# Ownership and Technological Intensities in Ugandan Manufacturing

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***Abstract***: This paper examines productivity, export-intensity and technological differences between foreign and local firms in metal engineering, food and beverages, and plastics firms in Uganda using an adapted version of the technological capability framework. Although the results were mixed, foreign firms enjoyed higher and statistically significant technological capabilities than local firms, and in its components of human resource, process technology and adaptive engineering. The relationship between labour productivity and export intensity, and technological intensity was stronger in foreign firms than in local firms. The relationship between foreign ownership and adaptive engineering was also positive and significant. Despite 25 percent of the foreign firms enjoying no cross-border subsidiaries, foreign firms showed higher participation in adaptive engineering activities than local firms.

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***JEL classifications***: O14, O33, O55, L61, L66

## 1. Introduction

In a landmark review, Lall and Streeten (1977) examined the circumstances under which FDI will bring economic benefits to developing economies, but argued that the obstacles inhibiting them outweigh the catalysts. Extensive work on multinationals have since flooded the academic world. Arguably the most significant of these works dealing directly with their developmental impact can be traced to Lall (1979, 1980, 1992, 1994), Dunning (1971, 1974, 1994a, 1994b) and Narula and Dunning (2000), Lall and Narula (2004), Cantwell and Mudambi (2005) and Rasiah (2004a).[2] This paper seeks to add to the literature by evaluating their potential contribution to technological capabilities in Uganda. Uganda offers a useful laboratory for this purpose for three reasons.

Firstly, little work exists on the impact of foreign ownership in the manufacturing capabilities of Least Developed Countries (LDCs). With a

per capita income of US$1,167 in 2001 – measured using purchasing power parity (PPP) – Uganda was one of the most underdeveloped economies in the world. Secondly, Uganda is a land locked country facing a high comparative cost premium for location of industries for export processing compared to the sea-fronted economies of Kenya and Tanzania. Thirdly, the experience of Uganda could offer lessons for Sub-Saharan economies considered losers in the globalization process (see Lall, 2001; Lall and Pietrobelli, 2002).

Ugandan manufacturing declined or stagnated in the 1970s, 1980s and in the first half of the 1990s owing to poor macroeconomic conditions. Macroeconomic stabilization from the late 1980s and external developments in the 1990s offered Uganda the opportunity to promote industrialization aggressively since the mid-1990s. A combination of severe economic failure in Kenya and slow transition in Tanzania, and the adoption of business-friendly policy instruments domestically helped attract industries that would not normally relocate in Uganda. Hence, manufacturing has grown since 1997. The share of manufacturing value added in GDP rose from 5.7% in 1990 to 9.1% in 2000 (World Bank, 2002). Rapid manufacturing growth has coincided with strong foreign direct investment (FDI) inflows from the second half of the 1990s: FDI shares in gross capital formation (GCF) rose from 0.0% in 1990 to 21.1% in 1999. The rise in FDI into manufacturing has made Uganda an exciting case to examine for its potential impact on technological capability development and economic performance.

This paper starts from the Schumpeter-Hirschman[3] vantage point that local firms can benefit technologically from foreign firms if the latter show higher technological intensities than the former – through demonstration effect, and potential knowledge flows from training and exposure to higher human resource practices, process and product technologies. In addition to providing implications for the technological capability methodology, this exercise is aimed at attracting further work comparing technological intensities between foreign and local firms. The rest of the paper is organized as follows. Section 2 discusses the literature review and 3 the methodology and data used in the paper. Sections 4 and 5 evaluate statistical differences and relationships respectively. Section 6 presents the conclusions.

## 2.  Theoretical Considerations

The theory of foreign direct investment posits that multinationals enjoy asset specific (tangible and intangible) technological advantages over local firms (see Dunning, 1958, 1971, 1974). Dunning (1988) had implied these advantages earlier but as a theory articulated it cogently later using the eclectic thesis of ownership, location and internalization (OLI) to argue that access to superior resources in parent plants abroad to provide this advantage. The

relocation of such an activity to developing economies allows multinationals to internalize such resources, thereby providing potential spillover opportunities at host-sites. While the argument is persuasive, economists are divided on how to estimate technological learning and spillovers and hence this section reviews the most widely used framework before an attempt is made to introduce the alternative evolutionary framework that will be used in the paper.

### 2.1  Neoclassical Models

Neoclassical models stem from the assumption that markets coordinate demand-supply functions effectively so that the natural economy-wide equilibrium is achieved through the optimal allocation of resources. Until the works of Romer (1986), Lucas (1988), Krugman (1986), Helpman and Krugman (1989) and Grossman and Helpman (1990), neoclassical analyses were anchored on Solow's (1956; 1957) production function accounting framework that reduced technology to an exogenous black box. Despite the introduction of elegantly constructed models demonstrating that in the presence of increasing returns markets no longer generate Pareto optimal solutions, these new growth models did not enter neoclassical policy analysis owing to the believe that government failure were far more serious than market failure. Hence, the World Bank (1993) while conceding that government intervention was extensive in Korea and Taiwan argued that it was neither necessary nor possible to pursue the same routes anymore to stimulate economic growth.

The relative price theoretic as the basis of resource allocation and the choice of technology can be traced to the use of the production function and the technology gap. Caves (1974) had initiated these models to examine spillover effects by adapting the growth accounting model originally advanced by Solow (1956) arguing that it generates demonstration and competition effects on local firms. Empirical works using refinements of this model produced mixed results (e.g. Blomstrom, 1986; Blomstrom and Sjoholm, 1999; Aitken, Hansen and Harrison, 1997; Aitken and Harrison, 1999; Sjoholm, 1999). However, Romer (1994), Nelson (1994) and Vaitsos (2003) provided a devastating critique of neoclassical growth models explaining technical change. These criticisms question the very use of production function approaches to examine productivity growth and technical change. Likewise, Lall (1992) and Rasiah (1995) have argued that spillovers being external to firms cannot be measured exhaustively. Besides, spillover has both pecuniary and non-pecuniary, and positive and negative dimensions so that its empirical investigation can never be carried out exhaustively (see Rasiah, 1995: chapter 2).

There has, however, been one consistent finding by neoclassical analysts, i.e. technological gap is inversely correlated with spillovers from foreign to local firms. The rationale is that the lower the technological gap, the easier is the diffusion from foreign to local firms. In addition to the problems associated with the production function, the logic and the evidence adduced to defend the technology gap argument are also fraught with weaknesses. Firstly, the typical measure of technological gap – the difference in the values of machinery and equipment of foreign and local firms – does not really capture technological differences. Secondly, the wide dispersion in technology within the international standards industrial classification (ISIC) 5 digit industries when controlling for industry dummies reduces it to a spurious proxy.[4] Thirdly, as Hirschman (1958; 1970) had argued convincingly the wider the gap the greater the potential for learning and that it is in the interest of local institutions and firms to respond by substituting imports with domestic production. Indeed, Hirschman emphasized the focus on backward rather than forward linkages as export markets would raise the scale (and scope) for expanding supplier links. It is the potential rather than the actual that sets the limits of learning and hence planning and effort can be targeted to raise the rate of diffusion to meet the potential level. Fourthly, *ceteris paribus* while it is easier to learn something close to what is already known than something far more sophisticated, such a sequencing of learning does not take into account the dynamics of the "S" curve where the rate of learning rises sharply once a certain critical mass of knowledge is attained until the technology frontier is reached by when the rate of absorption slows down owing to the difficulty associated with producing new knowledge.

### *2.2  Evolutionary Framework*

The framework of analysis adopted in this paper borrows extensively from evolutionary economics. Schumpeter (1934) had already demonstrated the significance of technology and innovation in driving accumulation. Evolutionary economics models added further emphasis to technology by advancing the national, regional and local innovation systems and its composition as a constellation of economic agents (firms and institutions) (see Nelson and Winter, 1982; Freeman, 1982, 1987; Lundvall, 1988, 1992). The focus on science and technology infrastructure and the "S" curve to explain learning goes right to the heart of evolutionary arguments of technology.

In addition to addressing the embodied nature of technical progress, evolutionary arguments broach the issue of institutions and institutional coordination that is critical in stimulating learning and innovation in firms (see Nelson and Winter, 1982; Nelson, 1994; Freeman, 1987). Lucid accounts of learning from the acquisition of technology to its adaptation

and eventually the innovation of exportable products offer considerable policy relevant implications. Using the experience of Japan, Freeman (1989) demonstrated convincingly that international flows of stocks of knowledge from developed to developing economies take a sequential shift involving import, adaptation, assimilation and innovation.[5] Lundvall (1988, 1992) introduced interesting empirical evidence to argue over the interactive nature of learning between producers and users. Edquist (2004) went further to include the need for interdependent relationships between economic agents – consistent with the industrial district exponents. Dosi (1982) and Pavitt (1984) advanced the importance of trajectories and taxonomies in technology development. Disentangling further the processes of learning and innovation – following the conceptual exposition of Lall (1992) – Figueiredo (2002) and Ariffin and Figueiredo (2004) and Rasiah (2004a; 2004b) showed how firms moved up the technology trajectory by learning initially simple and later complex technological capabilities before eventually participating in R&D activities.

This framework relies on embodied technical progress using related proxies to compare and examine technological capabilities – human resource, process technology and R&D (see also Rasiah, 2004a; 2004b). Given that spillovers are external firms and are not measurable exhaustively, the measurement of capabilities allows the estimation of the potential rather than actual spillovers that can take place at host sites. Although the measurement technique is different, the same arguments of Caves (1974) on the impact of foreign firms' demonstration and competition effects on local firms can also be used here. The higher the gap, the higher will be the potential, though as Hirschman (1970) had argued the benefits of it will depend on the embedding environment's capacity to enable the host-site's economic agents to appropriate them. These benefits can arise in the same product and process technologies, or in dissimilar but complementary technologies.

While extensive work on issues related to innovation systems exist, little work has been done to compare its effect on firm-level technological capabilities across economies, including on foreign and local firms. Hymer (1960) focused on multinational firms' superiority over national firms from their control of superior tangible and intangible assets (Hymer, 1960). Dunning's (1974) eclectic theory emphasized ownership, location and internalization (OLI) characteristics to explain the spread of multinationals to developing economies. Dunning (1994a) provided empirical evidence of R&D synergies from multinational operations. It is of course extremely difficult to address this issue given the openness and vagueness of the concept and the strength and relationships that exist among those involving institutions.

Any assessment of technological intensities and productivity in Uganda must address two special issues. Firstly, Uganda has a poor basic infra-

structure, low literacy rates and has a short history of political stability. Secondly, Uganda is characterized by weak high tech institutions. Because export-oriented foreign firms in Uganda target underdeveloped regional markets – especially Tanzania, Rwanda, Burundi, Zambia and Kenya – export-orientation may not be correlated with higher skills, human resource, process technology and R&D intensities. Given the underdeveloped status of high tech institutions hardly any firm is expected to undertake R&D operations in the typical manner it is carried out in developed economies. Nevertheless, because incremental engineering – both to raise efficiency as well as to substitute for a lack of skilled labour – is central to productivity improvements in such locations, R&D is defined to include such improvements – both product and process. Hence, engineers and technicians engaged in engineering improvements perform both production and development operations.

However, the pattern of differences is likely to vary between human resource (HR) practices, process technology and R&D. Foreign firms are likely to show higher intensity levels than local firms in the easy to move internalized practices associated with HR, and machinery and equipment and process technology associated with it. Owing to Uganda's underdeveloped high tech infrastructure, the normal conduct of firms to undertake R&D essentially at parent sites (see Vernon, 1966; OECD, 1998),[6] and the risks involved in intellectual property rights, R&D is unlikely to be undertaken in any significant level in Uganda. Uganda's high tech infrastructure is too underdeveloped to stimulate significant levels of R&D in local firms. Hence, both foreign and local firms are likely to face low R&D intensities. However, foreign firms generally enjoy higher product technologies as they access the knowhow and brand name from their plants abroad.

The discussion above logically leads to the examination of three hypotheses in the paper. Firstly, because metal engineering firms require relatively higher technological intensity levels than simple food processing and plastics firms, foreign firms are expected to enjoy higher human resource, process technology and R&D intensities than local firms. Secondly, the overall technological intensity is expected to show a stronger relationship with export-intensity among foreign than local firms. Apart from minor modifications (adaptive engineering), most firms are not expected to undertake any significant R&D operation owing to the weak high tech infrastructure in Uganda. Because foreign firms are engaged in supplying domestic and proximate regional markets with intermediary and consumer products the lack of human capital could force them to introduce adaptations to processes, machinery and equipment to deskill workers. Hence, thirdly, foreign ownership may be positively correlated with adaptive engineering.

## 3. Methodology

The paper uses labour productivity and export-intensity as proxies of productivity and export performance respectively, and employs indexes measured using related proxies to compare and examine their relationship with technological intensities. Industry level variations involving labour productivity and export-intensity are controlled with industry dummies. The use of capability indexes in examining the capacity of firms to compete can be traced to Lall (1992), Bell and Pavitt (1995), Westphal et al. (1990), Wignaraja (2002) and Rasiah (2004a, 2004b, 2004c). Wignaraja adapted the Ernst, Ganiatsos and Mytelka (1998) taxonomy of capabilities to fit the narrow range of data available to examine upgrading in Mauritius' firms. The methodology developed here uses the taxonomies and classification of specific technologies used above, but structures technology by functional application into human resource, process technology and adaptive engineering (AE) activities. In addition, most of the above studies attempted to locate firms' activities in a technology ladder against the axis of type and depth without attempting a link with economic performance. Wignaraja's (2002) and Rasiah's (2004b, 2004c) are an exception where a statistical link was attempted between the technology index, and productivity and export intensity. In addition to examining technological capability differences between foreign and local firms, this paper attempts to add to the findings on the statistical relationship between technological capabilities and economic performance.

To facilitate cross-industry statistical analysis, the technological components identified for normalization had to be limited to common proxies. Hence, the technological components used in the paper are less exhaustive compared to the rich data produced by Ariffin and Bell (1999), Figueiredo (2002), and Ariffin and Figueiredo (2004). The latter also used simple two-way correlations, showing higher technological capabilities in foreign electronics firms in Malaysia, but no obvious differences between foreign and local consumer electronics firms in Manaus. In addition to two-tail t-tests, this paper also uses multiple regression models to examine the statistical relationships involving the performance and technological capability variables. Although the national sampling frame was not used, questionnaires were sent to all manufacturing firms whose addresses were provided by the Bank of Uganda. The proxies used in sections 4 and 5 were measured and defined as follows (see also Table 1):

### 3.1 Productivity and Export Performance

The proxies of labour productivity and export-intensities were used to measure productivity and export performance respectively (see Table 1).

Table 1: List of variables and their relationship with the dependent variables,
         Uganda Sample, 2001

| Dependent Variable | Independent Variables | | | | | |
|---|---|---|---|---|---|---|
| | X/Y | SI | TI | FO | W | A |
| VA/L | +ve | | +ve | Unclear | +ve | Unclear |
| X/Y | | | Unclear | Unclear | +ve | Unclear |
| HR | +ve | +ve | | +ve | +ve | Unclear |
| PT | Unclear | Unclear | | +ve | Unclear | Unclear |
| AE | Unclear | +ve | | +ve | +ve | Unclear |
| TI | Unclear | +ve | | +ve | +ve | Unclear |

Labour Productivity = $VA_i/L_i$

where VA and L refer to monthly value added figures in 100,000 Ugandan shillings and total employees respectively of firm i in 2001.

Export Intensity = $X_i/Y_i$

where X and Y refers to exports and gross output respectively of firm i in 2001.

### 3.2  Technological Capabilities

Firm-level technological activities include minor improvements to machinery and equipment, inventory control systems and training methods and at the highest level, R&D effort. Since a number of characteristics and strategies have overlapping objectives and effects, it is methodologically better to integrate related proxies into a composition of indexes, which will not only help minimize double counting, but also avert collinearity problems in statistical analysis. In addition, adjusting firms' responses involving specific variables, e.g. AE – will offer a better approximation of its value than just any one proxy – e.g. R&D sales as a percentage of sales or R&D staff in workforce. Because there are no economic reasons to attach greater significance to any of the proxies used, the normalization procedure was not weighted. However, the indirect effects of these proxies would still remain as the hiring of key AE engineers and technicians by one firm from another would inevitably have a bearing on its AE capability. The following broad capabilities and related composition of proxies were used.

### 3.2.1  Human Resource

Two proxies were used to represent human resource. However, human resource capability was used separately to measure human resource practices that denote development in firms, and hence it excluded technical, professional and skilled human resource endowments (see Table 1). The exclusion allows the measurement of human resource capability that is developed by each firm – rather than those that are acquired or poached from other firms.

### 3.2.2  Human Resource Capability

Human resource (HR) is expected to have a positive relationship with labour productivity, process technology and skills intensity. Given the low value added nature of assembly and processing undertaken in the four industries in Uganda, a strong relationship is not expected between HR and AE activities.

Human resource capability (HR) was measured as:

$$HR = 1/3[TM, TE, CHR] \qquad (1)$$

where TM, TE and CHR refer to training mode, training expense as a share of payroll and cutting edge human resource practices used respectively in firm i. TM was measured as a multinomial logistic variable of 1 when staff are sent out to external organizations for training, 2 when external staff are used to train employees, 3 when staff with training responsibilities are on payroll, 4 when a separate training department is used, 5 when a separate training centre is used and 0 when no formal training is undertaken. CHR was measured by a score of one for each of the practices. The firms were asked if it was their policy to encourage team-working, small group activities to improve company performance, multi-skilling, interaction with marketing, customer service and AE department, life long learning and upward occupational mobility. HR was divided by three, which is the number of proxies used (see Table 1). The proxies were normalized using the formula below:

$$\text{Normalization Score} = (X_i - X_{min})/(X_{max} - X_{min}) \qquad (2)$$

where $X_i$, $X_{min}$ and $X_{max}$ refer to the ith, minimum and maximum values of the proxy, X. All normalized observations should be used strictly to compare the relative level of firm i's intensity against the leading firm in the sample. The normalization procedure raises the highest observation to one and reduces the lowest observation to 0. The mean score generally fluctuates between being closer to one when most observations are concentrated around the highest score, and close to zero when they fall close to the lowest score.

### 3.2.3  Skills Intensity

Skills intensity (SI) was used separately to capture the effects of different shares of managerial, professional, engineering, technical and supervisory personnel in the workforce. SI was measured as:

$$SI = H_i/L_i$$

where H and L refer to managers, professionals, engineers, technicians and supervisors, and total employees in 2001 respectively of firm i. SI was not included in HR only because it draws different spillover implications (see Table 1). Higher levels of SI in foreign firms could be the result of "poaching" from local firms or simply that the labour market has been saturated by demand from foreign firms thereby denying local firms sufficient supplies of human capital. This phenomenon of "crowding out" results can result in negative spillovers in the short run. The long run effects can still be positive if the tacit knowledge gained in foreign firms is diffused more productively into the local economy.

### 3.2.4  Process Technology Capability

Process technology (PT) – being important to participation in export markets even in low value added operations – can be expected to show a positive relationship with exports and HR. The same can also be expected with AE since process improvements dominate early participation in R&D activities.

Data on four proxies facilitated the computation of PT, which was calculated using the formula:

$$PT_i = 1/4[EM_i, PTE_i, ITC_i, QC_i] \tag{3}$$

where EM, PTE, ITC and QC refer to equipment and machinery, process technology expenditure in sales, information technology components and quality control instruments respectively of firm i (see Table 1). EM was computed as a multinomial logistic variable with average age of over 5 years = 0, 3-5 years = 1, 2 to less than 3 years = 2 and less than 2 years = 3. Likert scale scores ranging from 1-5 (least to strong) was used to measure ICT. QC was measured as a dummy variable (QC = 1 if cutting edge methods were used, QC = 0 otherwise). PT was divided by 4 owing to the use of four proxies.

### 3.2.5  Adaptive Engineering Capability

The examination of R&D in most underdeveloped economies must be treated with caution. Unlike typical notions of R&D, firms' participation in R&D activities in countries like Uganda normally refers to adaptations made to

process and product technology. What is referred to typically as engineering improvements constitutes the core aspects of AE undertaken here. Since firms typically start this way to eventually participate in formal R&D activities, its assessment will be useful in understanding technological intensities in Uganda. Because of the nascent nature of R&D undertaken in Ugandan firms, the paper uses AE rather than R&D. Given the very low figures, the percentage rather than the ratio of AE expenditure in sales was used. The limited amount of R&D undertaken was largely done in the modification of old machinery and equipment to absorb electronics control, and products to meet specialized local demand. These firms had engineers and technicians with AE duties, though, their functions extended into day to day routine repair work.

AE was computed to capture the effects of both AE expenditure and employees for use in the computation of the technology index. Given Uganda's underdeveloped high-tech institutions, R&D is unlikely to produce statistically meaningful results involving export-intensity.

AE was measured as:

$$AE_i = 1/2[AEexp_i, AEemp_i] \tag{4}$$

where AEexp and AEemp refer to AE expenditure as a share of sales and AE personnel in workforce respectively of firm i (see Table 1). AE was divided by 2 owing to the two proxies used. The AE personnel captured here refer to staff with AE responsibility who also often undertook technical and engineering duties. Although the incidence of participation in development activities was fairly high for an underdeveloped economy – 26 (54.2%) by foreign firms and 19 (38.8%) by local firms, the levels were extremely low (see Table 2).

### 3.3  Overall Technological Intensity

Since it is the overall technological intensity (TI) which is important when examining the relationship of technological intensities on labour productivity and export-orientation, the three components of embodied technology are aggregated here. The TI variable was estimated by simply adding the value of its components, i.e. HR, PT and AE and was measured as (see Table 1):

$$TI_i = HR_i + PT_i + AE_i \tag{5}$$

It now becomes clear why the component variables were divided by the number of proxies used, which is to provide equal weighting to all three of them. TI was aggregated simply because it is the overall technological effect that is important in establishing technological effects on labour productivity and export intensity.

### *3.4  Other Critical firm-level variables*

To complete the regression model, two additional explanatory variables were specified, *viz.*, wages and ownership. Wage is the proxy used to represent labour, while ownership is an explanatory variable in the paper.

### *3.4.1  Wage*

Typically wage will be correlated with skills intensity as the higher the skills the higher the bargaining power of the employee involved. Where unemployment levels are low and unions are strong the relationship between skills and wage will also be strong. Wage was used to represent labour market conditions. Union was dropped owing to only eight firms having it (see Table 2).

Given the premium enjoyed by skilled and knowledge workers a positive relationship can be expected between productivity and TI, and wages. The lack of statistical correlation between SI and wage (see Appendix 1) ensures that its use in the models does not create collinearity problems. Average monthly wages were used. Since it is difficult to obtain wages of just workers, it was measured by dividing total salaries and remuneration with workforce. Average wages in million Ugandan Schillings per year was used in all the regressions and was measured as:

$$W_i = S_i/L_i$$

where W and S refer to monthly wage per worker and total monthly salary bill in 10,000 Ugandan shillings of firm i.

### *3.4.2  Ownership*

Given the specific nature of stand-alone foreign firms in East Africa, ownership may produce statistical results atypical of firms associated with transnational ownership structure. However, only 12 (25%) of the 48 foreign firms were stand alone firms. Besides interviews show that the stand alone firms are managed by foreign settlers who themselves have gained tacit knowledge working in large firms abroad. Hence, Dunning's (1974) OLI framework explaining the conduct of foreign firms can be expected to hold.

There were only five joint-venture firms in the sample and all of them had 50% foreign equity. Ownership was estimated as:

$FO_i$  = 1 if foreign equity ownership of firm i was 50% or more;
$FO$   = 0 otherwise.

where FO refers to the status of ownership of firm i. A dummy was preferred over actual equity shares owing to the dominance of firms with 100% foreign

Table 2: Sample Breakdown, Uganda Sample, 2001

| | Ownership | | Export Experience | | Cross-border Asset Ownership | | Development Experience | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Foreign | Local | Foreign | Local | Foreign | Local | Foreign | Local | |
| Metal engineering | 13 | 12 | 9 (69.2) | 6 (50.0) | 12 (92.3) | 0 (0.0) | 8 (61.5) | 0 (0.0) | 25 |
| Food & beverages | 22 | 23 | 14 (63.6) | 15 (65.2) | 6 (27.3) | 0 (0.0) | 10 (45.5) | 14 (60.9) | 45 |
| Plastics | 13 | 14 | 11 (84.6) | 7 (50.0) | 1 (7.7) | 0 (0.0) | 8 (61.5) | 5 (35.7) | 27 |
| Total | 48 | 49 | 34 (70.8) | 28 (55.1) | 19 (39.6) | 0 (0.0) | 26 (54.2) | 19 (38.8) | 97 |

Note:   Figures in parentheses refer to percentages by ownership.
Source:   Tabulated from INTECH (2001) survey using Stata Package 7.0.

and local equities. The survey[7] produced 48 (49.5%) foreign and 49 (50.5%) local firms.[8]

### 3.4.3  Control Variables

Age, size, management type and industry dummies were tested as control variables in the regression models. Size (used as continuous as well as dummies) was dropped owing to multi-collinearity problems with wages. Following the norm in publications, results involving industry dummies were not reported here.

### 3.4.4  Age

Given that firms with longer experience is normally considered to enjoy greater experiential and tacit knowledge age is considered to provide a positive relationship with exports and technological capabilities. However, new firms are considered to offer greater flexibility for absorbing new ideas and hence, may provide the reverse influence. In addition, foreign transnational firms may relocate operations, which essentially carry far more knowledge than new firms. Hence, a neutral hypothesis is used here. The absolute age of the firm is used as an independent variable. The statistical relationship may not be positive if foreign firms using superior technology from abroad and enjoying strong access to global markets began starting or relocating operations recently. Age was measured as:

$$A_i = \text{years in operation of firm i.}$$

where A refers to age of operation of firm i.

### 3.4.5  Owner-managed Firms

With 52 firms (22 foreign and 30 local) enjoying at least partial owner-managed operations, management type may have a bearing on the statistical results. It is important to note that there are a number of owner-controlled transnationals since the most widely used definition is ownership of productive assets in two or more countries. This distinction becomes clearer when the distribution of subsidiaries is examined among the firms in the sample. Of the 48 foreign firms in the sample 36 had parent plants abroad and hence qualified as transnationals (see Table 2). No local firm had foreign subsidiaries. The remaining 12 foreign firms did not have subsidiaries abroad, though all of them enjoyed access to loans from foreign banks.[9] Foreign firms without subsidiaries abroad were generally owned by Asians who had emigrated from either Uganda or other African economies.

It is often argued that owner-managed (partially or fully) firms either impact positively or negatively in firms' performance. On the one hand, owners are considered to show greater drive to succeed owing to lower agency costs, and the autonomy to make quick decisions. On the other hand, owner-managers are considered to be less professional, especially when involving big businesses, and hence may lack the instruments to succeed in export markets. OM is measured using a dummy variable as follows:

$OM_i$ = 1 if firm is managed either partly or fully by the owner;
OM   = 0 otherwise.

where OM refers to status of management of firm i.

### 3.5  Statistical Equations

The following models were specified to examine the relationship involving labour productivity and technological capabilities. OLS regressions were used when the dependent variable was value added per worker. Tobit regressions were preferred when export-intensity, skills-intensity and the technological variables were used because they are censored on the right and the left side of the data sets. The models were run with industry dummies:

$$OLS: VA/L = \alpha + \beta_1 X/Y + \beta_2 TI + \beta_3 FO + \beta_4 W + \beta_5 A + \beta_6 OM + \beta_7 S + \mu \quad (9)$$

$$Tobit: X/Y = \alpha + \beta_1 TI + \beta_2 FO + \beta_3 W + \beta_4 A + \beta_5 OM + \beta_6 S + \mu \quad (10)$$

$$Tobit: SI = \alpha + \beta_1 X/Y + \beta_2 TI + \beta_3 FO + \beta_4 W + \beta_5 A + \beta_6 OM + \beta_7 S + \mu \quad (11)$$

$$Tobit: TI = \alpha + \beta_1 X/Y + \beta_2 SI + \beta_3 FO + \beta_4 W + \beta_5 A + \beta_6 OM + \beta_7 S + \mu \quad (12)$$

$$Tobit: HR = \alpha + \beta_1 X/Y + \beta_2 FO + \beta_3 W + \beta_4 OM + \beta_5 A + \beta_6 S + \mu \quad (13)$$

$$Tobit: PT = \alpha + \beta_1 X/Y + \beta_2 FO + \beta_3 W + \beta_4 OM + \beta_5 A + \beta_6 S + \mu \quad (14)$$

$$Tobit: AE = \alpha + \beta_1 X/Y + \beta_2 FO + \beta_3 W + \beta_4 OM + \beta_5 A + \beta_6 S + \mu \quad (15)$$

Regressions (9), (10), (11), (12), (13), (14) and (15) were repeated using foreign and local firm samples separately.

Specific industry-level questionnaires were designed, tested and mailed to all firms listed in official government statistics records in Uganda. In addition, the author with the assistance of the national consultant, i.e. Mr Tamale of the Bank of Uganda, distributed and collected 19 questionnaires personally.

## 4. Statistical Differences

This section examines if there are statistically significant differences between foreign and local firms in labour productivity, export-intensity, skills-intensity and technological capabilities. Differences in technological capabilities are examined using the overall aggregate TI, and its components HR, PT and AD. As mentioned earlier Uganda is likely to produce results unique to East Africa.

The two tail t-tests produced mixed results involving labour productivity, export-intensity, skills-intensity and wages (see Table 3). Labour productivity differences were only statistically significant in food and beverages at the 10% level: foreign firms enjoyed a significantly higher productivity level than local firms. Export-intensity differences were statistically highly significant in metal engineering (1% level) and plastics (5% level): foreign firms enjoyed higher intensity in plastics but lower intensity in metal engineering. Ownership differences were not statistically significant involving skills intensity in all three industries. Wage differences were significant only in food and beverages where foreign firms had a higher mean. The t-test results involving the skills-intensity index suggests that there are no obvious differences between foreign and local firms to suggest crowding out tendencies. A more detailed assessment of the origin of human capital in the firms is necessary to confirm this.

Except for AD, the remaining technological capabilities in metal engineering were statistically significant: foreign firms enjoyed higher TI (1%l), HR (5%) and PT (1%) levels than local firms. However, excluding metal engineering the results did not show a significant advantage enjoyed by foreign firms. AE intensity was extremely low as shown in the mean percentages of AE expenditure in sales (see Table 3). The lack of statistical significance between the technological capability variables in food and plastics may be explained by the small and politically risky regional markets.

Overall, the statistical analysis produced mixed results. No clear statistically significant productivity, export-intensity and skills-intensity differences existed between foreign and local firms in most industries. Foreign firms enjoyed a substantially higher labour productivity in food, and were more export-oriented in plastics than local firms. Foreign firms also paid higher wages than local firms in food than local firms. Besides, foreign firms enjoyed higher technology levels – TI, HR, PT and AD – in metal engineering than local firms.

## 5.  Statistical Relationships

Having identified differences by ownership in the previous section, this section evaluates the statistical relationship between labour productivity and

Table 3: Two Tail t-tests by Ownership, Uganda Sample, 2001

| | Foreign | Local | P>\|t\| | | Foreign | Local | P>\|t\| |
|---|---|---|---|---|---|---|---|
| *VA/L* | | | | *HR* | | | |
| Metal engineering | 6.072 | 6.053 | 0.906 | Metal engineering | 0.322 | 0.136 | 0.024** |
| Food & beverages | 42.713 | 9.838 | 0.077*** | Food & beverages | 0.498 | 0.354 | 0.254 |
| Plastics | 7.070 | 8.990 | 0.534 | Plastics | 0.356 | 0.339 | 0.743 |
| *TI* | | | | *PT* | | | |
| Metal engineering | 0.701 | 0.212 | 0.000* | Metal engineering | 0.292 | 0.075 | 0.000* |
| Food & beverages | 0.824 | 0.675 | 0.459 | Food & beverages | 0.252 | 0.205 | 0.591 |
| Plastics | 0.748 | 0.675 | 0.593 | Plastics | 0.264 | 0.271 | 0.900 |
| *X/Y* | | | | *AD* | | | |
| Metal engineering | 0.135 | 0.521 | 0.004* | Metal engineering | 0.087 | 0.000 | 0.104*** |
| Food & beverages | 0.329 | 0.344 | 0.909 | Food & beverages | 0.074 | 0.117 | 0.458 |
| Plastics | 0.273 | 0.049 | 0.019** | Plastics | 0.121 | 0.072 | 0.356 |
| *SI* | | | | *Wages* | | | |
| Metal engineering | 0.245 | 0.184 | 0.623 | Metal engineering | 4.346 | 1.967 | 0.425 |
| Food & beverages | 0.116 | 0.188 | 0.167 | Food & beverages | 8.961 | 2.657 | 0.052** |
| Plastics | 0.156 | 0.240 | 0.123 | Plastics | 2.806 | 3.102 | 0.791 |

Note: *, ** and *** – significant at 1, 5 and 10% level respectively.
Source: Computed from Interview Survey (Authors, 2002) using Stata Package 7.0.

export-intensity, and the technological variables controlling for wages, age, management type and ownership.

### 5.1 *Productivity and Export-Intensity*

Table 4 presents the econometric results establishing the statistical relationships involving labour productivity, export-intensity and skills-intensity. These regressions were also run using ownership samples. Not only that the overall model fit (*F* and chi-square statistics) was statistically significant, all the regressions also easily passed the Cook-Weisberg test for heteroskedascity.

Against labour productivity as the dependent variable, TI was statistically highly significant (1% level) and its coefficient was positive and strong, demonstrating a strong link between overall technological intensity and

Table 4:  Statistical Relationships Involving Labour Productivity and
　　　　 Export Intensities, Uganda, 2001

| | VA/L | | | X/Y | | |
|---|---|---|---|---|---|---|
| | All | Foreign | Local | All | Foreign | Local |
| X/Y | 2.633 | -7.223 | -1.617 | | | |
| | (0.55) | (-0.68) | (-0.55) | | | |
| TI | 20.764 | 24.133 | 15.117 | 0.077 | 0.243 | -0.193 |
| | (4.96)* | (3.54)* | (4.02)* | (0.67) | (1.98)** | (-0.72) |
| FO | 1.733 | | | 0.081 | | |
| | (0.35) | | | (0.73) | | |
| A | 0.012 | 0.263 | 0.121 | 0.015 | 0.013 | 0.011 |
| | (0.09) | (0.74) | (1.11) | (2.75)* | (3.12)* | (1.59) |
| W | 3.145 | 3.682 | 1.313 | 0.011 | 0.010 | -0.007 |
| | (8.174)* | (5.61)* | (2.93)* | (0.81) | (0.85) | (-0.39) |
| μ | 1.534 | 6.257 | -5.623 | -0.579 | -0.576 | -0.333 |
| | (-0.23) | (0.45) | (-1.35) | (-2.57)* | (-2.67)* | (-1.25) |
| N | 97 | 48 | 49 | 97 | 48 | 49 |
| *F, $\chi^2$* | 25.21* | 18.61* | 6.75* | 20.87** | 21.29* | 17.18** |
| $R^2$ | 0.731 | 0.801 | 0.611 | | | |
| Adj. $R^2$ | 0.713 | 0.769 | 0.510 | | | |

Note:　*, ** and *** refer to statistical significance at the 1, 5 and 10 per cent levels
　　　　respectively; Industry dummies used not reported here.
Source:  Computed from Interview Survey (Authors, 2002) using Stata Package 7.0.

productivity. While the results were also statistically highly significant (1% level) and positive involving both sets of firms, it was much stronger in foreign firms. Wages was also statistically highly significant and its co-efficients positive with foreign firms enjoying a higher coefficient suggesting that wages in foreign firms are more responsive to productivity changes than local firms.

Using export-intensity as the dependent variable, TI's relationship was statistically insignificant in all three samples, suggesting that firms' technological orientation did not differ between production for domestic and regional markets. Size was statistically significant and its coefficient positive in the overall (1%) and local (1%) firms samples, demonstrating a higher propensity to export among larger local firms. Age was the only other variable statistically significant but only in the foreign firms' sample. The relationship is positive but its influence on export-intensity was marginal.

The explanatory variable of TI shows a stronger impact on productivity in foreign firms than in local firms suggesting that the latter can learn through both demonstration effect as well as hiring tacit human capital from foreign firms to raise productivity levels and exports. Panel data is necessary to confirm if these developments are actually occurring.

### 5.2  Technological Intensities

Table 5 presents the econometric results establishing the statistical relationships involving TI, HR, PT and AE. These regressions were also run using ownership samples. Not only that the overall model fit (chi-square statistics) was statistically significant, the regressions also easily passed the Cook-Weisberg test for heteroskedascity. However, the results involving the AD regressions using the foreign and local firms' samples were dropped owing to a lack of convergence.

Against TI, the variables of age and wage enjoyed statistically significant results. As expected, wage was statistically significant and its coefficient positive in all three samples, demonstrating a strong link between technological intensities and wages. Age was inversely correlated with technology in the overall and foreign firms' samples, suggesting that new firms enjoying business-friendly incentives (e.g. investment guarantees and tax incentives) have installed higher technological capabilities.

Decomposing TI into HR, PT and AE also produced some interesting results. HR was positively correlated with wage and export-intensity. Wage was statistically significant and positive in all three samples, but the relationship was much stronger in foreign firms and in local firms. Export-intensity was statistically significant in both sets of firms and their coefficients positive (10% level). HR was inversely correlated with OM.

Table 5: Statistical Relationships Involving Technological Intensities, Uganda, 2001

| | TI | | | HR | | | PT | | | AE# | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Foreign | Local | All | Foreign | Local | All | Foreign | Local | All | Foreign |
| X/Y | 0.015 (0.16) | 0.482 (1.85)*** | -0.257 (-1.39) | 0.225 (2.25)** | 0.161 (1.85)*** | 0.101 (1.99)** | -0.037 (-0.69) | -0.075 (-0.102) | 0.057 (0.83) | -0.193 (-1.55) | 0.115 (0.77) |
| SI | 0.151 (0.61) | 0.108 (0.31) | -0.116 (-0.38) | | | | | | | | |
| FO | 0.059 (0.69) | | | -0.023 (-0.71) | | | 0.014 (0.67) | | | 0.123 (1.97)** | |
| A | -0.012 (-1.65) | -0.015 (-2.52)** | -0.006 (-0.97) | -0.001 (-0.37) | -0.002 (-0.58) | -0.000 (-0.04) | 0.002 (1.57) | 0.002 (1.13) | 0.002 (1.29) | -0.007 (-1.87)*** | -0.007 (-1.59) |
| W | 0.041 (4.87)* | 0.042 (4.00)* | 0.041 (2.38)** | 0.027 (6.59)* | 0.031 (5.55)* | 0.009 (1.90)*** | 0.012 (4.27)* | 0.010 (3.73)* | 0.019 (2.55)** | 0.032 (3.89)* | 0.039 (3.23)* |
| μ | 0.613 (3.77)* | 1.295 (5.89)* | 0.435 (2.63)* | 0.275 (4.34)* | 0.432 (4.23)* | 0.173 (3.95)* | 0.081 (1.67) | 0.099 (1.23) | 0.035 (0.57) | -0.523 (-2.97)* | -0.331 (-1.45) |
| N | 97 | 48 | 49 | 97 | 48 | 49 | 97 | 48 | 49 | 97 | 48 |
| $\chi^2$ | 34.51* | 29.39* | 29.67* | 80.72* | 51.12* | 46.15* | 70.03* | 43.19* | 32.13* | 48.27* | 24.43* |

Note:   *, ** and *** refer to statistical significance at the 1, 5 and 10 per cent levels respectively; # – $\chi^2$ results involving the local firms' sample was statistically insignificant; results of industry dummies not reported here.

Source: Computed from Interview Survey (Authors, 2002) using Stata Package 7.0.

PT was positively correlated with wages, which was also were statistically highly significant (1% level). However, export-intensity was statistically insignificant suggesting that firms did not specifically choose techniques, machinery and equipment on the basis of markets, which appears sensible since most firms only export to Tanzania, Rwanda, Burundi, Zambia and Kenya where the demand conditions are similar. The relationship between PT and foreign ownership was also insignificant demonstrating that the process technology levels in Ugandan manufacturing did not vary with ownership.

The regression results involving AE using foreign and local firms was dropped owing to non-convergence, which is a consequence of over 50% of them showing zero participation in AE activities (see Table 5). The overall and foreign samples produced statistically meaningful results for interpretation. Interestingly, foreign ownership showed a positive relationship with AE at the 5% level. Wage was inversely correlated in both the overall and foreign samples. Taken together, the results show that foreign firms participate in adaptive engineering activities to deskill work so as to overcome labour turnover problems.

FO was statistically insignificant in all the regressions involving labour productivity, and export, skills and technological intensities. The stand-alone nature of most foreign firms, poor infrastructure and the potentially risky political environment may explain why neither foreign nor local firms enjoyed a significant advantage over the performance and technology variables. Nevertheless, the higher elasticity between TI and labour productivity in the foreign firms' sample compared to the local firms' sample suggests that the former enjoys higher levels of productive efficiency in utilizing technology than the latter.

## 6. CONCLUSIONS

Uganda presented an interesting case of an underdeveloped economy with high amounts of FDI in GFCF – including in manufacturing. Despite its poor infrastructure, the economy has managed to attract significant amounts of FDI since the mid-1990s through both internal promotional policies, and the external environment that constrained inflows to neighbouring economies – particularly Kenya. However, despite a steady inflow of foreign capital its extremely weak infrastructure has set limits on firms' technological activities in Uganda. Despite these caveats, the analysis in the paper produced some interesting results that can serve as a signpost for other economies with similar endowments.

The two tail t-tests to examine statistical differences between foreign and local firms produced mixed results. Despite 25% of foreign firms in the sample being of the stand alone type, they enjoyed substantially higher labour

productivity in food and beverages, and were more export-oriented in plastics manufacturing than local firms. Foreign firms also paid higher wages than local firms in food and beverages than local firms. Local firms were more export oriented in metal engineering than foreign firms. Foreign firms enjoyed higher TI, HR, PT and AD in metal engineering than local firms supporting Dunning's (1994a; 1994b) argument over the potential benefits host sites can enjoy from foreign firms' access to superior knowledge base from abroad. Productivity levels and export-orientation in foreign firms were higher than local firms in food and plastics respectively.

TI was highly correlated with labour productivity, and the relationship was much stronger in foreign firms than in local firms. Export-intensity was neither correlated with labour productivity nor with TI, which is a consequence of the export markets facing the same competition as domestic markets. Skills-intensity was highly correlated with export-intensity. The X/Y coefficient was only slightly higher in foreign firms compared to the local firms, suggesting that little difference existed between foreign and local firms' hiring strategies. The statistically significant positive relationship between foreign ownership and AE, and the negative relationship between wage and AE show that foreign firms engage in adaptive engineering largely to deskill work so as to overcome labour turnover problems.

## Notes

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2. This paper avoids discussion of papers by economists using the production function to estimate spillovers as the estimation methodology used do not really capture them (see Rasiah, 2007).
3. While Schumpeter was the next economist after Marx (1867) to underline technology as the basis of driving cycles of growth, Hirschman (1977) provided a dynamic argument on how learning and catch up can be raised with higher technological gaps between lead and latecomer firms.
4. For example, PCB assembly in electronics is significantly different from wafer fabrication. The former is also associated with low margins and labour-intensive activities while the latter is a highly capital-intensive high value added activity. Hence, industry dummies used do not actually control for such effects.
5. Fukasaku (1992) used this framework to examine the evolution of technology in Mitsubishi Nagasaki Shipyard.
6. The OECD (1998; cited in Amsden, Tschang and Goto, 2001) reported that only 12% of R&D invested on average by companies in OECD economies is undertaken outside parent locations.

7. The initial data collected included responses from the garment and other industries. These industries – used in Rasiah and Tamale (2004) – were dropped owing to unequal firm numbers by ownership. The sample was expanded following following further responses from the metal engineering, food and plastic industries.

8. The original study also yielded responses from the garment and other industries. These industries were excluded from the paper owing to highly unequal distribution of firms by ownership.

9. Interviews on 22 May 2002 showed that these firms preferred to borrow from low interest foreign banks than to face the 20% interested rates available for loans in Uganda.

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Appendix 1: Correlation Coefficient Matrix of Independent Variables, Uganda, 2001

| | X/Y | TI | HR | PT | AE | A | S | FO | SI | W |
|---|---|---|---|---|---|---|---|---|---|---|
| X/Y | 1.000 | | | | | | | | | |
| TI | 0.102 | 1.000 | | | | | | | | |
| HR | 0.177 | 0.825*# | 1.000 | | | | | | | |
| PT | 0.027 | 0.822*# | 0.631* | 1.000 | | | | | | |
| AE | -0.018 | 0.619*# | 0.253 | 0.373 | 1.000 | | | | | |
| A | 0.271 | -0.211 | -0.151 | -0.071 | -0.255 | 1.000 | | | | |
| S | 0.137 | 0.122 | 0.154 | 0.121 | 0.187 | -0.162 | 1.000 | | | |
| FO | -0.011 | 0.173 | 0.119 | 0.162 | 0.125 | -0.207 | -0.242 | 1.000 | | |
| SI | 0.334* | 0.139 | 0.135 | 0.031 | 0.145 | -0.081 | -0.057 | 0.052 | 1.000 | |
| W | 0.161 | 0.195 | 0.607* | 0.444* | 0.201 | -0.166 | 0.321* | 0.171 | 0.067 | 1.000 |

Note:   # – overlapping composition; * – high correlation.
Source: Computed from Interview Survey (Authors, 2002) using Stata Package 7.0.