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LEARNING, PRODUCT INNOVATION AND FIRM HETEROGENEITY IN TANZANIA

Micheline Goedhuys[1]

Abstract

Using a unique firm level data set on learning and product innovation in Tanzanian manufacturing and commercial farming, this paper sheds light on the various sources of firm learning, investment and collaboration and their relative importance for product innovation. The results indicate that larger and foreign owned firms invest significantly more in human and physical capital than do local micro, small and medium sized firms, and they are better connected to the internet. Their ways of upgrading technology also reveals a better financial endowment. Small and medium sized firms on the other hand report to collaborate more intensively with other local firms on product development, marketing and on the input market and upgrade technology through in-house activities, imitation and cooperation with suppliers and universities. By doing so, they are able to offset the scale disadvantages they face in competing for the market information and inputs – new machinery and specialised labour - necessary for product innovation in imperfect markets.

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1. INTRODUCTION

In recent years, there has been an increased interest, by both policymakers and academics, in understanding the processes of innovation that underlie corporate success and international competitiveness of firms and states. This is especially true for developing countries, as the knowledge intensity of production has increased worldwide and the competitiveness of firms has become increasingly determined by their ability to innovate (Mytelka, 2000 and 1999). Developing country firms are put under severe pressure to engage in a process of continuous innovation if they want to become competitive on the global markets.

This increased interest has led to the development of new instruments and tools that enable better understanding of the processes that lead to successful innovation. Conventional economic models that viewed innovation as a linear process driven by the supply of research and development (R&D) are increasingly subjected to criticism for their limited explanatory power and lack of policy guidance. Alternative conceptualizations of the innovation process have emerged, namely those that understand innovation in more systemic, interactive, institutional and evolutionary terms. Firms do not innovate in isolation, but in collaboration and interdependence with other firms and non-firm organizations (Edquist, 2004). The innovation systems approach studies the process of innovation and emphasizes as key elements for innovation the learning process, interaction and investment by the actors in the system, both firms and other economic agents (UNU-INTECH, 2004).

In their search for new knowledge, firms may engage in learning efforts that are internal to the firm, by investing in R&D, education and training, investment in new equipment, connectivity and communication. This is a costly process. It involves investment and risk and requires a financial commitment (Malerba, 1992; Lazonick, 2004). In developing countries, where financial markets are poorly developed, and biased towards larger and foreign owned firms, the opportunities for learning and investment may be unevenly distributed and biased towards larger and foreign owned firms. Domestic SMEs may overcome these constraints by sharing risk through collaboration and interaction with other firms, especially with firms located geographically close. By establishing linkages and collaboration with other firms or institutions firms can source knowledge from sources external to the firm.

Using firm level data from Tanzania, this paper sheds light on the interactionist nature of the innovation process by providing empirical evidence on the different sources of learning and their relative importance for product innovation in an African country. We will first investigate the various sources of learning, including internal sources such as R&D, education and training

of the workforce, investment in new equipment, and telecommunication, as well as external sources through linkages and collaboration with domestic firms. The relative importance of these sources will be studied along the firm characteristics that are hypothesized to affect access to resources for investment and learning: firm size and foreign ownership. In line with the innovation system's approach, this paper subsequently analyses the importance of these learning mechanisms for product innovation.

Research on innovative behaviour at the firm level is largely missing for developing countries and especially for Africa. The absence of survey data providing information on innovation and learning in firms lies at the origin of this problem. In Africa, only South Africa has conducted innovation surveys so far [2]. Nevertheless, some relevant information on learning and innovation was collected in the framework of the World Bank's 'Investment climate survey', conducted in Tanzania in 2003. Though the survey was not designed from an innovation system perspective, and therefore the aspect of collaboration for innovation was not directly asked for in the survey, some indirect information could be extracted, giving some valuable insights.

The structure of the paper is as follows: section two highlights the concepts of innovation and learning as developed in the literature and applies the framework in the context of a developing country. It extracts relevant firm characteristics that may distinguish innovative from non-innovative firms, on the basis of the hypothesised opportunities for learning, linkages and investments. Section three highlights some of the main characteristics of the Tanzanian economy relative to learning and innovation. Section four discusses the methodology and data and the construction of the variables. Section five presents the results. Section six concludes.

[2] Following a surge in interest for the national innovation system perspective in Latin America and Asia, innovation system analysis is beginning to take off in Africa. The first NEPAD Ministerial Conference on Science and Technology called on the NEPAD Secretariat to initiate activities that would generate an African Innovation Outlook (AIO), that is, a comprehensive profile of the innovation landscape. It further agreed to promote the application of a national system of innovation (NSI) framework and methodology to guide and inform policy-making. As a basis for an AIO and its use by African leaders to benchmark the innovative performance of their countries, identify common problems and search for regional solutions, two distinct, but complementary surveys, one on science and technology and a second on innovation were designed. A methodology for a policy-relevant innovation survey for Africa was developed including a timetable for carrying out an innovation survey process (UNU-INTECH, 2004).

2. INNOVATION AND LEARNING IN A DEVELOPING COUNTRY CONTEXT: A SYSTEMIC APPROACH

For several years, technological change was studied from a neoclassical perspective, in which firms were assumed to behave as profit maximizers, operating on a common production function. Following this perspective, innovation resulted from new scientific knowledge that became (freely) accessible to and shared among firms. Empirical studies based on the conventional models focused on total factor productivity growth, in which the 'unexplained' residual captured technical change. The very process of innovation and technical change underlying the unexplained productivity growth remained poorly understood and the models did not provide any significant guidance for policy making.

More recently developed 'innovation systems' approaches were conceived to understand the process of innovation and the driving forces behind it. The innovation systems approaches develop the view that firms do not innovate in isolation, but in collaboration and interdependence with other firms and non-firm organisations. An innovation system is therefore conceptualized as a network of firms and other economic agents who, together with the institutions and policies that influence their innovative behaviour and performance, bring new products, new processes and new forms of organization into economic use[3].

Central to the innovation systems approach is the learning process of firms. It has been studied by several authors, and in the context of a developing country is often referred to as the building of technological capabilities (Lall, 1992, Enos, 1992, Wignaraja 2002 for an overview of the literature on technological capabilities). Generally the learning process is found to exhibit a number of features (Wignaraja, 2002), three of which have particular relevance for studying innovation in a developing country context[4]:

Learning is a costly and targeted process that takes place within the firm (Malerba, 1992). Access to and acquisition of new knowledge and technologies is not a costless process. Often it involves a tacit component that is not embodied in any written instructions and needs to be

[3] This definition of an innovation system draws upon the work of Nelson & Winter (1982); Lundvall (1988); Freeman (1988) among others.

[4] Malerba (1992) introduced the different sources of learning, internal and external to the firm, and the heterogeneity of firms in terms of knowledge capital, resulting in different patterns of innovative behaviour of firms. Wignaraja (2002) highlights five features of technological capability building in relation to export performance of firms.

acquired through experience and use. It requires a financial commitment on behalf of the firms to master technology or build up competences and skills, through R&D, training, engineering activities, information search, the outcome of which is uncertain and bears considerable risk.

Learning is an interactive process. When absorbing new technologies, developing new products, processes or exploring new markets, firms learn from interacting with other firms, which may include clients, suppliers, competitors or financial institutions, and from interacting with support institutions, such as research centres and universities, business support services centres and ministries. The interactionist nature of the innovation process was developed by Lundvall (1988), who showed the need of stable user-producer relationships for successful product innovation. Interaction through linkages with sources external to the firm is therefore a crucial element of the learning and innovation process of firms.

Learning is also an incremental and cumulative process. Firms build on existing competences and past investments to build up new skills and capabilities gradually, rather than moving to complete new areas of competence. As such, firms become characterised by different levels and types of knowledge capital and heterogeneity of firms persists. Specific stocks of knowledge, fed by a variety of learning processes, either internally generated or through collaboration with sources external to the firm, generate local incremental innovations, either product or process innovations.

The financial risk of building internal capabilities, and the opportunities offered by collaboration may have a differential impact when studying innovation in the context of a developing country where financial markets are poorly developed. Some authors have shown that in LDCs, financial markets are biased against SMEs and favouring larger enterprises or foreign owned firms which enjoy a more legitimate status in the industry, facilitating their growth and investment opportunities (Sleuwaegen and Goedhuys, 2003; Goedhuys and Sleuwaegen, 2002; Harrisson and McMillan, 2002; Beck et al., 2005; Nugent and Nabli, 1992). This may equally affect firms' opportunities for learning and capability building. The more financially constrained micro-enterprises and small and medium sized firms may find themselves in a disadvantages position to engage in those learning efforts that require a strong financial commitment.

In a neoclassical setting, this would imply that innovative activity is mainly concentrated in larger and foreign owned firms. However, the recent insights gained from the innovation systems approaches stress the interactive nature of innovation, where learning about new technologies, products and markets is driven by collaboration with other firms and institutions. In poorly developed imperfect markets, these linkages become important non-market

mechanisms to share information, knowledge, investment and risk, and they may offer unique opportunities for local SMEs to engage in a process of continuous learning and innovation.

The importance of collaboration for innovative activities in SMEs has also been elaborated in the literature on clustering, which states that the geographical or sectoral proximity of firms may enhance firm learning and technological dynamism under certain conditions[5]. Within a cluster, stable vertical relationships between users and producers, for example, can reduce the costs related to information and communication, the time needed and risks associated with the introduction of new products (Lundvall, 1988). Horizontal collaboration between same-sector SMEs, through sub-contracting relationships, can potentially yield collective efficiencies as transaction costs are reduced and gains from specialisation are reaped. Access to markets is facilitated as a concentration of producers in one place attracts customers and enhances firm growth (McCormick, 1998, Schmitz, 1995). A study by Mc Cormick (1999) on six African clusters shows that market access is the most important benefit of geographical clustering. Yet other studies have stressed the positive externalities generated by agglomerations in the availability of skilled and specialised labour, specialised suppliers, superior provision of utilities and infrastructure and improved access to information. More frequent innovation-generating informal exchanges and learning through cluster linkage are made possible through the adoption of a variety of embedded institutions (UNU/INTECH, 2004).

In what follows we will investigate empirically the implications of the innovation system approach using firm level data from Tanzania. The group of firms in the sample is heterogeneous and we will therefore analyse whether we observe different learning mechanisms – internal learning or through collaboration - in firms of different size and ownership structure – the firm characteristics that the literature commonly advances as determining access to finance and technology. We will subsequently measure the impact of the different learning mechanism on product innovation.

[5] A special issue of World Development (vol 27, n°9) is devoted to the role of clustering for industrialisation and technological dynamism in developing countries. Bell and Albu (1999) stress the importance of clusters as knowledge systems, rather than systems productions systems, and develop a conceptual framework that can be used to investigate clusters capacity to generate and diffuse knowledge based on their openness to external sources of knowledge and their internal organisation.

3. TANZANIA

Tanzania is a typical developing country, still mainly based on agriculture, which accounts for 45% of GDP in 2003 (World Bank, 2005), while industry accounts for 16.4% of GDP, including an important share of mining activities. The country has been undergoing reforms since 1985 to move away from a socialist centrally planned economy with large state participation towards a more liberal market-based economy.

Over the last decade a large scale privatisation programme was implemented, in which state participation in industry was reduced, often in favour of foreign participation. Foreign direct investment increased sharply since 1992[6], putting Tanzania among the major FDI recipient countries of Africa (UNCTAD, 2002). FDI was mainly concentrated in manufacturing, especially in the food and beverages industry[7]. Along with FDI, an injection of capital, investment and a transfer of technology, skills and improved management were expected.

There is no doubt that the recent foreign investments have increased the stock of technology, especially the embodied technology such as machinery and equipment. Portelli and Narula (2003) also find evidence that technological upgrading has occurred and that its magnitude is determined by the capabilities within the industrial base in Tanzania. Narrower technology gaps between firms are more likely to result in backward linkages. However, as some studies indicate, the scale of technology diffusion from foreign firms to local firms is still limited. Transfer of know-how, design, and R&D capabilities is not observed. (UNCTAD, 2002, p.18). Linkages between foreign and local private firms remain weak (Szogs, 2004).

Essentially this is due to two factors. First, foreign firms entering a developing country market are not typically interested in establishing an R&D entity in the local affiliate, but rather come to take advantage of local resources or demand to produce a product developed elsewhere.

Secondly, human resources and technological capabilities remain poorly developed in Tanzania. The educational and training systems have been insufficiently oriented towards science and engineering generating managerial, and technical skills (Wangwe, 1995).

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[6] In 1992 FDI was US$ 12 million, but it rose to US$ 193 million in 2002.

[7] The number of approved foreign affiliates over the period 1990-2000 are mainly in manufacturing, especially in the food and beverages industry UNCTAD (2002). Only 15% of the foreign affiliates approved are in agriculture. However, when looking at planned employment in the new foreign firms, agriculture and fishing is the leading sector, accounting for 38% of planned employment.

In general, the technology policies pursued in Tanzania paid little attention to the technological needs and problems of local private firms (UNCTAD, 2002). Domestic research capability was built in public research centres, doing research in priority areas determined by the Tanzania commission for Science and Technology. The choice of sectors and research areas was supply driven, rather than being based on an analysis of technological needs and problems of productive private enterprises. Some state-owed specialised technology related support institutions were established, but today they lack awareness of private sector needs as well as resources and motivation to carry out their mandate successfully (Lall, 1999, Wangwe, 1995). University – industry linkages are weak. Figure 1 illustrates the national innovation system of Tanzania.

Under these constraints it can be expected that product innovation in local firms is mainly taking place as a result of internal learning and inter-firm linkages among domestic firms, as linkages with research centres and support institutions are weak and the technology gap with foreign firms might be too large to facilitate close cooperation for innovation. This is also found by Murphy (2002) who points at the importance of networks and trust for innovation in Mwanza, Tanzania. He found that social networks of business people support innovation, as trust in these relationships improve the quality of information exchanges.

4. DATA AND METHODOLOGY

The data used for the empirical analysis were gathered in Tanzania in 2003, in the framework of the World Bank programme 'Investment Climate Assessment'. Survey data were collected through intensive interviews with owners and managers of firms. The objective of the investment climate assessment survey was to obtain firm level data that allow analysing the conditions for investment and enterprise growth in the country. As such, the many aspects and constraints of the African business environment that influence the investment decisions and performance of the firms were tackled, in a number of sub-questionnaires[8]. A set of questions was asked on the history of the firm, the background of the entrepreneur and manager, the acquisition and status of equipment and technology, the firm's human resource management, innovation activities, and institutional constraints to growth and investment.

Survey data are interesting for analysing innovative behaviour of firms, especially in Africa where the traditional measures for innovation such as R&D intensity and patenting reveal little information. Since innovation surveys were developed and the OECD's 'Oslo Manual' (OECD, 1992, 1997) appeared as a common practice in this field, a new type of innovation analysis emerged, focusing on firm level innovation activity. In these studies, the novelty of the innovation or innovative activity typically refers to what is 'new to the firm', irrespective of whether it is new to the country, the market or the world, the latter being considered 'invention' rather than 'innovation'. The surveys are designed to gather information on innovation inputs, including R&D but also non-R&D activities, innovation outputs, usually product innovation, collaboration for innovation, the sources of information, obstacles to and motives behind innovation. They focus on the innovating firm, the 'subject' of innovation who is the respondent to the surveys. Inherent to this type of data collection and the resulting indicator construction is a certain degree of subjectivity in the data, which also holds for the Investment Climate Assessment survey. Despite this criticism, a number of interesting studies based on survey data appeared, measuring and mapping innovation, and linking it to firm performance[9].

[8] The questionnaires included a section on entrepreneurship and the history of the business; production, investment and market share; finance; labour and training; capacity, learning and technology; infrastructure; trade; and the business environment.

[9] An interesting discussion on the measurement issues and an overview of studies based on the European Commission's 'Community Innovation Survey' is presented in Smith (2004).

Scholars do not seem to view this as an obstacle and they use the data to increase their knowledge on the very process of innovation as it takes place within the firm.

The Investment Climate Assessment survey sampled a heterogeneous group of firms for the interview in Tanzania, including firms of different size, ownership structure and active in manufacturing and commercial agriculture[10].

A total of 276 firm in manufacturing and 98 firms in commercial agriculture were surveyed. Due to missing responses to some of the variables used, the actual sample of firms used in the empirical analysis is reduced to 260, distributed over the different sectors of activity and size classes as shown in table 1. The number of firms with foreign participation, 61 in total, is also presented per sector[11]. They are mostly large (23 firms) and medium sized (20 firms). Fifteen of these foreign firms, or about one quarter, were previously state-owned firms and later on privatised. The number of state owned firms in the sample totals 27, and they are mainly in farming (9 firms), agro-industries (5 firms), but also in metal working (4 firms), textiles and construction materials (3 firms each), chemicals and paints (2 firms), plastics (1 firm).

Table 1. Distribution of the sample of firms, by size, sector and ownership

Numbers of firms	*micro*	*small*	*medium*	*large*	*foreign*	*Total sample*
Sector of activity						
Commercial farming	*20*	*19*	*9*	*8*	*14*	*56*
Manufacturing sub-sectors:						
Agro-industries	*10*	*17*	*18*	*12*	*15*	*57*
Textiles, garments, leather	*5*	*10*	*6*	*5*	*7*	*26*
Wood working, furniture	*13*	*17*	*6*	*4*	*5*	*40*
Chemicals and paints	*3*	*6*	*10*	*4*	*8*	*23*
Plastics	*0*	*1*	*2*	*4*	*4*	*7*
Paper, printing, publishing	*1*	*11*	*7*	*1*	*2*	*20*
metals	*6*	*8*	*7*	*2*	*4*	*23*
Construction materials	*1*	*3*	*2*	*2*	*2*	*10*
Total sample	*59*	*92*	*67*	*42*	*61*	*260*

[10] The Investment Climate Assessment survey was also conducted for firms active in construction and tourism. However, the questionnaires used in the tourism and construction survey did not include the key questions on innovation. Hence in our study, manufacturing and commercial agriculture are the sectors retained for the empirical analysis. The latter sector includes the produce of tea, coffee, cocoa, flowers, livestock, cotton , vegetables, grains, sugar and other products.

[11] Of the 61 firms, 23 are fully foreign owned, another 24 have a foreign majority ownership, the 14 others representing a foreign minority ownership, 10 of which being in the range of a 25-49% share. Of the foreign firms, 27 firms are entrepreneurial firms where the principal owner also manages or directs the firm. Of these foreign owned entrepreneurial firms, 14 have an owner/manager of Asian or Lebanese or Middle Eastern origin.

Methodology

The rich data set established by the Investment Climate Assessment includes a relatively large amount of variables that capture learning, investment, linkages and innovation[12]. In the literature there are a number of empirical studies that proceed to construct composite indexes measuring technological capabilities or technological intensity (see Rasiah, 2004 for an overview), subsequently linking the index to export or other firm performance indicators. We have deliberately not chosen to proceed with the construction of an index, as we are specifically interested in the different mechanisms for learning and their importance for firms operating under different financial and competitive conditions. They would be levelled out if an index would be constructed for the entire sample of firms. Therefore, we discuss the various sources of learning separately first. This is done by presenting a number of key variables capturing skills, training, research and development, connectivity, investment and linkages along the firm size, sector of activity and ownership dimension. Some statistical tests are done to investigate the existence of a relationship between the specific learning or collaboration activity and the firm characteristics.

Subsequently, product innovation is modelled following a logit model which relates the probability of being an innovative firm to the characteristics of the firm and the underlying learning activities. The firm is considered innovative if it reports to have introduced a major new[13] product line over the three year period 2000-2002.

$$\Pr(INNO_i) = \frac{\exp(a + bX_i + cL_i + dI_i + eC_i)}{1 + \exp(a + bX_i + cL_i + dI_i + eC_i)} \qquad (2)$$

[12] Ideally, a survey based on an innovation system perspective would also include interviews conducted in non-firm institutions, such as research centres, ministries, business support service centres and infrastructure providers. They would have to be interviewed using a separate tailor made questionnaire designed to capture the stance of the institutions. This is costly and complex and most innovation surveys do not include them in the first survey rounds. In the case of Tanzania, some interesting partial studies have been done, illustrating the constraints to industry-university collaboration (Bangens, L., 2004), the history, role and structure of the educational system in university-industry linkages (Mwamila, B. and Katalambula, H., 2004), SME clustering (Musonda, F., 2004) and the institutional framework (Wangwe, S., 1995).

[13] Similar to the OECD Oslo Manual and most innovation surveys conducted so far (UNU-INTECH, 2004), a product line is 'new' if it is new to the firm, even if competitors have already introduced such products. As in most surveys, the instructors manual accompanying the survey questionnaire provides an example that can help understand the criteria to consider a product line to be new. 'If a furniture establishment is making chairs and begins to produce another style, this is not a new product line. However, if a garments factory making shirts begins to produce trousers, this is a different product line because it requires retraining, even though it uses the same machinery. Let the manager decide what is a new product line' (World Bank, 2003, p.58.)

where X_i is a vector with relevant firm characteristics, including firm size and age, foreign ownership and sector of activity. Li is a set of learning or technological capability variables, including the skills level of the work force and training intensity, access to the internet and R&D. I_i is investment in new machinery and equipment and C_i represents collaboration for product development with other firms.

Variables

In line with the discussion above, the variables for learning include the education of the general manager, being 'higher' if the manager has a certificate of tertiary college, or a graduate or post-graduate degree.

The skills level of the labour force is measured by a continuous variable (SKUN), which is the number of management and professional and skilled production workers proportionate to the number of unskilled and non-production workers.

TRAINING is a binary variable taking the value 1 if the firm has offered formal training, beyond on-the-job training, to its permanent employees. TRAININT, or training intensity, is the proportion of the permanent employees that has received formal training in 2002.

RD is a binary variable taking the value 1 if the firm has invested in design or R&D in 2002.

Connectivity is captured by three closely related variables: INTERNET is a binary variable taking the value 1 if the firm has internet access. EMAIL is a binary variable taking the value 1 if the firm regularly uses email for interacting with domestic and foreign clients and suppliers.

WEBSITE is a binary variable taking the value 1 if the firm has a website that it uses for interacting with clients and suppliers.

Investment is captured by NEWEQ, a binary variable taking the value 1 if the firm has invested in new machinery and equipment over the period 2000-2002.

With respect to linkages and collaboration, the firms were also asked to rate the intensity of collaboration with other local firms in the field of product development, marketing and market research, the purchase of inputs and subcontracting, by indicating on a Likert scale the frequency of interaction, ranging from 1 (always) to 6 (never). From this, the variable was restructured so that higher values indicate higher intensity of collaboration and rescaled to vary between zero and three. Though the question was not asked with a focus on collaboration for innovation, collaboration for product development seems the most relevant variable to explain product innovation. Therefore, this is the variable that is used in the logit equation.

For the estimation of the logit equation, the dependent variable is a binary variable for firms that report to have introduced a major new product line in the period 2000-2002[14].

Firms are considered as foreign (FOREIGN), if there is foreign participation in the ownership structure. Firm size is measured by employment size classes: MICRO (1-9 employees), SMALL (10-29 employees), MEDIUM (30-99 employees) and LARGE (100 or more employees).

The sector binary variables included in the logit equation relate to food and beverages industries (FOOD), wood working and furniture (WOOD), metal working (METL), textiles, garment and leather products (TEXT), chemicals, paints and plastics (CHPL), paper, printing, publishing, and construction materials (PUCO), the reference sector being commercial farms.

To avoid unnecessary collinearity, not all the variables discussed in the learning section were included as explanatory variables in the logit estimation. As mentioned earlier, no index is constructed, but instead, the most important variables representing learning, investment and linkages are taken – skills levels, training intensity, R&D, the use of internet, investment and collaboration for product development

[14] In line with the studies based on Community Innovation Survey data, our empirical analysis did not focus on innovation through upgrading existing product lines, nor on process innovation or innovation through organisational change, due to the more stringent definitional concern about what is meant by 'new' or 'improved', which is also not well specified in the survey instrument.

5. LEARNING, LINKAGES AND PRODUCT INNOVATION IN TANZANIA

The different learning mechanisms and their importance for firms of different size, sector and ownership structure are shown in table 2. The first four columns present data on the skills level and training in firms, column 5 shows the proportion of firms doing R&D, columns 6-8 show the proportion of firms connected and column 9 the proportion of firms with investments in new equipment. A chi-square statistic and its significance are reported. For SKUN and TRAININT, which are continuous variables, a T-test on differences in mean values was done, for the respective subgroup of firms versus the rest of the sample. The significance of this test is indicated in parentheses after the mean values of the respective subgroup.

Table 2 : Sources of internal learning and investment, by firm size, ownership and sector of activity

	General Manager with Higher Educ.	Skills level of labour force (SKUN)	TRAINING	Training intensity (TRAININT)	R&D activities (RD)	Internet Access (INTERNET)	WEBSITE	EMAIL	NEWEQ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	% of firms	Mean values	% of firms	Mean values	% of firms	% of firms	% of firms	% of firms	% of firms
Size									
1-9	30.5	0.99(***)	20.0	0.84(***)	6.8	8.5	6.8	17.0	30.5
10-29	64.1	1.43	30.0	2.43(*)	14.1	42.4	16.3	53.3	39.1
30-99	86.6	1.95	62.5	5.12	26.9	67.2	29.9	74.6	49.3
100+	97.60	3.10(*)	72.2	12.78(***)	52.4	78.6	40.5	88.1	66.7
X^2	65.948***	n.a.	37.579***	n.a.	34.887***	63.692***	20.749***	63.834***	14.730***
Ownership									
Local	61.8	1.54	37.1	2.89(**)	20.1	40.7	17.6	48.7	39.7
Foreign	86.9	2.37	60.0	9.47(**)	27.9	67.2	34.4	80.3	59.0
X^2	13.424***	n.a.	8.843***	n.a.	1.646	13.174***	7.833***	18.916***	7.063***
Sector									
Agro-industries	75.4	1.71	51.9	3.82	28.1	61.4	24.6	68.4	47.4
Textiles	53.83	2.65	57.1	5.48	23.1	53.9	26.9	69.2	50.0
Wood working	55.0	1.11(**)	33.3	0.75(***)	17.5	37.5	20.0	40.0	35.0
Metal working	82.6	3.32(***)	36.8	3.60	30.4	47.8	17.4	60.9	52.2
Publishing& Construction materials	82.1	1.43	31.8	4.98	7.1	60.7	25.0	60.7	39.3
Chemicals& Plastics	80.0	2.36	60.9	12.26(**)	33.3	56.7	36.7	70.0	60.0
Commerical farming	55.4	0.94(***)	31.9	3.07	16.1	23.2	8.9	37.5	35.7
X^2	17.777***	n.a.	11.592*	n.a.	9.685	22.654***	10.575	20.224***	7.497

Note: SKUN (column 2) and TRAININT (column 4) are continuous variables. Instead of a X^2 statistic, a T-test was done, for the difference in mean value of each size category, ownership and sector, versus the rest of the sample firms. The significance of this T-statistic is represented in parentheses. *** significant at the 1% level; **significant at the 5% level; *significant at the 10% level.

Looking first at the size dimension, it is clear that all of the learning variables are strongly and significantly related to size, with higher skills levels, training and R&D activities and higher occurrence of connectivity and investment in larger firms than in smaller ones, and the relationship is gradual.

In a similar way, foreign firms outperform their local counterparts in every way. The difference is significant for all the variables, except for the skills level of the workforce and the incidence of R&D or design activities. This is in line with the findings discussed by UNCTAD (2002), which indicated that transfer of know-how, design, and R&D capabilities is not observed in Tanzania. Foreign firms seem to invest more in equipment, they are better connected to the Web, and train the workforce more intensively, with almost 10% of the workforce being trained against only 3% by local firms.

Some sectoral variations are also observed, with the highest proportions of highly educated managers, training, R&D, connectivity and investment being found in the sector of chemicals and plastics. The metal working and textiles sectors are also doing relatively well, in contrast to the sector of wood working and commercial farming, which are performing generally poorly on the learning and investment indicators.

Table 3 gives some information on the embeddedness of firms in the local structure. The first three columns present the reported intensity of collaboration with local firm in the field of product development (column 1), marketing and market research (column 2) and access to inputs (column 3). The proportion of firms that is doing subcontracting work is shown in column 4, and for the firms that are working in subcontracting relationships, the proportion of their production produced as subcontractor is shown.

Table 3: Linkages and collaboration, by firm size and ownership

	Intensity of collaboration for:			subcontracting	
	Product development	marketing	inputs	Proportion of firms	% of subcontracted production
Size					
1-9	0.47	0.29**	0.42**	15.3	22.1
10-29	0.61	0.58	0.75	9.8	11.8
30-99	0.48	0.63	0.67	17.9	39.8
100+	0.66	0.41	0.53	4.8	51.5
X^2				5.183	
Ownership					
Local	0.59	0.51	0.67*	13.1	25.2
Foreign	0.41	0.46	0.44*	9.8	38.4
X^2	n.a.	n.a.	n.a.	0.451	

*** significant at the 1% level; **significant at the 5% level; *significant at the 10% level.

When looking at linkages, the picture is less clear than for the learning variables. Local firms report to collaborate more frequently with other local firms than do foreign firms. The collaboration is more intense for product development, marketing and especially on the input market. Also the size dimension is less straightforward. Micro-enterprises seem less collaborative in marketing and accessing input, but for the small and medium sized firms this is reversed. Small firms report to be the most intense collaborators in the input markets. Medium sized firms do so for marketing and subcontracting. A small number of large and foreign owned firms are active as subcontractor, and this activity accounts for a large share of the firms' production.

The findings of table 2 and 3 jointly indicate that internal learning activities which require certain financial commitments, involving risk, are indeed found to be related to size and foreign ownership. In a developing country like Tanzania, smaller firms facing financial constraints in imperfect markets may therefore rely on networking and collaboration with other firms, to acquire inputs, information on markets, and to improve or upgrade products and production processes.

Additional and corroborating evidence is presented in table 4, which shows how respondents rate the importance of different mechanisms – including internal and external sources – for technological upgrading and learning in their firm. In the survey, firms were asked to indicate the three major ways of acquiring new technology, out of a list of 14 ways. For each firm, the most important way to acquire technology was subsequently given a weight of 3, the second most important way was given a weight of 2, the third a weight of one, the other options keeping a zero rating. For all the 14 ways to acquire technology, an average score could be calculated, as is done in table 4. New technology is mainly acquired through investment in equipment, developed in-house and through the hiring of key personnel, as can be seen from the magnitude of the score presented in the last column. However, some ways for acquiring technology are positively related with size, such as, investment in machinery and equipment, hiring of key personnel, and technology transferred from the parent company. Inversely related to firm size are technology developed in-house, trade fairs, technology adapted from the competitors and through business associations. In other words, smaller firms acquire technologies in ways that are less resource intensive and more relying on the other agents in the system. In a similar way, it can be observed that domestic firms are more actively working internally through in-house activities, study tours and trade fairs, in cooperation with suppliers, copying competitors and sourcing from universities than do foreign firms, implying a stronger embeddedness in the local productive structure. Foreign firms on the other hand, rate investment, hiring of personnel and sourcing from the parent company as major ways of acquiring technology, revealing a better financial endowment and a smaller local involvement.

Table 4: relative importance of different ways to acquire new technology, by firm size and ownership

Average score	Micro	Small	Medium	Large	Local	Foreign	All firms
New machinery	0.80	1.01	0.97	1.43	0.92	1.33	1.02
Developed in-house	1.22	0.90	0.94	0.64	1.03	0.67	0.94
Hiring key personnel	0.34	0.45	0.90	1.05	0.46	1.21	0.63
Trade fairs	0.44	0.35	0.34	0.33	0.41	0.23	0.37
Consultant	0.34	0.33	0.24	0.52	0.34	0.34	0.34
Adapted from competitors	0.47	0.46	0.13	0.10	0.36	0.20	0.32
Cooperation with suppliers	0.10	0.33	0.45	0.07	0.29	0.20	0.27
Study tours	0.14	0.29	0.13	0.12	0.21	0.11	0.19
Cooperation with clients	0.02	0.27	0.07	0.17	0.15	0.15	0.15
Parent company	0.00	0.09	0.24	0.31	0.10	0.28	0.14
University	0.05	0.17	0.10	0.00	0.11	0.07	0.10
Business Association	0.10	0.07	0.04	0.00	0.05	0.10	0.06
Licence from intl. sources	0.03	0.02	0.06	0.17	0.06	0.05	0.06
Licence from domestic sources	0.03	0.03	0.00	0.07	0.04	0.00	0.03

The impact of these different learning and collaboration mechanisms on product innovation is shown in table 5. The first column presents the basic estimation without the learning, investment or linkage variables. In the second column a selection of representative learning variables is included, as well as the investment variable and the variable COLLAB, collaboration for product development, being the most relevant variable for explaining product innovation. Out of the 260 firms, or 84 firms or 32% reported to have introduced a major new product line over the past three years.

The last column repeats this same estimation, for the more homogenous sub-sample of local firms. For this reduced sample, the probability of having introduced a new product line equals 0.28.

Table 5: Results of the logit model on the probability of being a product innovating firm

	All firms	All firms	Local firms
Constant	-2.377***	-3.415***	-3.914***
	(0.591)	(0.706)	(0.901)
Firm age (5-9 years)	0.841*	0.705	1.191*
	(0.478)	(0.552)	(0.695)
Firm age (10+ years)	0.164	0.473	0.407
	(0.388)	(0.440)	(0.576)
SMALL (10-29)	1.042**	0.699	0.554
	(0.461)	(0.513)	(0.588)
MEDIO (30-99)	1.767***	1.187**	0.769
	(0.486)	(0.561)	(0.679)
LARGE (100+)	1.039*	-0.546	-1.997**
	(0.552)	(0.686)	(1.002)
FOREIGN	0.397	0.552	-
	(0.348)	(0.386)	
FOOD	-0.344	-0.583	-0.104
	(0.478)	(0.546)	(0.686)
CHPL	0.987*	1.148*	1.458*
	(0.517)	(0.597)	(0.814)
PUCO	-0.207	-0.117	-0.030
	(0.567)	(0.641)	(0.790)
METL	0.639	0.163	0.353
	(0.562)	(0.655)	(0.829)
WOOD	0.418	0.486	0.329
	(0.495)	(0.542)	(0.672)
TEXT	0.509	0.521	0.859
	(0.539)	(0.612)	(0.784)
SKUN	-	0.069	0.095
		(0.059)	(0.089)
TRAININT	-	0.820	1.010
		(1.132)	(1.829)
RD	-	1.263***	1.662***
		(0.414)	(0.540)
INTERNET	-	0.673*	0.812*
		(0.377)	(0.488)
NEWEQ	-	0.697**	1.166***
		(0.335)	(0.418)
COLLAB	-	0.425**	0.625***
		(0.181)	(0.219)
Obs.	260	260	199
MC Fadden's R^2	0.108	0.229	0.303

Note: *** significant at the 1% level; **significant at the 5% level; *significant at the 10% level.

The most interesting result that can be derived from the first column is that with respect to firm size, medium sized firms, followed by small firms are the more innovative ones. Bearing in mind from the previous section that investment and learning were more pertinent in the largest size class, medium and small firms seem to have found a way to offset this disadvantage. Micro-enterprises, scoring low on both learning, investment and linkage indicators, are the least

innovative firms. The sector of chemicals and plastics is also performing well in product innovation, as expected from the previous section, followed by metal working and textiles. Foreign firms do not seem to have launched new product lines more successfully than local firms.

The inclusion of the learning, investment and linkage indicators provides additional interesting findings. All coefficients have the right sign and apart from skills and training they are all significant. Investing in design and R&D are most conducive to product development. Also investment in new equipment and being connected to the internet is important, yet the coefficients are smaller than for R&D. Estimated at the sample mean, the probability of being a product innovator increases by 13 percent points when the firm is connected to the internet, by 14 percent points when the firm has invested in new machinery and equipment and by 28 percent points when the firm is conducting R&D or is active in design activities. Interestingly, controlling for size, ownership and the main learning variables, collaboration for product development shows a positive and significant coefficient, supporting the hypothesis that linkages and collaboration are a successful mechanism by which firms succeed in moving new products to the market. The elasticity of the variable is 0.16. Medium sized firms followed by small firms remain the most innovative ones.

Leaving out the foreign firms raises the explained variation considerably. In this more homogenous sample of domestic firms, the impact of the learning variables is even larger, increasing the probability of being a product innovator by 21% points for NEWEQ, 16% points for INTERNET and 34% points for R&D. Also, more frequent collaboration with other local producers becomes highly significant, with the elasticity of the variable equalling 0.26[15].

[15] The mean value of COLLAB for the sample of domestic firms equals 0.594. Hence, estimated at the mean value, a doubling of COLLAB, representing occasional collaboration with other firms, results in a 26% increase of the probability of being a product innovator.

6. CONCLUSION

The innovation systems approach, developed to get a better understanding of the driving forces to innovation, stresses the importance of learning in firms, investment in new equipment embodying better technologies, and linkages and collaboration with other actors in the system. In developing countries where markets for finance, technology and information are highly imperfect, linkages and inter-firm collaboration may be an even more important non-market mechanism to overcome constraints to inputs related to innovation. This is especially true for small and medium sized firms, as collaboration with other local firms allows them to source knowledge from sources external to the firm and to share the risk of investments when financial markets are biased against them.

Using a unique dataset on learning and product innovation in the African context, this paper has presented evidence that supports the idea that inter-firm collaboration can indeed enable small and medium sized firms in developing countries to be product innovators, even when they show to be financially more constrained to invest in new machinery and to engage in training and research, development and design activities than their larger counterparts. Likewise, foreign firms active in Tanzania outperform their domestic competitors with respect to the various ways of internal learning – training, connectivity and investment in new machinery- and with respect to the ways to acquire technology. However, they seem to rely proportionately less on collaboration with local firms for securing access to inputs and technology, the latter being acquired through investment, and sourcing from the parent company. In sum, local small and medium sized firms prove to be more embedded in the domestic industrial structure and the interaction among them enables them to offset the scale disadvantages they face in securing access to market information and inputs, needed for successful product innovation.

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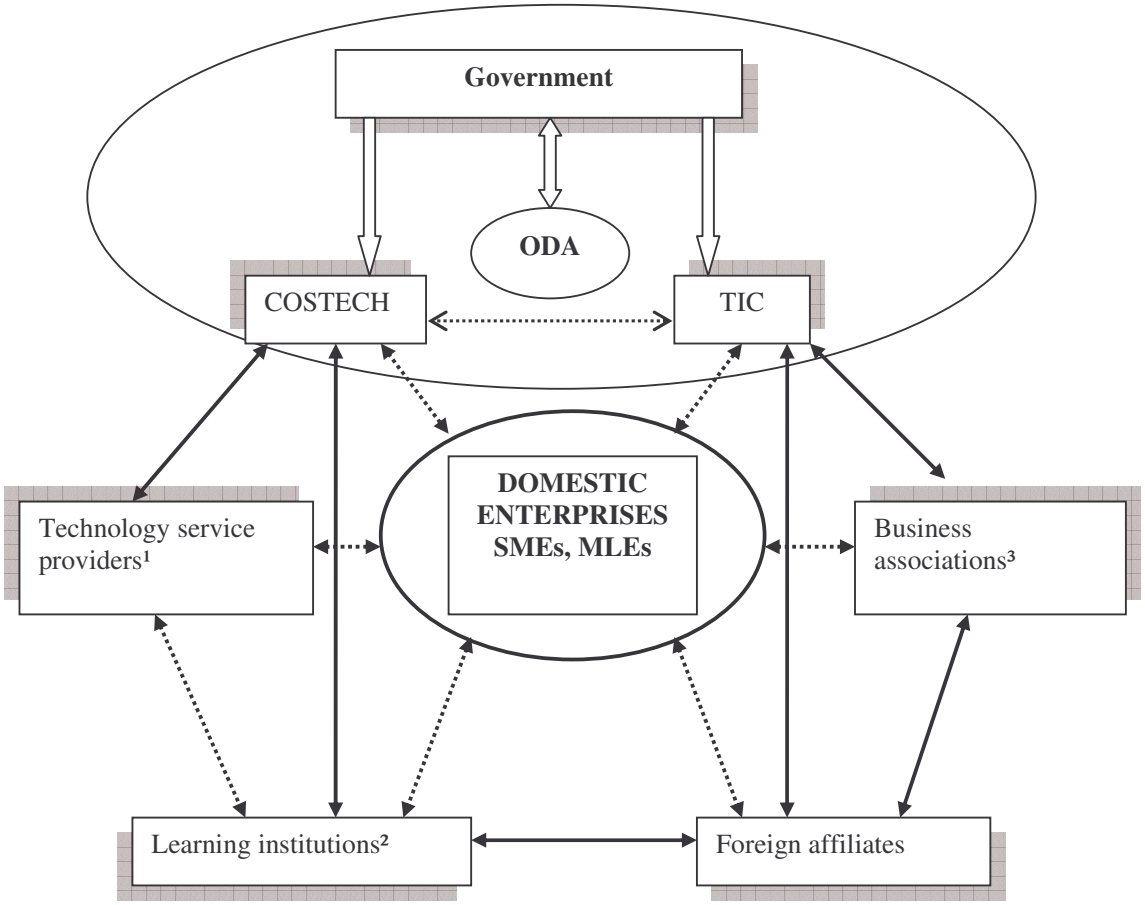
APPENDIX 1: NATIONAL SYSTEM OF INNOVATION OF TANZANIA



[1]National Centre for Development and Transfer of Technology (NCDTT), Centre for Agricultural and Rural Technology, Tanzania Bureau of Standards (TBS), Tanzania Engineering Manufacture and Design Organisation, Tanzania Industrial research and Development Organization (TIRDO), Tanzania Industrial Studies and Consulting Organization TTISCO), etc.
[2] University of Dar-es-Salaam, Sokoine University of Agriculture, Institute of Technology, etc.
[3] Tanzanian National Business Council (TNBC), Tanzania Chamber of Commerce, Industry and Agriculture (TCCIA), Confederation of Tanzanian Industries (CTI) and Tanzanian Private Sector Foundation (TPSF). *Source : UNCTAD (2002), Investment policy review, The United Republic of Tanzania*

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