Firm Size and Structural Change:

A Case Study of Ethiopia*

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Abstract

I use firm-level census data to study changes in the structure of Ethioipia's manufacturing sector between 1998 and 2008. Over this period, aggregate manufacturing value-added grew at the same rate as GDP, the number of manufacturing firms more than doubled, and average firm size fell by more than 40%. I highlight substantial heterogeneity in economic performance across firms, and emphasize a strong association between firm size and value-added per worker. I find that 29% of the value-added size gap can be attributed to differences in product selection across small and large firms. I find no systematic difference in the output price charged by small and large firms for a given product. I therefore attribute the remaining value-added size gap to a higher level of physical labor productivity in large than in small firms. I conclude that small and large firms in Ethiopia use quite different technologies to produce similar products, and that an increase in the number of large firms would raise value-added per worker and ultimately GDP per capita in the country.

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1. Introduction

Despite a decade of rapid economic growth, Africa's industrial sector remains small and underdeveloped. John Page (2010) highlights figures indicating that Africa has actually de-industrialized over the last 3-4 decades. Unless this trend can be reversed, Africa is likely to remain overly dependent on agriculture and the extraction of natural resources in the foreseeable future.

Improving the investment climate is often argued to be important for stimulating growth in Africa's private sector. The idea that better logistics, more sensible regulations, better courts etc. should help attract investors certainly has some intuitive appeal. However, judging by the Doing Business indicators published by the World Bank, many African countries have achieved significant improvements in the investment climate over the last decade, and yet manufacturing production has not taken off. One striking but sometimes forgotten fact about African firms is that considerable differences in firm performance can be observed across firms operating within the same investment climate. The premise of this paper is that something can be learned from such differences.

My outcome variable of interest in this study is the value-added per worker generated by manufacturing firms. Of course, this is not the only outcome of interest in the private sector in general. Firm-level decisions on jobs, exports, investment, training all impact on standards of living one way or another. However, as firm-level value-added is essentially the micro analogue of GDP, I think there is something to be said for paying close attention to the trends in this variable and its determinants. More specifically, my goal is to shed some light on why some firms are able to produce vastly greater amounts of value-added per worker than others. My country under study has recorded rapid economic growth over the last decade and yet remains one of the world's least industrially developed nations: Ethiopia.

The idea that Ethiopia needs to diversify its production does not seem contentious. The agricultural sector employs 85% of the labor force, and the value-added per person engaged in agriculture is only marginally higher than USD 200 per year according to the World Bank Indicators published by the World Bank. The remaining 15% of the workforce are engaged in activities for which the average value-added per person is about seven times as high as in the agricultural sector. One of the oldest ideas in development economics is that the route towards development involves structural change, with workers leaving the agricultural sector in order to join the modern sector where output per worker is higher (Lewis, 1954). Ethiopia has clearly not yet experienced structural change on a significant scale, but one can at least observe that there are segments of the economy in which the value-added per worker is quite high. Some manufacturing firms fall into the latter category, and one of my objectives is to better understand what distinguishes such firms from less successful enterprises.

Recent thinking on industrialization and structural change revolves around the idea that what a country produces matters crucially for its economic development. Hausmann et al. (2007), for example, argue that poor countries export "poor-country goods" that are associated with low value added, while rich countries export "rich-country goods", associated with high value added. These authors also show that the product mix adopted by countries matters for economic development and growth. My empirical analysis draws on this strand of the literature, and on related research for other regions emphasizing the importance of product choice for firm-level performance. Using rich firm-level data I test whether product choice, output prices and productivity are important driving factors of the value-added differences observed across firms. These data have been used in previous studies by Siba and Söderbom (2011) to study the effects of demand and productivity on firm survival, and by Bigsten, Gebreeyesus, Siba and Söderbom (2011) to test for agglomeration effects. As far as I know, there exists no previous study on Africa linking differences in value-added per worker to prices, products and productivity.

The most obvious observable variable correlating with value-added per worker is firm size. Large firms tend to record much higher levels of value-added per worker than small firms. Large firms also tend to pay higher wages, export more, invest more, etc. than do small firms. The vast majority of African firms, however, tend to be very small. From a technological and organizational point of view, the idea that manufacturing production is best performed within large numbers of separate, very small enterprises seems at odds with experiences elsewhere (e.g. in Asia) emphasizing the importance of economies of scale. Small firms do create jobs and offer a safety net for unskilled workers, and clearly play an important role. However, there is no way around the fact that the value-added associated with these jobs is low. Improving the understanding of why this is the case is the main goal of the paper.

The remainder of the study is organized as follows. Section 2 sets the scene for the rest of the analysis, summarizing key features of industry and development in African and Ethiopia. Section 3 introduces the Ethiopian firm-level data that provides the basis for the microeconometric analysis in the paper. Section 4 analyzes product choice across firms and over time. Section 5 decomposes the gap in value-added per worker observed between large and small firms into portions attributable to differences in product selection, pricing and physical productivity. Section 6 sums up the discussion and the main arguments.

2. Manufacturing and Industry in Africa and Ethiopia

Table 1 summarizes key indicators of economic and industrial performance in 1995-2008 for Ethiopia and for Sub-Saharan Africa (SSA). While per capita income has grown rapidly both in Ethiopia and SSA (column 1), the share of manufacturing in total value-added has been constant over the whole period, both for SSA and for Ethiopia. Thus there are no signs of a 'take-off' in manufacturing. Nevertheless, since the overall economic growth has been high and manufacturing has retained a constant share in GDP, it follows that there has been significant growth in manufacturing in absolute, albeit not in relative, terms. The industrial sector, defined as manufacturing plus mining, construction, electricity, water, and gas, has grown in relative importance over the sampling period. Between 1995 and 2008, the share of industry in total GDP rose from 0.29 to 0.33 for SSA, and from 0.10 to 0.13 for Ethiopia. Clearly this is driven by rapid growth in the non-manufacturing industrial sectors. In Ethiopia, for example, the construction sector has grown very rapidly.

The trends for exports are also encouraging. Merchandise exports per capita, expressed in current USD, have increased from USD 7.4 to 18.6 for Ethiopia, and from USD 130 to 411 for SSA, between 1995 and 2008. Manufactured exports have also grown, from USD 0.8 per capita to 1.7 for Ethiopia, and from 40 to 132 for SSA. Clearly for Ethiopia, this is growth from an extremely low level.

As noted above, the fact that the share of manufacturing in total value-added has been constant over the last decade implies that manufacturing output has grown at the same rate as the rest of the economy. This is true both for Ethiopia and for SSA. Because Ethiopia has recorded strong overall growth it must be that manufacturing has also grown quite fast in absolute terms. One of my objectives in this paper is to highlight the dynamics of Ethiopia's manufacturing sector and to look for significant changes over time. Before doing so, I will discuss the micro data that underlies the empirical analysis that then follows.

3. Ethiopian Firm-Level Data

Very rich and comprehensive firm-level data exist for Ethiopia. All manufacturing firms in the country that use electricity in production and that employ at least ten workers are surveyed every year by the Central Statistical Agency (CSA) of Ethiopia, as part of the *Large and Medium*

Manufacturing Industries Survey. There is information on output, capital, labor, raw material, energy inputs, and other industrial costs in the dataset. There is also a detailed product-price module in the survey instrument, which I will discuss in more detail below. These data have been used in several recent papers to study various aspects of firm performance in Ethiopia. The studies most closely related to the present paper are those by Siba and Söderbom (2011) and Bigsten, Gebreeyesus, Siba and Söderbom (2011). Table 2 shows the size distribution across industrial subsectors in Ethiopia based on the data for 2006/07. More details about the data, and survey reports, can be found at the website of CSA, http://www.csa.gov.et.

Manufacturing enterprises (including grain mills) which use power-driven machinery and which engage less than ten people are covered in the *Small Scale Manufacturing Industries Survey.* Three rounds of this survey are currently available, generating data for 2001/02, 2005/06, and 2007/08. Unfortunately there is no panel dimension in these data. More details can be obtained at the CSA's website.

Between them, these two surveys cover Ethiopia's power-driven manufacturing sector. Table 3 summarizes key characteristics of the firms in this sector, broken down by enterprise size. Summing across all size categories distinguished in the table, total value-added of power-driven manufacturing comes to about 10.3 billion birr, which is about 4% of Ethiopia's GDP. The size distribution of enterprises is highly skewed. The micro firms constitute 96% of all manufacturing firms, employ 51% of all manufacturing employees, but produce just 11% of manufacturing value-added. Firms with 50 or more employees account for more than 85% of manufacturing value-added. These figures imply large productivity differences across firms of differing size. In the category of micro firms, total value-added per person engaged is 8,200 birr. This is more than twice as high – 17,400 birr - for the category of firms with 10-19 employees. Amongst firms with 20-49 employees, value-added per worker is 27,200 birr, while for the group of firms with more than 50 employees it reaches 79,400 birr. Figure 3 shows a scatter plot based on the micro data. The log of value-added per worker is recorded on the vertical axis and log employment on the horizontal one. The strong association between value-added per worker and firm size is again apparent.

The magnitude of these differences is truly striking: a worker in a firm with 50 or more employees produces as much value-added in just over an hour as does a worker in a micro enterprise in a (10-hour) day, on average. One reason for this is that large firms have better technology. The figures in Table 3 indicate that the capital-labor ratio in the group of firms with 50 or more employees is about 10 times higher than that of the micro sector. Large firms tend to have better management and better qualified workers than micro firms too.

The positive correlation between firm size and value-added per worker is certainly not unique to Ethiopia. But it is much more pronounced than what is observed in most other countries. For Sweden, for example, firms with less than 10 employees account for 6% of total manufacturing value-added and 6% of total manufacturing employment, while firms with more than 250 employees generate 62% of total value-added and employ 53% of all manufacturing workers (Sato and Söderbom, 2011). This corresponds to a much smaller gap in the value-added per worker across large and small firms than what can be observed for Ethiopia. A strong association between value-added per worker and firm size has been documented for other African countries too, see e.g. Söderbom and Teal (2004) for an analysis of Ghana.

There is a large class of enterprises that are not covered by these surveys, namely enterprises that do not use power to produce output. Such firms belong to the cottage and handicraft sector, which engages many more individuals than manufacturing firms with power-based production. The latest available figures, which are for 2002, indicate that there are 974,676 cottage and handicraft establishments engaging a total of 1,306,865 individuals (CSA, 2003, cited in

Gebrehiwot and Wolday, 2001). Sixty-three percent of these enterprises were located in rural areas, and 74% of the persons engaged in this sector were women. As the technology is very rudimentary in these enterprises, the value-added per worker is likely to be very low.

3.1. Trends

In this section I present summary statistics based on the firm-level data that are informative about the nature of the growth and dynamics within the manufacturing sector. I exclude micro enterprises (firms with less than ten employees) from the analysis because of lack of data. While, as noted above, there has not been structural change, there have been several significant changes within the sector over the last decade.

Figure 1 shows that the number of registered formal manufacturing firms with ten or more workers grew very rapidly between 2001 and 2008. In the beginning of this period there were less than 700 formal manufacturing enterprises in the country, while at the end there were more than 1,600 such firms. A growth rate in the number of establishments of more than 100% over an eight year period is really quite exceptional. Yet, the share of manufacturing output in aggregate output did not change over this period. Why, despite such a high net entry rate of new establishments, did not manufacturing output grow faster?

Figure 2 provides some clues. This graph displays the average and the median number of employees in manufacturing firms between 1999 and 2008. Average employment fell from close to 120 in 1999 to less than 70 in 2008, clearly a very significant drop.[1] The median size in 2008 was 19 employees, which is lower than at any other year during the sampling period. These results are primarily driven by the fact that new firms entering the market are mostly quite small. This appears to be the main reason why manufacturing output grew at a much more modest rate

[1] Total employment in the formal manufacturing sector grew on average by 4% per year, which is a percentage point higher than the overall population growth rate as reported in the World Development Indicators.

than the number of establishments over this period. Moreover, as documented above, small firms tend to generate much lower levels of value-added per worker than large firms. Hence the drastic fall in average firm size will be accompanied by a fall in average value-added per employee.

4. Product Selection

Product selection has recently become an issue of great interest to economists concerned with industrial development and international trade. One implication of the findings reported by Hausmann et al. (2007) is that industrial development in poor countries requires a change in the product mix and a shift towards the production of higher value-added products. A related but more micro oriented literature has focused on the product choices made by individual firms, and how these change in response to trade liberalization. Iacovone and Javorcik (2010), for example, find that Mexican manufacturing firms have become more specialized as a result of the implementation of the North American Free Trade Agreement. Aw and Lee (2009) document higher specialization in the Taiwanese electronics sector as a result of increased foreign competition during the 1990s.

Ethiopia has experienced significant policy changes over the last decade, which may have impacted on the product choice made by the firms. To examine how product decisions have varied over time and across firms I run regressions of the following form:

$$P_{kit} = \delta \log L_{it} + \tau_{kt} + e_{kit}, \tag{4.1}$$

where P_{kit} is a dummy variable equal to one if firm i produces product k at time t and zero otherwise, L_{it} is total employment, τ_{kt} is a product-specfic time effect, e_{kit} is a residual and δ is a parameter to be estimated.

Based on the simple linear probability model (4.1), I investigate whether the likelihood that product k gets produced varies over time and across firms of differing size. If the proportion of firms producing a particular product is constant over time then time dummies should be jointly insignificant, and if product choice does not differ across small and large firms the parameter δ should not be significantly different from zero.

I have access to fairly rich data on what products the firms produce. Ignoring a product category coded as "other", the CSA dataset on formal manufacturing firms contains approximately 17,000 firm-year-product observations over the 1998-2006 period. Several of these products are imprecisely defined however. Following Siba and Söderbom (2011), I focus mostly on a sub-set of selected products that are quite precisely defined. These are the 27 products listed in Tables 4 and 5, and I shall refer to these as Category A products in this paper. Siba and Söderbom (2011) discuss the criteria for including a particular product in this subset of selected products in detail. The main issue is whether the product category is reasonably homogeneous or not. If the product definition is considered to be too general, the product does not get coded as Category A. For example, Siba and Söderbom (2011) exclude "meat" on the grounds that there are likely substantial quality differences within this category, but consider "beer" to be a suitable product category. All quantity measures are standardized so as to have a common unit of measurement, e.g. weights are measured in KG, volumes in liter, areas in square meter or square feet depending on the product etc. Unfortunately I have no product-level data for micro firms and this class of enterprises is therefore excluded in the remaining empirical analysis.

Table 4 summarizes the regression results for each product, highlighting the tests for a size effect and time effects. Underlying this are thus 27 regressions estimated separately. In 13 of these the time dummies are jointly significant at the 5% level of significance or better. This implies that the propensity to produce these products has varied over time. Columns [4] and

[5] summarize the proportions of firms producing each product in the first and last year covered by the data. While there are some large changes in these proportions, the overall picture that emerges from this analysis is that product choice is reasonably stable. It is also clear that product selection differs across small and large firms. For 14 of the products considered, the size coefficient is statistically significant at the 10% level or better. Large firms are more likely to produce beer, soft drinks, cotton fabrics, cotton yarn, leather garments, hides, cement and wires. Small firms are more likely to produce edible oil, oil cakes, bread, gravel, plastic footwear and cement blocks.

As already established, the dataset contains a lot of new entrants. Are new firms making similar product choices to those of older, more established firms? To shed some light on this I regress the product dummies on a dummy variable equal to one if the firm entered the market less than five years ago and zero otherwise. For these regressions I use only the last wave of the data. Results are shown in Table 5. The coefficient on the dummy for new entrant is statistically significant in ten cases, suggesting that the product choice of new firms differs from that of older firms in several ways. A striking result is that the production of wheat flour and gravel in 2006 appears to be carried out primarily by new firms.

I thus conclude that product choices vary over time, and across firms of differing size and age. In the next Section I investigate whether these different product choices are part of the reason as to why there are huge differences across firms in value-added per worker.

5. Why Do Large Firms Produce More Value-Added per Worker than Small Firms?

As established above, large firms generate more value-added per worker than small firms. From now on I shall refer to this fact as the value-added size gap, and what interests me in this part of the analysis is how much of the value-added size gap can be attributed to price differences, product choice differences, and differences in physical productivity.

I begin by decomposing the value-added size gap into a portion attributable to large firms operating in high-value added sectors; a portion that results from large firms choosing high value-added products; and a portion whose origin remains unknown. This is achieved by estimating regressions of the form:

$$\log\left(\frac{V}{L}\right)_{it} = \gamma_1 \log L_{it} + x'_{it}\beta_1 + \varepsilon_{1it}, \tag{5.1}$$

$$\log\left(\frac{V}{L}\right)_{it} = \gamma_2 \log L_{it} + \sum_j \eta_{2j} S_{jit} + x'_{it}\beta_2 + \varepsilon_{2it}, \tag{5.2}$$

$$\log\left(\frac{V}{L}\right)_{it} = \gamma_3 \log L_{it} + \sum_j \eta_{3j} S_{jit} + \sum_k \rho_{3k} P_{kit} + x'_{it}\beta_2 + \varepsilon_{3it}, \tag{5.3}$$

where V_{it} denotes value-added S_{jit} is a dummy variable equal to one if the firm belongs to sector j and zero otherwise, and ε_{1it}, ε_{2it}, ε_{3it} are time-varying firm-level residuals.

By comparing the γ's across the models in (5.1)-(5.3), I can get a sense of how much of the value-added size relationship is due to large firms producing in different sectors $(\gamma_1 - \gamma_2)$, and how much is due to large firms producing different products $(\gamma_1 - \gamma_3)$. Although this approach is descriptive, it can provide new insights into how higher levels of value-added get produced by African firms.

A recent literature emphasizes the importance of product choice for economic performance and development. Navarro (2008) use detailed product-level data on manufacturing firms in Chile and finds that product swapping accounts for 55% of the net increase in aggregate output. A similar study carried out by Goldberg et al. (forthcoming) for India suggests changes in the product mix accounts for 25% of the net increase in aggregate output. These findings suggest product selection is important. Could it be that large firms produce more value-added per worker than small firms because large firms produce products associated with higher value-added?

Table 6 shows regression results based on (5.1)-(5.3). Column (1) shows results for a model without sector and product dummies, but with year and town dummies included. The coefficient on log employment is estimated at 0.51 and is highly statistically significant. This implies that if we consider two firms, one of which is twice as large as the other, we would expect value added per worker to be around 50% higher for the larger firm. This is broadly in line with the figures shown in Table 3, and with the non-parametric regression displayed in Figure 3. In column (2) dummies for industrial sub-sector (at the 2-digit ISIC level) are added to the vector of control variables. As a result the coefficient on log employment shrinks rather marginally, from 0.51 to 0.47. Thus I conclude that approximately 8% of the value-added size gap can be attributed to firm size differing across sectors.

In column (3) I add a variable measuring the number of products produced by the firm. This is motivated by recent findings indicating that multi-product firms tend to perform better (Navarro, 2008, Bernard et al., 2010, and Goldberg et al., forthcoming). However the coefficient on the number of products produced is small and wholly insignificant, hence there is no evidence that multi-product firms have higher levels of value-added per worker than single-product workers, conditional on size and the other control variables in the model.[2]

Apart from this being an economically interesting result - and quite different from what is obtained for other regions - it also suggests I am not going to go far wrong by concentrating on single-product firms for part of the analysis. Such a procedure is appealing because I do not have product-specific measures of employment or other inputs. That is, if a firm produces two products there's no way of knowing how much raw materials (for example) were allocated by

[2] It is certainly true that large firms tend to produce more products than small firms. If I exclude firm size from the specification in (3), the coefficient on number of products is positive and significantly different from zero at the 5% level. This result is thus driven by the fact that large firms produce more products. See Shiferaw (2010) for a more detailed analysis of multi-product firms in Ethiopia.

the firm to these two products. This means it won't be possible to compute product-specific value-added without making further assumptions. By focusing on single product firms I do not have to tackle these difficult intra-firm allocation issues related to inputs and the computation of value-added.

In columns (4) and (5) of Table 6 I restrict the sample to contain only single product firms that produce a Category A product. Column (4) shows results for the same specification as in column (2) for this smaller sample. The coefficient on log employment is estimated at 0.55 and is highly significant. The point estimate is somewhat higher than in column (2), however I cannot reject the null hypothesis that the two coefficients are the same. Column (5) shows results for a model with product dummies added to the set of regressors. If product choice is an important reason why small and large firms record such different levels of value-added per worker, then we should see a large reduction in the coefficient on log employment as a result of including the product dummies. Adding the product dummies results in a notable improvement in the fit of the model (the R-squared rises from 0.37 to 0.44), and a non-trivial fall in the estimated size coefficient, from 0.55 to 0.40. This implies that approximately 29% of the value-added size gap can be attributed to large firms producing different products than small firms.

While it thus appears true that product choice is part of the answer as to why large firms produce more value-added than small firms, this effect is not very strong. That is, even conditioning on product fixed effects, the value-added size gap remains quite large. Why might this be? One possibility is that large firms produce higher quality output enabling them to charge a higher price in the market. Alternatively, it could be that large firms have market power and therefore add a high markup which again would result in high output prices. Since I do not have data on the marginal costs of production I cannot distinguish between these two hypotheses here. But I can investigate whether large firms tend to charge higher prices than small firms.

To do this, I run regressions of the following form:

$$\log PRICE_{kit} = \theta \log L_{it} + \sum_{k} \theta_{1k} P_{kit} + x'_{it}\beta_2 + u_{it},$$

where $PRICE_{kit}$ is the (standardized) unit price charged by firm i at time t for product k. In this regression it is important to control for product fixed effects for the simple reason that different products have very different average prices. The key parameter of interest is θ, which will tell me whether prices differ systematically across firms of differing size. Regression results are shown in Table 7.

In the first two columns of Table 7 I show results obtained from combining single and multi-product firms, while columns (3)-(4) I use single-product firms only. Across all specifications, the size coefficient is positive but very small and not significantly different from zero. This implies that I do not reject the null hypothesis that the output price charged for a given product does not vary with firm size. Whether I control for location or not, or whether I use only single-product firms or all firms make no difference. This is a somewhat surprising result, contradicting the notion that large firms tend to produce higher quality output and exploit market power. Moreover, it implies that the large value-added size gap that remains after conditioning on product dummies (Table 6, column 5) is due entirely to differences in quantities produced per worker.

Finally, I ask whether physical productivity varies across small and large firms. I consider the following specifications:

$$\begin{aligned}
\log(Q/L)_{kit} &= \phi_1 \log L_{it} + \sum_k \lambda_{1k} P_{kit} + x'_{it}\beta_1 + \xi_{1it}, & (5.4)\\
\log(Q/L)_{kit} &= \phi_{21} \log L_{it} + \phi_{22} \log(K/L)_{it} + \phi_{23} \log(E/L)_{it} & (5.5)\\
&\quad + \sum_k \lambda_{2k} P_{kit} + x'_{it}\beta_2 + \xi_{2it}, \\
\log(Q/L)_{kit} &= \phi_{31} \log L_{it} + \phi_{32} \log(K/L)_{it} + \phi_{33} \log(E/L)_{it} + \phi_{34} \log(M/L)_{it} & (5.6)\\
&\quad + \sum_k \lambda_{3k} P_{kit} + x'_{it}\beta_3 + \xi_{3it},
\end{aligned}$$

where Q is physical output (e.g. tonnes of cement, litres of vegetable oil, etc.), and K, E, M denote physical capital, electricity and raw materials, respectively. Physical capital is measured as the book value of the capital stock, electricity and raw materials are measured as annual expenditures, and all three inputs are expressed in constant values computed using a GDP deflator.

In Table 8 I report OLS estimates of the key parameters in (5.4)-(5.6). The results in column (1) confirm that large firms produce more physical output per worker for a given product than do small firms. The point estimate of the size coefficient ϕ_1 is 0.21, which implies that if we consider two firms, one of which is twice as large as the other, we would expect the larger firm to produce 21% more physical output per worker than the smaller firm.[3]

Why do large firms produce more physical output per worker than small firms? One possibility is that the workers in large firms are more skilled. Unfortunately I do not have data on the human capital of the employees so I can not test this hypothesis directly. However, it is easy to establish that the levels of education amongst the employees would have to have to be

[3] The reason this is smaller than the value-added size gap documented in Table 6 is that output embodies inputs, the latter being netted out when calculating value-added. For example, 21% more output will translate into 42% more value-added if the value of the output is twice as high as the value of the input.

implausibly much higher in large than in small firms for differences in schooling to be the explanation. Another possible explanation for the large differences in physical labor productivity across small and large firms is that large firms have more capital and use more electricity per worker than small firms. The results in column (2) provide some support for this idea. The coefficients on capital and electricity are positive and statistically significant (capital only at the 10% level), and the coefficient on firm size falls from 0.21 to 0.16. These results are consistent with the simple idea that, if each worker gets to use more inputs, the output per worker will rise.

In column (3) I probe this notion further by adding to the specification raw material per worker. One way of interpreting this model is as a four-factor Cobb-Douglas production function, expressed in labor productivity form. If interpreted as such, the coefficient on log employment is equal to zero under constant returns to scale. Of course, this interpretation is potentially problematic since several of the regressors may well be endogenous. For example, firms with high unobserved productivity will tend to be large, in which case the coefficient on employment may be upward biased. However, as discussed above, I am primarily interested in characterizing and decomposing the value-added size gap. Therefore, I prefer to interpret all parameter estimates as reflecting partial correlations rather than causal effects. The results indicate a strong relationship between raw materials per worker and physical output per worker. Moreover, conditional on raw materials per worker and electricity per worker, output per worker does not covary significantly with size or capital intensity.

6. Conclusions

Fundamental to the discussion of diversification and structural change in Africa is the idea that a worker in the modern sector will be able to produce more output than a worker in the traditional (agricultural) sector. However, the industrial sector is highly heterogenous, featuring very large differences in value-added per worker and other measures of economic performance across firms. In particular, small and large firms are very different. Small firms invest less, export less, and pay lower wages than large firms. Small firms are much more labor intensive, and generate much less value-added per worker, than large firms. One of my goals in this paper has been to shed some light on why.

The production function framework predicts that a high level of output per worker is associated with high levels of inputs per worker. Consistent with this prediction, inputs and output per worker are indeed strongly positively correlated in my data. Of course, inputs are endogenous variables that are chosen by the firms, so it is not clear how useful it is for policy makers to learn that the reason some firms produce more output than others is that they use more inputs.

In this paper I have approached the question as to why some firms generate much higher levels of value-added per worker from a slightly different angle. The premise of my analysis is that firm performance is determined by a wide range of firm-level decisions, and that the input-output explanation masks decisions and mechanisms that ought to be better understood. While it is useful to know the expected value-added per worker associated with a particular combination of capital and labor, this quantity tells us little about the underlying mechanisms linking inputs to output. Markets and products are completely invisible, for example.

I have tried to tease out some of these underlying mechanisms by focusing on product choice, pricing and physical productivity as potential driving factors of value-added per worker. I have found that small and large firms differ with respect to product choice, and that this accounts for a non-negligible portion of the value-added size gap in the data. That is, one reason large firms generate more value-added per worker is that they produce products associated with higher value-added. I have also tested for differences in output prices across firms of differing size. To my surprise, I find no significant relationship between size and output price in the data. There is thus no evidence that large firms produce higher quality goods, or that they earn higher rents, than small firms. This leaves me with the residual explanation why large firms produce more physical output per worker than small firms: because they use more inputs per worker. This is also confirmed by the data when tested directly. Indeed, once I condition on capital, electricity, and raw material inputs per worker, there is no relationship between physical output per worker and firm size.

I thus seem to end up in a very familiar territory, in which high output is mainly explained by high levels of inputs. Given that I control for prices and products at the level of the firm, however, I believe this result should be seen in a new light. One implication is that very different technologies are being employed to produce the same product. Just to give an example, the median capital-labor ratio amongst firms producing cement blocks (a reasonably homogenous product) is more than 4 times higher for the subsample of firms with 100-500 employees than for the subset of firms with 10-20 employees. Yet the median price of a cement block is only 14% higher for the group of large firms. This finding relates to the argument advanced by Hausmann and collaborators that poor countries need to change their product mix in order to develop. My results suggest that large gains may be achieved simply by changing *how* certain products get produced. For example, a large cement block factory will be able to make the same contribution to GDP as a very large number of small firms, but with less workers.

Clearly there is scope for much more research in this area. Micro firms have been excluded from most of my analysis, simply because I do not at present have reliable data on products and prices for this class of firms. Given that most firms in Africa employ very few workers, it would be of great interest to study the price and product decisions made by micro firms. Moreover, I have focused exclusively on Ethiopia, where manufacturing is very underdeveloped, and it is unclear whether any of the results established above generalize for other African countries. The product definitions that I have relied upon in the analysis may be too general. These shortcomings notwithstanding, I think it will be very important in the future to better understand the implications of what firms are doing, and how they are doing it, for enterprise success and economic development in Africa.

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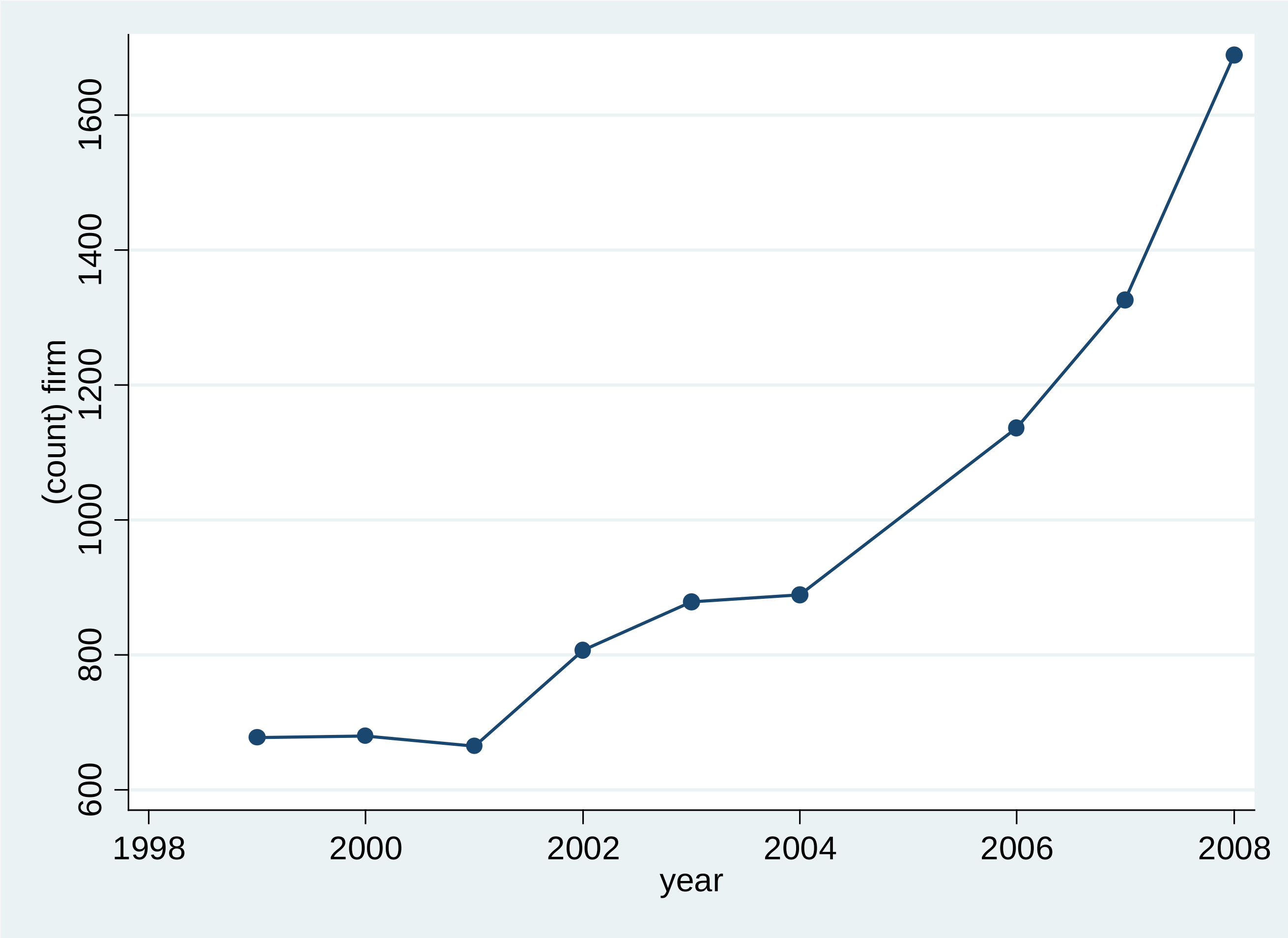
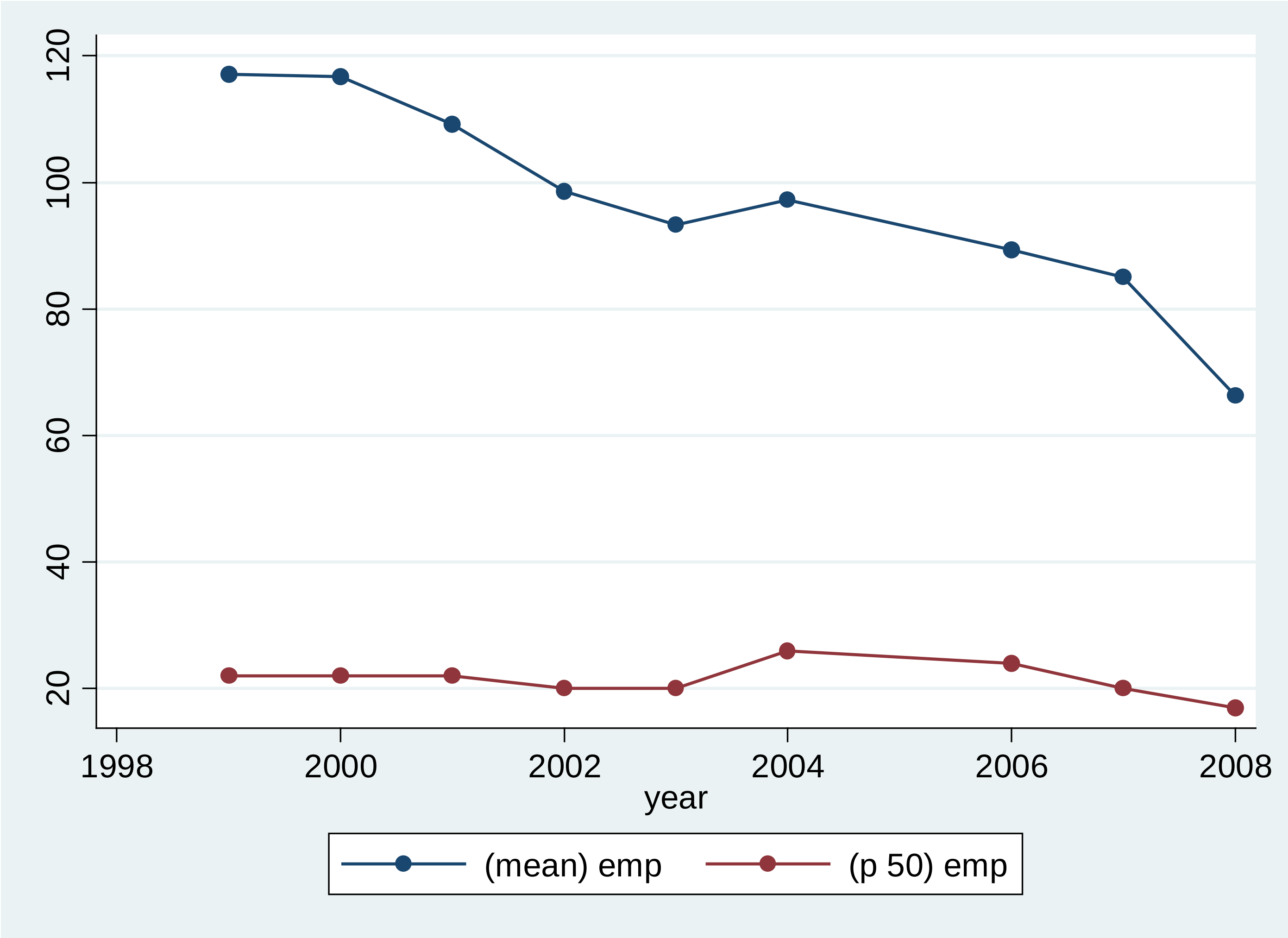
Figure 1: Count of Formal Manufacturing Firms in Ethiopia



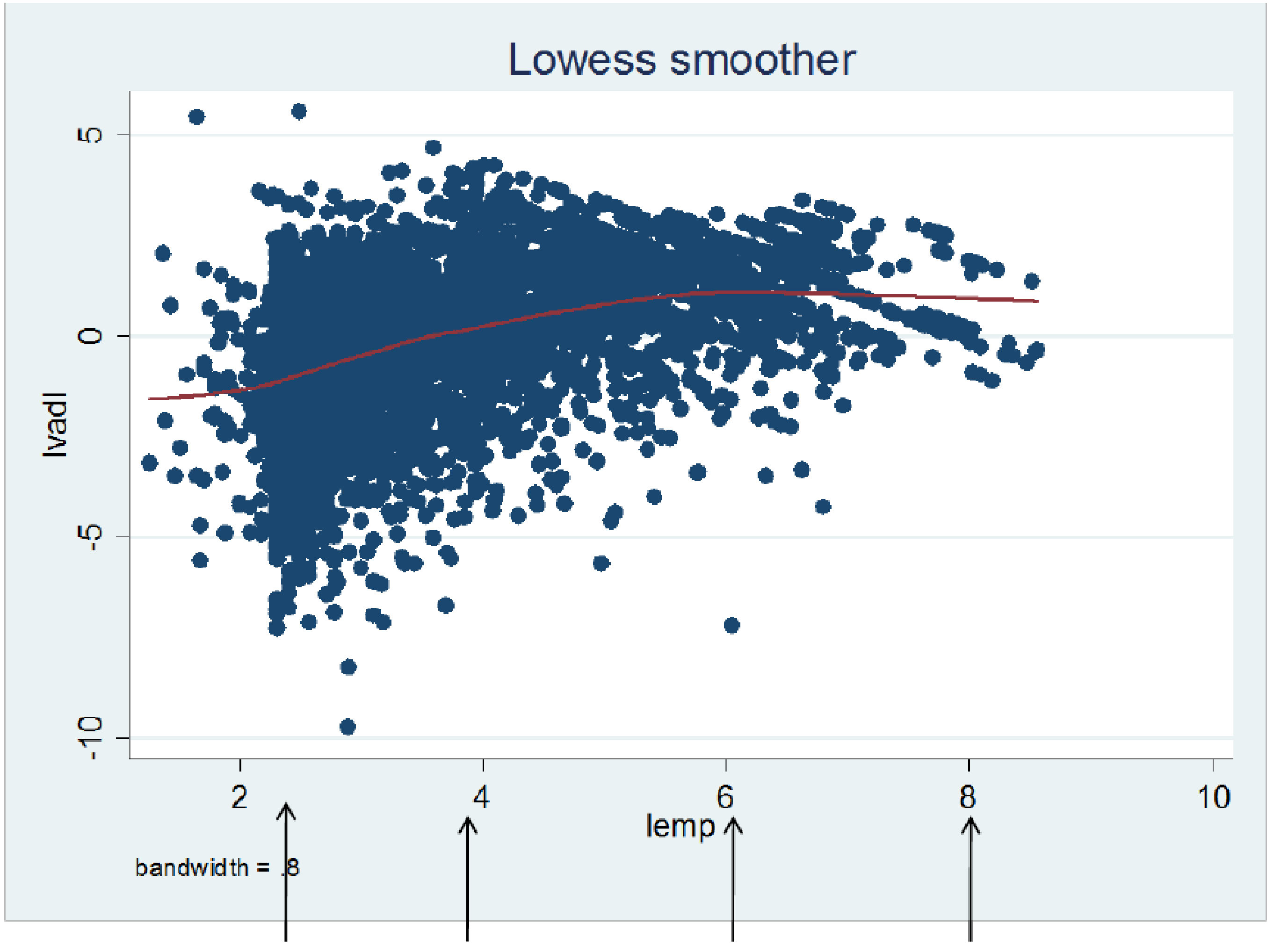
Source: Author's calculations based on enterprise level datasets provided by the Central Statistical Agency of Ethiopia.

Figure 2: Average and Median Employment among Formal Manufacturing Firms in Ethiopia



Source: Author's calculations based on enterprise level datasets provided by the Central Statistical Agency of Ethiopia.

Figure 3: Log Value Added per Employee and Firm Size



Source: Author's calculations based on enterprise level datasets provided by the Central Statistical Agency of Ethiopia.

Table 1

Economic and Industrial Performance Indicators for Ethiopia and Sub-Saharan Africa 1995-2008

Year	(1) GDP per capita (constant 2000 USD)		(2) Share of mfg in total value-added		(3) Share of industry in total value-added		(4) Merchandise exports per capita (current USD)		(5) Manufactured exports per capita (current USD)	
	Ethiopia	SSA	Ethiopia	SSA	Ethiopia	SSA	Ethiopia	SSA	Ethiopia	SSA
1995	115	492	0.05	0.16	0.10	0.29	7.4	130.0	0.8	
1996	125	504	0.05	0.15	0.11	0.29	7.1	142.2		39.8
1997	126	508	0.05	0.15	0.11	0.29	9.7	139.9	1.0	42.0
1998	118	506	0.05	0.15	0.12	0.28	9.0	113.9	0.6	33.0
1999	121	505	0.05	0.15	0.13	0.28	7.3	120.1	0.5	36.0
2000	125	510	0.06	0.15	0.12	0.29	7.4	139.1	0.7	43.1
2001	132	514	0.06	0.15	0.13	0.29	6.8	128.0	0.9	38.4
2002	130	517	0.06	0.14	0.14	0.30	7.0	132.6	1.0	49.1
2003	124	526	0.06	0.14	0.14	0.30	7.0	158.0	0.8	53.7
2004	137	544	0.05	0.13	0.14	0.30	9.3	207.5	0.4	
2005	150	561	0.05	0.13	0.13	0.31	12.1	252.5	0.6	
2006	162	581	0.05	0.13	0.13	0.32	13.6	290.3	0.7	87.1
2007	175	603	0.05	0.15	0.13	0.33	16.3	335.1	2.3	110.6
2008	190	618	0.05	0.15	0.13	0.33	18.6	410.9	1.7	131.5
Average annual growth rates										
95-08	3.9%	1.8%	0.0%	-0.5%	2.0%	1.0%	7.3%	9.3%	5.7%	10.5%
00-08	5.4%	2.4%	-2.3%	0.0%	1.0%	1.6%	12.2%	14.5%	10.7%	15.0%

Source: World Development Indicators.

Table 2

Size Distribution of Formal Manufacturing Firms in Ethiopia, 2006/7. Size Categories by Sales in USD.

	<100K	100K < < 1M	1M < < 10M	>10M	Total
Food (ISIC 1511-1600)	144	134	52	14	344
Textiles (ISIC 1710-1730)	11	7	17	4	39
Apparel (ISIC 1810)	12	14	3	1	30
Leather & Footwear (ISIC 1910-1920)	14	35	21	2	72
Wood & Paper (ISIC 2000-2200)	44	58	18	2	122
Chemicals (ISIC 2411-2429)	14	24	25	1	64
Rubber & plastic (ISIC 2510-2520)	6	33	23	2	64
Glass, concrete, cement (ISIC 2610-2699)	203	32	12	3	250
Iron & steel (ISIC 2710)	0	1	9	3	13
Metal (ISIC 2811-2899)	21	20	10	2	53
Machinery & vehicles (ISIC 2914-3430)	18	15	9	4	46
Furniture (ISIC 3610)	149	49	5	0	203
Total	636	422	204	38	1300

Source: Author's calculations based on enterprise level datasets provided by the Central Statistical Agency of Ethiopia.

Table 3

Micro, Small and Medium Sized Manufacturing Enterprises 2007/08

Size range (number of workers)	Less than 10	10-19	20-49	50+
Survey	Small-scale mfg		Formal mfg	
Number of persons engaged	138,951	10,690 [10,616]	14,757 [14,306]	108,226 [63,715]
Number of establishments	43,338	846 [841]	519 [505]	565 [420]
Total value-added	1.14 billion	186.1 million [184.1]	401.1 million [393.4]	8.59 billion [4.58bn]
Total value of capital installed	1.01 billion	244.5 million [244.0]	702.6 million [693.1]	7.58 billion [4.8 billion]
Value-added per person engaged	8,200	17,400 [17,300]	27,200 [27,500]	79,400 [71,900]
Average wage, all paid employees	3,144	3,590	5,750 birr	11,700
Average wage, production workers		2,856	3,640	6,716

Note: All financial figures are in birr, current values.

Source: Central Statistical Agency of Ethiopia (2009, 2010)

Table 4
Product Selection: Firm Size and Structural Change

	[1] Coefficient: log employment	[2] t-value	[3] H0: No time differences (*p*-value)	[4] Sample proportion in the first year	[5] Sample proportion in the last year
Tea	0.004	1.60	0.38	0.010	0.008
Edible oil	-0.014	3.37	0.03	0.069	0.041
Oil cakes	-0.011	2.82	0.00	0.067	0.034
Wheat flour	-0.004	0.69	0.00	0.045	0.112
Bread	-0.035	6.91	0.00	0.079	0.068
Sugar	0.011	1.74	0.94	0.005	0.004
Liquor	0.0001	0.03	0.10	0.017	0.016
Beer	0.013	2.36	0.78	0.010	0.008
Soft drinks	0.012	2.42	0.54	0.012	0.008
Cotton fabrics	0.024	2.92	0.43	0.020	0.008
Cotton yarn	0.026	3.21	0.27	0.017	0.015
Nylon fabrics	0.002	1.00	1.00	0.002	0.001
Leather garment	0.008	2.13	0.37	0.005	0.005
Crust hides and wetblue hides	0.010	2.47	0.25	0.010	0.008
Leather shoes and boots	-0.005	1.08	0.00	0.114	0.020
Timber	-0.004	1.55	0.01	0.032	0.019
Gravel	-0.004	2.12	0.00	0.000	0.042
Plastic footwear	-0.003	1.92	0.00	0.012	0.028
Bricks of clay	0.001	0.43	0.05	0.017	0.016
Cement blocks	-0.045	8.04	0.00	0.156	0.111
Cement floor tiles	0.003	0.86	0.00	0.045	0.012
Cement	0.008	1.87	0.81	0.007	0.007

The table continues on the next page.

Table 4 continued

	[1] Coefficient: log employment	[2] t-value	[3] H0: No time differences (*p*-value)	[4] Sample proportion in the first year	[5] Sample proportion in the last year
Nails	0.003	1.54	0.16	0.002	0.016
Wires	0.003	2.00	0.54	0.002	0.008
Vasilin	-0.002	1.18	0.05	0.022	0.009
Paraffine	-0.003	1.43	0.01	0.027	0.014
Coffee	-0.001	1.60	0.08	0.000	0.007

Note: Columns [1]-[3] shows results based on linear regressions in which a dummy for product X, X={Tea, Edible oil,…,Coffee} is the dependent variable and log employment and a full set of year dummies are the regressors. Standard errors are clustered at the enterprise level. Columns [4]-[5] shows proportions of firms manufacturing product X in the first and last year, respectively, of our sampling period.

Table 5
Product Selection of New Entrants. Year 2006.

	[1] Coefficient: Dummy for new entrant (last 5 years)	[2] t-value
Tea	0.006	0.59
Edible oil	-0.044	3.98
Oil cakes	-0.035	3.39
Wheat flour	0.080	2.46
Bread	-0.031	1.56
Sugar	-0.005	1.73
Liquor	-0.005	0.46
Beer	-0.010	2.46
Soft drinks	-0.002	0.33
Cotton fabrics	-0.010	2.46
Cotton yarn	-0.011	1.33
Nylon fabrics	-0.002	1.00
Leather garment	-0.007	2.00
Crust hides and wetblue hides	-0.010	2.46
Leather shoes and boots	-0.018	2.01
Timber	-0.008	0.78
Gravel	0.090	3.50
Plastic footwear	0.020	1.12
Bricks of clay	-0.005	0.46
Cement blocks	0.002	0.07
Cement floor tiles	0.000	0.04
Cement	-0.009	2.24
Nails	0.011	0.84
Wires	0.006	0.59
Vasilin	0.004	0.40
Paraffine	0.007	0.57
Coffee	0.015	1.39

Note: The table shows results based on linear regressions in which a dummy for product X, X={Tea, Edible oil,…,Coffee} is the dependent variable and a dummy variable for whether the firm entered the market less than 5 years ago is the regressor. Standard errors are clustered at the enterprise level.

Table 6
Value-Added per Worker, Firm Size and Type of Production

	(1)	(2)	(3)	(4)	(5)
ln employment	0.507 (13.73)**	0.465 (13.60)**	0.463 (13.31)**	0.554 (5.48)**	0.395 (3.94)**
Number of products produced			0.008 (0.51)		
Year dummies	Yes	Yes	Yes	Yes	Yes
Town dummies	Yes	Yes	Yes	Yes	Yes
Sector dummies (2-digit ISIC)	No	Yes	Yes	Yes	No
Product dummies	No	No	No	No	Yes
Sample	All firm-year observations	All firm-year observations	All firm-year observations	Single product firms producing category A product	Single product firms producing category A product
Observations	5417	5417	5417	1086	1086
R-squared	0.27	0.35	0.36	0.37	0.44

Note: The table shows OLS results. The dependent variable is log value-added per employee. A constant is included in all specifications. The figures in parentheses are t-values, based on standard errors clustered at the enterprise level.* significant at 5% level; ** significant at 1% level.

Table 7
Output Prices and Firm Size

	(1)	(2)	(3)	(4)
ln employment	0.012	0.011	0.020	0.017
	(1.12)	(1.00)	(1.14)	(1.04)
Year dummies	Yes	Yes	Yes	Yes
Town dummies	Yes	No	Yes	No
Product dummies	Yes	Yes	Yes	Yes
Sample	All firm-year-product observations	All firm-year-product observations	Single product firms producing category A product	Single product firms producing category A product
Observations	7502	7589	1131	1149
R-squared	0.91	0.91	0.96	0.96

Note: The table shows OLS results. The dependent variable is log unit price. A constant is included in all specifications. The figures in parentheses are t-values, based on standard errors clustered at the enterprise level.* significant at 5% level; ** significant at 1% level.

Table 8
Output Volume and Firm Size

	(1)	(2)	(3)
ln employment	0.213 (3.38)**	0.162 (2.62)**	-0.042 (0.99)
ln capital / emp		0.038 (1.90)	0.020 (1.11)
ln energy / emp		0.311 (7.73)**	0.126 (3.81)**
ln raw material / emp			0.693 (17.72)**
Year dummies	Yes	Yes	Yes
Town dummies	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes
Sample	Single product firms producing category A product	Single product firms producing category A product	Single product firms producing category A product
Observations	1131	1093	1088
R-squared	0.85	0.87	0.93

Note: The table shows OLS results. The dependent variable is log of the number of units of output produced per employee. A constant is included in all specifications. The figures in parentheses are t-values, based on standard errors clustered at the enterprise level.* significant at 5% level; ** significant at 1% level.