What drives productivity in Tanzanian manufacturing firms: technology or institutions?

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Abstract

Using the rich micro data set of the World Bank Investment Climate Survey, this paper examines the determinants of productivity among manufacturing firms in the context of a least developed country, Tanzania. In particular it seeks to evaluate the importance of technological variables - such as R&D, education and training, innovation, foreign ownership, licensing and ISO certification - and institutional variables – such as access to credit, health of the workforce, regulation and business support services. Among the technological variables, R&D, and innovations in the form of new products or processes fail to produce any significant impact, and only foreign ownership, ISO certification and high education of the management appear to affect productivity. Some of the institutional variables on the contrary are highly significant and robust to different specifications of the model. As such, formal credit constraints, administrative burdens related to regulations and a lack of business support services seem to depress productivity, while membership of a business association produces the opposite effect. The results of a quantile regression further indicate that the educational level of the managers and access to formal credit are significant for the less productive firms only, whereas for the more productive firms it is having an ISO certification or being a member of a business association that are the significant determinants.

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1 Introduction

Innovation is widely regarded as the key to economic growth in industrialized countries. Firms invest in R&D to develop new products or new processes. They acquire existing technology through licensing contracts, cooperation agreements, mergers and acquisitions. They train their workers, invest in new technologies, such as in information and communication technologies (ICT), or introduce new ways of operating, like selling and buying on the internet. By introducing new products, adopting new technologies, and reorganizing firms remain competitive; by investing in research, patenting and licensing they stay at the cutting edge of technologies (Baumol, 2002). It is an open question whether innovation plays the same essential role in developing countries.

One could argue that innovations would allow these countries to compete on a par with the developed countries and to become more independent of demand or exchange rate fluctuations. But, it probably makes little sense for a country that has a paucity of scientists and engineers and that lacks the institutions that create the conditions and the environment propitious to innovation to organize frontier type of research (Oyelaran-Oyeyinka, 2006). This does not mean, however, that less developed countries (LDC) cannot benefit from technological change. Innovation in LDC has perhaps more to do with adopting existing technologies than creating new technologies, i.e. reaching the technological frontier rather than shifting the frontier. Many authors have stressed the importance of building up a technological capability, an absorption capacity to be able to absorb and adopt new technologies developed elsewhere (Cohen and Levinthal, 1989; Lall, 1992; Enos, 1992). A first objective of this paper is to find out what kind of technological activities enhance productivity in a low-income country like Tanzania.

Some economists argue that institutions are 'the rules of the game' that guide and shape human interactions (Coase, 1998, North, 1991, Williamson, 1987). They can be formal – including laws, regulations, property rights - or informal rules, such as norms, habits and practices, social conventions. Jointly they form the basis of the incentive structure in which firms take decisions, they affect transaction and production costs and shift firm performance. Several forms of regulation on the start-up and scope of business activities and labour regulation result in severe market imperfections and create scope for rent seeking by civil servants. This is reinforced by a deficient contract enforcing system. As a result, in practice, some groups of entrepreneurs and businessmen have developed business attitudes by which problems are solved and business deals made on the basis of trust and reputation in the framework of unwritten values and norms of a more traditional society.

Banerjee and Duflo (2005) discuss how firm productivity is determined by incentives. Governments may overprotect some investors and underprotect others, resulting in productivity differences among firms. Excessive government intervention, related to a high degree of formalism or burdensome legal procedures, may create barriers to entry or growth and protect inefficient incumbent firms. At the same time, a lack of appropriate regulations regarding property rights and legal enforcement may discourage investment. Credit constraints in poorly developed financial markets likewise result in unequal access to finance, in misallocations of capital and productivity differences. In an overview article on the determinants of the size structure and productivity performance of manufacturing firms across developing countries, Tybout (2000) equally mentions the uncertainty about government policies and demand conditions, poor rule of law, and corruption as important factors hampering the operations of firms. Using firm level data from sixteen countries, including five African countries, Eifert, Gelb and Ramachandran (2005), found that high indirect costs- due to high transportation and utility costs, bribes, security etc… - and business environment related losses depress productivity of African firms.

We shall examine the relevant importance of innovation and institutional factors in explaining productivity of Tanzanian manufacturing firms using micro data from the Investment Climate Survey conducted by the World Bank in 2003. This dataset contains a whole panoply of data ranging from production and input choices to labor and training, innovation, finance, learning and technology, and perceived business environment.

The paper proceeds as follows. Section 2 presents the econometric specification. Section 3 describes the data. Section 4 discusses the results and section 5 concludes.

2 Empirical Approach

To analyze the effects of technological and institutional variables on firm level productivity we use the straightforward production function approach in which firms' value added Y_i is a function of the traditional factors of production, physical capital K_i and labour L_i, as well as other observable factors explaining differences in productivity, i.e. technological variables $Z_{1,i}$ and institutional variables $Z_{2,i}$.We assume that technological and institutional variables $Z_{1,i}, Z_{2,i}$ affect only total factor productivity, but not the marginal productivity of capital and labour. Within a Cobb-Douglas framework allowing for non-constant returns to scale we get the following specification

$$Y_i = \mathrm{A}(Z_{1,i,}Z_{2,i})K_i^{\alpha} L_i^{\beta}\, \mathrm{e}^{\varepsilon_i} \tag{1}$$

in which α and β denote marginal productivities of physical capital and labour, respectively. Constant returns to scale occurs if $\alpha + \beta = 1$, which will be tested empirically. $\mathrm{A}(Z_{1,i}, Z_{2,i})$ characterizes differences in total factor productivity (TFP) depending on technological and institutional variables. The stochastic term ε_i summarizes other unobservable factors affecting firms output.

As a starting point for our empirical analysis, we get after taking logarithms

$$\ln Y_i = \ln A(Z_{1,i}, Z_{2,i}) + \alpha \ln K_i + \beta \ln L_i + \varepsilon_i \tag{2}$$

This equation can be rewritten in terms of labour productivity in the following way:

$$\ln(Y_i / L_i) = \ln A(Z_{1,i}, Z_{2,i}) + \alpha \ln(K_i / L_i) + (\alpha + \beta - 1) \ln L_i + \varepsilon_i \tag{3}$$

The stochastic error term ε_i is assumed to be iid normally distributed. We further assume that total factor productivity is a linear function of technological and institutional variables. The coefficient of ln L_i measures the deviation from constant returns to scale.

Part of total factor productivity can be attributed to capacity utilization. When firms operate at higher capacity, they can produce more with the same amount of inputs. We therefore introduce variable u_i measuring capacity utilization:

$$\ln(Y_i / L_i) = \ln A(Z_{1,i}, Z_{2,i}) + \alpha \ln(K_i / L_i) + (\alpha + \beta - 1) \ln L_i + \gamma u_i + \varepsilon_i \tag{4}$$

We expect parameter γ to be positive, i.e. firms are able to increase labor productivity by using production capacities more intensively.

To estimate this equation two different estimation techniques are applied: Ordinary Least Squares (OLS) regression and quantile regression. If we summarize the explanatory variables, including a constant term, to X_i, the OLS estimator results from minimizing the sum of squared residuals, i.e. from minimizing the criterion function

$$\sum_{i=1}^{N}(\ln(Y_i / L_i) - X_i b)^2 \tag{5}$$

where b is the vector of estimated coefficients. Thus, OLS is in fact estimating the mean effects of explanatory variables X_i on log value added per employee. Heterogeneity in firms' characteristics and abilities that are not reflected in variables X_i are assumed to be random and to vanish in the mean. They are not allowed to have an effect on parameters to be estimated. Possible differences across firms are thus ruled out.

But, at different levels of productivity firms may face different conditions and have to cope with different problems. Technological activities may be organized differently in high and low productive firms. High productive firms are likely to have their own R&D department whereas low productive firms would rather acquire technology by licensing. Institutional conditions, such as rationing on the credit market and overregulation may be a more severe problem for low than for high productive firms. Returns to scale may he higher for high productive firms.

Therefore, in addition to OLS we apply quantile regression methods (see Koenker and Bassett, 1978, Buchinsky, 1998 and Koenker and Hallock, 2001) to shed some light on heterogeneity of firms and on the technological and institutional conditions creating it.[1] Instead of minimizing the sum of squared residuals, quantile regression coefficients result from minimizing the criterion function

$$\sum_{i=1}^{N}\rho\,\left|\ln(Y_i / L_i) - X_i b\right|\, I(\ln(Y_i / L_i) \le X_i b) + \sum_{i=1}^{N}(1-\rho)\,\left|\ln(Y_i / L_i) - X_i b\right|\, I(\ln(Y_i / L_i) > X_i b) \tag{6}$$

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[1] Quantile regressions have been successfully used to analyze a slightly related problem by Mello and Perrelli (2003). They examine cross-countries differences in growth and apply quantile regression techniques to pooled cross country data, while we use cross-sectional firm data within a country.

where $I(\cdot)$ is an indicator function taking the value of 1 if the condition in brackets is met and 0 otherwise, i.e. $I(\ln(Y_i / L_i) \le X_i b) = 1$ if $\ln(Y_i / L_i) \le X_i b$ and $I(\ln(Y_i / L_i) \le X_i b) = 0$ if $\ln(Y_i / L_i) > X_i b$. So, the left term is a weighted sum of all negative residuals, i.e. the less productive firms, while the right term is the weighted sum of all positive residuals, i.e. the high productive firms.

ρ is a weighting factor ranging from 0 to 1. In the special case where $\rho = 0.5$, both terms are equally weighted and minimizing the criterion function leads to the 50-percent quantile. This constitutes the well known Least Absolute Deviation (LAD) or Least Absolute Values (LAV) estimator. In this case, the procedure will result in the estimation of median effects in contrast to the mean effects of the OLS estimator. It is well known that this LAD estimator is robust, i.e. less affected by outliers than other estimators like e.g. the OLS estimator. If a few firms, e.g. foreign owned firms, behave different from the majority of local firms, this will influence the mean results of the OLS estimator but not the median results of the LAD estimator. In this case, the median would be a more adequate measure of location than the mean.

If $\rho = 0.25$ the negative residuals in the left term have lower weight than positive residuals in the right term of the expression. Minimizing the criterion function will then lead to estimated coefficients whereby 75 percent of the residuals are negative. By definition, this is the 75%-quantile, i.e. the upper quartile. The results of the estimation will show the effect of the explanatory variables on productivity for the highly productive firms.

Less productive firms can be examined setting $\rho = 0.75$. The positive residuals in the right term have higher weight than the negative ones. Minimizing the criterion function will lead to estimated coefficients where 75 percent of the residuals are positive, i.e. the distribution is evaluated at the 25%-quantile, the lower quartile. The lower quartile represents the less productive firms.

3 Data

Micro data are needed to analyze differences in firm level productivity within a country. While firm level data sets are well established for most of the OECD countries, corresponding data of good quality were hardly available in the past for most developing and especially for least developed countries like Tanzania. Considerable advances have been made by the World Bank with their Investment Climate Surveys (ICS).[2] They offer harmonized data on the investment climate, i.e. conditions affecting firm production and investment behaviour, in developing countries.

The Tanzanian ICS, organized and coordinated by the World Bank, was executed in 2003, by the Economic and Social Research Foundation in collaboration with the National Bureau of Statistics. The Tanzanian ICS is a rich data set gathering plant-level information on the business environment in which plants and firms operate, in order to understand how technological conditions and institutional constraints affect the operations and performance of firms, especially firm level investment, growth and productivity. The survey questionnaire includes a series of questions on firms' behaviour and their position on financial, labour and sales markets accompanied by information on infrastructure, regulation, international trade, innovation and learning as perceived by the firm. To benchmark firms' performance, another set of variables is included such as productivity.

The sample in Tanzania includes 275 plants in the manufacturing sector. These are randomly selected from a sampling frame constructed from different official sources and stratified by branch of industry, size and location[3]. Plants are selected from 11 different locations representing the major centres of industrial activity in Tanzania: Dar es Salaam, Arusha, Morogoro, Mwanza, Kilimanjaro, Tanga, Kagera, Iringa, Mbeya, Mara on the mainland, and the island of Zanzibar. The manufacturing sector is divided into eight industries: food and beverages, chemicals and paints, construction materials, metal working, wood working and furniture, paper and printing / publishing, plastics as well as textiles, garments and leather products. With respect to size, the sample is representative for the formally registered firms. The median size of the plants in the sample is 30 employees, the mean size is 125 employees, showing a highly skewed size distribution with a few very large firms and a majority of small firms. The micro firms with less than 10 employees and the informal firms, which are not

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[2] These Investment Climate Surveys (ICS) form the basis for the 2005 World Development Report (see World Bank, 2004b). More information on the Investment Climate surveys, the methodology and data collected can be found on the website of the Investment Climate Unit of the World Bank: http://iresearch.worldbank.org/ics

[3] More information on the sampling methodology can be found in the Investment Climate Assessment Report on Tanzania (see World Bank, 2004a).

registered with any government agency and tend to be small, are underrepresented in the sample (World Bank, 2004a).

Due to item non-response on variables crucial for the analysis, a number of observations had to be excluded from the data set, reducing the number to 187.[4] The distribution of the sample used for the econometric analysis with respect to sectors and size classes is shown in table 1. The table also presents the number of firms with some share of foreign ownership. A total of 35 firms are in this category. The foreign ownership is a minority share in seven firms, a majority share in 18 firms while ten firms are fully foreign owned.

Insert Table 1 about here.

The dependent variable is LABOUR PRODUCTIVITY, measures by the value added per employee in logarithms. Value added was calculated from the data as the value of total sales minus material purchases and fuel and electricity costs. All values are for the year 2002 and in logarithmic terms.

Labour productivity is a function of the CAPITAL/LABOUR ratio (in logarithm) and a function of LABOUR (in logarithm) if there are non-constant returns to scale. The variable capital represents the logarithm of the firm's capital stock by end of the year 2002, constructed by the replacement value of machines and equipment, plus the net book value of land and buildings. For a number of firms these values were not available. In these cases, information on net and gross book value of machinery and equipment as well as land and buildings was used to estimate the capital. Technical details on the construction of the variable capital are presented in the appendix. Labour input is measured by the log value of the total number of employees in 2002, being the sum of permanent workers and the average number of temporary workers employed in 2002.

As explained in sections 2 and 3, two additional sets of variables were constructed. One set represents information on firms' technological activity or sourcing, i.e. ways firms choose to build up firm specific skills and increase their knowledge base. Another set of variables is referring to the institutional environment the firm is operating in, which may differ from firm to firm even within one country.

Firms can choose different ways to increase technological capabilities in the production of goods. A straightforward way is to acquire new or improved technology from external or even foreign sources. ‘New’ or ‘improved’ means new to the firm in this context. Firms can source technology from abroad through established ownership linkages that stimulate transfer of production or organizational capabilities and generate higher levels of productivity. A binary dichotomous variable, the dummy variable FOREIGN, indicating whether the firm has a positive share of foreign ownership captures this effect. Moreover, firms can directly make use of external technology through licensing from other firms. The dummy variable LICENSE marks whether technology has been licensed from a foreign company.

Firms can also build up a stock of technological knowledge through a knowledge accumulation process. From the set of questions related to the firms’ learning and innovation activities, variables were constructed to measure the fact of conducting research and development (R&D) and the intensity of doing it. RD is a dummy variable indicating whether a firm conducts its own R&D. LRDEXP, the log of the firm’s R&D expenditures, measures the extent of R&D activities[5]. But R&D efforts do not necessary result in innovations successful on the market. In some cases R&D is not even a prerequisite. Thus, the introduction of innovations onto the market had to be captured by specific variables. The dummy variable PRODUCT indicates whether the firm has successfully introduced a product innovation onto the market while the dummy variable PROCESS points out whether a firm has introduced a new production process within an old or a new plant. Quite often product and process innovations go hand in hand.

The ability of firms to make use of external technologies and to efficiently convert research results in marketable products depends on their absorptive capacity, especially the educational level of the labour force and the top manager. This is captured by the variables AVYEDUC, measuring the average years of education of the work force and EDUCGM, a dummy variable for managers with higher education. Increasing the educational level of the labour force through training, either on the job or through formal training, is generally regarded to be an import aspect of competence building, increasing firm performance. The dummy variable

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[4] Some of the variables were imputed using secondary information to reduce the number of excluded observation to a minimum. Information on imputation methods used is delegated to the appendix.

TRAINING equals one for firms offering formal training to their employees. TRAININT measures training intensity by the proportion of employees that received formal training in 2002.

These variables are supplemented by two others, characterizing special aspects of technological activities. While the use of new information and telecommunication technologies is fully recognized as an important instrument in the search for information and knowledge, with access and use of the internet as a major indicator, ICT is still less widespread in Africa as compared to other developing regions. Though access to the internet has increased substantially in urban areas in Africa, and in Tanzania in particular, it is still limited to a subset of mainly top end businesses (WEF, 2004). In our data set, INTERNET, a dummy variable measuring internet access of firms captures this advantage. The technological and organizational level of firms in developed countries is sometimes accompanied by certification, such as the well-known ISO 9000 certification. For firms in our sample this is shown by the dummy variable ISO. Table 2 gives an overview of all variables considered and how they are defined.

Insert Table 2 about here.

A second set of variables deals with the institutional environment firms operate in. As in many least developed countries, financial markets are characterized by important failures and credit to finance business operations and expansion cannot be accessed equally by all firms. The variable CREDIT captures the benefit of having access to formal credit, as reported by the firms.

With respect to firms' relation with the government, two related concerns are mainly reported: firms complain about red tape and high taxes, combined with poor business infrastructure and support services (eg. WEF, 2004, World Bank, 2004a) The extent to which overregulation - i.e. the administrative burden associated with custom and trade regulation, and bureaucratic business licensing procedures - is hampering firms operations is captured by a dummy variable REGULATION. The lack of business support services hampering firms' growth and operations is taken into account by another dummy variable LACKSUPPORT. In a context

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[5] For firms that do not report to have any R&D activities or expenditures, LRDEXP is set equal to zero. To

of poor government support, formal and informal networks between firms play an increasingly important role. For instance, being member of a business association facilitates access to knowledge and information flows in the domestic market, and can alternatively be helpful to lobby with the government to defend the interests of certain business groups or the firm. Therefore, a dummy variable BUSASSOC indicating whether a firm is member of a business association is added to the list of regressors.

This list is completed by a variable referring to the health systems. With high HIV/AIDS infection rates among adult population and the high burden of other diseases, including malaria, absenteeism among the workers due to these and related illnesses may be depressing firms' productivity levels. This effect is measured by the variable DAYSLOST the average number of working days lost per employee due to health related problems.

Summary statistics of the variables are presented in table 3.

Insert Table 3 about here.

4. Results

The regression results are summarized in tables 4 to 5. Table 4 reports OLS results for three different specifications: a simple labour productivity equation without the extension of technological and institutional variables, the extended model including all technological and institutional variables listed in table 3, and a reduced model. In the reduced model only variables that prove to be significant after removing insignificant variables are included in the regression.

Insert Table 4 about here.

correct for this measurement error we include the dummy variable RD.

Starting with the simple specification, we find an elasticity of output with respect to capital of 0.356 and a scale elasticity of 1.154. Increasing returns to scale cannot be rejected. Labour productivity also increases with capacity utilization. Once we control for technology and institutional variables, the capital elasticity of output drops to 0.261, and constant returns to scale can no longer be rejected. Capacity utilization remains significant, but with a slightly lower coefficient. In the reduced specification where technological and institutional variables that are not significant are left out, the labour and capital elasticities of output drop even further, and the hypothesis of constant returns to scale has to be rejected at the 5 percent level in favour of decreasing returns to scale. On the basis of the adjusted R-square, this is our preferred specification.

But surprisingly, many of the technology variables do not have any significant effect on total factor productivity. While foreign owned firms have a significantly higher total factor productivity than firms without foreign ownership, as indicated by the coefficient of the variable FOREIGN, licensing (LICENSE) has no significant effect on production output. Thus, if there is access to external technology it is through foreign ownership. Both variables RD and LRDEXP are insignificant. Knowledge accumulation through R&D does not improve production conditions, at least in the short run. Even successful innovations in terms of products (PRODUCT) or processes (PROCESS) do not improve firms' TFP. In contrast to the findings in the literature, even the skills level and learning activities of the labour force (AVYEDUC, TRAINING, TRAININT) do not affect the Tanzanian firms' productivity. Only the qualification of the firms' managers seems to make a difference. This surprising result may reflect that in the short run training has two opposite effects: while it improves the productivity of the labour force it reduces the amount of labour being involved in the production process.

Hence, the technological factors of importance reduce to access to technology by foreign owned firms, the quality of management as reflected in the formal education of the management, and the technological capability revealed through ISO certification. ISO certification opens firms' access to international markets, it can act as a signal of quality, and allow firms to charge higher prices.

Institutional variables on the contrary capture a fairly large portion of the variance of labour productivity. This result is reinforced when the number of explanatory variables is reduced to those that are significant. First of all, firms which are members of a business association (BUSASSOC) have a significantly higher TFP. Being a member of this network seems to be very important for Tanzanian firms. Various reasons could be invoked to explain the benefit of this networking effect: access to information, increased bargaining power with government and foreign competitors, exploitation of synergies. Similarly, firms which have access to external financial funds (CREDIT) have a higher TFP. This indicates that either high productive firms have easier access to the credit market or, alternatively, that some projects which would improve firms' production technology are not implemented due to lack of financial sources. Overregulation of firms (OVERREGULATION) and lack government support (LACKSUPPORT), both capturing institutional problems and government failure likewise decrease firms' TFP, at least at the 10-percent level of significance. The same holds for a mal-functioning health system measured by the number of days lost due to health problems (DAYSLOST).

Thus, productivity differences in Tanzanian firms are not only explained by differences in production factors or differences in technology and know-how. Institutional aspects explain a large part of the variation in firms' productivity. This indicates that improving governmental institutions and protecting market forces are at least as important for increasing production in Tanzania as technology and learning.

These results are valid for the average firm and this picture seems to be quite homogeneous. But, looking at the quantile regression adds to the information given by OLS. Results for the 50-percent quantile, i.e. the median (LAD or LAV estimator), should more or less coincide with OLS results if the conditional distribution of the log value added was nearly symmetric. But, in fact they do not, since TFP as a rule is skewed to the right. A few highly productive firms face a majority of low productive firms. In contrast to the average firm, the median firm faces constant returns to scale. Education of management (EDUCGM) is not a key factor in explaining productivity, nor is foreign ownership (FOREIGN) important. Thus, the technological variables reduce to ISO certification. Some of the institutional variables like REGULATON, lack of government support (LACKSUPPORT) or the mal-functioning of the health system (DAYSLOST) are not relevant for the median firm while being member of a business association (BUSASSOC) and having access to credit (CREDIT) still is.

But the most interesting picture emerges by comparing the difference in results for low-productive and high-productive firms reflected by the lower and the upper quartile. High-productive firms work on decreasing returns to scale. Their marginal productivity of labour is lower while their marginal productivity of capital is higher. Looking at the technology variables, education of management is a crucial factor for low-productive firms to improve production. Differences in productivity of low-productive firms are ceteris paribus to a great extent explained by difference in the educational level of management. This is not the crucial problem for the high-productive firms since managers in general is well educated.

Having access to external technology (FOREIGN) counts for high productive firms. Again ISO certification is a way of increasing measured productivity for high-productive firms. For low-productive firms both variables are not important. They are far away from benefiting from certification. The institutional constraints firms have to cope with differ with the conditional distribution of labour productivity. Having access to finance (CREDIT) seems to be a key factor for low-productive firms since lacking credit is hampering them to install modern and more advanced technology. High-productive firms do not suffer from this problem. Government regulation (REGULATION) is mainly a stumbling block for high-productive firms. For all firms, it is beneficial to join a business associations (BUSASSOC).

5. Conclusions

This study uses the World Bank Investment Climate Survey data to investigate the relative importance of technological and institutional variables in explaining productivity differences among manufacturing firms in Tanzania. The traditional technology variables, R&D and innovation output measures, turn out insignificant. Only indirect technological influences, foreign ownership, ISO certification and the educational level of the general manager seem to have a positive effect on labour productivity in Tanzanian manufacturing firms. Instead, institutional factors, such as over-regulation, lack of government support, and a deficient health system, do seem to carry some weight. A quantile regression shows that there is some heterogeneity among the firms in our sample of manufacturing firms.

The results of this study point out the importance of the institutional setup in explaining productivity differences among manufacturing firms in a developing country like Tanzania, and the lack of importance attached to direct innovation factors. It would be interesting to test whether this also holds in other countries in other circumstances and different stages of development.

This study also shows the usefulness of the Investment Climate Survey data to study innovation, because it sheds light on many different aspects of relevance to the innovation system, some of which are not taken into account in the usual innovation surveys.

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Tables

Table 1: Composition of sample in terms of sector, foreign ownership, by size class

Size class (number of employees)	1-9	10-29	30-99	100+	Total
Sector of activity					
Agro-industries	7	16	12	22	57
Chemicals and paints	1	3	6	8	18
Construction materials	1	1	4	2	8
Metal working	0	12	4	4	20
Furniture, wood working	11	22	7	3	43
Paper, printing, publishing	2	9	5	3	19
Plastics	0	0	0	4	4
Textiles , garments, leather products	3	4	6	5	18
Ownership					
Foreign owned firms	0	5	13	17	35
TOTAL	25	67	44	51	187

Table 2: Construction and definition of the variables.

DEPENDENT VARIABLE	
VA/L	Value added per employee, in logarithmic terms Total value added is sales minus material purchases, fuel and electricity
EXPLANATORY VARIABLES	
Traditional variables	
LABOUR (L)	Total number of employees, including temporary workers (in log.)
K/L	Capital per employee, in logarithmic terms Capital stock includes machinery, equipment, vehicles, land and buildings
CAPACITY UTILISATION	Actual output produced /maximum output that can be produced with existing machinery and equipment and regular shifts (value between 0 and 1)
Technology variables	
FOREIGN	Dummy variable being 1 if the firm has some foreign ownership
ISO	Dummy variable being 1 if the firm has ISO certification
RD	Dummy variable being 1 for firms that invest in R&D or design
LRDEXP	Expenditures on R&D and design (in log.)
PRODUCT	Dummy variable being 1 for firms that have developed a major new product line or upgraded an existing product line in the last three years (2000-02).
PROCESS	Dummy variable being 1 for firms that have introduced new technology that has substantially changed the way the main product is produced.
LICENCE	Dummy variable being 1 for firms that use technology licensed from a foreign-owned company
INTERNET	Dummy variable being 1 for firms that have internet access
EDUCGM	Dummy variable being 1 if the general manager of the firm has a graduate or postgraduate degree or diploma of tertiary college
TRAINING	Dummy variable being 1 for firms that offer formal training to their employees
TRAININT	Training intensity measured as the proportion of total permanent employees that received formal training in 2002
AVYEDUC	Skills level of the work force, estimated by the average number of years of education of the permanent employees
Institutional variables	
BUSASSOC	Dummy variable being 1 for firms that are member of a business association.
CREDIT	Dummy variable being 1 for firms that report not to be credit constrained
DAYSLOST	The number of working days lost due to HIV and other diseases, per employee
REGULATION	Dummy variable being 1 if the firm reports ‘Customs and Trade Regulation’ and ‘Business licensing and operating permits’ as severely hampering the operations and growth of the firm
LACKSUPPORT	Dummy variable being 1 if the firm reports the lack of business support services as severely hampering the operations and growth of the firm

Table 3: Descriptive Statistics on the relevant variables

	Mean	Standard Dev.	25% percentile	median	75% percentile
Dependent variable					
VA/L	14.809	1.484	13.889	14.754	15.714
Traditional variables					
LABOUR	3.618	1.412	2.485	3.401	4.605
K/L	15.826	2.032	14.720	16.030	17.237
CAPACITY UTILISATION	0.587	0.222	0.470	0.600	0.750
Technology variables					
FOREIGN	0.187				
ISO	0.112				
RD	0.187				
LRDEXP (N=35)	14.808	2.099	12.794	15.177	16.118
PRODUCT	0.610				
PROCESS	0.289				
LICENCE	0.171				
INTERNET	0.471				
EDUCGM	0.663				
TRAINING	0.428				
TRAININT (N=80)	0.120	0.214	0.000	0.024	0.146
AVYEDUC	8.205	2.400	6.800	8.150	10.000
Institutional variables					
BUSASSOC	0.412				
CREDIT	0.198				
DAYSLOST	0.577	1.223	0.000	0.045	0.727
REGULATION	0.171				
LACKSUPPORT	0.086				

Note: Number of observations: 187
For binary variables, only the mean is given.
For the variable LRDEXP – log of R&D expenditure - the values refer to the sub-sample of 35 R&D performing firms (where RD=1).
For the variable TRAININT – training intensity – the values refer to the sub-sample of 80 firms that actually report to offer formal training (where TRAINING=1).

Table 4: Results of OLS Regressions

Dependent variable	**OLS Regressions**		
VA/L	Simple model	Extended model	Reduced model
Traditional variables			
LABOUR	0.154 **	-0.151	-0.184 **
K/L	0.356 ***	0.261 ***	0.246 ***
CAPACITY UTILISATION	1.514 ***	1.413 ***	1.353 ***
Technology variables			
FOREIGN		0.448 *	0.441 **
ISO		0.792 ***	0.706 **
RD		0.481	
LRDEXP		0.045	
PRODUCT		-0.087	
PROCESS		-0.124	
LICENCE		-0.032	
INTERNET		-0.121	
EDUCGM		0.791 ***	0.743 ***
TRAINING		0.031	
TRAININT		-0.160	
AVYEDUC		-0.024	
Institutional variables			
BUSASSOC		0.578 ***	0.485 **
CREDIT		0.552 **	0.534 **
DAYSLOST		-0.134 *	-0.136 **
REGULATION		-0.340	-0.388 *
LACKSUPPORT		-0.462	-0.524 *
Adjusted R-squared	0.320	0.448	0.467
Numbers of observations	187	187	187

Significant at 1% (***), 5% (**) and 10% (*) levels.
All regressions include constant term and 4 industry dummies .

Table 5: Results of Quantile Regressions

Dependent variable	OLS	Quantile Regression		
VA/L	Mean	Lower Quartile	Median	Upper Quartile
Traditional variables				
LABOUR	-0.184 **	-0.090	-0.165	-0.237 ***
K/L	0.246 ***	0.221 **	0.288 ***	0.301 ***
CAPACITY UTILISATION	1.352 ***	1.422 **	1.190 **	1.173 **
Technology variables				
FOREIGN	0.441 **	0.293	0.176	0.712 *
ISO	0.706 **	0.548	1.130 ***	0.915 ***
EDUCGM	0.743 ***	0.781 **	0.441	0.529
Institutional variables				
BUSASSOC	0.485 **	0.437 *	0.522 **	0.586 **
CREDIT	0.534 **	0.521 *	0.460 *	0.419
DAYSLOST	-0.136 **	-0.302	-0.639	-0.060
REGULATION	-0.388 *	-0.339	-0.124	-0.545 *
LACKSUPPORT	-0.524 *	-0.434	-0.189	-0.240
Testing hypotheses				
Constant returns to scale	4.95 **	0.79	2.25	5.34 **
Adjusted R-squared	0.467			
Pseudo R-squared		0.269	0.268	0.295
Numbers of observations	187	187	187	187

Significant at 1% (***), 5% (**) and 10% (*) levels.
Regressions include a constant and 4 industry dummies.

Appendix : Construction of the capital stock

The capital stock used in the estimation is the sum of the value of machinery and equipment and the value of land and buildings.

1) To estimate the value of machinery and equipment, we have used the value of replacement cost of machinery and equipment in 2002.
When replacement value was missing, we used the 'corrected' sales value. As a number of firms provided information on both replacement and sales value, we used the median ratio of replacement to sales value, at the industry level, to build the "corrected" sales value.
If both replacement and sales value were missing, we used the 'corrected' net book value of machinery and equipment in 2002. Similarly, we used the median ratio of replacement value to net book value, at the industry level, to construct the "corrected" net book value.
If replacement value, sales value and net book value were missing, we used the 'corrected' gross book value of machinery and equipment in 2002. To get to the "corrected" gross book value, we used the median ratio of net to gross book value and additionally the median replacement to net book value, at the industry level.

To summarize, value of machinery and equipment
= replacement value of machinery and equipment (incl. vehicles)

if missing:
= sales * median (replacement/sales)

if missing
= net book * median (replacement/net book)

if missing
= gross book*median (net book/gross book) * median (replacement/net book)

2) For land and buildings, replacement and sales value are not available. Hence, we have used the net book value in 2002, or the 'corrected' gross book value, where the correction factor is the median of net to gross book value at the industry level.