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The Role of ICT for the Performance of SMEs in East Africa

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Contents

Acknowledgements	
Abstract	1
Kurzfassung	2
1 Introduction	3
2 The East African economies and the SME sector	4
3 The role for ICT on firm performance in East Africa	9
The access to ICT in East Africa	9
The impact of ICT on economic performance	12
ICT and SME competitiveness	13
4 Methodology and theoretical framework	16
5 The data	19
6 Results	21
7 Conclusions	24
Annex	
Table A1: Sample characteristics by size	26
Table A2: Sample characteristics by use of ICT	27
References	28

List of Tables

Table 1: Some basic economic and social indicators for Tanzania and Kenya	4
Table 2: The manufacturing sector in Tanzania and Kenya	5
Table 3: Diffusion and costs of selected ICTs in East Africa	9
Table 4: Enterprise characteristics by country and sector	20
Table 5: Estimation of a production function	22

List of Figures

Figure 1: The ranking of obstacles for doing business by Tanzanian SMEs	6
Figure 2: The ranking of obstacles for doing business by Kenyan SMEs	7
Figure 3: Diffusion of ICT in Kenyan SMEs	11
Figure 4: Diffusion of ICT in Tanzanian SMEs	11
Figure 5: Perceived effects of ICT	15

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Abstract

Small and medium enterprises are an important factor in the East African economies especially with respect to employment. The increasing competition through globalisation puts them under considerable pressure. Through the rapid spread of information and communication technologies (ICT) and ever decreasing prices for communication, markets in different parts of the world become more integrated. Therefore, one basic question is whether the use of ICT (as production technology, as information processing technology or as information communication technology) can help them to cope with these new challenges.

Information asymmetries are one of the major causes for high transaction costs, uncertainty and therefore market failure. A reduction of the information gap also reduces the ability of the better informed to extract rents from the less informed be it buyers or sellers of goods or factors. A reduction of information asymmetry will also create new opportunities and therefore enhance the efficiency of resource allocation. On a macro level this will then lead to faster growth and diversification of the economy.

Our sample of 300 SMEs in East Africa shows that the use of ICT by SMEs in Kenya as well as in Tanzania is increasing over time. The usage of fixed phone lines nearly reaches the saturation point but is still lower in Tanzania than in Kenya. The percentage of firms that uses mobile phones is increasing fast in both countries. Especially in Tanzania, despite its late start only in 1994 it has already outgrown the usage of fax machines. Those enterprises that use different forms of ICT rate their effects mostly positive. On top are computer applications that are assumed by 88 % and 76 % of users to considerably increase management efficiency and competitiveness respectively. Mobile phones are considered to contribute significantly to regional market expansion by most enterprises, followed by fixed phones and faxes. For all sectors in both countries the average size of enterprises is generally bigger for users of more advanced ICTs. The average years of schooling also increase with the use of advanced ICTs with only small differences between sectors. Also with respect to exporting the relation with ICT is positive and similar for all sectors.

By regressing a Cobb-Douglas production function on a dataset of Kenyan and Tanzanian enterprises we analyse determinants of productivity. Our main empirical findings are that investment in ICT has a negative sign in different specifications of the regression but is never significant. However, the use of fax machines that gives managers access to formal information has a significant positive relationship with productivity in both countries.

Kurzfassung

Klein- und Mittelunternehmen sind für die Wirtschaft Ostafrikas von großer Bedeutung, besonders im Hinblick auf Beschäftigung. Allerdings werden sie durch den wachsenden Wettbewerb im Rahmen der Globalisierung unter erheblichen Druck gesetzt. Durch die schnelle Verbreitung der Informations- und Kommunikationstechnologien (ITC) und die ständig sinkenden Preise im Kommunikationssektor, wachsen die Märkte in verschiedenen Teilen der Welt immer mehr zusammen. Daher ist eine grundlegende Frage, ob der Gebrauch von ICT (als Produktions-, Informationsverarbeitungs- oder Kommunikationstechnologie) ihnen helfen kann mit diesen neuen Herausforderungen umzugehen.

Informationsasymmetrien sind eine der Hauptursachen von hohen Transaktionskosten, Unsicherheit und demzufolge Marktversagen. Eine Reduzierung dieser Informationslücke senkt auch die Fähigkeit der besser Informierten Renten von schlechter Informierten zu erhalten. Eine Verminderung der Informationsasymmetrie wird außerdem neue Möglichkeiten eröffnen und dadurch die Effizienz der Ressourcenallokation steigern. Auf der Makroebene wird dies dann zu schnellerem Wachstum und einer Diversifikation der Wirtschaft führen.

Unsere Befragung von 300 Unternehmen in Ostafrika zeigt, dass die Nutzung von ICT durch Klein- und Mittelunternehmen in Kenia wie in Tansania im Laufe der Zeit zunimmt. Die Verwendung von Festanschlüssen hat fast ihren Sättigungspunkt erreicht, ist jedoch in Tansania immer noch niedriger als in Kenia. Der Anteil der Firmen, die Mobiltelefone benutzen, steigt in beiden Ländern steil an. Diejenigen Unternehmen, die verschiedene Formen von ICT nutzen, werten deren Wirkung überwiegend positiv. Ganz oben stehen Computeranwendungen: 88 % (76 %) der Nutzer nehmen an, dass sie die Effizienz (Wettbewerbsfähigkeit) bedeutend erhöhen. Bei Mobiltelefonen geht man davon aus, dass sie wesentlich zur Ausweitung regionaler Märkte beitragen, gefolgt von Festanschlüssen und Faxgeräten. In beiden Ländern sind Unternehmen mit höherwertigen ICTs durchschnittlich größer. Die durchschnittliche Schulbildung nimmt ebenfalls mit der Verwendung höherwertiger ICTs zu. Auch die Beziehung zwischen Export und ICT Nutzung ist positiv.

Eine mit Hilfe einer Cobb-Douglas-Produktionsfunktion durchgeführte Regression ermöglicht die Analyse der Determinanten der Produktivität. Zu unseren wichtigsten empirischen Ergebnissen gehört, dass zwar die Investition in ICT einen negativen Einfluss aufweist, der jedoch in verschiedenen Versionen nie signifikant ist. Andererseits weist die Verwendung von Faxgeräten, welche Managern Zugang zu formalen Informationen bietet, in beiden Ländern eine signifikant positive Beziehung zur Produktivität auf.

1 Introduction

In many developing countries small and medium enterprises (SME) account for a significant share of production and employment and are therefore directly connected to poverty alleviation. Especially in developing countries SMEs are challenged by the globalisation of production and the shift in the importance of the various determinants of competitiveness. Through the rapid spread of information and communication technologies (ICT) and ever decreasing prices for communication, markets in different parts of the world become more integrated. Therefore, one basic question is whether the use of ICT (as production technology, as information processing technology or as information communication technology) can help them to cope with these new challenges. The spread of ICT has led several commentators to argue that these technologies are creating a new economy – an information economy – in which information is the critical resource and basis for competition. It is argued that in remote regions, the disadvantages that arise with isolation can be significantly lessened through access to rapid and inexpensive communication (Torero 2000). However, there are also more pessimistic views that assume that the digital divide will increase and therefore producers in developing countries and especially in rural areas will face even greater disadvantages relative to their competitors in developed countries (Bedi 1999).

At least there is little empirical evidence how the diffusion and application of ICTs can be a catalyst for economic competitiveness and growth in developing countries. In this study, we therefore particularly focus on how micro-level competitiveness is influenced by ICTs. In so doing, we also account for other factors that obviously influence competitiveness. Hence, the analysis incorporates the influence of the enterprise resources in terms of factor inputs, because the performance is partly a function of the resources that are invested in such basic factor inputs as labour, physical capital, and production materials. With two East African countries Kenya and Tanzania we concentrate our analysis in a region where marginalisation in terms of world markets is especially prevalent. Besides, the salencies of East Africa's SMEs (e.g., relatively small size and young age by international comparisons, human capital stock and profile, levels of investments in new technologies, etc.) are drawn into the analysis.

2 The East African economies and the SME sector

East Africa is a region that is rather marginalised in terms of economic production and world trade. However between the two study countries Kenya and Tanzania there are remarkable differences (see Table 1). Whereas Kenya is relatively more developed with more than double the GDP per capita, a higher percentage of industry value added of GDP and a higher school enrolment rate especially at the secondary level, Tanzania is the more dynamic country with 4.3 % annual GDP growth and even faster growth of industry value added and exports. Also labour productivity measured by average annual growth of real GDP per worker (1980-90) was with 2.3 % acceptable, whereas Kenya had a negative rate.

Table 1: Some basic economic and social indicators for Tanzania and Kenya

	Tanzania	Kenya
Population (million)	32.9	29.4
Population growth (annual %)	2.4	2.3
GDP per capita, PPP (US\$)	480	1,001
GDP growth (annual %)	4.3	1.6
Gross domestic fixed investment (% of GDP)	17.86	15.0
Gross domestic fixed investment (annual % growth)	9.35	..
Industry, value added (% of GDP)	14.34	16.8
Industry, value added (annual % growth)	7.60	1.4
Exports of goods and services (% of GDP)	19.8	24.7
Exports of goods and services (annual % growth)	7.3	4.5
Export concentration index (1992)	0.248	0.305
Av. annual growth of real GDP per worker (% 1980-90)	2.3	-1.4
Primary school enrolment (% net, 1997)	48.4	65.0
Secondary school enrolment (% net, 1997) ^a	5	61.1
Tertiary school enrolment (% net, 1995)	1	..

Notes: Data are for 1999 if not otherwise stated.

a - for Tanzania 1995 figures

Sources: World Bank 2001 a and b.

The three sectors we have chosen for our empirical analysis are of different importance for the two countries. Tourism is an important sector for both. The relative importance is highest for Tanzania with 32 % of export revenues and Tanzania is much more successful in dynamic terms. In Kenya food products account for the highest share in manufacturing value added with

32 % in 1995. In Tanzania textiles is the largest manufacturing sector with 19 % of value added. Value added per worker was only 767 US\$ in Tanzania compared to 4025 in Kenya. Employment in the manufacturing sector was lower in Tanzania than in Kenya despite the bigger population (see Table 2).

Table 2: The manufacturing sector in Tanzania and Kenya, 1995

	Tanzania	Kenya
Total value added (Mio. US\$)	119	814
<i>Of which:</i>		
<i>Food products (%)</i>	<i>11</i>	<i>32</i>
<i>Textiles and wearing apparels (%)</i>	<i>19</i>	<i>7</i>
Employment (ths.)	157	199
Value added per worker	767	4,025
Average wage (including supplements)	238	1,251

Source: UN, 1997.

Tanzania's economic landscape conspicuously reflects the dominance of SMEs. Particularly, in terms of enterprise structure and dynamics¹, reminiscent to the overwhelming majority of developing economies, the SME sector is the vanguard of the country's private sector. SMEs provide employment to more than 50 % of all employed labour force in the survey countries. In Kenya 49 % of employment in 1969 was in enterprises with one to nine workers and an additional 10 % in enterprises with 10 to 49 workers. For Tanzania the respective figures were 56 % and 7 % (Liedholm and Mead 1987). The SMEs are also accountable for more than 50 % of manufacturing gross domestic product.

The same investigation also confirms the often made assumption that SMEs with less than 50 employees are an important source of employment growth as for example in Kenya employment growth for enterprises with 10-49 employees 41 %, for 50 –99 employees 24 % and for more than 100 employees only 12.5 %. However the share of total job creation for small enterprises (10-49) is only 23.0 % compared to 15,2 % for middle size enterprises (50-99) and 55.5 % for large enterprises (100+). As determinants of firm growth similar variables as in developed countries are found to be important, namely initial firm size, firm age, human capital, sector and in some cases form of ownership and ethnicity.

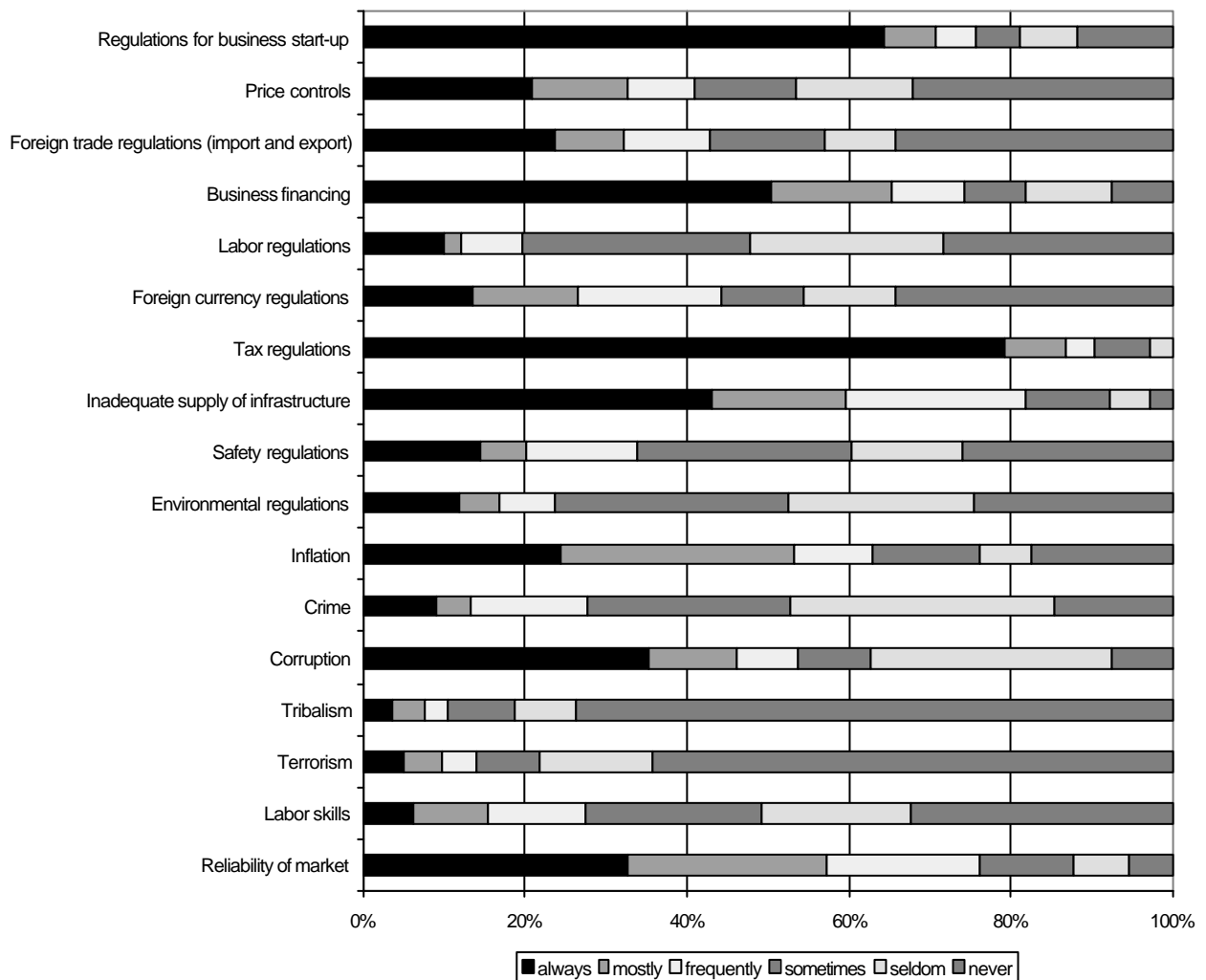
The dominance of SMEs in developing economies is due to different effects. One is the fact that the bad state of the infrastructure leads to relatively isolated markets with limited demand that can best be served by small-scale localised production. Therefore the majority of the

¹ In dynamic terms, the influence of SMEs is underscored by several facts as well. First, they utilise local resources and exert little pressure on limited foreign currency reserves. Second, they provide flexible and skilled production base. Third, they facilitate the opening up of new markets. Finally, they are particularly crucial for the economic dynamics of rural areas (Mead and Liedholm 1998).

small-scale producers are located in rural areas, absorbing workers when seasonal effects reduce agricultural employment. As demand for manufactures is concentrated in simple items these products can efficiently be produced using cottage technologies (Liedholm and Mead 1987, Tybout 2000).

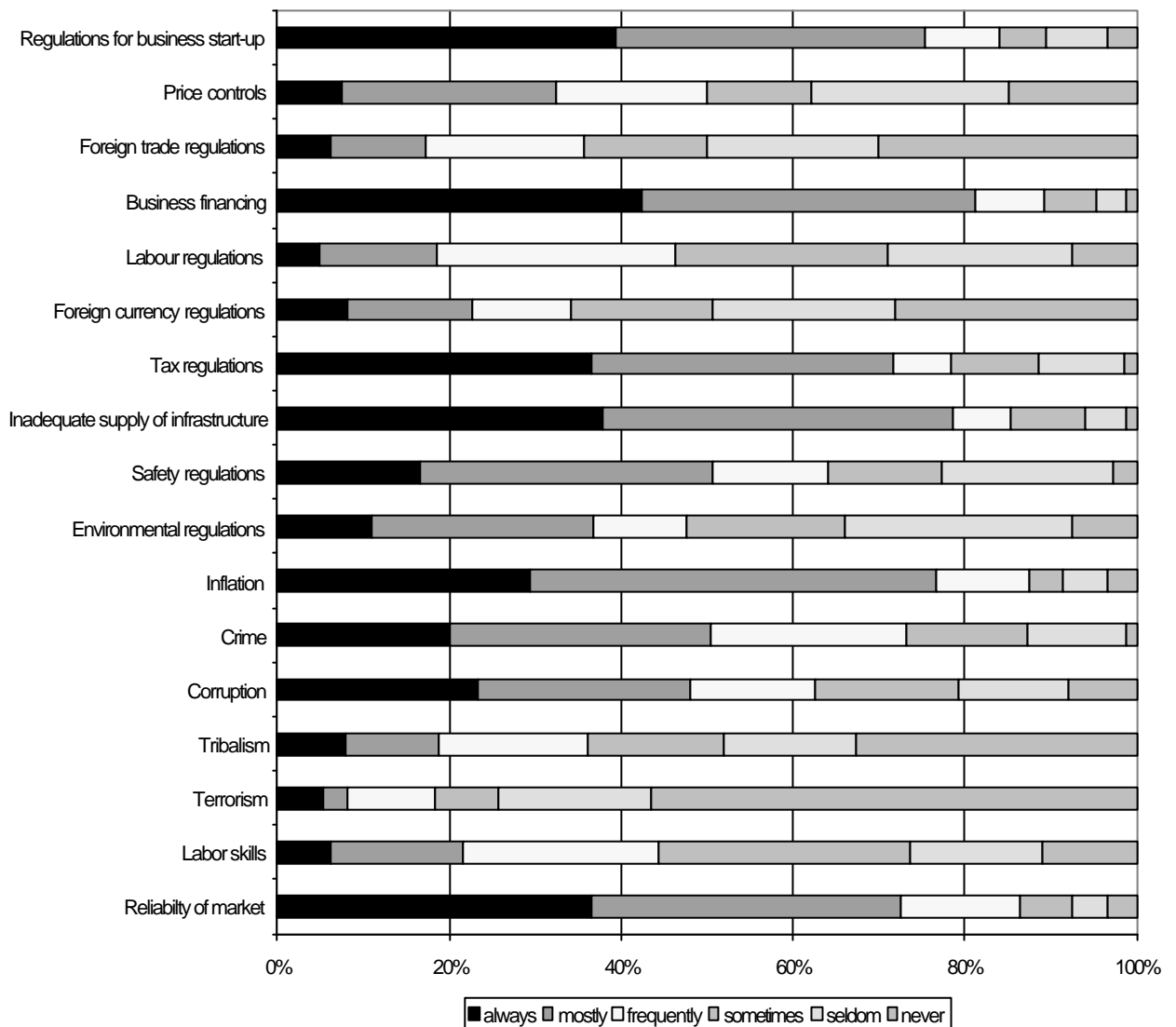
However, there are also a number of distinctive features of the business environment as compared with developed countries that might hurt SMEs most. Among these the limited access to manufactured inputs (especially high quality imported goods), low quality of the infrastructure, poor legal systems and crime prevention and high volatility of macroeconomic conditions and prices are often mentioned. Low levels of human capital, especially low secondary education and scarcity of technicians limit the range of goods that can be produced and negatively affect the ability to absorb new technologies (Tybout 2000).

Figure 1: The ranking of obstacles for doing business by Tanzanian SMEs



Source: East Africa SME Survey.

Figure 2: The ranking of obstacles for doing business by Kenyan SMEs



Source: East Africa SME Survey.

Figures 1 and 2, which present a summary of responses of Tanzanian and Kenyan SMEs to the question on the major obstacles in doing business, captures part of the pertinent obstacles to productivity and profitability.² Thus, of the 17 obstacles, 7 (9) were frequently highly ranked. For both countries these include, unfavourable tax regulations, regulations for business start-up, business financing, corruption, reliability of the product markets, and inflation. For Kenyan SMEs also safety regulations and crime are mentioned by at least 50 % of the sample enterprises to affect operation always, mostly or frequently. By Tanzanian enterprises tax regulations (“always”: 79.3 %) are mentioned most often, followed by regulations for business start-up (64.4 %), business financing (50.3 %), inadequate supply of infrastructure (43.1 %), corruption

(35.2 %) and the reliability of the market (32.7 %). On the other hand, (presumably as an expression of internal political stability), such factors as terrorism, tribalism, and crime, do not constitute key obstacles for doing business in Tanzania. For Kenyan enterprises business financing (42.3 %), regulations for business start up (39.3 %), inadequate supply of infrastructure (38 %), reliability of markets (36.6 %) and tax regulations (36.5 %) are the major obstacles. Thus overall the picture in the two countries is not very different but in Kenya the perception seems to be more pessimistic. In general these perceptions are in line with findings from other developing countries. The low ranking of lacking labour skills might be due to the fact that the level of education is relatively high in the sample enterprises in both countries. In the area of inadequate supply of infrastructure we are particularly interested in ICT infrastructure as the aim of this paper is to establish a link between ICT and SME performance.

² The enterprises were requested to respond to the following question: *please indicate on a six point scale which in your opinion pose obstacles in doing business*. The allowed answers were, “always”, “mostly”, “frequently”, “sometimes”, “seldom” and “never”.

3 The role for ICT on firm performance in East Africa

The access to ICT in East Africa

The portrayed nation-wide diffusion of ICTs is rather low by international standards in East Africa, as is underscored by a comparison with the average for Sub-Saharan Africa (SSA). For instance, in Tanzania the intensity of telephone main lines and mobile phones is around 1/3 of the comparable intensity for SSA and in Kenya the situation is only better for fixed line telephones but even worse for mobile phones. Actually the waiting time for a fixed phone in Kenya are by far the longest in East Africa and have even increased from 5.6 years in 1997 to 9.6 years in 1999. The increase in mobile phones was rather rapid in Tanzania where it increased from 0.1 phones per 1000 people in 1995 to 1.6 in 1999. With respect to radios that are traditionally an important means of information dissemination Tanzania is relatively well endowed compared to Kenya and the average of SSA (see Table 3).

Table 3: Diffusion and costs of selected ICTs in East Africa, 1997/99

Indicators	Tanzania	Kenya	SS Africa
Telephone main lines (per 1000 people) '99	4.5	10.3	13.6 ^a
Waiting list (thousands) '99	29	121	1,158,230 ^a
Waiting time (years) '99	1.6	9.6	6.0
Average cost of a 3 minute local call (US \$) '99	0.1	0.1	0.1
Average cost of a 3 minute call to the US (US \$) '97	3.7	11.2 ^b	n.a.
Mobile phones (per 1000 people) '99	1.6	0.8	5.2 ^a
Fax machines (per 1000 people) '97	0.1	0.1	n.a.
Personal computers (per 1000 people) '99	2.4	4.2	8.4
Internet hosts (total number '99)	158	560	n.a.
Internet hosts (per 10 000 people) '99	0.04	0.2	2.3
Radios (per 1000 people) '97	279.3	104.1	201.5
TV Sets (per 1000 people) '98	20.9	22.1	43.2

Notes: ^a Data only available for 1998. ^b Data only available for 1996.
Sources: World Bank 2001 a, and African Internet Connectivity web page.

The teledensity in both countries is characterised by a strong country-urban bias. In Kenya the teledensity in the largest city lies at 7.11 and 0.47 in the rest of the country. For Tanzania the value is at 3.07 in the largest city and 0.26 in the rest of the country. Telephone tariffs in business are relatively low in comparison to the European average tariff of 151 US\$ in 1999 for connection and average costs of 10.1 US\$ for monthly subscription. In Kenya the costs for connection amount to 30 US\$ and to 3.6 US\$ for monthly subscription. In Tanzania one has to pay a little more, that is 48 US\$ for connection and 4.1 US\$ for subscription. The dispersion of the average rates of people using a cellular mobile phone is relatively high in the study countries compared to world averages probably due to the fact, that the fixed telephone infrastructure is not very well developed, so a cellular phone may be more reliable than conventional fixed phones. In Kenya the rate of cellular subscribers relative to all telephone subscribers is 7.2 % and 25.4 % in Tanzania (ITU 2001).

In East Africa privatisation of the ICT infrastructure is still limited. In Kenya competition is established in mobile phones and Internet but for fixed lines services the state owned operator Telkom Kenya has still a monopoly. There is the intention to sell 49 % to a private investor. In 1999 an independent regulator was established. In Tanzania the situation is very similar with a state monopoly of the Tanzania Telecommunications Company as the sole provider of basic fixed services in the mainland and some competition in mobile phones and Internet access. In 1994 an independent regulator was established (AISI 2000). However the state monopoly for the fixed-lines services is not only affecting telephone users for voice mail but also undermining the development of internet. Despite that fact Tanzania has experienced a rapid growth in cybercafes that are also used by business people. Prices for a monthly subscription have come down to 37.50 US\$ in the beginning of 2001 (AITEC 2001, balancing act 2001).

In a survey of the African internet status Jensen (2000) reports that the average usage of Internet amounts one incoming and one outgoing e-mail per day. Communications are mostly done with people outside the continent. Most users are NGOs, universities or private companies and users are mainly male and well educated. E-mail is used for correspondence, document exchange, technical advice, managing projects, arranging meetings, and exchanging research ideas, but it is still limited for accessing formal information resources. 25 % of e-mail is replacing faxes, 10 % e-mails replacing phone calls and 65 % of the e-mails standing for communication that would not have been made without an e-mail-system. Users report that internet has increased efficiency and reduced information costs, although it is a still under-utilised resource.

Figure 3: Diffusion of ICT in Kenyan SMEs, % of firms using different ICTs

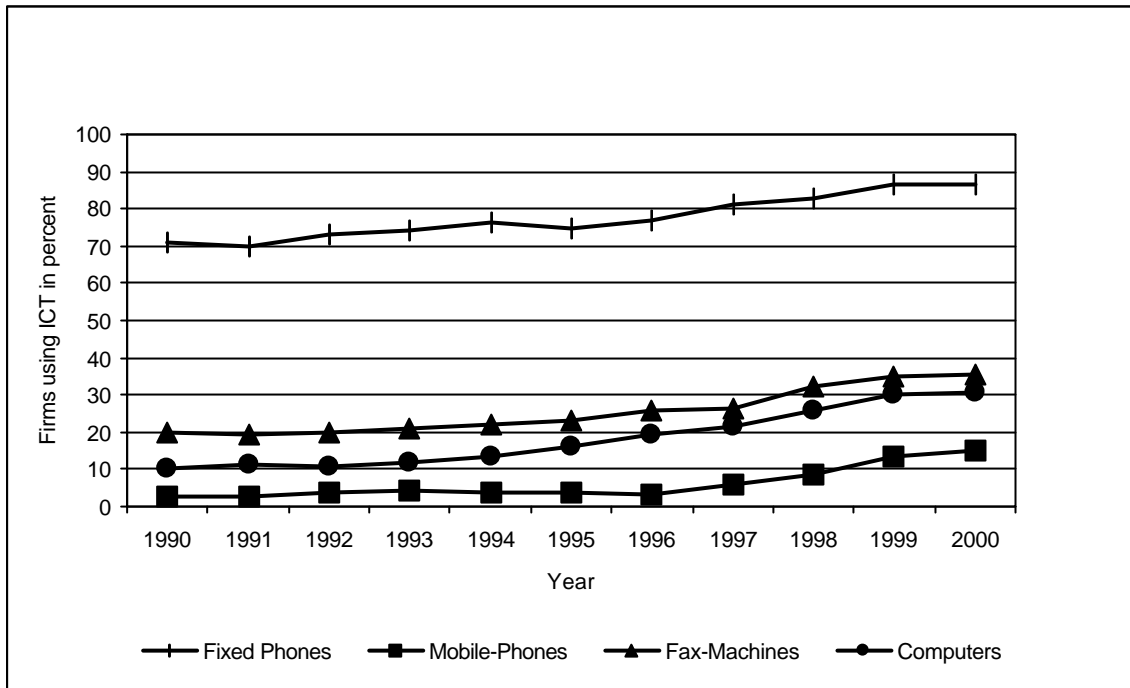
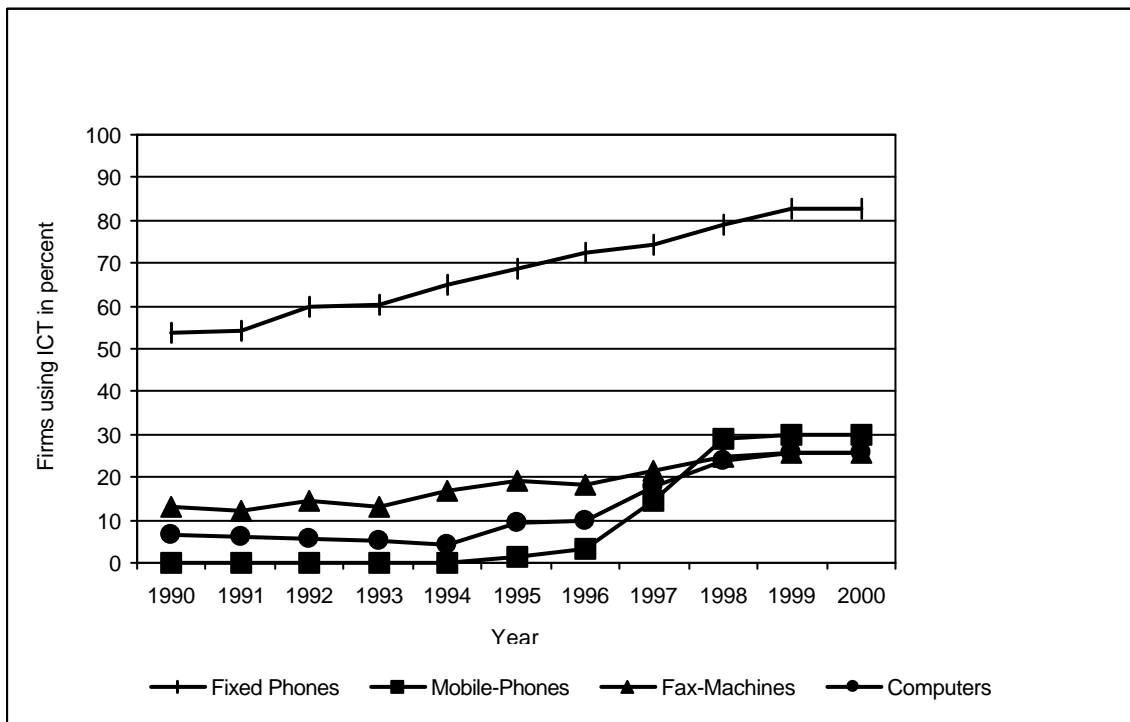


Figure 4: Diffusion of ICT in Tanzanian SMEs, % of firms using different ICTs



Our sample shows that the use of ICT by SMEs in Kenya as well as in Tanzania is increasing over time.³ The usage of fixed phone lines nearly reaches the saturation point but is still lower in Tanzania than in Kenya which is in line with overall teledensity. The percentage of firms that uses mobile phones is increasing much faster in both countries. Especially in Tanzania, despite its late start only in 1994 it has already outgrown the usage of fax machines. This picture is in line with the expectations that within the next three to five years the number of mobile phones will be higher than the number of fixed lines in many African countries. The higher percentage of mobile phone use in Tanzania, that is observed in overall country figures (see Table 3) as well as in our sample, could be due to the very low quality and still long waiting lists of fixed line services. This is an example how the use of advanced ICT can help to leapfrog some stages of technology adoption. As computers are still a relatively expensive investment for most SMEs their use, which is slightly higher in Kenya than in Tanzania, increases only slowly but steadily.

The impact of ICT on economic performance

The question remains now through what channels this improved access to ICT in Kenya and Tanzania will impact on enterprise performance for users and hence economy wide growth. Since the 1960s and 1970s, standard neo-classical theory based on the traditional assumptions of costless exchange at market clearing prices has given way to more refined analytical work that investigates, among other phenomena, the causes and consequences of transaction costs, uncertainty, incomplete markets and incomplete information. These developments have provided another perspective, i.e., the information-theoretic approach to understanding development. Information asymmetries are one of the major causes for high transaction costs, uncertainty and therefore market failure. A reduction of the information gap also reduces the ability of the better informed to extract rents from the less informed be it buyers or sellers of goods or factors. As the poor population and small firms usually have less access to information this effect might help to reduce disadvantages and inequality. A reduction of information asymmetry will also create new opportunities and therefore enhance the efficiency of resource allocation (Akerlof 1970). On a macro level this will then lead to faster growth and diversification of the economy.

One of the central tenets of the information-theoretic approach and a feature noted by early observers is that acquiring information is costly, especially within the context of developing countries. These difficulties associated with information acquisition have numerous implications: The high costs of acquiring information may lead to behaviour that differs markedly from what it would have been if more information had been available. The lack of information may reduce the extent of mutually beneficial exchanges and lead to economy-wide Pareto inefficiencies. Furthermore, due to information constraints, there will be considerable uncertainty surrounding economic and administrative decisions in developing countries. This will have implications for the efficiency, productivity, and welfare of the various agents in the

³ Müller Falcke (2001) observes a similar pattern in India.

economy, and the appropriate antidote in many cases is to engage in informational activities. In this context, the key role of ICT is that they may be used to acquire and process information and reduce uncertainty. A question in this respect is what kind of information is provided or distributed. Additional costs emerge when search costs increase because of information overflow and the reliability of information has to be checked. There is also the fear that dependence on the suppliers of information and equipment will increase.

ICTs can serve as information channels because they are able to support the decoupling of information from its physical repository, which can be argued to be the truly revolutionary aspect of these technologies (Evans and Wurster 1997, Pohjola 1998). This property allows the immediate transmission of large volumes of information and permits communication independent of the physical movement of individuals. The decoupling effect allows users access to a body of information and ideas which are non-rival in use and potentially generate large content-related externalities, that will improve the innovation capacity and diffusion. The use of ICT networks is also non-rival in nature, and an increase in network size generates network externalities. Therefore the analysis at the enterprise level will underestimate the effects of ICTs.

ICT and SME competitiveness

Flexibility is considered to be a major source of competitiveness for SMEs compared to larger enterprises. The use of ICT could now on the one hand increase the competitiveness of SMEs as they enable the creation of more flexible links with trading partners because of faster and more reliable communication channels. On the other hand ICTs could help bigger enterprises to increase their flexibility through a restructuring of the organisation which will enable them to adapt quicker to changing conditions.⁴ Therefore the competitive advantage of SMEs could also decline.

In general SMEs rely much more on informal information systems than larger enterprises. To get the relevant information that is needed for a rational decision is not costless especially as in SMEs usually there is only one decision maker – the owner/manager – who's personal resources (time, knowledge, capabilities) are restricted. However SMEs have the advantage of smaller internal coordination costs, as all decisions are made by one or few people (Blili and Raymond 1993).

External transaction costs are associated with the initiation, negotiation and enforcement of contracts. Especially the internet helps to screen the enterprises' environment for relevant information and thereby get information about sellers and customers that were previously out of reach (Müller-Falcke 2001). However for the actual delivery of goods and the transmission of payments also other infrastructure like transport and a reliable banking system has to be in place.

⁴ See Brynjolfsson and Hitt (2000a) for a discussion of the interrelationship between information technology and organisation.

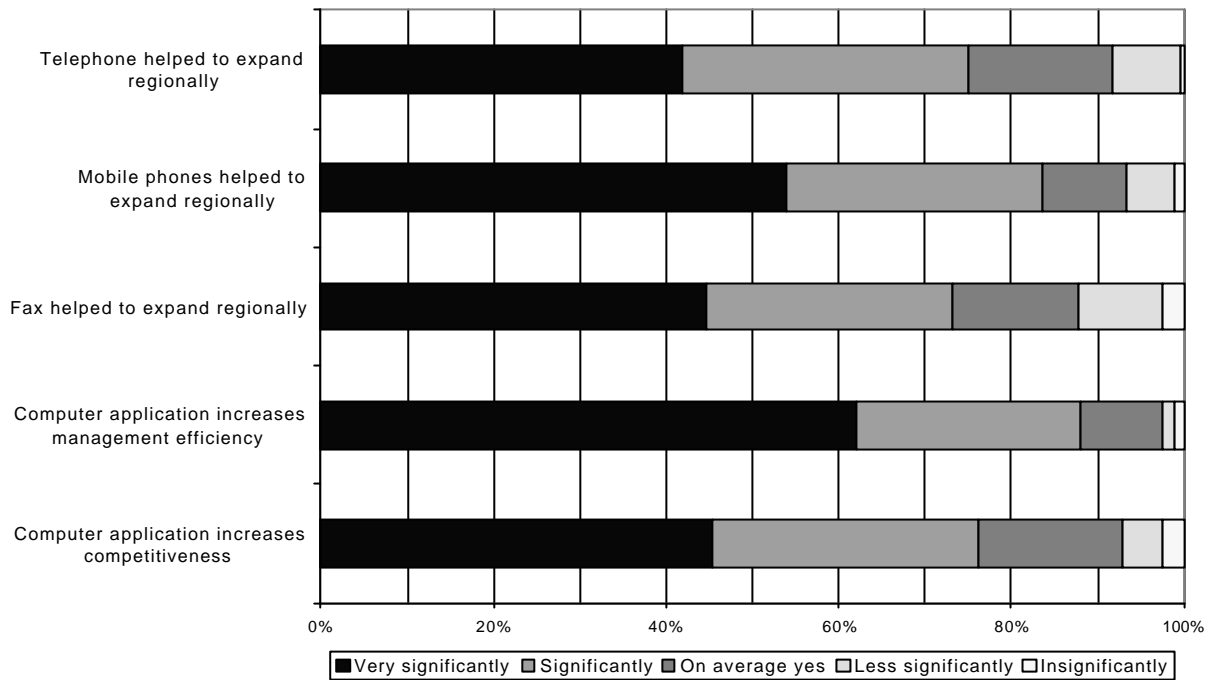
With the use of ICTs transaction costs could be lowered and therefore the economies of scale in exporting can be reduced. This will enable SMEs not only to stick to local markets but to expand regionally and internationally. On the other hand many SMEs that are located in rural areas, serve the local niche market and are protected against competition from bigger enterprises because of high transport and communication costs. Therefore ICTs might also increase competition for these enterprises, so they either have to become more productive or to close down.

There are hardly any studies that analyse the effect of ICTs on small enterprises in developing countries, partly due to data problems. Müller-Falcke (2001) finds for Indian manufacturing SMEs that enterprises that use more advanced forms of ICTs have on average a higher labour productivity and a higher growth rate. In a survey of 59 electric and electronic manufacturing Indian SMEs mainly employing less than 50 people, Lal (1996) observed higher profit margins, skill intensity and export and import intensities for firms using IT. There is also some evidence that export performance of SMEs is related to ICT adoption (Lal 1999, Nassimbeni 2001). However it is not the investment in the technology alone but the combination with other technologies and especially relevant skills that make ICT work.

A more qualitative study by Duncombe and Heeks (2001) stresses the different information and ICT needs for different types of SMEs. They conclude that smaller SMEs with little working capital (which they characterise as survivalists and trundlers) rely mainly on informal information from known sources where personal relations and trust plays a major role. For these enterprises ICTs are of minor relevance and only telephone can help to increase access to this kind of information. As phones can help to extend social and business networks and in some cases substitute for journeys and business intermediaries access to telephone services should be given priority.

However, for bigger SMEs that are growth oriented, belong to the formal sector, are export oriented etc. information becomes more important and therefore more advanced ICTs can be helpful for building business linkages. The survey SMEs in Botswana revealed the biggest information gap in market information pertaining to new customers and the need to expand into export markets. Information is also lacking about external finance and sources of skills and training. This lack of information was found to raise costs and reduce income. "ICTs can reduce time and money costs of business processes and can improve the certainty and quality of those processes." These benefits occur mainly in enterprises with bigger size (with annual turnover of a few tens of thousands of US\$) and in specific sectors of operation such as manufacturing exporters and the tourist industry, where the Internet can be used as a marketing tool. However for 90 % of the survey enterprises lack of finance and skills are the main constraints and they cannot afford to buy a computer or make efficient use of it in the short or even medium term (Duncombe and Heeks 2001).

Figure 5: Perceived effects of ICT



Source: Own calculations, East Africa SME survey.

From the survey we conducted in Tanzania and Kenya⁵ it can be seen that those enterprises that use different forms of ICT rate their effects mostly positive (see Figure 5). On top are computer applications that are assumed by 88 % and 76 % of users to considerably increase management efficiency and competitiveness respectively. Mobile phones are considered to contribute significantly to regional market expansion by most enterprises, followed by fixed phones and faxes.⁶

⁵ A more detailed background information on the survey will be given in the empirical section.

⁶ These figures only refer to enterprises that use the different technologies so they might be biased.

4 Methodology and theoretical framework

Generally, from the performance perspective, the competitiveness effect of ICTs derives from the impact that ICTs have upon the efficiency and productivity of the factor inputs. In this regard, ICTs can improve efficiency and increase productivity by different ways including, (i) improving efficiency in resource allocation, (ii) reducing the transaction costs, and (iii) technical improvement, leading to the outward shift of the production function.

In interpreting productivity in the context of this study, the conception of inputs goes beyond the traditional dimensions, where inputs are typically restricted to labour, physical capital and materials consumed. Inputs can be understood to include human capital such as worker training and education, organisational capital (e.g., supplier relationships, investments in new business processes, etc.), etc. (Brynjolfsson and Hitt 2000b). Productivity, as a proxy for competitiveness builds on the universal notion that sustainable success of an enterprise is a function of its ability to deliver (in absolute terms or relative to its competitors) more real value for its customers, without using more factor inputs (also, in absolute terms or relative to its competitors).

Though a necessary condition, high productivity is far from being a sufficient condition for competitiveness. Alongside efficiency in the use of economic resources, competitiveness depends on a host of other considerations related to the production and availing of the right product to the customer. These include among other things, product quality, flexibility in dealing with market differentiation and volatility, and responsiveness in terms of capabilities for innovation and absorption of new technologies as well as adapting to changing customer needs (Meyer-Stahmer 1995).

Recent literature presents various models for explaining why different enterprises use different technologies, how technology spreads, and what is the likely pattern of competitiveness. The relevant theories for our study are the vintage capital models and the technology models of plant dynamics.

A variation of the vintage models is based on the *sunk cost theorem*, and focuses on decisions to adapt technologies, as well as the productivity effect of technologies of different vintages. It builds on the assumption of what is technically referred to as *enterprise-embodied technical change*. Arguably, as existing enterprises face fixed costs, they are likely to face higher opportunity costs, if they immediately adapt the newest technologies. Hence, it might not be profitable for them to invest in new technologies immediately. However, a technology of older vintage might be less productive than a technology of recent vintage. Therefore, the sunk cost

theorem highlights the explicit advantages of new enterprises, with respect to investments in new technologies (Campbell 1993, Power 1998).

Another major stripe of technology adoption theory refers to the *technology models of plant dynamics*. The models categorised in this class build on the differences in dynamics associated with technology adoption decision of enterprises. In the one-agent learning model by Jovanovic and Nyarko (1994), for instance, it is postulated that, productivity increases as an enterprise learns about the new technology. Accordingly, immediate adoption of new technologies can be costly to enterprises, due to both the implicit loss of technology-specific human capital (which might have to be retrained, re-allocated, or retrenched altogether) and the less efficient use of technology during the learning phase. This underscores the prospects of factor substitution being associated with costs to the enterprise.

The increased use of ICT in enterprises, that can be observed in our sample (see Figures 3 and 4), leads to a substitution of ICT equipment for other forms of capital and labour and may generate substantial returns for enterprises that invest in ICT and restructure their organisation. However this does not necessarily imply that total factor productivity in the whole economy will increase. In fact in the industrial countries the growth of total factor productivity (TFP) that is associated with technical change has even declined in parallel to the increased use of ICT in the past 10 to 20 years (Jorgenson and Stiroh 1999).

In their studies of the effect of information technology on productivity, Brynjolfsson and Hitt (1995) observed that alongside firm effects, IT contributes positively and significantly to productivity. These results were consolidated even further in the more recent study (Brynjolfsson and Hitt 2000b), which again underscores the importance of IT for productivity growth. However, the mechanisms and direction of causality is not clearly established as firms with good performance are likely to spend their windfall on ICT equipment maybe also for prestige reasons.

To capture the effects of ICT use and other factors on productivity we construct a simple model. Following common practice we assume that the production function can be approximated by a Cobb-Douglas production function (see Brynjolfsson and Hitt 2000b, Söderling 2000, Söderbom and Teal 2001).⁷ Then gross production output Y can be expressed as the following function of capital, labour L and other production inputs I . As we are interested in the impact of investment in ICT on productivity we divide capital into ICT and other capital K to be able to measure the impact of ICT directly.

$$Y = A * K^{\alpha} * ICT^{\beta} * L^{\gamma} * I^{\delta} \quad (1)$$

⁷ The Cobb-Douglas functional form has the advantage that it is the simplest form that enables calculation of the relevant quantities of interest without introduce so many terms that the estimates are imprecise.

Taking log gives:

$$\ln Y = \ln A + \alpha \ln K + \beta \ln ICT + \gamma \ln L + \delta \ln I \quad (2)$$

The term A can be interpreted as total factor productivity as it captures differences in output across firms that are not accounted for by capital, labour or material inputs. It is assumed that total factor productivity is affected by other variables such as skill intensity of labour (sil), export orientation (exp) and also the use of ICT equipment (ICT_{use}) as well as sector and country dummies through a simple log linear function:⁸

$$\ln A = \lambda \text{sil} + \eta \text{exp} + \phi \text{ICT}_{use} \quad (3)$$

Substitution then gives:

$$\ln Y = \alpha \ln K + \beta \ln ICT + \gamma \ln L + \delta \ln I + \lambda \text{sil} + \eta \text{exp} + \phi \text{ICT}_{use} \quad (4)$$

By estimating this equation the determinants of TFP can be determined. Economies of scale can be directly identified from the coefficients of the production inputs.

⁸ Söderbom and Teal (2001) argue that this specification of the skills effect is preferred because of experimental results to a logarithmic form as in the usual specification where skills are treated as a form of human capital and therefore modelled in analogy to physical capital. Brynjolffson and Hitt (2000a) give an overview of studies that have used the use of technologies as well in empirical investigations.

5 The data

The data used in this study was collected from 150 SMEs in Tanzania and Kenya each, distributed equally in the food processing, textile and tourist sectors.⁹ The data collection exercise began in November 1999 and was completed in May 2000. The sample enterprises were randomly selected from major commercial corridors in the countries. The two key considerations in the determination of the sample regions were their economic significance, and their ability to proxy fairly for the SME sector. The selected commercial corridors are the Lake Zone, the Coastal Zone, and the Arusha Region in Tanzania and the Coastal Zone and Lake Zone in Kenya, thus including rural and urban enterprises.¹⁰

In Tanzania of the 144 enterprises which had consistently plausible data, 28 did not possess information and communication technologies at all. 13 of them however used external phone services. The remaining had invested at various levels in at least one of the ICTs. A number of 39 enterprises only use phones with fixed lines and an additional number of 26 enterprises has mobile phones on top. 5 enterprises have fax machines in addition but no PC-based communication technologies. Less than a third (45 enterprises) uses the most advanced ICTs email and Internet.

For Kenya the picture is a bit different as one would expect because of the better overall infrastructure and higher level of development. However, 37 enterprises out of 151 do not possess ICT at all with 18 of them using external phone services. The majority of phone users only uses phones with fixed lines for communication but a higher number than for Tanzania uses fax and computers (see Table A1).

In Tanzania 56.5 % of all sample enterprises invest not more than US \$ 200 in ICT facilities like phones, computers, etc. This puts a high number of enterprises below the critical mass in terms of investments in ICTs. One should bear in mind that given the low level of investment capital already the purchasing of one mobile phone can lead to relatively high shares of ICT investment. This is one explanation why Tanzanian enterprises invest on average a higher percentage in ICT. The limited resources of the enterprises and the high costs of procuring and using ICTs seem to be the major factors that hinder the diffusion of ICTs. This explanation was given by 91 % of the enterprises which do not use computer-dependent ICTs. Non-possession of computers is attributed to the high costs of hard- and software (80 %) and high labour costs of computer-skilled employees (62 %). Besides, close to 72 % of the sample enterprises did not

⁹ Thus the weight of sectors in our sample is not proportional to their relevance for the Tanzanian and Kenyan economy. This fact should be born in mind in the interpretation of the regression results.

¹⁰ As the quality of the answers in our questionnaire varies the number of observations is not the same for all areas. Especially with respect to financial data the number of observations was reduced because of missing values and implausible answers.

even see the use of computer-dependent ICTs. This could manifest limited business skills, or a product market situation where such lower order sources of competitiveness, as cheap labour, are still dominant (Matambalya 2000). It is noteworthy that enterprises that don't use ICT or only telephone have a workforce with less years of schooling in both countries. They are generally less export oriented and also more labour intensive than the enterprises that use more advanced forms of communication. This is compatible with the observations of other empirical studies on the effects of ICTs reported in part 3.

Partly these differences can be explained by sector characteristics (see Table 4). For example average years of schooling are highest in the tourism sector in both countries and this corresponds with the use of more advanced ICTs and a higher export orientation. The biggest enterprises are in the food processing sector, whereas the tourism enterprises are on average older. This is due to a different production structure that requires a bigger minimum capacity to become productive in the food processing industry.

Table 4: Enterprise characteristics by country and sector (averages)

	<i>Tanzania</i>			<i>Kenya</i>		
	<i>Food</i>	<i>Textile</i>	<i>Tourism</i>	<i>Food</i>	<i>Textile</i>	<i>Tourism</i>
number of employees	14.1	9.1	12.0	24.3	8.7	18.7
average years of schooling of workforce	9.1	9.6	11.5	11.0	10.6	12.0
age of enterprise	6.2	7.8	8.2	10.0	10.7	11.3
ICT Investment per employee (US\$)	53.1	43.9	401.7	49.7	431.4	432.8
% of exporting firms	20.7	25.5	89.7	24.5	17.3	74.0
% of firms in capital	41.4	51.1	38.5	63.3	59.6	80.0

Source: Own calculations from East Africa SME survey.

For the interpretation of the results of our study, skills are also relevant. For instance, education improves human resources, and the skills won through it are likely to impact on the ability of the enterprises to adopt advanced technologies including ICTs. Notably, schooling has allocative effects as it increases the ability to deal with disequilibria, e.g. changing factor and product prices (Weir 1999, Shultz 1975). Also, cognitive skills enhance the ability of entrepreneurs to access and use productivity-enhancing knowledge, and to adopt more positive attitudes towards modernisation and risk-taking (Weir 1999).

6 Results

The estimation of the modified production function (4) enables us to examine the determinants of TFP. The results of the regression analysis are displayed in Table 5. The results were obtained after excluding three outliers. Besides the regressions by country also a regression on the pooled dataset was run to make use of the larger number of observations, as the number of observations for the Kenyan dataset was rather low. For this bigger dataset two different specifications of the regression equation were used. As productivity usually varies across sectors we have included sector dummies in the regression. The correlation coefficients between the independent variables are relatively low in most cases (see Table A2). However, for non-ICT capital and material input the coefficient is 0.703 (at 1% significant) and for non-ICT capital and ICT capital it is 0.652 which means that the proportion of capital invested in ICT does not vary that much. Because of the underlying production function all parameters are kept in the equation. The use of fax machines which was the only ICT equipment that gave meaningful results in the regressions is significantly correlated with ICT investment but with a lower coefficient of 0.531. Auxiliary regressions among the independent variables have not too high R^2 so multi-collinearity seems to be not very problematic.

The coefficients for labour, capital (ICT plus other) and other production inputs which can be directly interpreted as elasticities of output are slightly lower than one for all regressions which implies that the assumption of a Cobb Douglas production function is plausible and no economies of scale exist.¹¹ For Kenya the coefficient for capital is slightly negative but highly insignificant. This could on the one hand be due to data problems as depreciation of capital was not properly recorded by most SMEs. It could also hint towards inefficient allocation of resources due to the adverse and deteriorating economic situation in the country.

The investment in ICT has a negative sign in all the regressions but is never significant. This observation can be explained by the relatively long time span needed to make full use of ICTs as training of employees is needed and restructuring of the enterprise. As computer literate personnel is relatively scarce in both countries and enterprises have to train employees first it is not surprising that productivity goes down first after investment in more expensive ICT devices was made.¹² In addition ICT devices are more expensive in East Africa as in developed countries which reduces their returns. However, the use of fax machines that gives managers access to formal information has a significant positive relationship with productivity in both countries. Because of multicollinearity not all types of ICT could be included at the same time in the regression. We only report fax use as only there a positive relationship with productivity could

¹¹ This finding confirms the enterprise studies on Ghana by Söderbom and Teal (2001) where also no scale economies were found.

¹² Therefore these findings are compatible with the technology models of plant dynamics described in part 4.

be found. This might be due to the fact that fax machines are mainly used for business purposes and not so much for private communication compared to mobile phones. They also serve less as a status symbol.

Table 5: Estimation of a production function

Dependent variable: ln (output)

Variable	Kenya		Tanzania		Pooled sample Version I		Pooled sample Version II	
	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
constant	0.709	[1.282]	4.435	[5.124]**	4.493	[6.266]**	3.812	[5.583]**
ln I	0.379	[3.017]**	0.500	[7.105]**	0.492	[7.697]**	0.508	[7.769]**
ln K	-0.022	[-0.179]	0.069	[1.067]	0.068	[1.157]	0.118	[2.097]*
ln ICT	-0.099	[-0.961]	-0.061	[-1.370]	-0.059	[-1.505]	-0.042	[-1.082]
ln L	0.653	[2.533]*	0.287	[1.391]	0.317	[1.792] ⁺	0.258	[1.428]
sil	0.044	[1.121]	0.041	[0.626]	0.034	[0.688]	0.057	[1.140]
exp							0.007	[1.999]*
fax	0.435	[2.342]*	0.452	[2.459]*	0.427	[2.745]**		
textile s	0.150	[0.699]	-0.136	[-0.609]	-0.089	[-0.462]	-0.144	[-0.725]
tourism	0.224	[0.847]	0.097	[0.324]	0.124	[0.497]	0.040	[0.139]
Kenya					-3.464	[-5.767]**	-3.003	[-5.062]**
No. observations	23		137		160		157	
Adjusted R ²	0.816		0.506		0.874		0.866	

Notes: Significance at the 1%, 5 % and 10 % level is indicated by **, * and ⁺ respectively. For a list of variables see Table A2.

Source: Authors' own calculations.

For the pooled regressions the country dummy had a negative significant coefficient which means that Kenyan enterprises are less productive than Tanzanian ones. This is counterintuitive to the more advanced level of development of the country but could be due to the fact that given the same combination of production factors and inputs the less dynamic situation and the adverse political environment described in part 2 (see Figure 2) have a negative impact on productivity. In a second version of the pooled regression we introduced a market extension index (covering regional as well as export markets) instead of fax use. This index also has a significant impact on productivity which is in line with other findings that conclude that higher competition in foreign markets forces enterprises to increase productivity. We did not

include fax use and market expansion at the same time as fax use is considered to be a determinant of exports as well.

The results of the regressions are fairly robust with respect to the variables included. However a number of variables that were expected to impact on productivity were not significant for neither Kenya nor Tanzania. Among these were age of the enterprise (not shown here) and skill intensity of the labour force (measured by average years of schooling). With respect to age there can be several reasons why this variable that usually has a relatively big impact on productivity as it is connected with more experience of the entrepreneur and therefore proxies human capital is not significant in our case (Biggs and Srivastava 1996, Söderbom and Teal 2000). As the use of ICT is associated with more human capital already the effects of age and skills could be captured by the ICT variables. On the other hand in accordance with the vintage capital theory older enterprises tend to use older technologies and therefore the two effects could compensate each other.

As can be seen from Table A1 the relation between the use of different ICTs and important performance factors are rather similar in the different sectors. This observation together with the high flexibility of the estimated production function might explain the fact that the sector dummies are not significant in the regression. For all sectors in both countries the average size of enterprises is generally bigger for users of more advanced ICTs. The average years of schooling also increase with the use of advanced ICTs with only small differences between sectors. Also with respect to exporting the relation with ICT is positive and similar for all sectors.¹³ This comparison confirms the evidence that the role of ICT is not sector specific but can be generalised for the whole economy. This is due to the nature of ICT as it reduces transaction costs and facilitates a better resource allocation which is not specific to a production technology or product characteristics.

¹³ Outliers are mostly due to very low numbers of observations in the respective category.

7 Conclusions

Our descriptive and regression analysis of the data on SMEs in Kenya and Tanzania indicate that ICT has a positive impact on total factor productivity. Although no significant relationship between investment in ICT and productivity could be found this means only that ICT investment is not more productive than other investment in the short run. From our descriptive analysis and findings from other studies we assume a positive effect of ICT once a certain threshold is passed.

A factor which limits the above analysis is that there may be a substantial time lag between ICT investments and their effects. Thus it is possible that lack of an ICT effect may simply reflect the time lag before investments in these technologies begin to payoff. Additionally, the approach with a sole focus on productivity may be too narrow. ICT technologies may exert their influence through product-quality improvements, through improved services and especially through improved networks. A further investigation with a second round survey could reveal further the links between ICT and SME competitiveness and may provide additional impetus for investments.

Most African countries have ICT development plans or even e-commerce programs in place or have the intention to develop them. Also the donor community is rather enthusiastic about the role of ICT for development as it can facilitate participation of formerly excluded in all kinds of interaction, from democratic processes to markets. However, as our empirical results and other considerations show the use of ICTs is at best one factor among others that improves firm performance. Therefore ICTs should not be regarded in isolation as this as well as other research shows that access to credit, managerial and other skills, infrastructure, rule of law etc. are at least as important as information and ICT.

These should include not only general improvement of infrastructure but especially the improvement of access to and quality of the communication network for SMEs. With respect to human capital secondary school enrolment has to be complemented by vocational training measures and the development of ICT skills. Not only more knowledge through ICT but also about ICT is needed. As economies of scale seem not to be very relevant in the sectors under investigation for our study the use of improved communication networks could facilitate co-operation between SMEs, which could include sharing best practices, general know-how and management capabilities how to make best use of ICT. Through an improved network SMEs could for example reduce the costs for imported inputs to improve their competitiveness further. As SMEs tend to produce more labour intensive than large firms the support for SMEs will also improve the distribution of income.

One important aspect of access to ICT is the high cost of devices and services in many African countries. In this respect liberalisation and privatisation that ensures competition will be the most important step to increase the use of ICTs by all possible users. Special priority should be given to the telecommunication infrastructure as this can be easily used also by less successful SMEs and even poor households have a relatively high demand (Torero 2000). Therefore in addition to private supply some support for disadvantaged regions might be rectified.

When designing support programs for SMEs to increase the use of ICTs one has always to bear in mind that access to new information that can be used by the enterprise is the goal not introduction of technology. This should also be mirrored in training courses where enterprise goals such as improved marketing or accounting should be in the centre and use of Internet or computers should be introduced as one tool to reach that goal. The provision of high quality courses instead of self-taught skills development that is currently done will help to increase efficiency not only in ICT use (Duncombe and Heeks 2001).

To increase access to useful information ICT intermediaries could also play a key role, as they are able to add value to the information they provide. This role could be played by non for profit organisations such as business organisations, SME associations etc. as they are aware of the information needs of small enterprises and can at the same time help to form and increase networks that will increase access to information about best practices of operation, market prices at different locations, sources of supply of inputs etc. Also of importance for small enterprises are government sites where regulations and support programs can be found. In addition to the time saving of enterprises this publicly accessible information could increase transparency and therefore reduce also other business obstacles.

Table A1: Sample means by country, sector and use of ICT*

a) Number of firms having different types of ICTs

	Tanzania				Kenya			
	food	textiles	tourism	total	food	textiles	tourism	total
no ICT	13	15	1	29	9	28	0	37
<i>external</i> phone	6	7	0	13	4	14	0	18
phone	33	25	7	65	21	14	8	43
<i>mobile</i> phone	15	8	3	26	2	0	0	2
fax	2	1	2	5	6	3	16	25
pc based	10	6	29	45	13	7	26	46
total	58	47	39	144	49	52	50	151

b) Average ICT investment

	Tanzania				Kenya			
	food	textiles	tourism	total	food	textiles	tourism	total
no ICT	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
phone	0.2	0.2	0.1	0.2	1.2	0.4	2.2	1.1
fax	0.8	2.3	1.7	1.4	2.3	3.0	4.6	3.9
pc based	8.0	3.3	5.7	5.9	3.1	1.5	16.5	10.7
total	1.5	0.6	4.3	2.0	1.8	0.5	10.4	4.4

c) Average number of employees

	Tanzania				Kenya			
	food	textiles	tourism	total	food	textiles	tourism	total
no ICT	9.3	6.6	-	7.9	5.0	5.3	-	5.2
phone	12.3	9.3	8.7	10.8	10.7	7.2	17.3	10.8
fax	26.0	10.0	21.0	19.5	55.2	18.3	14.7	23.6
pc based	24.0	14.2	12.1	15.1	52.1	23.3	21.7	29.7
total	14.1	9.1	12.0	11.9	24.3	8.7	18.7	17.0

d) Average years of schooling of labour force

	Tanzania				Kenya			
	food	textiles	tourism	total	food	textiles	tourism	total
no ICT	8.2	8.7	7.6	8.4	10.8	10.4	-	10.5
phone	8.9	9.9	9.3	9.3	11.9	10.8	11.0	11.3
fax	9.9	10.0	10.6	10.2	10.1	11.3	13.1	12.0
pc based	10.7	10.1	12.3	11.6	10.4	10.6	11.6	11.1
total	9.1	9.6	11.5	9.9	11.0	10.6	12.0	11.2

e) Share of enterprises that export

	Tanzania				Kenya			
	food	textiles	tourism	total	food	textiles	tourism	total
no ICT	7.7	0.0	0.0	3.4	0.0	7.1	-	5.4
phone	15.2	24.0	85.7	26.2	4.8	14.3	37.5	14.0
fax	50.0	100.0	100.0	80.0	83.3	33.3	81.3	76.0
pc based	50.0	83.3	93.1	82.2	46.2	57.1	80.8	67.4
total	20.7	25.5	89.7	41.0	24.5	17.3	74.0	38.4

Source: Own calculations from East Africa SME survey.

Notes: * The categories of ICT use are mutually exclusive. Phone use means only phone and nothing else. Fax use means eventually phone and fax but no PC.

The Role of ICT for the Performance of SMEs in East Africa

Table A2: Correlations of independent variables

	ln I	ln K	ln ICT	ln L	sil	exp	fax	textiles	tourism
ln I		0.703**	0.470**	0.387**	-0.287**				
ln K			0.652**	0.365**	-0.056				
ln ICT				0.360**	0.214**				
ln L					0.002				
Sil									
Exp	0.041	0.283**	0.497**	0.169*	0.448**				
Fax	0.110	0.407**	0.531**	0.186*	0.521**	0.518**			
Textiles	-0.114	-0.294**	-0.200*	-0.223**	-0.099	-0.140	-0.306**		
Tourism	-0.113	0.267**	0.379**	0.031	0.422**	0.588**	0.582**	-0.412**	
Kenya	-0.608**	-0.602**	-0.468**	-0.116	0.363**	-0.034	0.005	-0.066	0.051

Notes: Number of observations = 160 except for exp where it is 157.

In the upper triangle Pearson correlation coefficients are reported and in the lower one Spearman-Rho coefficients as ordinal data are involved.

** significant at 1 % level, * significant at 5 % level.

List of variables

ln I	ln (material inputs)
ln K	ln (capital without ICT investment)
ln ICT	ln (ICT investment)
ln L	ln (number of employees)
Sil	average years of schooling of workforce
Exp	market extension index
Fax	use of fax machines (dummy)
Textiles	textiles sector (dummy)
Tourism	tourism sector (dummy)
Kenya	country dummy

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