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Agricultural Productivity Growth, Rural Economic Diversity, and Economic Reforms: India, 1970–2000*

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A salient theme in D. Gale Johnson's work is the importance of agricultural development for general prosperity and for economic diversification (e.g., Johnson 2000). Johnson has also noted that most of the world's poor are engaged in farming, so that a key focus of development policy is to raise the incomes of farmers. From a global perspective, increasing the productivity of agriculture, given the fixity of land, is necessary for both poverty reduction and the development of the nonagricultural sector. At the level of the world, agricultural productivity gains, poverty reduction, and the growth of the non-farm sector are complements. However, the question remains whether these observations imply that every poor country should focus its public resources on agricultural development in order to raise the incomes of people now engaged in farming and whether such a policy is necessary for obtaining economic diversity.

In this article, we use the experience of India over the past 30 years to address the issue of whether agricultural technical change actually leads to economic diversification and income growth within the rural sector in the context of an open-economy country in which there are cross-area trade and capital flows. We focus in particular on the rural sector because this is the sector in which linkages between agricultural and nonagricultural sectors are thought to be the strongest. We exploit the fact that India has maintained a policy of openness with respect to agricultural technology over this period, permitting and actively supporting agricultural development, and has moved to a reformed regime in which goods are traded and capital is more mobile in the 1990s.

Evidence on the relationship between agricultural growth and nonfarm

growth has been mixed at the country level, mostly due to data limitations.¹ Moreover, most empirical studies lack a theoretical framework and, in particular, treat the rural, nonfarm sector as homogeneous, ignoring the distinction between traded and nontraded nonfarm goods that is relevant to open economies. We use newly available survey data covering the major states of India over the past 30 years within the context of a general-equilibrium framework to look descriptively at the effects of yield improvements associated with the Green Revolution on rural nonfarm activities, incomes, and enterprises distinguished by whether they are in nontraded (locally financed) or traded sectors with spatially mobile, nonlocal capital. Over this period, India has experienced significant increases in crop yields and a substantial expansion, especially in the last 20 years, in both rural per capita incomes and in rural diversification, with now almost half of rural incomes coming from outside the farm sector. This would appear to be consistent with the hypothesis that agricultural and nonagricultural development are complements. However, using time series of over 240 villages covering most of India, we find that in fact the rapid growth in rural industry occurred in areas with the lowest rates of improvements in crop yields, consistent with a model in which industrial capital is mobile and seeks low-wage areas. Given this mobility, within the country rural industrialization and agricultural development are substitutes.

Section I briefly describes the general-equilibrium framework we use to examine the data. Section II describes the data and presents descriptive statistics on the trends in agriculture and the rural nonagricultural sector in the past 30 years as well as the impact of high-yielding-variety (HYV) crop yield improvements on the agricultural sector, including effects on land prices, land improvements, and agricultural land and nonland wealth. In Section III, descriptive evidence in graphical format is adduced that shows the relationship across India between crop yield growth rates in the pre- and postreform periods and changes in income by source, changes in the activities of male labor by sector, wealth by source, and the placement of factories and local service-sector enterprises. The relationship between initial conditions in 1971 and subsequent agricultural and rural industrial development is also examined. The patterns suggest that agricultural development occurred in the less advanced area of India but that industrial activity grew in the more developed areas, leading to misleading inferences from cross-sectional comparisons that are prevalent in the literature. Section IV presents descriptive regressions that quantify the relationships between agricultural incomes, factory location, nonfarm wage incomes, local business incomes, and HYV crop yields and compares cross-sectional with over-time estimates that control for fixed differences across Indian villages. The empirical results indicate that cross-sectional estimates are biased positively, overstating the positive relationship between crop yield growth associated with the Green Revolution and agricultural incomes, and obscuring the strong negative relationship between such development and the growth in rural industry. The results also show that locally oriented, locally financed businesses grew little over the entire period and

were not significantly affected by local agricultural development. Section V contains a conclusion.

I. Framework

To characterize the process of economic diversification and how it is influenced by growth in agricultural productivity we develop a theoretical framework that incorporates three distinct sectors. Agricultural and manufactured goods are assumed to be traded across space whereas local services such as those provided by tailors, shopkeepers, and builders are consumed and produced locally. Households consume agricultural, manufactured, and service goods and allocate their labor to farming their own land, running a nonfarm business, and working as wage workers in the available sectors. Income is consumed, invested locally in farm or nonfarm capital, and saved through financial intermediaries, if available. Labor is mobile across sectors but not across localities. Local labor markets are competitive with wages equilibrating within each locality across the different sectors of the economy.

We adopt the assumption that labor is not mobile across space for two reasons. First, this assumption is realistic in a global model in which the local economies are countries. Thus, the model yields implications for traditionally defined open- and closed-economy models. Second, we apply the model to the Indian context in which permanent labor mobility is low relative to other economies. Wage differences persist across villages, and local demand and supply factors determine local wages (Foster and Rosenzweig 2003). In our panel data describing a representative sample of the population of all rural villages in India around the 1970s, less than 11% of men aged 20–37 in 1999 moved out of their village of birth. In contrast, the 1990 U.S. Census indicates that over 37% of men in the same age group were in a different state than the one they were born in. Below we assess the extent of regional variation in the spatial mobility of labor and consider the implications of any observed patterns for our analysis.

With respect to technology in our framework, we assume that agricultural output is increasing in land, labor, and capital and an exogenous productivity factor that varies across space and time. Nontraded services are increasing in labor and capital and are assumed to be dominated by owner-operated small businesses. Initially, it is assumed that local production is restricted to the agricultural and service sectors so that all manufactured goods must be imported. Subsequently, we consider the implications of opening up the village economy to the entry of rural manufacturing that is financed by mobile external capital, produces goods that may be traded externally, and employs local labor.

In the absence of rural manufacturing, growth in the nonfarm sector will depend importantly on the income elasticity of demand for local nontradables. If nonfarm services are inferior then growth in agricultural productivity may result in an expansion of manufactured imports and a decline in the nonfarm sector. Otherwise, expansions in rural agricultural productivity will increase demand for nontraded services and possibly generate capital that can be used

for nonfarm investment. But even in this case it is unclear that there will be an expansion in employment in the nonfarm sector. This depends on the factor intensity of productivity growth in agriculture and the shares and substitutability of labor and capital in the two sectors. There are two offsetting effects. On the one hand, given that agricultural goods can be exported in exchange for manufactured goods and that total land is fixed, agricultural productivity growth tends to push up the demand for agricultural labor, thus increasing wages and agricultural employment. On the other hand, this growth expands incomes which, given income-elastic demand for nontraded goods, increases the price of nontraded services and, thus, the demand for labor in the nontraded sector.

With the entry of mobile factory capital the effects of agricultural productivity growth change markedly because this capital will seek out low-wage areas, producing and exporting manufactured products from these areas to areas where manufacturing is more costly. Because productivity-driven increases in agricultural labor demand will tend to push up wages, factory capital and, thus, factory employment will tend to grow in those areas with low growth in agricultural productivity unless labor leaves such areas in great numbers. This means not only that the nonfarm sector is likely to be decreasing in agricultural productivity but also that the effects of agricultural productivity growth on income and wage growth will be dampened. This, in turn, has implications for inequality. Entry of mobile factory capital will tend to reduce the intervillage inequality that tends to emerge from differences in agricultural productivity growth across villages even in the absence of spatial labor mobility. Conversely, agricultural productivity growth will create greater inequality relative to the nonfactory case if there is inequality in land because wages will not rise as fast as land rents when agriculture becomes more productive.

II. Data and Trends in Agricultural and Nonagricultural, Rural Development: 1971–99

To assess how agricultural development affects the composition of rural activities and incomes, we use a series of household data sets from India covering the period 1971–99. India is a particularly good setting for examining how agricultural technical change affects development. First, as noted, Indian village economies in part mimic those of small countries in that permanent migration between villages is relatively small, so that wages and thus incomes are determined by village demand conditions, including local agricultural technical change, and local supply characteristics, while agricultural prices are set nationally by the central government. And, although industry has been regulated, entrepreneurs are able to establish factories wherever they wish across India, so that factory capital is mobile. Second, there has been substantial improvement in agricultural productivity associated with the Green Revolution starting in the late 1960s—due to the importation of new, high-yielding seeds and public investment in seed development (Evenson and

McKinsey 1999). The Indian Green Revolution thus reflects active government policy, to lift restrictions on specific imports and to support both technical development and dissemination and distribution of complementary inputs. The growth in agricultural productivity has varied widely across India due to natural soil and water conditions as well as, in part, government intervention.

The data we use characterizes households living in 240 villages in the 16 largest states of India based on a continuing survey of rural households that began in 1968 and has been carried out by the National Council of Applied Economic Research (NCAER). Collectively these data are known as the Additional Rural Income and Rural Economic Development Surveys (ARIS-REDS). The first round of the survey for which there is complete village and household information, in 1971, 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 1982, 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 1999, all of the 1971 villages were surveyed, excluding the eight sample villages in Jammu and Kashmir.² In this latest survey round, all of the surviving households in the 1982 survey were surveyed again, including for the first time 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. Given the sampling strata, each of the survey rounds characterizes the populations in each of the sampled villages so that it is possible to construct a panel of villages for the 1971–99 period for 240 villages in 15 states. The data sets in all years provide information on agricultural yields by seed type and crop, on infrastructure and industry, and on wages and prices at the village level; on incomes and assets, by source, at the household level; and on activities, by sector, at the individual level. We also appended to the data information on rainfall, obtained from the monthly time series available from 40 Indian weather stations, using our geo-coding of the villages and weather stations to compute nearest-station rainfall measures for the villages.

The key variable in any exploration of the effects of agricultural development is a measure of agricultural technical change. Prior studies have used adoption rates of high-yielding variety seeds. However, adoption choices reflect in part the returns to land, capital, and labor in alternative uses. To examine how agricultural development affects sectoral activities, we constructed from the village-level data on prices, seed types, and yields an index of typical HYV seed yields on irrigated lands for each village for each of the three survey years using a Laspeyres-weighted (1971 prices) index for four HYV crops—corn, rice, sorghum, and wheat. This measure, based on estimates from informed sources in each village, represents at each survey date the village-specific yield local farmers could obtain using HYV crops, and controls for a key determinant of yield, irrigation, and which itself responds to HYV

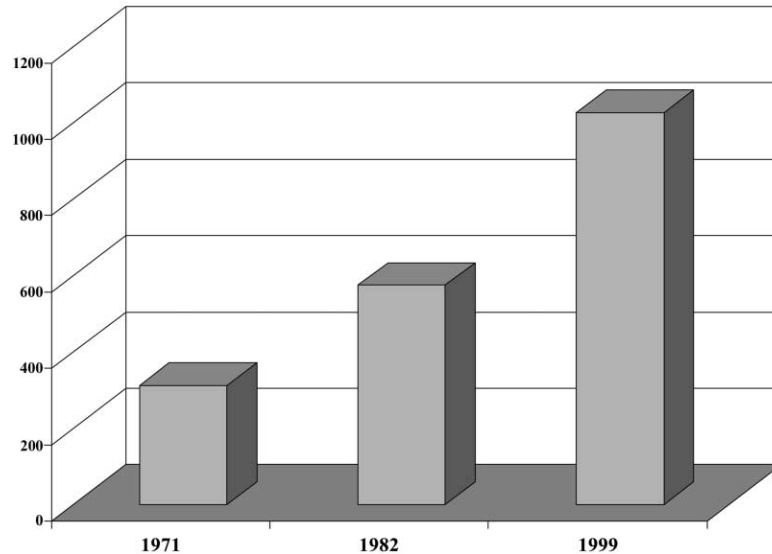


FIG. 1.—Average maximum HYV yield index (Laspeyres-weighted HYV crops), by year: 1971–99.

seed development. Because not all farmers have access to irrigation, the HYV yield figure represents the maximum farmers could obtain if they had the resources held by farmers with irrigated lands. We thus call the yield measure the “maximum” HYV yield.³ Figure 1 displays the max HYV yield index for the three sample years. As can be seen, the index of HYV yields on irrigated land rose by 86% between 1971 and 1982 and by 74% between 1982 and 1999. Clearly there has been substantial agricultural yield growth from 1971 through 1999, but the annual rate of increase in yields for these crops slowed down in the latter 2 decades.

For the purposes of analyzing the associations between agricultural technical change and development, we divided up the villages into five groups according to the growth rates in the max HYV yield index over the 1971–99 period. Figure 2 depicts the distribution of growth rates by quintile. As can be seen, the differences in yield growth rates across areas are substantial—yield growth in the highest quintile is almost seven and a half times that in the lowest quintile. The growth rates in yields had substantial effects in the agricultural sector over the period. For example, the growth rates in HYV yields were associated strongly with increases in real land wealth, as shown in figure 3. In the lower two quintiles of the HYV yield growth distribution, land values, relative to the consumer price index, rose by 68%, while in the highest three quintiles land values increased 10-fold.

Some of the relative increase in land values was due to rising land prices induced by agricultural productivity increases. Figure 4 shows the prices of unirrigated and irrigated land in 1971 and 1999 in each of the HYV yield

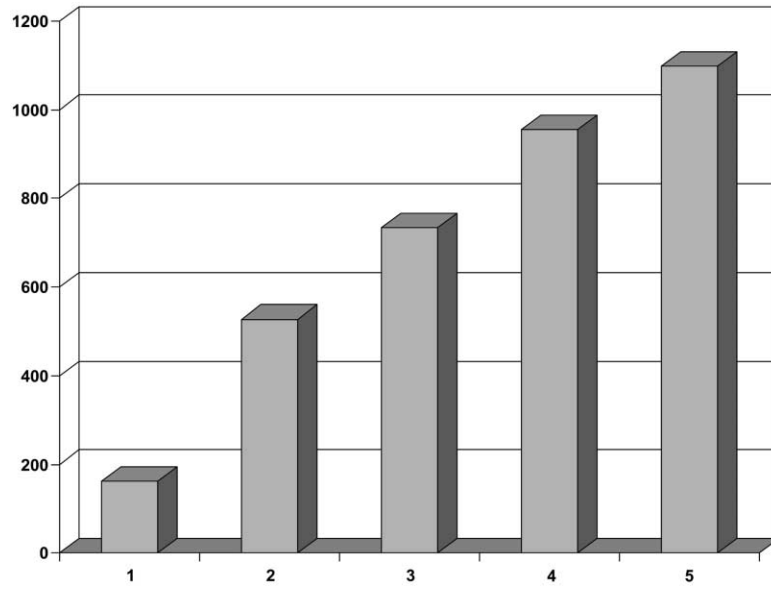


FIG. 2.—Absolute growth of HYV yields, 1971–99, by growth quintile

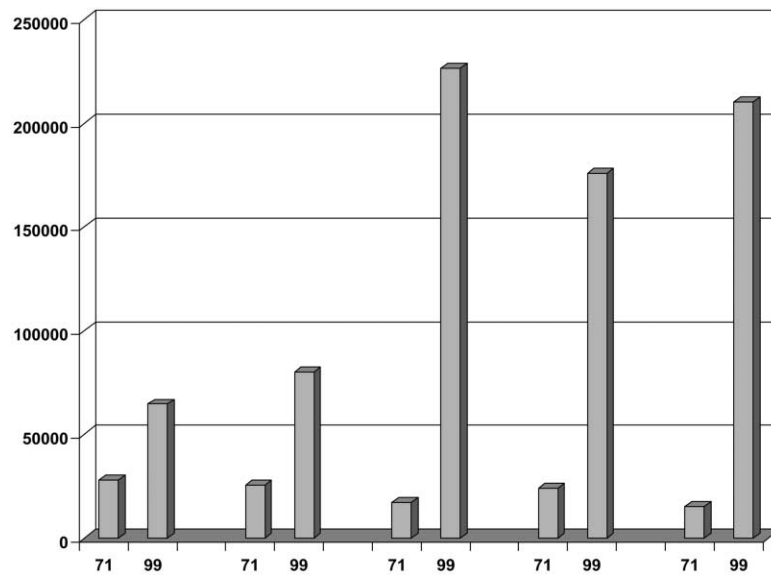


FIG. 3.—Land wealth by year and HYV yield growth quintile, 1971–99

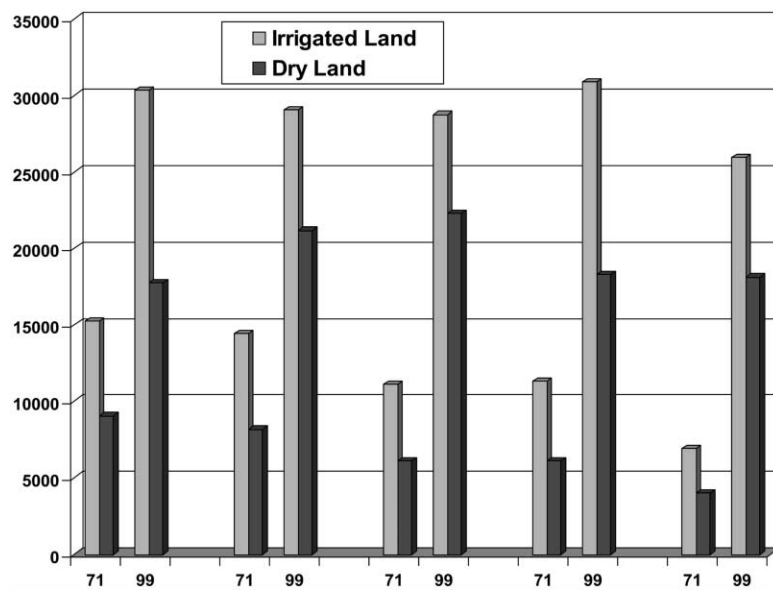


FIG. 4.—Land prices, by year and HYV yield growth quintile, 1971–99

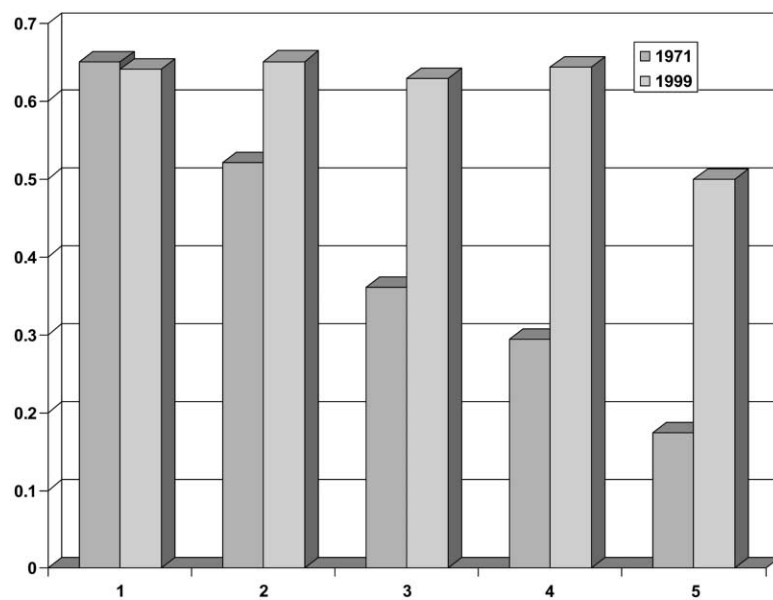


FIG. 5.—Share of irrigated land, by year and HYV yield growth quintile

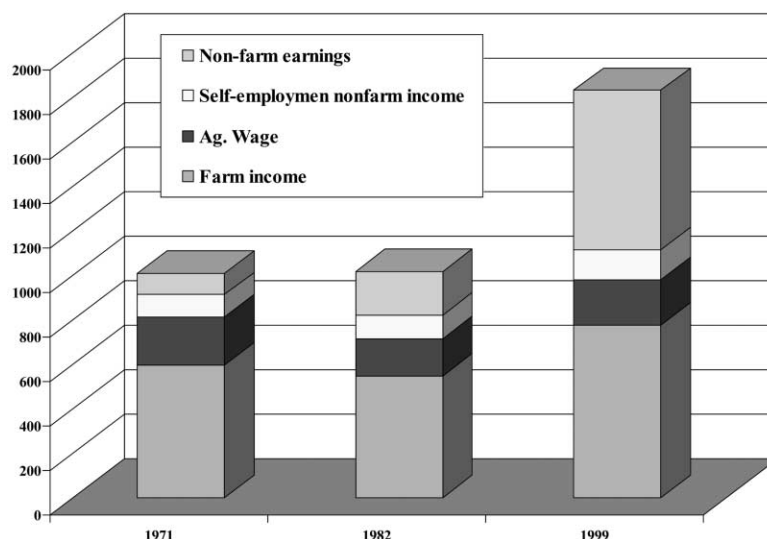


FIG. 6.—Mean real per capita household income (Rs 1982), by source and year, 1971–99.

growth quintiles. The prices of both types of land clearly rose more in the higher yield growth areas. Some of the rise in land values was also due to irrigation investment, however. Figure 5 depicts the share of irrigated land in 1971 and 1999 for each of the five quintiles of the HYV yield growth distribution. In the lowest quintile, there was essentially no overall increase in the share of irrigated land from its 64% value, while in the highest quintile the share rose from 17% of total arable land in 1971 to 50% in 1999. Figures 4 and 5 also display an interesting feature of the Green Revolution experience in India. HYV yield increases over the 1971–99 period were inversely related to the initial 1971 distribution of both land quality (as reflected in land prices by irrigation status) and irrigated land shares. Thus, those areas most developed in terms of agriculture in the initial period experienced the lowest subsequent advances in HYV crop yields over the next 28 years. Evidently as a consequence, the proportions of irrigated cropland across villages and land prices were substantially more equal in 1999 than they were in 1971. The strong inverse relationship between yield growth and initial agricultural productivity, and possibly other aspects of development, means that inferences about the role of agricultural development in fostering growth in nonfarm activities in India based on cross-sectional analyses can be misleading. We will consequently look at how changes in HYV yields are related to changes in measures of agricultural and nonagricultural rural development.

What happened to incomes and activities over the 1971–99 period? Figure 6 displays the average per capita incomes of the households, in 1982 rupees, in the three survey rounds by income source. As can be seen, in the 1971–82 period there was little change in per capita income. This was still an impressive

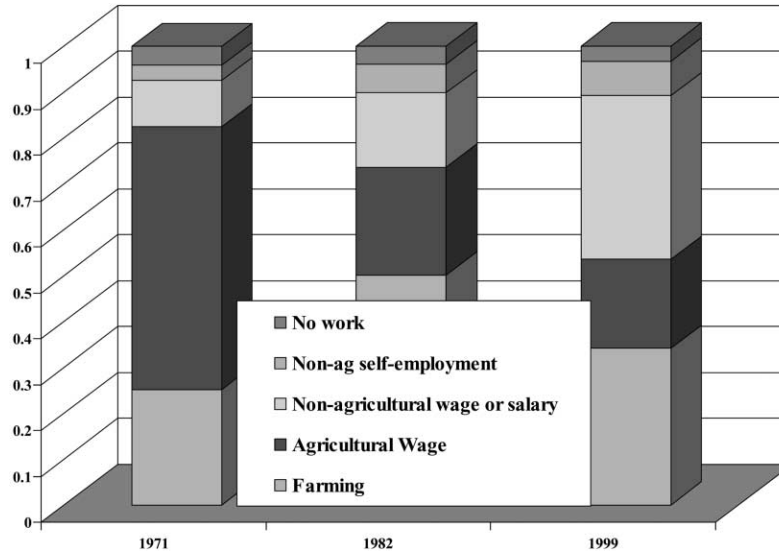


FIG. 7.—Distribution of primary activities of men aged 15–44, by year, 1971–99

accomplishment, however, as the population size of the villages expanded on average by 37%. During this period of agricultural development there was also a significant increase in the share of total nonfarm income in total income, from 19.3% to almost a third. However, none of this increase was in the form of local nonfarm enterprise or business income. Rather wage and salary incomes more than doubled. In contrast, in the 1982–99 period, per capita incomes increased by 70% while population grew by 47%. And the share of nonfarm incomes in total rural income rose to almost half by 1999 (48.1%). Again, all of the increase in nonfarm incomes was in the form of wages and salary.

Examination of the primary activities of young males aged 25–44 and the growth of villages with a factory from our data along with data from the National Social Surveys (NSS) reveal the same patterns. Figure 7 shows that there was an expansion of nonfarm activities by the young men over the whole 1971–99 period, but mainly in activities providing wages or salaries, not nonfarm business income. In 1971, 82% of men aged 25–44 reported that their primary activity was either farming or earning agricultural wages; by 1982 this proportion had dropped to 73% and by 1999 the proportion working in agriculture as a primary activity was only 53%. Between 1971 and 1982, the fraction of men in the age group working for wages or salary outside the agricultural sector rose from 10% to 16%; between 1982 and 1999 that proportion had more than doubled, to 36%. The increase in nonfarm wage employment appears to be from an expansion of manufacturing. Figure 8 shows the percentage of villages with a factory from our panel data and the number of rural workers employed in manufacturing based on the relevant rounds of

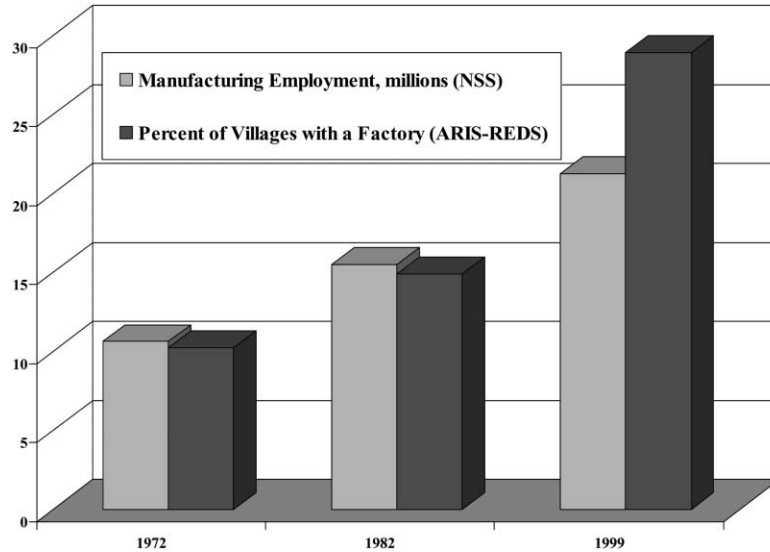


FIG. 8.—Growth in rural manufacturing, 1971–99: employment in millions (NSS) and percentage of villages with a factory (ARIS-REDS).

the NSS. Both of these time series show a substantial growth in manufacturing activities in the rural sector over the period—manufacturing employment doubled and factory presence increased almost threefold.⁴ Our data inventorying businesses employing village laborers suggest that rural factory employment increased even more than indicated in the NSS data sources—from 5.7 workers per village in 1982 to 57 workers per village in 1999.

Figure 7 also indicates that in the same time periods in which manufacturing employment increased, the fraction of males 25–44 listing nonfarm business as a primary activity went from 3% to 6% to only 7.5%. Increases in local enterprise activity may be understated by the distributions of primary activities, if such activities are engaged in as a secondary occupation by many workers. However, the lack of local business activity and development over the period is also seen in the income shares shown in figure 6 and in the changes in the nonland asset distribution, depicted in figure 9. Although the total value of nonland assets rose over the whole period, assets associated with local businesses remained stagnant in real terms. The largest growth occurred for housing and for financial assets, neither of which contributes to local business activity other than house construction. Local business development was thus not a major part of nonfarm activity expansion—the number of local, service-oriented establishments per village actually declined over the 1982–99 period, from an average of 36.2 per village to 33.2.⁵

Other factors that may have affected the composition of employment and incomes by sector between 1971 and 1982 include financial development and the growth of towns. Figure 10 depicts the proportion of villages with a post

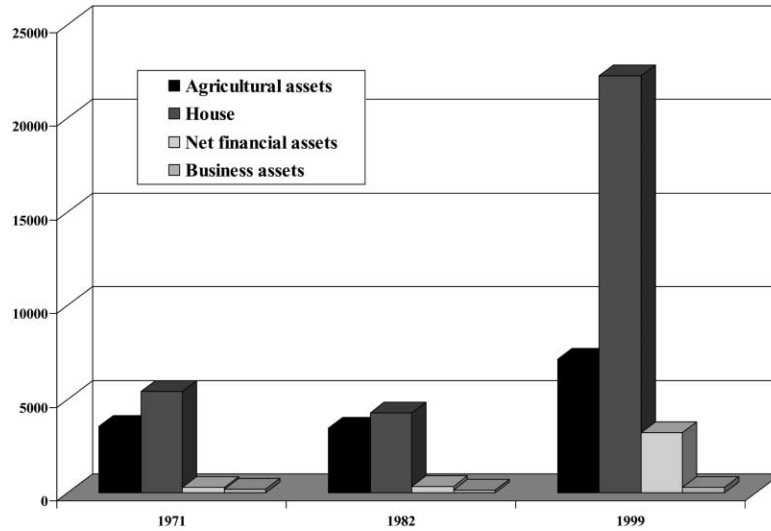


FIG. 9.—Mean real nonland household assets, by type and year, 1971–99

office, an important instrument for savings in rural India, and a commercial bank for the three survey years. As can be seen, there was a rise in village coverage of financial institutions. Sixty-two percent of villages had a post office in 1971, but over 90% had a post office in 1999. Similarly, just over 10% of villages had a bank in 1971, while 32% had one in 1999. There was also a significant rise in towns in the 1982–99 period, as depicted in figure 11. Although the proportion of villages less than 10 kilometers from a town remained at around 30% in 1971 and 1982, by 1999 47% of the villages were proximate to a town.

III. Descriptive Evidence

Income and Activity by Sector

In order to obtain a relatively complete picture of the consequences for the rural nonfarm sector of growth in agricultural productivity we examine a series of sector-specific measures of activity inclusive of income, capital, primary employment, and overall employment, stratified by year and the quintile-based spatial division of 1971–99 productivity growth in agriculture. We first consider sector-specific income growth, which gives a comprehensive picture of the relevance of particular types of activity at the level of the household to expansion in income. The relationship over the period between household income by sector and crop yield growth does not support the hypothesis that nonfarm growth is importantly tied to expansion in the agricultural sector. Specifically, figure 12 shows that, as a share of total income, nonfarm income growth was actually highest in the low yield growth quintiles.⁶ In the high yield growth quintiles, the nonfarm income share increased only 14 percentage points from 26% in 1971 to 40% in 1999. By contrast, in the lowest-growth

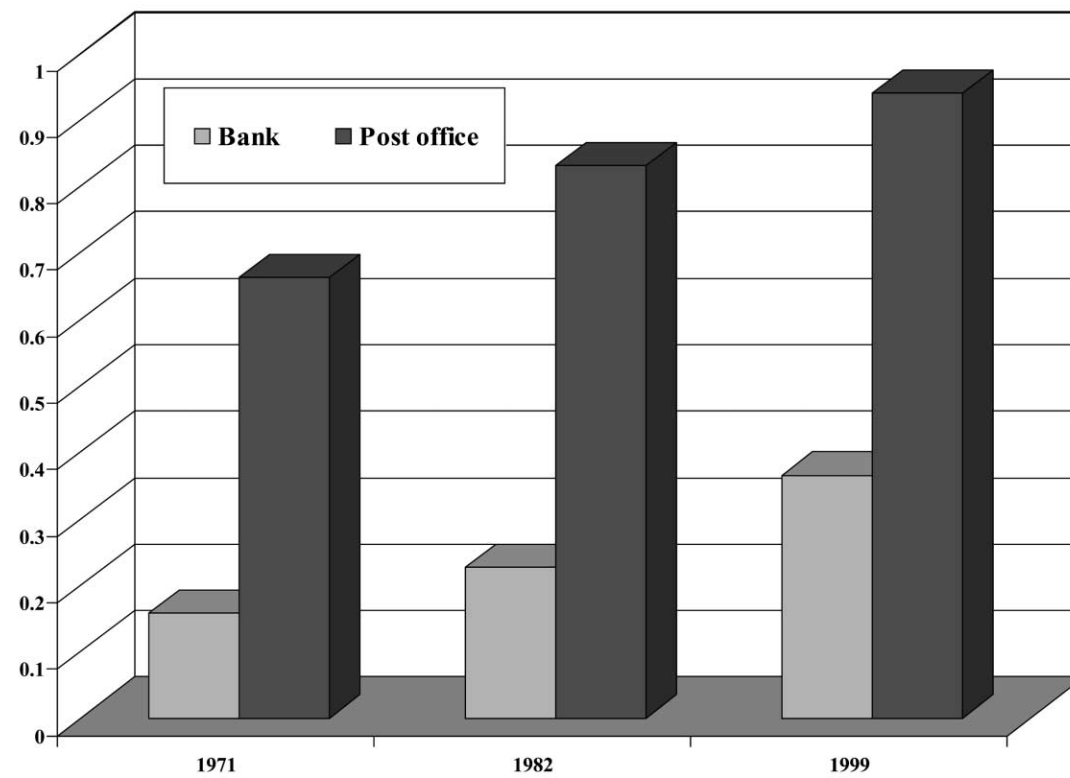


FIG. 10.—Proportion of villages with proximate financial institutions, by type and year

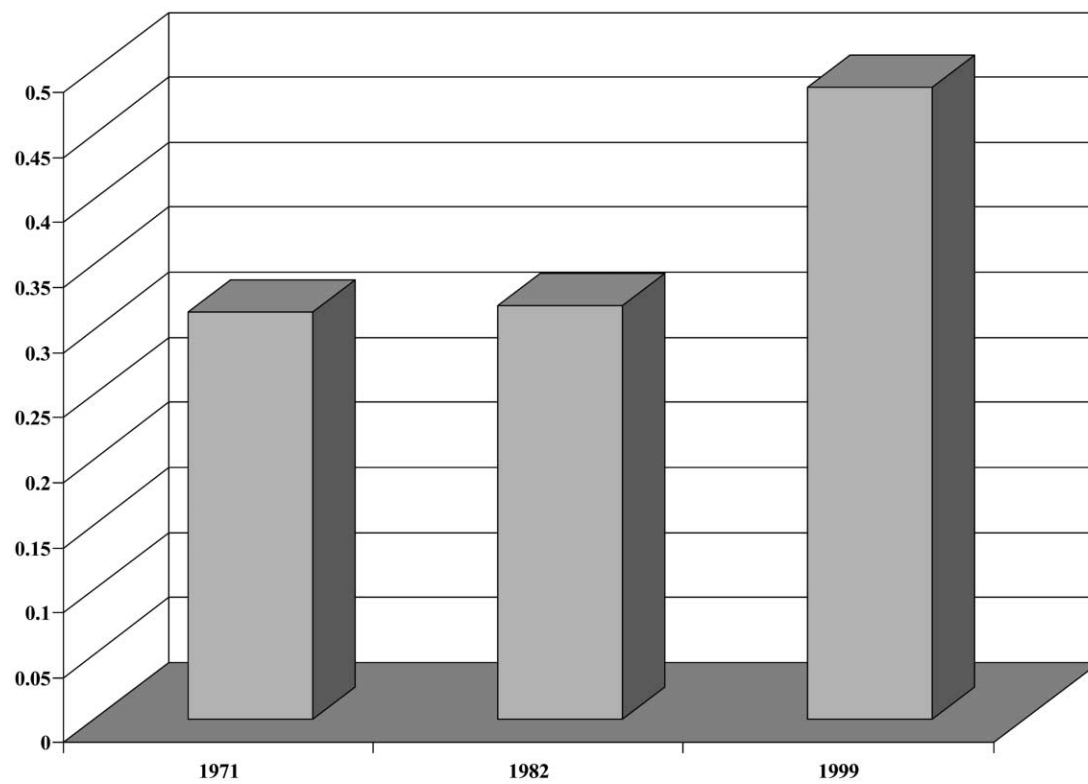


FIG. 11.—Proportion of villages proximate to towns by year, 1971–99

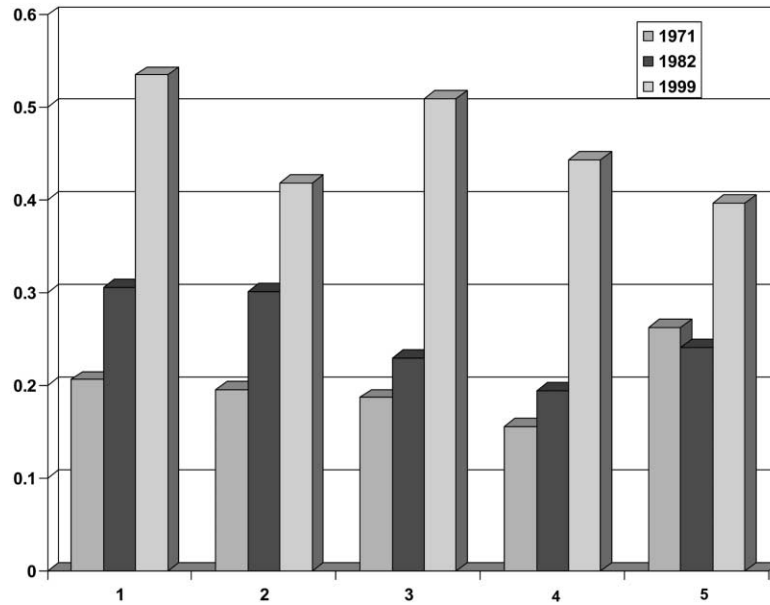


FIG. 12.—Proportion of nonfarm income in total income, by year and HYV yield growth quintile.

category the nonfarm income share increased by 33 percentage points, from 21% in 1971 to 54% in 1999. This provides evidence consistent with our framework in which growth in the nonfarm sector is importantly linked to a low opportunity cost of labor and, thus, to the absence of agricultural productivity. However, this evidence is somewhat limited in that the nonfarm sector here combines both the nontraded and traded components, which our framework suggests should be affected in opposite ways by productivity growth in agriculture. Moreover, given the use of income shares, this graph is consistent with the presumption that there has been little differential change in nonfarm activity by agricultural productivity growth so that differences in shares in total income are primarily driven by differences in growth in agricultural income.

Figure 13, which presents the two components of nonfarm income, provides further evidence to support the view that agricultural development has different effects on nonfarm activity given capital mobility. It is clear, first of all, that total nonfarm income increased markedly in each of the five yield growth quintiles, with the largest increases accruing in the lowest-productivity growth groups. In real terms, total nonfarm income grew by a factor of almost 5, from Rs 1,029 to Rs 5,102 per annum in the lowest quintile. By contrast, in the highest quintile, nonfarm income grew from a slightly higher initial level, Rs 1,154, to Rs 3,335, which is a factor of only 2.9. More importantly, most of this growth and essentially all of the differential growth in nonfarm income came from the nonfarm earning sector. Nonfarm business earnings

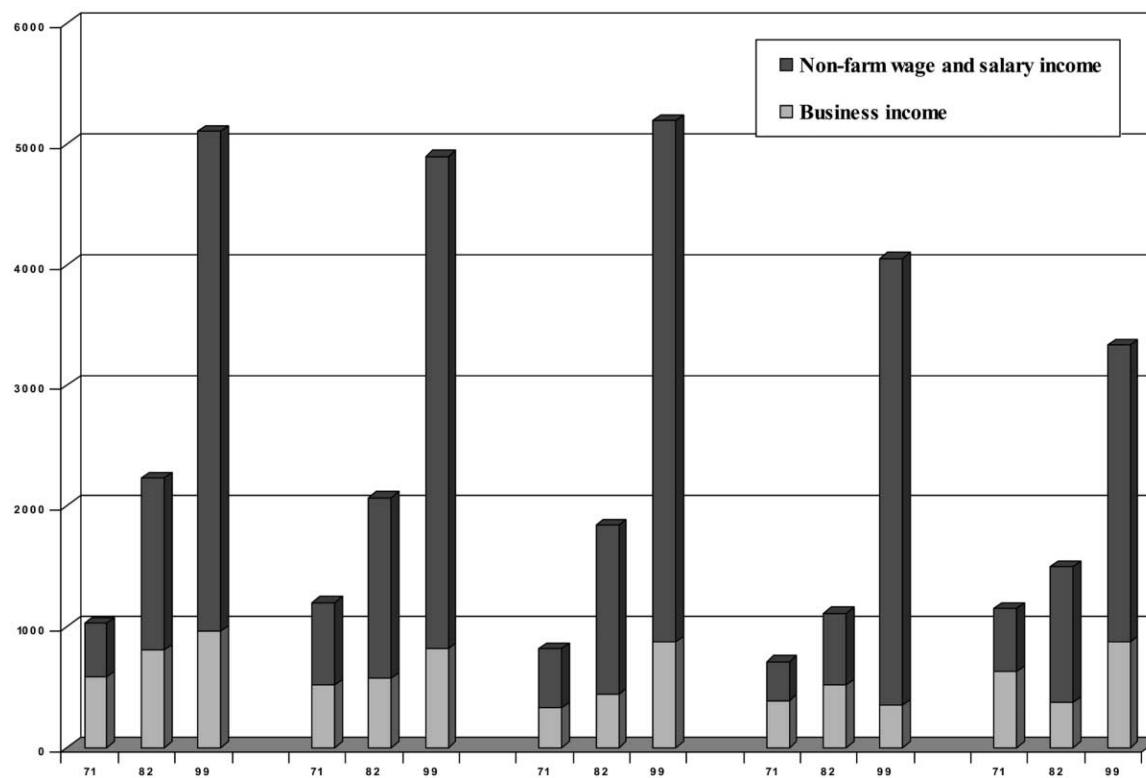


FIG. 13.—Real nonfarm wage and salary income and business income, by HYV yield growth quintile, 1971–99

growth was 66% in the lowest yield growth quintiles and 39% in the highest yield growth quintiles. By contrast, growth in nonfarm employment earnings was 824% in the low-growth villages and 366% in the high-growth villages. Thus, consistent with our framework, the primary source of the expansion in nonfarm income was growth in the nonfarm labor market, rather than in self-employment, and this expansion was highest in the low-productivity growth areas.

Interestingly, an analysis based on differential growth in nonfarm income by initial agricultural productivity would have yielded a very misleading picture of the relationship between agricultural productivity and the nonfarm sector. Figure 14 is comparable to figure 13 but is stratified by initial agricultural productivity in 1971 rather than crop productivity growth between 1971 and 1982. Given the results from figure 13 and the overall negative correlation between productivity growth and initial productivity level, it should not be surprising to see that total nonfarm income growth is highest in the high-productivity areas in 1971 and that growth, in particular, in employment earnings is increasing in 1971 productivity. Thus a researcher who mistakenly believed that productivity in 1971 was a good proxy for productivity growth in the subsequent 30 years might erroneously conclude that growth in nonfarm employment is increasing in agricultural productivity growth.

One limitation of examining changes by sector in income by source is that they are influenced by changes in factor prices as well as by changes in the allocation of time. Although the panel data do not contain detailed information on the allocation of time by household workers, reports of primary activity can be informative about how time is allocated. Figure 15 plots the share of men aged 25–44 by year and agricultural productivity growth for the two nonfarm activities, nonfarm wage work and nonfarm business. The results are consistent with those presented by income, with overall growth in the share of men reporting a nonfarm principal activity being somewhat higher in the low-growth areas and with this contrast being substantially stronger when limiting attention to nonfarm wage employment. In particular, there was a 39 percentage point rise in this measure of total nonfarm activity in the lowest yield growth quintile and only a 28 percentage point rise in the highest yield growth quintile. Within the nonfarm wage sector, by comparison, the rise in activity in the lowest-growth area of 45 percentage points is almost twice the rise of 23 points observed in the highest-growth areas. Conversely, business activity rose by 12 points in the highest-growth villages but only 5 points in the lowest-growth villages.

Establishments

Although household-level data permit a distinction to be drawn between family employment and nonfarm employment earnings in households, they provide an incomplete picture of the labor market and, in particular, the source of the expansion in nonfarm employment. This issue can be addressed through an examination of village-level data on enterprises that is available in the panel



FIG. 14.—Real nonfarm wage and salary income and business income, by HYV yield growth quintile in 1971

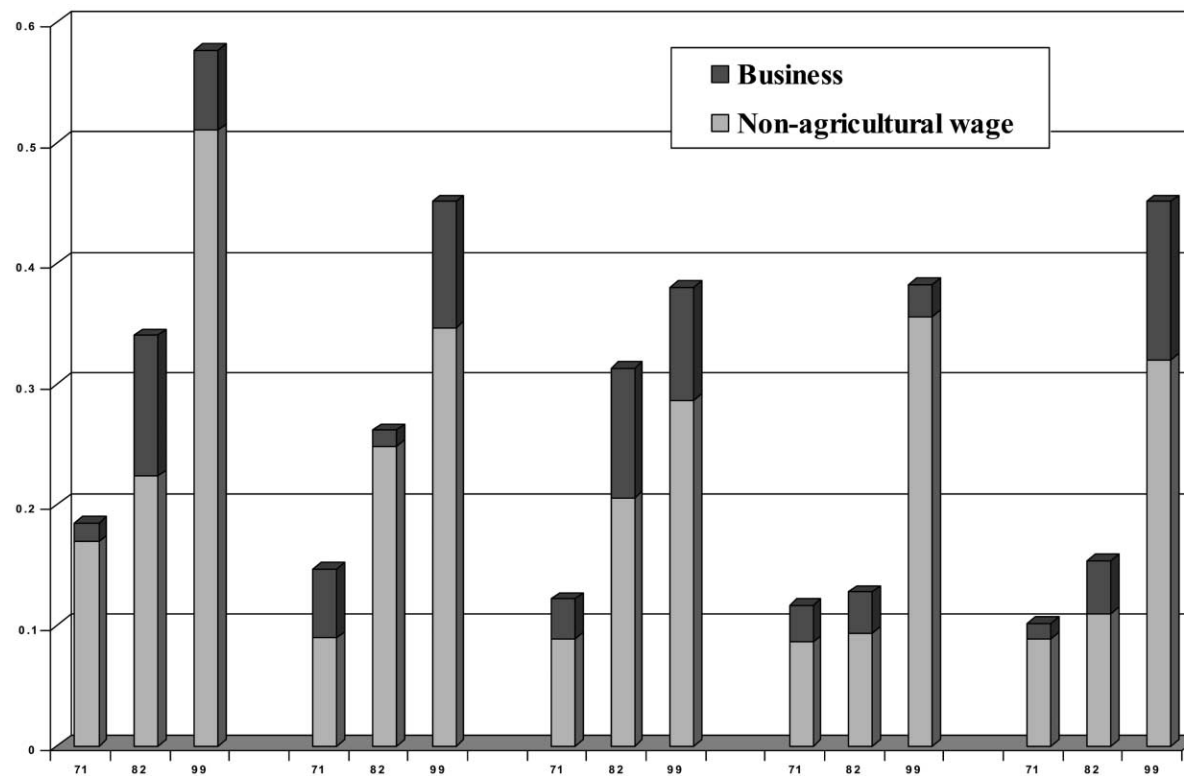


FIG. 15.—Proportion of men aged 25–44 by primary activity, year, and HYV yield growth quintile

data set and clearly supports our contention that the expansion in nonfarm employment is primarily due to growth in rural industry. Figure 16 plots the proportion of villages with at least one factory by year and yield growth category. In the two lowest agricultural productivity growth quintiles, the share of villages with a factory rose from just over 10% to approximately 50%. By contrast, in the three high-productivity growth quintiles there is little systematic change over time in the presence of factories. Indeed, in the highest yield quintile the fraction of villages with a factory fell from 20% to 12% over the 1971–99 period.

While factory employment data are not available in 1971 from our survey, both 1982 and 1999 enumerated employment of village workers by factories in the village or in neighboring villages. These data, presented in figure 17, also illustrate the dramatic expansion of the factory sector over this period, particularly in low-growth areas. Specifically, the number of factory workers per village in 1982 was roughly five, regardless of the level of productivity growth over the 1971–99 period. By contrast, factory employment averaged 48.9 in the lowest yield growth quintiles, an increase of more than 10-fold. Although growth in factory employment in the high-growth quintiles was also substantial, it was less than half of that in the lowest-growth quintiles, rising from 4.8 to 22 workers on average.

We interpret the data as indicating that factory capital was mobilized to areas with lower wages or the slowest wage growth.⁷ That low-wage areas attracted capital is understated by figures 16 and 17 to the extent that labor is also mobile, moving from low- to high-wage areas. Our survey data indicate, however, that out-migration is both relatively low and not more prevalent in the lowest-wage areas. Figure 18 plots by the HYV growth quintiles the percentage of sons of household heads aged 20–37 in 1999 who had left the village. The pattern is nonlinear, with the second-lowest rate of out-migration in the slowest-growth areas. If migration serves to equalize wages across rural areas, we would have expected that rates of out-migration would be highest in the slowest-growth areas and lowest in the highest-growth areas. On the other hand, the notion that agricultural productivity increases necessarily promote the escape of labor from agriculture via rural out-migration is also rejected by the data. Above the lowest-growth quintile out-migration declines linearly with agricultural productivity growth.

Similar village data on the number of local service enterprises were also collected in 1982 and 1999 and, in comparison with the results from figure 17, provide evidence consistent with the framework presented above in which the nontradable and mobile capital sectors are affected in opposite ways by agricultural productivity growth (fig. 19). In particular, the number of service enterprises per village decreased by 14% and 36% in the two low-growth categories while increasing by 31%, 17%, and 25% in the three high-growth categories. Unfortunately, a time series of business-enterprise employment data is not available; however, evidence from 1999 indicates that these enterprises tend to be quite small, with two to three workers on average. Based

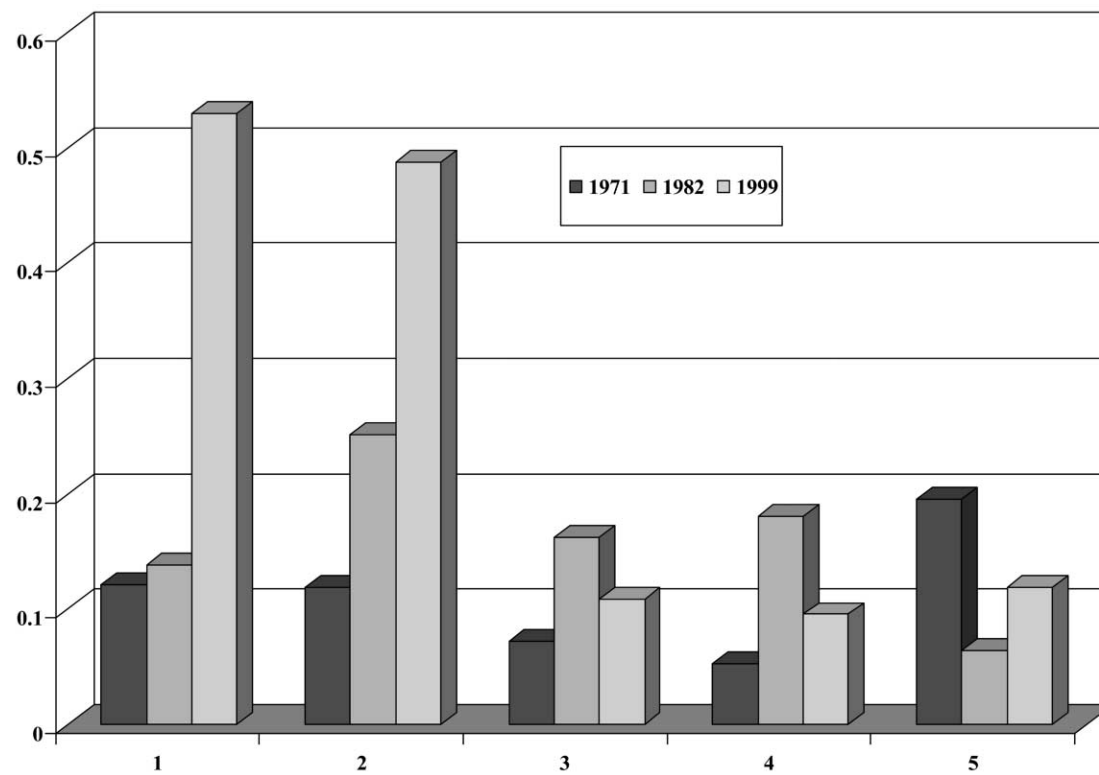


FIG. 16.—Proportion of villages with at least one factory, by year and HYV yield growth quintile

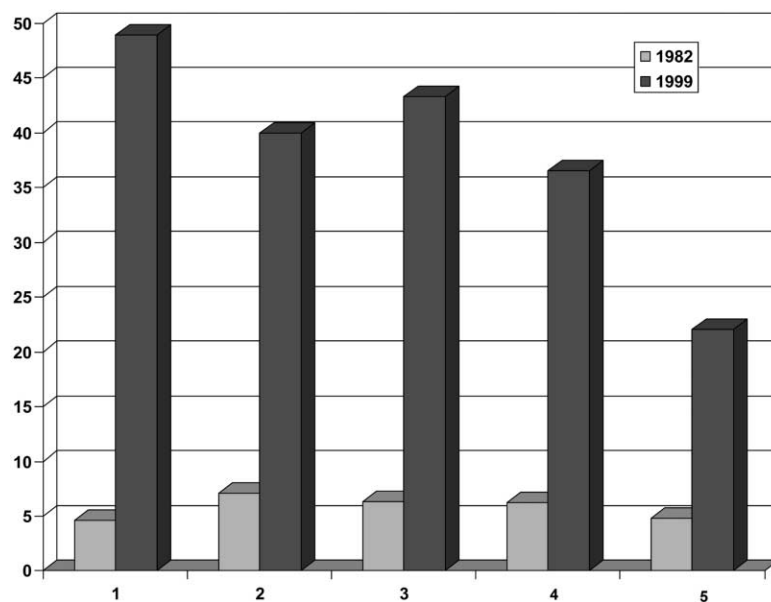


FIG. 17.—Number of factory workers per village in 1982 and 1999, by HYV yield growth quintile.

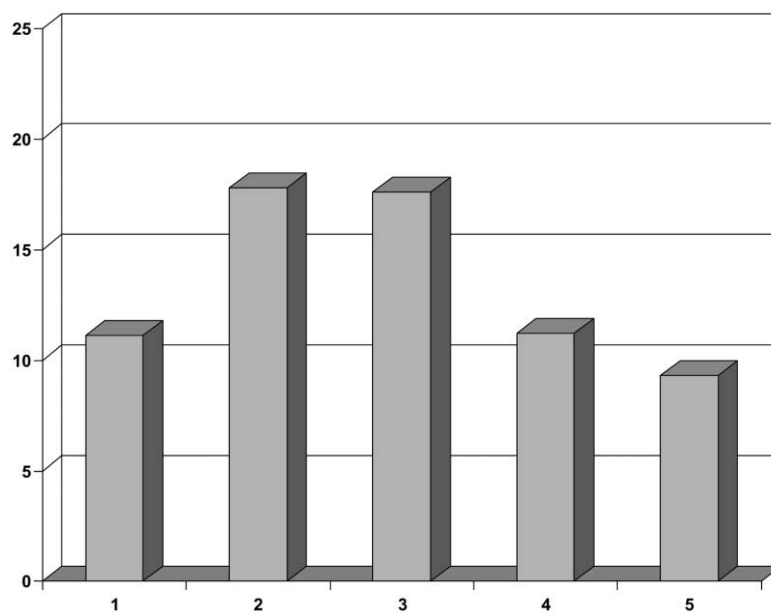


FIG. 18.—Percentage out-migrant sons aged 20–37 of heads in 1999, by HYV yield growth quintile.

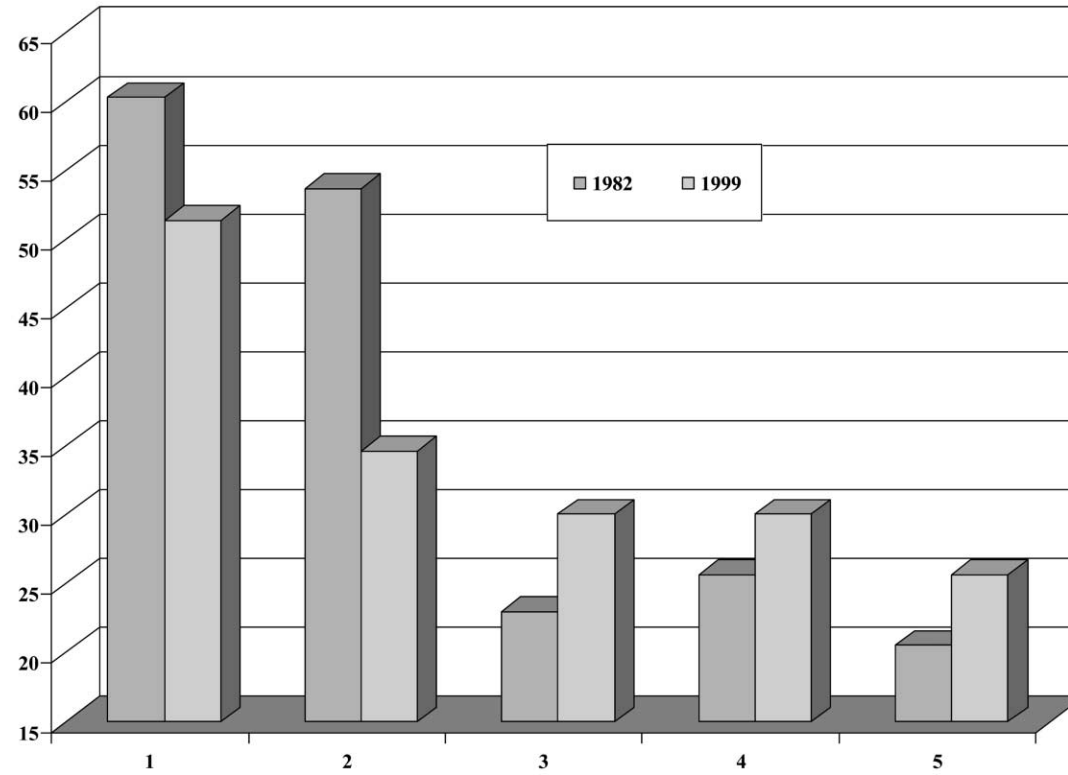


FIG. 19.—Number of local service enterprises, by year and HYV growth quintile

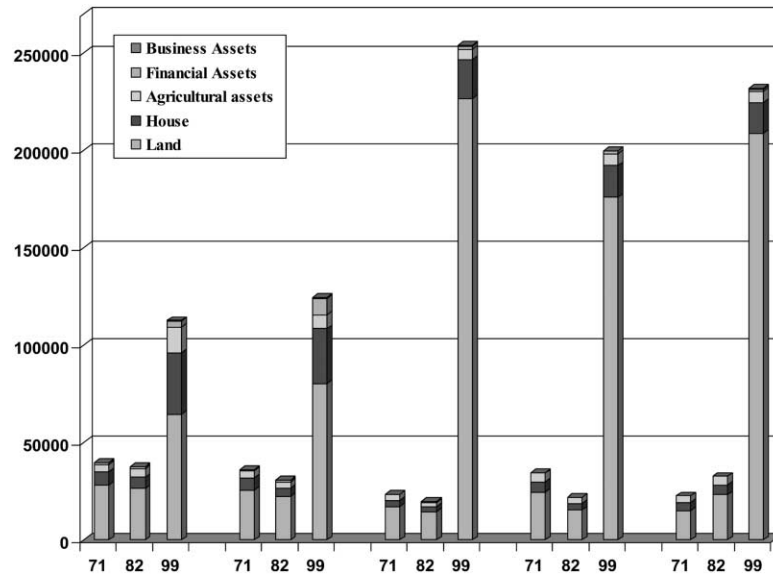


FIG. 20.—Wealth, by type, year, and HYV yield growth quintile

on these averages, low yield growth villages lost 20–40 service jobs in the 1982–99 period while high-growth villages gained approximately 10 workers. This differential is roughly comparable in magnitude but of opposite sign to the differential in factory employment growth by agricultural productivity growth observed in figure 17.

Effects of Capital

One as yet unaddressed component of the agricultural led growth thesis is that agricultural productivity growth produces incremental profits which may then be used to finance investment in nonfarm capital. Patterns of nonfarm income growth and primary activity suggest, as posited in our model, that growth in nonfarm self-employment has played a relatively minor role in terms of the overall expansion in nonfarm activity and thus indicate that this sector is not a significant destination for newly generated capital. The finding that factory growth is highest in the low yield growth quintiles provides further evidence against the proposition that local generation of capital plays an important role as an engine of growth for local nonfarm activity. More direct evidence, however, comes from an examination of how productivity of growth in agriculture affects the composition of wealth.

The data on wealth holdings clearly do not support the hypothesis that expansion in agricultural productivity releases capital for use in local nonfarm investment. Figure 20 shows that total wealth is dominated by land wealth and that growth in the value of land is highest in the high-growth areas. In 1971, there was relatively little variation by level of growth in agricultural

productivity in the share of land wealth, with the shares in all but the highest-growth areas being above 70% and the share in the highest-growth area only slightly lower at 66%. Between 1971 and 1999, however, land wealth grew by a factor of 15 in the high-growth areas while only growing by a factor of 2.3 in the low-productivity areas so that land wealth shares were 90% and 57%, respectively.

Although the finding that the share of nonland wealth declined in high-growth villages does not necessarily imply that capital for nonfarm investment in high-growth areas was not expanding, there is a sound theoretical reason to expect this decline. Given diminishing marginal returns to wealth, the rapid gains in land wealth enjoyed by landed households in the high growth will, *ceteris paribus*, cause households to reduce wealth holdings in other areas, not expand them as implied in the agriculturally led growth thesis. Figure 21 shows clearly that, in fact, growth in nonagricultural wealth was decreasing in agricultural productivity growth: while average nonagricultural wealth grew by Rs 27,358 in the lowest-growth category, it grew by less than half of that, Rs 13,411, in the highest-growth category. It is also evident from figure 21 that the house constituted the major source of nonagricultural wealth holdings and that capital is of minimal importance in terms of the growth of the one component of the nonfarm sector that responds positively to agricultural productivity, the self-employment sector. There is thus no evidence to support the hypothesis that growth in agricultural productivity releases capital that is then invested in the local economy in the form of small business. Nor is there support for the alternate view that capital generated through agricultural productivity growth enhances nonfarm growth elsewhere. Financial assets growth (Rs 2,399) over 1971–99 in the lowest-productivity areas is almost twice the growth of financial assets (Rs 1,353) in the highest-growth areas.

Finally, there is the possibility that agricultural incomes induce greater investment in human capital and that nonfarm activities, including manufacturing jobs, are human-capital intensive. However, our survey data indicate that the average years of education of nonagricultural wage workers in 1999 were one-half year less than for workers in agriculture. This difference is robust to the inclusion of village-level fixed effects.

Proximity to Town

The descriptive results presented thus far provide a strong case against the thesis that increases in agricultural productivity are a major engine of growth in the nonfarm sector. But it is useful to consider other possible factors influencing the growth of the factory sector with a view toward better understanding the process of economic diversification and due to possible mistaken inferences that might arise if these other factors are correlated with agricultural productivity growth. A natural factor to consider in this regard is proximity to an urban center or town. Such proximity may influence factory growth for a variety of reasons. If transportation costs are nonnegligible and urban centers are either a major source of demand for the products of rural factories or

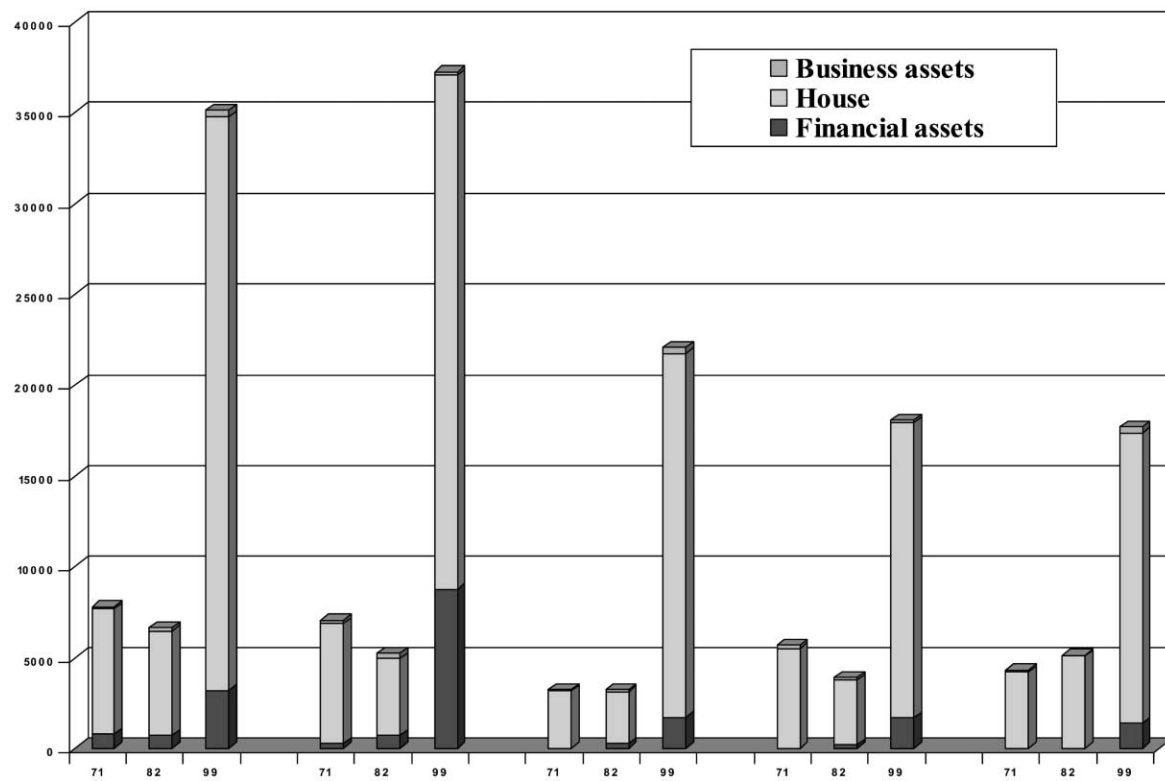


FIG. 21.—Nonfarm assets by type, year, and HYV yield growth quintile, 1971–99

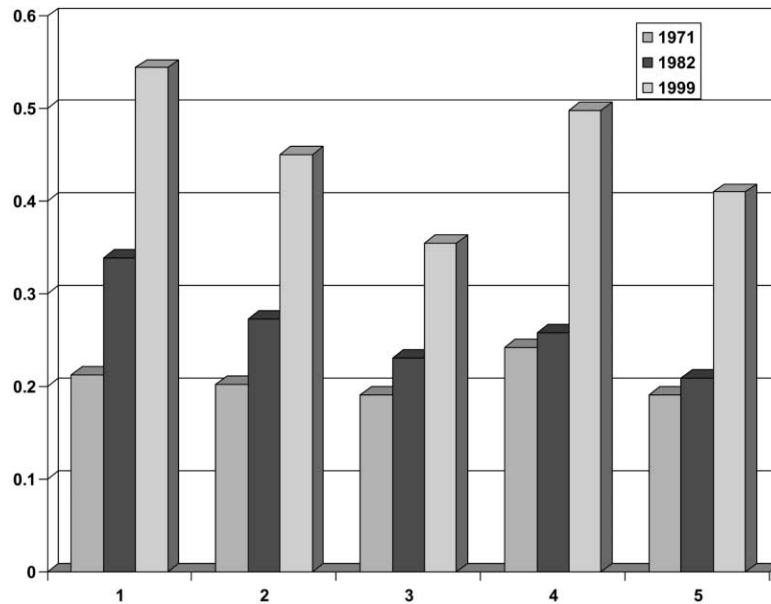


FIG. 22.—Proportion of nonfarm income in total income, by year and town proximity quintile.

provide key intermediate inputs then factories may find it impractical to locate themselves in isolated areas, even those areas with very low wages. The density and quality of the labor force may be different within urban areas, either promoting or discouraging location of factories in these areas. There is also a reasonable case to be made that the growth of towns is influenced by many of the salutary conditions that also predispose an area to productivity growth in agriculture.

Figure 22 presents the proportion of nonfarm income in total income by proximity to town, where proximity to the nearest town is measured in terms of categories based on the quintiles of the distribution of distance to town in the sample villages. There is some evidence of differential proportionate growth in the nonfarm sector. In the areas closest to a town there was an increase in the share of income due to the nonfarm sector from 21% to 54%, a rise of 33 percentage points. By contrast, the rise in the nonfarm sector fraction in the most distant area was only 22 percentage points. Not only are these differences substantially smaller than those observed when stratifying by agricultural productivity growth (fig. 12) but they also seem to be distributed equally between the employee and business components of nonfarm employment. In particular, over the 1971–99 period there was a 32 and 30 point rise, respectively, in the share of nonfarm income attributed to employee income in villages closest to a town as compared to that in villages that are distant from the nearest town (fig. 23). Thus although any correlation between distance to town might partially explain the relationship between productivity

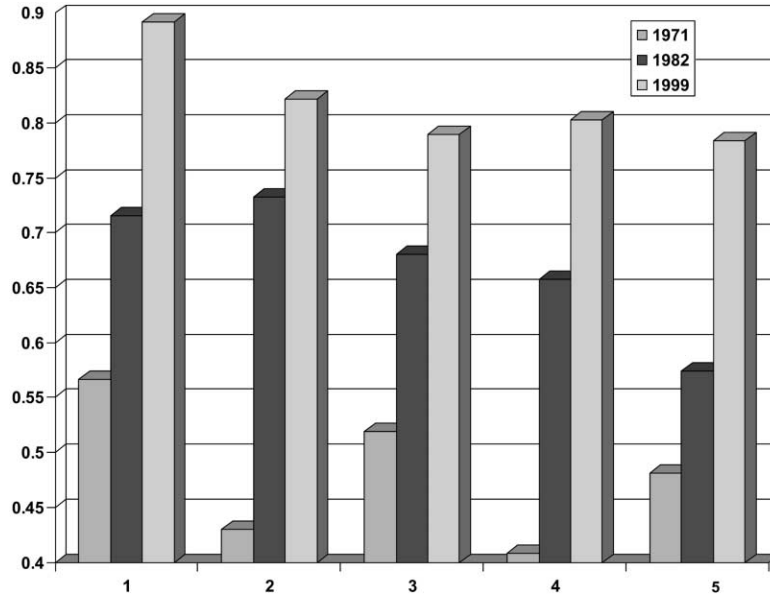


FIG. 23.—Proportion of nonfarm employee income in total nonfarm income, by year and town proximity quintile.

growth and total nonfarm income, it cannot explain the different effects of productivity growth on employee and self-employment income. We explore this issue in greater detail in Section IV.

IV. Econometric Estimates

In this section we obtain econometric estimates of the relationship between yield growth and changes in nonfarm income by source, net of trends related to proximity to towns. In addition we estimate the relationship between yields and factory presence. Based on the survey data in each survey round, we constructed for each village and year per-household agricultural income, wage and salary income, and business income. The equations we estimate are:

$$\begin{aligned}
 y_{it} = & \beta_1 \text{HYV}_{it} + \beta_2 (\text{year} = 1971) + \beta_3 (\text{year} = 1982) \\
 & + \beta_4 \text{town71}^* (\text{year} = 1982) + \beta_5 \text{town71}^* (\text{year} = 1999) \quad (1) \\
 & + \mathbf{Z}_{it} \boldsymbol{\beta} + \mu_i + e_{it},
 \end{aligned}$$

where y is the outcome variable for village i and year t , HYV is the log of the HYV yield index, town71 is a dummy variable indicating whether the village was located within 10 kilometers of a town in 1971, the $\mathbf{Z}$ -vector contains other variables that may affect the dependent variable, μ_i is an unobserved village-specific fixed-factor, and e_{it} is an independently and identically distributed time-varying error term. The coefficients β_2 and β_3 capture period

TABLE 1
ESTIMATES OF THE DETERMINANTS OF TOTAL AGRICULTURAL INCOME, 1971–99

Variable	GLS	FE	FE	FE
Log of HYY yield index	.281 (4.60)	.210 (3.52)	.209 (3.44)	.235 (3.38)
Total crop-year rainfall (mm x 10 ⁻³)	-.0662 (1.22)	.255 (2.64)	.249 (2.51)	.095 (.51)
Rainfall in March (mm x 10 ⁻³)	-.1.71 (1.79)	-2.70 (2.62)	-2.67 (2.59)	-1.26 (.62)
Distance to <i>mandi</i> < 5 km	.136 (2.00)	.266 (2.67)	.265 (2.79)	.151 (1.80)
Year = 1982	-.452 (6.59)	-.314 (3.45)	-.280 (2.70)	...
Year = 1999	-.536 (3.64)	-.402 (2.96)	-.370 (2.39)	...
Distance to town in 1971 × year = 1982 (km x 10 ⁻³)	...	...	-.0679 (.44)	-.091 (.57)
Distance to town in 1971 × year = 1999 (km x 10 ⁻³)	...	...	-.0247 (.13)	-.152 (.77)
Bank in village	...	...	-.0200 (.21)	.0188 (.20)
Post office in village	...	...	-.0777 (.76)	-.118 (1.09)
Constant	6.90 (18.8)	...	...	...
Specification includes state/year interactions	No	No	No	Yes
Number of observations	705	705	705	705

NOTE.—Huber/White estimates of absolute values of *t*-ratios are in parentheses. GLS = generalized least squares; FE = fixed effects.

effects common to all villages, and the coefficients β_4 and β_5 reflect period-specific trends in incomes and factory presence associated with initial town proximity.

We have seen evidence that villages differed in their level of development in the initial period and that villages with initially higher yields also had a more developed nonfarm sector in the initial period. This would induce an upward bias in the coefficient β_1 . To eliminate this source of bias we estimate (1) using fixed effects. Thus, all fixed-effects estimates of yield effects are identified from the relationships between changes in yields (induced by technical change) and changes in the outcome measures.

The first column of table 1 reports the generalized least squares (GLS) estimates of (1) for the log of total agricultural income (farm income plus agricultural wage income). As would be expected, the estimates indicate that higher yields are associated with higher agricultural incomes and that agricultural incomes are also higher in villages located closer to organized agricultural markets (*mandis*). A peculiar finding, however, is that total rainfall in the crop year, as well as rainfall in March, has negative effects on crop income. The fixed effects estimates in columns 2 and 3 indicate that the former

result is spurious. Once fixed factors associated with climate are swept out, total annual rainfall has the expected positive effect on agricultural income. The fixed-effects yield estimate is only slightly smaller than the GLS counterpart, however, indicating that a doubling of HYV yields raises agricultural incomes by 21%. In the third column, the initial proximity to towns and financial infrastructure variables is added. These have no effect—agricultural incomes, net of yield growth, did not grow more in villages initially close to towns or because of the presence of formal credit institutions. The time dummy variables indicate, however, that net of yield improvements, agricultural incomes are lowest in the postreform 1999 period and highest in 1971. This is consistent with the growth in nonfarm employment opportunities, which raises labor costs, occurring in the 1980s and 1990s. Finally, in the last column we report fixed-effects estimates from a specification in which we include both a full set of state dummy variables and interactions between year and the state dummy variables. These coefficients absorb any changes in policies across states over the time period, such as changes in regulations regarding factory employment, that may affect factory location (Besley and Burgess 2003). The addition of these variables does not substantially change the estimated coefficient for the HYV variable.

The estimates in table 1 clearly indicate that moving the yield growth frontier increases agricultural incomes. Does yield growth also increase local nonagricultural incomes? Table 2 reports GLS and fixed-effects estimates of the relationship between agricultural yields and the presence of a factory in the village, the log of nonfarm wage income and the log of business income. The estimates of the yield effects based on the cross-sectional relationships suggest that higher yields are associated with both higher nonfarm wage and local business income. However, these estimates appear to be substantially upward biased due to a correlation between local development and yields. When the fixed effect is removed, the estimates indicate, consistent with the figures based on yield growth, that an increase in crop yields reduces significantly the probability that a factory employs individuals from the village and decreases the level of nonfarm wage income. These results are consistent with a framework in which nonfarm capital is mobile and seeks low-wage areas, so that agricultural development and nonfarm activities are substitutes rather than complements. Agricultural development also appears to have only a negligible effect on local nonfarm business income. In particular, the fixed-effects point estimates suggest that a doubling of yields reduces the probability of a factory locating in a village by 27% (using the 1982 mean) but has little effect on nonfarm wage or business incomes taking into account any changes in the policy environment across states. The competition, rather than the complementarity, between agricultural and nonagricultural activities is also seen in the time dummy variables—local factory presence and nonfarm wage incomes are significantly higher, given crop yields, in 1999 compared to 1971, while from table 1, we saw that agricultural incomes were significantly lower

TABLE 2

ESTIMATES OF THE DETERMINANTS OF VILLAGE FACTORY PRESENCE, LOG OF MEAN NONFARM WAGE INCOME, AND LOG OF MEAN BUSINESS INCOME, 1971–99

DEPENDENT VARIABLE	FACTORY IN VILLAGE			LOG OF NONFARM WAGE INCOME			LOG OF BUSINESS INCOME		
	GLS	FE	FE	GLS	FE	FE	GLS	FE	FE
Log of HYY yield index	-.00543 (.29)	-.0719 (2.87)	-.0481 (1.98)	.127 (1.07)	-.246 (2.14)	-.102 (.80)	.270 (2.02)	.105 (.75)	-.131 (.92)
Year = 1982	.0558 (1.56)	.114 (2.81)	...	-.0086 (.04)	.522 (2.22)	...	1.02 (4.80)	1.17 (4.81)	...
Year = 1999	.0755 (2.00)	.178 (3.48)	...	2.01 (8.23)	2.81 (10.9)	...	-.367 (1.15)	-.0844 (.26)	...
Distance to town in 1971 × year = 1982 (km × 10 ⁻³)	.0905 (1.49)	.0530 (.69)	.0593 (.82)	1.27 (3.82)	.326 (.88)	.149 (.41)	.208 (.81)	.150 (.33)	.348 (.75)
Distance to town in 1971 × year = 1999 (km × 10 ⁻³)	.179 (2.71)	.141 (1.77)	.0003 (.01)	.468 (2.26)	-.495 (1.43)	-.600 (1.78)	.617 (1.48)	.534 (1.05)	.877 (1.75)
Constant	.141 (1.35)	...	...	4.29 (6.42)	...	...	2.68 (3.54)	...	...
State/year interactions included	No	No	Yes	No	No	Yes	No	No	Yes
Number of observations	705	705	705	705	705	705	705	705	705

NOTE.—Estimation procedures are GLS, generalized least squares, and FE, fixed effects. Huber/White estimates of absolute values of *t*-ratios are in parentheses.

TABLE 3
ESTIMATES OF THE DETERMINANTS OF LOG OF TOTAL INCOME, 1971–99

Variable/Estimation Procedure	GLS*	FE†
Log of HYY yield index	.144 (5.55)	.0796 (2.58)
Distance to town in 1971*year=1982 (km x 10 ⁻³)	-.0210 (.33)	.0662 (.59)
Distance to town in 1971*year=1999 (km x 10 ⁻³)	.033 (.23)	.051 (.36)
Degrees of freedom	239	433
Number of observations	705	705

NOTE.—Huber/White estimates of absolute values of *t*-ratios are in parentheses.

* Specification includes year dummy variables, state dummy variables, and interactions between year and state dummies.

† Specification includes year dummy variables and interactions between year and state dummies.

in the postreform period. Finally, none of the estimates indicate that initial proximity to towns has any effects on nonfarm activities.⁸

The fact that agricultural productivity improvements did not lead to increases in nonfarm incomes where they occurred and, indeed, led to decreases in nonfarm incomes, does not mean that investments in agricultural technology do not pay off. Table 3 reports GLS and fixed-effects estimates of the associations between yield rates and the log of total household income. Again, the GLS, cross-sectional estimate of the crop yield effect is evidently upward biased. The fixed-effects estimate of the yield effect, however, is still positive, but modest in size—indicating that a doubling of agricultural yields in an area raises total incomes by only 7.6%, compared to raising average agricultural income by over 20% (table 1). The difference is evidently due to the mobility of nonagricultural capital. The net beneficial effects of overall nonfarm employment growth on total incomes is seen in the national trends in incomes and nonfarm employment.

V. Conclusion

Although the success of the Green Revolution in India and around the world in raising rural incomes and reducing rural poverty by increasing agricultural productivity is widely acknowledged, there is also recognition that a single-minded focus on enhancing productivity growth in agriculture as a source of welfare enhancement in rural areas is likely to be counterproductive in the context of a global economy. Not only is increased global food productivity likely to result in decreased global prices and thus lower returns to poor farmers, but also there are substantial regions of the world where poor climate or topology provide little opportunity for expansion of agricultural yields in the absence of sustained subsidies.

Given these constraints it is no surprise that increased attention has been given in recent years in development-oriented entities such as the World Bank to the potential for expansion of the nonfarm sector in rural areas as a source

of income growth and poverty reduction. But this focus raises an obvious question that has long been of concern to development economists such as D. Gale Johnson: whether expansion of the nonfarm sector in rural areas is predicated on the prior expansion of agricultural productivity in those areas. The absence of data on sectoral time allocations and income generation that has sufficient geographical and temporal scope has made it difficult to bring empirical insight to bear on this issue, and thus the question has remained largely unresolved. There is, of course, strong theoretical grounding for the proposition that, given sufficiently low barriers to trade, there are important efficiency gains to be realized from having different regions specialize in the production of different commodities. What has been unclear is whether these barriers are sufficiently low in the context of contemporary rural areas of developing countries to achieve such gains.

In this article, we use a 30-year panel of households from a national sample of rural India to examine this question. Our results are striking and, to our minds, unequivocal. Growth in income from the nonfarm sector in rural India over the last 30 years has been substantial, and the primary source of this growth, the expansion of rural industry, is not predicated on expansion of local agricultural productivity. Indeed, as would be anticipated by a model in which rural industry producing tradable goods seeks out low-wage areas, factory growth was largest in those areas that did not benefit from enhancement of local agricultural productivity growth over the study period.

Not only do these results indicate that nonfarm growth can play an important role in the overall expansion of incomes in rural areas but they also suggest that nonfarm growth is especially pro-poor. Poor rural households are endowed with little other than low-skilled labor, and rural industry appears to be able to productively employ this labor. Thus, in contrast to agricultural productivity growth, which expands the return to a factor that is concentrated among the better-off households (land) in addition to expanding the return to unskilled labor, entry of the factory sector tends to have a greater proportional impact on the income of the poorest members of the village. This is not to say that investment in agricultural productivity growth is not an important dimension of an overall strategy for poverty reduction in rural areas of low-income countries. Instead, it suggests that, from the perspective of poverty reduction, removal of barriers to nonfarm capital and product mobility within and across countries is an important complement to investments in agricultural productivity that target those areas well suited to cultivation.

References

- Besley, Timothy, and Robin Burgess. 2003. "Can Labor Regulation Hinder Economic Performance? Evidence from India." Unpublished manuscript, London School of Economics.
- Evenson, Robert E., and James W. McKinsey. 1999. "Technology-Climate Interactions in the Green Revolution in India." Economic Growth Center Discussion Paper no. 805, Yale University, August.

- Foster, Andrew D., and Mark R. Rosenzweig. 2003. "Economic Growth and the Rise of Forests." *Quarterly Journal of Economics* 118 (2): 601–37.
- . 2004. "Agricultural Development, Industrialization and Rural Inequality." Mimeographed, Harvard University, John F. Kennedy School of Government.
- Johnson, D. Gale. 2000. "Population, Food, and Knowledge." *American Economic Review* 90 (1): 1–14.
- National Commission for Women. 2001. *Status of Women in India, 2001*. Delhi: Government of India.
- Ravallion, Martin, and Gaurav Datt. 1996. "How Important to India's Poor Is the Sectoral Composition of Economic Growth?" *World Bank Economic Review* 10 (1): 1–25.
- . 1999. "When Is Growth Pro-poor? Evidence from the Diverse Experiences of India's States." Unpublished manuscript, World Bank, Washington, DC.

Notes

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1. For example, Ravallion and Datt (1996, 1999) using a state-level data set from India that combines multiple national-level cross-sectional household surveys with state-level aggregate data on sectoral income, does not find strong evidence that agricultural growth increases nonagricultural growth. However, an important limitation of their data is that nonfarm income is not available from their data sources separately for rural and urban areas.

2. The question arises whether the 1971 set of villages is still representative of villages in India in the 1990s. According to the Indian Census, between 1971 and 1991, the number of villages increased by only 5.4%. Some villages consolidated into towns during this period, although none in our sample.

3. Thus, the yield figure is not the laboratory maximum; it reflects exogenous local growing conditions and resistance to disease and pests. Some component of the spatial and temporal variation in the measure, however, reflects input-use variation.

4. The NSS employment data indicate that the share of rural male workers employed in manufacturing rose from 5.7% of the total rural workforce to 7.3% from 1972 to 1999, a rise of 28%; the shares for rural women increased 62%, from 4.7% to 7.6%. These and other NSS figures are obtained through Indiatat, <http://www.indiatat.com> a web-based compilation of Indian statistics, and were extracted by Indiatat from National Commission for Women (2001).

5. The 1971 data do not provide information on the number of establishments or on factory employment. Villagers were employed in factories in only 10% of villages in 1971.

6. Unless otherwise qualified, the phrases "low-growth areas," "lowest-growth category," and "lowest quintile" refer to the villages in the lowest 20% of HYV crop yield growth measures over the 1971–99 period, and "high-growth areas," "highest-growth category," or "highest quintile" refer to the villages with the highest 20% of HYV crop yield growth in this period.

7. Foster and Rosenzweig (2004) present evidence that increases in HYV yield growth, net of factory expansion and population change, significantly raised unskilled wages.

8. Neither the financial institution nor rainfall variables have any statistically significant effect on the dependent variables in table 2.

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