United Nations University

INTECH

Institute for New Technologies

Discussion Paper Series

#2004-7

Sectoral Pattern of E-business Adoption in Developing Countries

Banji Oyelaran-Oyeyinka and Kaushalesh Lal

April 2004

United Nations University, Institute for New Technologies, Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 350 6300, Fax: (31) (43) 350 6399, e-mail: postmaster@intech.unu.edu, URL: http://www.intech.unu.edu

SECTORAL PATTERN OF E-BUSINESS ADOPTION IN DEVELOPING COUNTRIES

Banji Oyelaran-Oyeyinka and Kaushalesh Lal*

Abstract

Drawing on firm level surveys, we examine industry-specific factors that have influenced the adoption of e-business technologies in Uganda, Nigeria, and India. A sectoral typology of e-business adoption based on three broad sets of observations emerged. First, the study suggests that sector-specific factors influenced the degree of adoption of e-business technologies. For instance, the intensity of adoption of e-business technologies in the skill-and-knowledge-intensive electrical and electronic goods sector was found to be higher than in labour-intensive sectors such as garments, auto-component manufacturing, and food and beverages. Secondly, the intensity of adoption of e-business tools was not affected by organisational factors such as profitability, size of operation, age of firm, and per capital investment at the industry level. Third, there are significant variations in the conduct and performance of firms that use lower levels of e-business tools from those categorised as the most advanced users.

Keywords: E-business, SMEs, Innovation, ICTs, Developing Countries

UNU-INTECH Discussion Papers

ISSN 1564-8370

UNU-INTECH discussion papers intend to disseminate preliminary results of the research carried out at the institute to attract comments

* Corresponding Author: Ph: +31-43-350-6300; Fax: +31-43-350-6399
Email Addresses: oyeyinka@intech.unu.edu (B. Oyelaran-Oyeyinka); lal@intech.unu.edu (K. Lal)

TABLE OF CONTENTS

1. INTRODUCTION

It is generally argued that Information and Communication Technologies (ICTs) are the most pervasive technologies developed in the last quarter of the twentieth century. Their diffusion through different strata of society has been rapid, as has their adoption in manufacturing and services sectors. As with all new promising technologies, however, there have sometimes been unduly high expectations of the range of ICT applications, leading to disappointing results in certain areas. Furthermore, considerable efforts are still needed in order to understand the nature and rate of ICT penetration, which has by no means been uniform across sectors and the application spectrum. ICTs are being used for peripheral activities in some sectors whereas in others they are also in use for core activities[1]. In this paper, we examine whether industry-specific factors influence the intensity of adoption of ICTs in business applications. Since our study focuses on the application of ICTs in business, we prefer to designate the use of ICTs in business applications as electronic business (E-business).

Before presenting a partial survey of the literature on the adoption of e-business technologies, we distinguish between e-business and electronic commerce (e-commerce). An OECD (2002) study, focusing on e-commerce, defines it as "… the sale or purchase of goods or services, whether between business, households, individuals, governments, and other public or private organisations, conducted over computer mediated networks. The goods and services are ordered over those networks, but the payment and the ultimate delivery of the good or service may be conducted on or off-line" (pp89). The study thus focuses on the application of ICTs in commercial activities, which is only one of many business processes. E-business, on the other hand, encompasses applications of ICTs in all business processes such as office automation, production processes, co-ordination with other plants, customer relation management, supply chain management, and management of distribution networks (Lal, 2004). Our study investigates factors that have influenced the adoption of e-business in this broad formulation.

Although the adoption of e-business is a recent phenomenon, several studies have investigated its impact on business performance. We present a selected review of literature that focuses on Small and Medium-sized Enterprises (SMEs) and the adoption of e-business. The literature survey is focused on SMEs because the sample firms in the study fall predominantly under this

[1] This is in fact the finding of OECD (2002) cross-country studies. The study classified the Nordic countries as "pioneers", Western Europe as "followers", and Southern Europe as "laggards". At the level of the enterprise, 52% of establishments in Finland were classified as "B2B" online integrators or "all-round users", while only 25% in Italy had reached these levels in 2001.

type of business organisation. It has been argued in the literature that the adoption of ICTs in general and e-business in particular allows a reduction in co-ordination costs and leads to efficient electronic markets (Damaskopoulos & Evgeniou, 2003; Drew, 2003). Damaskopoulos and Evgeniou in their study of East European and Cyprus SMEs found that most of the sample firms (over 900) established their web sites to take advantage of cost reduction, facilitate easy search of new markets, and to gain competitiveness. The study reported that the percentage of firms that created their web sites due to the above reasons, vary from 67% in Poland to 86% in Cyprus. It concluded that "….e-business affects first the boundaries of the firm with the market in which it operates". The finding of Drew (2003) suggests that SMEs are placing e-business at the centre of their technology policy. A majority of the sample firms reported that the driving force behind the adoption of e-business has been opportunities for growth and the need to keep up with competition.

In the context of developing countries, several studies (Moodley, 2002a; Moodley, 2002b; Goldstein & O'Connor, 2002; Goldstein, 2002) have examined the adoption of e-business by manufacturing firms. Moodley (2002a) did not find sufficient evidence to support the argument that export-oriented apparel firms in South Africa gain more in adopting e-business despite the promise of improved market penetration and it's potential direct link to international markets. Moodley's (2002b) comes up with similar findings on the automobile industry in South Africa, but the reason for this remains unclear. An earlier study by Oyelaran-Oyeyinka and Lal (2004), while not specifically dealing with the adoption of e-business by business organisations in sub-Saharan Africa, identified several constraining factors in the diffusion of these technologies in this region. The authors conclude that a lack of proper infrastructure is the main reason for the ineffective use of new technologies.

1.1 Methodological Notes and sources of data

Although this study collected data for three developing countries, their needs and capacity for technological absorption differed significantly and data analysis was therefore conducted separately for each country. In addition, the intensity of adoption of e-business tools differs considerably in each country and for this reason a common unit of analysis could not be used. A comparative perspective was carried out instead, following the sectoral analysis for each country. Data were collected from three countries, namely: Uganda, Nigeria, and India. Firm-level information was collected through a semi-structured questionnaire between June 2002 and January 2003. In the case of India, we examined the pattern of e-business adoption in each sector, i.e. garments manufacturing, electrical and electronic goods manufacturing, and auto-component manufacturing firms separately. While it is possible to analyse the Ugandan data for

auto-component and food and beverages firms separately, the Nigerian analysis was limited to the pattern of E-business adoption in the modern sector only. This is because electronic goods and engineering manufacturing firms dominated the sample firms in Nigeria.

While analysing the pattern of e-business technology adoption in the three countries, sample firms were ranked according to the intensity of e-business technology used. Ranking was ordinal and it was done intentionally to associate the intensity of e-business tools with other firm characteristics. For instance, a firm employing electronic messaging system alone was assigned a lower rank than one that had adopted the Internet because Internet-using firms utilise email communication as well.

The main objectives of the study were to identify and analyse country- and industry-specific factors that influenced the adoption of e-business by SMEs in developing countries and the consequences of adoption on performance. We also sought to compare the adoption of e-business technologies within a sector across three developing countries. The decision to investigate the pattern of the adoption of e-business across countries was based on the premise that learning processes, learning opportunities, and education system affect the diffusion of ICTs. Having no a priori knowledge of any cross -country study that has compared the adoption of e-business in developing country, we aimed to identify those factors that have resulted in varying degrees of adoption. In addition to constituting the majority of business organisations, SMEs were selected for the study, as they are a major source of employment and foreign exchange in the three countries.

The rest of the paper is organised as follows: Section 2 presents empirical evidence related to the adoption of e-business. Sections 3, 4, and 5 provide some methodological notes, analyse the conduct, performance, and the adoption of e-business technologies in India, Uganda, and Nigeria respectively. A comparative analysis is presented in Section 6, while Section 7 summarises the findings.

2. E-BUSINESS ADOPTION: SECTORAL PATTERN, LEVELS, AND COMPLEXITY

In this section we carry out a selected review of the literature relating to levels of adoption, sector - specific factors and organisational factors that influence e-business adoption. A number of factors such as firm size, skills level and telecommunication infrastructure have been positively correlated with ICT adoption (Zimmermann, 2000; Spectrum/DTI, 2000; Oyelaran-Oyeyinka and Lal, 2004). However, we have no knowledge of studies examining sector-specific factors and e-business adoption in developing countries.

Hodgkinson & McPhee (2002) have examined the impact of the adoption of web enabled technologies on the export market development by SMEs in Australia. A study by Teltscher (2002) deals with the fiscal implications of e-business, while Drew (2003) investigates the causes and consequences of adoption of e-business by SMEs in East of England. Following an analysis of the total value of transactions conducted through electronic means and its implication on fiscal policies of developing and developed countries, Teltscher (2002) observed that "…an increasing number of e-commerce businesses are small entrepreneurs…" and "… the fiscal impact of international e-commerce is likely to be felt more strongly in the developing countries….". Hodgkinson & McPhee (2002) conclude that international networking by SMEs brought knowledge to the region that facilitates intra-firm learning. The study further found that adoption of the Internet by SMEs is higher (68.8%) than large firms (66.7%).

2.1 Levels and Intensity of E-business Adoption

At the most basic level, many enterprises use a range of ICT tools including the ordinary telephone, facsimile, and email. E-mail is a cost effective medium for transferring large amounts of texts both within and outside the organisation, through the Internet. Ordinarily all that is required is a local area network (LAN) within the organisational space where firms are able to store, retrieve, and share data. Another form of communication is Electronic Data Interchange (EDI) - a messaging system that facilitates order processing within firms and between firms, customers and suppliers. It is a highly "structured, formatted and secure messaging system that uses agreed standards to communicate over a network" (Spectrum, 2000).

At the next level, firms use the Internet for online advertisement by establishing a web site, in order to buy and sell on the web[2]. In doing this firms make the transition to a higher level of digital exchange in the supply chain due to the required support services in warehousing, inventory control and so on.

Manufacturing using e-business tools adds qualitatively new levels of complexity and requires additional competencies for functions such as computer-aided design/computer aided manufacturing (CAD/CAM). Systems integration of digital functions also calls for efficient interfacing at the different stages. However, few SMEs in developing countries can afford to acquire the necessary technologies, as well as to shoulder the costs of hiring and maintaining skilled system analysts.

.

2.2 Sectoral Pattern of Adoption

In a summary of several studies, Goldstein & O'Connor (2002) concluded that "…as multinational corporations integrate the Internet into their cross-border business operations, developing country firms run the risk of exclusion from global value chains if they cannot establish electronic ties with their major business partners." In spite of this observation, they argued that there is still a need for more detailed sectoral analyses of the adoption of e-business. A case study of one of the top automobile firms (Fiat) by Goldstein (2002) suggests that the company has been very successful in optimising supply-chain management in Brazil while it has not been able to do so in India. The study further reveals that the use of the Internet by the company in India (Fiat India) has been limited to knowledge management, R&D, and marketing.

While technology-intensive manufacturing sectors such as electronic and electrical, chemicals and aerospace would seem to be particularly predisposed to be faster adopters of e-business tools the service sectors (advertising, insurance, airline booking) were quicker in making use of ICTs. This is because service functions such as marketing and sales online, tend to be the most routinised and relatively easy to codify - often requiring no more than Internet access and a company web site. However, the nature of the industrial system such as the strength of local networks, the nature of supply chains at the sector level, the level of trust and telecommunications infrastructure impact the adoption intensity of e-business tools by firms (Damaskopoulos and Evgeniou, 2003; Windrum and Berranger, 2002). The decision to adopt could also be decisively impacted by the entrepreneurial ability of the local service providers

[2] Although with the tremendous promise of the Internet, online purchasing and online sales range between one percent in Japan to 26 percent in the USA for the former and between 8% in France to 29% in the USA for the latter in 1998, Spectrum (2000).

whose presence and perceived expertise give assurance to firms of continued post-investment service provision.

2.3 Benefits of E-business Adoption

The diffusion of any new technology depends on several factors such as the potential benefits of technology, absorptive capacity of firms, and the institutional environment within the country. Potential benefits need not necessarily be related only to manufacturers of products and services that use new technologies but may affect consumers of products and services as well. E-business has the potential to benefit not only producers but also users of services and products and numerous benefits that flow from its adoption have been cited in the literature (Damaskopoulos & Evgeniou, 2003; Hodgkinson & McPhee, 2002; Drew, 2003). These benefits range from employment, to productivity gains, consumer surplus, and improvement in product quality. A firm might adopt e-business because of its perceived impact in reducing co-ordination costs. Due to the relatively inexpensive access to global markets and information that the Internet enables, it is fast becoming the world's largest and most versatile marketplace for services, products, and information. E-business presents opportunities for firms to re-evaluate the way in which they operate and to redefine their existing business infrastructure. It could further lead to the re-engineering of business processes across the boundaries that have traditionally separated suppliers from their customers. Previously separated activities such as order processing, payments, and after sales services can be merged into a single process, resulting in lower costs for creating, moving, processing, and managing documents. However, the availability of large volumes of information neither translates to ready usable data, nor does it automatically build knowledge in firms. Firms will first make explicit investment in e-business tools and concurrently build capabilities through learning to convert information to knowledge.

E-business is also expected to reduce operational costs since electronic information tends to be more accurate, timely and easily available (Damaskopoulos & Evgeniou, 2003). Another benefit of e-business could be the higher efficiency obtained in business transactions due to a fast and accurate processing of information. Web-enabled services are likely to strengthen the competitiveness of firms as these technologies may change the relationship with customers by creating a stronger link between firms and their clients.

3. INDIAN FIRMS

In the Indian case, firms in the three sectors have been grouped into three categories depending on their level of adoption of new technologies, namely: EB_eo, EB_p, and EB_pw. The lower end E-business using firms, labelled EB_eo, were using these technologies for electronic messaging systems and office automation while firms using e-business tools in production processes along with electronic messaging systems and office automation tools have been labelled as EB_p. Firms doing business by using more advanced tools like portals and web sites have been categorised as EB-pu. The remainder of the section discusses the pattern of the adoption of E-business in relation to the conduct and performance of firms.

Table 1 presents the distribution of firms according to the intensity of adoption of e-business and the academic qualification of Managing Directors.

Table 1: Owners' qualification and degree of adoption of e-business.

Intensity of E-business→	Garments manufacturing firms			Automobile components manufacturing firms			Electrical and Electronic goods manufacturing firms		
Owners' Qualification	EB_eo	EB_p	EB_pw	EB_eo	EB_p	EB_pw	EB_eo	EB_p	EB_pw
MBA	3	2	2		3	4	4	5	4
	(5.17)	(25.00)	(15.38)		(17.65)	(100.00)	(6.67)	(41.67)	(50.00)
BE	1			4	7		24	3	3
	(1.72)			(7.84)	(41.18)		(40.00)	(25.00)	(37.50)
Post Graduate/	14	1	6	19	5		15	4	
LLB and CA	(24.14)	(12.50)	(46.15)	(37.25)	(29.41)		(25.00)	(33.33)	
Graduate	33	5	5	21	2		10		
	(56.90)	(62.50)	(38.46)	(41.18)	(11.76)		(16.67)		
Under Graduate	7			7			7		1
	(12.07)			(13.73)			(11.67)		(12.50)
Total	58	8	13	51	17	4	60	12	8
	[72.42]	[10.13]	[16.46]	[70.83]	[23.61]	[5.56]	[75.00]	[15.00]	[10.00]

Note: Figures in the parentheses are column percentage and row percentage in square brackets

From this table we see that a majority of firms in each sector have adopted electronic messaging and office automation tools. However, the use of advanced tools is higher in the electronic sector (10.00%) and in garments manufacturing (16.46%) compared to the automobile sector. The reason for higher adoption of advanced e-business tools in garments sector could be the export orientation of the sample firms. Table 1 also shows that academic qualification clearly impacts on the intensity of the adoption of new technology, across all the sectors. For instance, sixty -nine percent of garments firms that have adopted these technologies for email and management information systems were managed by graduates and under graduates. However,

the percentage of graduate managing directors declined to 38.46 percent in firms that adopted more advanced e-business tools based on portal and web site. The contrast is much clearer in knowledge-intensive sectors such as electrical and electronic goods manufacturing. More than eighty-seven percent of managing directors (MDs) with engineering qualifications at graduate level -many of whom had an additional management degree - were utilising portals and web sites in their business, while roughly forty-seven percent of MDs with these qualifications were satisfied with using only email and office automation systems. The picture in the auto-component manufacturing sector illustrates the relationship of education and advance e-business tools even more succinctly. All the firms being managed by MBA degree holders had adopted the most advanced e-business tools while more than fifty-five percent of MDs with a basic degree or lower, had adopted the lowest level of e-business tools. Table 1 shows that higher qualified managers have adopted more advanced e-business tools across all the sectors. However, this trend more evident in knowledge intensive sectors as compared to labour intensive sector such as garments manufacturing.

In Table 2 the distribution of firms according to the use of e-business technologies and age of managing directors is presented. There is no discernible pattern across the sectors, but there is evident relationship when classified by the skill- and knowledge-intensity of sectors.

Table 2: Owner's age and pattern of adoption of e-business.

Intensity of E-business→	Garments manufacturing firms			Automobile components manufacturing firms			Electrical and Electronic goods manufacturing firms		
Owner's Age	EB_eo	EB_p	EB_pw	EB_eo	EB_p	EB_pw	EB_eo	EB_p	EB_pw
< 35	5		1		1	1	2	1	2
	(8.62)		(7.69)		(5.88)	(25.00)	(3.33)	(8.33)	(25.00)
35 – 39	9	2	3	3	4	2	13	2	
	(15.52)	(25.00)	(23.08)	(5.88)	(23.53)	(50.00)	(21.67)	(16.67)	
40 – 44	7	1	2	2	7	1	11	4	3
	(12.07)	(12.50)	(15.38)	(3.92)	(41.18)	(25.00)	(18.33)	(33.33)	(37.50)
45 – 49	11	3	3	13	2		6	2	2
	(18.97)	(37.50)	(23.08)	(25.49)	(11.76)		(10.00)	(16.67)	(25.00)
50 – 54	14	2	4	9			3	2	
	(24.14)	(25.00)	(30.77)	(17.65)			(5.00)	(16.67)	
55 – 59	7			17	2		12	1	
	(12.07)			(33.33)	(11.76)		(20.00)	(8.33)	
60 +	5			7	1		13		1
	(8.62)			(13.73)	(5.88)		(21.67)		(12.50)
Total	58	8	13	51	17	4	60	12	8

Note: Figures in the parentheses are column percentage

In the garments sector, the age of owners seems to have little or no impact on the use of e-business technologies. Firms have adopted different degrees of e-business tools irrespective of

age of owners. However, this is not the case in the modern sector firms. By and large the trend in adoption of e-business in relation to age of owners follows is similar in other two sectors. For instance, only 8.88 % of firms that are managed by persons under 35 years while 25% of EB_pw firms are managed by persons who fall in the same age bracket in auto-component manufacturing firms.

The pattern of adoption of e-business technologies in relation to the skill intensity of firms is presented in Table 3. There is nominal variation in the skill intensity of firms that adopted the lowest level of tools compared to the most advanced users of e-business technologies. This observation holds true across all sectors. In fact the relationship between skill intensity and the use of e-business technologies shows a downward slope the case of labour intensive sector. The ratio of engineers to total workforce in EB_eo firms is 0.56 while it is 0.26 in EB-pu firms. This could be a result of the limited use of e-business technologies in developing countries in this sector. For instance, e-business technologies are not used in the core production process, i.e. garments assembly, which is a major employer of labour. Modern technologies in this sector are used for design, marker making, office automation, and co-ordination of business activities with other partners. Although firms require qualified staff to manage new technologies, the required number is low and does not vary with the total employment of firms. This peculiar relationship between skilled workforce and total employment results in decreasing skill intensity with advanced new technologies using firms, which are usually larger that others in terms of total employment.

Table 3: Employee's skill intensity and degree of adoption of e-business

Intensity of E-business→	**Garments manufacturing firms**			**Automobile components manufacturing firms**			**Electrical and Electronic goods manufacturing firms**		
Employees' Qualification	**EB_eo**	**EB_p**	**EB_pw**	**EB_eo**	**EB_p**	**EB_pw**	**EB_eo**	**EB_p**	**EB_pw**
Engineers	38	12	22	22	30	34	83	25	55
	(0.56)	(0.43)	(0.26)	(0.46)	(0.64)	(0.84)	(2.02)	(2.10)	(2.91)
PG/	567	89	404	641	635	530	441	137	215
Graduates	(8.36)	(3.20)	(4.83)	(13.37)	(13.50)	(13.06)	(10.76)	(11.48)	(11.38)
Diploma	102	32	145	3579	3407	2981	3188	923	1476
Holders	(1.50)	(1.15)	(1.73)	(74.62)	(72.46)	(73.48)	(77.78)	(77.39)	(78.10)
Others	6071	2645	7792	554	630	512	387	108	144
	(89.57)	(95.21)	(93.17)	(11.55)	(13.4)	(12.62)	(9.44)	(9.05)	(7.62)
Total	**6778**	**1193**	**8363**	**4796**	**4702**	**4057**	**4099**	**1193**	**1890**

Note: Figures in the parentheses are column percentage

In other words, while computing skill intensity in this sector the numerator remains unchanged, the denominator increases with the use of advanced e-business technology. This bring downs the skill intensity of advanced users of e-business tools. With regards to changes in the skill intensity of firms in modern sectors these are more evident among advanced e-business technology using firms, although the difference is negligible. In electrical and electronic sector, for instance, the skill intensity of EB_eo firms is 2.02 while it increases marginally to 2.91 in portal using firms. Similarly, we have tried to identify the relationship between the degree of the adoption of e-business technology and size, capital intensity, profitability, and age of firms.

Two measures of size, i.e. total employment and sales turnover were considered. We found a positive correlation between size and the use of e-business technologies, as employment size varies with the adoption of new technologies in all the three sectors. In the garments sector, 53. 85 % of EB_pw firms employ more than 400 persons while the percentage of EB_eo firms in this category of employment is only 1.72. Similarly in auto-component industry 76.47% of advanced e-business technology using firms employ more than 200 persons whereas the percentage of lowest level of e-business technology firms with total workforce more than 200 is merely 5.88%. This scenario is repeated in the electrical and electronic goods sector. While the percentage of EB_pw firms that employ more than 200 workers is 50%, only 1.67 % of EB_eo firms had similar levels of employment.

Concerning the relationship between the size of operation and the adoption of e-business technologies, the pattern is uniform across all the sectors. Sales turnover provides financial strength for firm-level innovative activity and it plays an important role in the adoption of e-business technologies. Although the e-business tools needed for garments manufacturing are not very costly, it was mostly firms with higher scales of operation that had adopted more advanced e-business tools. The adoption of such tools might not have been influenced by size alone but also by operational considerations such as the need to maintain or improve on capacity utilisation. In this sector, export orientation is an important driving force behind use of ICTs in production and non-production activities. This is because changes in garments' design are more frequent in international markets than in the domestic market. However this argument does not hold true for sample firms in the other two sectors where export intensity is nearly zero. All the sample firms, irrespective of their size, have adopted office automation techniques and electronic messaging systems.

We also examined the relationship between capital intensity, measured as capital employed per capita, and the adoption of new technologies. No distinct trends in the adoption of new technologies in relation to the capital intensity of firms could be discerned. The premise holds true in all the sectors. In fact the average per capita capital employed by EB_pw firms is less

than EB_eo firms in all the sectors. However, a different pattern emerges if we analyse the data in different categories of firms. For instance, the average per capita capital employed by EB_pw firms is Rs. 48940 (Approximately USD 1087) in the category of less than Rs. 75000 while it is Rs. 37030 (Approx. USD 823) in EB_eo firms.

One possible reason for a downward slope of per capita capital intensity and degree of the use of e-business technologies could be the relationship between the size of employment and the adoption of e-business tools. In general, larger firms have adopted more advanced e-business tools, but increase in capital is never proportional to the increase in employment. Consequently per capital employed by large firms is lower, even when they may have invested more in absolute terms. The distribution of firms by their age and the adoption of new technologies does not follow a uniform pattern across sectors. The majority of garment firms that came into existence before 1985 have adopted e-business tools according to their respective needs.

However, firms in modern sectors display a clear pattern where age seems to have influenced the adoption of new technologies although this is not completely unexpected. Most SMEs in the modern sectors came into existence after the liberalisation process in the Indian economy started in 1985, though the major policy reforms were undertaken in 1991. The major hindrance in setting up SMEs in the pre-liberalisation era was the availability of raw material (Capacitors, PCBs, ICs, LSIs, and VLSIs) in the electronic sector while the auto-component sector could not grow due to a weak domestic market. After major changes in industrial policies in 1991, several automobile companies came in existence. This generated a momentum for the growth of the auto-component manufacturing sector. Following an easing of regulations relating to the import of raw material and capital goods after 1991, many firms established in the post-liberalisation period were able to start with the latest technologies.

At the aggregate level of profitability the relationship is positive across all the sectors. Sample firms that adopted more advanced tools have experienced higher profitability. While the contrast between the profitability of EB_p and EB_pw is not very significant in the garments sector, it is quite large in modern sectors. This could be due to the contribution of new business tools employed in production and the Internet based non-production processes.

4. UGANDAN FIRMS

The types of e-business tools adopted by sample firms in Uganda differed significantly from those favoured by Indian firms. For this reason, the intensity of the adoption of e-business has been measured on a different scale. Sample firms were grouped in five categories, namely: no_EB, EB_tf, EB_eo, EB_p and EB_i. The first category of firms (no_EB) was not using any kind of tool. The second group of firms used telephones and fax machines, only. The next category of firms (EB_eo) had adopted office automation tools and electronic messaging systems in addition to telephone and fax. The fourth category of firms had adopted e-business tools in production processes, while the last group was using the Internet for co-ordinating activities with other firms. Although we have grouped EB-p firms separately, no meaningful inferences can be drawn because only three firms in the sample had adopted e-business tools in production processes. Unlike India, the analysis covered two sectors auto-part manufacturing and food and beverages. The pattern of adoption of e-business and sector-specific characteristics in Ugandan firms is presented in the tables that follow.

The relationship between the academic qualification of managing directors and intensity of the e-business adoption is presented in Table 4. The data show that academic qualification of MDs did not influence the pattern of adoption of new business methods. The pattern is similar in both sectors.

Table 4: Owners' qualification and degree of adoption of e-business.

Intensity of E-business→	Auto parts manufacturing firms					Foods and Beverages firms				
Owners' Qualification	no_EB	EB-tf	EB_eo	EB_p	EB_i	no_EB	EB-tf	EB_eo	EB_p	EB_i
Engineers	1 (12.50)	5 (19.23)	1 (33.33)					3 (75.00)		3 (16.67)
Technical Diploma	6 (75.00)	8 (30.77)			3 (42.86)	2 (40.00)	5 (50.00)	1 (25.00)	1 (50.00)	4 (22.22)
Others	1 (12.50)	10 (38.46)	2 (66.67)		3 (42.86)	3 (60.00)	4 (40.00)			7 (38.89)
No response		3 (11.46)		1 (100.00)	1 (14.28)		1 (10.00)		1 (50.00)	4 (22.22)
Total	8 [21.62]	26 [70.27]	3 [8.11]	1 [2.70]	7 [18.92]	5 [14.71]	10 [29.41]	4 [11.76]	2 [5.88]	18 [52.94]

Note: Figures in the parentheses are column percentage and row percentage in square brackets

Table 4 shows that a large number of auto part manufacturing firms (70.27%) conduct their business by telephone and fax while 52.94% of firms in the food processing industry are using the Internet for their transactions. A possible explanation for this behaviour could be that auto component manufacturing firms are located within close vicinity of their parent companies and hence they do not need the Internet for internal communications. Food processing firms, on the other hand, have their distributional networks spread out over a large geographical area and the Internet may therefore be the more suitable tool. It is not surprising, therefore, that the e-business tools adopted by these firms comprise mainly electronic messaging systems, office automation, and the Internet. These tools do not require a sophisticated understanding of their applicability and performance. Quite clearly, Ugandan e-business technologies in Uganda are mainly being used in peripheral activities rather than in the core business of firms. At this level of application, adoption is driven largely by vendors, who provide consulting services outside the firm.

Table 5 presents the distribution of firms according to age of managing directors and the adoption of e-business technologies. Although the pattern of adoption of modern tools is not influenced by the sector-specific factors, there is a positive association between the adoption of new technologies and the age of MDs. About sixty-seven percent of EB_eo managers in the auto-component manufacturing sector were less than 35 years of age. Similarly, all MDs of EB_eo firms in the food and beverages sector, fell in the 35-44 years bracket. The majority of managers (71.43%) of auto-component and 66.67% in the other sector were aged between 35 and 50 years.

Table 5: Owner's age and pattern of adoption of e-business.

Intensity of E-business→	Auto parts manufacturing firms					Foods and Beverages firms				
Owner's age	no_EB	EB-tf	EB_eo	EB_p	EB_I	no_EB	EB-tf	EB_eo	EB_p	EB_i
< 35		2	2			2	1			1
		(7.70)	(66.67)			(40.00)	(10.00)			(5.56)
35 - 39	3	4		1	2		3	1	1	3
	(37.50)	(15.38)		(100.00)	(28.57)		(30.00)	(25.00)	(50.00)	(16.67)
40 - 44	2	4			1	1	3	3	1	8
	(25.00)	(15.38)			(14.29)	(20.00)	(30.00)	(75.00)	(50.00)	(44.43)
45 – 49	3	8			2		1			1
	(37.50)	(30.77)			(28.57)		(10.00)			(5.56)
50 +		8	1		1	2	2			1
		(30.77)	(33.33)		(14.29)	(40.00)	(20.00)			(5.56)
No response					1					4
					(14.29)					(22.22)
Total	8	26	3	1	7	5	10	4	2	18

Note: Figures in the parentheses are column percentage

We have tried to capture the link between skill intensity of firms and the intensity of the adoption of new business techniques in Table 6. Although the sectors under the study in Uganda are not skill intensive, the adoption of the new tools shows a positive relationship with the skill intensity of firms.

Table 6: Employee's skill intensity and degree of adoption of e-business.

Intensity of E-business→	Auto parts manufacturing firms					Foods and Beverages firms				
Employees' Qualification	No_EB	EB-tf	EB_eo	EB_p	EB_i	no_EB	EB-tf	EB_eo	EB_p	EB_i
Engineers		2	1				4	1		1
		(3.70)	(8.33)				(13.79)	(2.78)		(1.52)
PG/ Graduates	1	4				1	2	6	2	5
	(6.25)	(7.41)				(14.29)	(6.90)	(16.67)	(28.57)	(7.58)
Diploma	3	8	5	1	2	1	4	6	3	19
Holders	(18.75)	(14.81)	(41.67)	(50.00)	(16.67)	(14.29)	(13.79)	(16.67)	(42.86)	(28.78)
Others	12	40	6	1	10	5	19	23	2	41
	(75.00)	(74.07)	(50.00)	(50.00)	(83.33)	(71.42)	(65.52)	(63.89)	(28.57)	(62.12)
Total	16	54	12	2	12	7	29	36	7	66

Note: Figures in the parentheses are column percentage

The highest educational qualification attained by the majority of workers (74.07%) in EB_tf firms in the auto-component sector is a diploma, while this percentage drops to 50% in EB_eo firms. Surprisingly, the skill intensity of the majority of EB_i firms in this sector is very low and the pattern in the food and beverage sector is similar to that of the other sector.

We also present evidence of the association between size of employment and degree of the adoption of e-business tools as well as other variables. We found that 88.46% of EB-tf firms were employing less than 4 workers while a majority of firms (66.67%) that had adopted office automation and email systems employed more than 4 persons in the auto-components sector. All the Internet using firms employed less than 4 workers – most likely because they are predominantly trading firms and do not require a large workforce to manage their activities. The main activity of these firms was business co-ordination with buyers and suppliers and they had consequently adopted the e-business tools that are needed for this purpose.

The observed pattern in the food and beverages sector is by and large similar. The average number of employees in firms that had adopted office automation tools is nine. In this sector a large number of firms (72.22%) that were using the Internet employed less than 4 persons. It is likely, again, that most EB-i firms might be primarily involved in trading activities, which in contrast to manufacturing, are most efficiently carried out by a small staff using advanced e-business tools. Consequently they rely largely on email communication and Internet based systems.

We further examined the relationship between capital intensity per employee and the use of new technologies and found that sector-specific factors have influenced the use of new tools. For instance, in the auto-components sector, capital investment follows a normal distribution in EB_i firms while it shows an upward trend in food and beverages firms. Among EB_i firms, 22.22% have invested less than 0.5 million shillings per capita, whereas 55.56% of firms have invested more than 175 million shillings.

Looking at the total per capita capital investment, however, we do find a common trend in both the sectors. For instance, EB_tf firms employed an average per capita capital 45.73 million shillings in auto-components sector while the average capital investment by EB_i firms was 85.57 million shillings. Similar trends at the aggregate level were observed in the second sector.

Although we tried to identify the relationship between the sales turnover and the adoption of new technologies, only 27.38 % of firms surveyed shared this data. It is well established, however, that adoption of new technologies by firms in general is influenced by the size of operations. While 80 % of EB-tf firms in the auto-components sector have a sales turnover of less than 3 millions shillings, over 50% of EB_i firms have a turnover of more than one billion

shillings. The number of food and beverages firms that provided sales turnover data was not sufficient for us to draw any inferences for the sector.

Sector-specific factors appear to be influential in the adoption of e-business tools in relation to the age of firms. In almost any category of firm grouped by the use of e-business tools, the majority came into existence after 1991.

The pattern of the adoption of email and the Internet is not surprising because these technologies came into the public domain after 1995. The trends observed for the use of the telephone (showing relatively recent adoption) were contrary to our expectation. One possible reason could be that, together with the fax, they were included in this category of e-business tools.

Next we examine the impact of the adoption of e-business on the profitability of firms. Profitability was computed as the percentage of profit after tax, to the sales turnover. Similar to sales turnover data, a mere 17.85% of firms shared this information thus making it difficult to draw any inferences regarding profitability and the adoption of new technologies. However, sample data in the food and beverages sector show that 55.56% of firms that had adopted Internet tools achieved more than 20% profitability.

5. NIGERIAN FIRMS

Although we are presenting the pattern of the adoption of e-business tools in this section, we are unable to make comparisons across sectors because all the sample firms belong to the engineering sector. While this limits industry level comparison, it provides an additional sector for comparison in measuring adoption of e-business across countries. We have grouped the sample according to the definition used for Ugandan firms.

Table 7 presents the distribution of firms according to the intensity of adoption of these technologies in relation to the academic qualification of their managing director. We observe that adoption is influenced by the qualification of managing directors with a relatively large number of managing directors (42.86%) with engineering degree adopted email and office automation tools.

Table 7: Owners' qualification and degree of adoption of e-business.

	Intensity of E-business				
Owners' Qualification	no_EB	EB-tf	EB_eo	EB_p	EB_i
Engineers	5 (13.51)	1 (9.09)	9 (42.86)	20 (74.07)	3 (33.33)
Technical Diploma	12 (32.43)	4 (36.36)	6 (28.57)	2 (7.41)	4 (44.44)
Others	10 (27.03)			2 (7.41)	
No response	10 (27.03)	6 (54.55)	6 (28.57)	3 (11.11)	2 (22.22)
Total	37	11	21	27	9

Note: Figures in the parentheses are column percentage

The engineering industry requires a thorough knowledge and understanding of tools suitable for production processes. Hence it is extremely important to have skilled staff within the firm who can evaluate the appropriateness and effectiveness of such tools before they are adopted, as well as during implementation. This is extremely important for small and medium sized firms to which the sample firms belong. In theory, technically sound and well educated managers are expected to have better insights into, and knowledge about the relevant tools, and as such would be the first to adopt advanced technologies. The sample firms exactly reflect this assumption, with a large number of managing directors (74.07%) that had an engineering background adopting e-business tools in production processes.

In the next table we examine the effect of managing director's age on the adoption of e-business technologies. There was no uniform trend observed in the adoption of new technologies among the categories of firms, which were grouped according to the intensity of such tools. This is counter-intuitive, because young entrepreneurs are expected to be first to adopt advanced new technologies. One of the reasons advanced for poor adoption relates to the prolonged economic crisis that slowed down investment in manufacturing between mid 1980s and the end of 1990s. Entrepreneurs explained that the sector had merely struggled to keep operations going in the face of the negative changes brought by the Structural Adjustment Programme (SAP) introduced at the mid-1980s.

Table 8: Owner's age and pattern of adoption of e-business.

	Intensity of E-business				
Owners' age	no_EB	EB-tf	EB_eo	EB_p	EB_i
< 35	8 (21.62)	2 (18.18)	1 (4.76)	4 (14.81)	1 (11.11)
35 – 39	3 (8.11)	2 (18.18	5 (23.81)	3 (11.11)	2 (22.22)
40 – 44	9 (24.32)	1 (9.09)	5 (23.81)	6 (22.22)	1 (11.11)
45 – 49	8 (21.62)	3 (27.27)	2 (9.52)	6 (22.22)	1 (11.11)
50 – 54	4 (10.81)	3 (27.27)	5 (23.81)	4 (14.81)	2 (22.22)
55 +	1 (2.70)		1 (4.76)	4 (14.81)	1 (11.11)
No response	4 (10.81)		2 (9.52)		1 (11.11)
Total	37	11	21	27	9

Note: Figures in the parentheses are column percentage

The relationship between the degree of the adoption of new technologies and skill intensity is examined in Table 9 where evidently the skill intensity of advanced users of e-business tools is higher than that of less advanced users. For instance, the ratio of engineers to total staff among EB-tf firms was 12.28% engineers while amongst firms using advanced e-business tools the figure was 16.98%.

Table 9: Employee's skill intensity and degree of adoption of e-business.

	Intensity of E-business				
Owners' Qualification	no_EB	EB-tf	EB_eo	EB_p	EB_i
Engineers	22 (13.42)	14 (12.28)	40 (12.54)	59 (13.56)	18 (16.98)
PG/ Graduates	21 (12.80)	37 (32.46)	116 (36.36)	146 (33.56)	35 (33.02)
Diploma Holders	50 (30.49)	48 (42.11)	108 (36.86)	145 (33.33)	27 (25.47)
Others	71 (43.29)	15 (13.16)	55 (17.24)	85 (19.54)	26 (24.53)
Total	164	114	319	435	106

Note: Figures in the parentheses are column percentage

The reverse is true with regard to firms employing largely diploma holders. From the table, EB_tf firms employed 42.11% of diploma holders whereas this percentage reduces to 25.47% in EB_i firms. The results suggest that a positive relationship exists between the skill intensity of firms and intensity of the adoption of e-business tools.

The association between employment size of sample firms and the use of new technologies was also analysed. The results show that there is almost no link between the telephone and fax using firms and the size of employment. However, a large percentage (85.72%) of firms that had adopted office automation and email systems employed more than 5 persons. This trend holds true for other firms that are advanced users of new tools.

Further, 77.78% of EB_i firms employed between 6 and 10 workers while 22.22% of such firms employed more than 10 workers. This suggests a negative relationship between the intensity of the adoption of e-business and employment size. However, this result should be interpreted with caution because some firms employing more than 10 persons may be subsidiaries of big companies and may not be required to carry out co-ordination activities, hence they may not have adopted tools required for co-ordination activities.

In terms of the adoption of new technologies in relation to per capita investment by firms, the average figures invested reveal that per capita investment is relatively high among more advanced users of e-business technologies. For instance, the average per capita investment of fax and telephone using firms was Naira 10550 whereas most advanced e-business tool using firms invested Naira 74670 per employee.

Similar to the Indian and Ugandan firms, the relationship between sales turnover and degree of the adoption of e-business technologies variables was positive among Nigerian firms. At the aggregate level, the average size of operation of EB_tf firms was Naira 3.04 million while the average sales turnover of most advanced users of new business technologies was Naira 5.93 million. Firms with greater financial resources are likely to invest in advanced tools although level of sophistication varies.

In spite of the increasing propensity to adopt new technologies in relation to size of operation at the aggregate level, no discernible pattern emerged when the data were analysed by different levels of sales turnover. For instance, 33.34% of EB-tf firms had a sales turnover of less than 2.5 million Naira, whereas in the EB_eo category of firms this percentage increases to 52.94%. Surprisingly this percentage decreases to 50 % in EB_p firms and again increases to 66.67% for Internet using firms. This trend holds true in other categories of size of operation of firms.

Finally, we examined the impact of age of firms on the adoption of e-business tools. Unlike the Indian sample firms, data do not show any relationship between these variables. The non-emergence of any relationship between these factors suggests that there may not have been major changes in industrial policies in the recent past in Nigeria that encouraged the development of new firms equipped with modern technologies in production, marketing, and co-ordination activities. As firm owners observed, the lack of investment was largely caused by declining profits in the wake of mostly negative changes brought about by structural adjustment policies. Lastly, the depth of ICT penetration at the general level of the industrial system plays an important part in influencing the rate at which firms adopt a new technology. Nigeria, in spite of its huge market, was slow in deregulating the telecommunication sector, with a boom in the telecommunication sector occurring only in the past two years. What this increase in telephone density might mean for firms remains to be seen, however.

6. COMPARATIVE ANALYSIS

This section compares industry- and country- specific factors that influenced the adoption of e-business technologies in all three countries. The results presented in Sections 3, 4, and 5 suggest that in the hi-tech sector irrespective of country, the academic qualification of managing directors correlates with the adoption of new technologies. The academic qualification of MDs played a crucial role in the adoption of new business technologies in electrical and electronic goods manufacturing sector in India and the engineering sector in Nigeria. Notable country-specific factors emerged for the auto-components manufacturing sectors in India and Uganda. While the qualification of owners influenced the degree of the adoption new e-business tools in India, the results do not show any significant impact in Ugandan firms. It was found that the academic qualification of owners did not influence the adoption of new technologies among food and beverages firms in Uganda.

We do know from related literature that the young entrepreneurs show a greater propensity to adopt new technologies and are therefore are most likely to conduct their business using ICTs. Data from the skill- and knowledge- intensive sector in India demonstrates the important role being played by the age of MDs. By contrast, the evidence from the engineering sector in Nigeria, which is also skill and knowledge-intensive, did not support the argument that younger managers are more technology oriented. A similar pattern emerges in the auto-components sector in India and Uganda. These results suggest that in a low-technology sector such as garments manufacturing in India and food and beverages in Uganda, the age of owners is irrelevant with respect to the adoption of e-business technologies.

Sample firms were further classified according to skill requirements of the workforce. Electrical and electronic goods firms in India and engineering firms in Nigeria were grouped as highly skill-intensive while garments manufacturing in India and food and beverages firms in Uganda were labelled labour-intensive. We investigated the impact of skill-intensity of the workforce on the adoption of e-business tools. The results show that skill-intensity is a very important factor that influenced the degree of adoption of new technologies irrespective of sector or geography. In all three countries and sample firms the skill-intensity of the workforce was positively associated with the adoption of e-business technologies. In comparing cross-country and cross-sectoral patterns it is clear that there are variations in the level and complexity of e-business tools adopted. For instance, while electrical and electronic goods manufacturing firms in India have adopted portal and web based e-business technologies, Nigerian firms remain at the most basic level of Internet use. Similarly, a large number of firms (26.61%) of auto-

component manufacturing sector in the Indian sample had adopted computerised methods in production processes whereas merely 2.22% of Ugandan firms in the same sector had adopted such tools. This finding reinforces the observation that the relative depth of technical capability of the industrial system tends to affect the sophistication of the tools adopted.

There are significant differences in the intensity of the adoption of e-business in relatively technology-intensive firms, compared to skill-based and other sectors. For instance, 16.67 % of electrical and electronic goods manufacturing firms in India employing less than 25 persons have adopted office automation tools, while roughly 5 % of the firms in other sectors have adopted such e-business tools. This comparison could not be made in the case of Uganda and Nigeria because sample firms of former country fall in the labour intensive category, whereas sample firms in the latter belong to a technology-intensive sector. A cross-country comparison of firms in skill-based sectors does not find similarity in the adoption of new technology. Ten percent of skill-based sample firms in India were doing business using web-enabled technologies, while not a single sample firm in Nigeria had a web site. However, only about 25 % of firms in India had adopted new tools in production processes compared to34.29 % of firms in Nigeria that had adopted new production technologies.

Due to differences in the currency of measurement of per capita capital investment, it is not possible to analyse the adoption of e-business in relation to investment. However there is a broad similarity in the sector level patterns in each country. For instance the average per capita investment in Indian garments firms that adopted new technology in production processes was Rs. 37910. The per capita investment by most advanced users of e-business technology in the same sector was almost double at Rs. 72380.. Surprisingly, the average investment by EB-eo firms was Rs. 81640, which is more than EB-p firms. Auto-component firms exhibited a similar pattern. The adoption of e-business technologies and per capita investment in the electrical and electronic goods sectors showed the reverse trend. The average investment by EB_pw firms was Rs. 132930, while it was Rs. 135750 among EB_eo firms. The auto-components sector in Uganda followed a similar pattern, while food and beverage firms showed an increasing per capita investment with respect to the intensity of e-business tools. By contrast, there was a negative trend for the electrical and electronic goods sector in India, while Nigerian firms showed a positive trend of per capita investment and the degree of the adoption of new technology.

The pattern of e-business adoption across countries and industries with respect to size of operation is broadly uniform. Firms with higher size of operation had adopted more advanced tools. However, the magnitude of the size of operation in relation to the adoption of degree of adoption varies across industries. For instance, average sales turnover in Indian garments firms that had adopted new technologies in production processes was Rs. 103.21 million whereas it

was Rs. 253.74 million for auto-component firms. Although there was a positive relationship between the adoption of new technologies and the size of operations in Ugandan firms, it is difficult to draw broad conclusions based on the few firms that provided data on the size of operations. A cross-country analysis is also not possible due to difficulties of comparing the size of operations due to the differing currencies. However, the Nigerian firms also showed a positive association between the size of operations and the degree of adoption of e-business.

The age of firms seems to have influenced the adoption of e-business in different sectors. 76.92 % of EB_pw firms in the Indian garment sector came into existence before 1980, whereas 62.5% of web enabled technology-using firms in electrical and electronic goods manufacturing sector were established between 1991 and 1995. The e-business tools used in skill-based sectors require customisation and they are costly. The liberalisation of the Indian economy in 1991 might have encouraged young entrepreneurs to set up firms in this sector and these firms might have started with latest technologies available in the world market. Similarly, latecomers in Uganda seem to have adopted more advanced technologies. More than 70% of Internet-using firms in auto-component sector and 61.11 % firms in food industry were set up after 1991. Firm-level adoption in Nigeria, however, has not followed this trend. The majority of firms that had adopted Internet tools were set up between 1986 and 1990. In the case of Uganda, a similar pattern emerged, but this time in relation to the early liberalisation of the telecommunications sector. The intensity of adoption of new technologies appears to be linked to increased profitability. For instance, the average profitability among EB_eo firms in the Indian garments sector was 7.95%, whereas it was 9.79% for most advanced technology using firms. This pattern is repeated across all three industries in India. Although, a number of Ugandan firms reported profitability data, any inference based on such a small sample would be questionable. The sample firms in Nigeria did not report profitability data at all, hence a cross-country analysis could not be made.

7. SUMMARY AND CONCLUSION

The analysis presented in the previous section suggests that there are sector-specific factors that have influenced the degree of the adoption of e-business technologies. For instance the intensity of adoption of e-business technologies in high skills sectors - such as electrical and electronic goods - was found to be higher than in labour-intensive sectors such as garments, auto-component manufacturing, and food and beverages. Another factor, which is derived from the skill-intensity of a sector, namely the knowledge and academic qualifications of managing director/owner, seems to have played an important role in influencing the intensity of the adoption of new technologies.

The results show that the intensity of the adoption of e-business tools has not been affected by factors such as profitability, size of operation, age of firm, and per capital investment at the industry level. However, there are significant variations in conduct and performance of firms that were using lowest level of e-business tools from those that were the most advanced users of new technologies within an industry. The technical depth of the industrial system tends to reflect the complexity of e-business tools adopted.

REFERENCES

Damaskopoulos, P. and Evgeniou, T. (2003). Adoption of New Economy Practices by SMEs in Eastern Europe. *European Management Journal*, 21(2), 133-45.

Drew, S. (2003). Strategic Uses of E-Commerce by SMEs in the East of England. *European Management Journal*, 21(1), 79-88.

Goldstein, A. & O'Connor, D. (Eds.). (2002). *Electronic Commerce for Development.* Paris: OECD.

Goldstein, A. (2002). Local Entrepreneurship in the Era of E-business: Early Evidence from the Indian Automobile Industry. In: Andrea Goldstein & David O'Connor (Eds.), *Electronic Commerce for Development* (pp. 93-120). Paris: OECD.

Hodgkinson, A. & McPhee, P. (2002). *SME Information Sourcing for Innovation and Export Market Developments: From Local or External Networks*. WP 02-08, Australia: Department of Economics, University of Wollongong.

Lal, K. (2004). E-business and Export Behavior: Evidence from Indian Firms, *World Development*, 32(3).

Moodley, S. (2002a). E-Business in the South African Apparel Sector: A Utopian Vision of Efficiency?. *Developing Economies*, 40(1), 67-100.

Moodley, S. (2002b). The Prospects and Challenges of E-Business for the South African Automotive Component Sector: Preliminary Findings from Two Benchmarking Clubs. In: Andrea Goldstein & David O'Connor (Eds.), *Electronic Commerce for Development* (pp. 67-92). Paris: OECD.

OECD (2002). Measuring the Information Economy 2002, Paris, *www.oecd.org/EN/document/0,,EN-document-570-1-no-4-35663-570,00.html.*

Oyelaran-Oyeyinka, Banji and Lal, K. (2004). The Internet Diffusion in Sub-Saharan Africa: A Cross-country Analysis, *Telecommunication Policy*, Forthcoming

Spectrum /DTI (2000). Moving into the Information Age: International Benchmarking Study, available at <http://www.ukonlineforbusiness.gov.uk/>

Teltscher, S. (2002). Electronic Commerce and Development: Fiscal Implications of Digitized Goods Trading. *World Development*, 30(7), 1137-58.

Windrum, Paul and Berranger, P. (2002). The adoption of e-business technology by SMEs, MERIT-Infonomics Research Memorandum series (23).

Zimmerman, F. (2000). The Impact of ICT Use on Export Orientation of SMEs: Theoretical considerations and Empirical Evidence from Chile, M.Sc. thesis, London School of Economics and Political Science.

THE UNU/INTECH DISCUSSION PAPER SERIES

#2004-7 Sectoral Pattern of E-business Adoption in Developing Countries By Banji Oyelaran-Oyeyinka and Kaushalesh Lal

2004-6 Non-Tariff Measures, Technological Capability Building and Exports in India's Pharmaceutical Firms By Frederick Nixson and Ganeshan Wignaraja

2004-5 Technological Intensity and Export Incidence: A Study of Foreign and Local Auto-Parts, Electronics and Garment Firms in Indonesia By Rajah Rasiah

2004-4 Science and Technology in Latin America and the Carribean: An Overview by Léa Velho

2004-3 Coping with Globalisation. An Analysis of innovation capability in Brazilian telecommunications equipment industry by Sunil Mani

2004-2 Learning and Local Knowledge Institutions in African Industry by Banji Oyelaran-Oyeyinka, January 2004

2004-1 Productivity, Exports, Skills and Technological Capabilities: A Study of Foreign and Local Manufacturing Firms in Uganda by Rajah Rasiah and Henry Tamale, January 2004

2003-12 Regulation of Foreign Investment in Historical Perspective by Ha-Joon Chang, December 2003

2003-11 Illusory Competitiveness: The Apparel Assembly Model of the Caribbean Basin by Michael Mortimore, November 2003

2003-10 The Role of Market, Trust and Government in the Development of the Information Hardware Industry in Taiwan By Rajah Rasiah and Yeo Lin, October 2003

2003-9 Growth Theories Revisited: Enduring Questions with Changing Answers By C. V. Vaitsos, October 2003

2003-8 Designing National Regimes that Promote Public Health Objectives By Padmashree Gehl Sampath, September 2003

2003-7 FDI-facilitated Development: The Case of the Natural Gas Industry of Trinidad and Tobago. By Lou Anne A. Barclay, September 2003

2003-6 Sources of Training in African Clusters and Awareness of ICTs: A Study of Kenya and Ghana By Catherine Nyaki Adeya, September 2003

2003-5 The Internet Diffusion in Sub-Saharan Africa: A cross-country Analysis By Banji Oyelaran-Oyeyinka and Kaushalesh Lal, July 2003

2003-4 Defining an Intellectual Property Right on Traditional Medicinal Knowledge: A Process-Oriented Perspective By Padmashree Gehl Sampath, July 2003

2003-3 New Wave Technologies: Their Emergence, Diffusion and Impact. The Case of Hydrogen Fuel Cell Technology and the Developing World By Lynn K. Mytelka, July 2003

2003-2 Systems of Innovation and Human Capital in African Development By Banji Oyelaran-Oyeyinka and Lou Anne Barclay, May 2003

2003-1 Deregulation, Entry of MNCs, Public technology procurement and Innovation Capability in India's Telecommunications Equipment Industry By Sunil Mani, February 2003

2002-10 Moving Up Or Going Back The Value Chain an Examination of The Role of Government With Respect to Promoting Technological Development in The Philippines By Sunil Mani, November 2002

2002-9 Research Capacity Building in Nicaragua:From Partnership with Sweden to Ownership and Social Accountability By Léa Velho, October 2002

2002-8 R&D in the Public and Private Sector in Brazil: Complements or Substitutes? By Lea Velho and Tirso W. Saenz, July 2002

2002-7 Systemic Coordination and Human Capital Development: Knowledge Flows in Malaysia's MNC-Driven Electronics Clusters By Rajah Rasiah, June 2002

2002-6 What is the 'Knowledge Economy'? Knowledge Intensity and Distributed Knowledge Bases By Keith Smith, June 2002

2002-5 Internet Access in Africa: an Empirical Exploration By Banji Oyelaran-Oyeyinka and Catherine Nyaki Adeya, May 2002

2002-4 Institutional Support for Investment in New Technologies: The Role of Venture Capital Institutions in Developing Countries by Sunil Mani and Anthony Bartzokas, May 2002

2002-3 Manufacturing Response in a National system of Innovation: Evidence from the Brewing Firms in Nigeria By Banji Oyelaran-Oyeyinka, April 2002

2002-2 Prospects for the Digital Economy in South Africa: Technology, Policy, People, and Strategies By Derrick L. Cogburn & Catherine Nyaki Adeya, April 2002

2002-1 TRIPs and Capability Building in Developing Economies by Rajah Rasiah, March 2002

2001-11 Government, Innovation and Technology Policy, An Analysis of the Brazilian Experience During the 1990s By Sunil Mani, December 2001

2001-10 Innovation Systems, Institutional Change and the New Knowledge Market: Implications for Third World Agricultural Development By Norman Clark, December 2001

2001-9 Working with the Market: The Israeli Experience of Promoting R&D in the Enterprise Sector and the Lessons for Developing Countries By Sunil Mani, December 2001

2001-8 Conditions for Successful Technology Policy in Developing Countries– Learning Rents, State Structures, and Institutions By Ha-Joon Chang Ali Cheema, December 2001

2001-7 Technological Change and Corporate Strategies in the Fertiliser Industry By Anthony Bartzokas, October 2001

2001-6 A Framework for Policy-Oriented Innovation Studies in Industrialising Countries By Anthony Bartzokas and Morris Teubal, September 2001

2001-5 Networks and Linkages in African Manufacturing Cluster: A Nigerian Case Study By Banji Oyelaran-Oyeyinka, September 2001

2001-4 Financial Markets and Technological Change: Patterns of Technological and Financial Decisions by Manufacturing Firms in Southern Europe By Anthony Bartzokas, August 2001

2001-3 Role of Government in Promoting Innovation in the Enterprise Sector An Analysis of the Indian Experience By Sunil Mani, April 2001

2001-2 Government and Innovation Policy an Analysis of the South African Experience since 1994 By Sunil Mani, February 2001

2001-1 Firm Size, Technological Capabilities and Market-Oriented Policies in Mauritius By Ganeshan Wignaraja, February 2001