CSAE WPS/2004-05

Survival and Success among African Manufacturing Firms

Alan Harding, Måns Söderbom* and Francis Teal

February 2004

Centre for Study of African Economies
Department of Economics
University of Oxford
Manor Road
Oxford OX1 3UQ
UK

Abstract

Recent reforms in most African economies of their trading and exchange rate regimes have eliminated much of the protection which previously limited competition. Despite these reforms, African manufacturing firms remain unsuccessful, particularly in international export markets. In this paper we consider the roles of learning, competition and market imperfections in determining three aspects of firm performance, namely firm exit, firm growth and productivity growth. We use a pooled panel data set of firms in Ghana, Kenya and Tanzania that spans a period of five years. We find that the main determinant of exit is firm size, with small firms having much higher exit rates than large ones. Productivity impacts on firm survival among large firms, but not among small firms. Reasons for this result are discussed. We find evidence that, among surviving firms, old firms grow slower than young firms, which is interpreted as evidence consistent with market constraints limiting growth of firms in Africa. We find no evidence that larger firms have faster rates of productivity or input growth, or are more efficient in the sense of benefiting from scale economies. We also find that competitive pressure enhances productivity growth. Given that one of the objectives of the reform programmes implemented in all three countries was to stimulate higher efficiency levels, this finding shows that one aspect of the reform programme has been successful.

We thank Paul Collier as well as seminar participants at CSAE and UNIDO for comments on earlier drafts of the paper. The data for all three countries used in this paper - Ghana, Kenya and Tanzania - was initially collected as part of the Regional Program on Enterprise Development (RPED) organised by the World Bank. The original questionnaire was designed by a team from the World Bank. The data for the later periods for all three countries was collected by a team from the Centre for Study of African Economies, University of Oxford in collaboration with the Economic and Social Research Foundation (ESRF), Dar-es-Salaam, the Federation of Kenya Employers in Kenya and the Ghana Statistical Office, Accra. Funding from the UK's Department for International Development (DFID) contributed to the Ghana and Tanzanian survey data collection, Sida and UNIDO assisted in the Kenyan data collection. We are greatly indebted to numerous individuals in these organisations for their assistance. We are responsible for all errors and the interpretation of the data.
* Corresponding author: Mans.Soderbom@economics.ox.ac.uk

I. Introduction

Manufacturing firms in Africa present an apparent paradox for those who see competition as the key to success in industrial policy. Firms are generally small and firm turnover (entry and exit) is substantial – apparently ideal conditions for competition to ensure that only the successful survive. Recent reforms in some African economies to their trading and exchange rate regimes have eliminated much of the protection which it could be argued previously limited competition. Yet firms remain conspicuously unsuccessful. Few export, investment rates are low and, for the sample of firms used in this paper, output has been falling rapidly in the 1990s in both reforming and non-reforming economies.[1]

Our purpose in this paper is to examine the determinants of growth in productivity and output in Africa's manufacturing sector during the 1990s. Firm-level panel data from Ghana, Kenya and Tanzania enable us to distinguish between growth resulting from a selection process of company turnover and growth occurring within firms. Recent research on firms in the U.S. and the UK indicate that aggregate productivity growth is driven primarily by a churning process in which less efficient firms exit and more efficient ones enter the market (Foster et al., 2001; Disney et al., 2003). Similar evidence of 'survival of the fittest' has been reported by Liu (1993) on Chile, and Liu and Tybout (1996) on Columbia and Chile. As far as we know, there exists no such analysis based on African firms.[2]

Africa, of course, may be quite different from the U.S., UK and South America. While survival of the fittest is likely in competitive economies where instruments (e.g. financial ones) designed to manage shocks are available, the link between efficiency and firm churning may well be weaker in environments without these characteristics. It is possible for instance that in Africa, because of limited availability of smoothing mechanisms, a temporary negative demand shock may force efficient and

[1] This paper draws on data from Ghana, Kenya and Tanzania. Reports documenting these aspects of the firms in these countries can be found in Söderbom (2001), Rankin, Söderbom and Teal (2002), Harding, Söderbom and Teal (2002) and Harding, Kahyarara and Rankin (2002).

[2] There is some related work on sub-Saharan African (SSA) firms. Mazumdar and Mazaheri (2003, chapter 12) and Van Biesebroeck (2001) examine issues of firm growth drawing on the recall histories of firms but provide no evidence on the determinants of exit or the growth of productivity.

economically sound firms to close down. If this is so, company churning will be associated with a welfare loss and result in modest or no aggregate productivity gains.

The second potential source of aggregate growth is growth within incumbent firms. In the empirical literature it has often not been possible, for data reasons, to distinguish between firm growth and the growth of productivity. In this paper we can make this distinction, which is potentially important. In a simple static conditional factor demand model based on a Cobb-Douglas production function there is a log-linear relation between inputs and total factor productivity, implying that with factor prices constant across firms the determinants of productivity growth and firm growth will be the same. This is not necessarily the case in more general models, however: for instance, even if firm age has no impact on TFP growth, age may still impact on investment through its effect on credit availability if there are financial imperfections. By analysing whether the determinants of firm growth and productivity growth differ, we can pin down more in detail the mechanisms by which different explanatory variables impact on firm performance and shed light on whether standard models with constant factor prices are supported by the data.

We focus on the roles of learning, competition and market imperfections as factors in determining firm performance,. The possibility of firm learning as a result of technological advances or organisational improvement has been a prominent feature of much of the literature on firm growth. In contrast, the evidence for the effectiveness of competition in enhancing growth is neither theoretically strong nor well grounded in the empirical literature (Nickell, 1996). Nevertheless, given the liberalisation in many African countries over the last decade and reduced barriers to entry, documenting whether the resulting increase in competitive pressure has improved the performance of the firms is of obvious policy interest (see e.g. Klein, 2003, for a policy-oriented discussion focussing on the role of competition in reducing poverty in developing countries). Further, by looking both at growth and turnover, we can provide insights relating to Nickell's (1996) conjecture that "perhaps competition works not by enforcing efficiency on individual firms but by letting many flowers bloom and that only the best survive" (p.741). Market imperfections, finally, are widespread in Africa and while there is growing evidence on their effects on factor accumulation (Bigsten et al., 1999a; 2004; Söderbom, 2002) little is known about the consequences for firm survival or growth of total factor productivity. As already noted sub-Saharan Africa offers a good laboratory for these theories and speculations. Births and deaths are numerous but few seem to grow. Is it simply the climate or does economics have something to offer by way of explanation? To the best of our knowledge, we are the first to undertake an analysis of this kind based on African firms.

The next section presents the data and shows summary statistics. The determinants of firm exit, using a probit analysis, are considered in section III and section IV provides an analysis of productivity and input growth for those firms that do survive. Section V takes account of some of the potential methodological problems associated with estimating growth equations and presents some robustness checks on the results. Section VI concludes.

II. The Data

Our data is drawn from a panel of manufacturing firms covered by the Regional Program on Enterprise Development (RPED) surveys[3] (for the period of the early 1990s) and follow-up surveys conducted in 1999 and 2000. The countries for which we have comparative data are Ghana, Kenya and Tanzania. Our sample covers two periods five years apart, 1993/94 and 1998/99.[4] The surveys cover seven sectors - food processing, beverages, textiles, garments, wood processing, furniture and fabricated metal – that comprise approximately 70 per cent of employment and value-added in these economies. The structure of the survey questionnaire was designed to make it comparable over time and across countries. Data was collected at the firm level on firm output levels and direct and indirect input costs, levels of employment and the replacement and resale value of plant, machinery and other fixed assets. We are able to use sector-specific producer price series to deflate gross output for both Kenya and Tanzania. In the case of Ghana firm-level price deflators have been created.

[3] A full account of work on the RPED surveys can be found in Mazumdar and Mazaheri (2003).
[4] The data for Ghana and Kenya refer to 1994 and 1999, while that for Tanzania refers to 1993 and 1998. While we have data on the intermediate years for Ghana, this is not the case for Kenya and Tanzania. In the interest of comparability, we therefore decided to use data from two periods only for all three countries.

In Table 1 we present basic summary statistics on several aspects of firm dynamics, notably exits, births and growth rates among surviving firms, for our whole sample.[5] For the first period we have 374 firms of which 125 exited in the five year period between the survey dates. The surveys captured 55 births (these are firms less than five years old at the time of the second survey). So in our second period we have 304 firms (249 survivors plus 55 births). The overall exit rate (over this five year period) is 33 per cent. In Tanzania and Kenya the exit rate was much higher at 40 per cent than in Ghana where the exit rate was 20 per cent. In the lower part of the table we show data on the growth of output and employment among surviving firms. There is a uniform picture of contraction across all three countries. The negative growth rates are most dramatic in the Kenyan sample, which is mirroring the overall economic decline in Kenya over the last half of the 1990s. Among the three countries Tanzania experienced the most moderate rate of output contraction. As expected, the fall in output among the surviving firms is mirrored by a reduction, on average, in employment in all three countries. While it is clear from these numbers that the end of the 1990s was a difficult period for manufacturers in all three countries, the high standard deviations indicate considerable variation in the growth rates across firms. That is, while on average firms were contracting, some firms were actually able to grow quite rapidly. One of the objectives of the econometric analysis below is to investigate what factors, if any, can explain such a wide range of outcomes.

Table 2 shows the differences in labour productivity, and capital intensity across firms of different size for both periods for which we have 678 observations. Labour productivity more than doubles in moving from micro or small firms to large ones. These differences are broadly matched by endowments of capital per employee. The next two variables in the table - firm age and ownership - are both strongly correlated with size. Larger firms are older and more likely to have some foreign ownership. As we will be interested in seeking to distinguish the roles of firm age and size such a close correlation means that such a task may prove difficult. Next in Table 2 we present our measure of the competitive pressures on the firm, *premp*, which is the average of the profits per employee in the two

[5] During the follow-up surveys considerable effort was devoted to distinguishing between firms that had indeed exited from the market and firms that could not be included in the sample for other reasons. To the best of our

time periods.[6] Profit per employee increases with firm size, which is consistent with the notion that large firms extract higher rents than small ones. Finally in Table 2 we show the relationship between exit and firm size. There is a monotonic decline in exit rates across the size distribution of firms from micro to large. This is the pattern we would anticipate given the high degree of turnover traditionally observed amongst small-scale and informal enterprises. Are these exit rates high?

We can compare the overall exit rate of 33% of firms over a five year period (approximately 6% per annum) with recent data for other countries. Data for UK enterprises in 1990-92 are presented by Hart and Oulton (1998). From a total sample of 83,573 independent companies, they find that 21,404 or 25.6% closed down during this two year period. These deaths are heavily concentrated amongst micro and small-scale enterprises. The average exit rate for firms with 32 employees or less is 29.9% (16,163 deaths out of 54,084), whereas the exit rate for firms with 512 employees or above is 6.5% (110 out of 1683). Figures reported in Tybout (2000) present evidence on high levels of per annum plant turnover in a number of developing countries, including 8.5% in Chile (1979-86), 11.9% in Columbia (1977-89) and 9.5% in Morocco (1984-90). Liedholm and Mead (1995) report turnover rates for micro and small enterprises in several African countries of between 19-25% per annum. In our sample, aggregate exit rates are lower than these figures. In a comparative perspective then, the degree of firm turnover in these countries during this period is not particularly high for small and micro firms. Has it been enough to provide the basis for selection on the basis of efficiency? To that question we now turn.

III. Firm Turnover

The nature of our data is such that we cannot analyse the determinants of firm entry so we can only investigate one aspect of firm turnover, i.e. exit from the market. We model exit as a function of some measure of productivity, firm size, age, and dummy variables for country, sector and firm status

---

knowledge, all firms recorded as exits in our data are genuine exits.

[6] Nickell (1996, p. 733) measures rents as an average over the sample period of profits less capital costs, normalised on value added. Disney et al. (2003) use a similar definition, but do not take the average over the period.

(whether there is any ownership or not). Productivity is hypothesised to impact negatively on the exit rate, reflecting a process in which only the fittest survive.

We consider three measures of productivity. The first approach involves using labour productivity, defined as the log of output per employee, and capital intensity as explanatory variables in the exit regression. Capital intensity is included in the regression as a way of ensuring that any effect of labour productivity is not simply driven by heterogeneity in factor intensity across the firms.

The second measure is TFP, calculated by subtracting inputs from output using appropriate weights. More precisely, assuming a four-factor Cobb-Douglas production TFP is defined as

$$TFP = \log Y - \left(\beta_l \log L + \beta_k \log K + \beta_m \log M + \beta_e \log E\right),$$

where Y, L, K, M, E denote output, employment, physical capital, raw material and indirect costs (e.g. electricity, transport, telephones, water etc. - but not labour costs), respectively, and the β:s are coefficients. To determine the values of these coefficients we draw on previous work in this area. Using seven years of panel data on Ghanaian manufacturing firms, Söderbom and Teal (2004) estimate production function parameters using a GMM instrumental variable estimator that controls for firm fixed effects. Table 4, column 4 in their paper reports the following estimates: $\beta_l = 0.17$, $\beta_k = 0.09$, $\beta_m = 0.68$, $\beta_e = 0.06$.[7] We calculate TFP using these estimates. In the next section we estimate the production function parameters directly, and as we shall see our results are not very different from those just cited.

To obtain our third measure of productivity we use one wave of 'pre-sample' data and the first wave of the sample. The pre-sample data refer to 1993 for Kenya and Ghana, and 1992 for Tanzania. Based on these two waves of data we estimate a production function allowing for firm fixed effects, and use the estimated fixed effects as our productivity measures.[8]

---

[7] In comparison, using two years of panel data from four African countries, Bigsten et al. (2004) obtain $\beta_n = 0.13$, $\beta_k = 0.04$, $\beta_m = 0.76$, $\beta_e = 0.09$ (long-run estimates based on the results in Table 2, column 3). The estimator yielding these results restricts the inputs to be orthogonal to the error term, which could explain why the coefficients on the two inputs likely to be most flexible (and hence most likely to be positively correlated with the residual) are somewhat higher than in Söderbom and Teal. The regression results in Table 3 are robust to using the Bigsten et al. estimates (results are available on request).

[8] The regression results are not reported to conserve space but are available on request from the authors.

Firm size and age have featured prominently in both theoretical and empirical analysis of the determinants of firm performance.[9] The conventional interpretation is that these variables reflect variation in productivity across firms. For instance in the model of Jovanovic (1982), which has been widely used to examine the firm life cycle, age will be correlated with performance because of selection on efficiency.[10] Given that we condition on productivity in the regressions, age or size effects on exit rates have a different interpretation, providing a direct test for whether productivity is a sufficient statistic for firm survival. One possible reason why it may not be is that old or large firms have higher survival rates because of better ability to withstand adverse shocks, perhaps because of relatively good access to credit. Alternatively, if adjusting inputs (e.g. physical capital) is costly and efficiency is serially correlated, old or large firms may choose to stay in the market at lower productivity realisations due to higher expected future returns (Olley and Pakes, 1996).

Table 3 presents a probit model of the exit decision, which examines the probability with which the firms in the sample existing in 1993/94 would have exited from the sector by 1998/99. We measure the explanatory variables in the initial period to predict exit at some point during the next five years. Columns (1)-(3) show linear specifications using our three different measures of productivity. In all three models the main determinant of exit is firm size, measured as the logarithm of the number of employees. Small firms have higher exit rates than large ones. Based on the model in column (1), the predicted exit rate for a firm with ten employees, evaluated at mean values of the other regressors, is 0.37. Increasing the number of employees to 50 holding everything else constant reduces the predicted exit rate to 0.28, while increasing the number of employees to 200 reduces the predicted exit rate to 0.21. The size effect is significant at the five per cent level or better in all three models. The coefficients associated with our productivity measures are all totally insignificant, providing no evidence that productivity influences the exit rates. This stands in sharp contrast to results reported for other regions

---

[9] There has been an extensive discussion as to whether small firms do grow faster than larger ones - Evans (1987a, b), Davis, Haltiwanger and Schuh (1996) Hart and Oulton (1996) - mostly confined to developed countries.

[10] Individual managers are initially uncertain about their own abilities, but can assess their capability by observing how they perform in the real business world. Over time efficient firms grow and survive, while inefficient firms decline and fail. This process generates a positive correlation between age and performance.

of the world (see the introduction). There is also no strong evidence that firm age affects exit rates. In all three specifications the point estimate on the age term is negative, suggesting that young firms have higher exit rates than old ones, however none of these estimates is significant at conventional levels.

In columns (4)-(6) we generalise the specification by allowing for an interaction term between size and productivity. We do this to see if we can find evidence of selection on efficiency in certain size groups. One possible reason why the efficiency effects may vary by firm size is that small firms face more competition than do large ones, in which case we would expect the efficiency effect to be strongest among the smallest firms. Another possibility is that small firms cannot handle adverse shocks very well, and so some small firms may be forced to close down even though they may be relatively efficient. In this case the efficiency effect would be weakest among the smallest firms. Strikingly, in all three models the interaction term between productivity and size is negative and significant, suggesting that selection on efficiency occurs among the relatively large firms and that for firms below some critical minimum size exit is not associated with selection based on efficiency. To facilitate interpretation of these results we show in Figure 1 how the predicted exit rates varies with TFP (i.e. column (5)) evaluated at three different sizes and at mean values of the other regressors. At ten employees the exit rate is insensitive to TFP, however at 50 and 200 employees there is a negative relationship which is both statistically and economically significant.[11] One interpretation of this result is that being relatively efficient does not protect firms from going out of business if they are small. The corollary is that if small and efficient firms could grow, this would have dramatic effects on their survival rates. We now turn to the determinants of growth.

[11] The TFP effect is significant at the five per cent level both at 50 and 200 employees.

IV. The Determinants of Productivity and Growth

What are the determinants of productivity and growth?[12] The starting point for this part of the analysis is the production function:

$$(1) \qquad y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_e e_{it} + \gamma_a a_{it} + \gamma_{aa} a_{it}^2 + t \cdot \theta \omega_i + \mu_i + \eta_{it}$$

where y_{it} is the log of output from plant *i* at time *t*, l_{it} is the log of employment, k_{it} is the log of the capital stock, m_{it} is the log of raw material inputs, e_{it} is the log of indirect costs, a_{it} is the log of firm age, ω_i is a vector of variables hypothesised to affect productivity growth (hence the interaction with time in levels), μ_i is a firm fixed effect and η_{it} is a time varying residual. Differencing (1) removes the fixed effect and results in a growth rate equation:

$$(2) \qquad dy_{it} = \beta_l dl_{it} + \beta_k dk_{it} + \beta_m dm_{it} + \beta_e de_{it} + 2\gamma_{aa} a_{it} + \theta \omega_i + d\eta_{it},$$

where *d* is the difference operator. Following Nickell (1996) and Disney et al. (2003), we assume that one of the factors in ω_i is competitive pressure, defined as profits per employee.[13] If there is learning in the form of rising TFP, this will be reflected in the results by a positive effect of firm age.

Table 4 shows OLS estimates of the cross section production function, expressed in labour productivity form. We ignore any fixed effects and growth effects operating through the interaction between ω_i and time, in order facilitate comparison with earlier studies and to establish a base to compare with the differenced production functions reported in later tables. Several points stand out from the cross section results. The first is that there is some evidence for increasing returns to scale. Constant returns to scale can be rejected at the 5 per cent level (but not at the 1 per cent level). Quantitatively, however, the increasing returns to scale effect is quite modest. The second is that ownership plays no role in determining productivity. The third is that there is some evidence for a non-linear relationship between firm age and productivity. The linear term is negative although not significant at the 5 per cent

[12] Teal (1999) examines the determinants of the growth of the Ghanaian firms from this survey over the first half of the 1990s. The determinants of exit was not considered nor was the role of competitive pressure in productivity growth. The paper found evidence for output growth over the early 1990s for firms in Ghana, a process that was reversed in the second half of the 1990s, see Rankin, Söderbom and Teal (2002).

level. In column (2) we impose constant returns to scale and in column (3) we drop the insignificant linear term in firm age and the ownership dummy. This is our preferred levels production function. The learning effect as modelled by firm age appears to be small. After 15 years productivity has risen by only 6 per cent. Given the low levels of investment and very limited exports which have been documented for these firms such small learning effects are not surprising, see Bigsten et al (1999a,b) and Söderbom and Teal (2003). In the most parsimonious specification the capital coefficient is 0.02 and is significant at the 10 per cent level.

In Table 5 we report the differenced production function (recall that the difference is over five years). Column (1) reports our most general specification where we do not impose constant returns to scale. We allow firm size, age, ownership and competitive pressures to enter as determinants of productivity growth. However, the only factor with a significant effect (at the ten per level or lower) on underlying productivity growth is our measure of competitive pressure, profits per employee. The negative sign on profits implies that firms operating in highly competitive environments (thus yielding low rents) tend to record relatively high rates of productivity growth. Dropping the irrelevant variables and imposing constant returns to scale (which can now easily be accepted) yields the results in column (2). In this specification profits per employee is significant at the five per cent level. The point estimate of -0.23 implies that an increase in profits per employee by USD 1,000 leads to a decrease in the growth rate of TFP by 2.3 percentage points. Given the non-linear term in age in the productivity equation we anticipate a positive coefficient on age in the productivity growth equation. While the point estimate is positive and not significantly different from that obtained in the levels production function, it is not precisely estimated. Hence we do not reject the null that productivity growth rates are independent of firm age.

In the literature estimating a production function in differences based on micro data has often resulted in unsatisfactory results, in the form of severely decreasing returns and high standard errors on the input coefficients (e.g. Griliches and Mairesse, 1997). A common explanation for this outcome is

---

[13] We have experimented with alternative normalisations, such as output and value-added, but obtain less precise estimates of the coefficients. This is not surprising given that output and value-added are relatively

that the explanatory variables are measured with error and that taking differences exacerbates the bias caused by measurement errors (Griliches and Hausman, 1986). Our estimated coefficients on the factor inputs appear sensible despite the differencing, however, possibly because of the relatively long period of time over which the data are differenced. In fact, the point estimate on capital rises slightly as a result of differencing and as already noted there is no evidence of decreasing returns to scale (constant returns are not rejected).

While the control for firm fixed effects protect us against bias arising from a correlation between factor inputs and time invariant unobserved factors (e.g. managerial ability), it is possible that there is simultaneity bias due to the endogeneity of a firm's factor input demands. This bias, which probably would be positive, is more likely to affect the coefficients associated with the most flexible inputs, such as raw materials. Further, by construction the data that is used in estimating the differenced production function consists only of surviving firms, and so there is a potential selectivity problem of the form identified by Olley and Pakes (1996).[14] This bias is likely to be negative. Which of these biases is the most serious and how it affects our assessment of the respective roles of firm age, size and competitive pressure on firm performance are clearly empirical issues. We test for endogeneity and selectivity in Section V.

Next we turn to the question of firm growth, as distinct from the growth of productivity. Most studies in the literature on firm growth define firm size as one of the inputs, usually employment. We take a different route and define firm size as a weighted average of *all* inputs, using as weights the estimated coefficients in the differenced production function. Firm growth is thus defined as

$$df_{it} = \beta_l dl_{it} + \beta_k dk_{it} + \beta_m dm_{it} + \beta_e de_{it} ,$$

which we regress on the set of variables hypothesised to affect TFP growth in Table 5:

$$df_{it} = \varphi \cdot a_{it} + \lambda \omega_i + \upsilon_{it}$$

---

noisy variables compared to employment.

[14] Assumed that there is a higher probability that firms with large capital stocks will survive at lower productivity realisations, there will be a negative correlation between capital and productivity in the sample. If productivity is unobserved, capital will be negatively correlated with the residual and resulting in downward bias in the capital coefficient.

where φ and λ denote coefficients and υ is a residual. As discussed in the introduction, it is perfectly possible that the effects of size, age and competitive pressure may not be the same on firm growth as on productivity. Firm age and size may be related to firm growth for reasons other than their impact on productivity, e.g. due to various market constraints. It seems possible, for instance, that large firms face more steeply sloping demand curves than smaller ones, and may therefore grow more slowly than small firms. Firms with foreign ownership may find it easier to break into exports markets and may therefore grow more rapidly as a result. The effect of competitive pressure on firm growth cannot be signed a priori. If productivity growth impacts on firm growth, the effect documented above of competitive pressure on productivity will translate into a firm growth effect. In this case the coefficient on the rent variable will be the same as in the productivity growth equation, i.e. negative. Alternatively, a reduction in competitive pressure may result in higher rents which, under financial constraints, may lead to more investment, a notion consistent with the analysis by Bigsten et al. (1999b). In this case the coefficient on the rent variable will be positive.[15]

Table 6 shows the regression results modelling firm growth. The result here for the effect of age is clear-cut. Older firms grow slower but neither foreign ownership nor size play any significant role. The effects from profitability are less clear-cut. We first measure profitability in the factor demand equation in an identical manner to that used in the productivity equation as profits per employee, column (1). While the effect of profits per employee on factor growth is positive it is not significant. In column (2) we show the effect of measuring profitability as profits per unit of inputs (i.e. we normalise profit by an index of all inputs rather than simply employment). This now has a highly significant positive effect on factor growth. In column (3) we report a parsimonious specification where we exclude both foreign ownership and size. The result is to confirm the significance of firm age and profitability as determinants of the growth of factor inputs.

Taken together, these findings imply a trade-off in the effects of profits on output growth. Higher rates of profit per input increase firm growth but lower productivity growth. These findings are

[15] Alternatively, a reduction in competitive pressure may be associated with firm growth if competitors have

consistent with the view that financial constraints impact on growth and that effort, induced by competitive pressure from lower profits, impacts on productivity. The finding that firm age impacts negatively on factor demand is consistent with older firms facing more limited market opportunities. It is also consistent with their being closer to their desired size.

V. Robustness Checks: Tests for Selectivity and Endogeneity

We now turn to address the simultaneity and selectivity issues that may arise in estimating the productivity and factor growth equations. Simultaneity bias may arise in estimating the productivity equation if high-productivity firms use more inputs than low-productivity firms, an old concern in the literature. A recent class of estimators designed to deal with this problem are derived from the firm's value maximisation problem, thus identifying the production function parameters via a more 'structural' route than that usually taken in the literature (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg and Caves, 2003). More conventional remedies for the simultaneity problem involve controlling for unobserved fixed effects and/or using extraneous instruments, e.g. factor prices. Selectivity bias is discussed in Olley and Pakes (1996). In their model, the firm's decision on whether or not to exit from the market depends partly on the outcome of a productivity draw, unobserved to the econometrician, and partly on the firm's state variables (e.g. size and age). Favourable productivity draws and good states increase the likelihood of survival, and so, in the sample of survivors, the state variables will be negatively correlated with unobserved productivity. Therefore, specifications in which the state variables appear as explanatory variables and unobserved productivity is part of the residual cannot be consistently estimated by OLS. The method proposed by Olley and Pakes to correct for such bias exploits the theoretical result that, under certain regularity conditions, unobserved productivity can be expressed as a function of investment and the firm's state variables.

Our objective in this section is to examine the robustness of the results, reported in previous sections, to simultaneity and selectivity. Recall that our growth equations by definition cannot be biased

exited and surviving firms manage to increase their sales as a result. In this case too, the coefficient on the rent variable will be positive.

by correlation between inputs and time invariant unobserved factors (since such factors have been removed by the differencing procedure). Previous research suggests that such factors account for a substantial share of the cross-section heterogeneity in African firm performance (Söderbom and Teal, 2004), and so possibly this is the most important dimension of unobservable factors. However, if changes in unobserved productivity correlate with changes in inputs, differencing the data may not be sufficient. The structural estimators developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003) do not control for fixed effects and so do not appear to be well suited to our problem.[16] Instead we adopt a reduced form approach, seeking to purge the data of potential selectivity and simultaneity using Heckman's (1976) 'Heckit' estimator and two-stage least squares.

To test for selectivity in the productivity growth equation we write the exit equation and the growth equation as a recursive system:

$$S_{it} = 1\{Z_{i,t-1}\psi_1 + v_{it}\} > 0$$

$$dy_{it} = X_{it}\psi_2 + d\eta_{it} \qquad \text{if } S_{i,t+1} = 1\text{, otherwise not observed;}$$

where S_{it} is a dummy variable equal to one if the firm has not exited between periods *t*-1 and *t*; *Z* and *X* are vectors of explanatory variables; and ψ denote parameter vectors. Notice that in the selectivity equation unobserved productivity goes into the residual v_{it}, which if correlated with the differenced productivity residual may lead to bias. To test the null hypothesis of no selectivity bias we report in Table 7, columns [1]-[2], full information maximum likelihood estimates of the selectivity model applied to the equations for the growth of productivity, and factor inputs, respectively. In both cases the estimated correlation between the residuals is positive, but relatively small and far from significant. Average profits per employee remains negatively correlated with the underlying growth of productivity, and old firms grow slower than young firms. This is evidence that our earlier results are not biased by selectivity.

[16] The Levinsohn-Petrin estimator has been used by Frazer (2003) to estimate production functions based on Ghanaian manufacturing data.

We now test for simultaneity bias in the productivity growth equation. We treat as endogenous variables average profits per employee and the growth of capital per employee, raw materials per employee and indirect costs per employee. We use as instruments average profits to output, export history, average size over the sample period, growth in log employment, foreign ownership and firm age. These variables need to be orthogonal to growth in unobserved productivity, and we see no obvious reason why they should not be. The model is overidentified, and so we can shed some light on this issue by using a standard Sargan-Hansen test for the validity of the overidentifying restrictions. Results are shown in column [3] of Table 7. The Sargan-Hansen test indicates we can accept the overidentifying restrictions, while a Hausman test accepts the exogeneity of the inputs. This is evidence that the results reported in Section IV are not biased by simultaneity. While the standard error on the profit per employee term rises substantially the point estimate is unchanged by the instrumenting. Again we interpret this as evidence that our finding that competitive pressure does exert an effect on underlying productivity growth can be given a causal interpretation, a result already found by Nickell (1996) for UK data.

To further probe the data to see how robust the results are, we finally consider the possibility that our results for profitability are driven by some outliers. Figure 2 shows the growth of productivity, where the measure is derived from the residuals of the production function, plotted against profit per employee. While there is clear clustering around 0 there do not appear to be obvious outliers driving the results. In Figure 3 we present a similar graph showing the growth of factor input with profits per input. This does suggest a possible role for outliers. We have experimented with restricting the sample by deleting values of profits per unit of input greater than 5 in absolute value. The result was to double the size of the coefficient on profit per unit of input and it remained significant at close to the 1 per cent level. We would argue that these tests suggest we may be understating the effect of finance on the growth of factor inputs and that our results are not driven by outliers in the data. The graphical relationship between factor growth and firm age is presented in Figures 4. The finding visible in the graphs that younger firms grow faster is confirmed by the econometric tests presented above. We have shown this is an age, not a size, effect. It is younger firms which grow faster, not smaller ones.

VI. Conclusions

Both Ghana and Tanzania have introduced substantial reforms since the 1980s. Both have undertaken a number of policy and regulatory changes to liberalise a previously highly protected and public sector dominated economy. Measures which have particularly impacted upon the industrial sector include the introduction of a market-based foreign exchange system, liberalisation of trade policy, privatisation of state-owned enterprises and fiscal policy reform. Kenya is a country which has not adopted the severe control regimes which have characterised both Ghana and Tanzania for long periods of time. Thus the period for which we have data - the late 1990s - for all three countries offers us an opportunity to test for SSA how far an open market environment spurs the performance of firms in the manufacturing sector. We have focused upon the inter-related questions of firm exit, scale, productivity and growth.

Summary statistics on exit rates show that these are significant although not atypically high compared to data from other countries, possibly due to rather limited competitive pressure impacting on the ability of firms to survive. Our initial models of firm exit show that the main determinant of exit is firm size, with small firms having much higher exit rates than large ones. There is no evidence from these specifications that productivity impacts on firm survival, which stands in contrast to what has been found in more developed countries. Generalising the specification, however, we find a negative and highly significant interaction term between size and productivity, indicating that selection on efficiency occurs among the relatively large firms. Being relatively efficient, however, does not protect relatively small firms from going out of business. Most firms in Africa are very small.

We have then investigated, for firms that do survive, the factors that affect the growth of their productivity and their factor inputs. Factor growth is most significantly related to firm age - younger firms grow much faster than older ones - and profitability. One possible explanation why firms appear to stop growing as they become more mature is the limited access these firms have to export markets. We find no evidence that larger firms grow faster and neither size nor firm age affect underlying efficiency. Perhaps surprisingly, foreign ownership is not a factor in explaining higher productivity or factor growth. The most significant and potentially interesting relationship is that from competitive pressure to productivity growth. Given that one of the objectives of the reform programmes implemented in all three countries was to stimulate higher efficiency levels and the eventual achievement of international competitiveness amongst African manufacturing firms, the finding that competitive pressure is positively associated with productivity growth shows that one aspect of the reform programme has been successful.

References

Ackerberg, Daniel A. and Kevin Caves (2003). "Structural Identification of Production Functions," mimeo. Los Angeles, CA: Department of Economics, UCLA.

Bigsten, A., P. Collier, S. Dercon, B. Gauthier, J.W.Gunning, J. Habarurema, A. Isaksson, A. Oduro, R. Oostendorp, C. Pattillo, M. Soderbom, F. Teal, A. Zeufack (1999a). "Exports of African Manufactures: Macro Policy and Firm Behaviour." *Journal of International Trade and Development*, 8:1, pp. 53-71.

Bigsten, A., P. Collier, S. Dercon, B. Gauthier, J.W.Gunning, A. Isaksson, A. Oduro, R. Oostendorp, C. Pattillo, M. Soderbom, F. Teal, A. Zeufack (1999b). "Investment in Africa's manufacturing sector." *Oxford Bulletin of Economics and Statistics*, Vol. 61, No. 4, pp.489-512.

Bigsten, A., P. Collier, S. Dercon, M. Fafchamps, B. Gauthier, J.W.Gunning, A. Oduro, R. Oostendorp, C. Pattillo, M. Soderbom, F. Teal, A. Zeufack (2004). "Adjustment Costs and Irreversibility as Determinants of Investment: Evidence from African Manufacturing," *Topics of Economic Analysis & Policy*, forthcoming.

Davis, S.J., Haltiwanger, J.C. and S. Schuh (1996) *Job Creation and Destruction*, Cambridge, MA: The MIT Press.

Disney, R., J. Haskel and Y. Heden (2003). "Restructuring and Productivity Growth in UK Manufacturing," *The Economic Journal* 113, pp.666-694.

Evans, D.S. (1987a) "Tests of some alternative theories of firm growth", *Journal of Political Economy*, Vo. 95, pp.657-74.

Evans, D.S. (1987b) "The relationship between firm growth, size and age: estimates for 100 manufacturing industries", *Journal of Industrial Economics*, Vol.35, pp.567-81.

Foster, L., J. Haltiwanger and C.J. Krizan (2001). "Aggregate Productivity Growth: Lessons from Microeconomic Evidence," pp. 303-63 in C.R. Hulten, E.R. Dean and M.J. Harper, eds. *New developments in productivity analysis*. NBER Studies in Income and Wealth, vol. 63. Chicago and London: University of Chicago Press.

Frazer, G. (2003). “Learning the Master’s Trade: Apprenticeship and Human Capital in Ghana,” paper presented at *Northeast Universities Development Consortium Conference*, Yale University, October 17-19, 2003.

Griliches, Z. and J.A. Hausman (1986) “Errors in variables in panel data”, *Journal of Econometrics,* 31, pp.93-118.

Griliches, Z., Mairesse, J., 1997. Production functions: the search for identification, in: Strøm, S. (Ed.), Econometrics and economic theory in the 20th century: the Ragnar Frisch Centennial Symposium. Econometric Society Monographs 31. Cambridge University Press.

Harding, A., G. Kahyarara and N. Rankin (2002) Firm Growth, Productivity and Earnings in Tanzanian Manufacturing 1992-1999. REP/2002-03 at http://www.csae.ox.ac.uk/reports/main.html

Harding, A., M. Söderbom and F. (2002) The Tanzanian Manufacturing Enterprise Survey 2002. REP/2002-04 at http://www.csae.ox.ac.uk/reports/main.html.

Hart, P. and N. Oulton (1998), "Job Creation and Destruction in the Corporate Sector: The Relative Importance of Births, Deaths and Survivors", National Institute of Economic and Social Research, London.

Jovanovic, B. (1982). “Selection and the Evolution of Industry.” *Econometrica* 50(3): 649-670.

Klein, Michael U. (2003). “Ways Out of Poverty. Diffusing Best Practices and Creating Capabilities – Perspectives on Policies for Poverty Reduction,” World Bank Policy Research Working Paper 2990. Washington D.C.: The World Bank.

Levinsohn, James and Amil Petrin (2003), “Estimating Production Functions Using Inputs to Control for Unobservables,” *Review of Economic Studies* 70, pp. 317-341.

Liedholm and Mead (1995), “Small-scale Industries in Developing Countries: Empirical Evidence and Policy Implications”, International Development Paper No. 9, Agricultural Economics Department, Michigan State University

Liu, L. and J. Tybout (1996), "Productivity Growth in Chile and Columbia: The Role of Entry, Exit and Learning" in Roberts M. and J. Tybout (eds.) *Industrial Evolution in Developing Countries*, Oxford University Press, Oxford.

Liu, Lili (1993) "Entry-Exit, Learning and Productivity Change: Evidence from Chile." *Journal of Development Economics*, *42*, pp. 217-42.

Mazumdar, D. and A. Mazaheri (2003) *The African Manufacturing Firm*, Routledge, London.

Nickell, S. (1996) "Competition and Corporate Performance," *Journal of Political Economy*, Vo. 104, No. 4, 1996, pp.724-746.

Olley, G. S., and A. Pakes. (1996) "The Dynamics of Productivity in the Telecommunications Equipment Industry*." Econometrica* 64.6: 1263-1297.

Pavcnik, N. (2000), "Trade Liberalization, Exit and Productivity Improvements: Evidence from Chilearn Plants", National Bureau of Economic Research, Working Paper 7852.

Rankin, N., M. Söderbom and F.Teal (2002) The Ghanaian Manufacturing Enterprise Survey 2000. REP/2002-05 at http://www.csae.ox.ac.uk/reports/main.html

Söderbom, M. (2001) Constraints and Opportunities in Kenyan Manufacturing: Report on the Kenyan Manufacturing Enterprise Survey 2000 REP/2001-03: http://www.csae.ox.ac.uk/reports/main.html.

Söderbom, M. (2002), "Investment Behaviour," 2002, Chapter 7 in *Structure and Performance of Manufacturing in Kenya* (Eds. A. Bigsten and P. Kimuyu), Palgrave.

Söderbom, M. and F. Teal (2003) "Are manufacturing exports the key to economic success in Africa?" *Journal of African Economies*, vol. 12, No. 1, March, pp.1-29.

Söderbom, M. and F. Teal (2004) "Size and Efficiency in African Manufacturing Firms: Evidence from Firm-Level Panel Data," *Journal of Development Economics* 73, 369-394.

Teal, F. (1999), "The Ghanaian Manufacturing Sector: Firm Growth, Earnings, Productivity, Exports and Investment", *Journal of Development Studies*, Vol. 36, No. 1, October, pp. 109-127.

Tybout, J. (2000). “Manufacturing Firms in Developing Countries: How Well do They do, and Why?” *Journal of Economic Literature 38*: 11-44.

Van Biesebroeck, J. (2001) “Firm development and the Lack Thereof in Sub-Saharan Africa”, Mimeo, Department of Economics, University of Toronto.

Table 1

Summary Statistics on Firm Dynamics:

Rates of Birth, Death and Growth Among African Manufacturing Firms

	Ghana	Kenya	Tanzania	All
Number of Firms in Sample in 1993/94	151	129	94	374
Number of Firms in Sample in 1998/99	121	95	88	304
Number of Firms which Exited	31	53	41	125
Exit Rate (per cent)	21	41	44	33
Births between 1993/94 and 1998/99	1	19	35	55
Number of Surviving Firms	120	76	53	249
Average Change in Log Output among Surviving Firms	-0.26	-0.42	-0.11	-0.27
Standard Deviation of Change in Log Output among Surviving Firms	1.00	0.84	1.35	1.04
Average Change in Log Employment among Surviving Firms	-0.20	-0.09	-0.11	-0.15
Standard Deviation in Change in Log Employment among Surviving Firms	0.65	0.52	0.80	0.65

Table 2

Firm Characteristics in African Manufacturing by Initial size of Firm: Means and Standard Deviations

	Large	Medium	Small	Micro	All
Real output per Employee (a)	15,528 [20,221]	11,286 [21,775]	5,844 [12,287]	6,171 [6,813]	9,575 [17,586]
Real Capital per employee (a)	22,707 [50,737]	10,319 [14,752]	5,701 [21,576]	2,761 [6,813]	10,329 [29,204]
Firm Age in Years	22.5 [13.3]	21.7 [13.2]	16.0 [12.3]	10.9 [10.6]	18.2 [13.2]
Any Foreign Ownership (b)	0.48 [0.50]	0.14 [0.35]	0.05 [0.23]	0.03 [0.16]	0.17 [0.37]
Profit per Employee (a)	3,011 [5,855]	1,817 [4,608]	1,241 [4,334]	1,171 [4,117]	1,787 [4,802]
N	153	186	229	110	678
Exit	0.21 [0.41]	0.32 [0.47]	0.35 [0.48]	0.50 [0.50]	0.33 [0.47]
N	82	106	130	56	374

Note: N is the number of observations. Figures in [ ] are standard deviations.
(a) The figures are given in constant price 1991 US$. (b) These are [0,1] dummy variables.

Table 3

Exit Probits

	(1)	(2)	(3)	(4)	(5)	(6)
log *L*	-0.155	-0.128	-0.176	0.567	0.694	-0.132
	(2.58)**	(2.25)*	(2.36)*	(1.46)	(2.33)*	(1.69)$^+$
log *Y* / *L*	-0.044			0.210		
	(0.58)			(1.28)		
log *K* / *L*	0.073			0.047		
	(1.50)			(0.41)		
TFP		-0.077			0.883	
		(0.44)			(2.35)*	
FE			0.162			0.655
			(0.96)			(2.39)*
Foreign owned	-0.062	-0.004	-0.036	0.041	0.061	0.012
	(0.27)	(0.02)	(0.16)	(0.17)	(0.27)	(0.05)
log Firm age	-0.133	-0.117	-0.075	-0.147	-0.128	-0.099
	(1.56)	(1.38)	(0.78)	(1.69)$^+$	(1.47)	(1.01)
log *Y*/*L* x log *L*				-0.091		
				(1.70)$^+$		
log *K*/*L* x log *L*				0.007		
				(0.19)		
TFP x log *L*					-0.362	
					(2.77)**	
FE x log L						-0.170
						(2.25)*
Observations	374	374	374	374	374	374
log likelihood	-218.3	-216.3	-219.3	-215.1	-218.9	-216.1

Note: The numbers in ( ) are *z*-statistics. Significance at the one per cent, five per cent and ten per cent level is indicated by *, ** and $^+$ respectively. All regressions include controls for sector and country. Notation: *L* = employment; *Y* = output; *K* = physical capital; TFP = Total Factor Productivity, calculated as described in the main text; FE = Fixed Effect, calculated from a fixed effects output production function.

Table 4

Determinants of Productivity: Cross-Section

log (Output per Employee)

	(1)	(2)	(3)
log Employment	0.03*		
	(2.09)		
log Capital per Employee	0.01	0.02^{+}	0.02^{+}
	(1.28)	(1.91)	(1.87)
log Raw Materials per Employee	0.68**	0.68**	0.68**
	(33.52)	(34.01)	(33.80)
log Indirect Costs per Employee	0.19**	0.19**	0.19**
	(9.90)	(9.97)	(10.15)
log Firm Age	-0.10	-0.10	
	$(1.80)^{+}$	$(1.74)^{+}$	
$(\log \text{Firm Age})^2$	0.03	0.03	0.008
	(2.03)*	(2.03)*	(1.96)*
Any Foreign Ownership/100	-1.72	0.38	
	(0.39)	(0.09)	
Constant	1.97**	1.99**	1.87**
	(13.37)	(13.44)	(13.48)
Number of observations	678	678	678
R^2	0.92	0.92	0.92

Note: A time dummy and sector and country dummies are included in all regressions. The numbers in ( ) are *t*-statistics. Significance at the one per cent, five per cent and ten per cent level is indicated by **, * and $^{+}$ respectively.

Table 5

Determinants of Productivity Growth

Δ log (Output per Employee)

	(1)	(2)
Δ log Employment	0.02 (0.43)	
Δ log Capital per Employee	0.05 (0.97)	0.04 (0.89)
Δ log Raw Materials per Employee	0.64** (17.30)	0.64** (17.23)
Δ log Indirect Costs per employee	0.18** (4.85)	0.18** (4.86)
log Firm Age/100	3.51 (0.72)	
Any Foreign Ownership/100	-0.47 (0.06)	
Average log (Employment)/1000	0.29 (0.01)	
Average Profits per Employee/10,000	-0.23+ (1.94)	-0.23* (2.05)
Constant	-0.50** (2.38)	-0.38** (3.31)
Number of observations	249	249
R^2	0.82	0.81

Note: Sector and country dummies are included in all the regressions. The numbers in ( ) are *t*-statistics. Significance at the one per cent, five per cent and ten per cent level is indicated by *, ** and + respectively.

Table 6

Determinants of Factor Growth

Δ log (Factor Inputs)

	(1)	(2)	(3)
log Firm Age/100	-0.35**	-0.33**	-0.31**
	(3.09)	(2.95)	(2.81)
Any Foreign Ownership/1000	-0.24	-0.22	
	(1.56)	(1.49)	
Average log (Employment)	0.07	0.07	
	(1.54)	(1.45)	
Average Profits per Employee/1000	0.15		
	(0.94)		
Average Profits per Input		0.06**	0.07**
		(3.18)	(3.23)
Constant	0.54	0.43	0.57
	(1.28)	(1.04)	(1.45)
Number of observations	249	249	249
R^2	0.08	0.11	0.10

Note: Sector and country dummies are included in all the regressions. The numbers in ( ) are *t*-statistics. Significance at the one per cent, five per cent and ten per cent level is indicated by *, ** and $^+$ respectively.

Table 7

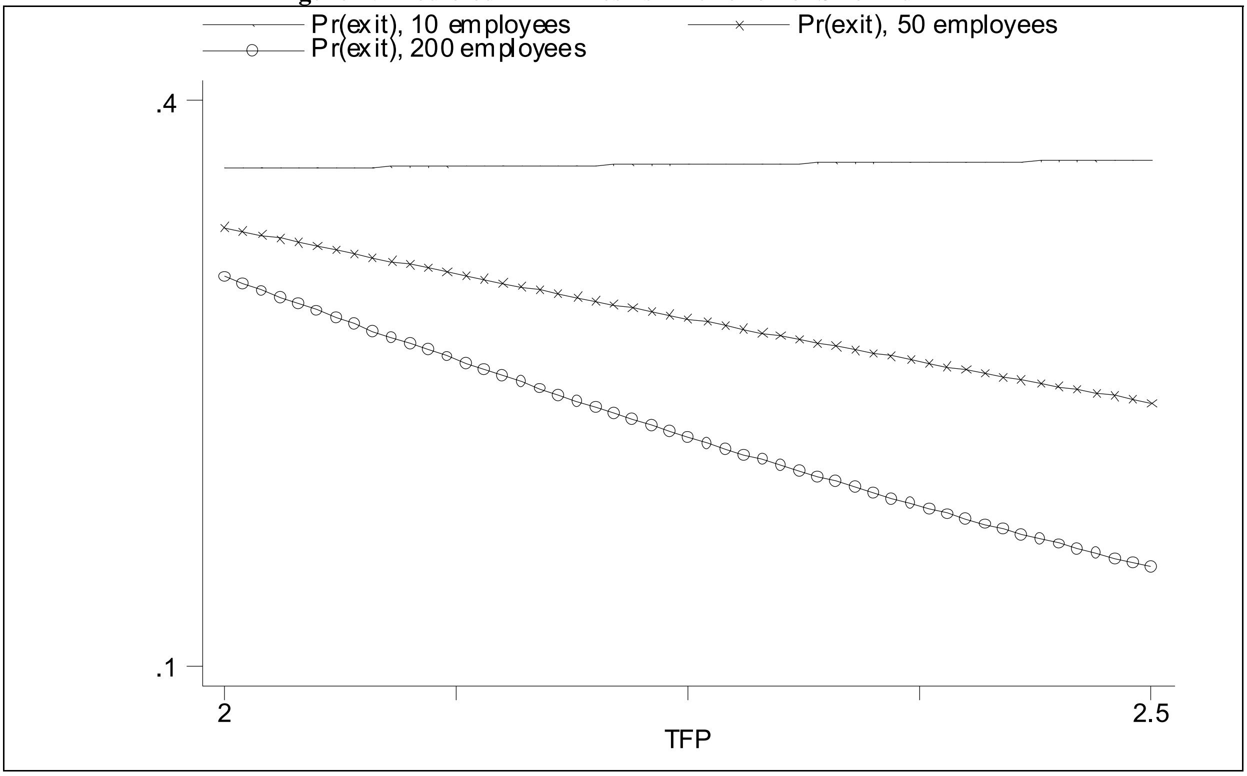
Selectivity and Endogeneity

	(1)	(3)	(4)
	FIML of Selectivity Model		2SLS[(a)]
	Δ log (Output per Employee)	Δ log (Factor Inputs)	Δ log (Output per Employee)
Δ log Capital per Employee	0.03 (0.89)		-0.03 (0.22)
Δ log Raw Materials per Employee	0.64** (25.21)		0.49* (2.42)
Δ log Indirect Costs per employee	0.18** (6.74)		0.38 (1.71)
log Firm Age	0.03 (0.57)	-0.29 (2.53)**	
Average Profits per Employee/10,000	-0.23** (2.68)		-0.25 (0.60)
Average Profits/ Input		0.07** (3.05)	
Rho	0.02 (0.07)	0.16 (0.55)	
Sargan χ^2 (4) [p]			2.93 (0.57)
Hausman χ^2 (11) [p]			1.01 (0.99)
Number of Observations	374	374	249

Note: Sector and country dummies are included in all the regressions. The numbers in ( ) are *t*-statistics. Significance at the one per cent, five per cent and ten per cent level is indicated by *, ** and $^+$ respectively.
(a) The instruments used for this equation are: average profits to output, average log of employment, export status (modelled as three dummy variables - whether the firm always exports, whether the firm enters exporting and whether the firm exits exporting, any foreign ownership, the log of firm age and the change in the log of employment. We have investigated how correlated are these instruments with the explanatory variables. The table below gives the R^2 on the reduced form regression and an F test on the significance of the overidentifying variables.

	Δ log Capital per Employee	Δ log Raw Materials per Employee	Δ log Indirect Costs per employee	Average Profits per Employee
R^2	0.53	0.09	0.13	0.21
F test on overidentifying variables	F(8,516)=70.22 (p=0.00)	F(8, 516)=4.90 (p=0.00)	F(8,516)=8.57 (p=0.00)	F(8,516)=8.0 (p=0.00)

Figure 1: Predicted Exit Rates as a Function of Size and TFP



Note: The predictions are based on the model reported in Table 3, column 5.

Figure 2: Growth of Productivity and Profits per Employee

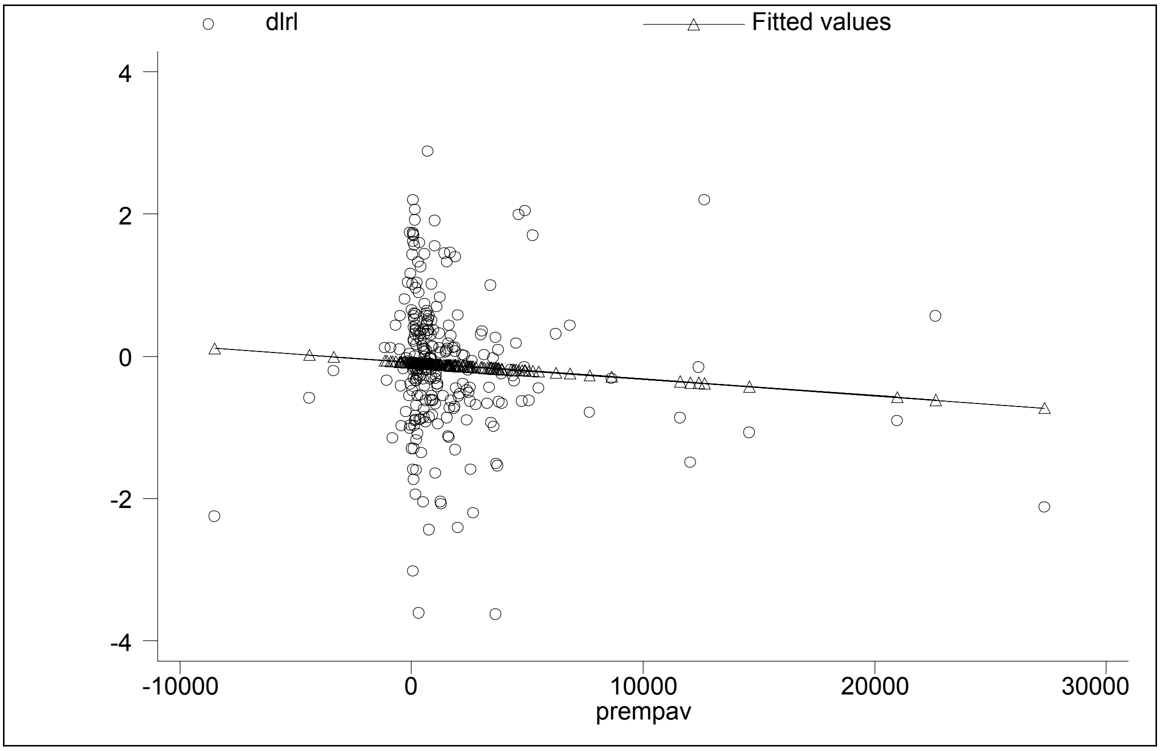


Figure 3: Growth of Factor Input and Profits per Input

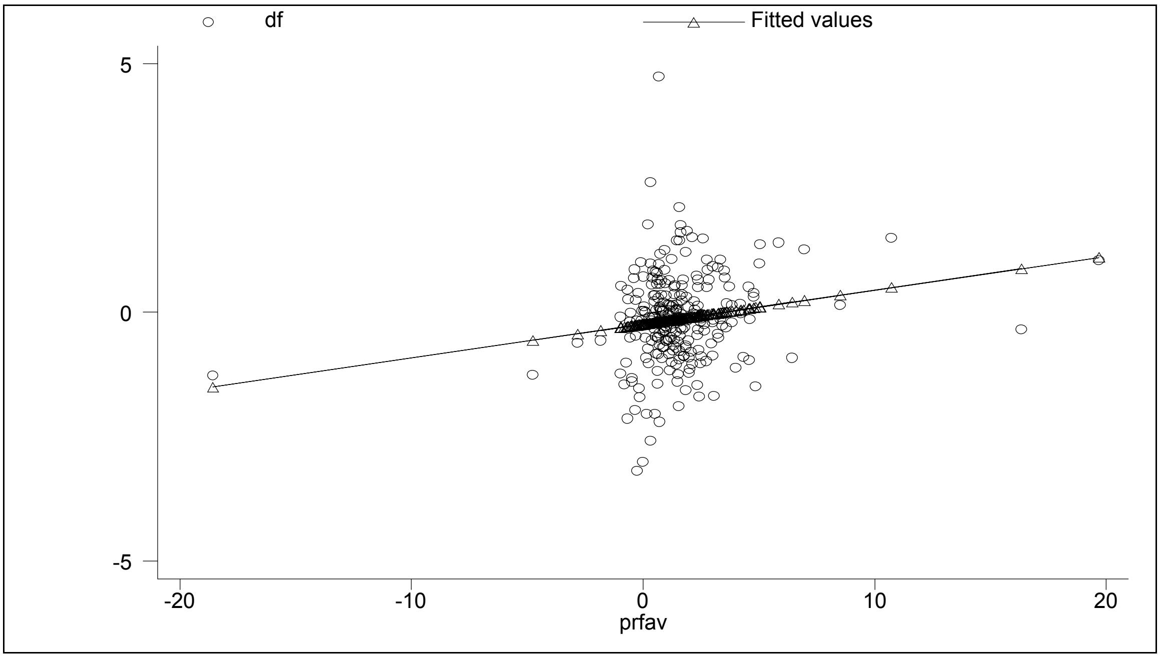


Figure 4: Growth of Factor Input and Firm Age