Private Enterprise Development in Low-Income Countries

Productivity and Competition in India's Brick Industry

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A detailed survey of the Indian brick industry shows substantial productivity dispersion, attributable to both technology differences as well as within-technology efficiency variation. In contrast to results from developing countries, we find no increase in productivity in larger (potentially more competitive) markets, nor do entrants have significantly higher productivity than exiting firms.

Introduction

Firms in developing countries exhibit large variations in revenue and output, even conditional on inputs. This empirical observation has motivated a large and growing literature on capital misallocation (Banerjee and Duflo 2005, Hsieh and Klenow 2009) that has compelled academics and policymakers to rethink the underlying causes of low productivity and growth. These studies imply that it is not so much the low levels of capital and technology in developing countries that perpetuate poverty, but rather that resources are not allocated to the entrepreneurs who would make the most productive use of them. Yet several fundamental questions remain unanswered by this literature. First, the link from high variability of input-adjusted revenue to dispersion in the marginal return to capital, and hence to capital misallocation across firms remains largely theoretical. Second, the question of why forces of competition have not, as theory would predict, led to a uniformly high level of productivity remains unresolved.

This project takes an approach new to the development literature by studying a single industry (bricks) across a wide variety of markets with different conditions. The brick industry has several advantages for this type of research: its output is relatively homogeneous, production is simple, and bricks are difficult enough to transport that markets remain quite separate. Finally, the industry is very large, with well over 100,000 firms across India.

Project Activities

The project has conducted 6 rounds of surveys in three Indian states. The 1st, 3rd, and 6th rounds carried out a census of all brick firms across 11 districts in 3 states of India, designed to measure the market level outcomes. The census rounds interviewed over 9,000 firms on their output, price, employment and other key outcomes. The 1st, 2nd, and 4th-6th rounds conducted a much more detailed survey of firm managers and owners that covered a random sample of 600 firms. The sample was stratified by market density, with 400 firms drawn from 100 dense brick clusters, and the remaining 200 from more isolated locations. Data was collected on the inputs, prices, wages, and other costs of the firm, and also on the financial status of the firm owner in terms of his access to credit and savings.

Finding 1: Large Regional Heterogeneity

Bricks are a relatively homogeneous good, with a simple production process. Therefore one might expect that a single brick manufacturing technology would be used throughout India, and all factories would be similar. This is far from the truth, both across and within markets. The brick study covers three states, each with distinctive market characteristics:

- Northern India (Uttar Pradesh): Essentially all firms produce bricks using *Bull's Trench Kilns*, a large-scale method that employs up to 250 workers during the main summer production season. Kiln density is relatively low.

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- Central India (Madhya Pradesh): All firms produce bricks using *clamps*, a small-scale method that frequently uses only family labor for production. Kiln density is high.
- South India (Karnataka): Firms use a variety of production technologies, ranging from the same small clamps seen in Madhya Pradesh to mid-sized *Open Kilns* to large-scale *Hoffman Kilns*. Kiln density is highly variable by market within the state.

Figure 1: Kiln heterogeneity in Karnataka. Open kiln (foreground) and Hoffman kiln (background).

Even with no further data on output or input use, these major differences in the fundamental technologies used to produce bricks suggest substantial productivity differences. While the variation between northern and central states might be explained by different soil types or market conditions, these factors cannot explain why very different technologies co-exist in Karnataka, often only a few hundred meters apart (Figure 1).

Finding 2: Substantial productivity dispersion across and within technologies

Quantitative data on brick output confirms the productivity heterogeneity suggested by the variety of brick kiln types. A simple regression of (log) bricks produced on indicator variables for kiln type and flexible polynomials of other inputs demonstrates this phenomenon. Since the major input is fuel, these regressions can be interpreted as measures of the relative efficiency of different technologies in transforming energy into bricks. Figure 2 graphs the residuals from these regressions, showing the distribution of productivity within and across different kiln types.

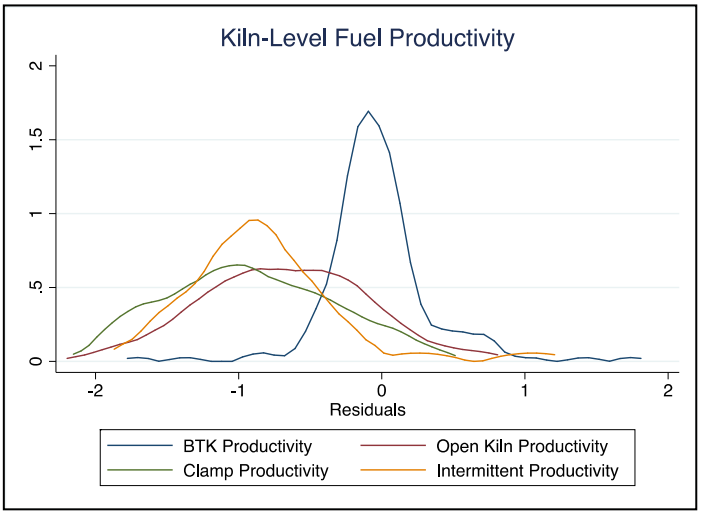

Figure 2: Kernel Density of Fuel Productivity

All kiln types are substantially less efficient than the Bull's trench kiln, and even among these there are significant differences. In particular, open kilns are significantly less productive than Intermittent kilns, again raising the question of how the two firms visible in Figure 1 both remain in production.

While these productivity differences derive from observable technologies, the existing literature has focused on the unobserved components of productivity, and here too we find substantial heterogeneity. We estimate the brick-fuel production function of all kilns in the sample[1], and examine the distribution of the implied TFP residuals. Even controlling for kiln type, the 75th percentile firm produced 84% more output than the 25th percentile, a spread of .61 log points. In contrast, Syverson's (2004) study of the US ready mix concrete sector finds a spread of .28 and Hsieh and Klenow find an average spread of 1.55 across all Indian industries. Since both of those studies exclude all small firms (whereas I do not) their results are likely biased downward relative to mine. Thus, while productivity dispersion remains economically significant and important, my results from the brick industry do not show the much larger dispersion in developing countries as documented by Hsieh and Klenow (2009).

[1] Production function details available from the author.

Finding 3: Substantial Quality Heterogeneity

Previous studies of productivity in manufacturing have generally avoided the issue of product quality, largely because of data limitations. However, ignoring quality differences both introduces a potential source of bias into the measures of productivity as well as limits our understanding of the market forces that may allow productivity dispersion to persist.

The study collected bricks from 600 firms (in 5 rounds) and subjected them to tests of compressive strength and water absorbency. Both these measures are highly correlated with brick price, and the correlations remain significant even when controlling for very fine measures of the geographical location of the kiln. Kiln type affects quality as well as productivity. Bull's trench kilns (BTK) produce the highest quality, with open, intermittent and Hoffman kilns producing slightly lower (10%-14%) quality. Clamps kilns are by far the worst quality, with 54% lower compressive strength than BTKs and 38% greater water absorption. These results are also robust to district fixed effects.

Turning to the unobserved dimension of productivity, we find that there is essentially no relationship between a firm's fuel productivity residual (as discussed in Finding 2) and the quality of bricks that it produces. Quality is not correlated with the TFP residual, nor does controlling for it reduce the observed variance of productivity conditional on kiln type.

The quality data deepen the mystery of coexistence of different kiln types. Open kilns and clamps do not falsely appear to be less productive because they are producing higher quality products, indeed the opposite is true. Similarly, the large distribution of TFP residuals cannot be explained by unobserved productivity either.

Finding 4: Larger markets do not have higher productivity

A robust finding of both the productivity literature and the agglomeration literature has been that larger markets have both reduced productivity dispersion and higher average productivity. This is taken as evidence of either the selection effects of tightened competition, or of the agglomerative spillovers present in larger markets. The brick study, with its coverage of multiple geographically independent markets of different sizes, is an ideal setting to examine these predictions.

The firm level results, in Figure 2, show a clear reduction in productivity dispersion in larger markets but no evidence of an increase in the mean level of productivity. Repeating the analysis at the market level (results available from the author) confirms this finding: larger markets have decreased productivity spread, but their firms are not, on average, more productive.

Policy Impact

The data analysis for the project is continuing, and we expect to generate additional findings and policy implications. However, the preliminary results point to several implications for government policy that seeks to improve productivity, either for economic development or environmental goals:

- Even in relatively homogenous markets, forces of market competition are not sufficient to eliminate firms with productivity levels many times below the market leaders. Since these less productive firms are the most polluting, they are unlikely to exit the market without explicit government regulation.
- Much productivity variation is at the regional level, due to differences in technologies and input qualities. Investments in infrastructure would allow greater competition across regions, potentially increasing competition across firms and reducing productivity dispersions.
- Attempts to introduce cement brick making technology among current clay brick entrepreneurs in

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Karnataka were unsuccessful, despite the generally increasing market share of cement bricks. This suggests that the main driver of productivity improvements may be new entrants in slightly different product types. Thus, if policymakers wish to improve brick productivity, the most effective policies may be to encourage entry from outsiders in more efficient substitute products (cement blocks), thereby shifting output away from a less efficient product (clay bricks). Conversely, targeting existing entrepreneurs to expand their product selection seems unlikely to succeed, perhaps because these entrepreneurs are reluctant to decrease their existing businesses.

Moving Forward…

The preliminary results suggest at least two promising directions for future research that have received little attention in the productivity literature. First, quality differences may be enabling productivity dispersion, rather than mediating it. If different customers have heterogeneous preferences for quality, firms may target different sectors of the market and competition will be less intense than if all firms were to sell identical productions. This in turn reduces the competitive pressures on low productivity firms, and allows them to maintain production in an environment where they might otherwise be forced to exit. Second, the forces that increase productivity in large markets in developed countries appear to be absent in this context. Perhaps the market forces that lower firms' profits in tighter competition are also reducing their ability to invest in higher productivity technologies (as in Aghion, Howitt 2005).

References

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