the civil service or the public sector, or where there was general wage inflation due to a skill shortage.

This is documented by Young (2004) for the Chinese economy. After correcting for what he believes to be a systematic understatement of inflation, Young recalculates growth rates and concludes that from 1986 to 1998, they averaged 6.2 percent per year, "3 percent less than the officially reported figures of 9.2 percent."

The paper documents an interesting finding that unlike in other countries productivity growth in agriculture has been higher than in industry for most sub-periods documented in table 5.[4] On the face of it, this suggests that the reallocation of workers from farms to industry could, at the margin, have an adverse effect on overall growth. However, this conclusion is probably incorrect since the *level* of productivity is likely to be higher in industry.

On the other hand, since both the productivity level and growth rates are higher in services than industry, farmers should switch to services instead of manufacturing. Almost all developed countries have seen a shift toward services and India is experiencing this at even lower levels of income. Why not capitalize on this rather than turn to manufacturing for growth?[5] The authors argue that the service sector is unable to generate sufficient employment or incentives for education. On the contrary, a large return to human capital will induce more accumulation and growth; there are gains from specialization and India is specializing!

A Puzzle

The low level of investment and investment growth in India relative to other developing countries is a puzzle. Given the large labor pool and respect for property rights, neoclassical economic theory would predict that rates of return on capital would be high with a concomitant high level of investment. Why then has the level and growth rate of investment been disappointing?

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4. A notable exception is the period 1999–2004.
5. See the section on Social Instability, below, for a non-economic reason.

One way to address this would be to undertake an exercise similar to the one performed in "Business Cycle Accounting" (Chari, Kehoe and McGrattan (2005)) and identify what the authors term "wedges", which are, essentially, discrepancies in first order equations in the neoclassical growth model. If investment is too low, it may be due to sizeable wedges that distort investment decisions.

A partial answer can be found in the Indian labor laws. The neoclassical prediction is based on the assumption that a labor surplus would translate into low wage rates. This is not, however, the case: hiring a worker implicitly involves a dual cost, a wage rate and unemployment insurance—since termination is a costly transaction—and results in raising the effective wage rate. While this benefit accrues to a relatively small portion of the labor force, the potential distortions are significant.

Given the well articulated bargaining power of Indian labor unions, it is probably politically non-feasible or inexpedient to change these laws. One solution could be to "grandfather" the current workers and have new laws apply to new hires,[6] a solution that has, historically, met with less resistance from unions.

Miscellaneous Comments

Growth through Outsourcing

If the current growth rates in the service sector persist into the future, income from outsourcing, as a percentage of GDP, will be substantial over the next 10 to 15 years. This will make the Indian economy sensitive to the US and other countries' business cycle fluctuations. In fact, the Indian BPO will manifest an "amplified fluctuation" because of the lack of equivalent job placement in the domestic economy. A worker laid off in the outsourcing industry will experience a substantial drop in income since there are few, if any, jobs that are substitutes. This in turn would impact on consumer demand and through the multiplier effect could precipitate a recession. It may also affect the banking sector. Currently, local banks are making consumer loans with a 5 to 10 percent down payment. In the event of a severe

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6. Another response to get around labor laws is domestic outsourcing. A senior Indian executive recently told me that his company, instead of starting an in-house IT department, decided to sub contract it. I am told the practice is becoming increasingly prevalent.

Yet another response is the lack of enforcement by some states in a bid to attract investment.

downturn, the possibility of a large-scale default could undermine, if not threaten, the stability of the banking system.

A time consistent solution would be to explicitly recognize this possibility and to tax a portion of service sector wages, with the proceeds being used to create a contingency fund, invested in assets whose performance is orthogonal to the economic well being of the US economy. This fund should be earmarked for partial unemployment insurance or as reserves, to bail out banks should the above scenarios occur.

Implications for Social Instability

The one billion plus Indian population can be roughly divided into three groups: the illiterate 400 million, the semi-literate 400 million and the 200 million with secondary and post secondary education.[7] The current trend in growth through services concentrates the vast majority of the gains in the hands of the 200 million. This is in contrast to the scenario in China where manufacturing plays a major part and the semi-literate also share in the gains.

In case of India, this pattern of growth is creating an increasing skewness in the wealth distribution with concomitant implications for social instability. As an example, witness the election results in several states with a flourishing service sector and the noticeable increase in Naxalite activity.

General Discussion

T. N. Srinivasan raised a number of questions related to data quality and estimation. First, contrary to the view taken by the authors, estimates of agricultural output are not that much better than those of outputs in other sectors. Second, the sample size of thin rounds of the NSS Employment Unemployment Surveys are sufficiently large for getting reliable estimates at the All-India level. In any case, there are serious problems in using NSS-based estimates of employment rates with census-based estimates of population to arrive at estimates of employment. (see Srinivasan, forthcoming). Therefore, the argument that only thick surveys can be used to get reliable estimates of employment, made by the authors, is not compelling. Third, one component of services is the government sector where output is measured by input. Any increase in the salaries of this component, say, following the recommendations of the Pay Commission, automatically translates

7. See table 8 in the paper.

into productivity increase. Fourth, there are serious problems with the way informal sector services and savings and investment are measured by the CSO. The methodology to measure them has not changed for decades. Finally, in estimating the rate of return on education, the authors do not take into account the selection bias. Who chooses to seek education and who does not is an endogenous decision and ignoring this would bias the estimate.

Abhijit Banerjee said we should not think of technology upgrading as in the traditional neo-classical model as the main source of TFP growth. In India, policy-imposed distortions lead to such vast differences between the values of marginal product of capital and labor (measured at world prices) across firms that equalizing them by itself can raise productivity by 2.5 times and eliminate the differences in productivity levels between India and the United States. One way to see this is to note that there are far too many medium size firms in India. These firms should either become very large or not exist at all. Distortions in the capital and labor market are the reason for the existence of so many medium size firms.

Banerjee raised two additional points. First, in line with what TN and Rajnish Mehra said, we do not know if the increase in the unit-value of services represented improved quality or price adjustment implicit in the methodology used to measure them that is unrelated to quality. Second, we need to understand why people do not want to move out of agriculture. Evidence shows that many who spend most of their time in agriculture do not actually earn most of their income from agriculture. They go out of their homes for less than 90 days and earn more income during that period than from agriculture the rest of the time.

Dilip Mookherjee joined the discussion on the measurement problems in services. He cited a careful survey that found the average monthly incomes of doctors in Delhi to be Rs 20,000. In comparison, the national income accounts use a figure of Rs 800 per month for the income of doctors. Similar problems must exist in other sectors such as transport and domestic services.

Focusing on the policy prescriptions in the paper, Aasha Kapur Mehta said that if poverty reduction is the objective, a lot more than what the paper prescribes needs to be done. Shankar Acharya referred to agriculture and its importance. Both farm and non-farm productivity must be raised. There is also the issue of people getting out of poverty and falling back into it.

Devesh Kapur made two points. First, the services aspect of manufacturing is being shifted to the unorganized sector and is now counted as services output. If you look at large manufacturing firms, prior to reforms,

things like transportation, security and canteen services were done within the firm. Since the reforms, there has been a trend towards shifting them out of the firm. This is true of not only the private sector, but the public sector as well. Class IV employees are being eliminated from public sector undertakings like BHEL. So, what is happening is that you see a smaller increase in the output of manufacturing because part of it is now being counted in the services.

Second, the issue of labor laws continues to surface in the discussions. But if you survey large firms on what constrains them, labor laws never figure among top five concerns, which typically include tax, corruption, a variety of micro regulations, and power supply. Most companies know how to deal with labor laws.

Kaushik Basu agreed with Devesh Kapur arguing that when firm managers are asked whether the labor law is binding and whether they are giving it top priority, they talk about a variety of other problems and labor laws do not figure in their replies. Perhaps, one of the reasons for that is that if one believes something to be inevitable, one does not mention it. The managers just take it as a given—something about which nothing can be done. Separately, Basu commented that Arvind Virmani put forward the point—a point widely made—that we need to emphasize the manufacturing sector. What is worrisome, however, is that we may be returning to the old Planning Commission view. The right thing to do is to remove all the stumbling blocks. There should be nothing, which is holding back the manufacturing sector. Labor laws are one of them. Corruption may be another. But you cannot have a target saying that really we want the manufacturing sector growth to be so much. That would throw us back to the old times.

Ajay Shah joined the discussion on labor laws offering an anecdote to make his point. He was once sitting face to face with a big Indian industrialist and asked him why he chose not to play in textiles even though he saw the end to the textile quotas coming? His answer was: the only way one could successfully play in the garment industry would be with 1,00,000 workers and that would not work with Indian labor laws. So, this businessman chose to go into other businesses like petroleum refineries in which he could work with a small number of contract workers.

Poonam Gupta commented on the point made by Devesh Kapur that growth in services may be grossly overstated on account of many manufacturing firms shifting services from within, to outside the firm. Based on her work, she found this outsourcing component to be very small. Much of the growth has come from other sectors that have been liberalized. And this growth is real and tangible.

Arvind Panagariya also joined the debate on labor laws. Taking cue from Ajay Shah's anecdote, he said those who we expect to say that labor laws are real hindrance to their operations are simply not there. These include large-scale manufacturers in the apparel or shoe industry. If you go and ask Infosys whether labor laws pose a threat to its operation, it is going to answer in the negative. Put differently, China produces and exports the unskilled-labor-intensive goods in large volumes. How is it that with very similar factor endowments, India does not do the same? Despite the abundance of unskilled labor, no one in India is willing to go into large-scale manufacturing of unskilled-labor-intensive products.

On a different issue, Panagariya said that one of the authors' premises behind the optimistic view on savings was questionable. The authors take the view that as we reduce the fiscal deficit, savings available to the private sector would expand one-for-one with the decline in the deficit. Whether or not this happens, is likely to depend on how you eliminate the deficit. If you are going to do this by increasing tax revenue, which seems to be everybody's favorite and perhaps the only feasible solution, it would almost surely cut disposable incomes and therefore private savings in significant volume. Indeed, even if you eliminate the deficit by cutting expenditure, private expenditure will rise at least partially (and correspondingly private savings would fall) to make up for the reduced supply of public goods.

Shankar Acharya joined the debate on labor laws expressing full agreement with Arvind Panagariya. Using a metaphor he attributed to Lant Pritchett et al. in their Development Policy Review of India, he said that in a desert one expects to see camels and not hippos. In other words, even if one has the factor endowment conducive to having labor-intensive industries (camels) but have crazy labor laws, you end up with capital and skilled-labor-intensive industries (hippos). Then if one asks hippos if humidity (crazy labor laws) bothers them, the answer will not be in the affirmative. That is the point Arvind Panagariya was making. If Reliance does not operate labor-intensive industries in the first place, no point asking them if crazy labor laws are a hindrance to their operations.

Turning to savings, Acharya said that a lot of the change is to be attributed to demographic change. That change is providing a lot of increase in the household savings. An extraordinary thing has been happening since '90s or thereabouts. In all households the number of dependents per household has dropped and the proportion of people in the working age population has risen. In a way this has rescued India from paying much larger cost of fiscal deficits.

Ashok Lahiri turned to the issue of productivity in manufacturing. Referring to the remark by Barry Bosworth that we do not expect high productivity growth in manufacturing because manufacturing activity consists of combining the machinery imported from abroad and domestic labor, he said that growth resulting from this process must show up mostly in TFP since the cost of imported machines is not especially high relative to the domestic machinery but it is more productive. For example, the difference in the cost of the second-hand textile machinery that we brought from Scandinavia in the last 10 years and that domestically available was minimal. But the productivity difference between the two sets of machines was enormous.

Lahiri also noted that whether savings prove a constraint on growth or not would depend on whether deficit declines or not. The reason is the low tolerance for the current account deficit. With the current account going into deficit after three years of surplus, concerns are already being expressed as if we are in a crisis.

The session concluded with brief responses by Arvind Virmani and Barry Bosworth. Virmani made four points. First, with respect to the measurement of services, modern services such as telecom and financial services and airlines services all of which are growing fast have reliable data. The real question is whether the remaining fast-growing services such as trade, hotel and restaurants have good data. Second, according to an event study, the change in the threshold from 300 to 100 workers for the application of chapter V B of the Industrial Disputes Act showed a significant drop in the number of firms with 100 to 300 workers. This is important evidence showing the labor law has stunted the growth of firms with more than 100 workers. Third, contrary to Kaushik Basu, manufacturing growth is not that important for GDP growth, but it is important for employment growth. Unless labor law changes, India will not have the transformation other countries have had and it will remain an outlier. Finally, if good policies are put in place and the economy is growing, savings will be forthcoming. Virmani agreed with the narrower point of Arvind Panagariya, however, that if the government has to tax to eliminate the fiscal deficit, the reduction in the deficit will have a negative impact on private savings.

Responding to Banerjee, Bosworth began by noting that the paper does take into account re-allocation effects. He also agreed that TFP is not a measure of technological change; indeed, technology innovation for developing countries is absurd. Differences in the level of TFP across enterprises are common and India is not especially different in this respect.

Much of TFP comes from inefficient firms exiting and efficient ones entering. There is no TFP growth within existing firms.

The other point Bosworth made concerned the selectivity bias issue that Srinivasan had raised. Virtually all studies have this selectivity bias. What this paper finds is that India is different in one important respect: non-linearity in the returns to education in that the return at the higher end of education jumps. This is consistent with the common observation that people in the middle of education distribution do not have very many job opportunities.

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Trade Liberalization, Labor-Market Institutions, and Poverty Reduction: Evidence from Indian States[#]

1. Introduction

International trade can affect poverty through its impact on both efficiency and distribution. There are a number of good reasons for expecting trade to reduce poverty through both channels. In the first place, trade generates efficiency gains from specialization and exchange, as well as through the availability of larger varieties of final and intermediate goods. Secondly, many poor countries are abundant in unskilled labor. Under fairly plausible conditions freer trade should lead to an increase in the returns to unskilled labor in poor countries and in this way reduce poverty.

A number of factors may, however, prevent trade from having its expected effect of reducing poverty. For example, only in the presence of perfect intersectoral factor mobility can we unambiguously say that trade will increase the returns to unskilled labor in highly labor-abundant developing countries. Such factor mobility may hold only in the long run. In the

shorter run, there will be adjustment costs to be incurred and at best inter-sectoral factor mobility will be imperfect. Under those conditions, the short to medium run impact of trade liberalization on poverty, in theory, will be ambiguous. These ambiguities are accentuated further by the lack of clear theoretical predictions also on the effect of trade on growth. Ultimately, the relationship between trade and poverty thus becomes an empirical question.

In this paper, we empirically investigate the impact of trade on poverty, using state-level data from India, an extremely labor-abundant country in which around a third of the world's $1-a-day poor live. This is also a country that has, starting from virtual autarky, experienced large scale and deep trade reforms since the early 1990s (or according to some the late 1980s). To obtain a clearer picture of what went on with respect to poverty during this period, we also investigate the impact of another important, comple-mentary component of economic reforms, namely product market deregu-lation. Since independence, a system of industrial licensing governed the entry, expansion, and location of manufacturing activities. Starting from the mid-1980s, the government began a serious process of exempting spe-cific industries from industrial licensing, a process commonly referred to as delicensing.

While the effects of economic reforms, in general, on overall prosperity are fairly visible, the effects of trade liberalization on poverty reduction, in particular, have been questioned by many. As for the effects of delicensing, we are not aware of any study examining the links between delicensing and poverty. Yet, it is an important link to examine. As Aghion et al (2005) point out in their recent study of delicensing, its impact on output, em-ployment, and investment in formal (organized) manufacturing appears to have varied by the particular regulatory environment across India's states. In particular, states with business friendly labor market institutions appear to have gained from delicensing vis-à-vis states with pro-worker labor market institutions. This leaves open the possibility that delicensing may have worsened economic conditions at least in some states, with possibly adverse consequences for poverty reduction.

The most sophisticated evidence brought to bear on trade-poverty linkages is that of Topalova (2005) who has examined the impact of trade liberalization on district level poverty in India. Her study finds that "rural districts where industries more exposed to trade liberalization were con-centrated experienced a slower progress in poverty reduction". She further

writes that "compared to a rural district experiencing no change in tariffs, a district experiencing the mean level of tariff changes saw a 2 percentage points increase in poverty incidence and a 0.6 percentage points increase in poverty depth. This setback represents about 15 percent of India's progress in poverty reduction over the 1990s." She also finds this poverty accentuating effect of openness to be much weaker in states that had more flexible labor market institutions. However, she finds "no statistically significant relationship between trade exposure and poverty in urban India", even though the point estimates of the effect are still in the same direction as in the case of rural poverty.

Although Topalova's study is based on a careful analysis of poverty-and trade-related data it is important to examine the robustness of her results. While our paper's focus on the impact of trade on poverty is, therefore, the same as Topalova's, there are some important differences. First, while Topalova restricts her analysis to tariffs, we look at both tariffs and nontariff barriers (NTBs), and alternatively at a principal components aggregation of the two policy instruments. We weigh tariffs and alternatively NTBs by sectoral employment to arrive at the state level inverse measure of the trade exposure of the labor force (as does Topalova at the district level for tariffs). However, we refrain from using nontradable employment weights in the aggregation of protection. Topalova uses nontradable sector employment in her tariff aggregation by assuming nontradable tariffs to be zero. We do not agree with this approach. Firstly, goods can be nontradable if the natural/informal barriers to trade are prohibitive (not if they are nonexistent). Also, given that this employment-weighted tariff is an inverse measure of trade exposure, assuming a zero tariff for nontradables would defeat the purpose of this instrument. The easiest way to understand this is to look at two states A and B which have the same distribution of their labor force in the tradable sectors across those industries but A has a larger fraction of its employment in the nontradable sector than B. In this case, while A has a lower exposure to trade overall, Topalova's measure will imply a lower inverse measure, that is, a higher exposure to trade. On the other hand, a higher tariff in one or more sectors, holding everything else constant, results in an increase in her measure and to that extent, it is indeed an inverse measure of trade exposure.[1]

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1. The size of the nontradable part of economy is endogenous to protection given to tradable sectors and to factor endowments (controlled for by our state-specific fixed effects).

Second, we allow for the transmission of changes in protection rates to domestic prices to vary by state in some of our analysis. This is an important possibility to consider since a variety of factors, such as a given geographical unit's distance from ports and its quality of transportation infrastructure will influence how domestic prices at that location are affected by changes in protection rates.[2]

Third, in contrast to Topolova's approach of using district-level measures of urban and rural poverty, we work with state-level measures of urban, rural, and overall poverty. However, we complement this analysis through robustness checks using region-level measures of poverty.[3] Our approach is based on the official position of the Government of India and the sample design strategy employed by the National Sample Survey Organization (NSSO) in collecting survey data on household expenditures.[4] The NSSO (1999) note on sample design and estimation for the 55th Round of their Consumption Expenditure Survey clearly states that the sample of households is random within each "stratum", which is formed by a random sample of "first-stage units (FSUs)" within it. While an FSU is a village for rural areas, it is an "urban-frame survey block" for urban areas. A stratum is normally a district in the case of the survey for rural areas, which means that estimation of rural poverty at the district level will normally be justified. However, in many cases a few small districts are combined to form a single stratum in the sampling process. This is done so that the sample of households is large and meaningful enough. Furthermore, some district boundaries change over time. The real problem arises in the estimation of urban poverty at the district level since an urban stratum is never a district but is based on either a "hospital area" or an "industrial area" or a "bazaar area" within a city or a collection of small towns.

Fourth, like Topolova's, our poverty measures are based on the poverty lines recommended by Deaton and Drèze (2002; henceforth, DD) and their approach for adjusting poverty estimates for a change in the questionnaire design of the 1999–2000 National Sample Survey (NSS) household

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2. We are grateful to T.N. Srinivasan for drawing our attention to this point.

3. These regions, often referred to as NSS regions, refer to an intermediate geographical unit lying between a state and district. A region is usually made up of several districts within a state with similar agro-climatic conditions and socio-economic factors (Murthi, Srinivasan, and Subramanian 1999).

4. Official estimates of poverty are computed by India's Planning Commission. These estimates pertain to poverty rates in rural and urban areas at the state level.

expenditure survey. However, we also use two additional sets of poverty measures to check the robustness of our results to alternative estimates of poverty. One corresponds to the official Government of India (GOI) estimates of poverty with an adjustment made for the new questionnaire adopted in 1999–2000. The other is based on a longer series (10 years of data for the 1990s and late 1980s) of state-level poverty rates created by Ozler, Datt and Ravallion (2006) using both the "thick" and "thin" rounds of the NSS in India.[5]

Finally, while our "thick-round" analysis is based on poverty estimates for three years—that is, corresponding to the latest three available "thick" rounds of the NSS (that is, 1987–88, 1993–94 and 1999–2000) for which protection data are available—Topolova's analysis is restricted to two thick rounds, those for 1987–88 and 1999–2000, as she believes there is uncertainty regarding whether the 1993–94 poverty is driven by post or pre-reform policies. We, on the other hand, include 1993–94 in our thick round analysis since the state-level trade exposure measure is being used as a regressor.

Our results are different from Topolova's. In no case do we find reductions in trade protection to have worsened poverty at the state or region level. Instead, we find that states whose workers are on average more exposed to foreign competition tend to have lower rural, urban and overall poverty rates (and poverty gaps), and this beneficial effect of greater trade openness is more pronounced in states that have more flexible labor market institutions. Trade liberalization has led to poverty reduction to a greater degree in states more exposed to foreign competition by virtue of their sectoral composition. Our results hold, at varying strengths and significance, for overall, urban and rural poverty.

It needs to be emphasized here that we do not believe it is the difference between the way we compute our tariff measure and the way Topalova computes hers that generates the difference in results. Just sticking to tariffs will not give us strong conclusive results. It is ultimately the additional use of NTBs and the first principal component measure of protection that generates a fairly, clear overall picture that trade liberalization is positively

5. While in theory the DD measure is superior to both the GOI and ODR measures, in practice in a world with imperfect data it is possible that it is not so. This could be due to the high demands placed on the wide variety of data required to compute the DD measure. Also, the ODR provides us with a much longer series, thereby enabling us to exploit the longer time variation available for our right-hand side variables.

associated with poverty reduction, at least in states with more flexible labor-market institutions. We also find some evidence that industrial delicensing has had a more beneficial impact on poverty reduction in states with flexible labor institutions consistent with the findings of Aghion et al (2005) on the relationship between delicensing and performance of registered manufacturing sector across Indian states.

The remainder of this paper is organized as follows. Section 2 reviews the literature on the relationships between trade, growth, and poverty. Section 3 describes key elements of the Indian policy framework relating to trade, labor regulations, and the industrial licensing regime over the 1980s and 1990s. Section 4 discusses data issues concerning poverty and measures relating to the policies described in Section 3. Section 5 presents the results of our empirical work while Section 6 concludes.

2. Trade and Poverty: Review of Related Literature

The effects of trade barriers on growth and income have been studied since the early 1990s. While Dollar (1992), Sachs and Warner (1995) and Edwards (1998), using different measures of openness, in many cases constructed from standard policy measures, showed positive effects of trade on growth, these papers have been strongly criticized by Rodriguez and Rodrik (2001) for the problems with measures of trade openness and the econometric techniques used as well as for the difficulty in establishing the direction of causality. While Rodriguez and Rodrik (2001) have criticized the measure of openness used by Sachs and Warner (1995) as capturing many aspects of the macroeconomic environment in addition to trade policy, Baldwin (2003) has recently defended that approach on the grounds that the other policy reforms captured in the measure, though not trade reforms per se, accompany most trade reforms sponsored by international institutions. Therefore, using such a measure tells us the value of the entire package of trade and accompanying reforms. Wacziarg and Welch (2003) have updated the Sachs-Warner dataset and have again shown the benefit of such reforms in driving growth.

Recently, the empirical literature has shifted focus to levels from growth rates. Frankel and Romer (1999) look at the effect of trade share in GDP on income levels across countries for the year 1985. They construct an instrument for the trade share by summing up the gravity-model driven,

geography-based predicted values of bilateral trade flows across all trading partners. The variables used to predict bilateral trade flows include distance, country size variables such as land area and population and dummies for whether the countries are landlocked, have a common border etc. They find that their instrumental variables approach produces positive effects of trade on income levels that are greater than the estimates produced by ordinary least squares. Irwin and Tervio (2002) apply the Frankel-Romer approach to cross-country data from various periods in the twentieth century to show that this trade-income relationship is indeed highly robust.

Building on two literatures, namely the one on institutions and incomes and the other on trade and incomes, Rodrik, Subramanian and Trebbi (2002) have looked at the simultaneous effects of institutions, geography and trade on per capita income levels. Using a measure of property rights and the rule of law to capture institutions and the trade-GDP ratio to capture openness in trade, and treating them both as endogenous in their growth regressions, they use the instruments that Acemoglu, Johnson and Robinson (2001) and Frankel and Romer (1999) use to instrument institutions and trade openness respectively (and separately). Rodrik, Subramanian and Trebbi (2002) find that "the quality of institutions trumps everything else". However, trade and institutions have positive effects on each other, so that the former affects incomes through the latter. Similarly, geography also affects institutions.

The literature on the impact of trade on growth and incomes is important in our context, as it is an important potential channel through which trade affects poverty. The literature on the direct determinants of poverty rates and changes (or rather reductions) in it is much smaller.[6] Dollar and Kraay (2002), in a cross-country study of 92 countries over the last four decades, find that the growth rates of average incomes of people in the bottom quintile are no different from the growth rates of overall per capita incomes, with the former growth always associated with the latter. Thus the share of the bottom quintile of the population in overall income is fairly stable. Also policies that promote overall growth promote growth in the incomes

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6. For an excellent, comprehensive survey of the evidence on the globalization-poverty linkage, see Harrison (2006). On the basis of all the evidence she surveys, Harrison concludes that globalization is more likely to help in poverty reduction if complementary policies that include human capital and infrastructure investment, credit promotion, macroeconomic stability etc are in place. She also emphasizes the need for "carefully targeted safety nets" arising mainly from the fact that even among the poor there are both winners and losers from globalization.

of the poor. These policies include trade openness, macroeconomic stability, moderate government size, financial development, and strong property rights and the rule of law. In another paper, Dollar and Kraay (2004), based on data from the post-1980 "globalizing developing economies", argue that per capita income growth arising from expansion in trade in those countries has led to a sharp fall in absolute poverty there in the past 20 years.

Ravallion (2001), on the other hand, used a more conventional definition of poverty in studying its relationship with growth. He finds that an increase in the per capita income by 1 percent can reduce the proportion of people below the $1-a-day poverty line by about 2.5 percent on an average. This varies across countries, depending on initial inequality. In other words, how close the poor are to the poverty line matters. Similar to this cross-country study, there is also research by Ravallion and Datt (1999) on the determinants of poverty reduction across India's major states between 1960 and 1994, which shows empirically how initial conditions—and thus initial inequalities—matter. Similar to the findings from cross-country comparisons of poverty-growth linkages, Ravallion and Datt find that the impact of a given amount of growth in non-farm output on poverty reduction can vary considerably across India's states. For example, a one percent increase in non-agricultural state domestic product leads to a 1.2 percent decline in poverty rates in the states of Kerala and West Bengal versus only 0.3 percent decline in Bihar. The fact that growth of non-farm output was also relatively meager in Bihar over the period under consideration exacerbated the poverty problem in Bihar.[7]

Finally, a recent paper that looks at the determinants of poverty, as measured by the headcount ratio, is by Hasan, Quibria and Kim (2003) who argue, using cross-country evidence, that "policies and institutions that support economic freedom are critical for poverty reduction." Economic

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7. Ravallion and Datt then explore which factors "explain" this differential impact of non-farm sector growth on poverty by state. Differences in initial conditions relating to rural development and human resources are found to be a key source of the inter-state differential in poverty impacts of non-farm output. The role played by initial literacy appears especially large. In particular, Ravallion and Datt find that more than half of the differential impact of non-farm output on poverty rates is attributable to Kerala's much higher levels of initial literacy. Their results suggest that while the transition from (low-wage) agriculture to (higher wage) non-farm sectors may be key for the removal of poverty, making the transition is not easy or automatic for the poor. In other words, there are costs to be incurred on the part of a poor agricultural worker to make the transition. These costs are not only pecuniary ones but also non-pecuniary associated with investments in minimum levels of education, nutrition, and health so as to be able to work productively in the non-farm sector.

freedom indicators used by these authors include, government size, price stability, freedom to trade with foreigners, absence of over-regulations of markets and civil liberties as reflected in property rights, rule of law etc.

As we can see, most of the empirical literature on the determinants of growth and poverty employs cross-country regressions. Since it is difficult to control for numerous institutional and other differences across countries, results from such regressions will not be reliable enough to draw any policy implications. Furthermore, some of the empirical studies on poverty described above use the concept of the "$1-a-day" poverty line. Ideally, the poverty line should be specific to a country (or a region within a country) and a point in time. Therefore, for the above reasons, a country-specific study like ours can be useful for policy evaluation.

3. Indian Policy Framework

3.1 Trade Policy Reforms in India

Import-substituting industrialization was one of the hallmarks of India's development strategy from the 1950s to the early 1980s. A complex regime of import licensing requirements along with other barriers to trade kept the Indian economy fairly insulated from international competition. Along with a system of industrial licensing (see below) and a large role for public sector enterprises, India's trade policies played an important role in the development of a highly diversified industrial structure. However, policymakers became increasingly convinced by the late 1970s and early 1980s that the interventionist trade and industrial policies had gone too far. The government embarked upon a modest effort at economic reforms. These included reducing barriers to trade, especially insofar as imports of capital goods were concerned.

By far the most decisive break with the trade policies of the past came in 1991, however, when the Indian Government was faced with a balance of payments crisis. The crisis was the result of several factors including a rapid rise in the fiscal deficit to GDP ratio, in foreign commercial debt, and in the debt service ratio during the 1980s. These problems were further accentuated by a dramatic increase in the price of oil as a result of the Gulf War of 1990–91. India's external payments problem assumed crisis like proportions and led the government to approach the International Monetary Fund (IMF) for assistance. The IMF provided India with a standby credit of $2.3 billion over 20 months. The IMF credit, however, came attached with

the strong conditionality of major economic reforms that were initiated almost immediately. Given several earlier attempts to avoid IMF loans and the associated conditionalities, these reforms came as a surprise.

The objectives of the reform program included the removal of most licensing and other non-tariff barriers on all imports of intermediate and capital goods, the broadening and simplification of export incentives, the removal of export restrictions, the elimination of the trade monopolies of the state trading agencies, the simplification of the trade regime, the reduction of tariff levels and their dispersion and the full convertibility of the domestic currency for foreign exchange transactions. The maximum tariff was reduced from 400 percent to 150 percent in July 1991. Subsequent reductions saw the maximum tariff down to roughly 45 percent by 1997–98. Mean tariffs, which were 128 percent before July 1991 had fallen to roughly 35 percent by 1997–98. The standard deviation of tariffs during this period went down from 41 percentage points to roughly 15.[8]

Non-tariff barriers were also reduced. Prior to 1991, there were quantitative restrictions on 90 percent of the value added in the manufacturing sector. In April 1992, all the twenty-six import-licensing lists were eliminated. However a "negative list" (from which most intermediate and capital goods were excluded) of items, whose imports were prohibited, was introduced. This eliminated many of the licensing procedures and discretionary aspects of the previous import regime. The reductions in tariffs and non-tariff barriers to trade were also accompanied by devaluations of the Indian rupee (the Rupee was devalued 20 percent against the US dollar in July 1991 and further devalued in February 1992) and the introduction of an explicit dual exchange market in 1992.[9]

3.2 Labor Markets: Regulations and Rigidity

A comprehensive review of labor regulations in India is beyond the scope of this paper. [10] However, two features of India's labor regulations are noteworthy. First, the placement of labor issues in the Indian constitution suggests variation in labor regulations and/or their enforcement across

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8. See Dutt (2003) and Krishna and Mitra (1998) for details.

9. It may be noted that the percentage reduction in tariffs and non-tariff barriers were much greater than the percentage devaluation—and even larger relative to the real exchange rate devaluation on account of fairly high inflation during the initial years of the reforms (hitting roughly 14 percent). Therefore, the import enhancing effect of trade liberalization should have more than offset the import reducing effect of the exchange rate devaluation.

10. See Anant et al (2006) for a detailed discussion of India's labor-market regulations.

India's states. Under the constitution, both the central (federal) government as well as individual state governments have the authority to legislate on labor related issues. In fact, the latter have the authority to amend central legislations or to introduce subsidiary legislations. In addition, the enforcement of many labor regulations, even those enacted by the central government, lies with the state governments.

Second, there is considerable debate among observers of the Indian economy regarding the impact of labor market regulations on a variety of dimensions of India's economic performance. Most pro-reform policymakers and analysts believe that India's labor laws have made labor markets in the formal (or organized) manufacturing sector rigid in the sense of placing serious constraints on the ability of firms to hire and fire workers. Consider chapter VB of the Industrial Disputes Act (IDA) which makes it compulsory for employers with more than 100 workers to seek the prior approval of the government before workers can be dismissed. Critics of the Act argue that while the IDA does not prohibit layoffs and retrenchments, governments have often been unwilling to grant permission to retrench (Datta-Chaudhuri 1996).[11] The unintended results of the regulation have been to create a strong disincentive to hire (additional) workers, and substitute (abundant) labor with (scarce) capital, thereby leading to weak employment growth. Similar arguments have been made for other elements of labor regulations, including specific provisions of the Industrial Employment (Standing Orders) Act and the Trade Union Act (TUA).[12]

Not all analysts agree, however, that India's labor laws have made for a rigid labor market. An important counter-argument to the views expressed above is that India's labor regulations relating to job-security have been either ignored (see Nagaraj (2002)) or circumvented through the increased usage of temporary or contract labor [see, in particular, Datta (2003) and Ramaswamy (2003)]. Ultimately, whether India's labor laws have created significant rigidities in labor markets or not is an empirical issue.

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11. The term layoff refers to a temporary or seasonal dismissal of a group of workers due to slackness of current demand. Retrenchments, on the other hand, denote permanent dismissals of a group of workers. Both terms may be distinguished from "termination" which refers to separation of an individual from his or her job.

12. As per the Standing Orders Act, worker consent is required to modify job descriptions or move workers from one plant to another. While the goal of promoting worker consent is certainly an important one, Anant (2000) argues that rigidities can creep in on account of how one defines or establishes worker consent. With the Trade Union Act allowing multiple unions within the same establishment and rivalries common across unions, a requirement of worker consent for enacting changes "can become one of consensus amongst all unions and groups, a virtual impossibility" (page 251).

3.3 Industrial Regulations and Delicensing

The centerpiece of industrial regulations in India has been a system of industrial licensing.[13] The Industries (Development and Regulatory) Act of 1951 required every investor over a very small size to obtain a license before establishing an industrial plant, adding a new product line to an existing plant, substantially expanding output, or changing a plant's location. Applications for an industrial license were submitted to a Licensing Committee, which examined each proposal in light of the national planning targets for industrial production and investment in the various sectors.

According to numerous observers, the system of industrial licensing imposed many rigidities on India's manufacturing sector adversely affecting various dimensions of industrial performance.[14] A tentative set of reforms of the industrial licensing system were introduced from 1975–1984. However, most observers have argued that as a whole these reforms were marginal and that the industrial licensing regime continued to impose binding constraints to entry and growth for most firms outside the small-scale sector. More serious liberalization of the licensing regime began in 1985 with delicensing—the exemption from the requirement of obtaining an industrial license—of 25 broad categories of industries. The next major reform of the licensing regime came in 1991 when industrial licensing was abolished except in the case of a small number of industries.

4. Data

4.1 Poverty

NSS household expenditure surveys and poverty lines for urban and rural sectors provide the basis on which measures of poverty in Indian states and NSS regions can be computed. However, differences in methods used to set (base year) poverty lines, the CPIs used to adjust these poverty lines over time and across states, and the treatment of expenditure data gathered from the 1999–2000 NSS round, have led to different estimates

13. Other elements of industrial regulation in India included special controls on the operations of large firms as per the Monopolies and Restrictive Trade Practices Act of 1969, the "reservation" of a variety of industrial products for exclusive production by firms belonging to the small-scale sector starting in 1967, and a variety of foreign exchange related regulations governing import-and export-related transactions of firms.

14. See the discussion in Fikkert and Hasan (1998).

of poverty.[15,16] Given the various controversies that exist regarding poverty estimates in India, we use three distinct sets of estimates for poverty rates (also known as head count indexes) by state. This is useful in establishing the robustness of our results to different methods and approaches used to estimate poverty. Additionally, we also examine the robustness of our results to an alternative *measure* of poverty, the poverty gap index (PGI). The PGI, unlike the poverty rate, gives a sense of how poor the poor are and is equivalent to the shortfall of consumption below the poverty line per head of the total population, and is expressed as a percentage of the poverty line.[17]

Our preferred set of poverty estimates are drawn from/based on DD (2002).[18] These are available for 1987–88, 1993–94, and 1999–2000, years

15. The starting point of the official methodology for computing poverty rates in India are separate "all-India" poverty lines for the rural and urban sectors areas (specifically, Rs. 49.09 per person per month in rural India and Rs. 56.64 in urban India, both based on a fixed basket of goods consumed by the poor at 1973 prices). State-specific poverty lines for urban and rural sectors are subsequently obtained by using spatial price indexes to capture interstate differentials in the cost of living and state-specific Consumer Price Index of Agricultural Laborers (CPIAL) and Consumer Price Index of Industrial Workers (CPIIW), for rural and urban areas, respectively, to capture changes in the cost of living over time. These poverty lines are used to identify the poor as those who fall below the minimum level of expenditure.

16. The 1999–2000 round of the NSS used a mixed recall period in its survey of household expenditures (7/30 days for many high-frequency consumption items such as food, 30 days for some items (for example, fuel and light), and 30/365 days for durables and other less frequently purchased items). This was different from previous thick sample rounds where a 30-day recall period was used for all items (along with a 365 days recall for some low-frequency items in the 1993–94 survey). In the case of food and other high-frequency consumption items, this was the only recall period used. Researchers argue that the usage of mixed recall periods for food and other high-frequency consumption items, in particular, affected the comparability of results arising from the 1999–2000 survey with previous surveys. See DD (2002) for a comprehensive discussion.

17. The PGI can be expressed as:

$$PGI = \left(\frac{1}{n}\right) \sum_{i=1}^{m} \frac{z - y_i}{z}$$

where y_i represents consumption of the i-th poor person, z is the poverty line, n the total population, and m the number of poor. The poverty rate, or head count index, is simply m/n, of course.

18. DD (2002) report their estimates of poverty only at the state level. In order to work with the region level, we also need region specific estimates of poverty that are analogous to the state-level poverty estimates of DD. We obtain these using the state-and sector-specific poverty lines of DD and a simplified parametric version of their methods to adjust for the changes in the 1999–2000 NSS questionnaire. For details on the adjustment method used, see Deaton (2003a).

which correspond closely with our protection data (see below). The DD estimates of poverty rates (and PGI) incorporate several adjustments to the official estimates. First, the DD estimates incorporate an adjustment for changes to the NSS's survey questionnaire adopted in 1999–2000. The adjustment attempts to make the 1999–2000 survey results comparable with previous thick sample NSS rounds.[19] Second, the DD estimates rely on CPIs, which are built up from unit values of consumption goods derived from the NSS expenditure survey data as opposed to standard CPI data available from government sources.[20] DD argue that the latter price indexes, such as the CPI for Agriculture Laborers and CPI for Industrial Workers, are based on "fixed and frequently outdated commodity weights". Finally, the starting point for the computation of the DD estimates is not the official all-India urban and rural poverty lines of 1973. Rather, it is the official all-India rural poverty line of 1987–88. This is then converted into state specific rural and urban poverty lines using the CPIs derived from the NSS expenditure and quantity data. In this way, DD claim to get around the "rather implausible" differentials between urban and rural poverty lines that are implicit in the official urban and rural poverty lines.[21]

A second set of poverty estimates is based on the poverty lines and CPI data used for computing the official Government of India poverty estimates, but with the adjustment proposed by Deaton (2003b) to make the household expenditure data of 1999–2000 comparable to earlier rounds. These estimates, which we label GOI, rely on the thick NSS rounds like the DD estimates and are obtained from Deaton (2003c). The third and final set of poverty estimates is that of Ozler-Datt-Ravallion (ODR).[22] While this set

19. The adjustment exploits the fact that the 1999–2000 expenditure survey used a 30 day recall period exclusively for a number of items, including fuel and light, non-institutional medical care, and various miscellaneous goods and services. DD (2002) find that the expenditure on these items turns out to be highly correlated with total expenditures and therefore use these to estimate total expenditures comparable with those of previous thick sample rounds.

20. DD note that households report not only expenditures but also the quantities purchased for over 170 commodities. Dividing expenditures by the corresponding quantities yields unit values, or estimates of the price paid on these items.

21. As examples, DD cite the cases of Andhra Pradesh and Karnataka where official urban poverty lines have been around 70 percent higher than the corresponding rural lines. These differentials result in official estimates of urban poverty being much higher than rural poverty in these states, a situation which DD consider unreasonable.

22. The ODR estimates are based on Ozler Datt, and Ravallion (1996), downloaded from LSE's EOPP Indian States Database website: http://sticerd.lse.ac.uk/eopp/research/indian.asp. The estimates available from the LSE website include updates that incorporate the results from the 1999–2000 NSS survey.

of estimates does not attempt to correct for the new survey questionnaire of the 1999–2000 NSS round, it is based on both "thick" as well as the "thin" rounds of the NSS and therefore, consists of a longer series.

All three sets of poverty estimates are available for rural and urban areas separately by state. We use a common series on state population by urban and rural areas, provided in the EOPP Indian States Database, to compute overall poverty (that is, a rural and urban population weighted overall measure). The time plots of the various estimates of poverty by state (overall poverty as well as urban and rural poverty) are posted on the website: http://faculty.maxwell.syr.edu/dmitra/hmu_appendix.pdf

4.2 Protection

State-level protection measures by broad sector (overall as well as urban and rural), have been constructed by weighting industry level tariff rates and NTB coverage rates (for manufacturing, mining and agricultural industries) by state and sector specific employment shares:[23,24]

$$(1) \qquad Tariff_{it}^{j} = \sum_{k_m} \gamma_{ik_m,1993}^{j} * Ind\_Tariff_{k_m t}$$

$$(2) \qquad NTB_{it}^{j} = \sum_{k_m} \gamma_{ik_m,1993}^{j} * Ind\_NTB_{k_m t}$$

where $\gamma_{ik_m,1993}^{j}$ is the employment share of industry k_m in broad sector j of state i from the 1993–94 round of NSS household data.[25] Ind_Tariff_{kmt} and Ind_NTB_{kmt} are industry specific tariff rates and non-tariff coverage rates that are measured at the 2-digit industry level for each year t. $\sum_{k_m} \gamma_{ik_m,1993}^{j} = 1$

23. The information on industry level tariff rates and NTB coverage rate are from Pandey (1999). Pandey reports these for various years over the period 1988 to 1998. As is explained below, our estimation strategy requires that we also have protection related data for 1986. We estimate these by assuming that tariff and NTB coverage rates grew at the same annual rate between 1986 and 1988 as they did between 1988 and 1989. The NTB coverage rates estimated for 1986 are bounded at 100 percent.

24. We also constructed state specific tariff and NTB rates for manufacturing and agricultural goods. Using these does not change our results in any significant way.

25. 1993–94 is the middle year in our data and we thus treat this as the base (reference) year in the construction of our state-level openness index. Like in the case of any good index, the weights therefore are not allowed to change from one year to another. Our results are robust to using any other year as the base, as well as to using employment weights which are the average over the three thick round years. Also, when we allow the weights to change with time, our results are qualitatively similar.

where k_m represents tradable 2-digit industries (comprising agricultural, mining, and manufacturing industries). Non-tradable industries were excluded from the calculations.

A combined measure of tariffs and non-tariff barriers is calculated using principal component analysis (PCA). PCA is commonly used to reduce the dimension of a matrix of correlated variables by combining them into a smaller set of variables that contains most of the variation in the data. In our case, the first principal component contains approximately 90 percent of the variation in the protection data for all industry groups, and hence is used as a combined measure. Figures showing the plots of the three protection measures by state (overall) are available on the website mentioned above.

4.3 Labor-Market Flexibility

As noted in Section 3, India's states can be expected to vary in terms of the flexibility of their labor markets. We use two approaches to partition states in terms of whether they have flexible labor markets or not. A first approach starts with Besley and Burgess' (2004) coding of amendments to the Industrial Disputes Act between 1958 and 1992 as pro-employee, anti-employee, or neutral, and extends it to 1999.[26] Five states are found to have had anti-employee amendments [in net year terms, as defined in Besley and Burgess, (2004)]: Andhra Pradesh, Karnataka, Kerala, Rajasthan, and Tamil Nadu.[27] Since anti-employee amendments are likely to give rise to flexible labor markets, a natural partition of states would be to treat these five states as having flexible labor markets.[28] These states are termed *Flex* states in our empirical analysis. For these states the variable *Flex* equals 1, while it takes the value of 0 for other states.

This partition has some puzzling features, however. Maharashtra and Gujarat, two of India's most industrialized states, are categorized as having

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26. Besley and Burgess (2004) consider each state-level amendment to the IDA between 1958 and 1992 and code it as a 1, –1, or 0 depending on whether the amendment in question is deemed to be pro-employee, anti-employee, or neutral. The scores are then cumulated over time with any multiple amendments for a given year coded to give the general direction of change. See Besley and Burgess (2004) for details. (The Besley and Burgess coding is available at http://econ/lse/ac.uk/staff/rburgess/#wp.)

27. With the exception of Karnataka these anti-employee amendments took place in 1980 or earlier. For Karnataka the anti-employee amendments take place in 1988.

28. An alternative measure of labor-market flexibility/rigidity would have been to use the cumulative scores on amendments. This is the approach of Besley and Burgess (2004). Using these scores in place of our labor-market flexibility dummy variable leaves our results qualitatively unchanged.

inflexible labor markets on account of having passed pro-employee amendments to the IDA. However, Indian businesses typically perceive these states to be good locations for setting up manufacturing plants. It is questionable whether Indian businesses would consider Maharashtra and Gujarat to be especially good destinations for their capital if their labor markets were very rigid. Conversely, Kerala is categorized as having a flexible labor market despite an industrial record which is patchy in comparison with that of Maharashtra and Gujarat. Moreover, few Indian businesses would consider it a prime location for setting up manufacturing activity.

An alternative partition of states arises by including Maharashtra and Gujarat in the list of states with flexible labor markets while dropping Kerala. A World Bank research project on the investment climate faced by manufacturing firms across 10 Indian states lends strong support to such a switch (see Dollar, Iarossi, and Mengistae (2002) and World Bank (2003)).[29] First, rankings by managers of surveyed firms lead Maharashtra and Gujarat to be the two states categorized as "Best Investment Climate" states; Kerala was one of the three "Poor Investment Climate" states. Second, the study reports that small and medium sized enterprises receive twice as many factory inspections a year in poor climate states (of which Kerala is a member) as in the two best climate states of Maharashtra and Gujarat. This suggests that even if IDA amendments have been pro-employee in the Maharashtra and Gujarat, their enforcement may be weak. Finally, a question on firms' perceptions about "over-manning"—that is, how the optimal level of employment would differ from current employment given the current level of output—indicate that while over-manning is present in all states, it is lowest on average in Maharashtra and Gujarat.[30]

Thus, we also consider a modified partition in which Maharashtra and Gujarat are treated as states with flexible labor markets while Kerala is treated as a state with inflexible labor markets. The six states with flexible

29. Over a thousand firms were surveyed across ten states. Over nine hundred belong to the manufacturing sector.

30. A supplement to the original World Bank survey carried out in two good investment climate states and one poor investment climate state was aimed at determining the reasons behind over-manning. The results indicated that over-manning was partially the result of labor hoarding in anticipation of higher growth in the future in the good investment climate states but hardly so in the poor investment climate state. In fact, labor regulations were noted as a major reason for over-manning in the latter. This lends indirect support to the notion that given Maharashtra and Gujarat's ranking as best investment climate states, labor regulations have in effect been less binding on firms than the amendments to the IDA may suggest.

labor markets as per this modification are termed *Flex2* states (that is, Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Rajasthan, and Tamil Nadu). For these states the variable *Flex2* equals 1, while it takes the value of 0 for other states.

4.4 Delicensing

Our measure of industrial delicensing, the share of state manufacturing output accounted by delicensed industries (in each year from 1986 through 1998), is based on Aghion et al (2005) who use industrial policy statements, press notes, and notifications issued by the central government to identify when various 3-digit manufacturing industries were delicensed.

Starting with Aghion et al's figure 1, which lists industries delicensed by year of delicensing, we carry out the following steps. First, since the manufacturing industries listed by them are expressed in terms of the Indian National Industrial Classification (NIC) 1987 industrial codes, we map the listed industries in terms of their NIC 1970 classification. This step is essential given that state level information on three digit manufacturing industries between 1986 and 1988 is available from the Annual Survey of Industry (ASI) in terms of NIC 1970 only. Second, we follow Aghion et al in dropping all three digit industries which are either included in any given state for less than 10 years or are active in less than five states. This step is carried out in order to maximize the comparability of states' experience with delicensing. Once all the above steps are undertaken, it is a simple matter to construct the share of state manufacturing output accounted by delicensed industries in any given year. A time plot of this variable by state can be viewed on our website mentioned above. Substituting output with employment yields very similar trends.

Table 1 provides the summary statistics for the measures of poverty, protection, and industrial delicensing by thick-round years.

5. Estimation Strategy and Results

5.1 Estimation Strategy

We estimate variants of the following basic specification for the various measures of poverty, trade protection and labor market flexibility with and without controls:

$$(4) \qquad y_{it}^j = \alpha + \beta_1\, protection_{it-1}^j + \beta_2\, Flex_i * protection_{it-1}^j + \delta_i + \varepsilon_{it}$$

T A B L E 1 .   Summary Statistics

Variables	Average*		
	1987	1993	1999
Poverty Measures:			
Deaton-Dreze Overall Poverty Rate	32.63	27.48	20.87
Deaton-Dreze Urban Poverty Rate	21.15	16.93	11.62
Deaton-Dreze Rural Poverty Rate	36.25	30.97	24.19
GOI Overall Poverty Rate	36.58	33.63	26.52
GOI Urban Poverty Rate	36.30	30.27	23.35
GOI Rural Poverty Rate	36.07	33.82	26.91
ODR Overall Headcount Index	40.28	36.66	31.28
ODR Urban Headcount Index	36.46	28.12	22.53
ODR Rural Headcount Index	41.34	39.12	33.70
Trade Protection Measure			
(Lagged by one year):			
Overall Tariff	94.69	70.63	24.38
Urban Tariff	131.49	93.84	36.72
Rural Tariff	90.22	67.86	22.86
Overall Non-Tariff Barriers	100	80.80	70.48
Urban Non-Tariff Barriers	100	74.25	53.33
Rural Non-Tariff Barriers	100	81.54	72.47
Delicensed Industry Measur			
(Lagged by one year):			
Real Output Share of Delicensed Industries	46.65	91.65	94.13

Note: * The average is taken over the 15 major states.

where y_{it}^j is the logarithm of poverty in state i and sector j (overall, urban, and rural), $protection_{it-1}^j$ refers to one of our three measures of trade protection lagged once,[31] and $Flex_i$ is a time-invariant dummy variable which takes the value 1 if the state is defined to have flexible labor market institutions according to one of the two definitions discussed above (that is, Andhra Pradesh, Karnataka, Kerala, Rajasthan, and Tamil Nadu if we use *Flex* and Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Rajasthan, and

31. Using contemporaneous protection on the right-hand side gave us smaller coefficients and at times reduced coefficients. But the overall message remained unchanged: trade liberalization reduces poverty on average and at times, more so in flexible labor market states. In many cases both protection and its interaction with labor market flexibility do not remain significant at the same time (though they have the right signs), but in most regressions at least one of them is significant. The fit of the contemporaneous regressions was much worse than that of lagged regressions. We therefore decided to work exclusively with lagged protection measures.

Tamil Nadu if we use *Flex2*) and 0 otherwise. δ_i represents fixed state effects. Alternatively, we consider the following specification with fixed year effects:

$$(5) \quad y^j_{it} = \alpha + \beta_1 \, protection^j_{it-1} + \beta_2 \, Flex_i * protection^j_{it-1} + \delta_i + \mu_t + \varepsilon_{it}$$

where μ_t represents the year dummy. The specifications for examining the impact of delicensing on poverty are similar and are obtained by simply replacing the lagged protection measure by the lagged delicensing measure. The additional control variables we use include development expenditures and alternatively gross state domestic product, both in per capita terms.[32]

5.2 Incomes, Liberalization, and Poverty

As noted by Bhagwati (2004), "The scientific analysis of the effect of trade on poverty ….. has centered on a two-step argument: that trade enhances growth, and that growth reduces poverty." In this subsection we examine a variant of this argument to first see how trade policy and state per capita income are related and then look at the relationship between state per capita income and poverty. It is important to note that since we are looking at income levels and not growth, our analysis is not strictly of the relationship between growth and poverty reduction.

Due to space limitations, we do not report these regressions in this paper.[33] Here we just provide a qualitative discussion of those results. Without year dummies, we find that declines in protection and increases in the share of manufacturing output accounted for by delicensed industries are associated with increases in per capita incomes. Moreover, these effects are stronger in the *Flex* or *Flex2* states. Even in the presence of time dummies, this relationship between tariffs and per capita incomes continues to hold. However, the effects of delicensing become weaker. None of the own terms is statistically significant in general. But the interaction terms between delicensing and *Flex* or *Flex2* have positive and statistically significant coefficients, indicating that per capita incomes increase with greater delicensing in states with more flexible labor markets.

32. The data on development expenditures (expenditure on education, public health, water supply, sanitation, relief from natural calamities and food subsidy) at the state level also come from the LSE's EOPP Indian States Database website mentioned above. They are converted into real values using gross state domestic product (GSDP) deflators. Gross state domestic product (GSDP) series were obtained from the official website of the Central Statistical Organisation (CSO) and www.statesforum.org. They are expressed in 1993 Rupees.

33. These regression results can be viewed at: http://faculty.maxwell.syr.edu/dmitra/hmu_appendix.pdf

Are poverty and state per capita incomes related? Two specifications are run for each measure of poverty, one without time dummies and one with time dummies. In every case, there is an unequivocal beneficial impact of state per capita incomes on poverty. A 1 percent increase in state per capita income leads to a 1.15 percent reduction in the poverty rate on average. The inclusion of time dummies into the specification leads to a reduction in the coefficient on per capita income. However, this is to be expected since the year dummies will capture that component of economic growth which is common to all states.

The regression results examined so far suggest that reductions in trade protection may, through their positive impact on per capita income, have contributed to reducing poverty. However, the trade-poverty relationship needs further investigation. For trade liberalization to generate economic growth and at the same time reduce poverty, it is essential that reductions in trade protection do not significantly worsen income distribution. In what follows, we therefore turn to examining the direct relationship between trade protection and poverty.

5.3 Poverty and Trade Protection

RESULTS WITH STATE FIXED-EFFECTS AND NO TIME EFFECTS. In table 2, we present results using the overall DD poverty rate as the dependent variable. In these regressions, we use state-level fixed effects but no time effects. The state-level protection measures used are tariffs and NTB weighted by employment across the different tradable sectors, as well as a principal-components combination of the two. There is considerable evidence here that poverty is increasing in protection across all measures of protection, when there are no controls. When an additional variable, namely an interaction of these protection measures with the state-level labor-market flexibility measure (either *Flex* or *Flex2*), is introduced, we find that this variable is positive but statistically insignificant. The protection variable, by itself, still remains positive and significant. Introducing the per capita development expenditure measure on the right hand side preserves our results on the effects of protection. The overall picture that emerges from this table is that poverty on average is increasing with respect to protection over time and across states. Based on column 1 of table 2, we can say that for every percentage point reduction in the weighted tariff rate, there was a 0.75 percent reduction in poverty. During the period 1991–99, the average value across states of the weighted tariff rate went down by about 75 percentage points, which implies there was a 55 percent reduction in poverty during this period

T A B L E   2 .   DD Headcount Index: Overall

Variables	Tariff					NTB					First principal component				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Constant	2.69	2.69	2.68	5.81	5.59	1.74	1.74	1.74	6.89	7.22	3.15	3.15	3.15	5.82	5.86
	[37.37]***	[35.10]***	[37.99]***	[2.32]**	[2.31]**	[8.89]***	[8.87]***	[8.68]***	[2.87]***	[3.02]***	[117.92]***	[118.63]***	[115.71]***	[2.34]**	[2.35]**
Protection	7.50E-03	7.28E-03	6.96E-03	5.61E-03	5.48E-03	1.7E-02	1.53E-02	1.63E-02	9.34E-03	9.63E-03	0.17	0.16	0.16	0.12	0.12
	[8.10]***	[4.92]***	[5.15]***	[2.60]**	[2.78]***	[7.94]***	[5.20]***	[4.99]***	[2.53]**	[2.38]**	[8.59]***	[5.31]***	[5.37]***	[2.71]**	[2.71]**
Protection* Flex		5.40E-04		4.10E-04			4.86E-03		3.35E-03			0.03		0.02	
		[0.32]		[0.26]			[1.25]		[0.88]			[0.83]		[0.70]	
Protection* Flex2			1.47E-03		1.13E-03			1.81E-03		1.13E-03			0.02		0.02
			[0.91]		[0.75]			[0.44]		[0.29]			[0.65]		[0.53]
Development Exp (per capita, log)				-0.33	-0.31				-0.51	-0.54				-0.30	-0.30
				[1.25]	[1.21]				[2.13]**	[2.27]**				[1.07]	[1.09]
Year Dummies	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Observations	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Number of states	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
R-squared	0.73	0.73	0.73	0.74	0.75	0.64	0.65	0.64	0.68	0.68	0.71	0.72	0.71	0.73	0.72

Notes: Absolute value of robust t statistics in brackets.
*significant at 10%; **significant at 5%; ***significant at 1%.

that was associated with tariff reduction. The results from columns 2–5 are qualitatively similar. However, the quantitative impact of tariff reductions on poverty sounds more plausible: moving to column 5 where we control for per capita development expenditure, this number goes down to 40 percent. We believe that this impact of trade liberalization on poverty is probably an overestimate, as there could be several other factors, correlated with trade reforms, which may be driving poverty.

As seen in column 6, there is a 1.7 percent reduction in poverty corresponding to every percentage point reduction in the NTB coverage ratio. However, the overall reduction in the across states average of the weighted coverage ratio was about 25 percentage points for the 1988 to 1999 period, implying a 42.5 percent average reduction in poverty associated with the NTB reduction that took place across states. Based on columns (9) and (10) where we control for per capita development expenditure, this number goes down to 12.5 percent which sounds more plausible. We need to interpret the magnitude of this effect with caution and should not consider it to be something in addition to the effect of tariffs, as there is a large overlap in the variation of these two measures of protection. As in the case of the tariff-based estimates, with NTB as well there is no evidence for statistically significant differences between the experiences of *Flex* or *Flex2* states. Using a principal-components aggregator of weighted tariffs and NTBs gives us a similar picture, that is, poverty goes down with trade liberalization in all states.

We see that per capita development expenditure appears with a negative sign and is significant in columns 9 and 10. This clearly shows the important role of development expenditure (expenditure on education, public health, water supply, sanitation, relief from natural calamities and food subsidy) in poverty reduction.

We have also run similar regressions with urban and rural poverty separately as dependent variables.[34] In the case of urban poverty the results are qualitatively very similar to overall poverty results with respect to weighted NTB, tariffs and the principal components factor. However, an important difference is that in every single case, the interaction terms with *Flex* or *Flex2* are all statistically significant. This indicates that trade liberalization has been associated with larger reductions in poverty in states with flexible regulations. This result remains even when per capita development expenditure is included as a control.

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34. The results for these are available at: http://faculty.maxwell.syr.edu/dmitra/hmu_appendix.pdf

Rural poverty's response is similar to that of overall poverty when it comes to both the protection variables as well as the *Flex* or *Flex2* interaction variables. This is not surprising as rural poverty is a much bigger component of overall poverty than urban poverty. Additionally, the finding that the effects of trade protection vary by *Flex* or *Flex2* in urban areas and not rural areas makes sense as regulations have primarily been targeted toward the formal (organized) sector—a sector which is largely to be found in urban areas.

RESULTS WITH STATE AND TIME FIXED-EFFECTS. We now turn to the effects of introducing fixed time effects in addition to the state fixed effects. The time fixed effects (or time dummies) will capture the effects of the component of protection variables that behaves uniformly across states. When reforms are being carried out, this component, that is time specific but is common across states, can be quite large. As before, the state effects will capture state-level relative endowments and structural characteristics that do not change significantly over time. Thus, in the presence of state and time-specific effects, what the employment weighted protection measures will capture will be the effects of the state-specific, time-varying elements of such protection. To the extent that different industries will have some differences in their protection trends and different weights will be given to different industries in different states depending on their employment composition, there could be a significant proportion of state-specific, time varying element of protection.

The results for overall, urban, and rural DD poverty rates are provided in tables 3 through 5, respectively. The results are similar to the specifications with state fixed-effects only—but the statistical significance is weaker. With overall DD poverty, the coefficients on tariff rates fail to be significant in all but one case (column 5). However, several of the NTB terms and all of the first principal component factor terms are statistically significant. As before, none of the interaction terms involving *Flex* or *Flex2* are significant. [35]

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35. With the GOI and the ODR poverty rates, the precise results are somewhat different from those obtained with the DD measure; more of the protection terms are statistically significant as are a majority of the interactions terms. However, a crucial feature common to the results across all three poverty measures is that to the extent that some of the specifications yield a statistically significant relationship between protection and poverty, this is always in the direction of reductions in protection being associated with reductions in poverty. Moreover, this result is stronger in the Flex or Flex2 states. Regression results using the GOI and ODR poverty measures are available at: http://faculty.maxwell.syr.edu/dmitra/hmu_appendix.pdf

T A B L E   3 .   DD Headcount Index: Overall with Year Dummies

	Tariff					NTB					First principal component				
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Constant	2.75	2.80	2.73	5.77	5.85	−0.22	0.07	−0.19	1.86	1.88	3.34	3.29	2.84	5.53	4.95
	[31.01]***	[22.44]***	[33.20]***	[2.19]**	[2.19]**	[0.14]	[0.04]	[0.12]	[0.46]	[0.45]	[26.39]***	[18.72]***	[25.81]***	[1.94]*	[1.71]
Protection	4.41E-03	2.11E-03	4.73E-03	2.51E-03	4.32E-03	0.04	0.03	0.04	0.03	0.03	0.31	0.28	0.32	0.25	0.28
	[1.60]	[0.47]	[1.65]	[0.69]	[1.76]*	[2.32]**	[1.98]*	[2.25]**	[1.54]	[1.67]	[4.45]***	[2.07]**	[5.29]***	[1.72]*	[3.02]***
Protection* Flex		1.49E-03		1.02E-03			3.55E-03		3.19E-03			0.02		0.01	
		[0.71]		[0.54]			[1.00]		[0.91]			[0.35]		[0.27]	
Protection* Flex2			1.20E-03		9.60E-04			1.82E-03		1.60E-03			0.03		0.02
			[0.65]		[0.54]			[0.54]		[0.48]			[0.83]		[0.73]
Development Exp (per capita, log)				−0.32	−0.34				−0.16	−0.18				−0.25	−0.23
				[1.14]	[1.17]				[0.50]	[0.57]				[0.77]	[0.74]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Number of states	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
R-squared	0.73	0.74	0.74	0.75	0.75	0.76	0.77	0.76	0.77	0.76	0.76	0.76	0.76	0.76	0.77

Notes: Absolute value of robust t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%.

But once again, this situation changes with urban poverty rates and the urban analogues of the protection terms. Although almost every protection measure's direct term loses statistical significance with the inclusion of time fixed effects, all the interaction terms are positive and significant indicating that declines in protection have been associated with poverty reduction in *Flex* or *Flex2* states (table 4). The results for rural poverty show no such tendency (table 5). But a few of the direct terms on protection remain statistically significant (columns 6, 8, 11, and 13). Significantly, for rural poverty, none of these terms involve tariffs—the measure used by Topolova—suggesting that omitting NTBs may give a misleading picture of the relationship between protection and poverty. Additionally, one must remember here that the state and the time effects together account for a lot of the variation in our protection measures, and that can account for the lack of statistical significance in many cases.

ROBUSTNESS CHECK I: STATE VERSUS REGIONS. How robust are these results? A first robustness check involves examining whether the use of states as our geographical unit of analysis, opposed to lower levels of geographical aggregation as used by Topolova, is driving the difference between our and her results. Tables 6 and 7 describe results when estimation is carried out at the level of urban and rural NSS regions. As noted in Section 4 earlier, not only do the NSS regions represent a more disaggregated geographical unit than the state, the NSS regions are also considered by Topolova.[36] These results are therefore directly comparable to those of Topolova's region-level estimates in so far as the geographical unit of analysis is concerned.

Our results using the NSS regions are very similar to those reported in tables 4 and 5. In urban areas, the direct term of every protection measure is statistically insignificant. But all the interaction terms involving *Flex* or *Flex2* are positive and significant. In the case of rural poverty, some of the interaction terms involving *Flex* (but not *Flex2*) are significant. More importantly, some of the direct terms on protection are positive and statistically significant. As with the state level estimates, none of these terms involves tariffs, the measure of trade protection used by Topolova and for which she obtains a negative and often statistically significant coefficient. The similarity between the results of tables 6 and 7 and tables 4 and 5 gives us confidence that our use of states as the unit of analysis is not biasing our results in some systematic manner. In what follows, we proceed with further robustness checks reverting to the state as our unit of analysis.

36. A draft version of Topolova (2005) also reports results using NSS regions (see table 4b of Topolova 2004). Her results are qualitatively opposite to ours. While she excludes the year 1993, we include it. Also following the literature, our left-hand side variable is the logarithm of the poverty rate while she uses the poverty rate in levels.

T A B L E 4. DD Headcount Index: Urban with Year Dummies

Variables	Tariff					NTB					First principal component				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Constant	1.91	1.89	1.69	4.21	4.22	2.58	0.91	2.43	3.35	5.33	2.70	3.23	2.76	4.75	5.40
	[2.39]**	[2.50]**	[2.39]**	[1.44]	[1.55]	[2.23]**	[0.63]	[1.94]*	[1.00]	[1.93]*	[7.27]***	[7.60]***	[8.12]***	[1.78]*	[2.43]**
Protection	8.11E-03	7.52E-03	8.75E-03	6.04E-03	7.04E-03	4.01E-03	0.02	3.63E-03	0.02	3.23E-03	0.20	0.46	0.20	0.42	0.16
	[1.34]	[1.29]	[1.63]	[1.04]	[1.23]	[0.35]	[1.30]	[0.29]	[1.13]	[0.27]	[0.92]	[1.94]*	[1.02]	[1.55]	[0.78]
Protection* Flex	2.31E-03			2.07E-03			7.36E-03		6.56E-03			0.10		0.09	
	[2.25]**			[1.93]*			[3.01]***		[2.35]**			[3.49]***		[2.66]**	
Protection* Flex2		2.68E-03		2.54E-03			4.82E-03		4.45E-03			0.07		0.06
			[2.52]**		[2.47]**			[2.15]**		[2.12]**			[2.30]**		[2.25]**
Development Exp (per capita, log)				-0.24	-0.26				-0.25	-0.32				-0.17	-0.29
				[0.83]	[1.02]				[0.89]	[1.34]				[0.55]	[1.14]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Number of states	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
R-squared	0.82	0.84	0.85	0.84	0.85	0.81	0.84	0.83	0.85	0.84	0.81	0.85	0.84	0.85	0.85

Notes: Absolute value of robust t statistics in brackets.

* significant at 10%; ** significant at 5%; *** significant at 1%.

T A B L E   5 .   DD Headcount Index: Rural with Year Dummies

Variables	Tariff					NTB					First principal component				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Constant	3.22	3.35	3.22	6.17	6.36	1.15	1.45	1.14	3.98	3.98	3.17	3.23	3.15	5.81	5.84
	[10.35]***	[8.65]***	[9.47]***	[2.40]**	[2.30]**	[1.19]	[1.56]	[1.13]	[1.10]	[1.06]	[18.82]***	[12.85]***	[16.16]***	[2.06]**	[1.98]*
Protection	2.98E-03	9.50E-04	2.96E-03	1.58E-03	2.72E-03	0.03	0.02	0.03	0.02	0.02	0.19	0.15	0.20	0.13	0.16
	[0.86]	[0.19]	[0.83]	[0.39]	[0.90]	[1.88]*	[1.50]	[1.83]*	[1.01]	[1.23]	[1.92]*	[0.87]	[1.81]*	[0.89]	[1.39]
Protection*Flex		1.38E-03		8.40E-04			3.49E-03		2.96E-03			0.02		0.01	
		[0.57]		[0.38]			[0.77]		[0.66]			[0.39]		[0.28]	
Protection*Flex2			-6.00E-05		-2.90E-04			5.90E-04		1.00E-04			9.04E-03		2.76E-03
			[0.03]		[0.13]			[0.14]		[0.02]			[0.20]		[0.06]
Development Exp (per capita, log)				-0.32	-0.35				-0.24	-0.26				-0.29	-0.30
				[1.14]	[1.16]				[0.75]	[0.80]				[0.94]	[0.93]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Number of states	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
R-squared	0.67	0.68	0.67	0.69	0.69	0.68	0.69	0.68	0.69	0.69	0.68	0.68	0.68	0.69	0.69

Notes: Absolute value of robust t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%.

TABLE 6. DD Headcount Index, Regional: Urban with Year Dummies

Variables	Tariff				NTB		First principal component		
	1	2	3	4	5	6	7	8	9
Constant	2.01	2.08	1.93	2.19	3.30	1.73	2.56	2.70	2.48
	[2.73]***	[2.95]***	[2.70]***	[0.88]	[1.31]	[0.69]	[6.53]***	[6.94]***	[6.42]***
Protection	7.85E-03	6.19E-03	7.18E-03	8.29E-03	−6.37E-03	8.80E-03	0.28	0.16	0.28
	[1.36]	[1.12]	[1.29]	[0.33]	[0.24]	[0.35]	[1.19]	[0.68]	[1.23]
Protection* Flex1		3.50E-03			0.01			0.10	
		[2.32]**			[2.07]**			[2.11]**	
Protection* Flex2			2.60E-03			7.85E-03			0.08
			[1.90]*			[1.76]*			[1.95]*
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	174	174	174	174	174	174	174	174	174
Number of regions	58	58	58	58	58	58	58	58	58
R-squared	0.47	0.5	0.49	0.46	0.49	0.48	0.47	0.49	0.49

Notes: Absolute value of robust t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%.

T A B L E   7 .   DD Headcount Index, Regional: Rural with Year Dummies

Variables	Tariff			NTB			First principal component		
	1	2	3	4	5	6	7	8	9
Constant	2.97	3.05	2.95	0.53	1.34	0.33	3.46	3.29	3.53
	[30.94]***	[31.96]***	[29.18]***	[0.32]	[0.82]	[0.20]	[16.81]***	[13.27]***	[15.86]***
Protection	4.63E-03	2.70E-04	4.99E-03	0.03	0.02	0.03	0.26	0.12	0.28
	[1.26]	[0.06]	[1.34]	[1.84]*	[1.15]	[1.82]*	[1.87]*	[0.69]	[2.00]**
Protection*Flex1		3.20E-03			8.13E-03			0.06	
		[1.71]*			[2.00]**			[1.48]	
Protection*Flex2			1.20E-03			3.31E-03			0.04
			[0.67]			[0.87]			[1.00]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	174	174	174	174	174	174	174	174	174
Number of regions	58	58	58	58	58	58	58	58	58
R-squared	0.45	0.47	0.45	0.46	0.48	0.46	0.46	0.47	0.46

Notes: Absolute value of robust t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%.

ROBUSTNESS CHECK II: TRANSMISSION OF CHANGES IN PROTECTION RATES TO DOMESTIC PRICES. A second robustness check concerns the transmission of changes in protection rates to domestic prices at the state level. In our analysis so far, we have implicitly assumed that this transmission is perfect and/or identical across states. However, this may be too strong an assumption. The transmission of changes in protection rates to domestic prices may vary across states for a variety of reasons.[37] Transportation costs of imported goods, for example, are likely to differ across states on account of whether a state has a port or not, the average distance from ports, and the quality of the transportation infrastructure. A given reduction in tariff rates could therefore lead to a different configuration of domestic prices across states. State specific policies regarding taxes and subsidies could also play a similar role.

We tackle this issue in two ways. The first is to estimate price transmission regressions whereby we regress domestic prices for various commodities on corresponding world prices, protection rates, the exchange rate, and a control for distance from ports.[38] We estimate the price transmission regressions using fixed effects and random coefficient models. Table 8 describes the results for urban and rural sectors, respectively.[39] The key finding is the positive and statistically significant coefficients on the tariff and world price terms indicating that world prices and protection rates do get transmitted to domestic prices.[40] As one would expect on the basis of their better access to markets, urban areas have higher coefficients. However, the tariff and world price terms enter the regressions for the rural areas with positive and statistically significant coefficients as well. In addition,

37. We are grateful to T. N. Srinivasan for raising this issue.

38. To capture domestic prices, we computed unit values for primary commodities using household level information on expenditures and quantities from the NSS data on consumer expenditure. For world prices, we draw on the index of export prices reported in the WTO International Trade Statistics handbook. The distance from port variable is variously based on the distance from a state's capital (or commercial capital in case of Assam and Gujarat) to major Indian ports and the volume of cargo traffic (in tons) being handled by each port. For example, one approach is to simply use the distance between a capital to the nearest port. Another is to weight the distance between a capital to a port by the share of that port in overall cargo traffic and sum over all ports. The distance data is obtained using the distance calculator provided at www.mapsofindia.com while the volume of cargo traffic by port is obtained from two sources, ADB (1992) and the Indian Ports Association website, www.ipa.nic.in/oper2b.htm

39. We use random coefficient regressions that allow coefficients to vary across states since there might be factors other than distance that might vary across states and may affect the transmission mechanism.

40. Since our NTB measure is a coverage ratio, it is difficult to figure out the precise functional form that captures its transmission into domestic prices, which might explain its statistical insignificance in the presence of the strong statistical significance of the tariff term.

TABLE 8. Price-Transmission Regression, Urban and Rural (Dependent Variable: Log of Unit Price)

| | Rural | | | | Urban | | | |
| | Random coefficients | | Fixed effects | | Random coefficients | | Fixed effects | |
Variables	1	2	3	4	5	6	7	8
log (1 + Tariff)	0.90	0.66	0.50	0.68	1.09	0.89	0.94	1.13
	(0.20)***	(0.19)***	(0.20)**	(0.28)**	(0.24)***	(0.24)***	(0.27)***	(0.34)***
log (1 + NTB)	0.23	0.19	-0.12	0.06	0.17	0.13	-0.02	0.08
	(0.18)	(0.17)	(0.15)	(0.31)	(0.17)	(0.16)	(0.18)	(0.23)
log (World Price)	0.75	0.41	0.42	0.47	0.76	0.43	0.56	0.57
	(0.05)***	(0.08)***	(0.06)***	(0.13)***	(0.05)***	(0.07)***	(0.05)***	(0.05)***
log (Exchange Rate)	0.35	-0.13	-0.38	-0.38	0.36	0.06	-0.06	-0.06
	(0.07)***	(0.14)	(0.14)***	(0.14)***	(0.06)***	(0.09)	(0.10)	(0.10)
log (Inverse Distance)		82.74				58.84		
		(81.18)				(56.02)		
log (1 + Tariff)* Inverse Distance		-0.04		-0.98		2.70E-03		-1.03
		(0.07)		(19.70)		(0.06)		(16.70)
log (1+NTB)* Inverse Distance		-0.07		-0.98		-0.04		-0.61
		(0.07)		(29.30)		(0.05)		(11.95)
log (World Price)* Inverse Distance		0.38		-0.22		0.28		-0.06
		(0.11)***		(9.84)		(0.08)***		(1.23)
Observations	265	265	265	265	266	266	266	266
Number of states	15	15	15	15	15	15	15	15
Wald Test Statistics	43149.67	213.81	142.06	79.62	55105.75	844.75	271.43	349.04

Notes: Bootstrapped standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

none of the interaction terms between protection rates and the distance variables are statistically significant.

Of course, the transmission of changes in protection rates to domestic prices may still vary in some systematic manner across states, thereby reducing the usefulness of the coefficients on protection rates in our poverty regressions in drawing inferences on the relationship between protection rates and poverty. A way to deal with this issue is to allow the impact of protection rates on poverty to vary by state specific factors that can be expected to influence the degree of transmission. As noted earlier, such factors would include variations across states in terms of their distances to ports, transportation costs, and tax/subsidy policies. In addition to the data on ports and distances discussed above, we use information on road density by state (total kilometers of road divided by total state area) and information on state revenues to construct proxies for transportation costs and state specific tax policy/rates.

Regardless of how we construct and introduce the distance to ports variable—for example, measuring it in terms of the distance of the state capital (political or commercial) to the nearest port, or as a weighted sum of the distance of the state capital to all major ports (with the weights based on each ports' share in total cargo traffic)—the general favor of results from tables 4 and 5 is unchanged. Reductions in protection rates are never associated with increases in poverty and tend to be poverty reducing (in urban areas) in states with flexible labor institutions. Constructing measures to capture states' tax regimes is more difficult. But once again, working with what we have, our results are unchanged. For example, some urban local governments impose octroi, a charge levied on the entry of goods for consumption or sale. Not all states levy the tax but the prominent ones levying it over the time period we cover are Maharashtra, Gujarat, Punjab and Rajasthan.[41] A simple way to check how accounting for octroi could change our results is to create and interact a dummy for these four states with our protection measures. Since octroi is levied by urban governments we carry out this exercise for our urban sample. None of our key results change. In fact, the interaction term involving the dummy for the four major octroi-levying states is always insignificant.[42]

41. We thank M. G. Rao for pointing this out.

42. Similarly, we interacted our protection measures with the ratio of the state sales tax less central sales tax collected by the state to gross state domestic product to try and account for differences across states in their tax regimes as may be pertinent to the issue at hand. Once again, in no case is a reduction in protection associated with an increase in poverty. (We obtained the state tax data from the Handbook of Statistics on State Government Finances published by the Reserve bank of India, http://www.rbi.org.in/scripts/publications.aspx.)

The main exception to finding little role for proxies of state-wise differences in the degree of protection-price transmissions is when we introduce interaction terms between protection rates and road density. Focusing on the statistically significant terms in tables 9 and 10, declines in protection rates are poverty reducing in states with high road density. Interestingly, this effect is stronger for rural areas. Presumably, this reflects the fact that most urban areas are relatively well covered by roads. The big difference in road density across states is likely to be driven by the situation in rural areas. More generally, it must be noted that even in these regressions, the usual pattern of results still follows. Declines in trade protection are not associated with statistically significant increases in poverty, while in urban areas they tend to be poverty reducing in states with flexible labor institutions.

ROBUSTNESS CHECK III: OTHER ISSUES. The results of our poverty regressions with and without time dummies together can be viewed as providing evidence that trade reforms reduce poverty and that states where the labor force is more exposed to foreign competition are likely to have lower poverty rates. Also, such states experienced greater poverty reduction as a result of trade liberalization. To make these statements even stronger and more unqualified, we run our regressions with time trends in place of time dummies. These results∗, clearly support our earlier results. Any poverty reduction, which is a departure from the national trend, seems to be strongly related in the expected manner to off-the-trend shocks to our inverse measure of exposure to foreign competition. Also, as before, while this relationship is uniform in the case of rural poverty across states with different labor-market institutions, in the case of urban poverty this relationship exists mainly in states with flexible labor markets.

Another robustness check we have tried is the use of Besley-Burgess (2004) direct cumulative scores on amendments in place of our *Flex* or *Flex2* variable. Our results remain qualitatively unchanged. A final check involves introducing the log of gross state domestic product per capita as a control in place of development expenditures (also available on the website mentioned above). As the results show, protection continues to show up with a positive sign in every case, several of which are also statistically significant. At a minimum, there seems to be no adverse distributional impact of trade liberalization which is poverty *increasing*.

∗ available at http://faculty.maxwell.syr.edu/dmitra/hmu_appendix.pdf

T A B L E 9 . DD Headcount Index: Urban with Normalized Road Density

Variables	Tariff			NTB			First principal component		
	1	2	3	4	5	6	7	8	9
Constant	1.91	1.27	1.90	2.17	0.87	1.98	2.71	3.24	2.81
	[1.79]*	[1.21]	[2.14]**	[1.90]*	[0.60]	[1.72]*	[7.17]***	[7.59]***	[8.29]***
Protection	8.17E-03	0.01	7.10E-03	8.54E-03	0.02	8.45E-03	0.20	0.46	0.22
	[1.02]	[1.52]	[1.04]	[0.75]	[1.37]	[0.73]	[0.92]	[1.96]*	[1.13]
Protection*Road	−1.00E-05	−9.70E-04	3.50E-04	2.83E-03	1.23E-03	3.02E-03	2.52E-03	−0.01	0.01
	[0.02]	[1.47]	[0.71]	[1.95]*	[0.74]	[2.23]**	[0.17]	[0.91]	[1.09]
Protection*Flex		3.17E-03			6.76E-03			0.11	
		[2.60]**			[2.49]**			[3.33]***	
Protection*Flex2			2.81E-03			4.96E-03			0.08
			[2.46]**			[2.25]**			[2.47]**
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	45	45	45	45	45	45	45	45	45
Number of states	15	15	15	15	15	15	15	15	15
R-squared	0.82	0.85	0.85	0.82	0.84	0.84	0.81	0.85	0.84

Notes: Absolute value of robust t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%.

TABLE 10. DD Headcount Index: Rural with Normalized Road Density

Variables	Tariff			NTB			First principal component		
	1	2	3	4	5	6	7	8	9
Constant	4.20	4.21	4.19	2.62	2.62	2.63	3.57	3.67	3.65
	[7.69]***	[7.70]***	[7.65]***	[2.36]**	[2.32]**	[2.19]**	[3.78]***	[3.78]***	[3.79]***
Protection	-7.97E-03	-8.08E-03	-8.09E-03	4.17E-03	4.38E-03	4.13E-03	-0.05	-0.12	-0.11
	[1.31]	[1.34]	[1.36]	[0.26]	[0.28]	[0.25]	[0.09]	[0.20]	[0.19]
Protection*Road	2.40E-03	2.36E-03	2.46E-03	5.82E-03	6.00E-03	5.84E-03	0.03	0.03	0.04
	[2.30]**	[1.91]*	[2.42]**	[2.63]***	[1.72]*	[2.46]**	[0.47]	[0.50]	[0.58]
Protection*Flex		2.00E-04			-5.90E-04			0.02	
		[0.08]			[0.10]			[0.44]	
Protection*Flex2			5.70E-04			-2.80E-04			0.02
			[0.26]			[0.06]			[0.46]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	45	45	45	45	45	45	45	45	45
Number of states	15	15	15	15	15	15	15	15	15
R-squared	0.7	0.7	0.71	0.71	0.71	0.71	0.69	0.69	0.69

Notes: Absolute value of robust t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%.

5.4 Poverty and Industrial Delicensing

We now turn to the relationship between poverty and industrial delicensing. Table 11 presents the results for overall DD poverty. The first five columns include only state fixed effects. The next five include time fixed effects as well. Focusing on the results without time fixed effects we find that all the delicensing terms are negatively signed (columns 1 through 5). This implies that an increase in the share of state manufacturing output accounted by delicensed industries is associated with a reduction in poverty. However, the direct delicensing terms lose significance when development expenditures are added as controls (columns 4 and 5). Moreover, none of the interaction terms with *Flex* or *Flex2* are significant. With time fixed effects, none of the direct terms retain significance (columns 6–10). However, the interaction terms with *Flex* become significant (columns 7 and 9).

The corresponding results for urban and rural poverty are available on our above-mentioned website containing our additional results. The results without time fixed effects are very similar to those in table 11. The point estimates on the delicensing term tend to be more negative in the case of urban poverty than rural poverty. To the extent that one would predict delicensing to impact poverty in one of the two sectors more, it would be the urban sector given that licensing applied to formal (organized) sector manufacturing—these are predominantly located in urban areas.

With time fixed effects, some differences emerge. In the case of rural poverty, none of the terms involving delicensing, whether direct or in interaction with *Flex* or *Flex2*—is significant. In the urban case, however, there is some evidence that delicensing may have been associated with greater poverty in the non-*Flex* states in particular. This is seen in the positive (negative) and significant coefficient on the direct (interaction) term involving delicensing.

What happens if we introduce the delicensing and protection terms together? It turns out that it is the trade protection measure that has a significant impact on poverty and not delicensing. The negative (and the somewhat marginally significant) coefficient of the interaction between delicensing and *Flex2*, provides some weak evidence, that in addition to the effect of trade liberalization, deregulation does reduce poverty in states with flexible labor markets.

5.5 Poverty Gap

Our entire analysis has so far focused on poverty rates. In this final subsection we consider briefly the implications of working with the poverty

TABLE 11. DD Headcount Index: Overall with Delicensed Output Share

Variables	1	2	3	4	5	6	7	8	9	10
Constant	3.70	3.69	3.69	11.98	12.04	3.42	3.38	3.41	6.07	6.48
	[33.53]***	[34.77]***	[34.93]***	[6.59]***	[6.48]***	[16.56]***	[19.77]***	[18.96]***	[2.52]**	[2.63]**
Delicensed	-6.93E-03	-5.87E-03	-6.01E-03	-1.36E-03	-1.62E-03	-6.60E-04	1.23E-03	4.30E-04	2.00E-04	-6.20E-04
	[4.52]***	[2.84]***	[2.66]***	[1.15]	[1.34]	[0.16]	[0.32]	[0.11]	[0.06]	[0.19]
Delicensed*Flex		-2.76E-03		-1.35E-03			-3.45E-03		-2.78E-03	
		[1.02]		[0.82]			[1.95]*		[1.87]*	
Delicensed*Flex2			-2.18E-03		-5.40E-04			-2.36E-03		-1.71E-03
			[0.79]		[0.31]			[1.25]		[1.07]
Development Exp (per capita, log)				-0.96	-0.97				-0.30	-0.34
				[4.61]***	[4.53]***				[1.11]	[1.23]
Year Dummies	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Observations	45	45	45	45	45	45	45	45	45	45
Number of states	15	15	15	15	15	15	15	15	15	15
R-squared	0.38	0.39	0.39	0.64	0.63	0.72	0.75	0.73	0.76	0.75

Notes: Absolute value of robust t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%.

gap index (PGI) as the measure of poverty. Table 12 presents the results of regressions of the logarithm of overall PGI on protection with both state and time fixed effects included. The regression results with rural and urban PGI are available on our website. Essentially, the results are very similar to the corresponding estimates for poverty rates described above. Whenever trade protection's relationship with poverty is significant, it is a positive one so that reductions in protection are associated with a decline in the PGI. A significantly different relationship between *Flex* or *Flex2* states and the others emerges in urban areas but not rural areas (i.e., the interaction term involving trade protection and the *Flex* or *Flex2* dummies are significant in urban areas only). Finally, any statistically significant relationship between protection and rural poverty is driven by NTBs.[43]

6. Conclusion

Our empirical investigation of the impact of economic reforms, mainly trade reforms but also industrial delicensing, shows that there is a fair amount of evidence in support of the poverty reducing effects of these reforms. The beneficial effects are larger and can be shown to have more certainly been present in states with more flexible labor market institutions. For example, our estimates indicate that reductions in tariff rates over the 1990s were associated with a 15 percent decline in urban poverty in states with flexible labor market institutions relative to other states. The evidence makes a case for the reform of labor laws, especially in these latter states. We also find that the positive impact of trade liberalization on poverty reduction works through both the efficiency and distribution channels.

Most of the regressions show that the impact of trade liberalization on poverty is statistically more significant and sometimes larger in magnitude in the absence of time effects than in the presence of such effects. This is not surprising due to the common, time-varying element of these reforms across states. Also, we find greater importance for flexible labor market institutions and deregulation in urban areas. This is also expected, given that these institutions and policies directly impact organized manufacturing firms, primarily located in urban areas.

43. We also ran regressions of PGI on delicensing with both state and time fixed effects included. Again, the results are quite similar to the case of poverty rates. For example, non-Flex states see higher PGIs in response to delicensing in urban areas. This is similar to the case of poverty rates and delicensing. The main difference is that while the results for poverty rates showed no significant relationship between delicensing and rural poverty, delicensing appears to lead to a fall in PGIs in Flex states in rural areas.

T A B L E 1 2 . DD Poverty Gap Index: Overall with Year Dummies

Variables	Tariff					NTB					First principal component				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Constant	1.06 [9.29]***	1.15 [7.47]***	1.03 [9.81]***	4.53 [1.37]	4.92 [1.38]	−2.70 [1.43]	−2.13 [1.12]	−2.66 [1.44]	−0.31 [0.06]	−0.22 [0.04]	1.66 [8.60]***	1.50 [5.83]***	1.28 [7.65]***	4.28 [1.18]	4.06 [1.03]
Protection	3.66E-03 [1.05]	−1.27E-03 [0.23]	4.13E-03 [1.14]	−8.20E-04 [0.18]	3.63E-03 [1.14]	0.05 [2.44]**	0.04 [1.93]*	0.04 [2.38]**	0.03 [1.44]	0.04 [1.68]	0.33 [2.99]***	0.21 [1.11]	0.34 [3.62]***	0.18 [0.86]	0.29 [2.15]**
Protection* Flex		3.20E-03 [1.16]		2.66E-03 [1.05]			6.90E-03 [1.44]		6.54E-03 [1.38]			0.05 [0.88]		0.05 [0.84]	
Protection* Flex2			1.75E-03 [0.69]		1.45E-03 [0.58]			2.72E-03 [0.56]		2.46E-03 [0.51]			0.04 [0.83]		0.04 [0.72]
Development Exp (per capita, log)				−0.37 [1.04]	−0.42 [1.10]				−0.16 [0.38]	−0.21 [0.48]				−0.31 [0.75]	−0.30 [0.72]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Number of states	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
R-squared	0.73	0.75	0.74	0.76	0.75	0.76	0.77	0.76	0.78	0.77	0.75	0.76	0.76	0.76	0.76

Notes: Absolute value of robust t statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Comments and Discussion

Kenneth Kletzer: This is an interesting and thoughtful paper that reconsiders the impact of trade liberalization on poverty rates across regions of India. The paper is a companion study to the district-level examination of differences in poverty reduction due to tariff reduction by Topolova (2005). Hasan, Mitra and Ural modify Topolova's approach and arrive at qualitatively different conclusions. The empirical methodology and theoretical arguments of the two papers are essentially the same. Therefore, my comments first address the line of research in both studies and then turn to the contribution of Hasan, Mitra and Ural.

The question of whether trade liberalization, or market reform in general, reduces poverty is an important one and does not have an unambiguous theoretical answer. As argued by the authors, the impact of protection on the incidence of poverty requires empirical investigation. The means by which trade reforms affect poverty rates are not quite as simple as suggested by these papers. It is tempting to place this research in the context of cross-country estimates showing that trade raises growth rates and growth in turn reduces the incidence of poverty. However, directly regressing poverty rates on measures of trade protection skips over the means through which trade reforms affect income growth and poverty. These include the static income distribution effects of trade policy changes and the net effects of trade liberalization on growth through factor accumulation and productivity increases.

The empirical model in the Topolova paper is interpreted using a specific factors model of trade with labor as a fixed factor in traded goods industries. This assumption is motivated by the low degree of unskilled labor mobility across sectors and regions, particularly for rural populations, in India. The approach of this line of research is to relate differences in the rate of decrease in poverty to differences in the impact of trade liberalization for regions of India. Trade impact is measured by weighting the relative prices of tradable goods by employment to obtain an index of the terms of trade for each state or district. Tariff reductions, therefore, should have a larger effect on the incomes of unskilled laborers for a region that has a higher share of employment in import-competing industries weighted by the percentage tariff reduction for the output of each industry.

This approach has a parallel in the estimation of the effect of trade or technological progress on earnings and employment in advanced indus-trialized countries using relative producer prices to measure trade impacts. The movement of labor from declining to expanding sectors takes time so that laborers in trade-impacted industries realize short-run income losses even if they eventually gain from trade liberalization. Workers with lower human capital are less mobile and tend to suffer larger losses in declining sec-tors. Therefore, the effect of trade on the incomes of low-skilled labor depends on rates of worker mobility and job creation in expanding industries.

The analog in the case of India is that the sign of the effect of regional trade exposure on low income households over the decade of the 1990s should depend on the rate of adjustment in employment as well as medium-run equilibrium returns to unskilled labor. While Topolova finds that districts with greater trade exposure experience a lower rate of poverty decline be-tween the 1988–89 and 1999–2000 surveys. This is consistent with the interpretation that unskilled labor is a specific factor. In the current paper, Hasan, Mitra and Ural find state-wide exposure to trade is correlated with a larger rate of poverty decline using the additional survey round for 1993–94, implying labor mobility between activities. This is only a partial interpret-ation since trade liberalization probably had a positive effect on India's aggregate growth rate in the 1990s contributing to the overall reduction in poverty. These papers measure the differences in poverty declines across regions that differ by trade exposure controlling for inter-regional dif-ferences in social spending on poverty reduction. The finding that districts with more employment in import-competing industries experienced lower rates of labor income growth may not be very surprising over a short horizon. The results of the current paper suggest that the poorest households are benefiting from India's trade reforms within a span of a few years.

The major differences in the empirical approach include the addition of a measure of non-tariff barriers by Hasan, Mitra and Ural. The reduction of quantitative trade restrictions complemented tariff rate reductions during the 1990s so that tariff rates might be an insufficient measure of the impact of trade reform on incomes. The index of non-tariff barrier coverage rates may measure the impact of non-tariff barriers poorly, but the addition seems reasonable and appears to matter for the results. Hasan, Mitra and Ural also add variables that measure labor market flexibility and industry de-licensing. Two measures are use to represent labor market flexibility. The first is the coding of state amendments to the Industrial Disputes Act by Besley and Burgess (2004). The second modifies Besley and Burgess' clas-sification of states based on the authors' view of the reasonableness of the

classification of states such as Maharastra, Gujarat and Kerala. The new measure is a qualitative measure based on survey data. Both measures are at best ad hoc and do not have a sound quantitative grounding. The last added variable is a more reasonable quantitative measure of industrial delicensing which may capture variance in the ease of firm entry across states.

The paper also aggregates the data to the state level but repeats the analysis for National Sample Survey regions (strata). The NSS regions are typically made up of several districts, so that the number of observations used in the district-level analysis of Topolova is much greater. Since many states of India are very populous, with populations for some exceeding one hundred million, the state-level regressions are analogous to cross-country regressions with a common policy change. Therefore, we should worry about all of the shortcomings of cross-country regressions. It is difficult to understand why aggregation is desirable, even if the analysis at the regional level confirms the results. It would be useful to run the regressions for the district level poverty data including the measures of policy reform added by Hasan, Mitra and Ural so that we might see if adding non-tariff barriers or delicensing variables leads to the reversal of Topolova's result. Otherwise, it is hard to see whether these measures or the unit of observation is responsible for finding that more trade-impacted regions experience higher rather than lower rates of poverty decline.

To elaborate this point, a state with a population exceeding any member of the European Union has a fairly diversified sectoral composition of output. A district, however, should be much more specialized in traded goods industries. A higher share of employment in import-competing goods may be associated with smaller decline in poverty at the district level, but aggregating over a large number of heterogeneous districts can make the result disappear. Adding up employment in import-competing, export and non-traded goods industries across districts could very likely yield regression results that reflect the overall gains from trade liberalization in poverty rate declines. A state that has more international trade can experience net gains from liberalization even though it will have a larger employment share in import-competing industries.

I would like to reiterate the major point made by T.N. regarding the measurement of the impact of tariff reductions on regional employment. The construction of the protection index uses tariff rates so that it measures border prices. With the high cost of transporting goods within India, this index is a poor measure of relative producer prices inland. Since transport costs for traded goods can vary widely by region, goods that are tradable in Mumbai may not be tradable in rural eastern Maharashtra. If the cost

of producing a tradable good locally is less than the cost of delivering the same good imported to a district, then that good is non-tradable. Reducing the tariff rate should not affect the local price of the good until the total cost of an imported unit equals the local cost of production. Therefore, tariff reduction will not proportionally reduce the price of some tradable goods, and the effect of tariff reductions on relative producer prices will vary by location. Some goods very likely can remain non-traded in some regions while becoming traded in others. Variations in commodity taxes both across regions and over time can also give rise to non-proportional changes in relative prices with tariff reductions.

Because the tradability of a good for an interior district that can be imported or exported at the coast is endogenous, the measure of relative prices used in this paper only works at the border. The index based on tariffs incorrectly measures impact of trade liberalization on different regions or states of India by overstating relative price changes for regions facing high costs of transportation from ports. A problem is that the costs of transportation and whether a good is traded could be correlated with changes in the level of poverty. Poorer districts could well have higher transport costs and be more specialized in production creating a bias in the estimations. This argument should also apply to the index of non-tariff barriers.

Studying the effects of policy reform on poverty using disaggregated regional variation in production and employment is an interesting and promising research agenda. The underlying theory connects trade liberalization and other policy reforms to regional outcomes through its impact on relative prices at the level of the producer. This requires the data on changes in local prices in the presence of significant variation in the cost of transportation. That said, the effort to estimate empirically the effects of trade and regulatory reform on poverty in India is a worthy enterprise.

T. N. Srinivasan: At the outset I want to express my appreciation for the hard work the authors have put in the revision, and the seriousness and care with which they have tried to address comments of the discussants of the conference version of the paper. My following comments raise my remaining concerns, some of which apply to the genre of the literature and not specifically to the paper and others, though specific to the paper, might be difficult or impossible to address without substantial additional work. Let me hasten to add that I will be quite happy with the publication of the paper as it is—it is a vast improvement over the much overrated paper of Topalova.

First, although the authors rightly emphasize the importance of tariff as well as non-tariff barriers (NTBs) to trade, they (and the literature in general) do not adequately recognize and address the fact, that both measures are often used simultaneously to protect the same product. For example, in India quantitative restrictions (QR), an ubiquitous Indian NTB until a WTO Dispute Settlement ruling several years after reform ruled it out, as well as a tariff were imposed on imports of many commodities. In many cases, the tariff served merely as a device to transfer part of the quota rent to the government—it had no protective effect, in the sense that any changes in tariff within limits would have had *no effect* on imports. Thus, the tariff equivalent of the QR in such cases was higher than the actual tariff. In others, the QR was not binding and only the tariff determined the level of imports. Thus, the joint protective effect of a tariff and NTB on a product is not a straightforward matter—at the margin, only one, affects imports and not both.

The authors construct a separate sectoral measure of tariffs and NTBs and use them *one at a time* in their regressions (in addition to using only the first principal component). I would argue that they should have used both in *each* regression, unless the correlation between the two was very high. Since there are only two, tariffs and NTBs, I would presume that there are only *two* principal components (which *are* orthogonal linear combinations of tariffs and NTBs). Only one degree of freedom is saved by using the first principal component, rather than both tariffs and NTBs in each regression. I do not see much point in using the principal component. While the authors are absolutely correct in rejecting Topalova's economically meaningless treatment of non-traded goods as if they are traded goods with zero tariffs, they do not probe the effect of changes in real exchange rates (that is, relative price of traded goods in terms of non-traded goods) following trade liberalization on poverty. It can go either way, depending on the weight of non-traded goods in the poverty basket.

Second, I am not convinced that there is any need to use several poverty measures—whatever may be the merits and demerits of one measure as compared to another, they would not be expected to bias the results of the paper (unless merits and demerits of a poverty measure interacts with protection, which is implausible), since its focus is the poverty impact of differences in protection *across states or regions*. If I am right, the authors can drop the discussion of alternative poverty measures and use only one and explain why. Also, the description of the methodology of computing "official" poverty lines by the Planning Commission in footnote 15 is misleading. Even if a fixed basket of goods (poverty basket) was used and

valued at 1973 prices to determine the 1973 price poverty line, its updating by price indices with a fixed weighting pattern that has no connection to the weights implied in the poverty basket breaks the link between the poverty line and the poverty basket for years other than 1973. The authors say (p. 4) that "an urban stratum is never a district but is based on either a "hospital area" or an "industrial area" or a "bazaar area" within a city or a collection of small towns." I have no idea where they got this idea. NSS report 506 (Appendix B, p. B-2) states that "In the urban sector, strata were formed within each NSS region on the basis of size class of towns as per Population Census 2001."

Third, the authors run price-transmission regressions in response to my comment on the importance of taking into account the implications of domestic transport costs, taxes, movement restrictions, etc. The broader thrust, beyond price transmission, of my comment was that each state or region of a country is open to trade, to varying degrees, *not only with other countries but also with other states or regions within the country*. This being the case, what is traded (exported from or imported into it) by a state or region, and what is not (that is, produced and consumed within the state) are endogenously determined in an equilibrium, in which the market clears within each state for *non-traded* goods, and for to other goods, markets may clear at the level of a sub-set of states or nationally or globally. Even if the country is a price taker in world markets so that global market clearance is not relevant for internationally traded commodities, still the general spatial equilibrium set-up is complicated. Although, the price transmission regressions are surprisingly strong, given the level of commodity aggregation, I am not sure they are to be interpreted as saying that, through tariffs and NTBs, world price movements are transmitted fully to relevant prices faced by producers and consumers in each state. Besides, there is an endogenous real exchange rate analogue at the state or regional level that has to be taken into account in analyzing poverty.

Fourth, given that any two digit sector almost surely will include exportables as well as importables, sectoral tariffs and NTBs apply only to the importable subset of products within the sector. This being the case, the fact that domestic taxes and transport costs would affect the domestic price of importable and exportable differentially relative to their prices at the port, I am not sure the price transmission regressions adequately capture the differential effects. And these differential effects are central to the determination of whether a commodity is a non-traded one within a state.

Fifth, the authors cite (but do not reference) the paper of Nagaraj (2002) for the finding that labour market regulations had no impact. This study

and several others are defective: they do not take into account the fact that the regulations affect the entry-exit dynamics of firms so that firms in existence at any point in time are survivors of those who entered earlier.

Lastly, the authors use a uniform one period lag between changes in tariffs and NTBs and their effect on poverty. One could argue that a distributed lag model would be more appropriate.

General Discussion

Esther Duflo began the general discussion by questioning the paper's decision not to use district level analysis. She argued that the NSS design in fact preserves random sampling even within districts, so that poverty rates calculated at the district level are valid. She further pointed out that performing analysis at the state level can introduce unnecessary noise into the data.

Professor Duflo also raised the issue of treatment of correlation in the error term of individual states over time. As the paper compares cross-sectional regressions run for three different time periods, she suggested that without taking account of the error correlation the paper's significance findings could be overstated.

Abhijit Banerjee noted that the regression coefficients on labor flexibility appeared quite sensitive to which measure of flexibility was used. He thought that the switching of only a few states from flexible to inflexible led to implausibly large changes in the coefficients, making interpretation of the results problematic. Dilip Mookherjee took up this point and suggested that because the two flexibility measures reflected distinct underlying trends (one in labor laws and the other in business climate), the regression should properly include both variables. Devesh Kapur cautioned against using the Besley and Burgess labor-law measure of flexibility, noting that it did not take account of the level of enforcement of labor laws in different states.

He also suggested that any study of poverty in India should control for remittances across states. If heterogeneous trade restrictions lead to variance in growth across Indian states, then it might follow that labor would migrate to the faster growing states leading to high levels of remittances to the poorer areas. It is possible that this would lead to observed reductions in poverty in poorer states, albeit through a very different channel than that investigated by the authors.

Arvind Panagariya questioned the relevance of the data series used for delicensing. In his view, the more important change in licensing restrictions

in India in the 1980s concerned the gradual across-the-board raising of the investment ceiling for firms without a license, rather than the industry-specific abolishment of licensing requirements used in the paper.

Abhijit Banerjee was concerned about the emphasis on the Deaton-Dreze measures of poverty. There is a large divergence between their and the official poverty measures that may have significant effects on the empirical results. There are also difficulties of comparing rural and urban poverty and poverty across urban areas of different size. He did not believe that state-level measures of poverty were particularly meaningful. The data difficulties were also highlighted by participants who pointed to the increasing divergence between reported levels of income and consumption in the household surveys.

Other participants thought that a further parsing of the trade restrictions data could be useful. The well-known theory of the second best says that reducing product market tariffs without concomitant reductions in input markets can lead to reduced living standards. It would therefore be useful to know something about input market imperfections in various states, particularly with regard to capital markets.

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Teacher Compensation: Can Decentralization to Local Bodies Take India from the Perfect Storm Through Troubled Waters to Clear Sailing?

I) Introduction: An Empirical Illustration of the "Perfect Storm"[1]

There are signs that publicly produced elementary education in India faces enormous problems. Although enrollments are up, a recent survey of rural areas (Pratham 2005) found shockingly low levels of learning achievement[2]. There is widespread dissatisfaction with government schooling, expressed in many ways, including parents and students voting with their feet and pocketbooks. Data from a recent household survey

1. We would like to thank Suman Bery for the invitation to produce this work and Barry Bosworth for helpful guidance. The comments of Esther Duflo at the India Policy Forum were, as always, insightful and grounded and improved the paper. We would like to thank Jishnu Das, Venkatesh Sundararaman, and Nazmul Chaudhury for a helpful exchange and to acknowledge Jishnu's influence—while granting him the usual complete deniability. In addition, conversations with Michelle Riboud, Ajay Shah, Geeta Sethi, Salimah Samji, and the WDR 2004 team have been instrumental in shaping the general approach to decentralization. Finally, Varad Pande is to be thanked as a substantial portion of the last section draws on Pande and Pritchett (2006).

2. The recent Annual Survey of Education study (Pratham, 2005) administered a simple test of reading and of mathematics to children in rural India. They found that only 60 percent of grade V students in government schools could read a simple story while 70 percent of private school students could do so. The fraction of pupils who could do written numerical sums was similarly about 10 percentage points higher in private than public schools. This varied a great deal from state to state. In Uttar Pradesh only about 45 percent attending government schools could read the story while 70 percent of those in private schools could (a 25 percentage point gaps, similar to that in the study below in Delhi), while in Maharashtra the performance was roughly equivalent and in some states public students outperformed the private sector on some subjects.

investigating school attendance of children 6-14 (SRI 2005) found that in urban areas of six major Indian states the share attending private (registered or unregistered) schools is above the share of private schooling (68 percent) in the Netherlands, where financing has historically been neutral between private and public providers and which has the highest level of private schooling at the elementary level of any country in the world. In only two states (Assam and West Bengal) was the share of children in private schooling significantly lower than in Chile—a country that "privatized" schooling in 1981.[3]

At the heart of this dissatisfaction are concerns about teachers. Paul et al. (2004) found that as a national average only 16 percent of households reported themselves "fully satisfied" with the reliability of the behavior of the government school teachers, with astoundingly low levels of satisfaction in some states: only 1 percent in Punjab, 3 percent in Orissa, 5 percent in Haryana, 6 percent in Rajastan, 9 percent in Bihar. This expressed dissatisfaction is consistent with the findings from a nation-wide study using random surprise visits to schools that found both high levels of absenteeism and very high levels of not being engaged in teaching even when present such that less than half of teachers are both present and engaged in teaching activity during the school day (Chaudhury et al 2006). These findings are corroborated by in-depth studies such as the PROBE report (1999) and the more recent report on schooling in West Bengal of the Pratichi Trust (2002) that found in interviews with parents that teachers are often absent, negligent when present, and frequently abusive.[4]

A recent study by Tooley and Dixon (2005) did a physical census to identify all schools in the North Shahdara neighborhood of New Delhi—government and private, including both registered and unregistered. They then interviewed parents, students and teachers in these schools and also directly measured student learning achievement. While this study has a small sample and this neighborhood of the capital is by no means representative of all of the country, the study does bring into one place features—wages, parental satisfaction, learning achievement, and teacher attitudes—that are rarely present in the same study. Together these features

3. This excludes the data from Orissa that are anomalous and at odds with other sources.

4. Two of the more telling anecdotes in the Pratichi Trust report were one villager recounting that dissatisfied with their local teacher's absenteeism they would force the teacher to go to the school in the mornings—but then they found he spent his day drinking tea, reading the newspaper, and "forcing the students to give him massages." Another mother told the researchers that when her child misbehaved at home she threatened to tell his school teacher—because of the abuse at school the child's school teacher was the one person the child was truly terrified of.

illustrate the "perfect storm" nature of current public sector teacher compensation. The standard findings that replicated those of many other studies were that:

- Teachers in government schools are paid much more than teachers in other schools. Public school teachers in this sample reported earning on average Rs 10,076 per month which is 7.4 times more than teachers in unregistered schools who reported making only 1,360 per month and almost three times as much as teachers in private registered schools who made 3,600 per month.
- Even though class sizes were much higher in government schools, (because teachers are so expensive) the average cost per student was about 2.4 times higher in government than in private schools.
- Students in government schools had lower learning achievement than those in private schools and in this study the differences are massive—private school students answered roughly *twice* as many questions correctly than did government students[5].
- Parent and student satisfaction with nearly every dimension of teacher performance was lower in government than private schools.

So far, this is a very big storm, but a storm that is often argued about, creating what appears to be an ideological divide between those who regard themselves as proponents of private schools and those who regard themselves as "defenders" of government schooling and of teachers. But the "perfect storm" nature of the current situation emerges looking at the results from interviewing the teachers themselves. The teachers in government schools were *less* satisfied with nearly every aspect of their jobs and careers than were private school teachers: they felt they got less respect from management, less respect from parents, they felt the school's leadership was weak and the work environment was worse. So, *teachers* are also unhappy with the current situation.

But the truly astounding element of the perfect storm emerges when teachers were asked if they were satisfied with their *pay*. Perhaps not surprisingly, 29.4 percent of government teachers were "very satisfied" with their pay. But what is astounding is that 25.9 percent of teachers in private unrecognized schools were also "very satisfied" with their pay—only 3.5 percentage points lower—in spite of the fact that the level of pay was

5. Of course, this does not in and of itself represent higher "value added" by private schools—better students might choose to attend private schools—but the raw differences in scores are large.

seven times lower! Moreover, while it is to be expected the roughly 20 percent of private unregistered school teachers were dissatisfied with their pay, what is astounding is that 11 percent of public teachers also reported themselves dissatisfied with their pay, even though they make wages that far exceed both the private market for teachers and the general market wage in the private sector in non-teaching.

This one study illustrates at least in one small locale the "perfect storm" by comparing government and private unregistered schools in New Delhi:

- Government teacher pay is 7.4 times higher,
- Government per student costs are 2.4 times higher,
- Government teachers are *half* as likely to be teaching when observed,
- Learning achievement in government schools is massively lower in all three subjects tested,
- Students are more dissatisfied with teachers in government schools,
- Parents are dissatisfied with government schools[6] and,
- *Government* teachers are *unhappier* with nearly every aspect of being a teacher,
- The only aspect of teaching on which government teachers were happier was pay—and even then the differences were small.

Now *that* collection of facts constitutes a perfect storm.

We argue here that at the heart of the difficulties with government produced schooling—the low learning achievement, the widespread dissatisfaction of citizens with teachers, the consequent massive shift into private schooling, and the unhappiness of teachers themselves—is the current *system* of teacher compensation in the public sector. Unfortunately much of the discussion about teacher compensation in India has focused exclusively on the differences in average pay between the public and private sectors. This focus on the average difference creates a false dichotomy in which supposedly proponents of "high" pay are associated with strong public sector schools, higher quality of schooling, and as advocates of the interests of teachers while proponents of "low" pay are associated with private

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6. Of course a major finding of the study is that only 27 percent of schools in the neighborhood were government schools implying parents are putting their children in private schooling even though they must pay the full cost out of pocket versus the subsidized and promoted government schools. The dissatisfaction with public schools had lead to a massive expansion in private schools: in this one neighborhood over a hundred new schools had been started in the last decade—*one* government school while the majority were private unregistered schools.

schooling, more concern about efficiency and fiscal costs than quality, and risk being labeled anti-teacher. We intend to stand this conventional wisdom exactly on its head. We argue the current system of compensation that combines a *high average* but *badly structured* compensation in the public sector produces a "high pay/zero accountability" outcome that is anti-teacher in that it undermines the morale and motivation of government teachers by not treating teaching as a *professional* activity, is *anti-education* in that it *lowers* the quality of learning achievement and commitment to a learning culture in the schools, and is *anti-public sector* in that it erodes the public sector's ability to produce schooling that attracts students which undermines political support for government schools.

Unfortunately we believe that nearly everyone would agree with our assessment that it is politically impossible to restructure the compensation of existing teachers or make sufficiently systemic changes in the current state based cadres. We argue that perhaps a thorough-going devolution of education to the Panchayati Raj Institutions (PRI), as envisaged in the constitutional amendments, provides an opportunity—quite possibly the only politically feasible way to sail out of this perfect storm—to completely restructure the entire system of compensation to be consistent with an accountable and performance oriented public sector.

Before moving to documenting the facts about the system of compensation in India and how that system produces negative results in Section III, we first must provide a theoretical grounding in section II. Though a bit abstract, the fundamentals of systems of compensation, organizational complementarities, and relationships of accountability are necessary in order to avoid the simplistic dichotomies that ensnare many discussions of teacher's wages. Starting from fundamentals helps avoid the invariable suspicion of all non-economists that when economists approach teacher compensation they have in mind a simple-minded "pay for performance" scheme that is both administratively unworkable, distorts education, and is incompatible with the realities of schools and teachers. Section IV then lays out a concrete proposal for a new system of compensation embedded in a reformed decentralized system of schooling that is *pro-teacher, pro-education* and *pro-public sector.*

II) Systems of Compensation and Relationships of Accountability

This section makes three points that should inform any discussion of the structure of pay. First, the structure of pay is only one element of a system

of compensation, and not necessarily the most important. Second, a system of compensation needs to be embedded in an organizational strategy—and there are complementarities between other aspects of an organization and the system of compensation so that neither can be decided without reference to the other. Third, organizations, particularly public sector organizations, are embedded in a broader set of relationships of accountability and organizational strategies need to be consistent with overall accountability relationships.

II.a) Systems of Compensation

Organizations—whether it be a private firm, a university, an NGO, a religion, a political party—have goals. In order to accomplish those goals organizations have strategies—an explicit or implicit mental model of how the actions of the organization will lead to accomplishing the organizational goals. In order to support the strategy, organizations adopt policies and practices. One of the sets of policies and practices organizations have are broadly "human resources." Within the broad arena of human resources an organization has a *system of compensation*. The objective of an organization's system of compensation is to *attract, retain*, and *motivate* people to carry out the organization's goals.

Far too much time is spent discussing a single number—the average wage—that only summarizes one small aspect of a system of compensation. A system of compensation has four basic elements:

The first element of a system of compensation is the rules about who will be compensated—that is, the *nature and duration of the employment relationship* with the organization. People could work on a job to job basis as contractors to an organization, people could work on fixed term contracts with terms and conditions for renewal, people could work as indefinite term employees—but who could be separated for causes like poor performance, or people could have a de facto or de jure "lifetime" employment relationship. While often the employment decision is thought of separately from compensation, in fact this is the building block of compensation and one can use separation and not differential wages of those employed to create high powered compensation.

The second element of a system of compensation is the *structure of pay* across "states of the world." Wages of individuals can be differentiated by a large number of criteria: by seniority, by qualifications of the individual, by position in the organization (promotions), by assessed performance (either bonuses or raises), by performance of the organization (for example,

bonuses linked to the firm's stock), linked to individual output (piece rates). The structure of pay are the rules linking criteria—including those that vary over time—to the wages of a specific individual in a given period.

The third element of a system of compensation is *assignment of workers to tasks*. Again, perhaps this is only a broader human resource policy but it has an important dimension of compensation as workers often prefer to work for the organization in one capacity or another (for example, higher in the organizational hierarchy), or in one location or another (rural versus urban), at one time versus another (day shift versus night shift). Often within public sector or non-profit organizations the monetary compensation is quite equal but huge differences exist in 'rewards' as choice assignments are given to better performers.

The fourth element of a system of compensation is the *mix of current cash compensation and benefits* both present (for example, health insurance) and future (for example, pensions). This allocation affects the time profile of compensation and hence the incentives to stay with a given organization. Moreover, if a large fraction of compensation is in benefits this tends to reduce the extent to which wages generate differences in total compensation.

These four elements of an organization's system of compensation affect the way in which the system of compensation generates a workforce with the appropriate set of characteristics (skills, competencies, and attitudes) and motivates the workforce to take actions consistent with implementing the organization's strategy to accomplish its goals.

ATTRACT. Economics is frequently caricatured as arguing that people choose jobs to maximize income. In fact, economic theory suggests that people choose jobs in order to maximize *expected lifetime well-being* and each element of a structure of compensation is important in attracting the "right" people.

First, we assume people act to pursue their own goals—call it utility, welfare, well-being—but we do not assume that people's goals are exclusively monetary. People choose occupations that they find of interest, where they feel they earn respect, where the work environment is pleasant, where they feel they "make a difference." Particularly for attracting teachers this "intrinsic motivation" is important.

Second, a job that is potentially a long-term career presents a structure of pay across states of the world—some jobs may pay little at first but earnings rise sharply, others may pay high performers well but low performers little, pay may depend on getting promotions within the organizational structure. Hence what matters for attracting people is not only the initial wage but the entire structure of the wage over a career cycle.

Third, since pay varies across states of the world each individual's expected lifetime well being from a given structure of compensation depends on their assessment of the probabilities of their being in different states of the world. So, occupations that offer higher pay for high performers will attract those who believe (rightly or wrongly) they will be in the high performer category as their expected lifetime pay is higher than for another person with less confidence in being a high performer—even though the two individuals face exactly the same structure of pay from the organization.

RETAIN. The retention of workers has two elements: whether workers choose to leave or whether the organization forces an involuntary separation. Retention is perhaps the key element in creating a workforce compatible with a high performance organization as if the organization attracts a large pool of potential long-term employees and then retains those for whom the "match" between individual characteristics and organizational goals is the best; then observed worker productivity can rise sharply with tenure in the organization. A commonplace of the literature on labor is that there is nearly always a large amount of "churning" early in people's labor force experience as they search for a job (occupation and organization) that has a good match—the person has high well being and the productivity for the firm is high. This typically means that very few of those who take a job with a firm stay in the job, but of those that stay they stay for a very long time.

Part of this churning is voluntary separation—which most organizations implicitly encourage in part by having low wages at entry and then have wages rise with seniority and in part by having benefit packages which are often back-loaded (for example, pensions). This churning is more important when the "match" between person and organization is important for productivity. While productivity in a variety of occupations might be associated with some underlying measure of worker "quality" in fact worker "quality" is a worker-organization specific phenomenon. Particularly with teachers people often refer to extremely crude measures of training or education attainment or certification as the measure of "quality" whereas these are in practice only very weakly related to the quality of a teacher.

Even though voluntary separation is common, every high performance organization, and certainly every high performance *professional* organization, has a means for involuntary separation of workers that do not meet some performance threshold. In many, if not most, professions there is something like a journeyman-master distinction of the old guild tradition. In universities professors have a probationary period followed by tenure.

In law firms recent law graduates become associates and then "make partner." In medicine doctors go through long-periods of residency and fellowships in specialization before being allocated into jobs. Actuaries have a period of working before they become "fellows" of the society of actuaries (based on a series of certifying examinations). This common "tenure-like" decision is often associated with a large increase in pay.

MOTIVATE. A system of compensation should motivate those who are currently employed to take actions consistent with the organization's goals. This is a very difficult and subtle question for organizations like schools. There is little question that as the basic structure of pay for teachers "pay for performance" is not feasible or desirable (although there could be some element of student performance linked compensation). The modern economic theories of compensation do not simply assume that "piece rates" are the optimal wage structure and that "high powered" money incentives are always the ideal method for creating organizational performance—even in the private sector. The modern economic theory of compensation (for example, Lazear 1995) is built up from various strands: "institutional" view of the firm (Williamson 1985), principal-agent theory (Milgrom and Roberts 1992, Laffont and Tirole 1993, Roberts 2004). Taking the organization as the principal and its workers as agents the extent to which systems of compensation should depend on 'high powered' incentives depends critically on the extent to which (a) organizational performance depends on the actions of the agents of the organization and (b) the extent of "contractibility" of the agent's actions.

In the debate about compensation "high powered" incentives are those that link closely with outcomes (either organizational (like stock options) or individually assessed performance). First, to implement high powered incentives based on worker performance in any organization one has to be able to individually assess the contribution to the organizational goals. In nearly all cases this is difficult as the production process is a team or joint affair. There are many determinants of outcomes beyond the control of the individual worker and making incentives too high powered with respect to outcomes beyond the agent's control simply creates undesirable variability in worker pay with little incentive effect. Second, if one moves to subjective based assessments of performance there is a risk of "influence activities" as agents divert effort from goals to influencing the perception of their performance. Third, when there are multiple goals (as is true in education) and some of those goals are more easily quantifiable than others then creating incentives for the objectively measurable goal will cause agents to redirect

effort from unmeasured to measured goals (the individual level counter-part of "what gets measured gets done"). Finally, excessively high powered monetary incentives could be inconsistent with the "vision and mission" or "culture" of the organization itself. Almost certainly there are good priests and bad priests but the Catholic Church is rightfully reluctant to use high powered cash incentives to motivate priests.

The elements of the system of compensation interact in determining the appropriate structure of pay. If in fact the system of retention has worked so that the vast majority of the organization's agents remain with the or-ganization (after attrition and involuntary separation) because they have "internalized" the organization's goals and are a good productivity match with the organization then individually high powered incentives in the structure are less important. But this requires an ability to attract many and then retain few. It may well be that all fighter pilots in the Indian Air Force make nearly the same amount of money, but they are a highly selective group due to rigorous entrance, training, assignment to task, and promotion. Proposing a "pay per enemy plane downed" scheme would strike everyone as enormously wrong headed. Introducing individual gaps in pay could actually undermine intrinsic motivation (but so potentially, as we argue below, does a system with no gap at all).

The key to a structure of pay for motivation in multiple-goal, team based, non-competitive culture organizations like schools is typically an assess-ment process that estimates overall performance and which generates only moderate gaps with grades or ranks in the service at any given time, but wider and wider gaps between top and lesser performers as promo-tions and cumulative assessments produce wide gaps. But at the same time, this has to be combined with ways of avoiding very low performance.

The four elements of a system of compensation can be combined in various ways to create a high performance organization. The objective is not to make schools in India look like private firms, but rather to make schools in India that have systems of compensation similar to high per-formance organizations with similar goals and contexts.

II.b) Complementarities: Fit of System of Compensation with Organization Goal and Strategy to Promote Performance

The conventional wisdom is that high performance organizations tend to be "coherent" in the sense that they have: *clear and limited* goals, regularly judge their *performance* against those goals, have a feasible and *technically sound* strategy for accomplishing those goals, have organizational *policies*

T A B L E   1 .   Types of "Compensation Strategies" Depending on the Extent to which Either Continued Employment or Wage Compensation is Based on Performance

Extent to which continued employment is based on current (or cumulative) performance	*Extent to which compensation of employed individuals is based on assessed performance*		
	Low	*Medium*	*High*
Low	"Civil Service" (employment is permanent, little pay variation)		"Commission based sales" or "piece rates" (pay linked strictly to individual output, anyone can work who wants to)
High then Low	"Probationary period" (After a probationary period all are kept on indefinitely, little variation in pay)	"Tenure" (employment is not secure for some time, followed by 'permanent' status, variation in pay by subsequent raises/promotions)	"Professional Partnerships" (employment as an associate/junior partner, followed by becoming full partner, pay depends on firm/partnership income and partner contribution)
High	"Up or out" (all people at a given rank have equal pay, but if people do not advance in rank they are forced out)		"Top private executives" (pay is often heavily dependent on bonuses, at risk to being fired)

and practices compatible with the strategy, and finally have human resource tactics—including the *system of compensation*—compatible with the organizational goals and strategy. While a great deal of economists attention is to for-profit private firms, there are many high performance organizations in many domains outside of the for-profit private sector (for example, universities, political parties, religious movements, NGOs). The key to high performance organizations is not mimicking the private sector firm but rather adopting a strategy consistent with the organization and its objectives.

Hence the second major point from the modern theory of compensation is the emphasis on *complementarities* between the system of compensation and other policies and practices of the organization (Roberts 2004). For instance, some types of organizational reform actually raise the impact of other changes and so are mutually reinforcing. When there are complementarities it is possible that individual changes that are incoherent with the overall organization may fail—even though they would have succeeded as part of a broader package.

This is particularly relevant to schooling as there are a number of research studies examining the impact of introducing teacher incentive schemes of various types that link some component of teacher compensation to observed student performance[7]. However, for the most part, these incentive schemes that link say, student learning or progression, to some small part of teacher pay (either at the school or individual level) are often wildly at odds with the overall "culture" of the public sector bureaucracies responsible for schooling. Education ministries tend to be classic "high modern" bureaucracies (Scott 1998) with an input and logistics focus (like budgets, filling positions) with process orientation (were the rules followed?) rather than a performance orientation around either outputs or outcomes. It is easy to believe the impact of introducing a once-off experiment or small component of the overall system of compensation will be small relative to the potential of a system change.

On the other hand, if done well, then student assessment could be linked both to creating a performance culture, to improved teaching practices, and to some extent to teacher compensation. For instance, there is a very interesting randomized experiment under way in Andhra Pradesh that has introduced some incentive payments (on both an individual and group basis) comparing them to increased inputs[8]. The preliminary results show that both group and individual incentives have a significant impact on student learning. What is perhaps just as important is that the design of the test was done in such a way that it emphasized conceptual learning and moreover, the test instrument was a diagnostic provided to each school and teacher to reveal the concepts their students were not mastering. This is designed to avoid rote "teaching to the test" but to promote "testing to teach" where the test itself provides useful feedback to the teacher. This is potentially an example where the incentive scheme is complementary to a change to a learning culture in the organization.

Similarly, many attempts to promote a "performance" and "outcome orientation" or accountability schooling organizations are stymied by a system of compensation that does not give school heads any latitude—they

7. There has been examination of these issues in the USA, particularly in the city of Chicago. In Israel Lavy (2002) finds substantial impacts of group effects on outcomes. There have been very few such studies in developing countries. Glewwe, Kremer and Ilias (2003) find some impacts of teacher incentives linked to student performance, but which disappear over time as the improved performance appears to be mainly "teaching to the test." See below for recent results in Andhra Pradesh.

8. This discussion is based on a presentation given on the AP RESt project given August 3, 2006 to the Department of School Education, Government of Andhra Pradesh.

cannot choose teachers, assign teachers, force separation of teachers, or affect pay—so school heads in the public sector are very limited in what they could do to create a high performance school.

II.c) Relationship to Accountability

Both of these points: (a) that the system of compensation should be the focus rather than "high" or "low" pay and (b) that the system of compensation is embedded in a larger institutional and organizational context, are (not coincidentally) embedded in the "accountability" approach to service delivery. The accountability approach (as for instance articulated in the World Bank's World Development Report 2004) analyzes the outcome of service delivery as the result of a four by five framework: four relationships of accountability, each with five elements.

Figure 1 illustrates the four relationships of accountability involved in the provision of basic schooling. Three of these are relevant when the public sector itself produces schooling (since there are three relationships this is called the "long route" of accountability). One relationship is called *politics* (between citizens and the state) as in order for the state to act in the interests of its citizens it must have accountability to them. A second relationship is

F I G U R E   1 .   Four Relationships of Accountability in Service Delivery: Politics, Compact, Management and Client Power
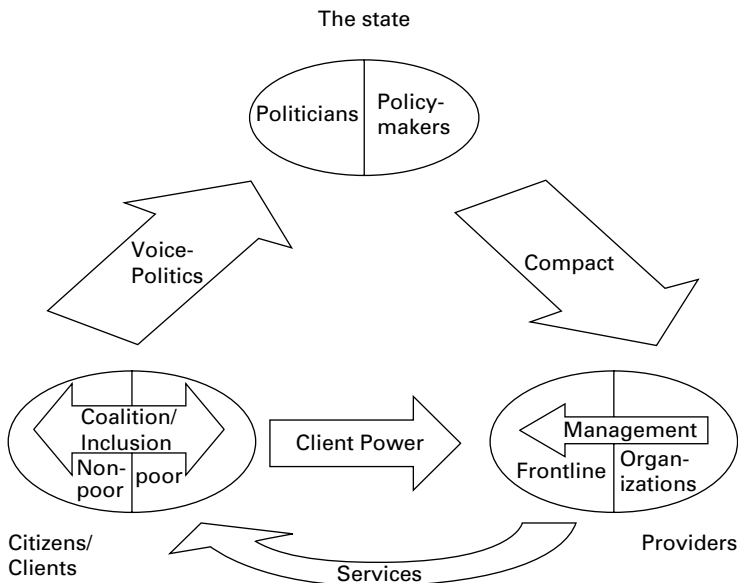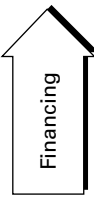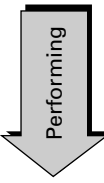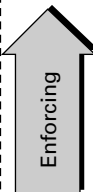

Source: World Development Report, 2004.
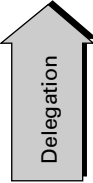
called, for lack of a better word, *compact* (between the state and its organizational providers). That is, for public production to be successful the executive and legislative branches that represent the state have to be able to control the line agencies (such as ministries of education). The third relationship of accountability in the long route is *management* (between ministries of education and teachers). If effective schooling is to happen millions of front-line providers (teachers) have to do the right thing hour to hour, day in and day out. A distinct route of accountability would run directly from clients to (organizational) providers, as when parents pay for schooling (or tutoring) out of pocket. There is no general rule that the "long-route" (public) works better than the "short-route" (private) as many of the best education systems in the world are almost entirely public. That said, a failure in any one of the relationships can lead to failure of the entire set—if politicians are not adequately accountable to voters they may undermine the efforts of even the most well meaning ministries or teachers.

To say that "politicians should be accountable to voters" is more a cliché than a tool of analysis. To unpack a relationship of accountability for analytical purposes, the framework posits five elements of any relationship of accountability: *delegation, finance, performance, information,* and *enforceability.* Performance is different from the other four, as it is chosen by the "accountees" (called the agent) while the other four are elements of design usually under the control (in some way shape or form) of the "accounters" (called principals). Figure 2 illustrates these five elements.

In the case of *management* as a relationship between an organization (school or school system) and front-line providers (teachers) the organization chooses the goals, the financing (both of assets, inputs, and wages), the information to be generated for internal (or external) accountability and the enforceability.

A system of compensation is another way of emphasizing the elements of "enforcing" available to management of organizations for creating accountability of front-line providers as "enforceability" which depends on the observed performance of teachers (which depends on what information is collected relative to the delegation to teachers of their tasks) is affected by all four elements of the system of compensation (durability, structure of pay across states of the world, assignment to tasks, and cash/benefits mix). The complementarity between the institutional context and system of compensation is also important. If in fact individual schools are not given clear goals or adequate financing nor are themselves subject to any "enforcing" then it is unlikely that high performance inducing systems of compensation will be introduced.

F I G U R E 2. The Five Elements of Each of the Four Relationships of Accountability

What is 'Accountability'?–
Demystifying the Elements of the Accountability Relations

There are Five Features to Any Accountability Relationship

Feature	What	Example 1: Buying a Sandwich	Example 2: Going to a Doctor
Delegation	You give a task to the accountable 'agent'	• You ask for a sandwich	• You go to the doctor to be treated
Financing	You give the 'agent' the money to do the task	• You pay for the sandwich	• You pay the doctor for the treatment
Performing	The 'agent' does the assigned task	• The sandwich is made for you	• The doctor treats you to try cure your ailment
Informing	You find out how well the 'agent' has done the work	• You eat the sandwich which informs you of its quality	• You see if you are feeling better–you assess the performance of the
Enforcing	You reward good performance and punish bad performance	• You choose whether to buy a sandwich from the seller the next time, affecting his profits	• You go to him next time (if he was good) or choose to go somewhere else if not

Source: Pande and Pritchett, 2006.

III) The Current Structure of Teacher Compensation in the Public Sector and How It Creates the Perfect Storm

Teachers in India are strikingly well-paid and they are strikingly badly paid. That is, the *level* of average compensation of teachers is very high, but at the same time every element of the system of compensation seems almost designed to eliminate any element of accountability—so teacher pay is extraordinarily badly structured to produce desirable educational results. This section first reviews the facts about the system of compensation, including the level and structure of pay and then illustrates how these features contribute directly to many of the observed weaknesses of public schooling.

III.A) Empirical Facts about Teacher Pay in India

We document four facts about the system of teacher compensation.

Fact 1: There is little or no ability to separate teachers from service—for any cause.

First, while this may vary legally a bit state to state, by and large state cadre teachers are protected by laws and even by an article of the constitution. Second, teachers, both collectively and individually are politically powerful and hence the de facto risk of separation is even less than the very little allowed for in theory. Third, in their interviews examining absenteeism researchers visited thousands of schools and asked the question "has any teacher ever been disciplined?" and in only one instance could *anyone* recall a teacher being disciplined, and not just in the survey period but *ever*. The nature of the durability of the employment relationship once entered into is: "forever, from the first instant, no matter what."

Fact 2: The average pay of public sector teachers is very high relative to alternatives (both private teaching and other private sector jobs).

In this paper we are more focused on the *structure* of pay because it is common knowledge that *average* pay of public school teachers is substantially higher than that of private school teachers. There are many small scale surveys of teachers in public and private schools and while few of them find the dramatic 7.5 to 1 differentials of the Tooley and Dixon study, everyone finds that average pay in the public sector is substantially higher than in the private sector. Kingdon and Teal (2006) cite several sources of information on public-private wage differentials for teachers: their own survey of 20 government-funded and 10 private schools which finds pay 38 percent lower in private schools (unadjusted difference), Kansal's (1990)

study of 233 teachers in New Delhi schools finds private sector pay 42 percent lower, and Govinda and Verghese's (1993) study of 111 teachers in Madhya Pradesh finds private sector pay 45 percent lower. The experience with para-teachers and with community teachers (such as the EGS teachers in Madhya Pradesh) or for alternative schools in West Bengal always finds that sufficient numbers of teachers can be attracted for a small fraction of the wages of the current teachers.

We use National Sample Survey (NSS) data from the 55th round to compare the reported earnings of public teachers to either private sector teachers or to private sector wage earners. We regress individuals reported (ln) daily wage on education, experience (and its square), whether or not the person lives in a rural area, and whether the person was male and a complete set of state dummies.[9] Therefore we can control for potential differences in public and private sector teachers in education or experience to estimate the wage premia of a "regression equivalent" person from being a public sector teacher. The final column of table 2 suggests that public sector teachers make more than twice what their "regression equivalents" in the private sector do—as their pay is .95 natural log units higher. This difference in pay almost certainly substantially *understates* the true compensation differential for the public sector worker as it does not include the value of employment security or benefits (both of which are higher in public than non-aided private sector).

What is true of public sector versus private teachers is also true comparing public sector teachers to all private sector salaried workers. A public sector teacher makes .79 natural log units (more than 100 percent) more than his 'regression equivalent' who works as a wage earner in the private sector.

Fact 3: The pay—seniority profile is shallower (less steep) in public sector versus either private sector teaching or private sector jobs— that is, the degree of overpayment is *higher* for public sector teachers at the early stages of a career.

Figures 3 and 4 show with graphs what the regressions in table 2 and 3 show numerically about the slope of earnings with respect to experience. The negative coefficient on the interaction term of a public sector teacher and experience shows that the average pay of teachers increases more slowly than of private sector teachers or of private earners. So as can be seen in

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9. Experience is measured as a continuous variable representing potential work experience, constructed by subtracting years of education and 6 additional years from the respondent's age.

T A B L E 2 .   Linear Regression Models of Ln Daily Earnings on Teacher Characteristics

Comparison of public and private teachers

	(1)	(2)	(3)
Public Sector	0.732	0.451	0.947
	(23.88)**	(17.18)**	(12.36)**
Rural Areas	−0.122	−0.082	−0.098
	(4.30)**	(3.28)**	(3.94)**
Male		0.332	0.475
		(12.62)**	(11.00)**
Secondary		0.88	0.902
		(14.92)**	(15.43)**
Sr. Secondary		1.058	1.073
		(17.51)**	(17.94)**
Tertiary		1.355	1.369
		(23.17)**	(23.64)**
Experience		0.057	0.065
		(14.09)**	(10.61)**
Experience Square		0	0
		(5.20)**	(2.64)**
Public* Male			−0.197
			(3.90)**
Public* Experience			−0.024
			(2.99)**
Public* Experience sq.			0
			−0.79
Constant	4.215	2.274	2.023
	(84.28)**	(31.18)**	(24.89)**
Observations	4043	4042	4042
R-squared	0.17	0.44	0.45

Sources: Authors' calculations based on NSS 55th Round Schedule 10 data.

Notes: t statistics in parentheses. % significant at 5%; ** significant at 1%. All regressions include state dummies.

figure 3 the gap with private sector teachers is very large when teachers are just starting out but by the time they reach 20 years experience the gap is much smaller—but, as we see below, many fewer teachers are retained in the private sector to 20 years experience.

Fact 4: The pay of those employed in the public sector has very little variance even potentially related to performance—less than either private sector teaching or the private sector.

As discussed above, systems of compensation create accountability (or enforceability) in very different ways (and combinations of ways). Some have very little differentiation by grade/rank/level of the organization but

T A B L E 3 . Linear Regression Models of Ln Daily Earnings on Employee Characteristics

Comparison of public teachers and private salaried non-teachers

	(1)	(2)	(3)
Teacher	1.048	0.562	0.787
	(59.82)**	(32.87)**	(14.21)**
Rural	−0.143	−0.097	−0.091
	(11.59)**	(9.43)**	(8.87)**
Male		0.494	0.554
		(36.93)**	(36.51)**
Secondary		0.388	0.375
		(30.47)**	(29.41)**
Sr. Secondary		0.602	0.6
		(35.79)**	(35.84)**
Tertiary		0.93	0.944
		(60.75)**	(61.70)**
Experience		0.059	0.059
		(49.29)**	(47.59)**
Experience square		−0.001	−0.001
		(36.10)**	(35.51)**
Teacher* Male			−0.3
			(9.53)**
Teacher* Experience			−0.016
			(3.02)**
Teacher* Experience square			0.001
			(4.76)**
Constant	3.896	2.609	2.562
	(197.95)**	(116.12)**	(108.01)**
Observations	17420	17419	17419
R-squared	0.23	0.49	0.49

Sources: Authors' calculations based on NSS 55th Round Schedule 10 data.

Notes: t statistics in parentheses. % significant at 5%; ** significant at 1%. All regressions include state dummies.

an individual's progress through the organization is performance based so there is performance related variability across individuals. Other organizations have very little variance in pay across individuals with the same seniority in the organization because they retain fewer and fewer people (for example, "up or out" organizations like universities or militaries)—which is *ex ante* variability in pay by the organization because it is a mix of zero (if not still employed) plus an amount if employed. One of the striking things about teacher compensation is that if one examines the variability of pay of those with similar labor market experience (which is our crude proxy for tenure in the organization—though not widely imprecise as we see

FIGURE 3. Earnings of Public Sector Teachers are Substantially Higher than of Regression Equivalent Private Sector Teachers—and the Gap is Higher at Younger than at Older Ages
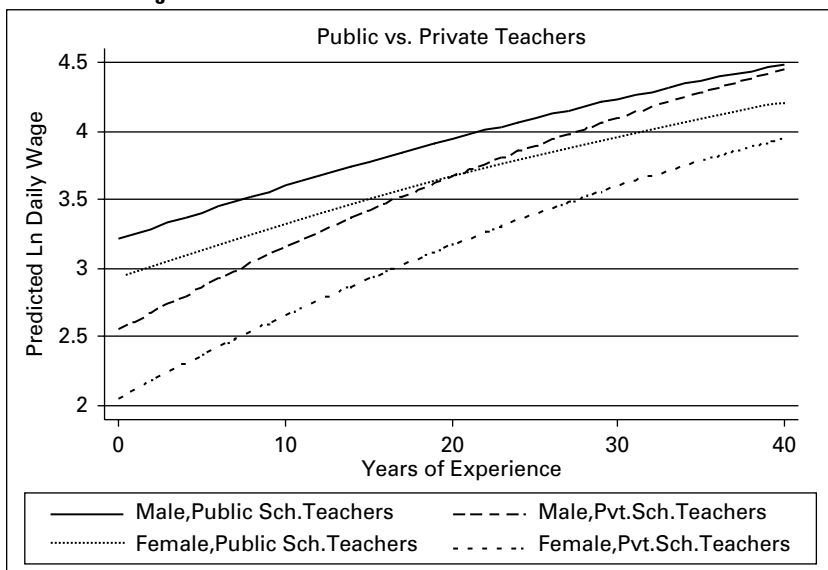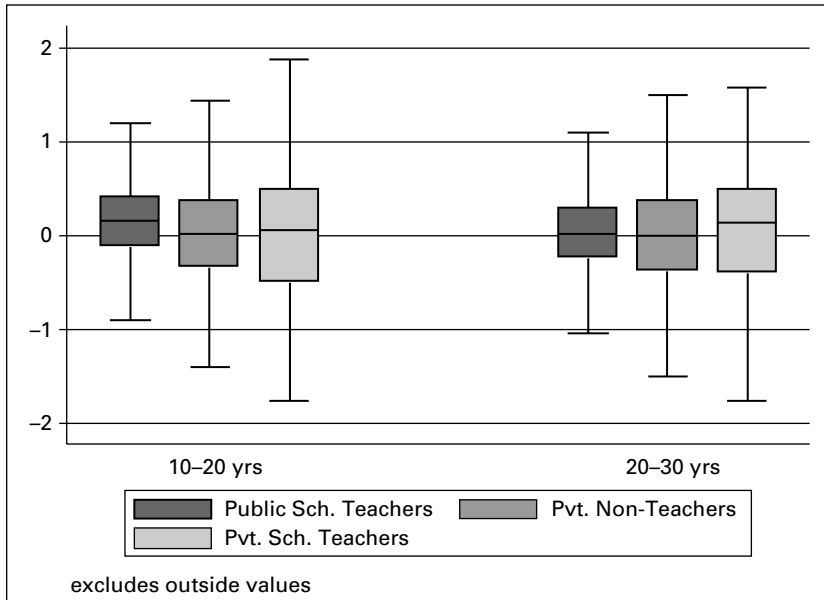

Source: Author's calculations with NSS 55th round.

FIGURE 4. Earnings of Public Sector Teachers versus All Private Sector Wage Employees (Not Teachers)
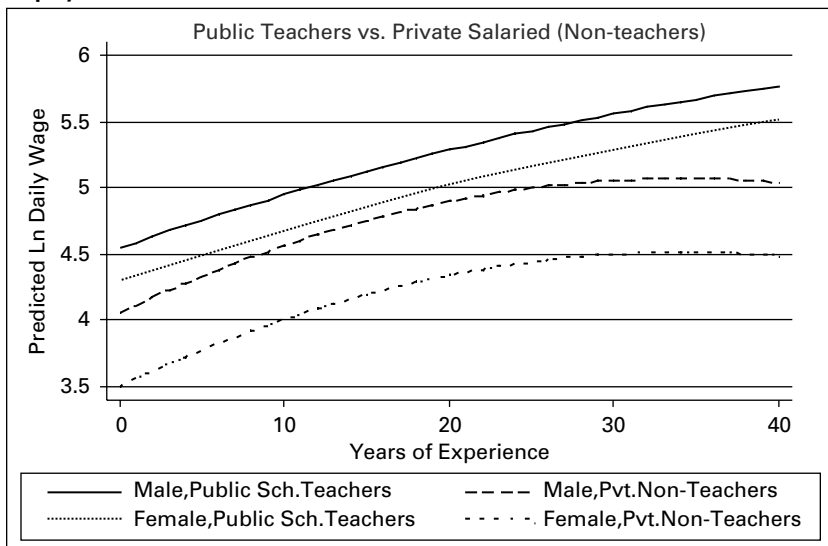
Source: Author's calculations with NSS 55th round.

FIGURE 5. The Variance in Earnings is Much Smaller among Regression Equivalent Public Sector Teachers than Either among Private Sector Wage Earners (Non-Teachers) or among Private Sector Teachers

excludes outside values

Sources: Authors' calculations based on NSS 55th Round Schedule 10 data.

Notes: Box plot of residuals from regressing ln (earnings) on employee characteristics including gender, education, years of experience and its square, and sector and state of residence. Regressions are estimated separately for the three sub samples: public school teachers, private school teachers and private regular/salaried non-teachers.

below with actual data on age and tenure), not surprisingly the variability of pay between regression equivalent public sector teachers (controlling for education, rural/urban, states) is much lower in the public than private sectors.

In fact, what is interesting is that the variability of pay among private sector teachers with 10–20 or 20–30 years of experience is roughly twice as large as among public sector teachers. If one supposes, not unreasonably, that private schools (and the competition among private schools for good teachers) have a spread in compensation that roughly reflects individual differences in actual performance as teachers (as opposed to mere qualifications or training) then the compression across teachers is striking—good teachers in the public sector make far too little relative to their low productivity counter-parts. Of course if one combines the higher average earnings of public (in figure 4) and the much lower variability of public one can

see that even the lowest productivity (which in the public sector with absenteeism and lack of effort approaches zero) teachers in the public sector make more than all but the highest paid teachers in the private sector.

III.B) How the Public Sector System of Compensation with High Pay/Zero Accountability Produces the Perfect Storm of Negative Consequences

The astute reader might point out at this juncture that the system of compensation in India actually looks a lot like compensation of teachers elsewhere—including countries with high performance education systems. But what is relatively unique about India is that the average pay for teachers for India is enormously high relative to the market alternatives— either as teachers in other capacity (the private sector, community schools) or in alternative private employment. India has reached a stage of "high pay/zero accountability." We believe it is this *combination* of compensation being badly structured with the very high average level that produces the "perfect storm" of negative consequences. As the combination of high pay and zero accountability destroys all motivation—including the sense of profes-sionalism, occupational pride and respect, and internal motivation that can drive high performance organizations even without "high powered" money incentives.

Consequence 1: Attracts—but does not select

Usually the question about public sector pay is whether or not it is sufficiently high to attract people of adequate quality into the public sector. Of this there is no question. Rather the excess of public sector pay over private sector for equivalently qualified individuals combined with zero accountability creates two problems.

First, there is no reliable method of choosing from among the excess supply of applicants those who would be the best teachers. This means that the gain in quality from the high wages is negated by the lack of a system of choosing the best.

Second—and this problem is much worse—the excess of public over private pay, particularly when combined with the lack of accountability makes teaching posts an attractive opportunity for those who have no interest in teaching at all. Politicians are tempted to reward supporters with teaching posts as patronage. At the extreme, particularly when governance is weak, and while this is difficult to quantify, many people believe the field is rife with "sub-contracting." That is, many suspect teachers gain the appointments through political connections then use some of the wage to pay

off the block officials and some of the wage to hire someone at the much lower market wage to actually take their place in the classroom and pocket the difference.[10]

High performance schools often rely on professional pride—people feel good about being a teacher as it brings respect and stature—and intrinsic motivation—people enjoy teaching and helping children learn, rather than high powered structure of pay. But this is impossible if people are attracted into the profession primarily by the high money wage—particularly if the system has no ability to actually hire the most intrinsically motivated.

Consequence 2: Attracts—but does not appropriately 'retain'

As we saw above, a typical way to have a system of compensation that supports a high performance organization is to encourage a fair amount of "churning" in the early years of one's employment such that those retained are of much higher "quality"—not necessarily in terms of overall general skill or credentials but in actual match with the organization. The difficulty with the system of compensation of Indian teachers is that the system has no mechanism at all for involuntary separation *and* by having a pay too high particularly at the early stages of one's career the system actively *discourages* voluntary separation. So, take someone who thinks they might like to be a teacher. They acquire the appropriate credentials (which given the common lack of 'hands-on' training this may involve quite little exposure to classrooms) and suppose that they get appointed to a permanent public sector teaching position. Now suppose that after a couple of years of teaching they discover they neither have any aptitude for teaching nor do they particularly enjoy teaching. The desirable thing for all concerned (students and teacher) is for the person to resign and look for another occupation that is a better match. Given the current system of compensation will they resign? Three good reasons why not.

First, as seen in table 3 and figure 4 on average they would have to take a pay cut—and a pay cut that is, perversely, much larger in the early years than in the later years.

Second, there is zero accountability so they can start to coast in their current job (for example, showing up infrequently, not teaching when they do show up)—in the extreme they can keep the position and its pay and sub-contract to someone else the actual work.

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10. This is not just heard from people outside the system. In personal communication with the authors, this has been noted by the Chief Secretaries of two different states, people who, one would imagine, have a reasonably good idea about the reality of what happens inside government schools.

Third, since a substantial part of compensation in the public sector is job security and benefits in-kind, this makes giving up the job even less attractive.

This means that, rather than only retaining those who are a good fit to be teachers the current system retains everyone—including those who cease to perform, which undermines the morale of the system, leads to disrespect from management and parents of all teachers (as reputation spreads), and makes it impossible to create an e*spirit de corps* around teaching as a noble calling and profession rather than as merely an occupation. This is the sense in which excessive retention is *anti-teacher.*

Figures 6 and 7 use the information about teachers in private and public schools from the publicly available DISE (District Information System for Education 2002/03) to examine the differences in retention by comparing the fraction of teachers with various years of tenure between public and private schools. This displays exactly the pattern one would expect. In Orissa for instance, the fraction of teachers with 20 or even 30 years in their job is almost as high as the fraction with less than 5 years experience. In contrast, the private sector shows the expected pattern of churning—there are ten times as many teachers in their first year as in their 20th year. While Orissa presents a particularly striking case, as shown in annexure figure A-1

F I G U R E 6 . The Distribution of Existing Teachers by Tenure in Service Demonstrates the Very Different Patterns of Turn-Over in Private versus Public Sector—Teachers are Much More Likely to Remain in the Public Sector

Orissa
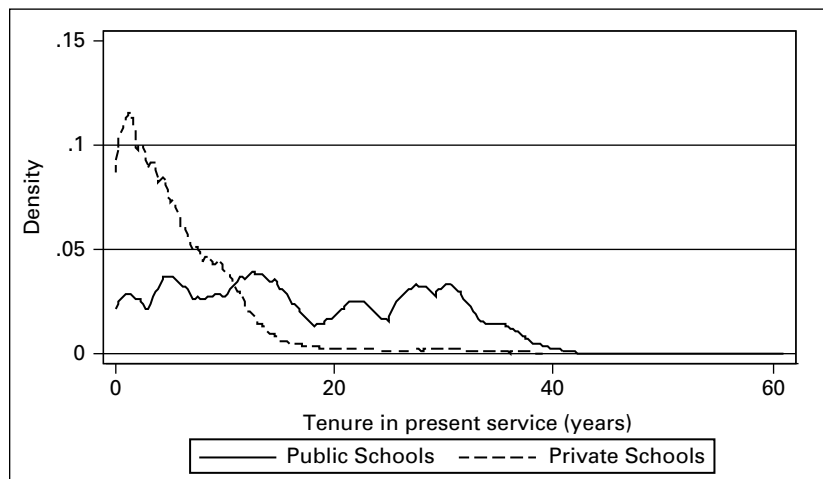
Source: Author's calculations based on the DISE data sets.

F I G U R E 7 .   The Age Pattern of Private versus Public Sector Teachers also Reveals the Extraordinary Retention of Teachers in the Public Sector (Especially the Retention of Teachers over 40 Years Old until Age 60 in the State of Orissa
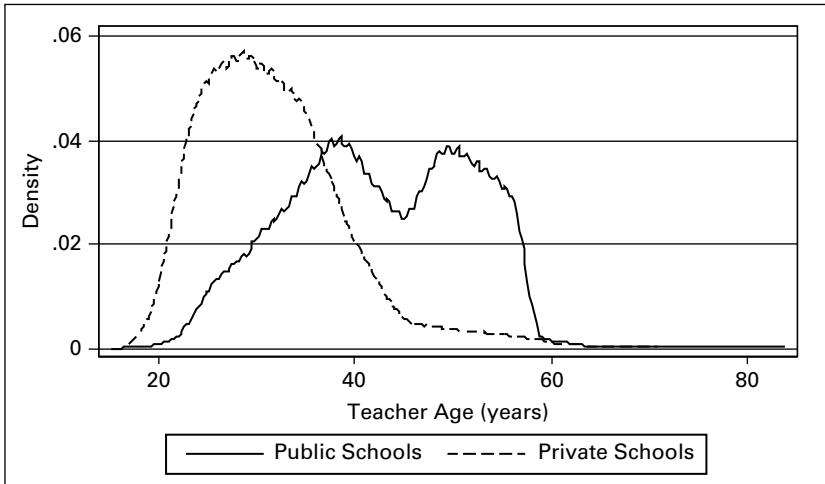
Source: Author's calculations based on DISE data.

this pattern of greater tenure in present service in public over private schools is observed in every single Indian state.

Figure 7 shows similar graphs of the average age of teachers for the public and the private sector. Again, the private sector shows what is a very typical pattern of distribution by age with search for best 'match' in job and occupation drive churning—that there are many more young than old and that those at any given age declines. On the other hand, the public sector in all three states shows a pattern of decreasing numbers up until around age 40, a decline thereafter which is then stopped and then almost complete retention until age 60.[11]

Consequence 3: Retains—but does not appropriately 'motivate'

The final feature is that there is nothing in the public sector system of compensation or structure of pay to align any aspect of compensation with contribution to the goals of the organization. Again, we are not suggesting some simple minded "pay for performance" scheme based on student tests as the basis of the system of compensation. But there are a variety of ways

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11. As with the tenure graphs it is difficult to distinguish between "steady state" and "growth of the system" effects as if there were big hiring expansions in certain years and many people of the same age are hired then this will show up in a cross section as a cluster at that age—even if there is nothing special about the age. Distinguishing between age effects and time effects is always a problem with a single cross section.

of assessing behaviors or characteristics of teachers associated with superior performance and rewarding those. For instance, one of the few reliably demonstrated correlates between teacher characteristics and student performance is that, not surprisingly, teachers who know the subject better have students who do better in the subject. Many are now suggesting that teacher compensation could be linked to teacher examinations on subject matter—or that annual increments could depend on having made certain progress in this. Unfortunately on this point we have very little evidence from India, as there has been so little experimentation.

Kingdon (2006) in a recent paper shows that in private schools one can demonstrate that teachers whose students perform better are also paid more. Using data from a sample of 186 schools, she finds that increasing teacher salary has a modest but statistically highly significant positive impact on performance of Grade 10 students in the board examination. In another paper, Kingdon and Teal (2006) find that teacher pay and student achievement are strongly related in private schools, but this is not the case in public schools in India.

Consequence 4: Negative complementarities: system of compensation is 'anti-teacher' and undermines an organizational 'learning culture'

The inability of schools or the school system to involuntarily separate teachers is an insult to the profession of teaching. Strangely, the protections of teachers against involuntary separation *for any cause* are sometimes defended as being "pro-teacher." But how could it possibly be "pro-teacher" to assert that the quality with which this job is done is *so* completely unimportant that anyone with the appropriate paper credentials can do it and that performance doesn't matter? A system that does not allow teachers to be let go based on performance is deeply *anti-teaching* and in the long run is deeply *anti-teacher* and it equates what should be the calling and profession of an educator with a factory worker. Doctors are liable for malpractice—because medicine is a profession that is important. Lawyers can be disbarred, no one would hire an architect whose buildings fell down. One cannot sustain good practice without any mechanism for penalizing bad practice.

IV) Decentralization of Basic Education to the PRIs as a Window of Opportunity

A litany all of the negative features of and consequences of the current system of teacher compensation might sound like a counsel of despair.

Everyone knows that teachers are enormously politically powerful and that no proposal to lower the pay of existing teachers has any political chance at all. We agree. We believe no sensible politician would ever propose to either cut the current wage (or wage structure) of any current teacher, nor would they put forward any proposal for involuntary separation of any current teacher. Either would be politically impossible. In everything we propose all current state cadre teachers would be exempted or "grandfathered."

But at the same time it should be acknowledged that this system of compensation is destroying publicly produced education in India. As detailed in the introduction the high pay/zero accountability public production of schools have proven a more effective mode of privatization of schooling than even privatization or vouchers.

This is an important point as it might naively be thought that high pay in the public sector would improve the quality in the public sector and hence defending high pay for teachers in the public sector would be "pro" public sector. But just as the "high pay/zero accountability" is anti-teaching it is also anti-public sector. Saddled with the restrictions it faces there is almost certainly no way public education can be viable in a competition with private sector providers. This is putting public education into a potentially vicious circle in which as quality deteriorates more and more parents place their children in private school which erodes the potential political interest in and coalition for school reform which then causes more to abandon public schooling and further lowers support. Maintenance of the current system of compensation that produces the perfect storm will be the death-knell of publicly produced education—it will sink the boat.

IV.A) Decentralization as the Last Best Opportunity to Reform Teacher Compensation

A political reality is that the only options for system reform, even with decentralization, are initiatives that affect *newly hired* teachers but even this is not easy, as many states have experimented with one form or another of "locally controlled" teachers—from the EGS teachers in Madhya Pradesh, local control of hiring in Rajasthan, the "alternative" schools in West Bengal, para-teachers or contract teachers in many states. However, in nearly all of these cases there has been "claw back" of the existing system as the new teachers pressure for "regularization" and eventually succeed.

But this collection of state experiences with alternatives to the standard state cadres does indicate three things. First, the reform cannot be seen as a

"temporary" expedient due to fiscal stress. If an alternative contractual model is seen as a response to a fiscal crisis then that modality is self-limiting as when the "crisis" is over (and no crisis can last forever) the teachers will demand "regularization". Second, the reform cannot be seen as jeopardizing the quality of education—if "contract" teachers are seen as a low quality substitute to the regular cadre then it is easy to mobilize politically to bring them back into the mainstream (even if of course the use of "quality" to mobilize public opinion is being used completely cynically). Third, to survive, the reforms must create a constituency who would lose from any wholesale back-sliding on the reforms. All three of these can be met with a well designed decentralization.

IV.B) Using Decentralization to Create a Performance Oriented Culture in Schools

As pointed out above a system of compensation is just one element of a larger institutional and organizational framework that creates (or fails to create) accountabilities. Before one can describe a desirable compensation system for a decentralized education system, one has to describe the allocation of functions and responsibilities across the tiers of government and how that overall institutional and organizational context creates a performance oriented culture in education.

Pande and Pritchett (2006) address the question of the desirable allocation of functions, funds, and functionaries between the state and the tiers of the PRIs in elementary education based on the first principles of public finance and the first principles of accountability. From that analysis three points emerge. First, one should not think of decentralizing sub-sectors like basic education to a given tier of government entirely. Rather, one should break the actions required in the effective provision of a service into distinct activities. We divide the functions into: standard setting, planning, asset creation, operations, and monitoring and evaluation. A key lesson of analyzing accountability is that accountability is enhanced if these functions are "unbundled"—that is divided among separate actors—whether between the public sector and private sector, across different agencies of the public sector (as the Reserve Bank of India monitors state owned banks), or across tiers of government. Obviously if the same agency or tier of government is responsible for both setting standards, operations to meet those standards, and evaluating their performance in meeting those standards this creates a conflict of interest—as if a player on one of the teams were also

the referee of the game. Separation of standard setting and monitoring of performance should be separated from the day to day operation.

Second, this unbundling *strengthens* the role of the state government in setting standards (creating clear and realistic goals for learning) and in monitoring and evaluation of learning outcomes. As the functions of planning, asset creation and operation of schools are turned over to the PRI the main responsibility of the state is to monitor the performance of each unit and school—in terms of actual performance related measures on *outputs* and *outcomes.*

Since the state's role is reduced to setting goals and monitoring progress to those goals (plus technical support) they can be effective in this without needing to be defensive about uncovering poor performance—as they are no longer directly responsible for performance. This is essential to an effective decentralization as it uses the opportunity of decentralization to create an outcome orientation in the education sector.

Third, in an unbundled system the control of operations—including of teachers pass as low as possible, with major responsibilities—particularly for teacher assignment—passing directly to the school committees (as functional sub-committees of the Gram Panchayat). But if decentralization is to be effective this cannot mean simply shifting an unreformed education ministry down a tier or two. Rather, the local bodies gain control of the schools—but their accountability is dramatically enhanced by creating clear performance measures, the monitoring of which is not under their control and these measures are given wide publicity at each level of aggregation—from school to GP to block to district to state. Performance measures then become the key performance metric for both internal and external accountability (as benchmarked information is actively and widely disseminated among the public through the PRI mechanisms (like Gram Sabhas).

The important point is that the decentralization itself first creates a system in which the "compact" and "politics" elements of accountability are strengthened. This will mean that individual schools, as organizational providers, will come under pressure for greater performance on outcomes. In the absence of this pressure for accountability on schools reforming the system of compensation used by schools is pointless—if not dangerous. But suppose the decentralization does succeed in giving greater autonomy and placing greater accountability on the lowest tier for performance of schools. Then the question of the accountability of teachers becomes paramount (the "management" relationship of accountability). This is where the system of compensation available to local bodies becomes paramount.

FIGURE 8. Allocation of "Three Fs" (Funds, Functions, and Functionaries) for Basic Education

First Principles of *Public Finance*

Function	Public Finance First Principle			
	Economies of Scale	Externalities/ System-wide Effects	Equity	Heterogeneity of Demand
Standards Setting				
Planning		-	-	
Asset Creation		-	-	
Operation - Non teacher		-	-	
Operation - Teacher		-	-	
Monitoring and Evaluation				

First Principles of *Accountability*

Function	Accountability First Principle		
	Discretionary?	Transaction Intensive?	Who Can Best Infer Performance (Technical or Local?)
Standards Setting	No	No	Technical
Planning	Somewhat	Somewhat	Bit Technical
Asset Creation	Yes	Yes	Local
Operation - Non teacher	Yes	Yes	Local
Operation - Teacher	Yes	Yes	Local / Technical
Monitoring and Evaluation	No	Yes	Technical

Functional Allocation in Primary Education Based on *First Principles* Analysis

Function	Responsibility				Village		Service Provider (school)
	Central Govt	State Govt	District	Block	Gram Panchayat	User Group	
Standards Setting							
Planning							
Asset Creation							
Operation - Non teacher			Support				
Operation - Teacher			Support				
Monitoring and Evaluation			Support				

Key Messages

- States do **Standards Setting and Monitoring**
- PRIs assume responsibility for actual **Operation**
  - As much as possible as low as possible
  - Higher PRI tiers back-up on professionalism, technical

Source: Pande and Pritchett, 2006.

IV.C) The Right System of Compensation in a Decentralized Performance Oriented System of Basic Schooling

The key issue with any proposal about education is the quality of teaching. Without quality teaching all other attempts to improve schooling are simply froth on the ocean. We are going to make a specific proposal for how to do that. We do not mean this to be an exact blueprint that is correct in every detail, but rather the illustration of a class of proposals with various options.[12]

We propose that, in conjunction with decentralization to the PRIs of responsibilities for the functions of elementary education, the current state cadre of teachers be gradually replaced by a District Professional Teacher Cadre (DPTC) that creates a *system of compensation* that is up to the task of *attracting, retaining,* and *motivating* high quality teaching in the public sector. (Again, for political and legal reasons all existing teachers in the government schools would have their terms of employment 'grandfathered', that is, no change would be made to their terms which would remain unchanged until they retire.[13])

A three phase career track would be applicable only to newly hired teachers, with the following phases:

- Phase I: *Shiksha Karmi*s
- Phase II: *Adhyapak*
- Phase III: *Maha-Adhyapak*

Phase I In Phase I a teacher is *Shiksha Karmi*s (SK or apprentice). To enter Phase I as an SK a person must be approved by the ZP as *eligible* to be appointed as a teacher. To be in this pool of eligible SKs a person must satisfy two sets of requirements. First, they must be recommended by a GP (indicating a desire to hire, if approved). Second, candidates must also fulfill certain basic technical requirements (as specified by the district (possibly following state or national guidelines).

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12. This section follows Pande and Pritchett 2006.

13. This creates some difficulties in moving towards block grants or money follows the student in the transition period, but not problems that are insurmountable as a special 'transition fund' can be created. For instance, in a block grant system in which the GP receives a per student amount each old cadre teacher assigned to the school would be accompanied by a teacher specific "transition grant" that was a bookkeeping device. In all new hiring decisions the GP would face the same marginal cost of old cadre or new cadre—but the teacher specific grant would lapse with the retirement of the teacher. Given the age composition of much of the existing teaching force the magnitude of this transition fund would diminish quite rapidly over time and the cost savings could be allocated in a variety of ways.

From the 'pool' of all eligible SKs teachers *schools* (GP/VEC/SMC) choose teachers for an *assignment*. We use GP/VEC/SMC interchangeably as this could happen in a variety of ways. One plausible model is that School Management Committees whose leaders and members are chosen by parents become constituents of a Village Education Committee which is constituted as a sub-committee of the GP (and hence would contain elected members from the GP and representatives of the SMC to balance village level and parental concerns). In this case the GP is the hiring entity (through which the funds flow) but acts on the basis of recommendations of the SMC.[14]

Why this separation of "hiring" from "assignment"? Two reasons.

First, even at salary levels much lower than their current salary structure teaching positions are in huge demand—and hence there are huge pressures for corruption—in which the person(s) responsible for appointing teachers take bribes from prospective teachers in order to allocate the positions.[15] This separation means that the level of government responsible for certifying the technical quality of teachers cannot also give the teacher an assignment, which reduces their ability to extract bribes rather than follow the criteria in a transparent manner. By the same logic, the fact that the district has to approve a teacher means that the officials at the GP/SMC/ VEC cannot extract bribes and promise jobs to unqualified teachers. Of course, there can always be collusion but the hope is separating these processes and making each transparent makes that more difficult than the existing system.

Second, as discussed above a major problem with the existing system of compensation is that people want the high pay of being a teacher but often do not want to be assigned to distant rural schools. One suspects this then accounts for a great deal of the absence problem as teachers live far

14. There are other models in which the SMC committee is the primary legal entity and tiers of government (perhaps districts deal directly with schools). In some variants of this model the PRIs are actually cut out of the loop entirely. This model also has its attractions as then the move to a more or less unified 'voucher' like system in which money follows the student is easy as funds are already flowing on a per student basis to schools.

15. There is evidence that even in the EGS schools in Madhya Pradesh, which created three tiers of teachers (old cadre and two new types) even the lowest paid of the three frequently reported paying substantial bribes to get their positions (Leclerq 2002). There is evidence from surveys of teachers in Orissa and Rajasthan that even in the private sector where reported wages were a third or less the public sector levels a good fraction of the teacher paid bribes to get their positions. (This is something of a puzzle—why not just lower the wage—but perhaps there are binding regulations even for private schools).

from schools and travel back and forth infrequently.[16] Moreover, this also means teachers spend time, effort, and resources lobbying within the system to get transferred to a more attractive school. So, school specific assignment means that schools can choose those who they believe actually want to be in the village—and within the pool of the eligible can give preference to choosing local residents.

When assigned in Phase I of their career the SKs will only have a fixed term contract (perhaps only year to year) with the school. This contract is renewable entirely at the discretion of the local authority (GP/VEC/SMC). The SK is also of course free to take up an assignment in any another school in the district that is willing to re-hire the SK. This will ensure that the SK is accountable to the local pressures as they need an assignment to be paid.

In Phase I of their career the salary of the SK will be at a level commensurate with the position and set by the district. That is, each district will be free to set a pay scale with a fixed amount paid to each SK. This will of course potentially vary from district to district but will likely be set at levels similar to those already paid by state governments to para-teachers that they are hiring (or to those paid by private schools).

Phase II. After the probationary/learning period of five to seven years the SK can apply to become an "associate" (*Adhyapak*) teacher. This decision will depend on an evaluation of the teacher's performance as an SK. The performance evaluation will receive inputs from:

- The school(s) the teacher has been teaching in, to solicit parental input,
- Peer input from peers (teachers) in the school and outside,
- Technical review from the district based on trainings, observations, track record, potentially including the performance of students.

Again, note the design of the confirmation decision to involve input from a variety of sources is designed to place checks and balances. The district or line agency cannot simply override the local community (as the community retains assignment rights)—but neither can a corrupt local *Sarpanch* simply approve a teacher without the approval of the district.

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16. An indication of the really difficult straits the Indian education sector is now in is that a frequently reported reason why teachers resent rural postings is that there are no private schools and it is important to them that their children be in private schools.

There are benefits to a teacher to moving to Phase II both in structure of pay and also in durability of the employment relationship. The pay structure changes in two ways. There is a substantially higher base level (teacher pay could as much as double). Moreover, unlike the annual structure of apprentice teachers, the teacher can receive annual structural increases (based on some mix of seniority and performance discussed below).

Second, after "confirmation" the GP/VEC/SMC is free to sign longer term contracts with the teacher (three to five years). That is, the teacher does not acquire tenure in the given assignment, but can have a longer duration of contract.

Third, the conditions for removal from service become more stringent. As a probationary teacher one is eligible in the pool but if, in a given year, a teacher does not have an assignment from a school they do not receive a salary. However, once a teacher becomes an Associate then the district acquires some obligation to pay them a salary even if they are temporarily without assignment (but under very strict conditions)—which gives the district incentive to "place" all of the associate teachers.

But the power of *assignment* still rests with the school. If a school no longer wants an Associate teacher they do not have to accept them—the district cannot simply 'assign' teachers to schools. In the end, the assignment function is the ultimate check on accountability. If control over the assignment is lost then the "regularized" associate teachers would have the temptation to become as unaccountable as the existing teachers.

This tension between a "regularized" right to compensation versus continued local control of assignment does raise a tricky issue of matching. For good teachers this will not be a problem as schools will be competing for them and they will have a surplus of offers. Even medium quality teachers have the advantage of continuity and are unlikely to be replaced (although, see the caveats below on match of pay scale to performance). The question is what to do with teachers who perform well in the probationary period but whose performance deteriorates (absent, abusive, uncaring)? If one school terminates their assignment it may be difficult for them to find another school—which is good—but if the district has an open ended employment guarantee the district would acquire a pool of teachers not capable of being placed. Again, different states/districts could deal with this problem in different ways. One is to design the system so that pay is contingent on assignment. Then if a regular teacher cannot find an assignment in one year the district pays them a salary anyway, but in the second year they only make two thirds, in the third year one third and there after some minimal amount.

This encourages teachers to either get an assignment (which hopefully means improved performance as a teacher) or resign from service or stay on but without substantial pay.

Phase I is a probationary, training and learning phase for aspiring teachers. Having a probationary period has several advantages. As is well known from studies of a variety of labor markets there is enormous "churning" and instability in job tenure at the early stages as people seek out jobs they are well adapted to. By granting teachers immediate job security this discourages those who dislike the profession from leaving. A second benefit of a probationary period is that since so many dimensions of teaching are subjective and difficult to measure most "pay for performance" schemes are difficult to implement. Instead, one wants more "intrinsic" motivation and commitment to the profession as the primary motivators. But these can be assessed only after a substantial period. A final benefit to a long probationary period is that one can do an evaluation of the teacher that truly captures their performance as an educator, not just one narrow dimension.

Phase 3. Selected outstanding *Adhyapak*s can be promoted to *Maha-Adhyapak*s or Masters, which would carry another step jump in salary, more perks and prestige. In effect, this would be a reward for sustained outstanding performance of exceptionally good teachers, once again selected based on comprehensive criteria discussed above, in addition to more rigorous inspections to verify the recommendation for promotion to Phase 3. The jump to Phase 3 would be controlled and limited, with most teachers expecting to spend their career as *Adhyapak*s.

One purpose of this final phase of a career is to create a committed component of the cadre who are the best teachers and help diffuse the learning culture among the remaining teachers. This also implicitly encourages those who do not make this transition to retire, perhaps well before 60 (as their opportunities for future pay increases remain limited). This prevents the common problem of stagnation in service.

This proposal is summarized in table 4.

Note that our proposal has three elements of performance-based structure of pay, illustrated in figure 9:

- The initial step jump to *Adhyapak* at the end of the SK period,
- The annual pay increments based on the comprehensive criteria discussed while an *Adhyapak*,
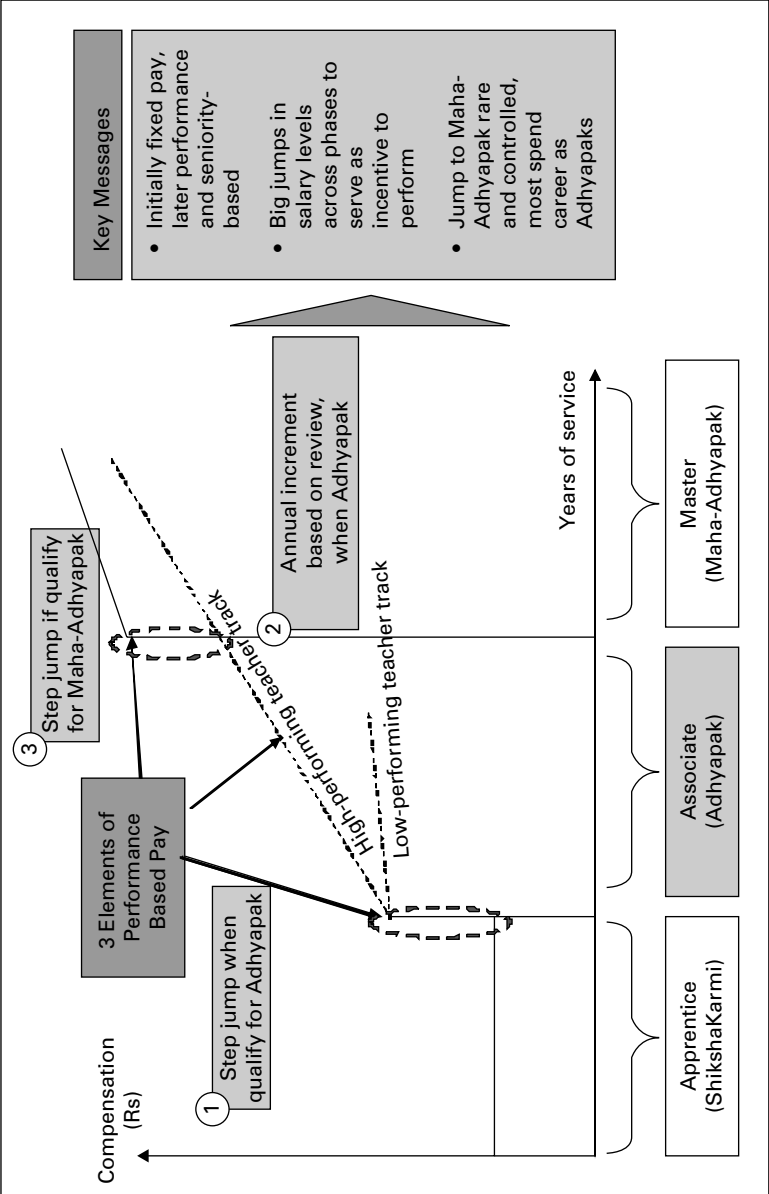- Another step jump in compensation when being promoted to *Maha-Adhyapak*.

T A B L E   4 .   A Structure of Teacher Career in a Decentralized System

	Phase I apprentice	*Phase II journeyman*	*Phase III master*
Durability of employment relationship	Year to year contracts	Multi-year contracts with school. Longer term commitment of district	Tenure with district
Structure of pay	Relatively low and flat over entire probationary period	Large jump up over apprentices. Annual increases based on cost of living, seniority (small), and assessed performance (periodic)	Large jump up over Phase II. Annual increases based on cost of living, seniority (small), and assessed performance (periodic)
Assignment to tasks	District approves eligibility.School makes assignment from eligible pool.	School makes choice to renew or not renew contract (controls assignment) District provides temporary guarantee	District guarantees employment until retirement.These teachers assume mentoring and coaching (not supervision) roles.
Cash versus benefits	Few to none	Regular benefits. Pension portable to facilitate voluntary retirement when desired.	Regular benefits and continued pension accrual.

This is a "professional" cadre proposal, not a "pay for performance" scheme and there is no simplistic recommendation of linking pay to the performance of students in a "high powered" way. While this is certainly one element of a performance evaluation, this needs to be brought in very carefully (particularly since so much of student performance is driven by child and household characteristics that "attributability" of student performance to teacher quality is weak). That said, one could certainly add to this basic structure some elements of compensation directly related to student performance, such as those being experimented with in Andhra Pradesh.

This is a "professional" cadre because it is modeled on the structure of recruitment, screening, retention, and compensation of professional type occupations (for example, lawyers, doctors, architects, university professors). In all of these there is a long probationary period, a stringent review, a change in employment status—but all the while they have to perform to remain. This encourages a "professional" ethos rather than a "worker" ethos among teachers.

FIGURE 9.   A Structure of Pay that Builds in Three Elements of Pay Related to Performance

Compensation (Rs)

Key Messages
- Initially fixed pay, later performance and seniority-based
- Big jumps in salary levels across phases to serve as incentive to perform
- Jump to Maha-Adhyapak rare and controlled, most spend career as Adhyapaks

③ Step jump if qualify for Maha-Adhyapak

② Annual increment based on review, when Adhyapak

3 Elements of Performance Based Pay

① Step jump when qualify for Adhyapak

High-performing teacher track

Low-performing teacher track

Years of service

Apprentice (ShikshaKarmi)

Associate (Adhyapak)

Master (Maha-Adhyapak)

IV.D) Devils in the Details

Readers have every right to be skeptical that the proposals are either politically feasible or that, if implemented, they would work as planned. While we cannot address all problems at length, we address a few of the major concerns.

First, many different states, for a variety of reasons, though often purely fiscal, have introduced alternative modalities for hiring teachers—and most of these have eventually disappeared as the political pressure for reabsorbing these teachers is immense both from teachers unions and from existing "contract" teachers. We do try and address that concern by creating a new career stream and ending the old cadre entirely. Moreover, if one moves to a system of true PRI control and this provides greater satisfaction then there would finally be a substantial constituency to resist the claw-back as there are more than three million elected PRI representatives.

Second, the evidence on the impacts of existing attempts at "community" engagement are mixed. As pointed out by our discussant, Esther Duflo, it is not clear that initiatives such as "village education committees" have played much—if any role. Moreover, the evidence from the absenteeism study often found levels of absenteeism as high for contract teachers as noncontract teachers. The alternative of muddling through with randomized evaluations to demonstrate the existence of high impact interventions might have less risk. In response, while it might be said that complementarities are the last refuge of the scoundrel, we believe the evidence is consistent with the view that enormous gains, particularly in the cost-effectiveness of learning, are possible and prefer this system change approach, based on four observations.

First, the evidence that existing "community" schemes have not been particularly effective (for example, that participation is low, etc.) is not particularly relevant. Most existing schemes (outside of EGS or Lok Jumbish) did not really pass any significant degree of control to the local level and hence low interest in participation is natural.

Second, there is evidence that enormous gains in cost-effectiveness are possible from system reform: the private sector operates in exactly the same environments as these schools and produces results at much lower cost. Many experiments of educational innovations find only small effects (Pritchett 2004) and those that do find impact find "effect sizes" (learning gains normalized as a standard deviation of the existing individual distribution of scores) at best of .2 or perhaps .3. But often the private school

options have a cost-effectiveness effect size of one standard deviation or larger. Even adopting all of the demonstrated innovations would leave Indian government schools dramatically less effective than private schools—whereas in well-functioning public sector systems the private sector advantage is quite small.

Third, the evidence from EGS in Madhya Pradesh (Leclerq 2002) and from Alternative Schools in West Bengal (Pratichi Trust, 2002) is that just community control even without other systemic changes can produce equivalent (or higher) quality at much lower cost—even with teachers with much lower formal qualifications. For instance, while absenteeism is not much lower outside of government schools there is some evidence that effort when present is higher.

Fourth, the experience of programs that truly engaged communities and provided appropriate support to teachers such as Lok Jumbish in Rajasthan appear to have produced substantial impacts (though one must admit there is no rigorous evidence). We are not arguing for moving to "contract teachers." We are arguing for a new system of PRI based cadres of teachers embedded in a decentralized accountability framework oriented around performance. This would include having training and capacity building both of teachers and communities in this new system.

V) Conclusion

Teacher compensation is like the weather—everyone complains but no one does anything about it. It is also like the weather in that it is a complicated inter-connected system and discussing just one aspect while ignoring the others or "piece-meal" approaches to bits of the system of pay without attention to the entire system of compensation and its connection with the overall fit with the institutional and organizational structure of schooling is unlikely to be helpful.

First, design of a system of compensation for a high performance organization should attract, retain and motivate workers who, on a day to day basis, pursue the goals of the organization. All four elements of a system of compensation (*durability of the employment relationship, structure of pay across states of the world, assignment of workers to tasks,* and *cash versus benefits)* should work together towards this goal. There are complementarities between the system of compensation and other policies and practices of the organization.

Second, while there are many variations across states it is not unfair to describe the current status of the system of compensation in India as a combination of high compensation/zero accountability. All four elements of the system of compensation reinforce the overall lack of accountability. Moreover, the institutional context of basic schooling—all the other relationships of accountability—are also weak. There is nothing in the present system to attract people well matched to teaching, to retain the best and most committed teachers, or to motivate performance of good teachers (for that matter, prevent good teachers from becoming disillusioned, cynical, and embittered and yet stay until they are 60 years old).

Third, this system of compensation plays a large role in producing the current "perfect storm" in public schooling: learning achievement of students is low, absenteeism of teachers is high, the treatment of teachers of students is often abysmal, recourse to private tuitions is rampant, parents and students are dissatisfied with government schools and people are voting with their feet and pocketbooks into the private sector. Perhaps worst of all, the potentially good teachers within public system are disenchanted, overburdened, feel disrespected by parents and managements. Any reform of teacher compensation needs to be *pro-teacher* while the current system is dramatically *anti-teacher*.

Fourth, decentralization to PRIs is certainly no panacea—but it may well be the last best hope. Simply moving the existing system with its lack of performance orientation, lack of external accountability, and existing strictures on the system of compensation onto the PRIs is unlikely to lead to improvements. That said, decentralization to PRIs, if done well, has the potential to break the political impetus behind business as usual. With a thorough-going decentralization the reallocation of functions across PRIs could produce greater service provider autonomy and local accountability. But only if PRIs are allowed to develop their own systems of compensation—systems of compensation that do not mimic a private firm but are designed about the realities of public employment and the particularities of the practice of teaching—will they be able to compete successfully. With the adoption of a new cadre of teachers under district control, newly hired teachers can be launched into a new system and sail out of the existing perfect storm.
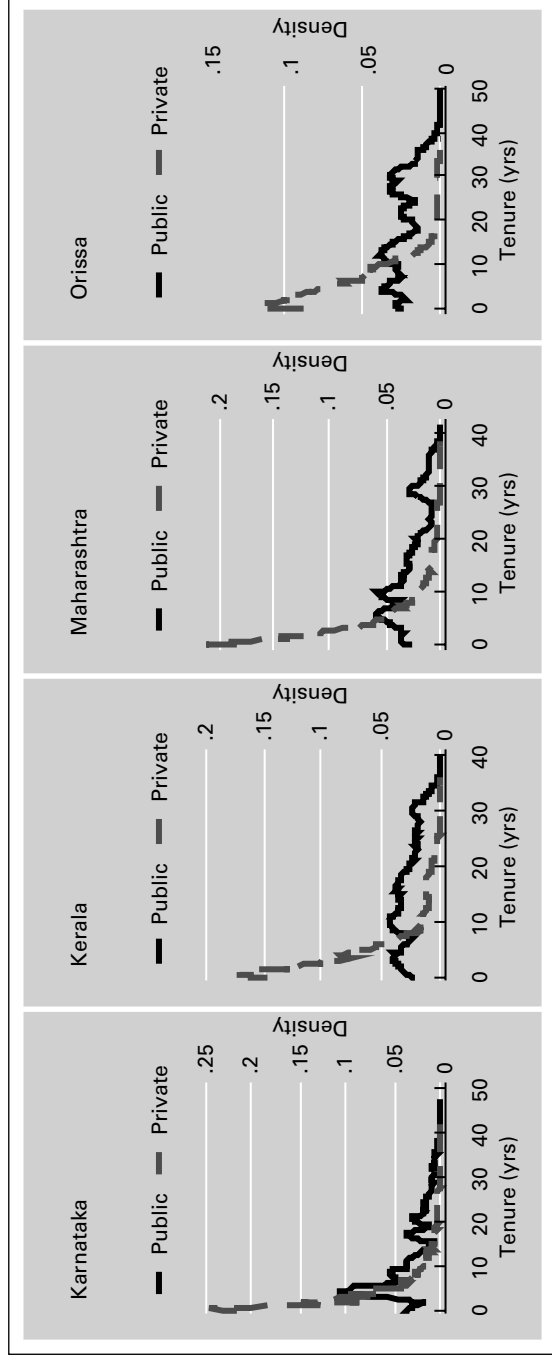
A N N E X U R E
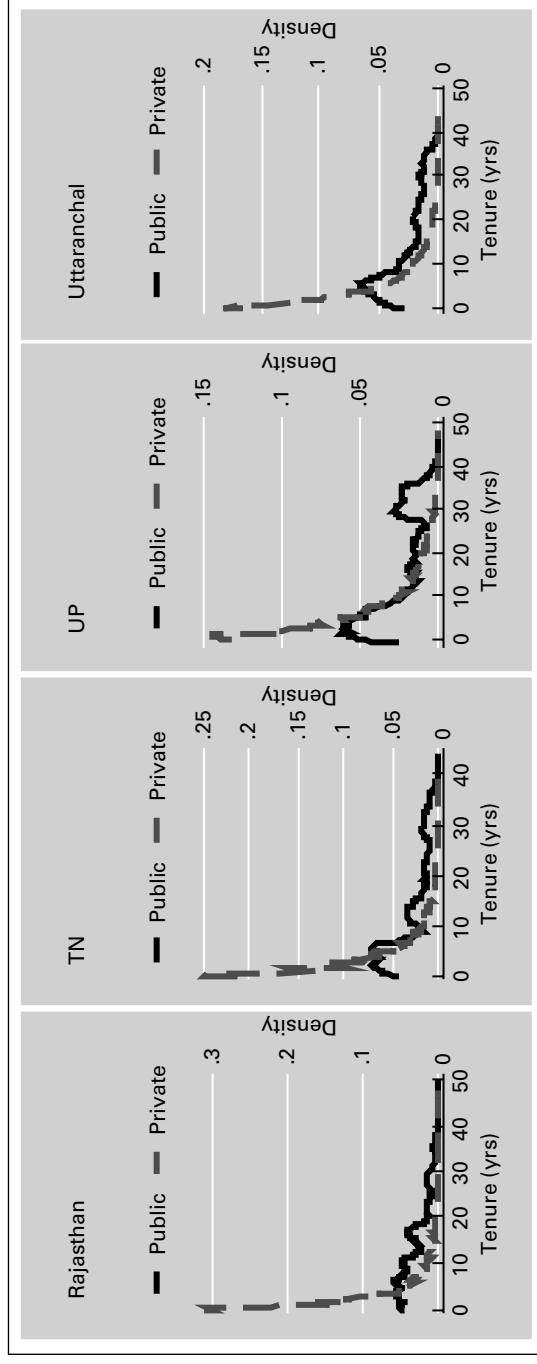
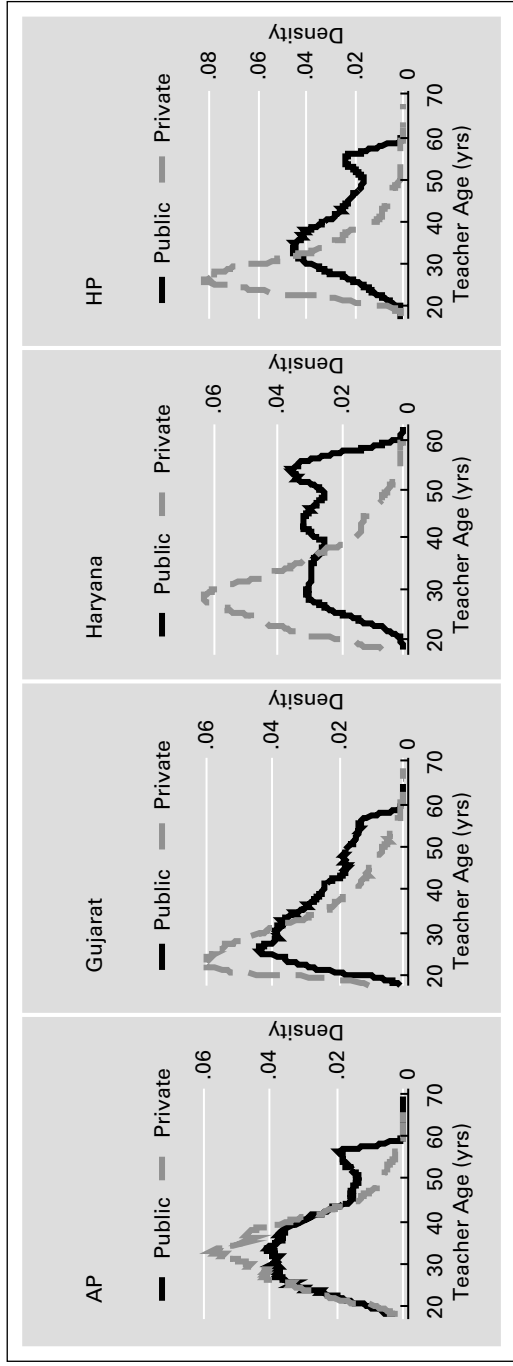**F I G U R E   A - 1 .   Tenure in Private and Public Schools**
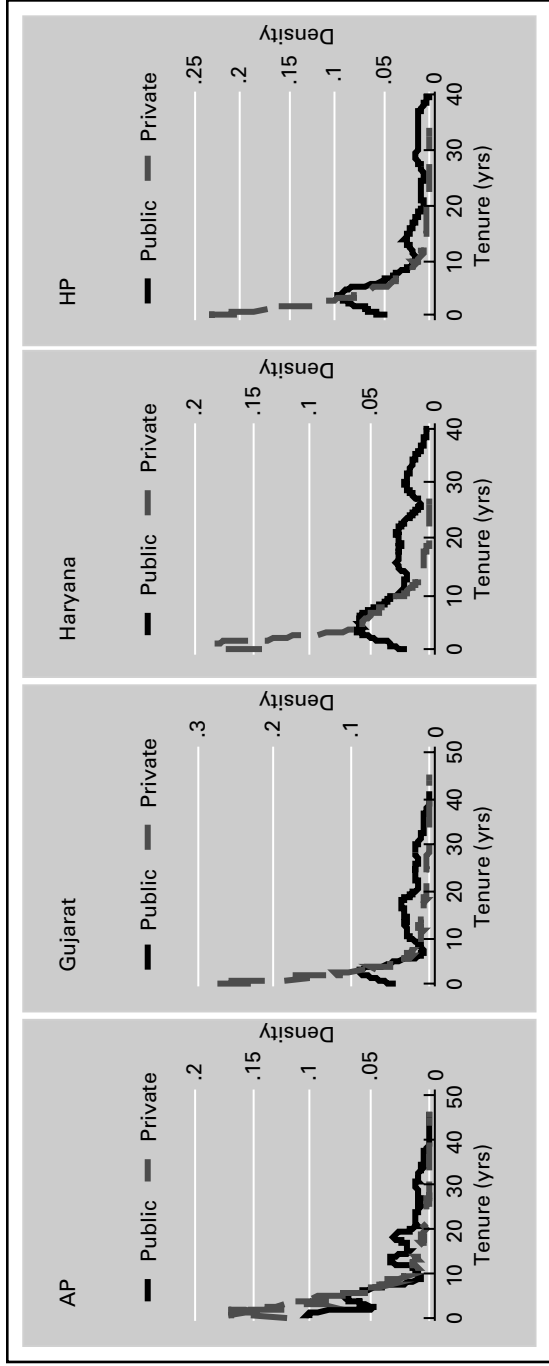
(Figure A-1. continued)
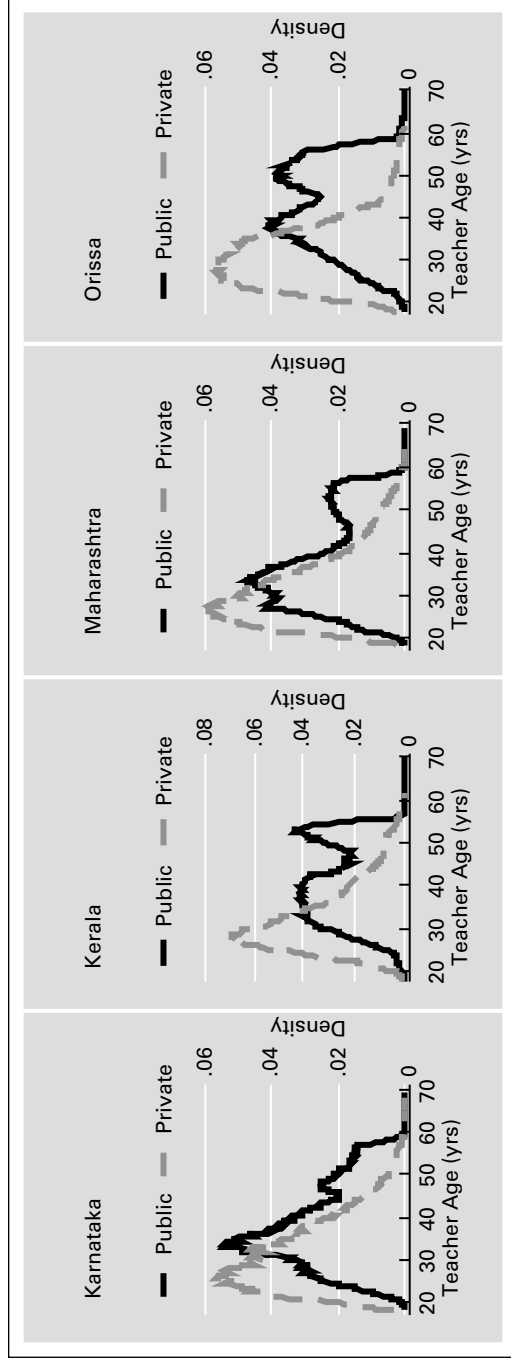
(Figure A-1. continued)

Source: Author's calculations with DISE data.

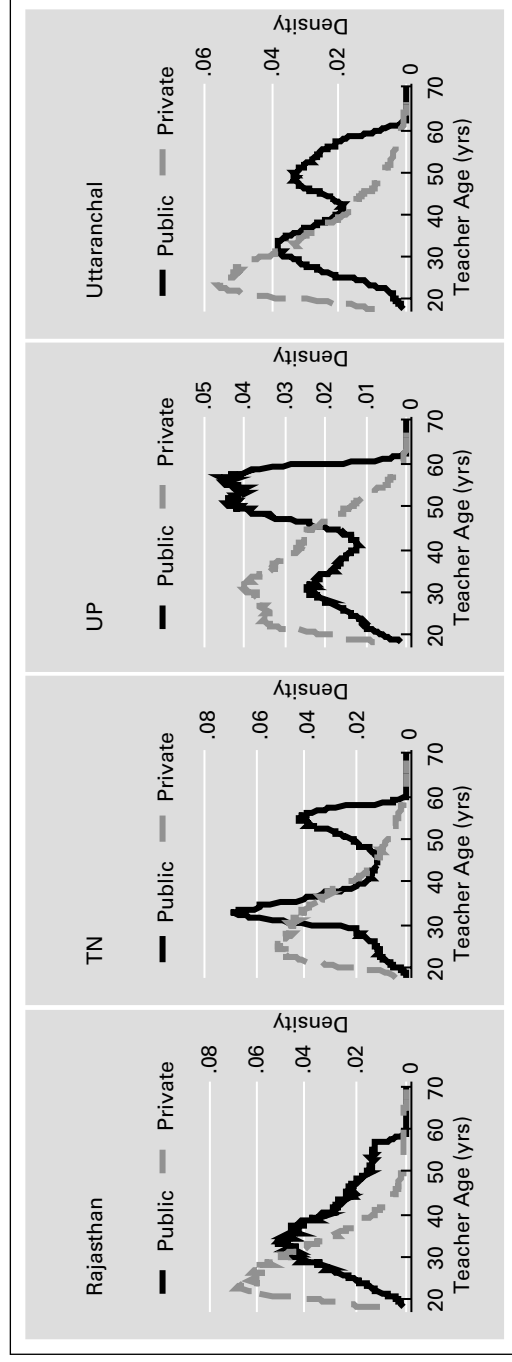**FIGURE A-2.** **Average Age of Teachers in Private and Public Sector**

(Figure A-2. continued)

Source: Author's calculations with DISE data.

Comments and Discussions

Esther Duflo: This is a chilling paper, even for those who, by virtue of having studied the Indian education system, know some of the facts that are presented here. This is also a much needed paper, especially for a volume like this. It paints the situation of the education system in India without complaisance, and, two thirds the way through, the reader should be convinced that there is a problem, and that rescuing education should be an absolute policy priority. The paper could have stopped there, but it does not: The authors devote the last third of the paper to describing the design of a plan that *may* be able to extricate India out of the impossible situation it has placed itself into.

We start with a brief summary of the problem. The system does not perform, as Pratham's ASER (2005) report has convincingly established. Only 60 percent of children enrolled in grade 5 in public schools can read a simple paragraph. The math level is even worse. Parents are dissatisfied with public schools, and more and more send their children to private schools. Private schools perform better than public schools on average (despite spending about half per pupil) but there is wide variability here as well.

Since teachers are the main source of input to the education production function, it is not surprising that they are a large part of the problem: Teacher absentee levels are high (24 percent, as found both by the ASER study and by another nationwide survey conducted by Chaudhury et al. (2005), and many teachers do not teach even when they are present in school.

Getting teachers to come to school and to teach while there, appears to be a logical and intuitive first step. And indeed, experimental work I have conducted with the NGO Seva Mandir in Rajasthan suggests that if teachers come to school more, children learn more (Duflo and Hanna 2005). Yet this is not really what successive attempts to improve the system have focused upon. Operation blackboard provided only extra inputs. DPEP was almost entirely focused on teacher training and SSA tries to channel additional resources to school committees whose members do not always belong (Banerjee et al., 2006).

In the Seva Mandir study, we used technology to link pay to presence. More generally, this paper makes a convincing case that teacher compensation structure is at the heart of the teacher motivation problem. This argument, and the evidence presented for each part of it is the central contribution of the paper. What the paper shows very clearly is that the system of hiring, retention, and pay is structured as if it were designed to minimize teachers' fit to the job and incentives to perform. We learn that government school teacher's salary is high (twice as high as that of an equivalent private school teacher, and 75 percent higher as that of any other private sector employee), but it does not rise very fast with seniority. The gap between the salary of a teacher and that which he could earn elsewhere is thus the highest at the early stage of his or her career, when it would be optimal to have a period of discovery. This combined with the fact that no teacher is ever fired, means that even those who turn out to be not very good at teaching stay in the profession forever. And of course this also has the implication that the teaching profession becomes attractive mostly for people who do not intend to teach, since nobody derives much utility from working at a job where one's effort is not rewarded. The issue, then, is what to do? This description should make any policymaker want to take all the elements of the system one by one from the inside out, and start from scratch. This, however, is not realistic, as the authors reckon. Existing teachers are very unlikely to take major modification to their current system of compensation lightly: After all, they were hired under some sort of implicit contract that this is the way their life would be. Moreover, the fact that the teaching profession in India is attractive for people who plan to be paid without teaching has made it a particularly good political patronage to distribute. As a result, it is believed (and the authors repeat, though I have not seen any quantitative evidence on this) that many teachers are politically influent, and upsetting them is not a good political move.

The suggestion offered by this paper is to let the current system die by attrition (a good side effect of the fact that teachers never leave the service is that most of them are pretty old) and to start building something else from inside, with the PRI as the backbone. Many States have been *de facto* doing something like this, refraining from hiring any new regular teachers and instead hiring para-teachers, placed under the control of NGOs, the panchayats, or headteachers in regular schools. One reason to do this is of course to keep the budget in check. But many official documents also state that these para-teachers should also be subject to stronger incentives (both because they are at risk of losing their job and because they may be

locally hired, so more likely to be under the control of the community), and may therefore be able to perform better. In practice, however, absentee rates at non-formal education schools run by para-teachers is actually a little bit *higher* than that of regular teachers (Chaudhury et al, 2005), suggesting that it is certainly insufficient to simply put para-teachers in place, one must make sure that the "potential" incentives turn into "actual" incentives. And when they do [like in two studies I have been involved in, the Seva Mandir study discussed above and an evaluation of Pratham's Balsakhi program (Banerjee et al, forthcoming)], these teachers do come to school, they teach, and the children learn.

The paper thus proposes a specific organizational structure that would provide the new teachers with adequate motivation to perform, or to retire if they are not ready to perform. It rests on a combination of top-down monitoring and bottom-up monitoring and evaluation. In particular, the PRI and the parents would have to approve a specific teacher for them to get an assignment in their school. Salaries would initially be low, teachers would gain tenure in the system only later, and they would never have tenure at a particular school. It is brave, and commendable, of the authors to have taken the plunge and proposed an actual plan to ameliorate the structure. They do not claim it has to work, but that it just may work.

Unfortunately, there are number of signs suggesting that it may be difficult for such a system to work. In Banerjee and Duflo (2005), we review (limited, so far) experience with "bottom-up approaches" to improve social services delivery. We conclude that to date, there is very little evidence that any of these has worked.1 Banerjee et al (2006), which collected detailed data on how school committees work in Uttar Pradesh provide some insight into why these attempts to improve the quality of services through improving beneficiary control have not worked on education. The SSA was an attempt to improve bottom-up control on the schools through the formation of village education committees (VEC). Yet, years after they were instituted, 92.4 percent of parents have never heard of the VEC. Of the 7.6 percent who have, 5 percent cannot name any member, and only 1.4 percent can name members other than the Pradhans and the VEC. Perhaps what is even more worrying, 23 percent of the parents who are VEC members do not know it. And 73 percent do not know that, through SSA, funds are provided to schools. Neither parents nor teachers know what the children know, or do not know, very well. For example, only 38 percent of the children can do simple arithmetic. Yet, the average parent thinks that 58 percent of children are able to perform simple arithmetic.

This, however, may simply be a problem of lack of information. In that case, providing information to both parents and VEC members of what the state of education is and what they can do to improve it will help, and may lead them to take action. This is part of Murgai and Pritchett's plan, where information will be continuously gathered and shared. This may also, however, be the sign of a profound disaffection for the system. The system may have failed the poor for so long that they do not expect anything of it. They are therefore not particularly willing to invest anything to improve it, let alone to learn about it. Those who can exit, do so (to private schools). The others resign. Preliminary evidence of attempts (organized by Pratham, and evaluated in a randomized experiment) to provide information and guidance of what could be done suggest that this has no impact. What seems to work, however, is to provide villagers with hope: In some villages, Pratham (a large education movement which was at the origin of the ASER study) conducted their "Read India" program, where volunteers were recruited and trained to teach reading classes. Although the evidence is very preliminary, it appears that in those villages, both the reading levels of the children who could not read initially and of that of those who could have both improved. The latter fact may mean that a way forward helps motivate parents exercise effort to change the situation.

If this is the case, then the situation could be either worse than the paper paints, or possibly a bit better. It could be worse if parents are already so disinterested in the system that it will be impossible to enroll them in delivering an improvement in the quality of any public system. In that case, a voucher system and a regulated private school market may be a better option to contemplate than a decentralized public system that places an important burden on the parents, though it would take considerable experimentation to get it right (I guess it is my privilege as a discussant not to even try). It could be better if this means that it is possible to improve the school system by providing everyone with a better (and more realistic) sense of what they are meant to do: realistic expectations of what the system can deliver to the children and the parents; realistic expectations of what the teachers must do; and accountability to this minimum standard. Since then a recent experiment in Uganda (Svensson, Lindelow, Reinikka) of providing household with feedbacks on the performance of the health workers in their villages has produced much more promising evidence. It is possible for example, that if teachers were told that coming to school is part of their job, and that their pay is on the line, they would not find this to be that outrageous. In our experiment in Seva Mandir, teachers actually seem to have found this liberating, since this was a task they could certainly

manage. Giving them in addition a set of concrete pedagogical ideas may help them regain a sense of what the job is about or at least help the newer teachers retain that sense.

Shubhashis Gangopadhyay: According to the authors, a "perfect storm" is about to break over the Indian school education system. This dramatic description is based on an analysis of the data from a region within the city of Delhi. If there is any possibility of generalizing this finding for other regions, it is indeed a cause for serious concern. The authors draw from secondary data to suggest that such a generalization may be possible.

One thing to remember is that much of private schooling in India is also government funded. This, however, need not be a serious problem if the major issue, management, is in private hands in a private school. Much of the literature on private school successes are anecdotal and involve schools that have some other characteristics minority status, or schools given autonomy from the school regulatory boards because of particular policy decisions. Also, most of these "good" non-governmental schools are in metropolitan cities. This study, on the other hand, is not anecdotal but carries out a systematic comparison of private versus public schools in a specific geographical area.

The authors spend a lot of time demonstrating that the public education system in India is everything but conducive to bring out the best among teachers. This they show by drawing from the literature on organizations and what keeps employees honest in their work. I think that this is the major part of their study; while some may not dramatize the system as much as the authors, few would question the need for an overhaul of the Indian public school system.

The authors suggest five functions that the school system should draw up to maintain the efficacy of such a system—standard setting, planning, asset creation, operations, and monitoring and evaluation. They maintain that planning, asset creation and operation of schools be turned over to the PRI, while the state (I presume state governments) take on the main responsibility to set standards and monitor the performance of each school. At the same time, the way teachers are chosen for schools and their compensation, need to be reformed in a manner that makes teachers more accountable. The authors go on to say that this new approach, for political reasons, may be used for the new recruits, while the already existing body of teachers may be "grandfathered" till their retirement. Unfortunately, it is doubtful

how politically feasible this is, simply because our judicial system may not allow such "discrimination" among people engaged in similar jobs.

It is here that I feel that the paper becomes too idealistic and a bit removed from the reality in India. They propose a three tier system of teachers wherein teachers reach a higher level of compensation only if they perform creditably, for some time, at the lower level. However, such performance based pay (and promotion scheme) has been difficult to implement in any public sector enterprise (PSE) in India. This is inspite of the fact that it is easier to measure performance in commercial PSEs. In a school system, where the impact of teachers on students takes many years to manifest itself and is dependent on the performance of other teachers in the school, this would be even more difficult to implement. However, this is not to say that one need not solve this issue; on the contrary, this is an essential ingredient of any school system reform but it will require a lot more thought to get to a politically feasible solution.

There is another implicit assumption in the reforms being proposed here. The authors expect PRIs to wield significant powers to implement accountability among the teachers. In a country where literacy is low, especially in rural areas, how will this be done? Barring easily observable indicators, like absenteeism, it may not be possible for the PRIs to assess the quality of a teacher's effort.

I think a major contribution of the paper, and this is a significant one, is the finding that private teachers get lower pay than government teachers and that, their level of satisfaction with their job is no less than that of government teachers. This turns on its head the argument that better pay will create better schools.

General Discussion

Abhijit Banerjee led off the general discussion by expressing amazement at the revealed magnitude of the failures of the education system. The inability of students to perform at the most basic levels of literacy and mathematics was a stunning condemnation of current performance.

Ajay Shah followed up on Ester Duflo's comments and suggested that it might be possible to make a substantial portion of teacher compensation dependant on attendance—in effect, teachers would be paid on a daily attendance basis. He also thought it would be useful to extend the analysis of education to the public provision of healthcare where the exit to the private sector had been even larger. Thirdly, he argued that something should be

said about the effectiveness of the Sarv Shiksha Abhiyan (SSA) program, which has been a primary vehicle by which the United Progressive Alliance (UPA) has sought to increase education expenditures.

Dilip Mookherjee emphasized three potential areas of reform. First, greater effort should be made to monitor basic performance measures, such as whether teachers show up on a daily basis. Second, he argued that there should be more centralized oversight of schools. The current emphasis on a decentralized education system was a mistake because it increased the probability that the schools in backward areas would be controlled by individuals with insufficient understanding of what constituted good performance. Third, given that much of the system is already effectively privatized, he believed that more consideration should be given to introducing a system of school vouchers. The government should shift its focus to establishing effective means of school accreditation and provide vouchers for poor families.

Devesh Kapur also suggested that, given the difficulties of challenging the current system, perhaps the best response would be to allow the current trend toward privatization of the education system to continue. He also questioned the effectiveness of establishing an agency focused on monitoring and oversight. He thought it would require substantial time to develop a tradition of active intervention. More should be done to understand the dynamic of behavioral change that leads agencies to change from passive acceptance to effective monitoring of performance.

T. N. Srinivasan agreed that, if the issues of access and financing of education could be set aside, there would be little reason to oppose the privatization of the education system. The government could focus on certification, the setting of standards, and monitoring. A voucher or similar transfer mechanism could address the needs of low-income families. He was concerned, however, that some localities might not have effective private schools to compete with public schools. In such cases the problem of poor public schools has to be addressed directly. Another delegate emphasized the political aspect of the problem by noting that the Indian constitution was quite unique in providing teachers with direct representation in some state legislatures. The fact that many teachers are also legislators greatly complicates the reform process. For example, the gap between public and private sector teacher compensation has actually been rising over time, in part because of effective lobbying activities. Furthermore, there is substantial evidence of cheating in the administration of exams. It is likely that actually achievement rates are significantly lower than reported.

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Does Economic Growth Reduce Fertility? Rural India 1971–99

Introduction

Reducing fertility is often seen as an important, if not necessary, means to achieve sustainable economic development. And, many countries have adopted policies ranging from subsidization of fertility control to restrictions on the size of families with the aim of reducing pressures on the environment and augmenting economic growth. Among policy advocates for direct measures that reduce fertility there is also skepticism that economic growth will lead to fertility reductions without at least major increases in the education of women. That there should be controversy about whether economic growth per se plays a major role in driving declines in human fertility seems at first look to be quite surprising. From a cross-sectional perspective richer, more developed economies tend to have lower fertility rates than do poorer less developed ones. Over time many formerly poor countries have begun to develop and this process of development has typically been accompanied by sustained fertility declines. There are, of course, important anomalies such as China, with its one-child policy, and countries such as Cuba, Costa Rica, and Sri Lanka with traditionally high levels of education, health and correspondingly low levels of fertility. There is also evidence that the timing of a first sustained decline in fertility is not well-connected with a particular level or threshold of economic development. These patterns have lead to a general impression that fertility decline is best understood either as a fairly mechanical response to falling mortality and/or as a transition in cultural perspective, with relatively little role given to changes in basic economic incentives.

Nonetheless, there is significant literature testing specific economic mechanisms thought to link economic growth and fertility decline and, on the whole, these results are supportive. In particular, there is evidence

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that fertility levels are negatively affected by the opportunity cost of time faced by women and that exogenously imposed increases in the number of children tend to result in reductions in average levels of child schooling (if not the schooling of every child in the household). This result, in combination with the finding that economic growth importantly raises both the returns to and levels of schooling (Foster and Rosenzweig 1996), is consistent with the proposition that economic growth lowers fertility through a quantity-quality tradeoff. Rosenzweig and Zhang (2006) also used twinning to show that the reductions in fertility due to the one-child policy in China increased human capital investments in children. Rosenzweig and Zhang review major studies using twins as a source of identification for examining fertility effects on child quality. They conclude that the results from all of these studies are consistent with the proposition that exogenous decreases in fertility decrease average quality. It seems what is missing is a data set of sufficient time frame and scope to go beyond testing the basic mechanisms. To assess the importance of these economic mechanisms it is necessary to obtain robust estimates of the magnitudes of the respective effects in a particular population and then trace out the implications of aggregate changes in economic conditions for the aggregate changes in fertility in the population.

This pair of requirements puts significant demands upon data. Estimation of the magnitudes of the value-of-time and quality-quantity effects requires data with substantial, plausibly exogenous, variation in economic conditions across time and space in the context of a reasonably unified policy environment (thus ruling out, for all intents and purposes, cross-country data). There must also be a setting in which there is substantial aggregate level change in fertility that is to be explained.

Rural India over the last three decades can in principle provide the appropriate setting for carrying out such an analysis. Figure 1 provides an illustration of fertility rates by year based on the NCAER ARIS-REDS panel survey of rural households covering the period 1971–99 that will be discussed in some detail below. As the figure shows, and consistent with other sources of data, while there was relatively limited change in rural age-specific fertility between 1971 and 1982, there was a pronounced decline across all age groups in the 1982–99 period. As will be documented below, over this interval there were both significant spatial variation in changes in economic conditions including substantial increases in the productivity of agriculture and agricultural wages and increases at a more modest pace in access to schools and health and family planning services. As previous research has shown, the variation in economic conditions was

FIGURE 1. Period 5-year Rural Fertility Rate, 1971–99, by Maternal Age and Year
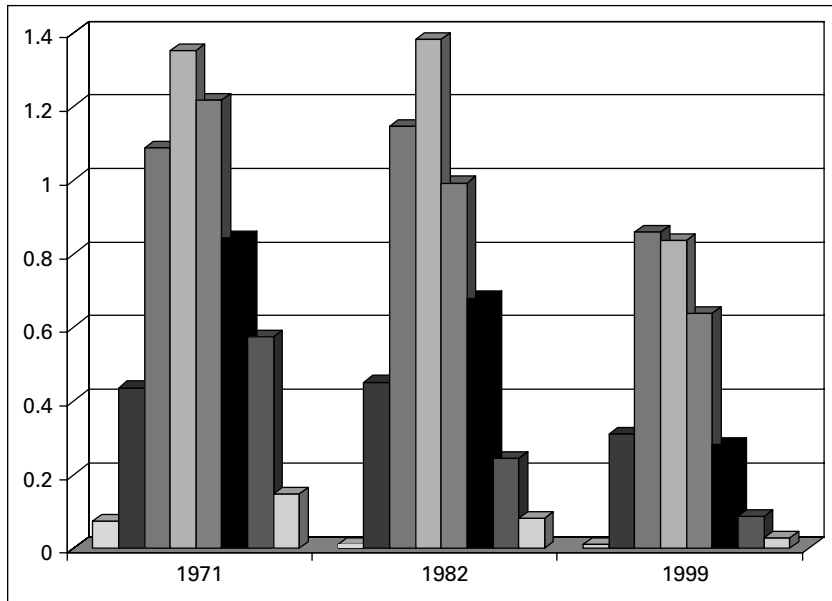
driven by important differences in the suitability of land and climatic conditions to the adoption of first and subsequent generation green-revolution crops (Foster and Rosenzweig 1996). Moreover, given historically limited migration across villages as well as differences in state policies that have affected the growth of the non-farm sector there is also substantial village-level variation in rates of return and changes in rates of return to schooling (Foster and Rosenzweig 2005).

Recent assessments of fertility change in India have largely been consistent with the non-economic literature on fertility change in developing countries in that they suggest that fertility decline has and is likely to continue to proceed through a process of cultural diffusion facilitated in part through increased access to media and family planning services. Dyson (2002, p. 7) in an analysis of overall and regional trends reports "In my view the ongoing state-level fertility declines will continue during the medium term future largely independently of trends in conventional socio-economic variables like per capita incomes and urbanization. In other words, to a considerable extent these TFR declines now have a 'life of their own'." Bhat (2002 p. 378) notes the prominence given to maternal education as a source of fertility decline in India and argues, in contrast, "that fertility is declining in India primarily because of its decline among illiterate

women, and they are doing so because of the diffusion of a *new reproductive idea* of having only a few children but investing more on their future." (Italics added). Brookins and Brookins (2002) indicate that "economic factors" explain 70 percent of the state level variation in fertility but female autonomy measures (considered separately) explain 84 percent of the state-level variation.

However, the economic factors that are used in the empirical analyses examining fertility change in India are simply broad measures of economic circumstance such as urbanization or income, which are poorly related to the particular economic mechanisms that are highlighted in economic models of fertility decline. Moreover, most analysis is cross-sectional which, given India's tremendous cultural heterogeneity, is a poor basis for inference about changes in fertility. Guilmoto and Rajan (2001, p. 713) note the spatial correlation in fertility decline and argue that "preoccupation with the effect on fertility of factors that are poorly correlated with spatial location, such as family planning campaigns or structural transformations of the economy, may have concealed the progression of fertility change through diffusion processes at the micro-level".

In this paper, we use a newly available panel data set that constitutes a representative sample of rural India over the period 1971–99. We first develop a simple dynamic model of fertility choice that incorporates the possibility of cost-of-time effects, a quantity-quality tradeoff, and increased access to health and family planning services. This model is used to structure the empirical analysis of fertility decision-making. A key feature of the empirical analysis is that it controls for household level fixed effects by linking households from different rounds of the survey. Without control for cultural and preference differences across Indian states and families that are absorbed in the family fixed effect we obtain results similar to those obtained by others from cross-sectional analyses—in particular, the importance of maternal literacy and the relative insignificance of costs of time or technical change. However, the results eliminating the family fixed effect provide strong support for the importance of increases in the value of time of women and of technical change-induced investments in child schooling that accompany economic growth in accounting for fertility decline, with little role for parental schooling. In particular, we find that aggregate wage changes, dominated by increases in the value of female wages, explain 15 percent of the decline in fertility over the 1982–99 period. In combination, changes in agricultural productivity and agricultural wage rates explain fully 61 percent of the decline. Health centers are found to have had a significant effect on fertility but the aggregate increases in the

diffusion of health centers in villages only explains 3.4 percent of the fall. In summary, our results suggest that the process of economic growth has had a major impact on fertility in India over the last two decades and that, given sustained economic growth that continues to raise wages and increase returns to human capital, the fall in fertility in India will persist in the foreseeable future. A demographic revolution now appears to have at least in part resulted from, rather than just accompanied, the green revolution.

I. Theoretical Framework

Fertility reflects the outcome of a dynamic process in which parents make current fertility decisions based on their expectations of the returns to investments in children in the future, given their current resource constraints. To characterize the potential mechanisms by which economic change may influence fertility in the context of a changing economy, we use a simple dynamic economic model. The model incorporates two important features highlighted in economic analyses of fertility: the value-of time effects for parents and children and the trade-off between the number of children and human capital investment. We use the model to focus in particular on how changes in wage rates, by gender and age, and agricultural technical progress affect fertility and human capital investment.

The appendix contains the elements of the model. We assume a couple maximizes expected discounted utility, which is defined over consumption, the eventual stock of children, and the children's levels of human capital. A key element of the model is that the returns to human capital investments in children are higher the higher the level of expected agricultural technology. This reflects the complementarity of schooling and technological change, as in models of Nelson and Phelps 1966 and as found for India by Foster and Rosenzweig, 1995.

In the model, human capital for a child is produced using the time of the child (for example, studying, attending school) and the time of other children (reflecting the possible caretaker role of other children), the time of the mother and father, and purchased inputs to human capital per child. The efficiency by which human capital is produced may be affected by the parent's own human capital, as in Behrman et al. (1999). Household income derives from farm production on household land (if owned) using the labor of the children, mother and father plus earnings from off-farm work.

The time of children is allocated between on-farm activities, the labor market, and schooling. Mothers and fathers allocate their time between

on-farm activities, the labor market, and human capital production of their children. Households can save to acquire productive assets, but cannot borrow. A key feature of the budget constraint is that the cost of increasing the number of children is higher the higher amount of human capital invested in them. Similarly, augmenting the average human capital of children is more expensive the larger the number of children. Thus, the budget constraint incorporates the basic quantity-quality trade-off. Households are assumed to choose at each age whether to have a child, consumption, savings, human capital investments, and labor allocations to maximize their expected utility given their constraints. Childbearing is chosen first and then, upon the realization of gender for that group of children, decisions are made about human capital investments. The decision rules for fertility and the average human capital of the children at each point in time are, respectively:

(1) $\qquad n_{ijt} = n(x, A_{ijt}, N_{ijt}, h_{ij}^{m}, h_{ij}^{p}, w_{ijt}^{b}, w_{ijt}^{g}, w_{ijt}^{m}, w_{ijt}^{f}, \varphi_{ijt}, p_{t}^{e}, v_{ijt}).$

(2) $\qquad h_{ijt}^{v} = \theta_{ijt}^{b} h_{ijt}^{b} + \theta_{ijt}^{g} h_{ijt}^{g}$
$\qquad\qquad = h(x, \theta_{ijt}^{b}, A_{ijt}, N_{ijt}, h_{ij}^{m}, h_{ij}^{p}, w_{ijt}^{b}, w_{ijt}^{g}, w_{ijt}^{m}, w_{ijt}^{f}, \varphi_{ijt}, p_{t}^{e}, v_{ijt}).$

where n_{ijt} denotes childbearing by a couple at time t in household i and area j, x denotes the age of the woman, A_{ijt} is the assets held by the household, $N_{ijt-1} = \sum_{s=t-x+\alpha}^{t-1} n_{ijt}$ is the stock of children born to that woman previous to time t, h_{ij}^{k} for $k \in m,p,b,g,v$ denotes human capital of the mother, father, boy children, girl children, and the children on average, respectively, w_{ijt}^{k} for $k \in m,p,b,g$ is the wage for the mother, father, boys, and girls, respectively, φ_{jt} is the level of technology, p_{t}^{e} denotes the price of goods used to produce human capital, v_{ijt} reflects time-specific unobservables such as household tastes, and θ_{ijt}^{k} for $k \in b,g$ denotes the fraction of children that are boys and girls, respectively.

The model yields a number of implications for how changes in the value of time of the parents and the children affect both fertility and investments in human capital. In particular, the model shows that wage effects will differ by both gender and age. For example, as shown in the appendix, a rise in the female wage will raise the cost of children and thus tend to lower fertility but an increase in the male adult wage may raise fertility. This is because of the assumption that mothers and possibly older sisters participate in the production of child human capital to a greater extent than do older boys or fathers.

In a low-income country context it has been recognized that the contribution of children to household earnings creates an incentive for larger families. What is less recognized, at least in economic analyses, is that the roles of girls and boys in the household, like that of mothers and fathers, may also differ and thus the value-of-time effects of children on fertility may also differ by gender. In particular, a rise in the boy wage will tend to lower the net marginal cost of boy children. However, a rise in the girl wage will tend to raise the cost of boys to the extent that girls contribute to the human capital of their brothers. There are symmetric effects for the wage rate of girls. However, if boys play little role as child care-givers, it is possible for the effects of boy and girl wages on fertility to be of opposite signs, with the boy wage having a positive effect (net costs of having children lower) and the girl-wage a negative effect (costs of caring for children higher), echoing the opposite parental wage effects.

Finally, it should be noted that the results for child wages depend on the presumption of an active labor market for children. Not surprisingly, there is some evidence for imperfections in child labor markets in rural India (Foster and Rosenzweig 2004). If the on-farm marginal product of boy labor exceeds the local boy child wage for large landowners, for example, then increases in the boy-wage will of course not affect the cost of childbearing. However, in that case an increase in landholdings for these households will increase the value of children's contribution to income and thus increase the opportunity cost of schooling and lower the net cost of adding a child. Thus, size of landholdings and fertility may be positively related and landholdings and schooling of children negatively related even though households with greater landholdings are wealthier.

The effects of changes in agricultural technology on fertility in the model are more complex. An increase in future technology will both raise the return to human capital investments, given childbearing, and raise the return to childbearing given human capital. However, because a rise in the human capital of children raises the cost of childbearing and vice-versa, the net effect on fertility and human capital investment is ambiguous. Nonetheless, previous work (Foster and Rosenzweig 1995) has shown that the Green Revolution in India did indeed raise the returns to and investment in schooling. Whether this results in a reduction or increase in fertility depends on a number of factors, not least of which is the extent to which households can effectively borrow against the future earnings of their children through reductions in assets. See Narisamhan et al. (1997) for an assessment of these two sources. Thus while the model suggests that a finding of a positive effect of agricultural technology improvements on fertility is possible, the finding

that technological advances both reduce fertility and increase human capital investment would be evidence supportive of the importance of the quality-quantity trade-off as a source of fertility decline.

II. Data

a. Construction of Fertility and Child Schooling Variables

The main objective of our empirical analysis is to estimate equations (1) and (2) in order to assess the role of economic theory in explaining variation in fertility across households as well as the contribution of economic change to aggregate fertility decline in rural areas. Such an analysis, particularly given the presence of persistent household and village level unobserved heterogeneity, puts substantial demands on the data in terms of both geographical and temporal coverage and in terms of the broad spectrum of variables that are required. Traditional data sources at multiple points in time that have been used to study Indian fertility inclusive of the SRS and the NFHS are not up to the task for three reasons.[1] First, as these samples are constructed independently in each round it is not possible to link households or even villages across time and thus to control for unmeasured spatial and household variation in preferences, culture, and agro-climatic conditions. Second, the scope of economic variables collected is limited; for example there is no information on the wages of individuals in the household. Thus a key economic hypothesis concerning whether changes in the value of time associated with economic development affect fertility decisions cannot be addressed. Third, there is little information on institutions and market prices at the village level. While it is possible to examine changes over time in both economic conditions and fertility at the level of the district or state using a combination of census and other data sources, such analysis masks considerable intra-district variation in the price-signals facing individual households that are likely to impact their childbearing and other decisions.

We use data from a comprehensive village and household panel survey that provides information at three points in time on the demography, economic characteristics and village environment of rural Indian households residing in 240 villages over the period 1971–1999. The data are from a continuing survey of rural households residing in approximately 250 villages

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1. See Narisamhan et al. (1997) for an assessment of these two sources.

located in the 17 major states of India that began in 1968 and has been carried out by the National Council of Applied Economic Research (NCAER). The first round of the survey for which there is complete village and household information, in 1971 [the Additional Rural Income Survey (ARIS)], includes 4,527 households in 259 villages and is meant to be representative of the entire rural population of India residing in the 17 major states. In the 1982 round (Rural Economic Development Survey (REDS)), 250 of the original 259 villages were revisited (the state of Assam was excluded) and 4,979 households surveyed, approximately two-thirds of which were the same households as in the 1971 round. In the 1999 round (REDS 1999), all of the 1971 villages were surveyed, but excluding the 8 sample villages in Jammu and Kashmir. In this survey round, all of the surviving households in the 1982 survey were surveyed again, including in this round all split-off households residing in the same villages, plus a small random sample of new households. Because of household division and the new sample design incorporating all village-resident male 1982 surveyed household members, the number of households in the 1999 round increased to 7,474.[2] The data in both 1982 and 1999 provide information on fertility, child schooling, household member characteristics, agricultural yields by seed type and crop, wages and prices at the village level, and landholdings by irrigation status.

Variables characterizing fertility and child investments are taken from information provided by all married women aged 15–59 residing in the surveyed households in each of the survey rounds. Measures of cumulative childbearing as well as the number of births in the last 5 years were constructed from the full birth histories provided by each married woman. After excluding households from non-panel states and removing cases in which data were incomplete, a working sample was constructed with 5,405 married women in 1971, 5,503 married women in 1982, and 10,019 married women in 1999.

Information is also provided in the survey on the activities of children. In particular, the school attendance of children are available from the individual roster files in 1982 and 1999. However, in the 1971 data this individual-level information on children is not available (it was lost after coding), although there is aggregate information at the household level on the fraction of children 5–14 currently in school. Consequently we constructed

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2. Because of the custom of patrilocal exogamy, women leave the village when married. Thus the panel households in 1999 are defined in terms of male members related to the 1982 household head and who resided with him in 1982.

this household-level school attendance variable for all three survey years. In order to account for possible differences across households in the age-composition of children in this relatively wide age range (which may itself reflect fertility), the child attendance variable was normalized for each household using an age-standardized schedule based on the 1971 survey. In particular, the household 1971 fractions of children aged 5–14 in school were regressed on the fraction of children in each single-year of age in the household. The resulting 10 coefficients were then used to impute for each household predicted school attendance for children in the age group 5–14 given the actual age composition of the children in that age range from the household roster. In each year, the fraction of kids in school in each house-hold was then adjusted by taking the actual fraction of children attending school and dividing by the predicted fraction given the household's age distribution of children.

Figure 2 depicts the average number of births in the five years prior to each survey date and the normalized current school attendance rates for children 5–14 for the three survey dates. Similar to the age-specific fertility rates in figure 1, the aggregate 5-year current fertility variable indicates that fertility started to decline only in the 1982–1999 interval, from about .8 births on average to .4 births. Over the same interval child school attend-ance rose at an accelerated pace, being 33 percent higher in 1982 than in 1971 and over 2.6 times higher in 1999.

b. Construction of Economic Variables

The data sets enable the measurement of three key economic variables spanning the 28-year period—agricultural productivity growth; wage change, by gender and age; and wealth change. To characterize the growth in agricultural productivity, we constructed from the village-level infor-mation on prices, seed types and yields an index of high-yielding variety (HYV) seed yields for each village for each of the three survey years using a Laspeyres-weighted index for four HYV crops—corn, rice, sorghum and wheat—of output per acre on irrigated lands. By using HYV yields on irri-gated land we obtain a measure of the "best" or maximal yields that villagers could obtain using the new seeds. Figure 3 displays the substantial rise in HYV productivity over the 1971–1999 period, but as can be seen, agricul-tural productivity growth per-year is evidently slower in the 17-year period, 1982–1999 compared with the 11-year 1971–1982 period.

Because the yield measure inevitably reflects potential productivity with error, inclusive of measurement error, and the influence of weather out-comes, we estimated a predicted HYV yield equation, using as determinants

F I G U R E 2 .   Fertility and School Enrollment Rates, by Year: 1971–99
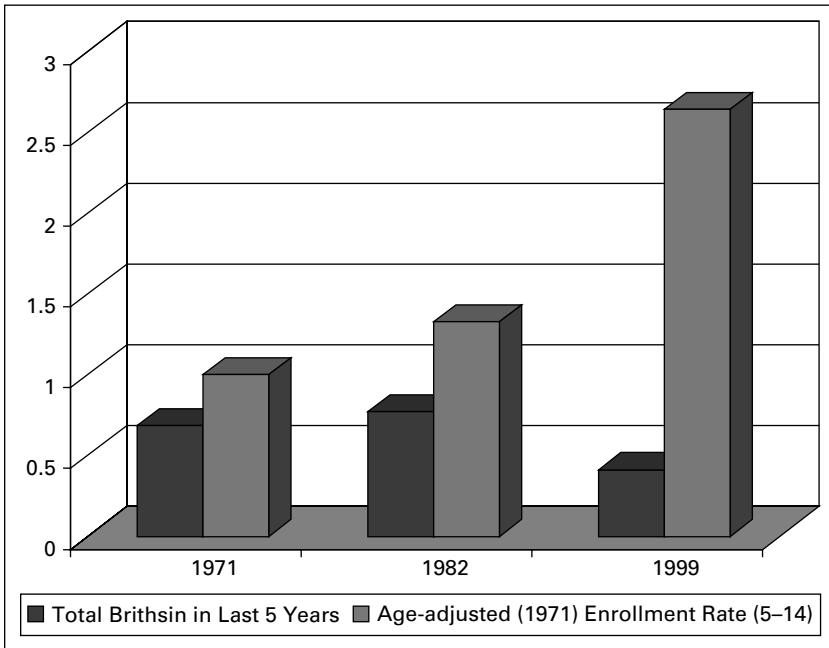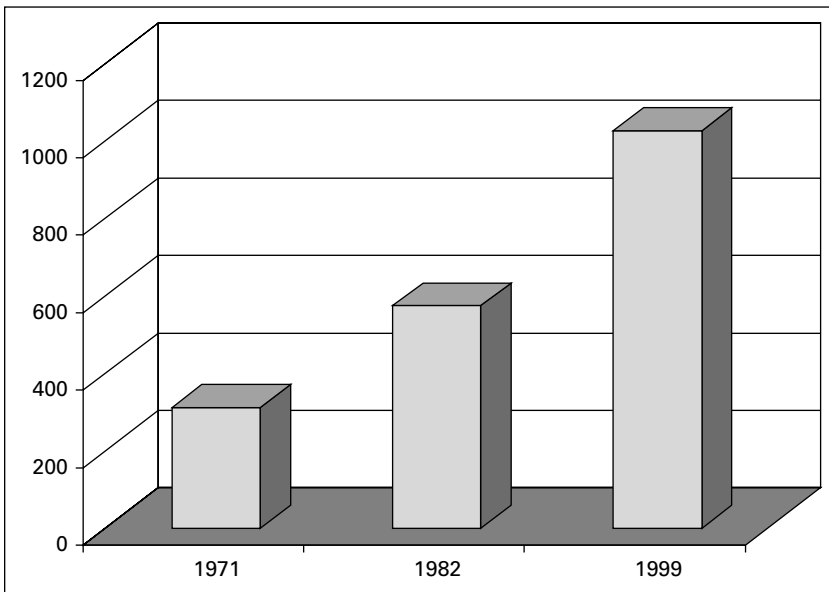

F I G U R E 3 .   Average Maximum HYV Yield Index (Laspeyres-weighted HYV Crops), by Year: 1971–99

the types of crops grown in the village in the initial, pre-green revolution period (using the 1968 data). In particular, we regressed the log of the maximum yield in the village in the survey year on the pre-green revolution proportion of acreage devoted to rice or to wheat in that village, allowing the effects on yields to vary by survey year. We also included whether or not the village was in an Intensive Agricultural Development Program (IADP) district, again with the effects allowed to differ by year. Table A in appendix 2 reports the random-effects estimates. The three pre-green revolution variables combined with the period dummies account for over 38 percent of the variation across villages and time. The coefficient estimates indicate that initially wheat growing villages had significantly higher HYV yields compared with rice-growing and all other villages, but this initial advantage eroded almost completely by 1999. These estimates are in accord with scientific developments, which yielded benefits late for rice relative to wheat productivity. Similarly, the significant initial advantage of the IADP areas eroded substantially over time, reflecting both the spatial spread of advances in crop technology and the termination of the program in the late 1970's.

Wage data by gender and age (adult/child) at the village level were computed somewhat differently from each of the three survey rounds. For 1982 and 1999, wages by crop (and by task in 1999) were collected at the village level. Crop-area (crop and task) weighted average wages by age and gender were then constructed for these two years. In 1971, earnings by sector and time worked were reported on an individual basis. These individual reported wage data were averaged for the different demographic groups and then aggregated at the village level. Figure 4 provides the computed real, village-level agricultural wages for adult males and females and boys and girls (ages 5-14) in 1982 rupees at the three survey dates. As can be seen, wages for all four groups rose significantly in the 28-year period between 1971 and 1999, but in the 1982–99 period adult wages rose at a faster pace than did child wages compared with the 1971–82 period. In 1971, for example, the adult female wage is less than 10 percent higher than the male child wage. By 1982 the adult female wage was 35 percent higher, while by 1999 the adult female wage is 56 percent higher than the child male wage. To the extent that the parental value of time, particularly that of women, is an important cost of child-rearing while child earnings are an important return to having children this growth in the adult/child wage gap could be an important factor in explaining the fall in fertility in the latter period. The adult male wage rose at a faster pace than the adult female wage between 1982 and 1999 compared to the earlier period as well, but to the extent that fathers

F I G U R E 4 .   **Real (1982 Rupees) Agricultural Wages of Adult Males and Females and Boys and Girls, by Year: 1971–99**
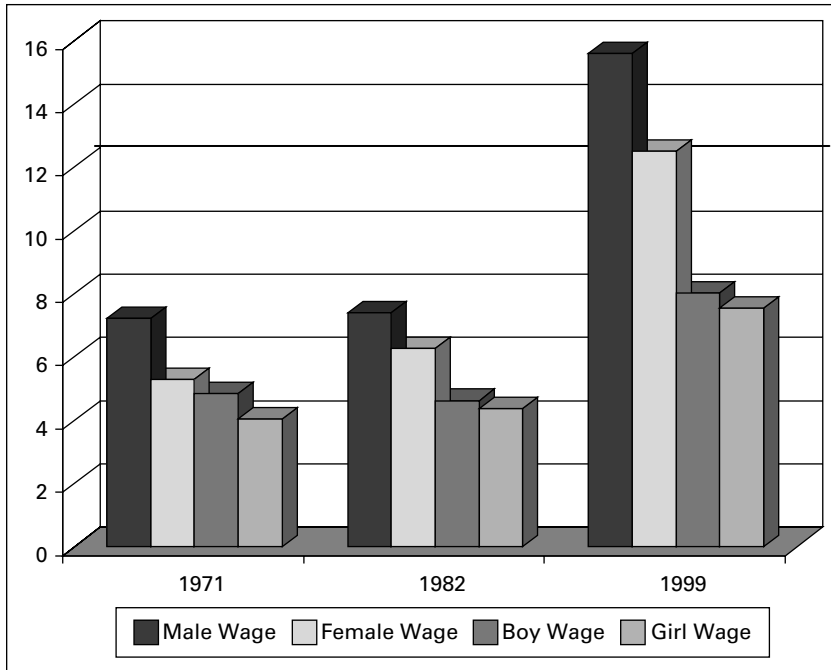
spend less time than mothers in child care this change is less relevant to fertility change than the adult/child wage gap change.

The main component of wealth in rural India, which is well-measured compared to other components, is land wealth. We constructed the total value of landholdings, in 1982 rupees, for each household in each of the three survey rounds. Average household land wealth also rose substantially between 1971 and 1999—from an average value of 21,000 rupees in 1971 to 33,000 rupees in 1982 and to 95,000 rupees in 1999. Increases in the value of land make it easier to raise large families and to increase human capital investment at the intensive margin. However, increases in land productivity via irrigation, a major component of the land value increase, also raises the return to child labor if child labor markets are imperfect and thus also increases the opportunity cost of child schooling.

c. Additional Variables

Many studies find that parental schooling and literacy, particularly that of mothers, is an important determinant of fertility and child schooling.

From the roster data in all three surveys we constructed variables indicating whether each mother was literate and/or completed primary school and for each father whether he had completed primary or secondary school. In figure 5 it can be seen that average schooling levels increased for mothers and fathers. In particular, the literacy of married women aged 15-59 rose from under 10 percent in 1971 to over 50 percent in 1999. Moreover, not only did primary schooling rise for mothers between 1971 and 1999, it rose relative to their husbands—in 1971, husbands were nine times more likely than wives to have completed primary school; in 1999, the fraction of wives with primary schooling was only 28 percent lower than that of husbands. The closing of the gender gap in parental schooling appears to have occurred in both the 1971–82 and 1982–99 periods.

F I G U R E 5 .   Parental Schooling, by Gender, Level and Year: 1971–99
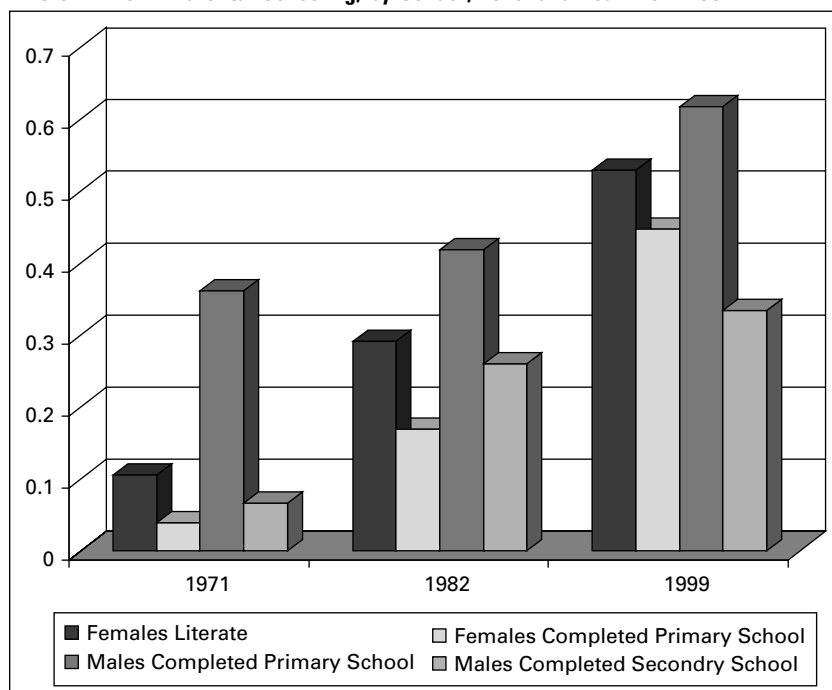
The provision of health, family planning and school services also increased between 1971 and 1999. All three survey rounds provided information on the presence of health centers and family planning facilities in the village at the time of the survey. The 1999 REDS also provided information on schools by whether they were public or private and by level,

including information on when the schools were established. From this establishment information we were able to construct a time-series of village secondary schools for each sampled village that could be matched to the survey dates. Figure 6 shows the growth in the fraction of villages with each of these facilities. As can be seen, although there is some growth in the coverage of family planning facilities over the period there are very few villages (5 percent) with such facilities even by 1999; it is thus unlikely that formal family planning facilities played a major role in the observed fertility decline, even if such facilities were effective in reducing the cost of fertility control. On the other hand, the proportion of villages with a health center grew from 9 percent in 1971 to over 26 percent in 1999. Health facilities could contribute to fertility decline by lowering infant mortality and by raising the returns to schooling to that extent that healthier children are better students. The presence of secondary schools in villages also rose substantially, from 30 percent coverage in 1971 to 54 percent village coverage in 1999. However, as noted, lowering the cost of schooling by increasing school proximity does not necessarily induce lower fertility, as it in part makes children cheaper.

F I G U R E   6 .   **Proportion of Households in a Village with Family Planning and Health Facilities and Secondary Schools, by Year: 1971–99**
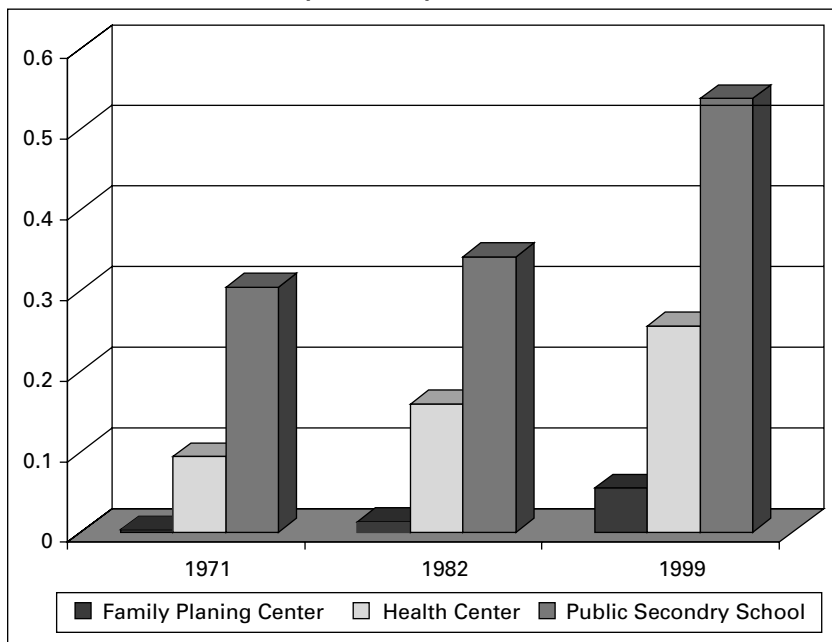
d. Linking Households

The panel component of the data allows the linkage of not only villages but also individual households across time, to the extent that they were sampled, as noted above. This permits one to control for unobservables that are persistent over time within families that might otherwise lead to a correlation between outcome variables like fertility, parental attributes such as education, and measures of household wealth. In this case we connect families at the "dynasty" level. A dynasty consists of the original sampled household based on the year it was surveyed (1971 for most households but also 1982 and 1999 for the new households introduced in each round to assure representativeness) plus all sampled sub-households that split from these original households. Preferences of families within dynasties are likely to be similar and to have a large persistent component that is ignored in prior work on fertility in India. The data do not allow the linking of individuals across time. However, there would seem to be limited bene-fit from linking women across such extended gaps in the survey rounds for the purpose of removing individual effects, given that fertility mostly occurs for women at young ages.

III. Estimates

a. Fertility

We estimate a linearized version of the fertility decision rule (1) of the model, in which the number of children born in the five years prior to the survey for each married woman in each household is the dependent vari-able and the right-hand-side determinants include the mother's age and it's square; the number of her previous children born; variables indicating whether the mother is literate or completed primary school; variables indi-cating whether the husband completed primary or secondary schooling; the log wage rates of men, women, boys and girls; the log of the agricultural productivity measure; the log value of household landholdings; and vari-ables representing whether or not the village has a health center, family planning facility or school. The number of observations from the three sur-vey rounds is 18,896, including 6,650 dynasties.

Three estimation procedures are used: The first is OLS, which exploits both the cross-sectional and over-time variation in the variables over the households, villages and states. The second set of estimates controls for state fixed-effects, and thus controls for variation across states in time-persistent

preferences, traditions and agroclimatic conditions. The third incorporates a dynasty fixed effect, and thus additionally controls for persistent variations across families in preferences for schooling and family size. Identification of parameters from the estimates including a dynasty fixed effect thus comes from variation across women within families (dynasties) and over time within families (dynasties). Elimination of the influence of the dynasty fixed-effect does not eliminate all sources of bias. We discuss some of these as we examine the point estimates. For all estimation procedures coefficient standard errors are corrected for clustering at the state-year level.

The first column of table 1 reports the OLS estimates. These appear to replicate the findings of recent cross-sectional studies—the "economic variables" wages, HYV yield rates and wealth are all statistically insignificant—but maternal literacy, the presence of health centers and urbanization are each statistically significant and negatively related to fertility. Inclusion of a state fixed effect, in column two, however, suggests that these results are spurious, reflecting substantial differences across Indian states in unobservables such as preferences for female schooling and agro-climatic conditions affecting yields that affect fertility decisions and that are also correlated with the fertility determinants. In this specification, the log female wage rate is statistically and negatively related to fertility as is log HYV yield, whose coefficient is almost double in absolute value its OLS counterpart. Moreover, the female literacy coefficient is almost halved and is no longer statistically significant.

The statistically-preferred (Hausman-Wu tests) estimates that control for persistent differences across dynasties conform even more closely to the economic model implications. The results indicate that increases in female wage rates lower fertility while increases in the wage rates of boys, which offsets their costs, increase fertility. The point estimates suggest that a doubling of female wage rates (mother's value of time), approximately the magnitude of the change between 1982 and 1999, would decrease the five-year birth rate, ceteris paribus, by about 10 percent, given the 1982 birth-rate levels. A similar increase in the wage rates of boys (value of children) would increase birth rates by about 7 percent.[3] Interestingly, increases in girls' wage rates also lower fertility, which suggest, as noted, that girls assist

3. The number of children born could directly affect adult and child wages—a positive shock to fertility might lower the labor force participation rate of women, thus raising the female adult wage. If these direct within-village supply-demand effects are strong, then the negative female wage effect is positively biased (too small in absolute value). Similarly, an exogenous increase in the number of children would lower the wage child wage. Again, the estimated positive male child wage may be too small in absolute value

T A B L E 1 . **Determinants of the Number of Live Births in Last 5 Years to Married Women Aged 15–59, by Estimation Procedure**

Variable/estimation procedure	OLS	Fixed-effects state	Fixed-effects dynasty
Log maximum HYV yield in village	−0.063	−0.116	−0.185
	(0.0685)	(0.0724)	(0.0766)
Log male wage	−0.0647	0.0681	−0.039
	(0.0662)	(0.0576)	(0.0471)
Log female wage	0.0185	−0.078	−0.0711
	(0.0479)	(0.0382)	(0.0363)
Log male child wage	0.0187	0.0109	0.0484
	(0.0210)	(0.0243)	(0.0256)
Log female child wage	0.00637	−0.022	−0.0458
	(0.0221)	(0.0171)	(0.0241)
Log value of landholdings	−0.00166	−0.00324	0.0029
	(0.0019)	(0.0018)	(0.0024)
Mother literate	−0.0578	−0.0301	−0.0236
	(0.0246)	(0.0257)	(0.0299)
Mother completed primary school	−0.00612	−0.00497	0.0271
	(0.0261)	(0.0256)	(0.0301)
Father completed primary school	−0.00315	−0.00868	0.00866
	(0.0206)	(0.0215)	(0.0229)
Father completed secondary school	−0.00271	−0.00344	0.0105
	(0.0175)	(0.0167)	(0.0205)
Health center in village	−0.0324	−0.0413	−0.127
	(0.0180)	(0.0164)	(0.0435)
Family planning center in village	0.0251	0.0183	0.0923
	(0.0313)	(0.0224)	(0.0784)
Secondary school in village	0.0328	−0.116	0.0271
	(0.0168)	(0.0275)	(0.0164)
Proportion district urban	−0.189	−0.152	−1.21
	(0.0983)	(0.0895)	(0.6080)
Year = 1982	0.192	0.169	0.147
	(0.0790)	(0.0633)	(0.0635)
Year = 1999	0.16	0.0946	0.0273
	(0.1220)	(0.1170)	(0.1070)
Number of mother-years	18896	18896	18896

Source: Authors' calculations.

All specifications also include children ever born as of 5 years ago, mother's current age and mother's age squared. All estimated standard errors corrected for clustering by state and year.

All estimated standard errors corrected for clustering by state and year.

in child-rearing. Increases in HYV yields also reduce fertility, consistent with the hypothesis that technical change raises the return to schooling and thus reduces numbers of children to augment schooling investment in children. The point estimate suggests that a doubling of yields, for given wealth and schooling and wage rates, would lower fertility rates by 24 percent.

None of the dynasty fixed-effects coefficients for the parental schooling variables are statistically significant—the impressive rise in female literacy in rural areas depicted in figure 5 thus does not seem to be a significant factor in determining the fertility decline once family, village, and state-level heterogeneity is taken into account. However, the presence of a health center does appear to be associated with reductions in fertility—the point estimate in column three suggests that women in a village with a health center have a birth rate that is 17 percent lower than those women residing in identical conditions in a village without a health center. Note, however, that the point estimate for the health center yielded by the dynasty-fixed effects procedure is less than half in absolute value of that obtained using OLS. The presence of a village family planning clinic, however, does not appear to be important and this result is robust to estimation procedure. This result may be due to the relatively small presence of these clinics in rural India, as seen in figure 6, or the relative availability of family planning information and devices from other sources.

b. School Attendance

Table 2 reports, for the three estimation procedures, the estimates of the determinants of the age-adjusted school attendance rates of children aged 5–14. The specification is the same as that for fertility, corresponding to (2), except that we have added the proportion of boys in the age range to assess if there is discrimination by the gender of children. Because, as noted, the schooling measure is aggregated at the household rather than at the mother or child-level and not all households have children in the relevant age range, the number of observations for this analysis is about half of that for the fertility analysis, 9,158.

The quantity-quality dimension of the economic model of fertility suggests that the coefficients for the variables determining family size and child schooling should be of opposite sign. The principal economic determinants of fertility in table 1, column three, are the HYV yield and the female wage, both of which were negatively associated with fertility. In the third column of table 2, which reports the statistically-preferred within-dynasty estimates, the coefficients on these variables are indeed positive, although the coefficient on the log female wage is only marginally statistically significant with a one-tail test. The point estimate for the log HYV yield variable suggests that a doubling of HYV yields would increase children's school attendance by 50 percent, using again the 1982 mean. Doubling the female wage would also increase attendance, by 8 percent. Neither the

T A B L E 2 . Determinants of Age-Adjusted School Attendance Rates of Children Aged 5–14, by Estimation Procedure

Variable/estimation procedure	OLS	Fixed-effects state	Fixed-effects dynasty
Log maximum HYV yield in village	0.131	0.469	0.681
	(0.1620)	(0.1440)	(0.1970)
Log male wage	0.388	−0.0501	−0.0282
	(0.1650)	(0.1410)	(0.1490)
Log female wage	−0.0659	0.196	0.111
	(0.1460)	(0.1210)	(0.0863)
Log male child wage	0.0625	0.0835	0.0504
	(0.1090)	(0.0838)	(0.0724)
Log female child wage	−0.0659	0.196	−0.0509
	(0.1470)	(0.1210)	(0.0700)
Log value of landholdings	0.00536	0.00823	0.00601
	(0.0040)	(0.0035)	(0.0055)
Mother literate	0.555	0.413	0.302
	(0.0348)	(0.0485)	(0.0536)
Mother completed primary school	−0.035	−0.0672	−0.0779
	(0.0527)	(0.0392)	(0.0511)
Father completed primary school	0.304	0.33	0.166
	(0.0471)	(0.0454)	(0.0348)
Father completed secondary school	0.0935	0.0153	0.023
	(0.0630)	(0.0528)	(0.0576)
Proportion of children boys	0.217	0.24	0.269
	(0.0499)	(0.0506)	(0.0457)
Health center in village	0.147	0.114	−0.0567
	(0.0416)	(0.0431)	(0.0874)
Family planning center in village	−0.00273	0.0145	−0.0629
	(0.0923)	(0.0971)	(0.1680)
Secondary school in village	−0.00273	−0.00568	0.00642
	(0.0977)	(0.0432)	(0.0777)
Proportion district urban	0.838	0.647	−2.21
	(0.2550)	(0.2600)	(1.1400)
Year = 1982	0.11	−0.227	−0.278
	(0.1430)	(0.1350)	(0.1520)
Year = 1971	0.397	−0.0119	0.14
	(0.2500)	(0.2220)	(0.2670)
Number of household-years	9158	9158	9158

Source: Authors' calculations.
All specifications also include children ever born, mother's current age and mother's age squared.
All estimated standard errors corrected for clustering by state and year.

male nor female child wage is the theoretically appropriate sign, although neither is estimated with any precision.

Maternal literacy, negatively associated with fertility, also is positively associated with schooling, although in this case the coefficient is statistically

significant. Whether the father has a primary school education also is positively associated with child schooling. The point estimates indicate that attendance rates of children with literate mothers are 23 percent higher compared with children of illiterate mothers; attendance rates are 13 percent higher if the father completed primary school. As for the fertility estimates, however, the magnitudes of the within-dynasty point estimates are less than half the OLS estimates. It is still possible that individual households *within* dynasties differ in preferences for schooling, in which case the estimated schooling associations may still be picking up variation in tastes for schooling. Note that variations in wages and HYV yields, aggregated at the village level are orthogonal to differences in unobserved, within-dynasty household-specific preferences.

Elimination of the influence of cross-village time-persistent heterogeneity also appears to reduce and eliminate the estimated positive association between the presence of health centers and school attendance. We also cannot find any association for any estimation procedure between the presence of schools and school attendance, although it is notable that the OLS and within-state estimates are not even the correct sign. It is not unlikely that the village distribution of government schools over time increasingly reached villages with lower preferences for schooling, biasing downward even the within-village (and-dynasty) estimates of the school proximity effect.

IV. Explaining Fertility Change

Are the fertility estimates in table 1 informative about the aggregate fall in rural fertility observed between 1982 and 1999? In particular, how much can the changes in wage rates and in agricultural productivity between 1982 and 1999 account for the 46 percent decline in period fertility in that time span? To quantify the contribution of economic change to fertility decline, we use the actual changes in the economic variables, depicted in figures 3 through 6 and the table 1 coefficients. For a variable to have played an important role in explaining the change in fertility, the estimated effect of the variable on fertility must be non-trivial and the change in the variable over the time span must also be substantial. An example is the urbanization variable. Although this variable has a statistically significant effect on fertility, over the 1982–99 period in our data there was almost no average change in the percent of urban districts.

The estimated contributions of the health centers and female literacy to fertility decline illustrate the two conditions that are required for a variable

to have played an important role in fertility change. The coefficient on the presence of a health center in the village in table 1 is statistically significant, and health center presence evidently reduces fertility non-trivially, by 17 percent, perhaps due to the contribution of health centers to lowering infant and child mortality. However, as indicated in figure 6, coverage of health centers increased by less than 10 percentage points over the period. The growth in health center coverage in rural Indian villages, given its estimated effect, therefore can only account for 3.4 percent (.0965*(–.127)/.358) of the fertility decline.[4]

In contrast, female literacy increased by 81 percent (figure 5) between 1982 and 1999. However, we could find no evidence that changes in female literacy affect fertility. Thus, despite the rise in female literacy, female literacy appears to have played no role in the fertility decline over the period, while despite the evident strong effect of health centers on fertility, the limited spread of health centers meant that the role of health centers in inducing fertility decline too was only marginal.[5]

In contrast to the change in health center coverage, the rise in adult wages from 1982 to 1999 was substantial, and was greater than that for child wages (figure 4). And in contrast to the estimated effects of female literacy, wage rate effects on fertility are evidently strong. Based on the set of four wage coefficient estimates in table 1 and the changes in the complete set of wages, we calculate that the rise in agricultural wage rates accounts for 23 percent of the rural fertility decline between 1982 and 1999 (15 percent of the decline is explained by the doubling of the female wage alone). The 79 percent increase in HYV yields accounts for another 36 percent of the decline in the birth rate, net of the wage rate effects. Note that real agricultural wage rates did not increase significantly in the 1971–82 period, when fertility did not fall. The rise in HYV yields, however, should also have led to a fertility decrease in that period.

We can also disaggregate the total contribution of the post-1982 change in agricultural productivity to the post-1982 fertility decline into that part due to induced wage change and that part due to direct effects, such as the greater

4. Over the period 1971–99, the proportion children dying by the age of 5 fell from .0562 to 6.0229. Thus at most (assuming a one-to-one replacement rate) the decline in infant and child mortality could contribute to fertility decline is a reduction of fertility of 3.4 percent (www.indiastat.com/india/ShowData.asp?secid=90643&ptid=17796&level=4 [November 2006]).

5. Another example is the urbanization variable. Although this variable has a statistically significant effect on fertility, over the 1982–99 period in our data, there was almost no average change in the percent of urban districts.

incentives to increase investments in child schooling seen in table 2. To do this we need to estimate the effects of variation in HYV yields on wages. Table 3 reports within-village estimates of the effects of the predicted log HYV yield on the log of each of the four wage rates using data from all three surveys covering the period 1971–99. Also included in the specifications are the log of the village population, whether there is a public secondary school in the village, the proportion of the district that is urban and year dummy variables. The estimates indicate that for all but girls, increases in HYV yields pushed up wages significantly—the point estimates suggest that the 79 percent increase in HYV yields between 1982 and 1999 increased real male wages by 23 percent, real female wages by 19 percent and the real wages of boys by 24 percent in that period. The total effect of agricultural technical change on the fertility decline is the effect on fertility due to the increase in wages (3.2 percent) induced by technical change plus the direct effect, net of wages, from table 1 (36 percent). Thus, the increase in HYV yields over the 1982–99 period accounts for 39.2 percent of the fall in rural fertility, of which 92 percent is the direct effect net of wages.

T A B L E 3 . FE-Village Estimates, 1971–99: Determinants of Log Agricultural Wages for Men Women, Boys and Girls

Variable/Group	Men	Women	Boys	Girls
Log maximum HYV yield in village	0.332	0.276	0.347	0.0229
	(0.0814)	(0.0969)	(0.1500)	(0.1730)
Log population in village	–0.0169	–0.00884	–0.0107	–0.00606
	(0.0047)	(0.0055)	(0.0077)	(0.0089)
Public secondary school in village	0.0187	0.0209	0.0404	0.105
	(0.0311)	(0.0371)	(0.0539)	(0.0625)
Proportion district urban	0.269	–0.0652	–2.57	–1.46
	(2.1800)	(2.6000)	(3.5300)	(4.1400)
Year = 1982	–0.577	–0.569	–0.391	–0.546
	(0.0619)	(0.0737)	(0.1160)	(0.1290)
Year = 1971	–0.342	–0.496	0.17	–0.557
	(0.1170)	(3.5600)	(0.2180)	(0.2510)
N	717	717	668	682

Source: Authors' calculations.
Estimated coefficient standard errors in parentheses.

The importance of the rise in wage rates in accounting for rural fertility decline, particularly the wages of women, presupposes that women participate in the rural labor market. The survey data for 1982 and 1999 provide detailed information on the daily time allocation of women for typical days in three agricultural seasons. These data permit estimates of both labor

force participation and time worked. We define a woman as being in the labor force if she works as either an agricultural worker, wage worker, salary worker or is self-employed (non-farm) for at least one hour during a typical day.[6] Based on this definition, over 79 percent of women aged 25-49 were in the labor force in 1982 and over 74 percent in 1999. Among these women in the labor force, the average number of hours in the day spent in these activities was close to six.

If part of the story of fertility decline is the increased return to women's allocation of time to employment, then we ought to observe that increases in agricultural productivity, which pushed up wages, also induced increased female work time. To assess this, we estimated reduced-form regressions, again using the within-dynasty estimator, of the determinants of both fertility and female labor supply for mothers aged 25-49. By reduced-form we mean that we excluded from the specifications the variables that could have endogenously been affected by changes in labor supply, such as wage rates, land values and parental schooling. The reduced-form, FE-dynasty estimates for fertility and labor supply (log of hours worked per day average over the three seasons) are reported in table 4. As can be seen, increases in agricultural productivity did indeed induce a shift in female time from rearing children to working in the labor market. Although over the period 1982 through 1999 female market work time declined, where agricultural productivity growth was higher, fertility was significantly reduced, consistent with the estimates in tables 1 and 3, and female labor market time was significantly increased.

V. Conclusion

The results in this paper provide clear evidence of the importance of changes in the implicit cost or shadow price of children and women as sources of fertility change during the process of economic growth. This basic insight was provided by Gary Becker to help understand how it could be that a process that fundamentally and broadly expanded a household's choice set could result, without invoking a need for overall changes in preferences, in a reduction in the number of children per household. But these results should not be understood to imply that a relationship between fertility change

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6. Following conventional practice, we excluded from the definition of labor force activity such household production activities as grain grinding and pounding, collecting fuel, making dung cakes, and fetching water.

T A B L E 4 .   FE-Dynasty Estimates: Reduced-Form Determinants of Fertility (1971–99) and Maternal Labor Supply (1982–99)

Variable	Live births in last 5 years	Log hours worked per day
Log maximum HYV yield in village	−0.0708	0.441
	(0.0343)	(0.1410)
Health center in village	−0.0997	−0.00671
	(0.0404)	(0.0224)
Family planning center in village	0.0997	0.0963
	(0.0530)	(0.0377)
Secondary school in village	0.0406	−0.0299
	(0.0215)	(0.0232)
Proportion district urban	−1.09	−0.263
	(0.4630)	(0.3000)
Year = 1999	−0.245	−0.37
	(0.0412)	(0.1050)
Mother's age	−0.133	0.0195
	(0.0082)	(0.0058)
Mother's age squared	0.00111	−0.000178
	(0.0001)	(0.0001)
Number of mother-years	16261	10631

Source: Authors' calculations.
All estimated standard errors corrected for clustering by state and year.

and economic growth occurs without structural change. Economic growth generally is not just an expansion in income but arises through changes in the nature of production and thus in the organization of economic units including the household. Thus economic growth may largely affect fertility through the nature of economic incentives available to the household, with household preferences and decision-making being reasonably fixed.

In India, the Green Revolution, by changing the opportunities available to farming households, lead not just to an expansion in income but to changes in the labor market. There was a rise in the returns to skills, which lead to increased investment in schooling, a process that not only resulted in lower levels of fertility but likely changed the opportunities of children to pursue other opportunities outside of traditional agriculture. The Green Revolution, along with other economic changes that were likely in part responsive to the increased growth and occupational diversification made possible by the overall expansion in agricultural productivity, also expanded worker productivity and thus lead to an expansion in labor demand. The resulting rise in wages not only made child-rearing more expensive but shifted the nature of women's activities both within and outside the household. As a result patterns emerge that look much like a fundamental change in women's

autonomy. However, the results in this paper suggest that fertility change can in large part be explained through a rise in the female wage, regardless of the source of this rise. Future work should examine this issue more directly.

Clearly the rapid economic growth enjoyed by India in the period since the 1999 survey used in this paper has continued to alter the nature of economic relations and thus will likely further impact the decisions that parents make regarding childbearing. Expansion in opportunities in urban and peri-urban areas that are both a direct consequence of growth in the tradeable service sector, and that arise indirectly through the general expansion in economic activity that is linked to this growth, will continue to alter the incentives faced by rural households. To the extent that these changes have and continue to increase both the returns to education and the economic activity of women outside the home, it is likely that the process of fertility decline will continue. These processes will also likely further link labor and other markets across villages and, in return, reduce the power of the empirical strategies adopted in this paper, that is the use of fundamental differences across villages in the nature of opportunities available to households to test basic hypotheses about the responsiveness of households to these opportunities. Thus our continued understanding of how fertility is changing in rural India and how these changes are, in turn, affecting economic well being is contingent not only on the continued collection of the kind of detailed wide-spectrum panel data that has been utilized in this paper, but in the development of new empirical and theoretical approaches as well.

Finally, our finding that economic models emphasizing the importance of changes in incentives can explain a substantial proportion of fertility change does not imply that policy interventions, such as those improving health, did not or cannot significantly affect fertility. The effects of national policy initiatives such as vaccination campaigns that vary little across space or time cannot be picked up using our methodologies. Moreover, we did find evidence that health centers were associated with fertility decline; however, over the period examined, there was little aggregate change in health center presence in the sample villages.

APPENDICES

Appendix 1

The expected utility for a couple i residing in area j and where the wife is age x at time t is

(A1)
$$u_{ijxt} = E_t \sum_{s=t}^{t+\omega-x} \beta^{s-t} u(c_{ijs}, n_{ijs}, h_{ijs} N_{ijs-1}; \nu_{ijs})$$
$$+ \sum_{s=t-x+\alpha}^{t+\omega-x} n_{ijs} (\theta_{ijs}^b r(\varphi_{ijt+\omega-x}, h_{ijs}^b) + \theta_{ijs}^g r(\varphi_{ijt+\omega-x}, h_{ijs}^g))$$

where α is the minimum and ω the maximum ages of childbearing, β is the discount factor, c_{ijs} denotes single period consumption, n_{ijt} denotes childbearing at time t, $N_{ijt-1} = \sum_{s=t-x+\alpha}^{t-1} n_{ijt}$ is the stock of children bornprevious to time t, ν_{ijt} denotes household tastes, $\theta_{ijt}^b + \theta_{ijt}^g = 1$ are the fraction of boys and girls respectivelyborn at time t, r() denotes the parental return to child human capital, whether through financial transfers or utility, $\varphi_{ijt-x+\omega}$ denotes technology faced by the children when the parents are old, and h_{ijt}^b and h_{ijt}^g are sex specific levels of human capital for these children. As constructed in (A1) the returns to humancapital investments in children are higher the higher the level of expected agricultural technology.

Human capital for a child of gender k

(A2) $$h_{ijt}^k = h^k(t_{ijt}^{bk}, t_{ijt}^{gk}, t_{ijt}^{mhk}, t_{ijt}^{phk}, e_{ijt}^k, h_{ij}^m, h_{ij}^p)$$

is produced using the time of the child (e.g., studying, attending school) and the time of other children (reflecting the possible caretaker role of other children), the time of the mother (m) and father (p), purchased inputs to human capital per child, e_{ijt}^k, and parental human capital levels.

Household income derives from farm production on household land (if owned) using the labor of the children, mother and father plus earnings from off-farm work:

(A3) $$y_{ijt} = \varphi_{ijt} f(n_{ijt} \theta_{ijt}^b t_{ijt}^{bf} + t_{ijt}^{br}, n_{ijt} \theta_{ijt}^g t_{ijt}^{gf} + t_{ijt}^{gr}, t_{ijt}^{mf} + t_{ijt}^{mr}, t_{ijt}^{pf} + t_{ijt}^{pr}, A_{ijt}, h_{ij}^m, h_{ij}^p)$$
$$+ w_{ijt}^b (n_{ijt} \theta_{ijt}^b t_{ijt}^{bo} - t_{ijt}^{br}) + w_{ijt}^g (n_{ijt} \theta_{ijt}^g t_{ijt}^{go} - t_{ijt}^{gr}) + w_{ijt}^{mo} (t_{ijt}^{mo} - t_{ijt}^{mr})$$
$$+ w_{ijt}^{po} (t_{ijt}^{po} - t_{ijt}^{pr}),$$

where φ_{ijt} denotes agricultural technology, A is the stock of productive assets, such as land, and thesuperscript br, gr, mr and pr time terms denote

hired labor. The time of children is allocated between on-farm activities, the labor market, and schooling; e.g., for girls:

$$(A4) \qquad t_{ijt}^{gg} + t_{ijt}^{gb} \frac{\theta_b}{\theta_g} + t_{ijt}^{gf} + t_{ijt}^{go} = T^1$$

The time of mothers and fathers is allocated between on-farm activities, the labor market, and the human capital production of their children. The time constraint for mothers is thus

$$(A5) \qquad n_{ijt}\, \theta_{ijt}^{b}\, t_{ijt}^{mhb} + n_{ijt}\, \theta_{ijt}^{g}\, t_{ijt}^{mhg} + t_{ijt}^{mf} + t_{ijt}^{mo} = T$$

with a parallel constraint for fathers.

The budget constraint in each period is thus

$$(A6) \qquad c_{ijt} + p_t^e\, n_{ijt}\, (\theta_{ijt}^{b}\, e_{ijt}^{b} + \theta_{ijt}^{g}\, e_{ijt}^{g}) + s_{ijt} = y_{ijt},$$

where p_t^e denotes the cost of purchased goods that increase child human capital such as health services and s_{ijt} denotes net savings, with

$$(A7) \qquad A_{it} + s_{it} = A_{it+1}$$

reflecting the use of savings to acquire productive assets. We assume that local economic conditions follow a random walk so that the best predictors of current and future technologies and wages are current levels of those variables.

Households choose at each age x whether to have a child, consumption, savings, human capital investments, and labor allocations to maximize their expected utility (A1) given constraints (A2)–(A7). Childbearing is chosen first and then, upon the realization of gender for that group of children, decisions are made about human capital investments. Although closed-form explicit comparative statics for dynamic models of this sort are unavailable, basic insight into the underlying processes can be obtained by examining the implied shadow prices of children and human capital and to obtain value-of-time effects. In particular, consider the sex-specific per-child net cost function

$$(A8) \qquad p^{k*}\, (h^k, p_e, w^k, w^k, w^m, w^p),$$

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1. Note that if each boy receives t units of human capital input from the girls, the girls must each contribute t θ^b/θ^g units.

and implied conditional time and good demand functions denoted by, for example,

(A9) $$t^{mkh*} \, (h^k, \, p_e, \, w^b, \, w^g, \, w^m, \, w^p)$$

which characterizes the minimum net cost in terms of expenditures on children net of child earnings to produce the specified levels of children and human capital in a given period.

The first-order conditions for fertility and human capital are

$$(A10) \quad 0 = \frac{\partial u}{\partial n_{ijt}} + \frac{\partial V}{\partial n_{ijt}} + \theta^b_{ijt} r^b (\varphi_{ijt+\omega-x}, b^b_{ijs}) + \theta^g_{ijt} r^g (\varphi_{ijt+\omega-x}, b^g_{ijs})$$

$$- \lambda (\theta^b_{ijt} \pi^b_{ijt} + \theta^b_{ijt} \pi^b_{ijt})$$

and

$$(A11) \quad u_{ijxt} = \frac{\partial u}{\partial h_{ijt}} + n_{ijt} \left(\theta^b_{ijt} \frac{\partial r^b}{\partial h^b_{ijt}} + \theta^g_{ijt} \frac{\partial r^g}{\partial h^g_{ijt}} \right) - \lambda n_{ijt} \left(\theta^b_{ijt} \frac{\partial \pi^b}{\partial h^b_{ijt}} + \theta^g_{ijt} \frac{\partial \pi^g}{\partial h^g_{ijt}} \right),$$

respectively, where V denotes the maximized value of (A1) at time t + 1 and λ is the period t Lagrange multiplier on the budget constraint.

Differentiating the cost function (A8) with respect to the female wage w^f and using the envelope theorem yields the value-of-time effect on fertility for women

$$(A12) \qquad \frac{d\pi^{k*}}{dw^f} = t^{mkh} * > 0.$$

The effect of the boy wage on the shadow price of a male child is

$$(A13) \qquad \frac{d\pi^{b*}}{dw^b} = t^{bb*} - T < 0$$

and the effect of a change in the girl wage on the shadow price of boys is given by

$$(A14) \qquad \frac{d\pi^{b*}}{dw^g} = t^{bg} * < 0.$$

There are symmetric expressions for the shadow price of girls.

If the on-farm marginal product of boy labor exceeds the local boy child wage for large landowners, for example, then an increase in landholding for these households will have an analogous effect

(A15)
$$\frac{d\pi^{b*}}{dA} = (t^{bb}* - T)f_A/f_{t\,b} < 0.$$

where the subscripted-f terms denote the corresponding marginal products.

Appendix 2

T A B L E A . Random-Effects Estimates: Determinants of Log Maximum HYV Yield Index, 1971–99

Variable	
Proportion village acreage planted in wheat in 1968* (Year = 1971)	1.48
	(0.302)
Wheat * (Year = 1982)	−0.875
	(0.383)
Wheat * (Year = 1999)	−1.22
	(0.390)
Proportion village acreage planted in rice in 1968* (Year = 1971)	0.318
	(0.160)
Rice * (Year = 1982)	−0.113
	(0.204)
Rice * (Year = 1999)	−0.194
	(0.202)
IADP * (Year = 1971)	0.285
	(0.123)
IADP * (Year = 1982)	−0.291
	(0.157)
IADP in 1971* (Year = 1999)	−0.344
	(0.158)
Year = 1971	5.05
	(0.084)
Year = 1982	0.903
	(0.106)
Year = 1999	1.67
	(0.106)
R2	0.382
Number of villages	240
Number of observations	702

Source: Authors' calculations.
Estimated coefficient standard errors in parentheses.

Comments and Discussion

Mihir Desai: As Lazear (2000) notes, establishing the role of economic incentives in dictating demographic change and family structure has been one of the great achievements of "economic imperialism." Yet various accounts of the rapid changes in Indian fertility in the final two decades of the twentieth century have given short shrift to the role of economic incentives. These accounts have found little evidence for the role of a crass economic calculus in family decision-making and, instead, have emphasized loftier ideals—the diffusion of ideas on the role of women, female literacy and the spread of knowledge through public health systems. In India, economic imperialism, perhaps unsurprisingly, seems to have met a reluctant audience. Foster and Rosenzweig enter this contested area with a desire to reconcile the dramatic recent Indian experience with the considerable extant evidence on the significance of economic incentives. If imperialists were given to doubt, Foster and Rosenzweig provide them much comfort with their efforts.

Foster and Rosenzweig contribute to this debate by utilizing a novel data source and by innovating on traditional Beckerian logic. Various NCAER surveys have been knitted together to allow for a panel data set that permits for the removal of dynasty fixed effects. The theoretical framework emphasizes traditional value-of-time and quantity-quality tradeoffs but Foster and Rosenzweig innovate by providing a role for girls in family care that parallels the role of mothers. This innovation leads to novel, if somewhat strained, empirical predictions on the effects of girl wages. The empirical framework is fairly straightforward with predicted signs on wage rates and agricultural productivity that reverse between the regressions that explain the number of children and educational attainment.

The OLS findings help explain why others have disputed the role of economic incentives while the dynasty fixed effects results reveal why the OLS results should not be trusted. Taken together, the results provide a stark victory for the imperialists: changes in agricultural productivity and wages accounted for eighty percent of the documented decline in the rural fertility rate. Public health facilities, while associated with a statistically significant effect, explain little of the decline given their wide presence at

the beginning of the sample. Female literacy does not materialize as an important factor in changes in fertility rates. Dynasty fixed effects appear to have revived the imperial project in India.

This study provides a convincing refutation to the prevailing wisdom that economic growth has not driven the decline in rural fertility. While the general thrust of the results is very convincing, it is worth pausing to consider some qualifications. First, the dramatic changes to the OLS results when using state fixed effects and dynasty fixed effects raise questions on the appropriate fixed effects to employ. The use of year and dynasty fixed effects control for persistent unobservables that drive variation across families. As such, identification comes from comparing women within dynasties and women over time within families. Given that the windows between sample years are so long, dynasty fixed effects allow for comparisons between a mother with herself through time (which is presumably minimal), between daughters and mothers through time, and between daughters in a period. The final comparison would seem the most valuable and the use of dynasty/year effects would control for non-persistent unobservable variables as well. This is particularly important given that public health campaigns might have influenced those unobservables over the time period under analysis. More generally, the authors have used community fixed effects in other work and it would be nice to see how much power there is in controlling for communities rather than families. Finally, the centrality of the dynasty fixed effects to the results recommends greater discussion of what dynasties look like and how many women are in typical dynasties.

Second, the paper links the dramatic reduction in rural fertility to the dramatic increases in rural productivity from the Green Revolution. While this argument is generally convincing, it is worth dwelling on the fact that the rural fertility decline came well after the revolution in agricultural productivity (1982 to 1999 relative to 1971 to 1982, in the sample here). This fact would recommend estimating these equations by period rather than just allowing for period fixed effects. Moreover, the mapping of the coefficients to estimates of the contribution of agricultural productivity would more appropriately use period-specific coefficients given the asynchronous nature of the changes. Finally, the case for the role of agricultural productivity would be even more convincing if predicted wage changes based on a first-stage regression of wages on changes in productivity were employed rather than actual wages. It is entirely plausible that agricultural productivity changes have a lagged effect on family decision-making and these lags could usefully have been considered further in this analysis.

Finally, the authors begin their paper by contrasting the role of economic incentives with the view that a "new reproductive idea" has disseminated in rural India giving rise to changes in beliefs that have a "life of their own." This alternative hypothesis about the role of public health campaigns is not fully confronted in their analysis. While the number of health centers is controlled for, these centers are complemented with mass media campaigns, outreach campaigns, and changing technologies of reproductive health. Of course, the dynasty fixed effects allow for some comfort in this regard but there are alternative hypotheses. While migration is assumed to be minimal (and the authors cite evidence of minimal migration), it is conceivable that the effects of migration on wages are largest in areas close to urban areas and that these areas also feature access to mass media campaigns and the easiest access to changed reproductive health technologies. Such an alternative hypothesis would require something more than a dynasty fixed effect to force it to surrender. Subsequent efforts might usefully consider the "splitters" in families (considered in other work by the authors) to fully identify the relative effects of public health efforts and economic incentives in dictating reproductive and schooling decisions.

Until then, Foster and Rosenzweig have clearly demonstrated that economic incentives have mattered greatly for the decline in rural fertility in India. The relative importance of other factors, including public health campaigns and the dissemination of ideas, remains an open question. As Garrett (2007) has noted, a remarkable opportunity awaits as a flood of dollars dedicated to public health issues needs to be targeted effectively in the coming decades. Foster and Rosenzweig's effort should be required reading for decision-makers charged with disseminating those funds. Their efforts remind us that spending public health dollars, and measuring their impact, should be embedded in a deep understanding of how families respond to economic incentives.

Ajay Shah: There has been a considerable debate about the role of economic factors in shaping fertility. The paper has an exciting dataset where households are observed in 1971, 1982, and 1999. A fascinating feature of the results lies in the 'dynasty' fixed effects. The coefficient of log female wage and the coefficient of log max HYV yield in the village—both of which are unclear in a straight OLS—become negative and statistically significant once dynasty fixed effects are controlled for.

There are technical difficulties with the econometrics in that a fixed effects OLS model is used when faced with a problem that is clearly count

data. It may, however, be possible to argue that under certain conditions this does not gravely affect the results.

While the coefficient of log female wage is of the correct sign and statistically significant, it still appears to be implausibly small. Broadly speaking, in most countries, the demographic transition takes place across two to three doublings of the female wage. In other words, we know that TFRs drop dramatically when wages rise by a factor of 4x to 8x. The reported coefficient in the paper appears to be associated with smaller effects. This may, of course, be because when female wages go up by 4 to 8 times, the values of many of the other explanatory variables also change considerably. However, it may suggest that there are complexities in the income–fertility relationship that are not being fully understood by the authors.

The importance of a primary health centre (PHC) in the village is a surprising result. Empirical evidence from the National Fertility and Health Survey (NFHS)—which is arguably the best quality household survey data in India—suggests that once standard explanatory variables are controlled for, the presence of a PHC does nothing for many health measures. In this context, the finding of the paper that PHCs matter for fertility is surprising. Similar concerns arise on the role of school access. One possibility could involve selectivity effects: the decision by a government to place a PHC or a school may itself respond to the kinds of variables that affect fertility. The PHC or school dummy may, then, be picking up the explanatory variables which shape the decision of the government, such as income, road access, etc.

In interpreting the results, it is interesting to think about potentially unmet interest for contraceptive technology. Could it be that the diffusion of knowledge about HYV is correlated with the diffusion of knowledge about contraceptive technology? If so, there may be a spurious correlation between the two.

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Managing the Environmental Consequences of Growth: Forest Degradation in the Indian mid-Himalayas[1]

1. Introduction

The environmental consequences of growth is an actively debated issue, particularly in the current context of high growth performance in India and China [see, Arrow et al. (2006), Dasgupta *et al* (2000), Economy (2004),

Economist magazine (July 8, 2004),[2] McKibbin (2005)]. The 2006 Summit Report of the World Economic Forum, for instance, declared:[3]

> "China and India are at inflection points in their development requiring them to sustain economic development, in particular to manage natural resource consumption and environmental degradation."

A recent World Bank study of deforestation in India expressed significant concerns about the impact of population and economic growth:

> India's agricultural intensification has had a major positive impact, relieving pressure on marginal lands on which most of the forests remain. But urbanization, industrialization and income growth are putting a tremendous demand pressure on forests for products and services. The shrinking common property resource base, the rapidly increasing human and livestock population, and poverty are all responsible for the tremendous degradation pressure on the existing forest cover. (World Bank 2000, Summary section)

These assessments raise a number of important questions. Is there empirical evidence of substantial environmental degradation, and is it likely to be aggravated by growth? What is the likely impact of degradation on living standards, particularly of the poor? What is the nature of the externality involved; are local communities likely to resolve this via collective action and self-regulation? Or is it the case that there is need for external policy interventions? If so, what kind of policies should be considered; how effective are they likely to be?

There are a number of contrasting points of view among academics and policy makers concerning the environmental implications of growth. One is a pessimistic assessment, based on the notion that growth will raise the pressure on the earth's natural resources, for example, by raising the demand for energy, implying the need for policy measures to moderate and regulate environmental pressures. The viewpoint expressed at the World Economic Forum is representative of this. At the other extreme is a view (often labeled the Poverty-Environment-Hypothesis) that poverty is the root cause of environmental problems, implying that growth leading to poverty

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Forests, Himachal Forest Department, Dr R. S. Tolia, Principal Secretary, Uttaranchal Government. Finally, this survey would not have been feasible had it not been for the ardent and enthusiastic involvement of the local community inhabiting this region.

2. Economist, July 8 2004, "No Economic Fire Without Smoke," Books and Arts Section.

3. www.weforum.org/pdf/summitreports/am2006/emergence.htm.

reduction will solve environmental problems.[4] An intermediate hypothesis is that development may initially aggravate environmental problems, but once it passes a threshold it will subsequently ease them: often referred to as the 'Environmental Kuznets Curve'.[5] Yet another viewpoint stresses the importance of local institutions such as monitoring systems and community property rights.[6] It argues that deforestation in the past owed primarily to poor control and monitoring systems: once local communities are assigned control they will be successful in regulating environmental pressures, leaving no role for external policy interventions.

These hypotheses present different perspectives on the environmental consequences of development, and the role of policy. Yet there is remarkably little systematic micro-empirical evidence on their validity. Efforts to test these hypotheses have been cast mainly on the basis of macro cross-country regressions, with only a few recent efforts to use micro evidence concerning behavior of households and local institutions governing use of environmental resources [Chaudhuri and Pfaff (2003), Foster and Rosenzweig (2003), Somanathan, Prabhakar and Mehta (2005)].

This paper focuses on forests adjoining villages in the Indian mid-Himalayas (altitude between 1,800 and 3,000 metres), in the states of Himachal Pradesh and Uttaranchal. Pre-existing accounts of the state of these forests suggest a significant common property externality problem at both local and transnational levels. The local externality problem arises from the dependence of livelihood systems of local inhabitants on neighboring forests, with regard to collection of firewood (the principal source of household energy), fodder for livestock rearing, leaf-litter for generation of organic manure, timber for house construction, and collection of herbs and vegetables. Sustainability of the Himalayan forest stock also has significant implications for the overall ecological balance of the South Asian region. The Himalayan range is amongst the most unstable of the world's mountains and therefore inherently susceptible to natural calamities [Ives and Messerly (1989)]. There is evidence that deforestation or degradation aggravates the ravaging effects of regular earthquakes, and induces more landslides and floods. This affects the Ganges and Brahmaputra river basins, contributing to siltation and floods as far away as Bangladesh [see Myers (1986) and Metz (1991)].

4. Barbier (1997a, 1998, 1999), Duraiappah (1998), Jalal (1993), Lele (1991), Lopez (1998), Maler (1998).

5. Barbier (1997b), Grossman and Krueger (1995), Yandle, Vijayaraghavan and Bhattarai (2002).

6. Baland and Platteau (1996), Varughese (2000).

Our analysis is based on a range of household, community and ecology surveys of a sample of 165 villages divided equally between Himachal Pradesh and Uttaranchal, carried out by our field investigators between the years 2000–2003. Section 2 describes relevant economic and geographical characteristics of these villages pertaining to living standards and dependence on forests. Further survey details, and a detailed assessment of the state of the forests accessed by local villagers based on forest measurements, community interactions and anthropological surveys is provided in a companion paper [Baland et al (2006)]. Tree measurements in 619 adjoining forests accessed by villagers in our sample indicated that degradation (in the sense of declining tree quality) rather than deforestation (declining forest area or tree density) represented the predominant problem. Trees were severely lopped, forests exhibited low canopy cover and low rates of regeneration, mostly owing to firewood and fodder collection by neighboring villagers. Reported collection times for firewood increased over 60 percent during the past quarter century, amounting to approximately six additional hours per week per household. The extent of degradation was similar on average across state protected forests, community managed forests and unclassed forests. Vigilance mechanisms in state forests were widely reported to be ineffective. Only a small fraction of villages reported the existence of effective community management mechanisms. Households were aware of the deteriorating forest situation, yet the large majority reported absence of any significant local institutions or initiatives to arrest the process. This could not be explained by lack of knowledge of tree management practices (which are widely practiced on private trees and sacred groves), nor absence of social capital (as most villages have functioning local collectives for managing other local resources). These findings lend special urgency to the questions raised above concerning the likely impact of future growth and the need for corrective policy interventions in the Himalayan forests.

The absence of any significant forms of collective action among villagers concerning use of forests indicates that the major determinants of forest degradation are those that govern incentives of individual households to collect firewood and fodder from the forest, unconstrained by community norms or sanctions. Testing the Poverty-Environment hypothesis or the Environmental Kuznets Curve hypothesis then requires estimation of the income elasticity of demand for forest products, using conventional tools of demand analysis. In particular, these different hypotheses can be understood as presumptions concerning the nature of relevant wealth and substitution effects. The Poverty-Environment hypothesis is based on the

notion that income increases generate negative wealth and substitution effects: households tend to switch to alternative fuels both because firewood is an inferior good and the shadow cost of time spent collecting firewood rises with household wealth. The Environmental Kuznets curve on the other hand could be generated if firewood is a normal good and the wealth effects dominate the substitution effects up to some wealth threshold, while substitution effects dominate past this threshold. Those expressing the view that growth will worsen the environment, focus attention primarily on positive wealth effects arising out of rising energy demands. Those arguing that growth and poverty reduction can improve the environment in contrast stress the importance of the negative substitution effects, apart from the possibility that firewood may be an inferior good.

Testing hypotheses concerning linkages between wealth and firewood collection and forming future projections of forest pressures thus requires us to estimate the related wealth and substitution effects. In our context, however, this raises a number of econometric difficulties. The chief problems concern potential endogeneity of income, as self-employment income constitutes the bulk of incomes earned by households in remote mid-Himalayan villages. For one, these depend on labor supply decisions of households in self-employment activities, which are jointly determined with firewood and fodder collection. One cannot therefore use actual income as an independent determinant of collection of forest products. Second, there may be many omitted variables that are not measured, which affect both incomes earned as well as firewood collected. Some of these may be unobserved household characteristics: for example, those with greater energy or better health may both earn higher incomes and collect more firewood, and the observed income-firewood correlation may reflect their joint dependence on these unobserved household traits rather than a causal link from income to firewood collection. Other omitted variables may be unobserved village characteristics, such as geography or climate that affect both incomes and forest stocks available. Third, firewood collection is a non-market activity, the cost of which from the standpoint of any household cannot be measured with reference to any market prices. The relevant 'price' of forest products is the value of time needed to collect them, which households will compare with the market price of alternative fuels. One needs to estimate the shadow value of time, on the basis of a model of intra-household allocation of time between self employed production tasks, household chores and leisure.

The approach we take to deal with these problems is as follows. In the short run, we take as given the size and structure of the household, the assets it owns, and its preferences for cooking and heating energy, consumption

goods and leisure. We estimate a household production function which predicts self-employment income as a function of its asset composition, and use this to estimate the shadow value of time. This is subsequently used to impute a cost to the time spent collecting firewood. We also use the household production function to predict the income the household would have earned if it fully employed its available stock of labor for self-employment. This is a measure of 'potential income' which depends only on the assets owned by the household, and can be viewed as the relevant measure of wealth in the short run which does not depend on its labor allocation choices. Moreover, it is independent of unobserved household traits that may jointly affect labor supply and firewood collections. This measure of potential income is then used to estimate wealth and substitution effects, both with respect to household assets as well as cost of alternative fuels. We control for a variety of observed village characteristics (such as the composition of neighboring forests, village infrastructure and geography), and for unobserved village characteristics with fixed or random village effects. Section 3 describes the model and econometric methodology in more detail, and presents our estimates of household demand patterns.

The rest of the paper uses these estimated demand patterns to address the principal questions posed at the outset. Section 4 estimates the effects of future growth in household assets. For most households we find that the substitution and wealth effects neutralize each other: firewood and fodder collections turn out to be remarkably inelastic with respect to improvements in living standards. In particular we find no evidence in favor of the Poverty-Environment hypothesis, nor do we find any Kuznets-curve patterns. The effect of economic growth (that is, in assets or their productivity) *per se* is thus unlikely to increase the pressure on the mid-Himalayan forests, contrary to the assertions mentioned at the beginning of this paper.

In contrast, the effects of growth in population are likely to be adverse: rising population will cause a proportional rise in collections at the level of the village, while leaving per capita collections almost unchanged. To the extent that household division induces a shift to smaller household sizes, resulting loss of economies of scale within households will raise per capita collections even further. Hence anthropogenic pressures on forests are likely to be aggravated by demographic rather than economic growth. Unless there is substantial migration out of the mid-Himalayan villages, the pressure on forests is likely to grow substantially.

Section 5 estimates the effect of further forest degradation on the future livelihoods of neighboring villagers. These effects will be felt mainly in increased collection times. We have not attempted so far to estimate how

collection of firewood and fodder at current levels will translate into forest degradation and increased collection times in the future. Instead we estimate the effects of increased collection times by one hour, which is a plausible estimate for the next decade or two, given the changes observed in collection time (one and half hour increase) over the past quarter century. The impact of this on livelihoods of neighboring residents turn out to be surprisingly low: the effect is less than 1 percent loss in household income, across the entire spectrum of households. Moreover, our model predicts no significant increases in time spent by children or male adults in collection, nor any increase in child labor. This indicates that the magnitude of the local externality involved in use of the forests is negligible, providing a possible explanation for lack of effort among local communities to conserve neighboring forests. The argument for external policy interventions then rests on the larger ecological effects of forest degradation. We are not qualified to assess the significance of these non-local externalities, while noting that these continue to be actively studied and debated among scientists and ecologists.

Should the ecological effects demand corrective action, Section 6 studies policy options available. The principal alternative to firewood is LPG among these households; kerosene and electricity only appear as secondary sources of fuel. Household firewood use exhibited considerable substitution with respect to the price and accessibility of LPG gas cylinders, suggesting the scope for LPG subsidies as a policy which could be used to induce households to reduce their dependence on forests for firewood. We estimate the effectiveness and cost of a Rs 100 and a Rs 200 subsidy for each gas cylinder. The latter is predicted to induce a rise in households using LPG from 7 percent to 78 percent, reduce firewood use by 44 percent, and cost Rs 1,20,000 per village annually (about 4 percent of annual consumption expenditure). A Rs 100 subsidy per cylinder would be half as effective in reducing wood consumption, but would entail a substantially lower fiscal cost (Rs 17,000 per village annually, approximately 0.5 percent of annual consumption).

The econometric estimates also show that firewood use is moderated when local forests are managed by the local community (van panchayats) in Uttaranchal. However, this effect is limited to those community managed forests that were judged by local villagers to be moderately or fairly effective, which constituted only half of all van panchayat forests. It is not clear how the government can induce local communities to take the initiative to organize themselves to manage the neighboring forests effectively, when they

have not done so in the past. Moreover, even if all state protected forests could be converted to van panchayat forests, firewood use would be predicted to fall by 20 percent, comparable to what could be achieved with a Rs 100 subsidy per LPG cylinder. Hence policies aimed at increasing local community management of forests are likely to be less effective in curtailing firewood collection than subsidies on alternate fuels.

2. Survey Details and Descriptive Findings

Preceded by pilot surveys in representative villages, final surveys were done in 165 villages divided evenly between Himachal Pradesh and Uttaranchal over a period of three years 2000–03. A stratified random sample of 20 households in each village was selected, with villages selected on the basis of altitude, population and remoteness, and households on the basis of land-holding and caste. Further details of the sampling design are provided in Baland et al (2006). All data reported here are based on our surveys, unless otherwise mentioned.

Figure 1 shows that average time taken to collect one bundle of fire-wood currently is 3.84 hours, as against 2.36 hours a quarter century ago.[7] The increased collection time reflects greater time taken within the forest to collect firewood, rather than shrinking forest areas: distance to the forest increased marginally from 2.06 to 2.31 kilometers. Time spent within the forest thus multiplied more than three times. This indicates that forest degradation rather than deforestation has been the main problem. Figure 2 shows that the amount of firewood used has dropped by 38 percent in the summer and 34 percent in winter over the past quarter century.[8]

Uttaranchal has a higher average standard of living compared with Himachal. Average household per capita annual consumption in Uttaranchal is Rs 9,300, and in Himachal is Rs 7,900 (all at prices at the time of the surveys); the poverty head count rates (using state-specific poverty lines) are

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7. This data is from an ecology questionnaire based on interviews with 3 or 4 prominent village residents. The data concerning 25 years ago are based on recall by these respondents, with the exception of data on household size which we take from the Census. A bundle of firewood is the amount typically carried on the back of an adult, amounting to approximately 35 kg.

8. The econometric results of this paper provide the following explanation for this drop: increased collection times, rising levels of education and non-farm business, falling livestock ownership, and greater accessibility to alternate fuels such as LPG.

F I G U R E   1 .   Change in Firewood Collection and Distance to Forest
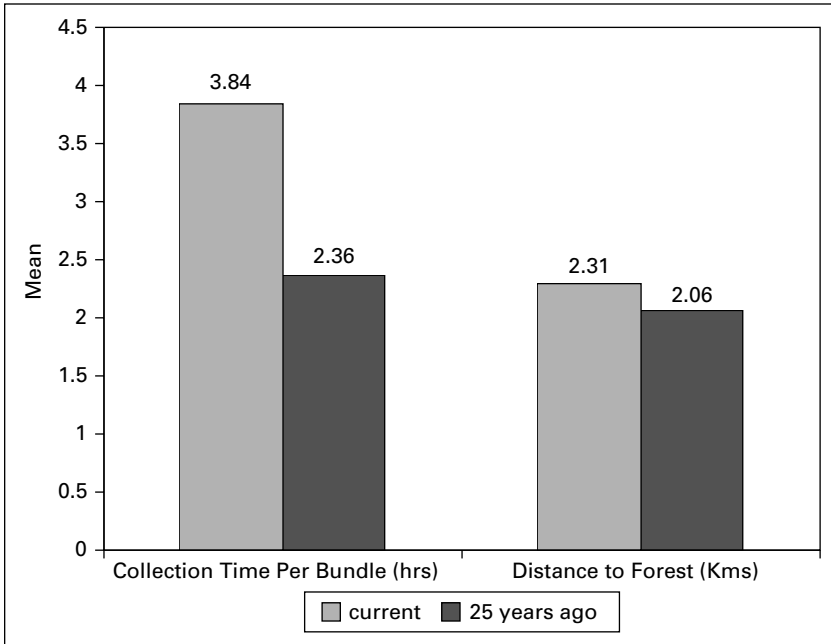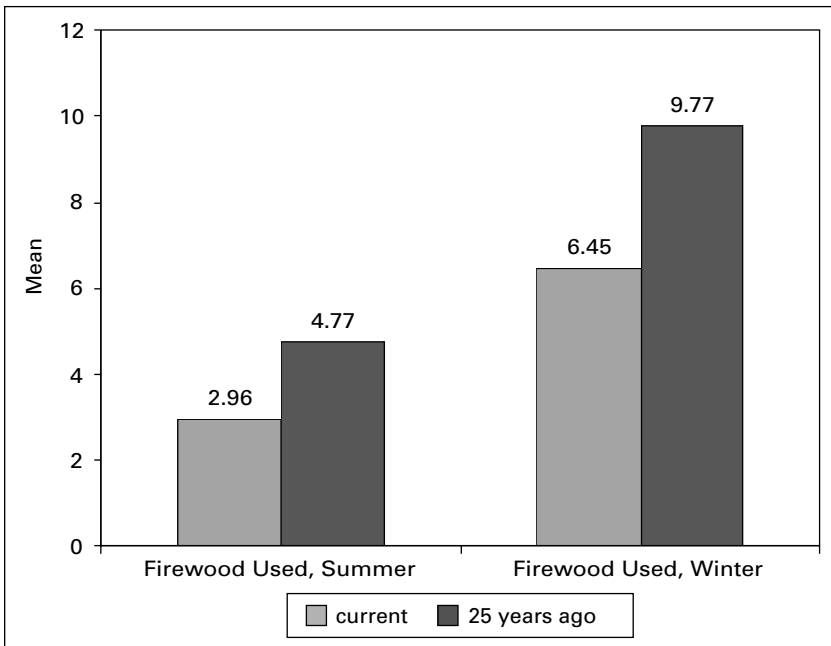

F I G U R E   2 .   Change in Bundles of Firewood Used Per Week Per Family

4.8 percent and 24 percent respectively.[9] The average size of non-farm business per household is Rs 22,000 in Uttaranchal, double that of Himachal's. On the other hand, Uttaranchal households have fixed income (typically in the form of salaries and pensions) that is less than half of fixed incomes in Himachal. Levels of education are similar across the two states: total education in a household (that is, aggregating across all household adults) is approximately 13 years of schooling. Himachal villages have a higher average population of 545 people, compared with 334 for Uttaranchal. Finally, Himachal households collect more firewood—47 *bharis* on average per household member, compared with 40 in Uttaranchal. With an average household size of 5.6 in Uttaranchal and 5.8 in Himachal, this amounts to about 225 bharis for the household per year in the former and 270 in the latter. This translates into an annual collection time of approximately 750 hours in an average Uttaranchal household, and 900 hours in an average Himachal household.[10] Collection times are similar across the two states.

Figures 3–7 show changes in key village characteristics over the past quarter century. Roads have brought these villages much closer to the outside world, reducing distance to nearest road-link from 9.4 to 3.8 hours. Occupational patterns have moved away from reliance on agriculture and livestock, salaried employment has risen, and illiteracy rates have dropped considerably. Population has risen: the number of households per village doubled, while mean household size remained virtually the same.[11]

Figures 8–13 describe nature of fuel used by households in Himachal; we do not show the corresponding figures for Uttaranchal as they are very similar. Firewood is the principal source of cooking energy in the summer

9. Consumption was measured on the basis of a detailed questionnaire of household expenditure on different items, along the lines of a World Bank Living Standards Survey. Assets and fixed incomes are based on household responses to corresponding questions. Self-employment incomes are constructed on the basis of detailed questions concerning various inputs, outputs and prices of these in agricultural and livestock based activities. Potential income is constructed according to a method which is explained in the next section in some detail. This is an overstatement of the predicted permanent income of the household on the basis of various assets owned, owing to it being based on the assumption that the household utilizes all its available labor stock rather than at the observed utilization rates.

10. Collection times here are approximately 3.3 hours, the average of the times reported by the households in the sample. This is in contrast to the higher average collection time of 3.8 hours reported in the ecology questionnaire. Since the household questionnaire is based on a larger sample, we use these numbers from this point onwards.

11. Explaining these changes in village characteristics is outside the scope of this paper. A broader examination of growth effects on forests could conceivably encompass this, a task we leave for future research.

F I G U R E   3 .   Change in Accessibility
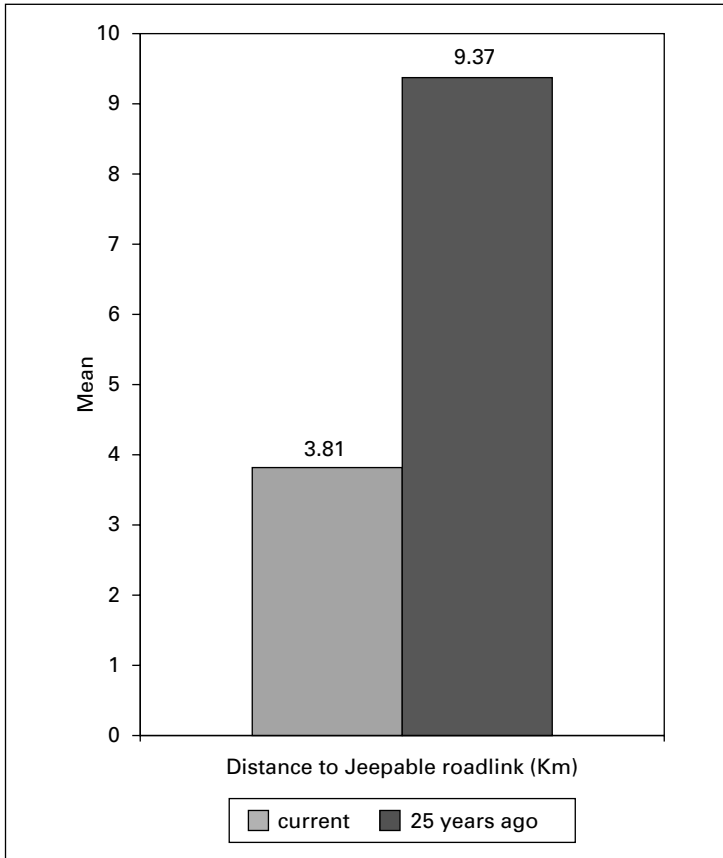
for 90 percent households, followed by LPG which is used by 9 percent, and kerosene by the remaining 1 percent. Reliance on firewood becomes even more acute in the winter, when it becomes the primary source for both cooking and heat for over 99 percent households. LPG, charcoal and electricity are the primary source of the minority of remaining households. Kerosene and LPG appear as important secondary sources of cooking fuel, and electricity as a secondary source of heat energy.[12]

12. To avoid confusion, it is helpful to note that the figures concerning allocation of secondary fuel sources concern only the sub-population that reported using secondary fuels, whereas the figures concerning allocation of primary fuels applied to the entire population. Of the 1,636 households in Himachal, 543 used a secondary fuel and 111 used a tertiary fuel for cooking in summer where as 73 used a secondary fuel and only 1 household used a tertiary fuel.

FIGURE 4. **Change in Occupation Structure of Household Head**
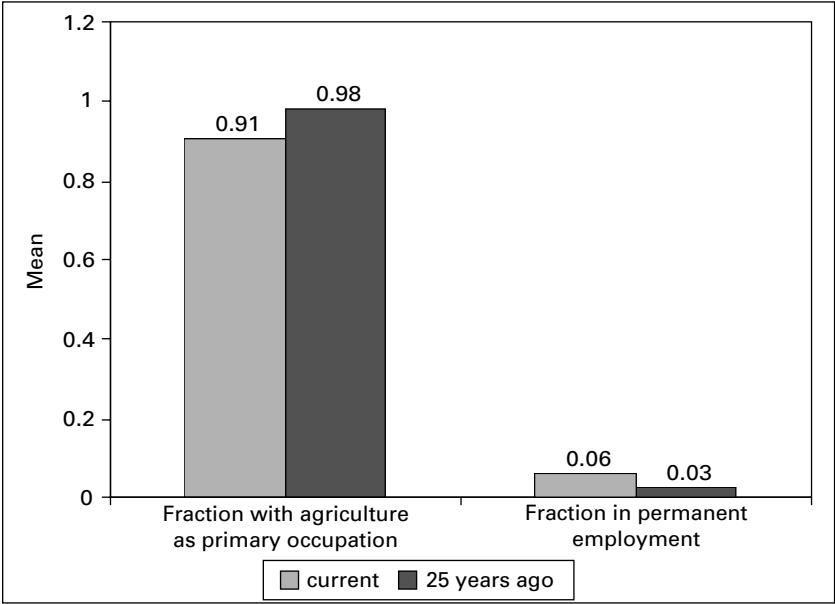
FIGURE 5. **Change in Livestock**
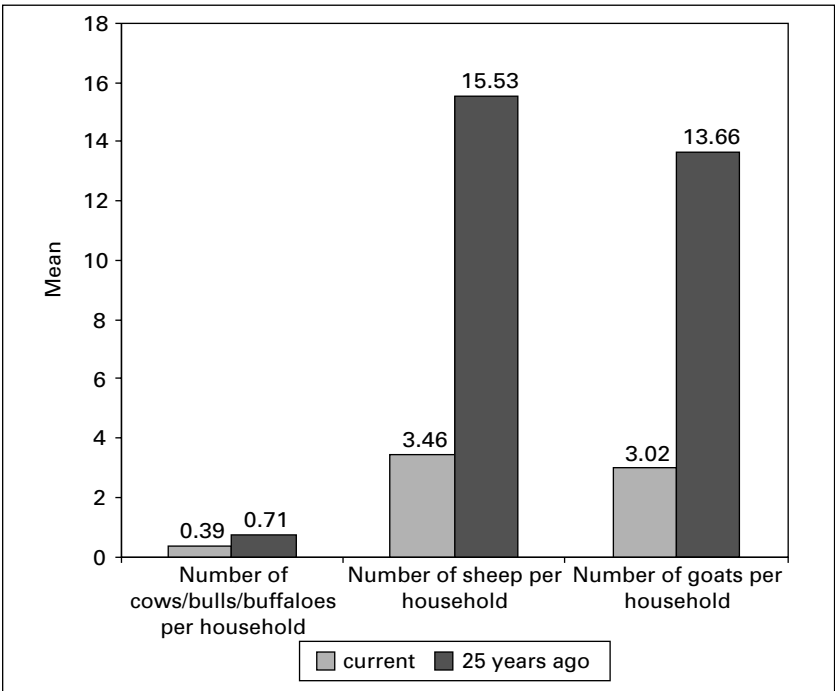
FIGURE 6. Change in Literacy of Household Heads
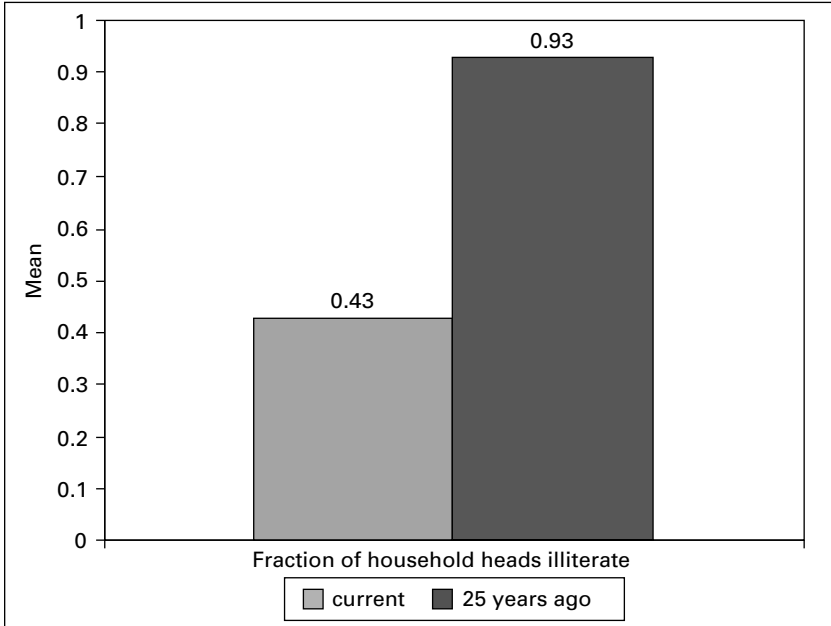
FIGURE 7. Change in Demographics (Source of Household Size 25 yrs Ago: Population Census of India)
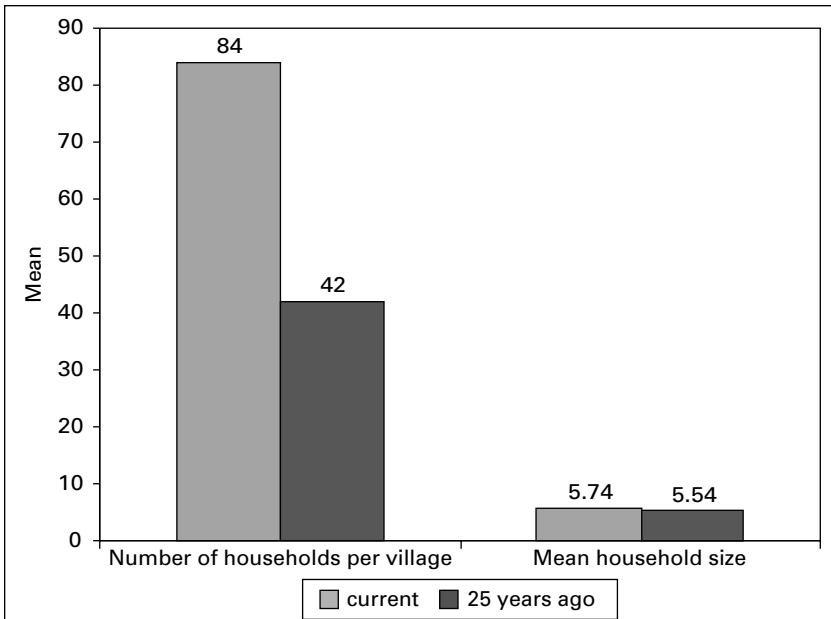
F I G U R E 8 . **Primary Summer Cooking Fuel Source in Himachal Pradesh (Percent Households)**

Summer Cooking

1.04%

8.74%

90.22%

☐ Wood   ◼ LPG   ☐ Kerosene
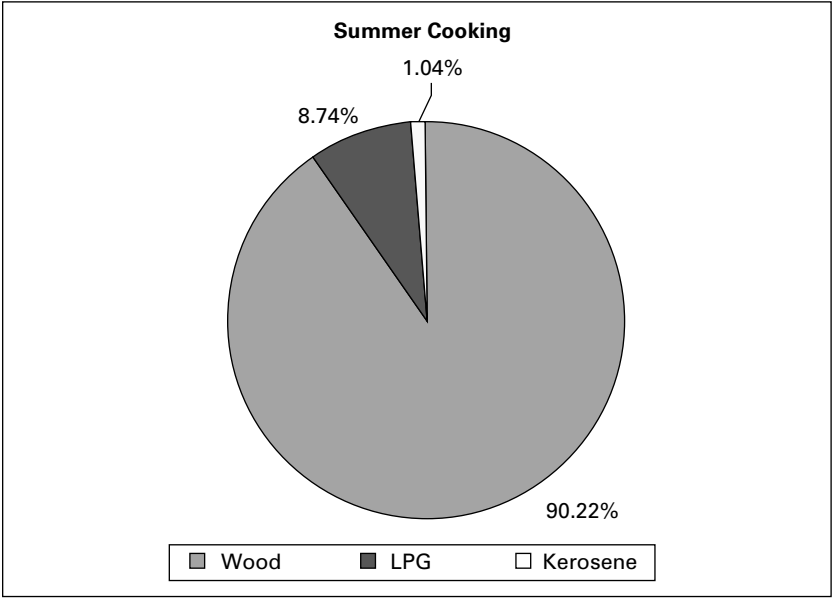
F I G U R E 9 . **Primary Winter Cooking Fuel Source in Himachal Pradesh (Percent Households)**

Winter Cooking (Primary Fuel Source)

0.73%

99.27%

☐ Wood   ◼ LPG
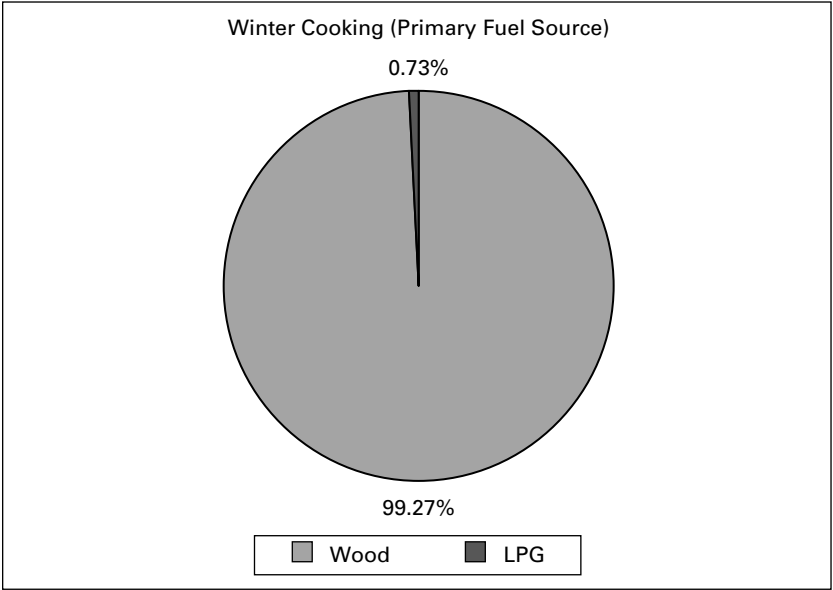
F I G U R E   1 0 .   Primary Winter Heating Fuel Source in Himachal Pradesh (Percent Households)

Winter Heating

0.06%

0.06%   0.18%

99.69%

◨ Wood   ◼ LPG   ◼ Electricity   ☐ Coal/ charcoal
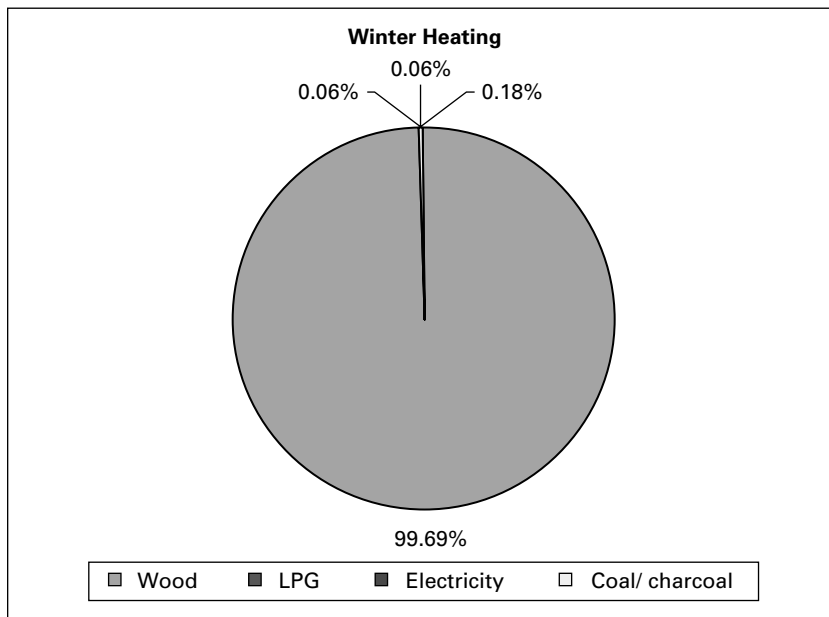
F I G U R E   1 1 .   Breakdown of Secondary Fuel Source in Himachal Pradesh (Percent Households Reporting Use of Secondary Fuels)

Summer Cooking

0.18%

0.37%

23.57%

50.64%

25.05%

☐ Wood   ◼ LPG   ☐ Kerosene   ◼ Electricity   ☐ Coal/ charcoal
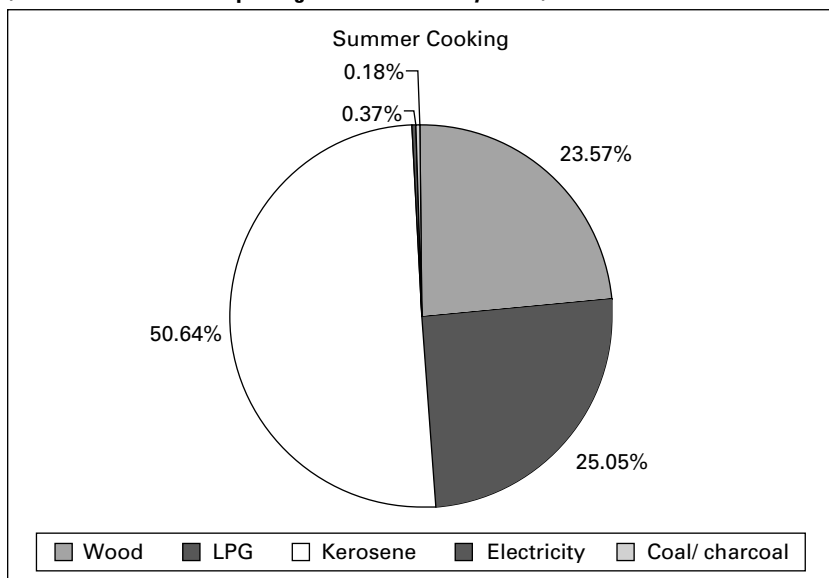
F I G U R E 1 2 .   Breakdown of Secondary Fuel Source in Himachal Pradesh (Percent of Households Reporting Use of Secondary Fuels)

Winter Cooking

0.84%

0.42%

0.21%

1.68%

44.63%

52.21%

Wood ■ LPG ▨ Kerosene ▨ Electricity ▢ Coal/ charcoal ▨ Pine-cones

F I G U R E 1 3 .   Breakdown of Secondary Fuel Source for Winter Heat in Himachal Pradesh (Percent of Households Reporting Use of Secondary Fuels)

Winter Heating

8.22%

20.55%

46.58%

17.81%

6.85%

▨ Wood ■ LPG □ Kerosene ▨ Electricity ▢ Coal/ charcoal
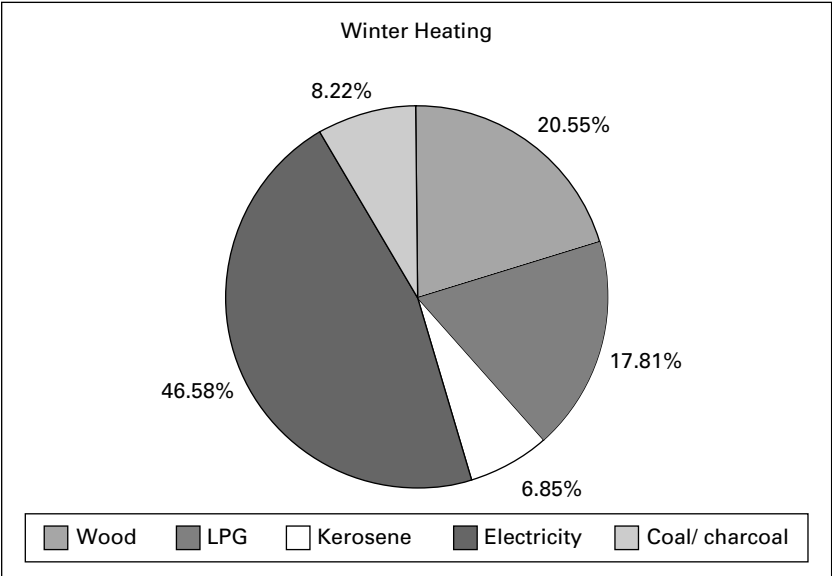
The principal findings of our ecology and community interaction surveys were consistent with the above facts and are summarized as follows.

(a) The chief problem appears to lie in the degraded quality of forests, rather than deforestation. Measures of forest quality such as canopy cover, tree lopping and forest regeneration indicated severe degradation, with the problem being especially severe in Uttaranchal. 40 percent of all forest patches fell below sustainability thresholds used by ecology experts for canopy cover; in Uttaranchal the mean percent of trees severely lopped was exactly at the threshold of 50 percent. Tree stock density in comparison appeared quite healthy by comparison: only 15 percent of forest patches fell below the sustainability threshold of 35 square metres per he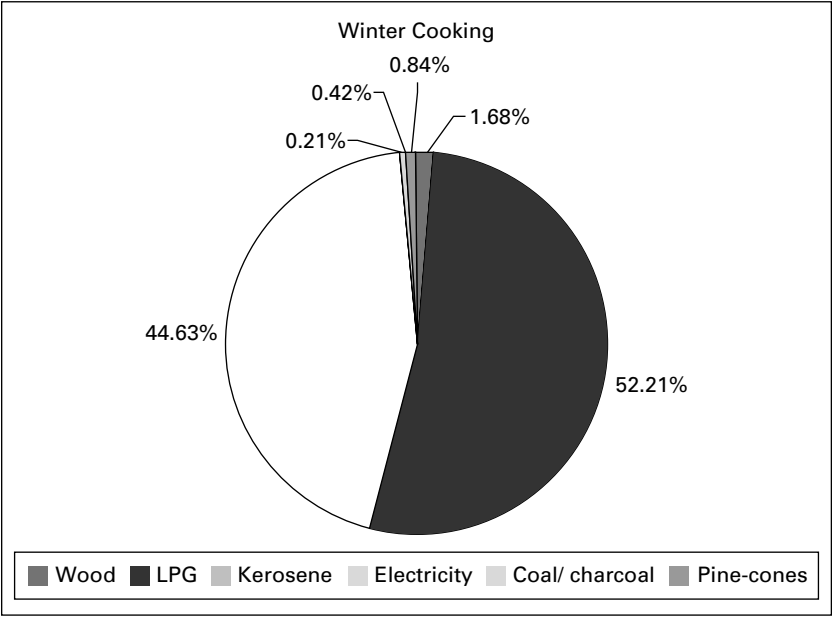ctare. Hence the nature of degradation does not involve a substantial reduction in forest biomass, and would not be picked up by aerial satellite images.

(b) Collection times for firewood have increased 60 percent over the past quarter century, while distance to the forest increased only 10 percent, another indicator of the importance of forest degradation rather than shrinking forest area. 60 percent of reported encroachment occurred with respect to village commons, as against only 5 percent with respect to forests.

(c) The main cause of forest degradation appears to be anthropogenic (collection of firewood, fodder and, timber) rather than natural causes (damage owing to fire or snow), with firewood and fodder collection predominating.[13]

(d) Over 80 percent of villages interviewed expressed awareness of deteriorating forest quality. Yet only 45 percent reported any sense of alarm within their communities. Most were aware of methods of sustainable tree management and practiced these on their private plots and on sacred groves. There was little or no evidence of informal collective action exhibited by local communities to arrest forest degradation, while there are numerous instances of collective action in other areas relevant to current livelihoods, such as agriculture and credit, besides women's groups, youth groups, temple committees etc.

(e) Measures of forest degradation do not vary between different categories of state or community forests. Monitoring of use of state forests appeared to be poor; collective plantation programs initiated by the forest departments have been ineffective.

13. Timber accounted for biomass removal of only 48 tons per village per year, compared with 456 tons per village per year for firewood.

(f) Formal community management of forests were largely ineffective in Himachal Pradesh. Half of the Uttaranchal villages had van panchayats (community managed forests), only half of which were perceived to be effective by local residents. Van panchayat forests exhibited the same extent of degradation as other forests.

(g) Anthropological studies in four villages corroborated the main findings of the ecology and community surveys: anthropogenic pressures are imposing a heavy toll on neighboring forests, and existing institutions of state or local community management appear to be largely ineffective to arrest this process.

3. Determinants of Household Firewood Collection

Given the findings reported above, it is necessary to study patterns in household behavior pertaining to their activities that affect sustainability of the forest stock. Since the primary source of degradation is lopping of trees for collection of firewood, we examine determinants of firewood use by households.

Theoretical Framework

The conceptual basis for this is a model of a household maximizing a utility function with five arguments:

$$U(C, E_h, E_c, \Lambda, n)$$

where C stands for consumption expenditures, E_h for heat energy, E_c for cooking energy, Λ for leisure and n for family size. Firewood is the sole source of heat, while LPG and firewood can both be used for cooking. Hence firewood has a joint product property: the exclusive dependence of households on firewood for heat in the winter months implies that all households will use firewood for cooking as well, with LPG used as a possible supplement. The inclusion of family size takes into account the fact that energy, and particularly heating energy, is to a large extent a public good within the household while consumption expenditures are not. Letting F stand for firewood and G for LPG, we have:

$$E_h = \phi F \text{ and } E_c = \omega F + \mu G$$

where (ϕ, ω, μ) represent the energy conversion coefficients.

Household income is the sum of fixed income (pensions, salaries of permanently employed members and wage employment earnings), denoted by I, and self-employment income, Y. The latter is in turn determined by the value of household production, given by a Cobb-Douglas production function of household labor supply, S, and the productive assets owned by the household: land N, big livestock, L_b, small livestock, L_s, education, E; and non-farm business assets, B:

$$Y = S^{\alpha_1} \, N^{\alpha_2} \, L_b^{\alpha_3} \, L_s^{\alpha_4} \, E^{\alpha_5} \, B^{\alpha_6} \tag{1}$$

Note that self-employment income Y is determined endogenously by the labor supply choices of the household, while fixed income I is exogenous. Hence it will not make sense to take self-employment income as a fixed household characteristic. However, household assets and demographics can be taken as given in the short run. To represent the household's wealth, it will thus be convenient to use as a proxy the following variable: *potential (self-employment) income W* defined to be the self-employment income that the household would earn if it were to fully utilize its labor stock available for self-employment activities.[14] Let T denote this labor stock, obtained by multiplying by 16 hours per day the number of adults (plus an adult equivalent scale of 0.25 for children) that are not engaged in salaried employment elsewhere, therefore available for household activities, productive self-employment and forest collection. Then potential income of the household is given by

$$W = T^{\alpha_1} \, N^{\alpha_2} \, L_b^{\alpha_3} \, L_s^{\alpha_4} \, E^{\alpha_5} \, B^{\alpha_6}$$

which by construction always exceeds the actual self-employment income. The main benefit of using this is that it is a function of household demographics and assets, and thereby independent of short run labor allocation choices made by the household. It aggregates the assets of the households into a single measure of wealth. Estimations based on reported income rather than potential income are subject to an endogeneity bias, as labor used in self-employment is a decision variable. For instance, it is likely that more dynamic or better skilled farmers will simultaneously choose to

14. One reason why we separate fixed income and potential income is that access to a regular flow of income, such as provided by salaries or pensions may induce household to rely more extensively on LPG, by making liquidity available at regular time intervals, and reducing income risk. The other reason is that potential income can be treated as a proxy for the shadow wage, as explained further below.

work more and to collect more firewood. Our measure of potential income is not subject to this type of bias. Moreover, this measure also removes sources of transitory shocks and measurement error in reported self-employed income.

There is no market for firewood, so households collect firewood themselves.[15] As a result, the primary cost of firewood is the opportunity cost of time involved in collecting it. Since ownership of different assets affect allocation of household time between different occupations, some of which are complementary with firewood collection while others are substitutes, the time taken to collect firewood, t_f, also depends on the assets owned by the household. Since occupational choices are endogenously determined by labor allocation decisions within the household, we use as proxies the corresponding assets owned by the household that influence occupational choices. Letting t_c represent the time taken to collect firewood for a household with no assets, we assume:

$$t_f = t_c \left(1 + \gamma_1 N + \gamma_2 L_b + \gamma_3 L_s + \gamma_4 E + \gamma_5 B\right) \qquad (2)$$

where γ_i measures the degree of complementarity between the activity associated with asset i and firewood collection. For instance, it might be hypothesized that grazing big livestock reduces the time taken to collect firewood ($\gamma_2 < 0$) while running a non farm business increases it ($\gamma_5 > 0$). The cost of LPG is the price (including transportation cost) that must be paid for it, p_g. The budget constraint can then be written as:

$$C + p_g G = I + Y,$$

and the labor allocation constraint is given by:

$$T = S + \Lambda + t_f F,$$

where it may be recalled T represents the total amount of labor available for self employment.

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15. See appendix table A-3: only 3 percent households in our sample purchase any firewood, and 0.1 percent do not collect any on their own. Even old people collect firewood: 2.68 percent of all collectors are above 65. There are 103 individuals of age 70 who collect; 12 at the age of 80; and 1 each from the ages of 86–93! Moreover, old people rarely stay alone: 0.2 percent of households have people only above the age of 65. In our field-work we were struck how even the most well-to-do households collected their own firewood rather than delegating it to servants or purchasing it from others.

The household maximizes utility by simultaneously choosing labor supply, firewood, LPG and consumption expenditures, taking assets, fixed income, demographics, the price of gas and the time taken to collect firewood as given in the short run. The resulting demand functions for firewood and for gas can be written as function of potential income, W, fixed income I, the shadow price of firewood (equal to the time t_f required to collect one bundle of firewood multiplied by the shadow value of time), the price of gas and household demographics (represented by household size, n, in adult equivalent consumption units).[16] The shadow value of time, w, corresponds to the marginal productivity of labor in self-employment occupations (determined in turn by the labor supply choice and household assets). We thus have:

$$F = F(W, I, w.t_f, p_g, n) \text{ and } G = G(W, I, w.t_f, p_g, n) \tag{3}$$

Taking a Taylor expansion, and allowing for higher order terms in income and demographics, we obtain the following equation that can be directly estimated:

$$F/n = \beta_0 + \beta_1 W + \beta_2 W^2 + \beta_3 I + \beta_4\, w.t_f + \beta_5 p_g + \beta_6 n$$
$$+ \beta_7(1/n) + \beta_8 X_v + \varepsilon_{iv} \tag{4}$$

and similarly for LPG, where X_v is a vector of village effects such as geography, type of local forest, proximity to towns, availability of alternate fuels etc.

A number of remarks on this formulation are in order. First, potential income as defined above provides a single measure of wealth which values and aggregates the different assets owned by the household. The second and third terms on the right-hand side of (4) represent the wealth effect on firewood demand. This wealth effect can be positive or negative, as it will include on the one hand rising demand for household energy, and a rising concern with indoor smoke on the other that may tend to reduce demand for firewood and switch to less smoky fuels such as LPG or electricity.

Second, the shadow value of time w also increases with potential income W, because the marginal productivity of self-employed labor is an increasing function of the assets owned by the household that are complementary

16. Household size in adult equivalent consumption units differs from labor stock T available for self-employment in two respects: it includes all adults in the household whether or not they are employed elsewhere, and it applies a weight of 0.5 rather than 0.25 to children.

to labor supply. Wealthier households therefore have a higher value of time, and a higher shadow price of using firewood. This implies that the substitution effects (represented by the fifth term in (4) above) also rise with W. To the extent that the wealth effects are positive, and the substitution effects are negative, a rise in wealth of the household will tend to raise both at the same time, so the overall effect is theoretically indeterminate. As explained in the Introduction, the difference between different viewpoints in the literature concerning the determinants of environmental degradation such as the Poverty-Environment hypothesis, the Kuznets curve can be interpreted as arising from different presumptions concerning the signs and significances of these wealth and substitution effects.

Third, if labor markets were perfect, the valuation of household time would simply be the market wage rate. Here however, the shadow value of time is the marginal productivity of household time, estimated using the household production function.[17] One problem with using the measured shadow wage as a determinant of the shadow price of firewood is that it depends on endogenous labor supply decisions of the household. We shall show below in our empirical estimates that shadow wages and potential income move closely together, controlling for household size. Therefore per capita potential income (that is, potential income W divided by T, the labor available for self-employment) can be used as a proxy of the shadow wage rate. Recalling the formulation of collection time t_f above as a function of household assets, the firewood demand equation can be written as a function entirely of household characteristics fixed in the short run:

$$F/n = \beta_0 + \beta_1 W + \beta_2 W^2 + \beta_3 I + \beta_4 (W/T).$$
$$t_c (1 + \gamma_1 N + \gamma_2 L_b + \gamma_3 L_s + \gamma_4 E + \gamma_5 B) \qquad (5)$$
$$+ \beta_5 p_g + \beta_6 n + \beta_7 (1/n) + \beta_8 X_v + \varepsilon_{iv}$$

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17. One source of imperfection is the existence of nonpecuniary costs for family members, especially women and children, to work outside the home or own farm. Another source of divergence between (measured) market wages and the value of time arises due to seasonal fluctuations in the labor market. Wage employment arises for a few months in the year (for example, during harvesting and sowing seasons), when market wage rates rise above the value of time in household production. In our sample all households participating in wage employment were also involved in home production. For this reason reported market wage rates (which pertain to the high demand periods) turned out to be substantially above shadow wages (which pertain to year-round labor). Hence wage employment earnings were intramarginal, and the margin of labor-leisure choices operated solely with respect to home production.

Here the substitution effects appear as interactions between per capita potential income (*W/T*) of the household, average collection time in the village (proxied by t_c) and household asset stocks.

Empirical Results

The first step in the empirical analysis is estimating the household production function (1). Table 1 shows the estimated production function, with village fixed effects and labor hours instrumented by family size and composition.[18,19] The elasticity with respect to labor hours is 0.2, indicating that marginal products are one-fifths the size of average product of labor. Hence shadow wages are considerably below self-employment earnings per hour. Household income is particularly sensitive to ownership of land and big livestock (cows, bulls and buffalos), which have elasticities of 0.48 and 0.27 respectively.[20] The elasticity with respect to non-farm business assets is 0.08, and to schooling of adults is 0.06.

T A B L E 1 .   Household Production Function

	Log self-employment income
Log Labor Hours#	.21***
	(.04)
Log Land	.48***
	(.03)
Log Non-farm Business Assets	.08***
	(.003)
Log Big Livestock	.27***
	(.03)
Log Small Livestock	.04***
	(.01)
Log education	.06***
	(.02)
No. Households	3291
No. Villages	165
Within-R sq.	.41

Notes: ***, **, * significant at 1 percent, 5 percent, 10 percent respectively, s.e. in parentheses. Regression includes village fixed effects.

#: Instrumented with number of male and female adults in household

18. See Jacoby (1993) for a similar approach.

19. We use reported family labor hours in self-employed occupations, applying a weight of 0.25 to child labor hours. For instruments we use a number of adult males and females not engaged in permanent employment. We do not include the number of children among the instruments, since fertility decisions may be correlated with unmeasured household attributes relevant to its productivity.

20. The definition of the asset variables used is provided in appendix table A-3.

The estimated production function is then used to calculate shadow wages and potential income. Recall that the shadow wage depends on assets of the household as well as labor supply decisions, and are thus endogenously determined. Table 2 shows the main determinants of shadow wages: potential income, household labor stock available for self-consumption, and occupational patterns (proxied by asset composition). A Gaussian kernel regression[21] between per capita potential income and shadow wage is shown in figure 14: the relationship is increasing, and approximately linear. Hence we can use per capita potential income as a proxy for the shadow wage in the firewood demand equation.

T A B L E 2 . Shadow Wage Regression

	Shadow wage
Potential Income	18E-6***
	(4.31E-7)
Potential Income Square	−6.16E-12***
	(3.97E-13)
Labor Stock	−.22***
	(.008)
Non-farm Business Assets	1.96E-6***
	(1.65E-7)
Land	.015***
	(.002)
Big Livestock	.003
	(.005)
Small Livestock	97E-6
	(5E-4)
Education	−.0016
	(.001)
No. Households	3272
No. Villages	165
Withjn-R sq.	.65

Notes: ***, **, * significant at 1 percent, 5 percent, 10 percent respectively, s.e. in parentheses. Regression includes village fixed effects.

Table 3 shows the estimated firewood demand equation corresponding to equation (4), where the shadow wage is used to measure the substitution effects. Table 4 shows the firewood demand corresponding to equation (5),

21. Kernel regression is a technique to relate the two variables in our case without imposing any functional form for the relationship. In short, it is a smoothed version of a scatter plot so that the nature of the relationship is easily observable; see Prakasa Rao (1983) for a survey of such techniques. We have used a Gaussian (normal) density function in the process and hence the name.

FIGURE 14.   **Per Capita Pot. Inc. & Shadow Wage**
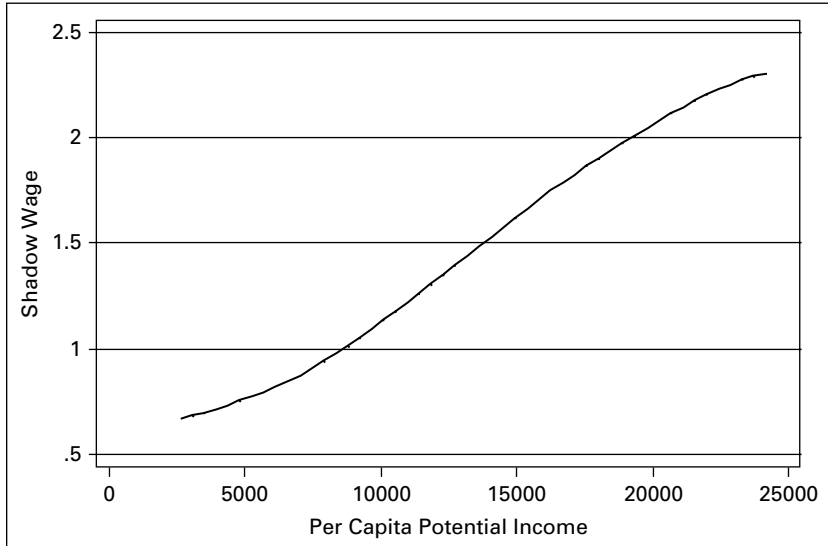
where per capita potential income is used as a proxy for the shadow wage. Since this uses exogenous household characteristics only as regressors, table 4 is the more reliable set of results, though we see that the results are very similar between tables 3 and 4. The first column of table 4 shows the estimates with village fixed effects, while the remaining columns (as well as table 3) include village characteristics and village random effects. The last two columns of table 4 show corresponding regressions for summer and winter use of firewood. The winter use can be interpreted as reflecting the joint effect of cooking and heating needs, while summer use reflects cooking needs alone.

Village characteristics include proportion of local forest area of different types that may be subject to different regulations concerning forest use: *van panchayat*s, sanctuaries, and un-classed state forests, with state protected forests (DPFs and RFs) being the control category.[22] Others are the price of LPG cylinders (plus transport cost to the doorstep of the household), a dummy for irregular availability of LPG as reported by households, altitude,

22. *Van panchayat*s are forests owned and managed by the local community, which arise only in Uttaranchal. Remaining forests are mainly state forests, of which some are sanctuaries (where households have no collection rights at all), demarcated protected forests (DPF) and reserved forests (RF) in which households have restricted collection rights, the remainder being unclassed or undemarcated state forests where there are no restrictions on their collection rights. For further details see Baland et al (2006).

T A B L E   3 .   Per Capita Firewood Use with Shadow Wage

	Random effect
Potential Income	5.62E-05***
	(1.57E-05)
Potential Income Sq	−1.36E-11
	(2.11E-11)
Fixed Income	2.02E-06
	(7.19E-06)
Firewood Collection Time * Shadow Wage	−0.89***
	(0.17)
Firewood Collection Time * Shadow Wage*Big Livestock	0.052***
	(0.02)
Firewood Collection Time * Shadow Wage*Small Livestock	.001
	(0.002)
Firewood Collection Time * Shadow Wage*Non-Farm Business Assets	3.02E-08
	(1.68E-07)
Firewood Collection Time * Shadow Wage*Education	−0.01**
	(0.004)
Firewood Collection Time * Shadow Wage*Land	−0.001**
	(0.005)
1/Household Size	109.69***
	(4.85)
Household Size	−0.88***
	(0.26)
% Forest Area Van Panchayat	−0.07***
	(0.03)
% Forest Area Sanctuary	0.03
	(0.04)
% Forest Area Other Excluding DPF	0.048**
	(0.02)
Population	0.004*
	(0.002)
LPG Price	0.08***
	(0.03)
LPG Irregular Availability Dummy	1.70
	(1.47)
Altitude	0.005**
	(0.002)
Firewood Collection Time	−3.81**
	(1.28)
No. Households, Villages, within-R sq.	3268,165,0.36

average collection time in the village, and a number of measures of climate, infrastructure, remoteness, village population, land inequality, ethnic fragmentation which may affect energy preferences or local collective action to regulate forest use.

T A B L E 4 . **Reduced Form Regression of Per Capita Household Firewood Use**

	Village fixed effect-all year	Random effect†-all year	Random effect-summer	Random effect-winter
Potential Income	5.01E-05***	4.05E-05**	3.14E-05**	9.07E-06
	(1.81E-05)	(1.78E-05)	(1.35E-05)	(8.67E-06)
Potential Income Sq.	1.57E-11	2.41E-11	3.00E-12	2.14E-11**
	(2.09E-11)	(2.03E-11)	(1.54E-11)	(9.89E-12)
Fixed Income	7.32E-07	-6.55E-07	-1.46E-07	-6.08E-07
	(7.25E-06)	(7.22E-06)	(5.47E-06)	(3.53E-06)
Firewood Collection Time*PCPotential Income	-5.24E-05***	-4.56E-05***	-3.64E-05***	-8.48E-06
	(2.00E-05)	(1.74E-05)	(1.33E-05)	(8.22E-06)
Fw. Collection Time*PCPotential Income*Big Livestock	4.01E-06**	4.33E-06**	3.15E-06**	1.20E-06
	(1.79E-06)	(1.72E-06)	(1.31E-06)	(8.33E-07)
Fw. Collection Time*PCPotential Income*Small Livestock	9.43E-08	1.54E-07	1.87E-07	-3.52E-08
	(2.85E-07)	(2.84E-07)	(2.15E-07)	(1.39E-07)
Fw. Collection Time*PCPotential Income*Nonfarm Business Assets	-2.36E-11*	-2.45E-11*	-1.13E-11	-1.33E-11*
	(1.40E-11)	(1.39E-11)	(1.05E-11)	(6.78E-12)
Fw. Collection Time*PCPotential Income* education	-1.24E-06***	-1.35E-06***	-5.46E-07	-8.22E-07***
	(4.72E-07)	(4.69E-07)	(3.55E-07)	(2.29E-07)
Fw. Collection Time* PCPotential Income*Land	-6.63E-07	-7.43E-07	-5.46E-07	-2.15E-07
	(5.07E-07)	(4.74E-07)	(3.61E-07)	(2.29E-07)
1/Household Size	104.33***	104.06***	46.14***	58.01***
	(4.81)	(4.79)	(3.63)	(2.34)
Household Size	-1.01***	-9.38E-01***	-6.60E-01***	-2.67E-01**
	(0.26)	(2.62E-01)	(1.99E-01)	(1.28E-01)
Fw Collection Time		-4.24***	-2.90***	-1.35**
		(1.29)	(1.05)	(5.41E-01)

(Table 4 continued)

(Table 4 continued)

	Village fixed effect-all year	Random effect†-all year	Random effect-summer	Random effect-winter
LPG price		8.05E-02*** (2.87E-02)	4.79E-02** (2.34E-02)	3.26E-02*** (1.21E-02)
LPG Irregular Availability Dummy		1.84 (1.48)	1.35 (1.21)	4.96E-01 (6.21E-01)
% forest area van panchayat		-8.05E-02*** (2.52E-02)	-5.45E-02*** (2.06E-02)	-2.63E-02** (1.06E-02)
% forest area sanctuary		2.98E-02 (3.64E-02)	-4.68E-03 (2.98E-02)	3.42E-02** (1.53E-02)
% forest area other excluding DPF		4.88E-02** (2.31E-02)	9.20E-03 (1.89E-02)	3.96E-02*** (9.70E-03)
Altitude		5.21E-03** (2.24E-03)	2.89E-03 (1.77E-03)	2.36E-03** (1.01E-03)
Population		3.68E-03* (1.94E-03)	1.33E-03 (1.59E-03)	2.36E-03*** (8.15E-04)
No. Households, Villages, within-R sq.	3288,165,.35	3284,165,.35	3284,165,0.17	3284,165,0.39

Note: ***, **, * significant at 1 percent, 5 percent, 10 percent respectively, s.e. in parentheses.
† Random effect regression additionally includes the following village characteristics whose coefficients are not reported here—time to jeepable road, time to block office, ethnic fragmentation, gini of land, snowfall and whether a village had electricity connection. All of these turned out to be statistically insignificant.

For the sake of brevity, we focus mainly on the firewood use regressions, though we have estimated analogous fodder collection regressions as well, which are shown in the appendix. Firewood and fodder collection are highly complementary activities, often accomplished on the same trip to the forest. So it is not surprising that fodder and firewood regressions exhibit similar properties, justifying our focus on firewood use in the main body of the paper.

The results of the fixed and random effects wood use regressions in table 4 are very similar, lending confidence to the random effects specification (which is based on the assumption that omitted village characteristics are uncorrelated with included characteristics). Village characteristics included (apart from the ones reported in the table) are time to roads, government block office, ethnic fragmentation, land inequality, snowfall, and an electrification dummy; all of these were statistically insignificant. A larger set of village characteristics pertaining to geography and infrastructure altered the reported coefficients very little. We therefore report the more parsimonious specification in table 4.

The regression results show wealth effects are positive and significant, while a number of substitution effects are negative and significant, with one exception. Since firewood collection and grazing of livestock are complementary activities, the substitution effect is positive with respect to ownership of big livestock. On the other hand, education, ownership of non-farm business assets and land are associated with non-livestock occupations; time spent in such occupations and in collection of firewood or fodder are substitutes. This explains why the estimated substitution effects with respect to ownership of non-livestock assets are negative.

There is evidence of household economies of scale: larger households use less firewood per capita.[23] Firewood use is sensitive to the cost of LPG, and not so much to whether it is available regularly. Proximity to van panchayat forests is associated with less use of wood compared with state DPF forests, while unclassed forests involve higher use of wood. This suggests that monitoring by state or community appointed forest guards are effective to some extent, and community monitoring more effective than state monitoring. Higher village population is associated with slightly higher use of wood, owing possibly to a dilution of enforcement or monitoring in larger villages.

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23. A decrease in household size by one adult (resp. one child) in an average household (i.e., with characteristics equal to the average characteristics in the sample) is estimated to raise firewood use per capita by 10.6 percent (resp. 5.2 percent).

The regression for fodder in appendix table A-1 additionally includes number of big and small livestock owned (in addition to their interaction with the shadow cost of firewood collection time). Here wealth effects are negative, and the substitution effect is positive with respect to ownership of small livestock. LPG use does not affect fodder collected, nor does the presence of van panchayat forests. In other respects fodder collection is similar to firewood use.

4. Effects of Growth

The estimated patterns of firewood collection yield predictions for effects of future growth in incomes, assets and population. The underlying assumption is that cross-sectional variations in firewood collection across households at a point of time can be used to predict how behavior of any given household will respond when its circumstances change over time. Temporal responses are typically smaller compared with what cross-sectional long run elasticities predict: for example, because households may treat part of the increased incomes as transitory, or may take time to adjust their habits. However, short and long run responses tend to move in the same direction. As we shall argue, this consideration will further strengthen our main findings below.

An additional problem is that the estimated income elasticities may be biased owing to omission of unobserved household attributes that affect both their assets and firewood collection. For instance more farsighted, energetic, better located, or better connected households may both accumulate more assets and collect more wood. The estimated elasticities from the cross-sectional variations across different households will then overstate the extent to which wood collection will increase following asset increases of any given household. Again, this will turn out to strengthen our principal conclusions below.

Tables 5 and 6 show the impacts on per capita firewood use of: (i) a 10 percent increase in each relevant asset and (ii) a 10 percent change in potential income owing to an increase in productivity of assets while asset compositions remain unchanged. Table 5 shows the effect on an 'average household', defined to be a hypothetical household with average characteristics (that is, each characteristic is set equal to the corresponding average in the sample). It shows that firewood use is inelastic with respect to income growth, irrespective of whether it arises from productivity increases

T A B L E   5 .   Effects of 10 percent Growth on Yearly Per Capita Firewood Use of Average Household

Variables	% change
Increase in Land by 10 percent	−0.08
Increase in Big Livestock by 10 percent	0.15
Increase in Small Livestock by 10 percent	0.01
Increase in Education by 10 percent	−0.19
Increase in Non-Farm Business Assets by 10 percent	−0.01
Increase in Productivity of Assets by 10 percent	−0.06

T A B L E   6 .   Impact of 10 percent Growth on Yearly Per Capita Firewood Use of All Households

Potential income PI	Variable	Obs	Mean
Overall	Land	3283	−0.14
	Big Livestock	3283	0.21
	Small Livestock	3283	0.01
	Education	3283	−0.32
	Non-Farm Business Assets	3283	−0.05
	Increase in Productivity of Assets	3279	−0.08
First Quartile	Land	822	−0.05
(PI < 22059.54)	Big Livestock	822	0.04
	Small Livestock	822	0.0002
	Education	822	−0.06
	Non-Farm Business Assets	822	−0.01
	Increase in Productivity of Assets	819	−0.07
Second Quartile	Land	820	−0.08
(PI > = 22059.54	Big Livestock	820	0.09
and < 34213.83)	Small Livestock	820	0.01
	Education	820	−0.13
	Non-Farm Business Assets	820	−0.01
	Increase in Productivity of Assets	820	−0.08
Third Quartile	Land	820	−0.10
(PI > = 34213.83	Big Livestock	820	0.16
and < 55737.3)	Small Livestock	820	0.01
	Education	820	−0.21
	Non-Farm Business Assets	820	−0.01
	Increase in Productivity of Assets	819	−0.08
Fourth Quartile	Land	821	−0.33
(PI > = 55737.3)	Big Livestock	821	0.55
	Small Livestock	821	0.02
	Education	821	−0.89
	Non-Farm Business Assets	821	−0.17
	Increase in Productivity of Assets	821	−0.09

or asset accumulation. For the average household, firewood use per capita falls 0.06 percent following an increase in asset productivity of 10 percent. The elasticity with respect to growth of any asset is uniformly below 0.02 in absolute value.

Table 6 shows the average of the predicted impacts across households, evaluated at their observed characteristics, and broken down into different quartiles. The elasticity with respect to increased asset productivity is less than .009 in absolute value for all groups. With respect to growth in big livestock the average elasticity is .02, and is –.03 with respect to growth in years of schooling. These elasticities get larger for the richest households (upper-most quartile) for whom they are only .05 and –.09 respectively. Hence firewood use is essentially inelastic with respect to growth in incomes or assets. If temporal elasticities are smaller than cross-sectional elasticities, the inelasticity is further reinforced.

Appendix table A-2 shows similar results for fodder. These findings are consistent with anthropological studies in selected villages (reported in our companion paper (Baland et al. (2006)), in which villagers claimed that everyone in the village uses the same amount of firewood irrespective of their circumstances. We therefore do not find support for any of the viewpoints on the connection between growth and the environment: differences in living standards have no discernible impact on firewood or fodder collection.

Why does firewood use exhibit this inelasticity? This is a natural question to ask since firewood is virtually the sole source of heat energy, the demand for which one would have expected to rise with income. And the firewood collection equation does exhibit sizeable and positive wealth effects. The answer lies in the fact that rising potential income also raises the shadow wage, thus raising the substitution effects, which offset the wealth effect. Firewood is becoming more expensive at the same time that wealth is increasing, so households are switching to alternate forms of energy as they become richer (which will be verified below for LPG in Section 6).

Note that the inference that economic growth *per se* is unlikely to increase the pressure on forests is further reinforced if we take account of short run adjustment costs or possible biases arising from omission of unobserved household traits in the firewood regression, since these are likely to have resulted in overestimation of the effect of increased wealth on collections.

Next consider the effects of population growth. The average household size of 5.7 indicates that most families are nuclear already and there is little

scope for further fragmentation of households. Recall also from Section 2 that household size has not changed much over the past quarter century. Moreover, within villages we find little variation in household size with per capita potential income.[24] So it is reasonable to assume that household size will remain fixed in the near future, irrespective of economic growth. This implies that population growth will consist mainly of an increase in the number of households. Unless there is substantial out-migration from villages, it is reasonable to suppose that population will grow by at least 10 percent in the next decade. If the number of households in the village were to grow by 10 percent, the demand for firewood and fodder will correspondingly rise by approximately 10 percent.[25] If households become more fragmented, the loss of household scale economies will further reinforce this.

We therefore conclude that demographic changes rather than economic growth will determine future growth in household use of firewood and fodder. In the absence of significant increases in migration out of these villages, the pressure on forests will rise approximately in proportion to the rise in population, that is, of the order of 10 percent or more in the next decade, resulting in further forest degradation.

5. Quantifying the Local Externality: Impact of Deforestation on Local Living Standards

Continued forest degradation will impact the lives of neighboring villagers primarily by raising the time it takes them to collect firewood and fodder. If trees are more severely lopped, the villagers will take longer to collect a single bundle, either by searching longer for trees that still have branches that can be lopped, or walking further into the forest parts that have not yet been harvested. This is the principal source of the local externality: higher

24. The average number of adults across quartiles of per capita potential income are 3.50, 3.63, 3.44, and 3.37 respectively, with a standard deviation of approximately 1.4. The average number of children are 1.49, 1.71, 1.54, and 1.38; the standard deviation is approximately 1.4. Hence these differences are not statistically significant.

25. Recall that table 4 showed that rising population in the village tends to have a negligible (positive) impact on per capita household use of firewood. A 10 percent rise in village population would correspond to a population increase of approximately 40, which table 4 shows will raise per capita annual firewood use by .015 bundles, compared to the current average of 45 bundles. Hence the effect on per capita use would be negligible, implying that the effects of population growth will be approximately proportional to the rise in population.

collections today by any single household will raise collection times for all households in surrounding villages in the future.

Precise quantification of the magnitude of this local externality requires knowledge of the rate at which future collection times will rise in response to current collection levels.[26] We have not attempted to estimate this so far. Instead we will try to provide some bounds for the magnitude of the externality, on the basis of certain simplifying assumptions. In the past quarter century collection times have risen by one and a half hours per bundle, while collection levels have fallen. *Assuming that the relation between collection levels and the subsequent rise in collection time observed in the past will continue into the future,* one would expect the future rise in collection times to be lower than has been observed in the past. Since population growth rates are slowing, and economic growth is unlikely to matter in determining collections, the rate of growth in collection can be expected to be slower than observed in the past. If the relationship between growth in collection and changes in collection times are linear, one can project on the basis of past trends.

The justification for this is that there do not appear to be any noticeable thresholds in forest degradation in the areas covered in this study: In most of the forest areas concerned, villagers have traditionally accessed a small fraction of the overall forest area adjoining their villages, with vast portions of the forest yet to be actively tapped. As the areas close to the villages become more degraded, households can simply walk deeper into the forest to find un-lopped trees. Therefore the prospect of sudden increases in collection times disproportionate to those observed historically seems to us fairly remote, though of course further scientific opinion needs to be sought on this matter.

We shall therefore consider the effects of an increase in collection time by one hour per bundle; under the assumption mentioned above, this seems a reasonable upper bound for the increased collection time that may be expected for the next decade or two. It will turn out that the results will hardly change if we double the estimated rise in collection time from one to two hours per bundle.

Applying Hotelling's Lemma, the effect of a small increase in collection time on household welfare can be approximated simply by calculating the shadow cost of additional time required to collect the same number of bundles of firewood selected by the household prior to the increase in

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26. We thank Andy Foster for pointing out the need for this information in order to estimate the magnitude of the externality.

collection time. For large changes in collection time, this provides an upper bound to the welfare loss of the household, since the household can adjust its collection levels as the collection time rises. Indeed, as we saw in table 4, households do indeed reduce collections considerably as collection times rise, implying that the actual welfare loss is smaller than this upper bound. We compute this upper bound by using the estimated shadow wage to value the added collection times that would be involved in collecting the same amount of firewood as today.[27]

A simple back-of-the-envelope calculation indicates that the mean effect of an increase in collection time by one hour per bundle is extraordinarily small. The average shadow wage is Rs 1.5 per hour, and mean firewood collected by a household is 181 bundles per year. Given a per household consumption of Rs 38,200 per year, this translates into an average drop of 0.81 percent in annual consumption.

Could it be the case that this average effect conceals large distributional effects? How would the costs vary across poor and rich households? The distributional impact is not *a priori* obvious. On the one hand, the poor have a lower shadow wage. So the *total* impact on the poor will be lower. On the other hand, their consumptions are also lower, so the *proportional* effect is not clear. Since firewood use is inelastic with respect to wealth increases, the poor will rely proportionately more on firewood, though less in absolute terms. This suggests that the poor will be more adversely affected. On the other hand, their shadow wage is lower, so the overall proportional effect is unclear.

For each household we compute the proportional income loss by multiplying the shadow wage with the increased collection time associated with the same level of collections, and then express this as a proportion of their estimated permanent income (the predicted income from the household production function, using their current labor supply). Figure 15 shows a nonparametric (Gaussian kernel) regression of estimated proportional income loss against per capita potential income. The loss is higher for the poor: the loss is decreasing monotonically with respect to income (except at the very top end). But even for the poorest, the loss is less than 1 percent. Table 7 controls for other characteristics presents the parametric regression of estimated proportional income loss against household potential

27. Households could not distinguish between times spent collecting fodder and firewood, consistent with our view that these activities are highly complementary, often accomplished in the same visit to the forest. Hence there is no need to separately add effects on time spent collecting fodder. We also found negligible effects on incomes collecting vegetables and medicinal herbs, so we have neglected this in the discussion below.

FIGURE 15. **Per Capita Pot. Inc. & Degradation Impact**
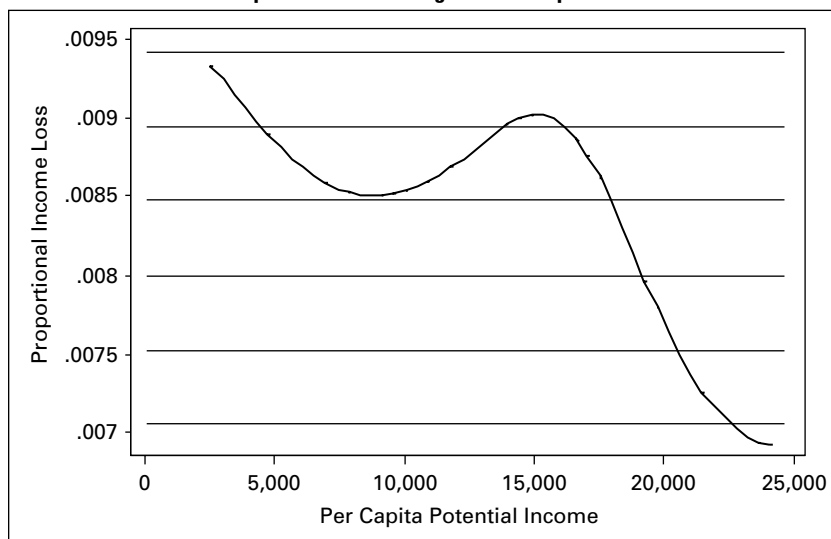
TABLE 7. **Proportional Income Loss Owing to Increase in Firewood Collection** Time by One Hour

	Proportional income loss
Constant	0.01***
	(0.0005)
Potential Income	3.07E-08***
	(8.18E-09)
Potential Income Square	−3.11E-16
	(7.77E-15)
Labor Stock	−0.0003**
	(0.0002)
Non-farm Business Assets	−2.13E-08***
	(3.04E-09)
Land	−9.31E-05**
	(3.84E-05)
Big Livestock	−3.4E-04***
	(1.01E-04)
Small Livestock	−1.28E-05
	(9.20E-06)
Education	−1.12E-04***
	(1.92E-05)
No. Households	3272
No. Villages	165
Withjn-R sq.	0.05

Note: ***, **, * significant at 1 percent, 5 percent, 10 percent respectively, s.e. in parentheses. Regression includes village fixed effects

income. Both regressions show that the loss is bounded above by 1 percent. If collection times rose by two hours instead of one hour, the welfare loss would be bounded above by 2 percent of current consumption.

The magnitude of the local externality on living standards is thus remarkably small, assuming that current collection activities give rise to increases in future collection times on a scale similar to those observed in the past. In any case, it is unlikely that households in neighboring villages would expect future increases in collection times to be substantially larger than what they have observed in the past quarter century. Hence the local externality *perceived* by villagers is likely to be very small. This provides a possible explanation for the absence of any significant collective action or concern among villagers to conserve forest use.

What about the impact on other dimensions of household living standards, such as leisure, child labor or gender allocation of household tasks? How exactly are households likely to adapt to higher collection times? Tables 8 and 9 show the effects on firewood use and on total time spent collecting. Wood use declines by 14 percent, averaging across all households; the cutback tends to rise with wealth: for the bottom (rep.) top quartile it falls by 10 percent (resp. 19 percent). This reduction is less than the increase in collection time per bundle, implying that total time spent

T A B L E 8 . **Effect of an Increase of One Hour in Collection Time on Per Capita Wood Use**

Potential Income	No. households	% change
Overall	3283	−14.20
First Quartile (< 22,059.54)	822	−10.45
Second Quartile (> = 22,059.54 and < 34,213.83)	820	−12.85
Third Quartile (> = 34,213.83 and < 55,737.3)	820	−13.58
Fourth Quartile (> = 55,737.3)	821	−19.91

T A B L E 9 . **Effect of Forest Degradation on Total Collection Time of Households**

Potential income	Total time before degradation (in hrs)	Total time after degradation (in hrs)	Change in total collection time (in hrs)
Overall	654.95	747.00	91.91
First Quartile (< 22059.54)	661.05	776.98	115.93
Second Quartile (> = 22059.54 and < 34213.83)	650.21	750.23	100.02
Third Quartile (> = 34213.83 and < 55737.3)	657.09	753.68	96.59
Fourth Quartile (> = 55737.3)	651.47	707.11	55.10

collecting rises, as shown in table 9, by about 14 percent on average, with a larger increase for poorer groups (presumably because wealthier groups substitute into LPG to a greater extent).

In order to estimate how this increased collection time is divided among members of the household, we estimated regressions for time allocation of male adults, female adults and children between household work, productive work and (firewood and fodder) collection activities, with respect to the same set of regressors as in table 4.[28] For the sake of brevity we do not show these regression results. We use these regression coefficients to estimate the impact of an hourly increase in collection times per bundle on labor allocation of women and children, shown in table 10. Collection time was not a statistically significant determinant of time allocation of adult males, so we do not show any predictions for them. Collection times impacted time allocation only for adult females, who are likely to bear the brunt of the increased forest degradation: of the average increase in 91 hours annually for each household in collection firewood, 68 hours is predicted to come from women. In addition, women are predicted to devote 43 hours more, annually to household tasks, and withdraw 122 hours from productive tasks. Aggregating across all categories of work, however, total hours worked by women is not predicted to increase. Similarly, there is almost no effect on total hours worked for children, as well as its allocation across different activities. Hence forest degradation is not predicted to increase child labor or women's labor; only a reallocation of women's time.

6. Policy Options: LPG Subsidies

The previous sections have argued that degradation of the mid-Himalayan forests adjoining villages with human settlement is likely to be aggravated in the future owing to continuing anthropogenic pressures. This is likely to exert a limited impact on the livelihoods of neighboring residents, which possibly explains any lack of effort among local communities to limit forest use. Hence the argument for external policy interventions rests on the importance of the non-local ecological externalities involved. If the scientific evidence suggests the ecological effects on soil erosion, landslides, and water flowing into the Ganges and Brahmaputra basins are significant, there is a need to consider policies that may reduce the dependence of households on neighboring forests.

28. Since many children do not work, we estimated a random effects tobit for child labor.

T A B L E   1 0 .   Effect of Increased Collection Time (1 hr) on Women and Child Labor

Activity type	Potential income	Change in hrs of women	Number of households with working children before change	Annual hours worked for children working before change	Annual hours worked for all children before change	Number of households with working children after change	Annual hours worked for children working after change	Annual hours worked for all children after change
Domestic Work	Overall	43.43	3084	179.43	168.14	3045	175.31	162.20
	First Quartile	35.90	731	173.32	154.14	732	168.50	150.05
	Second Quartile	42.94	786	174.36	166.72	784	170.34	162.46
	Third Quartile	46.46	800	185.65	180.68	797	181.52	176.00
	Fourth Quartile	48.44	767	183.94	171.01	732	180.67	160.30
Productive Activity	Overall	−122.52	766	90.46	21.06	925	91.78	25.80
	First Quartile	−106.97	164	55.65	11.10	225	60.37	16.52
	Second Quartile	−126.69	192	100.36	23.44	242	100.93	29.71
	Third Quartile	−131.94	227	93.60	25.85	271	96.78	31.91
	Fourth Quartile	−124.46	183	107.39	23.82	187	110.48	25.04
Forest Collection	Overall	67.79	2225	141.33	95.55	2187	148.76	98.86
	First Quartile	37.62	560	103.16	70.28	581	108.78	76.88
	Second Quartile	53.38	578	132.81	93.39	575	142.89	99.96
	Third Quartile	67.95	577	152.09	106.76	571	160.61	111.57
	Fourth Quartile	112.22	510	180.74	111.73	460	191.89	107.00

Given the lack of any significant social norms, local collective action or state monitoring activities regulating forest use, successful interventions must act through their effect on individual household incentives to use firewood and fodder. The regression results in table 4 showed that use of firewood is related significantly to the cost of LPG. We also saw earlier that LPG is the only principal alternative primary source of household energy; kerosene and electricity are used only as secondary sources of fuel. Lack of reliable supply of electricity is often mentioned as the main reason why they do not rely more on electricity. The average number of hours per day that electricity was reported to be available was 14 hours in the summer and 11 hours in the winter. Only 20 households in the entire sample used kerosene as a primary source of fuel, despite the fact that practically every household purchased and used kerosene (mainly for lighting purposes). The average per capita annual income of those using kerosene as a primary fuel was Rs 9,614, compared with Rs 8,036 for those using wood as primary fuel, and Rs 14,060 for those using LPG as primary fuel. This indicates that the cost of kerosene was a factor for poor households in deciding to use wood as their primary fuel. Other factors also played a role in a household's preference for LPG over kerosene, as reported in household interviews.[29] Hence LPG subsidies represent one conceivable policy option for halting forest degradation. In this section we explore their effectiveness in curtailing household reliance on firewood, and the fiscal costs they may entail.

To get a better sense of the energy substitution between firewood and LPG, we can look at the separate per capita wood use regressions for summer and winter seasons displayed in table 4. LPG is primarily a source of cooking fuel, while firewood serves both as a cooking fuel and source of heat. There are virtually no substitutes for firewood as a source of heat in the winter months, while the demand for cooking fuel extends the whole year. Hence one would expect greater substitutability with respect to LPG during the summer. This is precisely what we see in table 4: the coefficient with respect to LPG price alone in the summer is –.05, against –.03 in the winter. The substitution effects with respect to the cost of collecting wood (with the exception of the interaction of collection time with education) are also stronger in the summer.

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29. These reasons were as follows: (i) the availability of kerosene through government distribution outlets is intermittent; (ii) transportation and spillage of kerosene is a greater problem; (iii) kerosene stoves are noisier; (iv) cooking vessels turn black when kerosene stoves are used; (v) LPG burners are easier to operate and maintain than kerosene stoves; (vi) once an LPG cylinder is acquired it can be used for 3 months, whereas kerosene has to be procured repeatedly.

Table 11 shows estimated effects on annual per capita firewood use of Rs 100 and Rs 200 subsidy per cylinder of LPG for different quartiles as well as for the entire distribution, broken down into summer and winter. The cutback in wood use is predictably larger in the summer, but the magnitude of the elasticity for either season is striking: 38 percent and 55 percent respectively, averaging to a 44 percent increase for the year as a whole. Interestingly the effects are felt in all quartiles, not just among the wealthy: even for the poorest quartile the change in annual use is 37 percent. In short, LPG price cuts are expected to have large effects on use of firewood, quite unlike the effect of increased collection times by one or two hours. And they will affect the behavior of households across the board, not just the wealthy.

T A B L E   1 1 .   Effect on Per Capita Wood Use Due to Fall in LPG Price by Rs 100 and Rs 200 of All Household

	Potential income	Observation	% Change (Rs 100) mean	% Change (Rs 200) mean
All Year	Overall	3286	−22.21	−44.41
	First Quartile	822	−18.55	−37.11
	Second Quartile	820	−22.08	−44.16
	Third Quartile	820	−22.35	−44.71
	Fourth Quartile	824	−25.83	−51.66
Winter	Overall	3283	−27.26	−54.52
	First Quartile	822	−22.53	−45.06
	Second Quartile	820	−27.22	−54.44
	Third Quartile	818	−26.85	−53.71
	Fourth Quartile	823	−32.42	−64.84
Summer	Overall	3283	−19.13	−38.26
	First Quartile	820	−16.19	−32.39
	Second Quartile	819	−18.51	−37.01
	Third Quartile	820	−19.61	−39.23
	Fourth Quartile	824	−22.19	−44.39

To estimate the fiscal cost involved, table 12 reports a random effect tobit regression for annual per capita LPG use, which incorporates both whether or not a household will use LPG, as well as the extent of use for those who do. The tendency to switch to LPG is higher among those with higher fixed incomes, smaller households, more education, land and small livestock, and less among those with more big livestock. These patterns are more pronounced when firewood collection times are higher. LPG use is also related to the cost of LPG (with a Rs 200 subsidy inducing a rise in LPG use by 4.4 cylinders per capita per year), and whether its availability

T A B L E 1 2 . **Reduced Form Regression of Per Capita LPG Use**

	All year–random effects tobit[†]
Potential Income	4.11E-06
	(2.65E-06)
Potential Income Sq.	−1.48E-11***
	(2.64E-12)
Fixed Income	6.33E-06***
	(1.03E-06)
Firewood Collection Time*PCPotential Income	−5.68E-06**
	(2.22E-06)
Fw. Collection Time*PCPotential Income*Big Livestock	−4.75E-07**
	(2.27E-07)
Fw. Collection Time*PCPotential Income*Small Livestock	1.40E-07***
	(4.08E-08)
Fw. Collection Time*PCPotential Income*Nonfarm Business Assets	4.68E-12***
	(1.80E-12)
Fw. Collection Time*PCPotential Income*education	6.16E-07***
	(6.60E-08)
Fw. Collection Time*PCPotential Income*Land	1.70E-07***
	(5.60E-08)
1/Household Size	1.88**
	(8.57E-01)
Household Size	−1.47E-01***
	(5.20E-02)
Fw Collection Time	1.27E-01
	(1.34E-01)
LPG price	−1.64E-02***
	(3.22E-03)
LPG Irregular Availability Dummy	−3.48E-01**
	(1.57E-01)
% forest area van panchayat	3.45E-03
	(2.73E-03)
% forest area sanctuary	−1.06E-02
	(7.47E-03)
% forest area other excluding DPF	−4.60E-04
	(2.41E-03)
Altitude	1.06E-03***
	(2.90E-04)
Population	−3.70E-04**
	(1.89E-04)
No. Households, Villages	3284,165, −1903.7217

Note: ***, **, * significant at 1 percent, 5 percent, 10 percent respectively, s.e. in parentheses.

[†] Random effect includes the additional village characteristics—time to jeepable road, time to block office, ethnic fragmentation, gini of land, snowfall and whether a village had electricity connection—all of which turned out to be statistically insignificant.

is irregular. All these results are consistent with the notion that house-holds are trading off the costs of time spent collecting firewood against the pecuniary costs (and reliability in supply) of LPG.

Table 13 uses these results to predict the effect of LPG subsidies on LPG use. A Rs 100 subsidy per cylinder is predicted to raise the fraction of households using LPG from 7 percent to 36 percent. A Rs 200 subsidy will raise this proportion to 78 percent. For those in the bottom three quartiles currently using LPG, the Rs 100 subsidy will raise their LPG use signifi-cantly, though the effect on the top quartile (forming the majority of the cur-rent users) will be smaller (about 20 percent). The overall impact will be a five-fold rise in per capita LPG use from .07 to .39. The Rs 200 subsidy will have more dramatic effects, raising per capita use to 1.34. Hence LPG subsidies are likely to be very effective in inducing a large scale shift in household energy use towards LPG.

Table 13 permits us to estimate the fiscal cost of the subsidies. The Rs 100 subsidy induces 37 percent of households to use LPG at the rate of 1.07 cylinders per capita. Using the average household size of 5.3, this translates to a demand of 5.7 cylinders per year per household. Hence the subsidy will amount to approximately Rs 570 per using household. With 84 households per village there will be approximately 30 households using gas in each village, yielding a cost of Rs 17,000 per village, or Rs 200 per household annually, approximately 0.5 percent of their annual consumption expenditure.

The fiscal costs are substantially higher for the Rs 200 subsidy: 65 house-holds will demand an average of 9 cylinders annually, yielding a cost of Rs 1,17,000 per village, or Rs 1,400 per household annually, approximately 4 percent of their annual consumption expenditure. A special annual grant of Rs 1,20,000 to each village panchayat in the mid-Himalayan region for the purpose of a Rs 200 subsidy per gas cylinder can thus be considered as a policy intended to induce substitution of household energy away from firewood. With the 829 Census villages in this region, this translates into a total cost of about Rs 10 crores annually.

Another policy option often discussed is to turn over state forests to community management, along the lines of the Uttaranchal van panchayats. Table 4 showed that the type of local forest does have an effect on household wood use. Van panchayat forests are associated with lower use of firewood compared to state protected (DPF) forests and sanctuaries, while non-DPF forests involve higher use than DPF forests. Hence community management is associated with reduced household reliance on firewood compared with

T A B L E 1 3 . Effect of Fall in LPG Price on Per Capita Gas Use of all Households

	Potential income	Number of household using gas before change*	Number of cylinders for households using gas before change	Number of cylinders for all households before change	Number of household using gas after change	Number of cylinders for households using gas after change	Number of cylinders for all households after change
Fall in LPG Price by Rs. 100	Overall	229	0.95	0.07	1189	1.07	0.39
	First Quartile	16	0.36	0.01	195	0.70	0.17
	Second Quartile	23	0.45	0.01	236	0.79	0.23
	Third Quartile	44	0.51	0.03	311	0.92	0.35
	Fourth Quartile	146	1.23	0.22	447	1.48	0.80
Fall in LPG Price by Rs. 200	Overall	229	0.95	0.07	2576	1.71	1.34
	First Quartile	16	0.36	0.01	636	1.29	1.00
	Second Quartile	23	0.45	0.01	574	1.47	1.03
	Third Quartile	44	0.51	0.03	646	1.67	1.31
	Fourth Quartile	146	1.23	0.22	720	2.31	2.02

all other categories of forests. However, it turns out that this moderating effect is limited to those van panchayats that were judged by local villagers to be moderately or fairly effective.[30]

Moreover, conversion of 100 percent state demarcated forests to 100 percent van panchayat forests will reduce per capita firewood demand by 8 bundles annually, or approximately one fifth of annual consumption. The Rs 100 LPG subsidy will therefore be more effective than converting all state demarcated forests to van panchayat forests. Moreover, the considerable heterogeneity of monitoring effectiveness of *van panchayat*s implies that the impact of community management is unlikely to be uniform, and will be restricted to those that have effective monitoring systems.[31] The effect of LPG subsidies is likely to be more uniformly spread across different villages, since they would be likely to apply uniformly to household incentives in all areas.

6. Conclusion

In summary, we find considerable evidence of degradation of the mid-Himalayan forests, manifested mainly by high degrees of lopping for firewood and fodder collection. This form of degradation does not represent a substantial reduction in forest biomass, and would not be picked up by aerial satellite images. Yet it has considerable consequences for the time taken by local villagers to collect firewood, which have risen over 60 percent on an average over the past quarter century. Ecology surveys, household responses and ethnographic accounts suggest that state or community management of forests make little difference, with the exception of some *van panchayat*s in Uttaranchal. Since state monitoring and local community control seem quite ineffective, the pace of forest degradation depends mainly on household choices of fuel.

Our econometric analysis shows that these depend on living standards, occupational patterns, education and access to affordable modern fuels such as LPG. Economic growth is unlikely to have any impact on firewood collected from forests, while population growth is likely to raise it proportionately.

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30. When we add a dummy for monitoring effectiveness of the van panchayat as evaluated by local villagers, the van panchayat effect vanishes, while the monitoring effectiveness dummy becomes large and significant.

31. See our companion paper (Baland et al (2006)) for further detail on this issue.

The reverse impact of degradation on living standards is surprisingly small: further degradation of a magnitude comparable to that observed over the past quarter century would lower living standards of local villagers by less than 1 percent, across the board. This may explain why local communities appear unconcerned about the need to conserve forests. The argument for external policy interventions must therefore be based on the importance of ecological considerations *per se,* and the related non-local externality on landslides, soil erosion and downstream river basins.[32]

LPG subsidies can be an effective policy option to relieve pressure on the forests. A subsidy to the tune of Rs 200 per cylinder is estimated to reduce firewood demand by 44 percent, and induce the proportion of households using LPG to rise from 7 percent to 78 percent. Community management of forests on the pattern of Uttaranchal van panchayats are also likely to moderate firewood demand, but their effect is likely to be less significant and less uniform. In the longer run, out-migration from mountain villages, modernization of occupational patterns (for example, decline in livestock-based occupations) and rise in education will ease the pressure on the forests further. Moreover, households will cut back on firewood use as the collection time rises.

Our ongoing research involves estimating growth and policy effects more precisely using a structural econometric model rather than reduced form regressions; and more careful estimates of van panchayat forest management. Some of the unresolved issues concern the ecological effects of forest degradation, and the magnitude of the non-local externalities. This will require an interdisciplinary effort combining expertise of ecologists, geographers and economists.

32. See Kumar and Shahabuddin (2005) for evidence relating grazing and firewood extraction with biodiversity in a Northern India forest, resulting from the heavier impact of these activities on particular species. They also find significant effects on tree height and girth.

A P P E N D I X

T A B L E   A - 1 .   Estimates of Per Capita Fodder Collection (in Bundles)

	Random effects tobit
Potential Income	−1.74E-04**
	(7.76E-05)
Potential Income Sq.	3.51E-10***
	(9.00E-11)
Fixed Income	−6.48E-05**
	(3.12E-05)
Firewood Collection Time*PCPotential Income	1.87E-04***
	(6.43E-05)
Fw. Collection Time*PCPotential Income*Big Livestock	−2.06E-05**
	(9.36E-06)
Fw. Collection Time*PCPotential Income*Small Livestock	8.25E-06***
	(1.59E-06)
Fw. Collection Time*PCPotential Income*Nonfarm Business Assets	−1.22E-10**
	(5.98E-11)
Fw. Collection Time*PCPotential Income* education	−1.60E-06
	(2.02E-06)
Fw. Collection Time*PCPotential Income*Land	−7.24E-06***
	(2.10E-06)
1/Household Size	103.01***
	(20.3)
Household Size	−6.31***
	(1.12)
Fw Collection Time	−9.94**
	(3.92)
LPG price	2.37E-02
	(7.56E-02)
LPG Irregular Availability Dummy	−12.42***
	(4.05)
% forest area van panchayat	−3.79E-02
	(6.08E-02)
% forest area sanctuary	−1.69E-01**
	(8.30E-02)
% forest area other excluding DPF	1.45E-01**
	(6.66E-02)
Altitude	3.96E-03
	(7.40E-03)
Population	3.29E-03
	(6.06E-03)
Big Livestock	9.98***
	(8.04E-01)
Small Livestock	−1.67E-01**
	(8.07E-02)
No. Households, Villages, log likelihood	3284,165, −16418.902

T A B L E   A - 2 .   Effects of Degradation and 10 percent Growth of Assets on Per Capita Fodder Collection for all Households

Potential income	Impact of	Number of households collecting before change	Annual bundles collected by collecting households before change	annual bundles collected by all households before change	Number of households collecting after change	Annual bundles collected by collecting households after change	Annual bundles collected by all households after change
Overall	Increase in collection time by one hour	3241	71.08	70.00	3204	62.73	61.07
First Quartile		815	71.88	71.27	810	63.12	62.20
Second Quartile		816	75.62	75.07	809	67.24	66.18
Third Quartile		816	72.32	71.80	814	63.50	62.89
Fourth Quartile		794	64.29	61.88	771	56.77	53.05
Overall	Increase in Productivity of Assets	3245	74.64	73.59	3245	74.51	73.47
	Land	3241	71.08	70.00	3244	69.43	68.44
	Big Livestock	3241	71.08	70.00	3247	72.44	71.47
	Small Livestock	3241	71.08	70.00	3245	72.82	71.81
	Education	3241	71.08	70.00	3245	74.31	73.28
	Non-Farm Business Assets	3241	71.08	70.00	3244	69.02	68.04
First Quartile	Increase in Productivity of Assets	669	72.16	71.73	669	72.01	71.58
	Land	742	71.70	71.22	742	70.55	70.07
	Big Livestock	679	71.16	70.74	679	71.92	71.50
	Small Livestock	676	71.12	70.71	676	71.96	71.53
	Education	669	70.98	70.56	669	72.15	71.72
	Non-Farm Business Assets	727	71.66	71.17	727	70.04	69.56
Second Quartile	Increase in Productivity of Assets	800	86.13	85.07	800	86.67	85.60
	Land	814	75.45	74.72	814	73.54	72.83
	Big Livestock	805	75.47	74.64	804	76.83	75.88
	Small Livestock	802	75.59	74.75	801	78.70	77.73

	Education	801	75.72	74.88	800	84.83	83.78
	Non-Farm Business Assets	813	75.30	74.56	812	73.03	72.23
Third Quartile	Increase in Productivity of Assets	852	73.93	73.58	852	73.32	72.97
	Land	818	73.06	72.53	818	70.89	70.37
	Big Livestock	846	73.63	73.11	846	74.47	73.94
	Small Livestock	849	73.55	73.12	849	74.12	73.69
	Education	852	73.56	73.21	852	73.93	73.58
	Non-Farm Business Assets	822	73.24	72.71	822	70.50	69.99
Fourth Quartile	Increase in Productivity of Assets	924	67.13	65.16	924	66.89	64.92
	Land	867	64.56	62.33	870	63.27	61.29
	Big Livestock	911	64.76	62.63	918	67.10	65.39
	Small Livestock	914	64.78	62.59	919	67.14	65.22
	Education	919	64.79	62.55	924	67.13	65.16
	Non-Farm Business Assets	879	64.67	62.46	883	63.13	61.25

T A B L E   A - 3.   Data Appendix

Variable	Description	ALL		Himachal Pradesh		Uttaranchal	
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Potential Income	Potential income is the estimated maximum possible income from self employment if all available labor not permanently employed was engaged in self employment. (in Rs) (current prices)	48271.79	59803.1	39410.15	45609.37	57026.28	70016.8
Per capita consumption	Per capita consumption (Rs/year, current prices)	8646.40	5264.79	7887.02	5563.05	9397.06	4838.22
Head count poverty rate	Percent households below state poverty line	14.3		24		4.8	
Household size	Actual Household size	5.74	2.26	5.87	2.25	5.61	2.21
Household size	Household size (adult equivalent)	4.99	1.94	5.11	1.98	4.88	1.90
Proportion of hh purchasing wood	Percent households purchasing wood	3		2		4	
Proportion of hhs not collecting	Percent households not collecting wood	0.1		0.2		0.1	
Per capita wood used	Per capita wood use (bharis/year)	43.57	20.92	46.86	24.68	40.31	15.72
Per capita wood used in summer	Per capita wood use in summer(bharis/year)	22.42	14.17	24.61	17.89	20.26	8.59
Per capita wood used in winter	Per capita wood use in winter(bharis/year)	21.15	10.47	22.25	11.91	20.05	8.69

Variable	Description						
Shadow wage	Estimated shadow wage (Rs/hour)	1.21	1.25	1.02	0.85	1.41	1.53
Land	All cultivable land owned by the household; used largely for agriculture and/or horticulture; measured in bighas (5 bighas = 1 acre)	7.27	6.13	7.13	6.71	7.41	5.48
Non-farm business assets	Market value of the business (in Rs)	16851.96	87389.63	11498.75	76577.7	22143.72	96631.5
Big livestock	Number of cows, buffaloes and mules in the household	3.67	2.30	3.12	2.02	4.21	2.43
Small livestock	Number of goats and sheep in the household	6.49	20.03	7.06	21.74	5.92	18.17
Education	Sum of years of schooling of all adult members in the household	13.44	12.00	13.35	12.40	13.54	11.59
Fixed income	Sum of annual income from wage employment and pension (in Rs)	14468.72	38410.94	19608.23	46928.27	9388.22	26567.4
Firewood collection time	Time to collect one bhari (in hrs)	3.31	0.54	3.28	0.65	3.34	0.39
LPG Price	LPG price (in Rupees) per cylinder	299.02	34.01	307.48	29.00	290.66	36.45
LPG Irregular Availability Dummy	Dummy if LPG is not always available.	0.48	0.49	0.55	0.49	0.42	0.49
% Forest Area Van Panchayat	percentage of neighboring forest area consisting of van panchayat forests	14.33	29.19	0	0	28.49	35.93
% Forest Area Sanctuary	percentage of neighboring forest area, where villagers are not allowed to collect altogether	4.25	20.18	0	0	8.46	27.83

(Table A-3 continued)

Variable	Description	ALL		Himachal Pradesh		Uttaranchal	
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
% Forest Area Other Excluding DPF	percentage of neighboring forest area consisting of all other types of forest (excluding DPF, RF, van panchayats, sanctuaries)	16.00	29.43	20.37	34.55	11.68	22.49
Proportional Income Loss	Estimated shadow wage, times increased collection time, as a proportion of actual income (in Rupees)	0.01	0.01	0.01	.01	0.01	0.004
Altitude	Elevation above sea level (mts)	2057.27	258.62	2094.04	258.93	2021.00	253.21
Population	Population of village	439.39	365.93	545.37	473.91	334.63	149.14
Number of Observations		3291		1636		1655	

Comments and Discussion

Andrew Foster: In recent years, development economists have given increasing attention to empirical analyses of the processes underlying the use and protection of environmental resources. A particularly fruitful literature has emerged on the subject of forest cover. The key questions here are what are the key drivers of forest cover and forest quality change, whether policy interventions into the management of local forest resources are justified on grounds of equity or efficiency given the presence of local institutions that may or may not preserve forest resources, and, if so, what types of policies are likely to be most effective. In the process of undertaking this research it has become clear that there is a high return to the integration of economic theory, household-survey methods, careful ecological measurement, and the modeling of ecological processes.

This paper is an important contribution to this emerging literature in a number of respects. First, a detailed large-scale survey has been conducted by the authors with a particular focus on the issue of the use of forest product extraction. Existing multi-purpose surveys do not have sufficient detail on this issue to provide a compelling basis of inference. Second, the survey has been linked to a careful ecological assessment of forest quality. These latter data permit a more nuanced understanding of how forest cover is being affected by changing economic conditions than would be possible otherwise. They also provide some basis for thinking about the extent to which current practices are sustainable given natural processes of forest renewal. Third, data analysis is organized in the context of a reasonably constructed model of household behavior that yields important insights in terms of how firewood use varies across households, the potential for substitution across different fuels, and the likely consequences of future growth in population and income. Fourth, the authors sketch the costs and benefits of a plausible mechanism for forest protection, the subsidy of alternative fuels for cooking and heating. Finally, the authors address the issue of the strength of local externalities associated with extraction of forest resources. They come to a novel conclusion that has not, to my knowledge, been demonstrated elsewhere: that, despite the evident degradation of natural systems, the magnitude of the local externality generated by this degradation is small.

It is worth considering this latter contribution in some detail. At the heart of the issue is whether institutions are in place at the level of the community that largely internalize potential externalities that may arise given individually-rational maximizing behaviors at the level of the household and the public access nature of forest resources. Put another way, in the absence of effective property rights over the products of the forest or community institutions that substitute for these rights, there will be overinvestment in forest good collection and overconsumption of forest goods relative to what would obtain if household behavior were sufficiently coordinated. But how do we measure the extent of these efficiencies and thus the need for and or efficacy of new policies that protect forest resources?

As noted, the authors conclude that in the case of the mid-Himalayan villages in their sample, the local externality is small. The primary source of evidence here is the low opportunity cost of the increment in forest good collection time that may be attributable to forest degradation over the last 25 years. This seems a plausible basis for inference but the relationship between those two concepts may not be obvious to readers of this paper as the authors do not formally model interaction among households in the forest sector. To help illustrate the case I have developed a simplified model that does take this additional step. For analytic simplicity the model focuses on the source of static local externalities and ignores dynamic ones. That is, I focus on the static tragedy of commons in which households receive the average product of labor in forest wood collection and disregard dynamic externalities arising from the fact that households (or the village as a whole) do not internalize the possible future benefits (arising, say, from natural renewal) of limiting forest good extraction today. This simplification would be problematic if the relevant forests were in danger of generating a large-scale ecological collapse; however, I concur with the authors that such a collapse is a remote possibility given the recent history and likely future economic, demographic, and natural resource trajectory of this area.

Take the simple case in which household utility u() is defined as a log-linear function over forest good f and consumption of other goods c

$$u(c, f) = \beta \ln(f) + c.$$

Total village forest good production is based on a Cobb-Douglas production function of total forest land and total forest labor with the share of village forest good being allocated to households based on their share of total labor. So a given household's forest good consumption is

$$f = A^{(1-\alpha)} (Nl_f^*)^\alpha \, l_f/(Nl_f^*)$$

where *A* denotes total forest land, l_f denotes household labor, l_f^*, the average extraction by other households, and *N* the total number of households. The household budget constraint is

$$c + \tau(l_f - l_f^*) + wl_f = wT$$

Where *w* the wage, *T* is the labor time endowment, and τ denotes a tax on forest labor that may be implemented by the village to control access, with proceeds redistributed on a lump sum basis to the household. In the *laissez-faire* case, of course, $\tau = 0$.

Assuming N identical households it follows immediately that

$$l_f = l_f^* = \beta/(w + \tau),$$

that the village welfare maximizing tax is

$$\tau = w(1 - \alpha)/\alpha,$$

and that the income-equivalent gain from village welfare maximization relative to lassaiz faire as a fraction of the value of total labor income is

$$(\alpha \ln(\alpha) - \alpha + 1)(l_f/T)$$

The first term in parentheses ranges from 1 to 0 as the labor share α ranges from 0 to 1. Thus in the context of this simplified model it is clear that the importance of the local static externality is governed by the share of time spent in forest labor as the authors imply. It is also sensitive to the labor intensity of forest good extraction which can be estimated, in the model, from the authors' data using information on changes in collection time per hour, the total number of households, and the wage change.

Of course this model misses a great deal. It does, however, highlight a number of key factors that can lead local externalities to be small. First, it shows, as noted, that a low labor contribution is indicative of a small local externality. Second, a small local externality can arise if the labor share is high, which minimizes the difference between the average and marginal products of labor in forest good production. Third, the price elasticity of demand, which is fixed at one in this model for notational simplicity, is important. The local externality will be larger if demand is relatively price inelastic—and thus smaller if substitute fuels such as LPG are available and relatively cheap. Fourth, rising wages by reducing forest labor allocation

will reduce the local externality. But population growth, by depressing wages, may have the opposite effect.

In summary, this paper is an important contribution in terms of what it tells us about forest policy. In particular, it suggests that community management of forest resources, even among communities with effective governance, may not lead to substantial improvements in forest resources. If there are strong external benefits to protecting local forests arising from issues of downstream silting, species protection, or global warming then it is likely that external subsidies will be needed to support these protections. The LPG subsidy approach seems to be a potentially promising avenue to consider in this regards. But in addition to these policy insights, this paper is important because it provides a path forward in terms of gaining a better understanding of the complex natural resource issues that will face village India over the next decades.

Devesh Kapur: Comments on "Managing the environmental consequences of growth: Forest Degradation in the Indian Mid-Himalayas."

India's galloping growth rates (and high projected rates), coupled with the country's resource constraints, mean that the environmental implications of this growth are a matter of growing concern. Hence, the importance of the issues raised by this paper is quite obvious. Nearly two decades ago, N. S. Jodha (1986) raised the question: in the Indian context, does poverty lead to greater reliance on the commons and subsequent degradation of the commons? Or do increasing levels of wealth lead to a greater use of the commons, at least initially?

The answer is surprisingly complex. The scholarship on resource use and management has highlighted a bewilderingly large number of variables that affect common property resource management. Knowledge about the magnitude, relative contribution, and even direction of influence of different causal processes on resource management outcomes is still poor. Agrawal and Chhatre (2006), in their analysis of community forest governance in Himachal Pradesh, identify 24 variables that were statistically significant, ranging from biophysical (4), demographic (5), economic (6), institutional (5) and socio-political factors (4).

Even using this model, there are concerns regarding possibly omitted variables, causal mechanisms and the dynamics of different variables. Resource characteristics and biophysical variables form the context within which socio-political and economic characteristics of users and institutional variables shape resource management outcomes. Institutional arrangements

can range from self-initiated systems, cooperatives, corporate clan-owned forests, sacred forests, and co-managed forests. Although community participation in common property resource management has been fashionable, the term is often not very specific, whether as a spatial unit or a social grouping with shared norms. Clearly there are multiple interests and actors within communities that influence decision-making, and institutions both within and external to the group shape the decision-making process. Even the incentives facing a community are not unambiguous. On the one hand, one might expect villagers to make greater efforts to protect forests when it clearly affects their livelihoods. On the other, if villagers do not view a forest as important to them, its condition may improve because villagers will extract less from it. While it may not be impossible to identify a set of necessary and sufficient conditions that affect common property local resource governance, it certainly appears to be very difficult.

Consequently, the paper's research design and the meticulousness with which data has been gathered and analyzed is especially commendable. The paper finds an absence of any effects of poverty or growth on forest quality. Moreover, it finds no Kuznets-curve type patterns on the environmental-growth tradeoff. Instead, it concludes that anthropogenic pressures on forests are more likely to occur due to demographic pressures than due to economic growth.

The first issue raised by the paper relates to the measurement of forest degradation—the dependent variable. In the 1980s, the National Remote Sensing Agency (NRSA), under the Department of Space, was created to analyze satellite images of the earth, including forest cover and degradation. The Forest Survey of India (FSI) became quite defensive and argued that the NRSA estimates were much lower than its own estimates. However, recently Prabhakar et al. (2006) used a software program instead of humans to interpret satellite images and argued that data from the Forest Survey actually considerably underestimates the degree of degradation in Indian forests. The larger question—one common to many of the papers in this volume—is the troublsome quality of official data. Since policy debates, from poverty estimates to agricultural growth, depend on accurate data, this issue of data quality is fundamental. When there is so much argument on the facts themselves, the interpretation of the facts becomes an even larger problem.

The second fundamental issue relates to the determinants and implications of local-level collective action on the management of the commons. The literature reveals a large number of variables that affect the management of the commons, ranging from those that affect the characteristics of the

resource system (for example common water or forest resources), group characteristics (social heterogeneity such as class, gender or caste), institutional arrangements, and the external environment, especially the role of the state. Recent work in other parts of India, such as Stuart Corbridge et al. (2004) in Jharkhand, and Agrawal and Chhatre (2006), and Chhatre and Saberwal (2005) in Himachal Pradesh, appear more sanguine about collective action efforts than does this paper. Since all look at forests as the common property resource, are the differences mainly due to differences in the institutional context or the purposes for which the resource is most used? For instance, for Corbridge et al. the pressures in Jharkhand relate to deforestation (especially by the timber mafia) rather than forest degradation, which is not an issue in this case.

A third issue is the intra-household allocation of labor due to an increase in firewood collection times, as a result of forest degradation. One might expect a larger investment of time spent on collecting firewood, especially for young women, therefore impacting time spent on their education. However, there does not seem to be a correlation between deforestation and educational outcomes. Is this because education is measured by years of schooling rather than learning abilities?

A fourth issue is the choice in sources of household fuel. There are substantial subsidies for kerosene and LPG in India, and in most cases when poor households switch from firewood, they begin to use kerosene, only later switching to LPG. LPG cylinders (even smaller ones) are much heavier to carry on winding hill tracks away from the main road, while kerosene can be carried in smaller quantities and can be used for lighting as well. However, in this study, households did not seem to switch from firewood to kerosene, but instead jumped straight to use of LPG. What factors influenced this household preference for LPG?

The fifth issue (one which the paper refers to) is the precise nature of externalities. Admittedly, it is very hard to measure externalities, especially global ones; however, if one is advocating subsidies, then one has to estimate these externalities in order to give policy makers an idea of the appropriate quantum of subsidies. For instance, although there is an initial suggestion that deforestation increases either the intensity or the magnitude of natural disasters, the paper neither defines nor measures them.

The sixth question hovers around what one might call "modernization" in a sociological sense. The paper very nicely highlights one contributing factor to increasing forest degradation: the rise in the number of households, due to an increase in the number of nuclear families. Since this change

is occurring without a corresponding modernization in occupational structures, it contributes to an increase in the demand for fuel. However, the negative impacts of this increasing demand depend considerably on future demographic trends. In Himachal Pradesh, the Total Fertility Rate (TFR) has declined from 2.97 in 1992–93 to 2.14 in 1998–99 and 1.94 in 2004–05 (that is, below replacement levels), while in Uttaranchal there has been a marginal drop from 2.61 to 2.55 between 1998–99 and 2004–05. This may partly be due to the lower levels of education in Uttaranchal: the percentage of the population with no education was 33 in Uttaranchal in 2005–05 versus 19 percent in Himachal.[1] Thus demographic trends in Himachal may portend a more sanguine future for the forests there, as compared with Uttaranchal.

Seventh, while the paper documents a sharp reduction in the number of livestock (ownership of large animals dropped by a third, while ownership of smaller animals such as sheep and goats dropped by a little more than half over a 25-year period), it is unclear from the paper if this is an equilibrating mechanism that reduces the community's demand for fodder in response to a growing demand for firewood. Since in the case of small animals, the biomass demand is greater for foliage, whereas for energy the demand is greater for branches, this shift in biomass demand is likely to result in larger undergrowth, but a degraded forest.

The paper mentions in-migration in the villages but does not discuss out-migration. One interesting feature about Himachal and Uttaranchal is that these states have some of the highest rates of recruitment in the Indian army. This would augment incomes through remittances and perhaps also gradually induce changes in behavioral and occupational patterns.

Policy Options

The empirical results clearly point to a growing energy demand (for heating and cooking) in a context of occupational and spatial immobility, as the principal reason for forest degradation. The energy needs of the villagers drive the case for LPG subsidies rather than kerosene, which is not used much in these villages. Might a better longer-term solution lie in policy options that would increase local externalities from the use of forests, thereby increasing the motivation of villagers to protect their forests?

For instance, it might be possible (at least in certain areas) to leverage developments in micro-hydel technologies, which allow for pico-hydel plants of less than 100 KW and which require a head of barely one meter.

1. Data from the National Family Health Surveys.

Although most of these villages are electrified, power supplies are irregular (with power available for only a few hours each day) and there are high transmission and distribution costs. However, micro-hydel technologies are fairly simple, do not require a major capital investment and can be managed on a village-level, providing a modest but reliable power supply to the village. These micro-hydel power stations could potentially create a virtuous cycle, creating strong motivation for the preservation of the commons. If villagers can see direct and visible links between the preservation of the commons and the maintenance of the water supply to power the micro-hydel electrical sources used in their village, there is much greater incentive to protect the commons. The creation of these links could be fundamental to incentivizing the protection of forests. Thus a better use of subsidies might be for reducing the capital costs of small turbines used in these power plants.

The second policy issue is the need to create non-agricultural livelihoods, given the limited scope for economic activities in the areas of agriculture and livestock. Occupational modernization in these areas can only occur either if people migrate or if there is a growth in services, such as ecotourism. The latter, however, will still require alternate sources of energy.

A third policy issue concerns the role of the state, especially regarding its management of forests. Direct state management of forests has not produced good results. The shift to co-management, through joint community-state partnerships, has not been much more successful. Government officials' involvement in community decision making appears to be negatively related to forest condition and prospects for conservation (Kumar and Vashisht 2005). In this study as well, forest guards do not seem to play much of a role. This is both surprising and sobering. The success of Himachal Pradesh in providing primary education gives the impression that the state government is an effective manager of common properties. Yet even in Himachal, where the state government is supposedly more effective than other states, it is not particularly effective in any absolute sense. Indeed, all the papers in this conference seem to convey the same message-wherever there is any intervention by the Indian state, its interventions are either insignificant or inimical.

General Discussion

Kirit Parikh found a couple of the empirical results counter-intuitive. He would not have expected any link between the form of forest management (community vs. state) and firewood consumption and was surprised

that the empirical estimates showed that firewood consumption was lower where forests were community managed. He was also puzzled by the lack of income elasticity of LPG use, since in urban areas LPG was demonstrably a superior good. A third empirical result that was counter-intuitive was that ownership of large animals was associated with increased firewood use: his argument was that the dung produced by large animals would substitute for firewood as a fuel source.

Surjit Bhalla expressed surprise that there was no apparent reduction in firewood use as income and wealth rose. He felt that there must be a point of inflection at which firewood became a less preferred fuel source. **Kaushik Basu** noted that, given the very low income of the poor in India, a relatively small income effect of increased firewood collection time could still be hugely significant in terms of reduced welfare. **T. N. Srinivasan** felt that it was inappropriate to ignore market wage rates completely since they influenced the opportunity costs for households in choosing between wage employment and self-employment in household production. **Siddharth Roy (Tatas)** referred to an experience in a different region of India, namely Kutch, where the provision of a technological alternative, namely biogas plants, significantly reduced time for fuel collection, allowing womenfolk to undertake other activities.

Rinki Sarkar confirmed that kerosene was extremely rationed in supply and therefore used only for lighting, not heating or cooking. Electricity supply was too erratic to be trusted despite the abundance of hydropower assets in the region. Community managed mini-hydel plants were certainly a technological option, but their prevalence was so far quite limited. The low income elasticity of demand for firewood reflected its role in both heating and cooking; there was as yet no effective replacement for it as a heating source. **Kirit Parikh** suggested that separate demand functions be estimated for summer and winter to differentiate the price sensitivity of firewood as a source of heating versus cooking.

Responding to T. N. Srinivasan, **Dilip Mookherjee** noted that there was considerable seasonality in market wage rates; market wages, on annual basis, were intra-marginal; the effective margin for opportunity cost was provided by self-employment. He also clarified that the basis for calculating the price elasticity of LPG was largely intra-village, thereby controlling for differences in distribution based on problems of access. Finally, he accepted that a dynamic formulation of their model might generate additional insights, but his own judgement was that the size of the local externality would remain relatively small, and the incentives for collective action correspondingly weak.

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