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ICTs FOR INNOVATION

Policy Issues for Developing Countries

INTRODUCTION

The trajectory of Information and Communication Technologies (ICTs) over the past decade has been one of rapid emergence and diffusion in some countries mirrored by broadening inequality in access to these technologies for most of the world's population. The UN World Summit on the Information Society (WSIS) aims to take stock of what has been achieved globally to bridge this gap and to facilitate broad agreements on how to continue to address the three related themes of: providing access to ICTs for all; ensuring that ICTs serve as a tool for social and economic development; and enhancing confidence and security in the use of ICTs. The articles presented in this Technology Policy Brief discuss some of these issues, focusing particularly on policy measures that developing countries can take to enhance the impact of ICTs in sustainable development.

Oyelaran-Oyeyinka highlights the findings of a recent study into patterns of adoption and constraints to Internet use in Kenyan and Nigerian universities. Almost all of the 200 researchers interviewed were unable to make use of the Internet to plug into the knowledge base - a tool that is taken for granted by researchers in Europe, North America and many Asian countries. The study concluded that much stronger policy measures are needed to hasten Internet diffusion in Sub-Saharan Africa.

Picking up on the issue of telecommunication infrastructure, *Cassiolato and Szapiro* take a critical look at government policies in Brazil over the last three decades. They describe the changing policy landscape - from the early days of proactive government intervention that put Brazil at the forefront in providing high quality telecommunication services, to the impacts of privatisation and increasing globalisation during the 1990s. The authors argue that the lack of policy alternatives for strengthening the telecommunication innovation system has hindered the continued availability of high-speed communication networks at internationally competitive prices.

Lal further delineates the link between the institutional environment and production of ICTs. Citing case studies of major hardware and software producing countries he underlines the need for government policies to strengthen domestic markets as a crucial first step to building and maintaining export-led growth in the ICT sector.

Aichernig discusses the opportunities for developing countries in the development of open source software (OSS) systems. He cautions that although OSS is free, independence through OSS is not. Citing initiatives taken by several developing countries, the author suggests that countries can only harness the benefits of OSS through active participation in its development and this requires governmental support.

The final article by *Narayanan* reviews the latest empirical studies of e-business practices among small and medium sized firms in developing and developed countries. The author argues that the adoption of e-business technologies is crucial for maintaining a share in international markets that are increasingly characterised by flexibility and customisation of product design and distribution.

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POOR INTERNET ACCESS HINDERS KNOWLEDGE CREATION IN SUB-SAHARAN AFRICA

Contrary to more optimistic conceptions, the "digital divide" continues to widen. An Index of Technological Progress (ITP) constructed by Rodriguez and Wilson (2000) found an average growth rate of 23% in developed areas, while that of poorer countries averaged 18%. Only East Asia seems to be keeping up with the developed nations. Given that developing countries need to grow at a faster rate if they are to 'catch up' and benefit from these technologies, this is a cause for concern.

The consequences of this digital gap were captured in a recent UNU-INTECH (2002) survey among academics in 10 Kenyan and Nigerian universities. The study found that high Internet costs continue to hinder access by academics to on-line data and teaching materials.

Factors affecting Internet Use

The study focused on individual and institutional user levels. Using component extraction the study categorised the main constraints to Internet use - classified as determinants of access and use - into five categories namely connectivity infrastructure, skills, ease of use, costs and perceived advantages of the Internet. The variables were rated on a five point Lickert scale and we elicited responses by asking questions such as "please rate on a scale of 1 (not severe) to 5 (very severe) how telephone costs affect your use of the internet".

The table below shows the total as well as the mean for each category of determinants disaggregated into their components.

In the constraint categories, cost ranks highest in Nigeria, followed by skills, physical infrastructure and the connectivity infrastructure, while ease of use was not a severe problem. In Kenya, connectivity was ranked the most limiting factor, followed closely by costs. Unlike Nigeria, ease of use was considered a far more severe constraint than skills and physical infrastructure. This may well reflect the relatively better state of power supply in Kenya. Nigeria suffers from particularly aggravating power outages. Institutions depend on Uninterrupted Power Supply (UPS) units and other costly backup systems to mitigate power outages and fluctuations. The inadequacy of these back-up units causes constant damage to equipment, further raising access costs.

The most binding constraints are therefore inadequate access points, connectivity problems as well as a lack of affordable computing accessories. These are critical factors as they entail extra costs to end-users. We also found that service costs, such as Internet subscription fees, constitute an important determinant of use where the service is available. One infrastructural constraint, that of 'lack of computer terminals', is

Determinants of Internet Use

Constraint	Nigeria	Kenya
CONNECTIVITY INFRASTRUCTURE	**15.41 (2.57)**	**18.67 (3.11)**
Availability of Internet connection	2.36	3.13
Availability of access points (computers)	2.67	2.53
Ease of logging on	2.23	3.41
Speed of connection	2.68	3.41
Telephone Access	3.05	3.06
Number of internet sites	2.42	3.13
SKILLS AND PHYSICALINFRASTRUCTURE	**7.79 (2.60)**	**7.03 (2.34)**
Computer skills	2.18	2.13
Power supply	3.07	2.35
Internet search skills	22.54	2.55
EASE OF USE	9.30 (1.86)	12.54 (2.51)
Level of privacy	2.32	2.65
Availability of time	2.31	2.65
Language	0.73	1.90
Accessibility of sites	2.15	2.87
Quality of information	1.69	2.47
COSTS	**5.80 (2.90)**	**5.86 (2.93)**
Telephone costs	3.14	2.93
Internet subscription fees	2.66	2.93
PERCEIVED ADVANTAGES	**19.04 (3.17)**	**19.30 (3.21)**
Traditional (printed) books and journals are of higher quality than online resources	2.72	3.11
My academic work has improved and my career prospects enhanced	3.49	3.05
The Internet has improved the quality of academic research and research papers	3.51	3.15
Access to the Internet enhances the learning process	3.75	3.88
The Internet enables access to up-to-date and better quality lecture material	3.05	3.11
The Internet increases the information gap	2.52	3.00

1=Not a Constraint; 5=Severe Constraint

often a result of improper deployment of computers rather than a lack of access.

The language of content was not cited as a significant factor for the respondents since both countries are former British colonies that have adopted English, the predominant language on the Internet, as the common medium for educational instruction. Privacy in the use the facilities is not a significant factor as most respondents primarily use the Internet for academic research purposes. Similarly, skill constraints did not emerge as a significant problem in using computers.

Conclusion

This study reveals an arid individual Internet user environment in the countries studied - one that is replicated in most of SSA. The fact that the survey was carried out among university lecturers, who are, as a group, among the most privileged in terms of computer and Internet access underlines the magnitude of the problem.

As most Afican countries are still in the early stages of Internet diffusion it is in the interests of national governments and donors to boost current efforts to invest in telephony and other basic services that promote Internet use. Accordingly, governments should adopt a two-pronged strategy that addresses telecommunication infrastructure requirements and supports learning systems that enhance skills in the use of ICTs with a view to contribute to economic, social and political development. In this context further research is needed to explore how the Internet can be used to optimise networking for knowledge creation in the region.

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References

Rodriguez, F., and Wilson III, E.J., "Are Poor Countries Losing the Information Revolution?" InfoDEV Working Paper Series, The World Bank, Washinghton DC, May 2000.

Oyeyinka, B. and Adeya, C.N, "Internet Access in Africa: An Empirical Exploration", UNU-INTECH Discussion Paper 2002-5, May 2002

TELECOM PRIVATISATION IN BRAZIL: IMPACTS ON THE INNOVATION SYSTEM

During the 1970s and 80s, the federal government of Brazil enacted a number of policies to encourage innovation in the country's telecommunications system. These policies specifically targeted the local development of technologies and the establishment of national telecommunications equipment firms. There were two main objectives in this strategy: first, to reduce dependence on foreign technologies and second, to attain equilibrium in the trade balance for the telecommunications sector.

The development of the innovation system brought many benefits for the telecom sector. The share of locally developed products in the total market for electronic equipment steadily increased, from an average of 4% during the 1980s to 14% in the mid 1990s. These products were developed jointly by CPqD (the state owned services monopoly and centre for R&D), local firms, multinational subsidiaries and other research institutions. CPqD developed a range of digital exchange systems designed not only to suit Brazil's tropical climate, but also the local telephone traffic conditions found in the various regions. CPqD's close relationship with industry enabled technology transfer and joint development with local firms in exchange, transmission and peripheral telecom technology. By the 1980s Brazil was probably the leading Third World country in the development of digital telecommunications, mostly as a result of the policies adopted after 1974.

Innovations in the telecom sector significantly contributed to a reduction in the prices of key products. The price of installed terminals, which averaged US$ 800 in 1987, fell to approximately US$ 200 in 1993. If CPqD had not developed appropriate local technologies, the costs of setting up such a network in such a large country would have been exorbitant. The smallest exchanges available internationally at that time had a much higher line capacity than that needed by small towns and rural areas and would certainly have been under-utilised.

Trade Liberalisation in the 1990s

The institutional and regulatory changes that took place in Brazil from the 1990s were to have a profound effect on the telecommunications sector as a whole, primarily due the increase in the share of foreign capital in the industry.

In the initial stages, however, the new economic climate did not significantly affect the market structure or the organisation of innovation activities. Although import tariffs were significantly reduced technical barriers to entry remained important during the first half of the 1990s as Telebrás (the stated owned services monopoly) maintained its mandate to evaluate and license all equipment used. Firms (both local and foreign owned) continued their production activities, which entailed interactions with other actors within the system. While trade liberalisation resulted in changes in its orientation, CPqD remained the leading technology developer. However, the Centre did make a few changes, including undertaking more careful selection of its products, intensifying the development of operating systems for large clients (i.e. carriers of the Telebràs system) and beginning to focus on software development.

With time, however, the intensification of trade liberalisation and the absence of sectoral policies led to increased competition in the telecommunications equipment industry and forced firms to drastically reduce their costs. Although complete data are not available interviews with key actors reveal that firms - especially the technology-intensive nationally owned ones - reduced their investments in Research and Development (R&D) as a way of cutting costs to cope with the escalation in competition.

In 1995 there was a second round of liberalisation and deregulation, which led to profound changes in the telecommunications sector. Privatisation was preceded by huge public investments (approximately US$ 20 billion) in the modernisation of the Telebras´ system.

Throughout the privatisation process, the Brazilian government grappled with two fundamentally opposed policy options. The first entailed retaining a level of strategic control by the government and local capitalisation of the sector. Thus strategy, capital control and technology would become important variables to be considered in the bidding process. This option would consider foreign private partner(s) as long as their countries of origin were prepared to negotiate policies to foster local production of equipment. This is a strategy that has been followed by several countries, in their privatisation process.

The second alternative was to look for a good financial bid and consequently to maximise financial revenues and recoup Brazil's telecom investment costs. The second was eventually implemented in 1998 when, pressed by the imminent financial crisis, the Brazilian government privatised its operating companies and collected approximately US$ 20 billion.

An important consideration in the original planning for the privatisation process was to promote a duopoly in each region during a transition period up to 2001. This was to be achieved through stimulating the entrance of a new operator - the mirror companies - to compete in each region (3 in local telephony and one in long distance). However a real duopoly never occurred. In fact, after four years of operation, the mirror companies had acquired less than 5% of market share in the local telephony market. In the state of São Paulo, Telefonica, the incumbent operator, has a de facto monopoly with 98,7% of the local telephony market in 2003. Due to an article in the concession contracts (which allows for a yearly readjustment in tariffs using an index, IGP-DI, that is heavily influenced by changes in the exchange rate) there was a steep rise in telephone tariffs following privatisation. In July 2003, for instance, telephone rates were up by 32.75% from the previous year, in spite of significantly lower costs for the major operators (12.75% for Telemar, 16.34% for Telefonica and 13.06% for Brasil Telecom).

As a consequence profits for the key players increased substantially with the three companies raising approximately US$ 1 billion in 2002. Such high profits may be responsible for the bulk of profits remittance by Latin American subsidiaries of Spain´s Telefonica. Some analysts suggest that Telefonica do Brasil alone remitted 1 billion Euro in profits to its Spanish headquarters in 2002.

Developments in the mobile services market followed a completely different trajectory. The changes began in 1996 with the division of the country in ten regions for the purposes of selling mobile operating licences. During the privatisation of Telebrás in 1998, the mobile phone service was sold to different groups, thus setting up a real duopoly, unlike in the fixed line sector. In the last few years new operators have been licensed to supply mobile services within the regions, with three to four competing suppliers in most parts of the country.

From the point of view of the services supply, there has been a significant increase in the number of both mobile and fixed lines. The investment made by Telebrás prior to privatisation and expansion by the new operators led to a considerable increase in the number of installed lines. Similarly large increases occurred in the mobile telephone sector. In the latter case however, the primary causes for the increase are attributed to rapid technological change and competition between the three to four operators in each region.

Impacts on Innovation

The entry of foreign-owned carriers greatly affected the competitive position of local telecom equipment producers. These multinational subsidiaries - Telefonica de España, Telecom Italia, MCI, Qualcomm and France Telecom favoured their traditional equipment suppliers when placing new orders. The presence of a specific clause in the concession contracts stating that operators would not discriminate against local suppliers did not, in practice, have any effect on their preferred strategy towards equipment acquisition as it was not mandatory. As a result, local equipment suppliers were either forced to accept acquisition by foreign equipment suppliers or carve out a market niche in order to survive.

The outcome of these processes was a significant deterioration in the trade balance for the sector. Imports increased significantly during the 1996-2001 period. Although mobile phones are exclusively assembled in Brazil, there is still a heavy dependence on imported components.

The entry of foreign-owned producers of telecommunications equipment had a dramatic effect on the structure of the sector. To increase their competitive edge these companies acquired local producers and pursued import intensive and assemblage strategies, all of which led to the rapid de-nationalisation of the local equipment industry. From a high of 77% in 1988 the market share of nationally owned firms had been reduced to a mere 8.7% in 2000.

CPqD, the leading R&D institution during the 1980s, has been transformed into a private foundation (now called CPqD Foundation). Funds for the foundation were assured for the three year transition period as part of the deal signed with the new operators. During this period, CPqD was expected to establish new contracts with clients to enable it to continue its operations after 2001. Services that CPqD could provide include technical cooperation with national and international firms, providing technology services and consultancy to carriers and telecommunications manufacturers.

As a result, the Centre has cut down on research and increased its involvement in short-term consultancies, technical training and support activities. It is important to point out, however, that a number of R&D activities had already been discontinued during the early days of privatisation as a result of the uncertainties caused by institutional changes in the sector. Without assured government financing after the transitional period, it is unclear if CPqD will continue to function as the leading R&D agency in the telecom sector.

Conclusion

The main outcome of privatisation and liberalisation of Brazil's telecommunications sector in Brazil has been a rapid increase in the number of fixed and mobile installed lines. Unfortunately, these increases have not been matched by a lowering of service tariffs. These developments have therefore resulted in an unfavourable trade balance and have hampered continued innovation within the sector.

Following the national elections in 2002 the new Ministry of Communications is trying to implement new policies for the telecommunications sector. The local development of technologies, especially for advanced software and digital television is certainly on the agenda. However, it is too early to assess its feasibility. Although the innovation system has been negatively affected by the changes described in this paper, the enactment of proactive policies could help in harnessing new opportunities to improve the Brazilian telecommunications industry.

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ENABLING STATE POLICIES FOR ICT PRODUCTION

The pervasiveness of ICTs notwithstanding, the diffusion and development of ICTs in developing countries remains highly uneven, as countries in different regions of the world have continued to follow different trajectories of ICT production and diffusion. A Stanford University (1997) survey of several European and Asian countries found that some countries have clear advantages in the requisite factors for software development. China and India, for instance, have a comparative advantage of a large pool of skilled workers.

A comparative advantage of this kind is necessary but not sufficient for the development of IT hardware manufacturing, which is skill- as well as capital - intensive. In contradistinction, the software sector is neither capital-intensive nor does it face the problems of procedural delays in fulfilling the commitments of foreign buyers. The software developed for foreign buyers can be transferred instantaneously through the Internet.

Table I below presents the findings of the Stanford University survey. The findings show that India, Israel and Ireland have clear advantages in factors that are suited to software development. Not surprisingly, these countries have done extremely well in software production while their contribution to the hardware sector has been negligible.

Some country-specific indicators of production and diffusion of ICTs are presented in Table 2. The data relate to countries that have a major share in customised application software (India, Ireland and Israel) and others such as China, Korea, Mexico, Malaysia, and Taiwan that have emerged as significant producers of information systems hardware (Rasiah and Lin, 2003).

The data show that spending on ICTs in traditional software exporting countries is much lower than that of hardware producers. It is worth mentioning, however, that Ireland, which has traditionally been a software exporter, has increased its market share in hardware sales in recent years.

Policy Implications

While the software industry in nearly every country has grown without the explicit support of State policies, advances in hardware production are strongly linked to proactive measures by governments. Recent studies show that in order to achieve sustainable growth in the ICT sector, countries need targeted policies for the diffusion of ICTs as well.

In its analysis of the causes and consequences of the adoption of ICTs in developing countries, UNCSTD (1997) concluded that governments need to give priority to policies, regulations, education and training as well as to technology assessment programmes to enhance the capacity for creatively producing or using ICTs.

In this context the model of ICT development followed by Korea, Malaysia and Ireland can be regarded as worth considering. These countries are following a Schware (1992) model of export growth -producing for the domestic market to give companies the skills and a strong financial basis needed to enter export markets.

Having been one of the top producers of software products in international markets Ireland has recently taken measures to encourage higher diffusion of ICTs in the country. These include higher investment in the sector (6.7% of GDP) and the presence of a very high density of secured servers. Similarly, Korea and Malaysia - emerging big players in global hardware information systems - have initiated policies aimed at increasing the domestic diffusion of ICTs. Such policies include providing subsidies for the purchase of ICT equipment (computers, servers, routers etc) by educational institutions and the use of ICTs in governance structure. By enlarging their domestic market for ICTs, these countries are steadily improving the balance between export-led growth and national technology capability building .

By contrast, China's strategy has focused on export-led growth in its hardware sector while India is a highly successful software exporter. However, the initial high growth rates in these countries may not sustainable in the long run because of stiff competition from other countries, the development of open source software and saturation in the demand for customised products. Without proactive policies, the adoption and spread of the latest technologies, such as e-business and e-governance, will remain very low. Consequently, the process of technological capability building and, ultimately, overall economic development might be negatively affected in these countries. Policies that could enhance local diffusion include the development of a higher bandwidth communication network and encouraging the use of EDI (Electronic Data Interchange) technologies.

Table 1: Comparative Advantages of Selected Developing and Developed Nations

	India	Russia	E.Europe	Malaysia	Singapore	China	Japan	Israel	Ireland
1 Good general engineering education system	+	+	+	-			+	+	
2 Specific software and system training	+			-			+	+	
3 Large pool of capable programmers	+	+	+	-	-	+	+	-	
4 English language competence	+	-	-			-	-	+	+
5 Government policies on investment	+	-		+	+	-	+	+	+
6 Communication infrastructure	+	-		+	+		+	+	+
7 Entrepreneurial know-how	+	-			+		+	+	+
8 Foreign corporate investment	+	+			+	+	-		+

+ (strong positive)
- (strong negative)

Adapted from the Stanford University Computer Industry Project, 1997

Table 2: Production and Diffusion of ICTs in Selected Countries

Country	ICT EXP (as % GDP)	Telephone Density(per 1000 persons)	Secured Servers (per million persons)	Internet users (per 1000 persons	PCs (per1000 persons)
India	3.80	32.00	0.08	4.92	4.54
Ireland	6.70	419.80	76.44	206.64	359.13
Israel	NA	481.80	N/A	203.75	253.60
China	5.40	111.80	0.14	17.82	15.90
Korea	6.60	463.60	6.62	402.75	237.95
Malaysia	6.80	199.10	5.50	159.00	103.14
Mexico	3.20	124.70	2.23	27.69	50.57

Data source: World Development Indicators 2002

NB: Data relate to the year 2000

Lessons for less developed countries

Can other developing countries, particularly LDCs, follow the same path, given the competing priorities for investment funds in these countries? The experiences cited in this article highlight the need for countries to identify their comparative advantages in ICT production as a critical first step to harnessing these technologies as a development tool. Although ICT production in general is considered as capital and skill-intensive, there are many activities that are labour-intensive such as assembly of end-user computer, production of computer consumables, and manufacture of communication cable.

Simultaneous efforts should be made for greater diffusion of ICTs in business, government organisations, and educational institutions. Encouragement of the use of ICTs in educational institutions can serve the dual purpose:of building skills (that can be channeled into software production, for instance) and opening up access to universal education systems. While not all countries will be able to produce sophisticated ICT hardware in the short term, they can derive economic value from enacting policies aimed at wider diffusion of ICTs.

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References

Rasiah, Rajah and Lin, Yeo. 2003. The Role of Market, Trust and Government in the Development of the Information Hardware Industry in Taiwan UNU-INTECH Discussion Paper 2003-10

Schware, Robert. 1992. Software Industry Entry Strategies for Developing Countries: A 'Walking on Two Legs' Proposition. World Development 20(2): 143-64.

Stanford University Computer Industry Project.1997. Report of the Computer Industry Project. Stanford: Stanford University Press.

United Nations Commission on Science and Technology for Development (UNCSTD).1997. Report of the Working Group on Information and Communication Technologies for Development. E/CN.16/1997. Geneva:

OPEN SOURCE SOFTWARE: CHALLENGES AND PROSPECTS FOR DEVELOPING COUNTRIES

From its very beginning the idea of Open Source Software (OSS) has been highly political. The principle of publishing the source code of software and allowing its redistribution contributes to a free society, where one is able to help one's neighbours by lending or giving them software without legal consequences. This Free Software Movement, where "free" is interpreted in the political but not in the commercial sense, has gained a considerable momentum since its origins in the 1970s. This is mainly due to famous and successful OSS projects like the Linux operating system and the Apache web server. With the growing influence of software on people's daily life and the threat of commercial monopolies, the role of OSS has entered a new political level. A growing number of public institutions are already following, or considering an OSS policy. In the following article, we discuss the role this OSS movement could play for developing countries.

Open Source Software Licenses

Despite the fact that OSS provides access to the source code, its use is regulated through licenses. Generally, a software license is a statement of the control, rights, liberties, and risks of the use of software a user has to agree on. The difference from conventional software licenses is that the OSS licenses establish typically a "copyleft" rather than a copyright principle. This means that the developers transfer the right to copy the software to the user community, and also insist that this right is included in any further transfer. Over time a number of standard OSS licenses with varying levels of restriction have been designed.

One well known OSS is the GNU General Public License (GPL), invented by the Free Software Foundation under the leadership of Richard Stallman. The main motivation of the project was to fight the growing commercialisation of the UNIX operating system. There are a number of rules relating to the distribution of GPL licensed software: (1) The distributor must have a GPL license contract; (2) Anyone with access to the executable programme must also have access to the source code files; (3) All of these files must start with a short copyright note; (4) GPL software must not be sold, although the distribution process can be commercial; (5) GPL does not provide any warranty; (6) All changes to the software have to be documented. The most restrictive part, however, is the rule that every software that uses components of GPL licensed software, nor matter how small, falls itself under the GPL license. This last rule has led to a domino effect creating more and more free OSS. However, it also prevents some developers and companies from using GPL OSS. To overcome this drawback, Stallmann developed the Lesser GNU Public License (LGPL) where commercial software is allowed to link to LGPL software libraries.

Even more liberal is the Berkeley Software Distribution License (BSD). A BSD licensed piece of software can be freely copied, used and sold. Even the availability of the source code is not mandatory. The only restriction is that a copyright notice and license must be included. Prominent examples of BSD OSS is Free BSD Unix, and, with a slightly modified license, the Apache Web server. It is interesting to observe that both the Microsoft and Apple operating systems contain elements of BSD.

These examples demonstrate the broad range of OSS concepts today. Even the large software producers are offering OSS licenses to their main customers, albeit in a restricted manner. For the purposes of this discussion, however, we will focus on Free Software under licenses like GPL and BSD since this type of OSS is likely to be highly relevant for developing countries.

OSS Initiatives

One of the main political arguments in favour of the adoption of OSS strategies by public institutions is the notion of technological independence. Governments around the world are increasingly aware of their growing dependence on proprietary standards and software for carrying out day to day public administration. The fact that software for processing highly critical data is usually shipped without any warranty, coupled with a tendency for ever greater concentration software production, presents a very real threat to any

highly automated administrative structure. This is especially true for governments that wish to provide efficient and transparent services through e-government initiatives.

Many governments in the industrial world are slowly switching to an OSS policy. The European Union, which funds a number of OSS projects, and the City of Munich, which uses Linux, are two examples. But a growing number of governments promoting OSS are from developing countries or countries in transition. A reason for this might be the history of these countries that makes them especially sensitive to all forms of dependence. In April 2002, for example, Peru mandated the use of OSS in governmental organisations. Although, some of the relevant bills have not been turned into law, the trend towards OSS in Latin America is clearly visible. True independence, however, can only be achieved if a country participates in the development of OSS. A critical mass of local people is needed to persuade the OSS community to address specific local needs in software development, and to maintain the code. This need for participation is both an opportunity and an obstacle for the use of OSS in developing countries.

Participation in OSS Projects

OSS is usually collaboratively developed through the Internet. A core international group of typically 10 to15 experts who share a common interest in an application develop about 80 percent of the code. Subsequently, a larger community of users interact with the developers by reporting bugs, suggestions, and code improvements. Experience shows that this concurrent inspection process leads to a quality that can easily compete with that of commercial products.

It is this open feature of the OSS development process that creates opportunities for developing countries to participate in the technological developments in this area. This is in contrast to commercial software, which is mainly developed in industrial countries and then sold to developing countries. Thus, OSS can be considered as one means for bridging the digital divide between the developing and the developed world.

However, as a precondition for a country to be able to play a role in the OSS scene, governments must provide the necessary technological, educational and social infrastructure. Programmers must have cheap access to the Internet, sufficient technological knowledge to be able to contribute, and a certain financial security to spend part of their time in "non-direct-profit" OSS projects. Since financial security is a real issue in developing countries, publicly funded OSS projects might be the only way to go. Consequently, although OSS is free, independence through OSS is not.

Knowledge Transfer

OSS is a rich source of technological knowledge for developing countries. It should be pointed out that in the case of OSS "cheap" does not imply "low-quality". The opposite is, in fact, the case: the offered technology is of high quality, often outperforming commercial products. The high quality is the outcome of team work among idealistic and self-motivated people who freely share their knowledge via the Internet. It is now recognised that it is the very publication of the source code that makes the validation and verification phase more efficient than that of conventional software, since the costly 'debugging' is done in parallel. As a consequence, the OSS Apache powers 60% of the worlds web-servers today. This is about twice the share of Microsoft's IIS (Internet Information Server). Another example, is the open source database server MySQL. With more than 4 million installations it powers websites, data-warehouses, business applications and so on. In developing countries, this source of knowledge could be used in the training of young computer scientists. In programming courses the students should be encouraged to contribute pieces to OSS. Once they mastered these skills, one can be assured that they are well trained and ready to make a meaningful contribution to the sector.

Production or Servicing

There are two main forms of activity that industries devoted to software can undertake: production of software, either for sale on the market or as part of projects for clients, and servicing: maintenance, adaptation, training, and other forms of assistance and support. As OSS becomes more common, production is likely to become relatively less important than servicing, thus making software development more of a service industry. As this happens, so the

competitive edge of the local company, speaking the local language and aware of local conditions, will tend to improve.

Beyond OSS

Inspired by the success of OSS, professionals in other fields are trying to simulate this model of knowledge sharing. OpenLaw is an initiative hosted at the Harvard Law School with the idea of crafting legal arguments in an open forum. This is in contrast to current practice where legal arguments are designed by lawyers in secrecy. As in OSS, OpenLaw uses the power of an Internet connected society. Similar movements have been started in biology, where academic researchers try to outperform highly funded corporate researchers by sharing and publishing their knowledge. Another project in this line is OpenCourseWare, a free and open publication of Massachusetts Institute of Technology (MIT) course materials using the web. It can be foreseen that education systems in developing countries will benefit from this access to the lecture materials of one of the world's most reputed institutes of higher education and research.

Adapting OSS to Special Needs

A further advantage for a country participating in the OSS movement is the possibility to adapt free OSS packages to the special needs of a society. Such special needs may range from local language translations of application software to - importantly for developing countries - the development of low cost solutions. Language barriers present a major obstacle for gaining access to technological knowledge. A South African initiative is currently translating Linux into all 11 official languages. A group in Argentina has developed an optimised Linux version that is tailored to Argentinian users. This operating system can be executed from a CD and does not require installation. In India, the Simputer project is developing a low cost computer adapting Linux to use less resources.

The African continent is currently trying to overcome its infrastructure problems through relatively cheap OSS projects. Examples are projects on radio e-mail in Guinea, thin-client solutions in Nigeria, and a Linux wireless router in Ghana. The Free Software And Open Source Foundation For Africa was founded in February 2003 to coordinate such activities.

This growing trend towards broader sharing of knowledge via the Internet provides an opportunity for developing countries to participate in ongoing research and technical developments. In general, this will help countries to gain and maintain technological independence. However, the OSS movement shows that although the source code comes for free, real benefit can only be gained if a country actively participates in these projects. This requires governmental support with respect to infrastructure and social security. For further information on OSS activities in developing countries and for references to the projects mentioned above we refer to the recent studies cited below.

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References

Cesar Brod. Free Software in Latin America. January 2003. (http://www.maailma.kaapeli.fi/america.html)

N.S. Coetzee. Free- and Open Source Software in Africa.October 2002. (http://www.maailma.kaapeli.fi/africa.html)

Frederick Noronha. Liberation Technology for the lands of diversity? Free Software in Asia. February 2003.
(http://www.maailma.kaapeli.fi/asia.html)

Niranjan Rajani. Free as in Education: Significance of the Free/Libre and Open Source Software for Developing Countries.
(www.maailma.kaapeli.fi/FLOSSReport1.0.html)

E-BUSINESS AND ECONOMIC DEVELOPMENT: OPPORTUNITIES FOR DEVELOPING COUNTRIES

Until the mid 1990s the use of Information and Communication Technologies (ICTs) was mostly limited to product design and the productive activities of firms. Subsequent developments, however, have enabled both large and small firms to adopt ICTs in their business activities. These so-called e-business technologies can play a catalytic role in improving the performance of all types of businesses if other enabling factors, internal and external to the firm, are addressed. This article briefly revisits theoretical arguments in favour of e-business technologies and examines empirical findings from different regions of the world. The discussion is centred on small and medium enterprises, SMEs, because they are the major source of employment in developing countries and they contribute substantially to foreign exchange earnings in these countries.

Characteristics of E-Business

E-business tools are associated with business innovation and the management of a rapidly changing market landscape. Firms seek to reshape the way they go to markets and the manner in which customers buy products and services. E-business is, by definition, a broader concept than e-commerce, as it transcends the sale of goods to encompass the applications of ICTs in all business processes. Such applications include office automation, production processes co-ordination with other plants, customer relation management, supply chain management, and management of distribution networks.

In their study of East European and Cyprus SMEs, Damaskopoulos and Evgeniou (2003) found that most of the 900 firms sampled had established their websites to take advantage of cost reduction, easy their search for new markets, and to augment competitiveness. The study concluded that "…e-business affects first the boundaries of the firm with the market in which it operates".

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" .

Developing Countries and E-Business:

While clear evidence of the added value of adopting e-business techniques has been found in developed countries, the experience of developing countries remains mixed. Two recent studies by Moodley (2002) of the adoption of e-business technologies by South African manufacturing firms did not find sufficient evidence that export-oriented apparel firms and car manufacturers in the country have gained significantly from the adoption e-business practices.

A survey of several studies by Goldstein & O'Connor (2002) concluded that "…as multinational corporations integrate the Internet into their cross-border business operations, firms from developing countries run the risk of exclusion from global value chains if they cannot establish electronic ties with their major business partners." They argued, however, that there is evident need for a detailed sectoral analysis of the adoption of e-business. A case in point is Fiat's success 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.

A study by Lal (2002) captures the factors that influence the successful use of e-business technology to boost export performance. These factors are internal to the firm as well as external (beyond the control of firms). For instance the capacity to use e-business technologies effectively is an internal factor, while the speed of the communication network is an external factor that significantly influences the diffusion of web enabled technologies. A study by Mehta (2000) suggests that the availability of higher bandwidths is a prerequisite for the penetration of the Internet and web-enabled services in India.

Policy Implications

The implications of these findings are twofold. First, an appropriate environment for the effective adoption of e-business needs to be put in place if countries are to derive any benefits from these new technologies. This is particularly crucial for firms that seek to enhance their share in international markets by incorporating e-business tools to improve online financial transactions and

the monitoring of consignments. Governments can assist the SME sector in this by putting in place measures to encourage greater diffusion of ICTs, for instance providing access to high speed communication networks at competitive costs.

Another incentive for e-business among export-oriented firms could be the granting of tax holidays on the value of goods and services traded electronically.

A second area of government intervention relates to policies on collective learning and training facilities aimed at SMEs. Many studies on the consequences of the adoption of e-business have shown that the incorporation of e-business practices, as well as a higher skilled workforce, can enable firms to perform better. Hence policy makers need to target learning and training facilities for SMEs by providing logistical support to industry associations located in SME clusters.

In conclusion, it is imperative for developing countries to provide proper institutional support to firms, particularly export oriented ones, for the effective use of e-business. If proactive measures to speed up the adoption of e-business are not taken, developing country entrepreneurs might end up on the losing side in international trade.

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References

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

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

Lal, K. (2002) "E-Business and Export Behaviour: Evidence from Indian Firms", UNU-WIDER Discussion Paper, DP-2002/68.

Mehta, D. (2000): "Internet and E-commerce: The Global Scenario", in Dewang Mehta (Ed.) E-commerce and E-business: Background and Reference Resource (pp. 15-19). New Delhi: NASSCOM.

Moodley, S. (2002a): "E-Business in the South African Apparel Sector: A Utopian Vision of Efficiency?" The 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.

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

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Future UNU-INTECH Technology Policy Briefs will address: The Interrelationships between the TRIPs Agreement and the Convention on Biological Diversity; Biopharmaceutical Innovation Systems; and, North-South Partnerships in agricultural biotechnology and bioprospecting.

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