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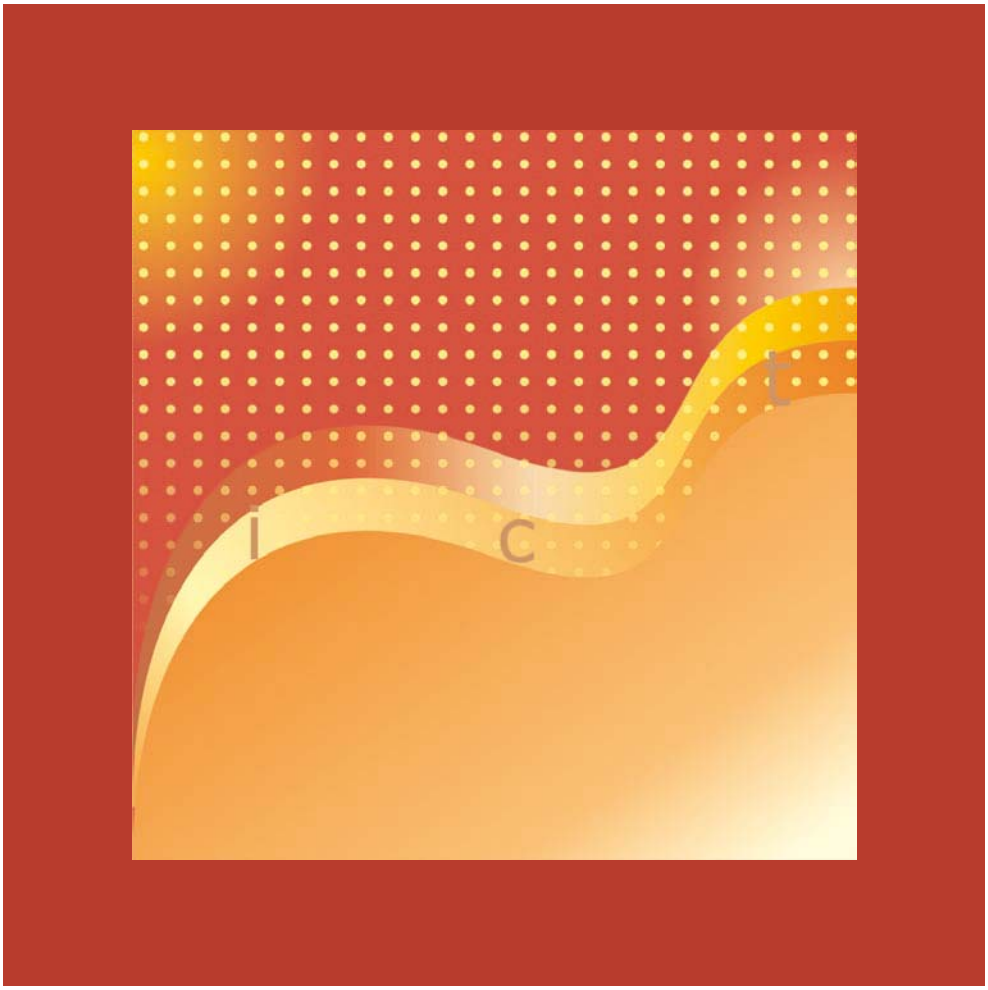
Science and technology for development: the new paradigm of ICT

Prepared by the UNCTAD secretariat



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Chapter 4

ICT, E-BUSINESS AND INNOVATION POLICIES IN DEVELOPING COUNTRIES

A. Introduction

As economies, mostly in the developed world, but increasingly in developing countries too, move towards an even more knowledge-intensive stage of evolution, understanding the role of the technologies that facilitate the accumulation, diffusion and absorption of knowledge in innovation-driven competition becomes crucially important. In particular, knowledge has long been recognized as one of the key factors underpinning innovation and, through it, economic growth and development in market economies.

The Introduction to this Report explores the general issues of knowledge generation and accumulation, and the conditions under which the results of scientific and engineering endeavours translate into business competitiveness at the micro level and growth and development at the macro one, including the cross-border distribution of the benefits of scientific and technological progress. Focusing on a specific aspect of technological development, this chapter looks at the role in that broad picture played by information and communication technologies (ICTs), which are generally considered to have been the prime mover in the powerful wave of innovation that transformed the global economy over the last quarter of the 20th century.[1]

The importance of innovation policies

Innovation, in a narrow sense, can be defined as the introduction by an enterprise of an entirely new product, service or productive process not previously used by anybody else. In a broader sense, the concept of innovation can be applied to the activities of enterprises which introduce for the first time products or processes that were not present in the particular market in which they operate, or in certain contexts, were merely new to the firm. [2] In that broader sense, innovation can also take place when new products or processes spread through imitation or when gradual improvements resulting in higher productivity are made. Innovation matters because, thanks to its positive effects on productivity, it is the major driver of long-term increases in output per worker and hence it determines the ability of the economy to support better living standards for all. Chart 4.1, taken from Hall and Mairesse (2006), illustrates the major relationships between innovation, productivity and firm performance.

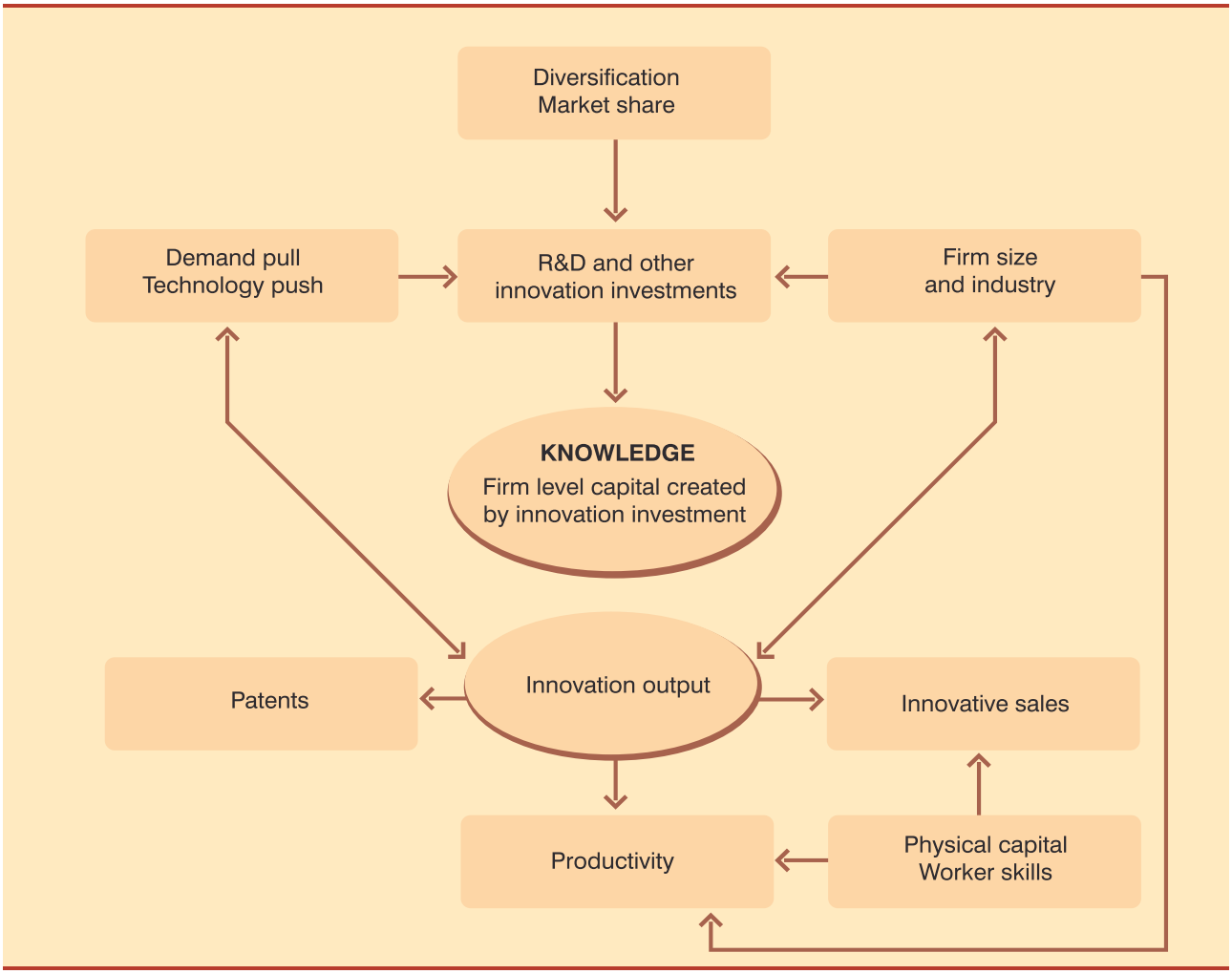
Public policies in support of the innovative activities of enterprises are justified by the existence of a number of possible market failures that could result in private investment in innovation that would fall below the socially desirable levels. Such market failures can affect both financial markets and markets for goods and services. Intellectual property regimes and cross-border investment rules also play fundamental roles in the generation and diffusion of knowledge and innovation. The existence of a strong national scientific base is another crucial reason for policy interventions to support innovation.

R&D is often highly capital-intensive. At the same time, the uncertainty of innovation and the existence of large asymmetries in the information that is available to innovators and to the providers of capital make it more costly for innovative enterprises, particularly the smaller ones, to access capital to fund R&D activities and/or the practical implementation of their outcome. The fact that knowledge spillovers make it impossible for the financial returns of innovations to be fully appropriated by innovative firms adds to the risk that the operation of financial markets may result in suboptimal levels of R&D investment.

Failures that affect the operation of markets for goods and services may also hold back innovation. Competitive pressure is a strong motive for innovative behaviour among enterprises; removing factors that unnecessarily restrict competition may therefore provide a way to accelerate innovation. The reduction of the impediments that limit market size and hence the opportunities for innovators to recoup the sunk

Chart 4.1

Innovation and productivity



Source: Hall and Mairesse (2006)

cost of R&D activities is another measure to consider in innovation-supporting policies.

Patents, the main instrument of intellectual property regimes, offer innovators a time-bound monopoly in the commercial application of the knowledge they produce. This enables them to recover the investment that R&D activities represent and may thus provide an incentive for innovation. However, innovation can happen, and has happened, in the absence of strong patent protection. A strong patent regime makes it more costly for other potential innovators to build on existing knowledge in order to generate their own innovation. The balance between the benefits and costs of patents from the point of view of the public interest (i.e. to support innovation and to facilitate knowledge spillovers) is not a straightforward one.

Knowledge spillovers may derive from the activities of publicly funded academic research centres and also from private-sector, commercially motivated research. Transnational corporations tend to be more active and obtain better results in their innovation efforts than domestic firms. [3] But it does not necessarily follow from this that policies to attract foreign direct investment (FDI) are the only, or even the best, instruments that developing countries have to facilitate the dissemination of innovation spillovers in their economies, because (a) transnational corporations are also better than domestic firms in preventing knowledge spillovers,[4] and (b) domestic enterprises in developing countries often lack the capacity to absorb potential spillovers without outside support. In order to diffuse knowledge and innovation across the economy, FDI policies are therefore often complemented with interventions to facilitate the interaction between local firms and

innovative international firms. From the point of view of the reinforcement of the absorptive capacity of local firms, it is important to facilitate the emergence of a solid scientific base at the national level. Even in a highly globalized world, knowledge transmission often takes place within relatively small networks and does not always flow easily across borders.[5]

The application of ICTs to productive, financial, administrative and commercial activities has been particularly fertile in terms of innovation. ICT use by enterprises has helped them to become more efficient through business-process innovations (for example, electronic data interchange), and it has also resulted in the emergence of entirely new products or services (for example, online banking).

The importance of the dynamic relationship between the use of ICT and innovation is increasingly recognized at the policy level. A sign of this is the abundance of initiatives at all governmental levels aimed at supporting ICT-driven innovation. Another one is the emerging trend for policies to promote ICT use by enterprises on the one hand and policies to foster innovation on the other hand to be entrusted to the same policymakers or placed under the same overall political responsibility. For example, in around half of the countries covered in a recent survey by the European Union the ministry or agency that is responsible for innovation policy is also involved in e-business promotion.[6] Most often, innovation policies include or address aspects of the use of ICT by businesses. However, even when innovation and policies related to the use of ICT by enterprises share the same institutional framework, it is not necessarily the case that they are envisioned as a single set of policy objectives with a coherent arsenal of policy instruments to achieve them. The borderlines are uncertain and ministries and agencies dealing with matters such as industry, small and medium-sized enterprises (SMEs), education, scientific research and others may be involved at various levels.

Earlier editions of UNCTAD's *Information Economy Report* and its predecessor, the *E-Commerce and Development Report* have covered extensively the general effects that ICTs have had as drivers of globalization. They have also discussed specific aspects of how enterprises in developed and developing countries need to adapt their operations in order to ensure sustainable competitiveness in an environment that is heavily influenced by ICT considerations. This chapter complements that coverage, looking (from the development and policy perspectives) at the linkages between ICT adoption in general and e-business in particular, and the facilitation of innovation processes in enterprises with regard to both ICT- and non-ICT-related aspects of their operations. The thrust of the chapter will be a description of existing best practices with a view to facilitating the choice of better support instruments and policies by developing countries.

B. Impact on innovation of the use of ICTs by enterprises

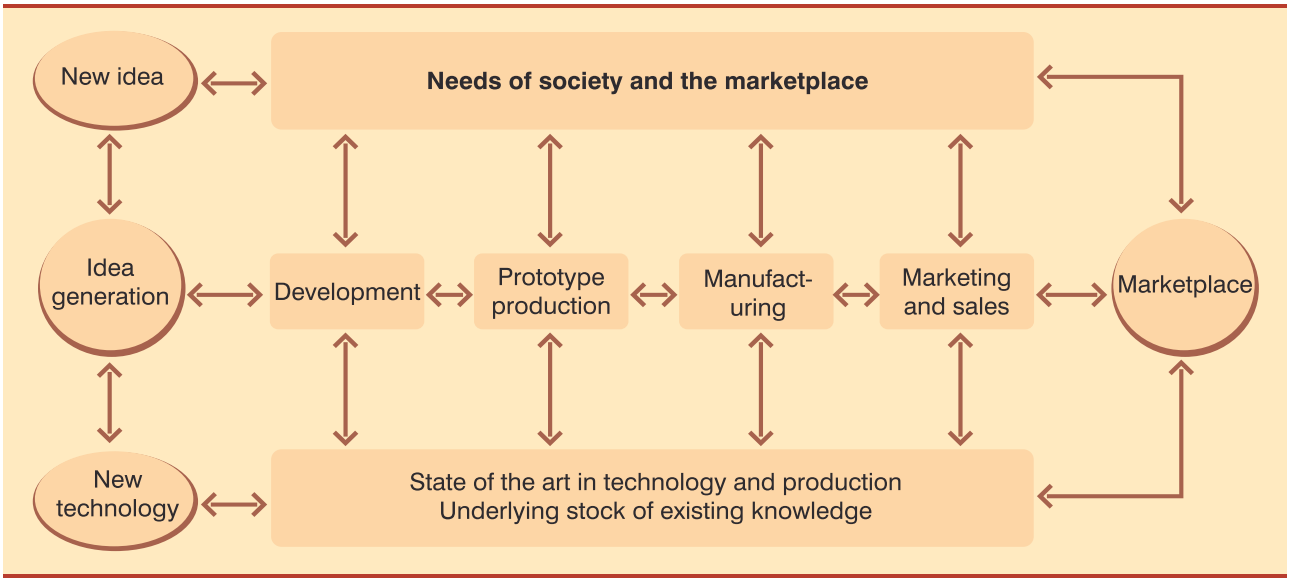
Economic globalization has significantly increased the competitive pressure on enterprises in many sectors. This comes as a result of, among other factors, the emergence of new, lower-cost producers, fast-changing demand patterns, increased market fragmentation and shortened product life cycles. In such an environment, innovation (either in terms of business processes or of final products and services) becomes crucial for the long-term competitiveness and survival of enterprises. It also enables them to climb the value ladder, a particularly important consideration for the enterprises of many developing countries. At the same time, the enterprises of those countries, particularly SMEs, face serious difficulties in benefiting from ICT-led innovation. For example, since R&D involve high fixed costs, they are intrinsically a high-risk activity and are subject to economies of scope that favour larger firms. Other general features of SMEs such as greater vulnerability to the essentially unpredictable market responses to innovative activity, or the greater difficulties they face in accessing financial and human capital, place them in a disadvantaged position with regard to engaging in innovative activities. When it comes to ICT-based innovation, policymakers need to take into account the general difficulties encountered by enterprises in developing countries, particularly in connection with ICT access and use by enterprises.[7] This section will consider the ways in which ICTs affect innovation, present examples of how ICTs may contribute to innovation in its different aspects, and explore a number of implications for developing countries.

How are ICTs connected with innovation?

Chart 4.2 presents a classic model of the interactions between markets, science and technology, and innovation in the context of the operation of markets. ICTs (irrespective of whether they are regarded as commodified tools or as drivers) can be introduced at any point in that model in order to bring about

Chart 4.2

Innovation system diagram



Source: Mowery and Rosenberg (1978).

innovation – product or process. They can be applied in, for example, marketing or communication, supply chain management, knowledge management, recombining existing technologies and product development.

Often ICT adoption by enterprises is regarded as a self-contained event that takes place in the course of an enterprise's development within a given technological, commercial and business environment. From that viewpoint, ICT use in businesses' operations would not be considered fundamentally different from, say, the purchase of more up-to-date machinery. In reality, however, if the full potential of ICT use in enterprises is to be realized, it must be understood and implemented as an integral part of a much broader process of transformation of business structures and processes, a transformation that necessarily involves the emergence of new or significantly improved products or services, and/or the implementation of new productive or managerial methods, namely innovations.

This chapter started with a reference to the value-creation role of knowledge as source of innovation and the central function that the latter performs in the development of a market economy, a view articulated in a path-breaking manner by Schumpeter (1943). However, the knowledge that is available to a society at a given point in time and the knowledge that is actually involved in innovation have not historically been identical magnitudes. Before the explosive development of ICTs, information and knowledge were much more costly to acquire and, in particular, to disseminate. The consequence was that they were much less available to enterprises and society at large, and therefore the pace of innovation was slower: only a few people would have the necessary knowledge, and decision-making processes would be strongly hierarchical (which may have been the most socially efficient solution in an environment of high cost of information). The link between innovation and information remained at the top socioeconomic layers and reached the mass of enterprises only after significant delays. With the fall in the cost of access to information the situation changes radically. The possibility of innovating is open to much wider strata of economic actors. Indeed, for many firms innovation becomes not a possibility, but a necessity. When everyone can innovate everyone must innovate, or risk being undercut by competitors. Abundant information creates a pro-innovation force by itself.

While in an environment of scarce, costly information innovation tended to result more or less exclusively from advances in technology embodied in material capital (better machines), the abundance of information makes innovation in intangibles (for example, brands or business models) increasingly important, hence the importance of innovation in business processes and structures. This is particularly visible in the flattening of organizational hierarchies. As enterprises become more aware of the importance of innovation for their competitiveness, and the need to be proactive

innovators, interactions among different categories of employees and managers evolve. Information has to be shared much more widely than in the past and ICT-enabled business processes tend to generate information flows that ignore formal hierarchies.

It is easy, almost trivial, to explain the many ways in which adopting ICTs can improve business performance, particularly by allowing companies to operate differently and at lower costs, and also to bring new products to the market. However, determining with precision what is going to be the net financial impact of particular ICT implementations, choosing the links in the value chain where interventions could yield better results and deciding on the sequencing and pace of adoption are not necessarily equally simple tasks. A decision to put in place e-business methods at a particular point in the diagram in chart 4.2 may require matching investments in skill acquisition, business process re-engineering or communications. All of those complements to ICTs represent additional expense, but without them e-business benefits may not materialize and the endeavour may worsen, rather than improve, the company's competitive stance.

Research tends to support the concept that e-business cannot be considered in isolation from other aspects of business change.[8] A common finding is that the positive effects of ICT use can include increased revenue and market share, greater adaptability to market conditions, shorter product development cycles, improved quality of after sales and, as a result, greater profitability. At the same time, research indicates that companies that complement their e-business projects with investments to enhance their workers' skills and to facilitate business process change are the ones that reap most of the benefits of e-business. In the absence of those conditions, the impact of ICT on the performance of enterprises tends to be significantly less.

Why ICT still matters for innovation

It has been argued that ICTs are now so widely prevalent in developed economies that their adoption can no longer be considered to be able to make a noticeable difference in innovation-based competitive strategies. According to this view, ICTs, like other "infrastructure" technologies (such as electricity), would have become essential for business operations and, at the same time, irrelevant in terms of strategic advantage.[9] UNCTAD data in chapter 1 of this Report show that approximately two thirds of enterprises in developed countries have an interactive website, although the average figure for all the countries (including developing countries) for which information is available is around 30 per cent. Other UNCTAD data in the same chapter show how for the sampled countries only an average of 13.9 per cent sell online and 22.5 per cent place orders via the Internet. Therefore, it seems that any possible signs of a "commoditization" of information technologies are most likely not applicable to developing countries. Furthermore, even in the context of an advanced economy the effects of ICTs on innovation and hence on competitiveness depend on the extent to which the implementation of those technologies has led to actual changes in business processes. Large variations seem to persist in the modalities by which enterprises incorporate ICTs into their competitive strategies, including innovation-related activities. Another reason for caution is that while the theoretical connections between innovation and ICTs are not difficult to establish, there is some difficulty in gathering hard statistical information about how those two phenomena interact in the real life of enterprises. The statistical measurement of e-business is still in its early stages of development, the notions involved are not always homogeneously understood and technological progress keeps moving the goalposts.

Changing the innovation paradigm

In spite of the above considerations, it can be argued that there are fundamental differences between ICT and other "infrastructure" technologies that make ICT a force for change in production/exchange processes and an accelerator of innovation. In fact, what seems to be happening is that the contribution that ICT makes to the competitiveness of enterprises is not decreasing; on the contrary, the gap between the potential of ICT and the value it delivers to organizations is actually growing (Brown and Hagel, 2003). For example, in a recent survey of innovative enterprises in Europe, around half of all innovations introduced in recent years were ICT-enabled, and they seemed to be at least not inferior to other innovations in terms of impact on enterprise profitability. While ICT-enabled innovations were more visible with regard to process innovation compared with product and service innovation, the latter seemed to have a greater impact on profits (Koellinger, 2005).

In this context it can be useful to refer to the concept of techno-economic paradigm, according to which a widespread set of related innovations, developed in response to a particular cluster of technical problems and using the same scientific principles

and organizational methods, provides the basis for scientific and productive activity at a particular point in time (Freeman and Perez, 1988). ICTs have profoundly changed the techno-economic paradigm within which innovation takes place today in developed and more advanced developing countries. Prior to those changes innovation revolved around concepts of mass production, economies of scale and corporate-dominated R&D. In the last three decades of the 20th century this has been replaced to a large extent by an emphasis on economies of scope, exploiting the benefits of interconnected, flexible production facilities and greater flexibility and decentralization of R&D and development. Flexibility, interconnectedness and collaboration rely on ICTs, which also play a fundamental role in facilitating research diversification and collaborative, interdisciplinary approaches.

Since the early 1990s, multinational corporations from developed countries and increasingly some advanced developing countries have increased their cross-border investment in the field of R&D, including in R&D facilities located in developing countries. For example, table 4.1, which is taken from a report published by Booz Allen Hamilton (2005), lists the top 10 global companies by R&D expenditure in 2004 and shows how practically all of them have established research facilities in developing countries. Those investments have acquired a greater significance than that of their previous role as mere agents of transfer of technology to the local market, becoming the locus of technology development for local, regional and increasingly global markets. The fast-moving integration of those research activities has given rise to the emergence of global R&D networks (Serapio and Hayashi, 2004).

ICTs also enable faster cross-border knowledge dissemination, particularly within transnational corporations, but also by facilitating networking and partnering among smaller players. By investing in ICTs enterprises improve their capacity to combine disparate technologies in new applications. This is important not only from the point of view of ensuring that firms achieve an adequate spread of internal technological undertakings but also from the point of view of the need to engage in R&D partnerships. In that regard, the major benefit of adopting ICTs may not necessarily derive from the technology per se but from its potential to facilitate technological recombination and change.

The relative decline of economies of scale as the massively dominant factor of competitiveness provides another justification for the role of ICT in the emergence of a new innovation paradigm. Product specialization, which through mass production generates competitive advantage, can be complemented in terms of competitive strategies by product or market diversification, which places a premium on the notions

Table 4.1

Geographical distribution of R&D facilities of the top ten R&D companies in 2004

Company	Home country	Locations of R&D facilities	Newest locations
Microsoft	United States	United States (3), China, India, United Kingdom	India
Pfizer	United States	Unites States (5), Canada, China (planned), France, Japan	China
Ford	United States	United States, Germany	Germany
DaimlerChrysler	Germany	Germany (4), United States (4), China, India, Japan	China, Japan
Toyota	Japan	United States (2), Europe (2), Australia, Thailand	Thailand
General Motors	United States	11 centres, including in Australia, Brazil, China, Germany (planned), Republic of Korea, Mexico, Sweden (planned), United States	Germany, Sweden
Siemens	Germany	150 centres in 30 countries (15 per cent in Germany)	China, India, Russian Federation
Matsushita Electric	Japan	10 sites in the United States and centres in Canada, China, Europe and Malaysia	China
IBM	United States	United States (4), China, India, Israel, Japan, Switzerland	India
Johnson & Johnson	United States	Australia, Belgium, Brazil, Canada, China, France, Spain, Switzerland, United Kingdom, United States	United States

Source: Booz Allen Hamilton (2005).

of flexibility, customization and adaptability for which ICTs are particularly fitted.

Much as the capital goods sector provided the means by which innovation moved across sectors and industries in earlier innovation waves based on the steam engine and electrification, ICTs are playing a crucial transmission role in the new innovation paradigm. But, instead of being a mere instrument for the transmission of knowledge about how to apply technology to various fields of activity, ICTs facilitate the connection of different fields of innovation potential (inside the firm or among members of value networks). This results in broader scope for innovation.

The dominance of ICTs in the new innovation paradigm also influences the geographical distribution of innovative activities and centres of excellence. Companies that fully understand and implement ICT-enabled strategies can become capable of participating in geographically complex international networks made possible by, among other factors, the new combinations of activities, whose respective centres of excellence may have been sited in distant locations. ICT-intensive innovators can be effective in managing those geographically dispersed networks, and in recombining formerly distinct and distant learning processes. This observation is mostly applicable to the manufactures industries in general and more particularly the ICT equipment sector, in which global learning networks are a common consequence of participation in global networks for the sourcing of technology – a case in point being that of original equipment manufacturers in Taiwan Province of China and in mainland China. In this way, ICTs can be seen as the string that bundles together three trends in innovation in the globalizing economy that were sketched out in the preceding paragraphs: the emergence of R&D networks that bind specialized poles of innovation, the diversification of innovation activity at the level of the firm, and the emergence of technology-focused inter-firm alliances

Some implications for developing countries

What does all this mean for developing countries? Enterprises in those countries face particularly difficult conditions in their innovation activities. Major constraints include the following: in most cases they cannot rely on a strong local scientific research community; they have to be able to make a profit while operating in narrow, low-income markets; and they lack the funds to support in-house R&D activities, with little or no venture capital ready to finance innovations. Clearly, ICTs do not provide immediate responses to those problems. However, some of the features of the ICT-led innovation paradigm that were discussed above could help create a more innovation-friendly environment in developing countries.

In the first place, the reduction in the cost of accessing and processing information and knowledge can help reduce the cost of generating the local scientific base of innovation. ICTs' significant enhancement of scientific-content accessibility should not be underestimated. The means for those involved in R&D in locations away from the leading scientific centres to remain abreast of the latest developments in any particular field of study are today vastly superior and cheaper than they were just two decades ago. In addition to providing easier access to the outputs of scientific research, ICTs are generating, stocking and enabling the manipulation of enormous databases that, by themselves, represent an opportunity for accelerated progress in natural and social sciences. At the same time, one should bear in mind that the generation and the accumulation of knowledge constitute complex social process whose success is not determined merely by the material availability of information. The tacit component of knowledge remains much less amenable to transfer through ICTs than its codified one. History, institutions, and even the physical and geographical conditions in which enterprises in developing countries operate, have a considerable influence on their capacity to move from acquiring information to learning.

Over a shorter time-span, the ICT-facilitated trend towards decentralization and diversification of research and innovation can benefit those developing countries where there is already some innovative activity by facilitating their integration into global learning networks and technology-based alliances. As technological change accelerates, competitive pressures force companies to augment their knowledge and capabilities. An increasingly important way to do that is to use "open innovation", a term that describes how even companies that are leaders in their field must complement their in-house R&D efforts with technologies developed by others, and open up their own technological knowledge to outsiders (Chesbrough, 2003). Traditional, inward-oriented technological capacity-building efforts tend to be complemented or even replaced with more outward-looking strategies that rely on the output of networks of universities, joint ventures, start-ups, suppliers and even competitors. This often results in technology-based alliances, which are being more and more used

as instruments of learning.[10] In addition to providing a fundamental means of cooperation in R&D within alliances, ICTs themselves are among the technologies that are more frequently the subject of technology-based alliances.

Technology-based alliances are increasingly important means of facilitating cross-border technology and know-how transfer. In 2000 estimates of R&D activity that were based on the number of patents indicated that only about 10 per cent of the technology development work of transnational corporations was done away from their home country, and only about 1 per cent was taking place in the developing countries (Archibugi and Iammarino, 2000). More recently, UNCTAD (2005) indicated that the share of developed countries in R&D expenditure had fallen from 97 per cent in 1991 to 91 per cent in 2002, while that of developing Asia had risen from 2 per cent to 6 per cent. According to Narula and Sadowski (2002), over 93 per cent of the technology partnerships they studied were between developed countries. The partnerships undertaken by firms from developing countries were signed almost exclusively with firms from developed countries. The countries most actively engaged in those agreements are the East Asian newly industrializing countries, together with several economies in Central and Eastern Europe. The participation of African firms was negligible.[11]

On the other hand, UNCTAD (2005) found that R&D was internationalizing rapidly and that between 1993 and 2002 the R&D expenditure of foreign affiliates worldwide increased from an estimated $30 billion to $67 billion (or from 10 per cent to 16 per cent of global business R&D). While the rise was relatively modest in developed host countries, it was quite significant in developing countries: the share of foreign affiliates in business R&D in the developing world increased from 2 per cent to 18 per cent between 1996 and 2002.

UNCTAD (2005) also indicated that the reported increase in the internationalization of R&D was affecting developing countries in a very uneven way, with developing Asia as the most dynamic recipient by far. The case of the R&D facilities established in India by a number of leading foreign companies suggests some factors that, over and above the lower salaries of scientists and engineers, may account for the decisions to engage in ICT innovation activities in developing countries. Such factors are often considered to include the existence of good-quality scientific and technical universities, which in turn results in the availability of a sufficient number of science and engineering graduates, and the pre-existence of a tissue of commercial and academic entities that are relevant to the relevant area of work.

The interplay of the factors that have made possible the emergence of ICT R&D poles in some developing countries is a complex one. Archibugi and Pietrobelli (2002) suggest that the arrival of a leading foreign technology firm may "generate externalities and induce the public sector to give prominence to associated Faculties and other public research centres". They quote as an example the R&D facility established by Texas Instruments in Bangalore as long ago as 1985, which specialized in design circuits. While it is not possible to ascertain whether the specialized ICT hub that currently exists in Bangalore would have developed irrespective of that decision, it seems clear that the large number of ICT firms that have been created and developed there would not have emerged without active public support policies for the ICT sector, particularly those that relate to the generation of a large pool of qualified engineers.

ICTs also facilitate and influence the location decisions in relation to R&D activities of enterprises from developing countries, which may sometimes choose to locate some facilities in developed countries. This may be done in order to facilitate the absorption of best practice and its transfer to the home country production sites. For example, according to Serapio and Dalton (1999), firms from the Republic of Korea owned more R&D facilities in the United States than companies from several developed countries with economies of comparable size. Those facilities were mainly operating in the field of ICTs. More recently, UNCTAD (2005) reported that the foreign R&D activities of developing country TNCs were growing rapidly. That trend is driven by the need to access advanced technologies and to adapt products to major export markets. Some of those TNCs are targeting the knowledge base of developed countries, while others are setting up R&D units in other developing economies.

Open innovation approaches

Open source software represents an innovation-oriented form of ICT-focused collaboration that is of increasing interest to enterprises in developing countries. In this case, ICTs provide not only the origin of the conceptual framework for a new mode of production and dissemination of knowledge and innovation, but also the main tools through which that framework can be put into operation.

Open source software, which consists of collaborative projects involving people located around the world and who, had it not been for the Internet, would never have had an opportunity to pool their knowledge, is one of the major examples of Internet-driven social and economic change. Free and open source software (FOSS) provides the most visible model of that trend. A discussion of the economic rationale for the open source software model and the advantages it offers from the point of view of developing countries is to be found in UNCTAD (2003).

With regard to innovation, FOSS gives developing countries the opportunity to benefit in a number of ways. In the first place, thanks to FOSS, software developers are able to enhance their skills and to improve more easily on ICT (software)-based business models. Participation in FOSS projects facilitates the creation and consolidation of local pools of expertise in ICTs, and given the low barriers to access to that software, enables the emergence of new ICT-related business activities. This may result in the launching of new (innovative) products or services, geared to the specific needs of local demand, that may not have been possible with proprietary software.

FOSS also reduces the cost of access to ICTs, although it should be stressed that cost considerations are not the primary advantage of the FOSS model for developing countries.[12] Since ICTs, as discussed above, are powerful enablers and accelerators of innovation, FOSS can play a crucial role in improving innovation in developing countries by supporting the accumulation and dissemination of knowledge. As FOSS uses open standards, it provides all economic actors with access to this key technology on equal terms. This works against the emergence of monopolies, favours technological diversity and promotes the emergence of new innovative business models.

The approach followed in the implementation of open source software projects is now being applied in fields outside software development. In the case of open source software, individuals cooperate on line with their peers in the production of software that is openly available to anyone who is interested in carrying the work further. The same model of on line collaboration can be applied to any business model in which the end product consists of information.

The open approach to innovation is based on the notion that as knowledge becomes more widely available and increasingly varied in sources and content, companies cannot limit themselves to their own research in order to be innovative and stay competitive. They have to be able to integrate and exploit external knowledge and skills (Chesbrough, 2003). ICTs are used to integrate the originally highly dispersed information and capabilities in a trial process from which innovation emerges. This is as valid for the individual enterprise as for cooperative networks of enterprises organized online. This open cooperation process of production can take place on a volunteer basis, with the end product being made available to everyone at no cost (such as Wikipedia). Alternatively, some form of compensation may be demanded by contributors and the end product may be used in a commercial operation.

Open innovation is related to the idea that competent users should be integrated into the innovation process (von Hippel, 2005). This refers to the trend for users (whether enterprises or consumers) to develop themselves the product or service they need and then freely release their innovation, as opposed to the traditional, manufacturer-centred approach whereby a manufacturer identifies the users' needs, develops the products and profits from selling them. User innovation is common in many fields, from scientific instruments to computer applications (for example, e-mail) or sports equipment (von Hippel, 2005). Users tend to innovate collaboratively in communities, a process rendered much more effective by the Internet. They also tend to grant free access to their innovation because often it does not make sense to protect it. Their major motivation for innovating is the improved usefulness of the product, which can be enhanced even further if other users have access to it so that they can improve on it. In many cases, their reputation as a skilled user-developer also matters strongly to them. The innovativeness of the results of the process can be so great that some suppliers may even decide to concentrate exclusively on manufacturing, giving up all product development and limiting themselves to downloading user-developed designs from user community websites. As an example, von Hippel (2005) mentions cases in fields as different as kitesurfing equipment, spine-surgery devices and toys. It is clear that the social benefits of user-led innovation would be significantly reduced without ICTs that provide users with strong computing capabilities needed for product design at a reasonable cost, as well as fast, cheap and far-reaching means for collaboration in users' communities.

The growing reliance by online media on "user-generated content" and the emerging phenomenon of "crowdsourcing", whereby the Internet is used to involve interested individuals in the definition and

development of new products or in the identification of a solution for a particular problem, are similar manifestations of the capacity of ICTs to democratize innovation processes.

Other business models have been developed for using the Internet to harness the resources of large pools of individuals or firms in order to address innovation problems in an open context. This includes NineSigma.com, which claims to have access to a global network of 1.5 million experts. According to the company, 60 per cent of the experts come from companies, 30 per cent are academic researchers and the remaining 10 per cent are with research laboratories, either publicly or industry-funded. Since those experts are free to forward the request for a solution to an innovation problem to other experts they know, as much as 40 per cent of solutions provided come from experts that were not originally contacted by NineSigma. The company reports that solutions have been provided by sources in a number of developing and transition countries, including Bulgaria, China, India, the Russian Federation, the Syrian Arab Republic and Yemen.[14]

Another example is Yourencore.com, which matches demand from companies looking for expertise regarding a particular scientific or engineering problem with supply of expertise from retired scientists and engineers who can thus earn extra income while working according to their own flexible schedule and staying intellectually active in their preferred professional field.

Based in India, Ideawicket.com has recently launched an "Open Innovation Portal", which provides a platform for individual innovators and corporations to exchange their innovation resources and requirements. Innovators are also able to give visibility to their creations and eventually make them available to interested enterprises.

A similar concept with a developing country involvement is the OpenBusiness project launched jointly by Creative Commons UK, Creative Commons South Africa and the Centre for Technology and Society at the FGV Law School in Rio de Janeiro, Brazil.[15] They describe OpenBusiness as a "platform to share and develop innovative Open Business ideas-entrepreneurial ideas which are built around openness, free services and free access".

Box 4.2 gives two concrete examples of how this kind of tool can be used to increase the efficiency of innovation activities even in companies that were well known as highly successful innovators in the pre-Internet paradigm.

Open approaches to innovation can take different forms. In some cases they may consist in a form of outsourcing of part or all of a company's R&D. Contracts and market conditions are the fundamental factors governing such projects. ICTs are helpful, but not necessarily crucial. In other cases, enterprises may go for a closer cooperative arrangement where reciprocity, long-term strategic considerations and

Box 4.1

The experience of InnoCentive

"Crowdsourcing" may be considered to be conceptually close to the business model of InnoCentive, an e-business venture that was launched in 2001 by the US-based multinational pharmaceutical company Eli Lilly. InnoCentive uses the Internet to help firms find scientific and technical expertise that they can use to meet innovation challenges. The "seeker" companies (which include very large transnational corporations) post on InnoCentive's website information about the problem they are trying to solve. Any participant in the network can attempt to provide a solution – for which they can be paid anything between $10,000 and $100,000. The occupations of the people who are providing these solutions cover a very broad spectrum, from people without formal expertise to scientists or engineers whose formal occupations do not fully satisfy their intellectual curiosity, or whose career paths have taken them far from their preferred domain of engagement, or others who are interested in the challenge of putting their specialization (say in physics) to use in a field outside its conventional application (biotechnology). Companies active in a completely different field can also provide innovative solutions to the "seeker" problem: a maker of tooth whitener can benefit from the experience of a laundry product maker, and polymers used in the semiconductor industry can help a maker of wrinkle-free shirts. InnoCentive is active in a number of developing and transition countries, including China, India and the Russian Federation. China in particular, where InnoCentive has established partnerships with 26 academic institutions, now represents over 30 per cent of the company's source of "solver" competition. The advantages of the participation of Chinese scientists in schemes such as these are not merely financial, since it allows them to gain exposure to, and an understanding of, the problems and methodologies of international companies in a wide range of industries.[13]

partnership are the keys. ICT-enabled cooperation becomes an important element in that case. Finally, taking the approach one step further they can go for what one could describe as "open access" innovation, along the conceptual lines of the FOSS model. In that case, innovation is the work of networks involving enterprises, users and eventually other stakeholders. Transparency, reputation and trust are the keystone concepts and ICTs are indispensable for the implementation of such projects.

The emergence of an ICT-based paradigm of innovation makes it advisable to gear government intervention to the promotion of cross-firm and cross-border knowledge flows, it being assumed that firms follow the model of a continually interactive search for better methods and improved products, and hence a Schumpeterian search for higher profits through experimental innovation. This could be more socially efficient, particularly from the standpoint of developing countries than the more traditional approach of protecting the exclusive right of the private owners of the resources invested in the generation of knowledge to protect that knowledge. The next section looks at how Governments can shape their e-business and ICT policies so that their interaction results in faster, more development-relevant innovation.

C. Maximizing synergies between e-business and innovation policies

While e-business is approaching maturity status as an operational technique and there is no controversy about the role of ICTs in recent business innovation waves, the recognition at the policy level of the need to simultaneously consider e-business and innovation issues is recent and incomplete, and to a large extent led by developed countries. As developing countries adapt their national innovation systems to benefit from the dynamic interplay between ICT use by enterprises and innovation-led competitiveness policies they need to be aware of available experience in this regard and

Box 4.2

Use of open innovation by Procter and Gamble and Nokia

In 2002, marketing executives at Procter and Gamble, a US-based consumer goods transnational corporation, came up with the idea that a good way to make their potato crisps more enticing to customers would be to have text or images printed on them. When this turned out to be rather challenging technically, the company did not use its extensive internal engineering resources to solve the problem. Instead, it exploited the potential of global networking. A document detailing the technical challenge to be met was circulated throughout the company's global networks of individuals and institutions, the purpose being to find anyone who had already thought about the same problem. Eventually, they found a small bakery in Bologna, Italy, run by a university professor who also manufactured baking equipment. He had invented an ink-jet method for printing edible images on cakes and cookies, and this was rapidly adapted to print on potato crisps. Less than two years later the product was launched and it was delivering high revenue growth to the division concerned.

Procter and Gamble has a long history of in-house generated innovative output. For more than a century the company had followed a policy of heavy investment in internal R&D work. However, in 2000 it decided to radically change its innovation model, from its traditional continuous internal innovation approach to a "connect & develop" model. The reason for this was that the company needed to accelerate its innovation rate, which had stalled at a success rate of 35 per cent. This was considered to be a factor in the fall of its stock price. Since the most successful innovation projects seemed to result from linking ideas across internal businesses, it seemed plausible that an increase in the number of ideas coming from outside businesses would be equally productive. The target was to increase the rate of external innovation to 50 per cent. This was to be done by connecting and collaborating with suppliers, scientists and entrepreneurs and systematically exploring their business environment in search of innovation opportunities to which the company could apply its expertise and capacity. Through this approach, R&D productivity is said to have increased by about 50 per cent in the five years that followed and some 100 new products have been launched, for which some of the development was not done internally. In the words of Larry Huston, Procter & Gamble's vice president of innovation and knowledge, "It has changed how we define the organization. We have 9,000 people on our R&D staff and up to 1.5 million researchers working through our external networks. The line between the two is hard to draw."[16]

Another example of an innovation network is the "Nokia Developer Operations" peer production system for software development operated by the Finnish telecom equipment manufacturer. Nokia has created an electronic platform on the Internet that allows about 2.5 million users to obtain any kind of technical information about Nokia products that they may need in order to develop new solutions. This turns users into partners of the company. This network of users is actually integrating Nokia into a broader open source community, which makes it easier for the company to spot users' changing needs and tastes and to innovate in response. Nokia partners with large and small corporations and asks them to join the network.[17]

adapt the lessons from it to their specific needs and concerns. This section will present the main lines of convergence of e-business and innovation policies, and identify best-practice examples that may be relevant and transferable to developing countries.

Emerging approaches to innovation policy: integrating e-business

Innovation policy aims at increasing the amount and enhancing the effectiveness of innovative activity by enterprises. As discussed above, broadly defined innovative activity not only includes the creation, adaptation or adoption of new or improved products or services, but also refers to many other value-creation processes. Therefore, innovation policy needs to consider not only strictly technological innovation but also organizational (new working methods) and presentational (design and marketing) innovation. Given the strong links between ICT use by enterprises, competitiveness and innovation, it is clear that enterprises need to align policies in those fields.

In practice, the integration of policies to promote ICT use by enterprises within general innovation policies still has some way to go in most countries. Two broad categories of approach can be identified in this regard. A relatively small number of countries, mostly in Northern Europe, have adopted an approach to innovation policy that sees it as a cross-cutting issue that must be included in the policies of individual agencies, together with ICT and e-business policies. This often leads to a reduction in the number of independent initiatives undertaken by individual agencies and ministries. A second, more common approach still sees innovation as a dual phenomenon. On the one hand, it is perceived as being the result of R&D processes, support for which is in the hands of agencies dealing with research and education. On the other hand, it is also considered to be a tool for the enhancement of competitiveness and SME modernization and this aspect of innovation is handled by ministries in the sphere of economics, industry and trade. In this approach, programmes to support innovation may include e-business as one issue among others to be dealt with. The instruments used, however, may not be too different from the ones chosen by policymakers who focus primarily on e-business as an innovation driver. This is particularly true in the case of SME-targeting programmes, since for this group of enterprises adapting to the changes in the competitive environment that have been brought about by e-business is probably the priority innovation strategy.

While the links between the policy framework of innovation and that of e-business policymaking are becoming stronger in a growing number of countries, the range of policy interventions and actors remains wide, particularly since different levels of Governments and quasi-governmental agencies see innovation, competitiveness, e-business and/or entrepreneurship support as crucial to their development objectives. From the substantive point of view, the differentiation between ICT/e-business policies on the one hand and innovation policies on the other remains visible with regard to several important dimensions of the problems in question. For instance, standard innovation indicators are not frequently considered relevant to efforts to benchmark the development of the "information society". On the other hand, it is common to see e-business promotion plans that lack an explicit reference to innovation as an objective, even though different forms of innovation represent the core goal of those plans. In practice, this results in e-business measures that are implemented at the operational level by the same ministries or agencies as innovation measures, ones that address the same target population and share policy instruments, but lack a clear common conceptual framework and formal feedback mechanisms, and waste opportunities for synergies.

The importance of integration and coordination of policies from different ministries and at different levels must be stressed. Since e-business affects many sectors and processes, an integrated approach to the issues is more likely to produce practical results than a piecemeal one. A way to seek coordination can be to bind together all instruments for ICT use promotion and innovation support in one single public sector ministry. However, that does not always produce optimal results in terms of integration. A way to improve that is to bring together in policy formulation all different stakeholders. Up to three levels of policymaking can be distinguished in this field. One includes decision makers in national ministries and agencies. A second level is formed by entities such as internal agency working groups, inter-agency commissions and the like. The third level involves different ICT user groups. While the clear distinction between the policy and the operational levels should be maintained, the involvement of all those stakeholders is necessary, and there should be channels to ensure a reasonable balance between top-down and bottom-up policymaking. It is also important to support networking across sectors and across innovation themes.

Adapting best practice in e-business and innovation promotion

There is a major opportunity for developing countries to learn from best practice in the field of public support related to e-business and innovation. They should explore some of the existing mechanisms of governance and weigh up the pros and cons of pursuing national, regional and local agendas and also exploring alternative ways to distribute public, private or public/private responsibilities for implementation.

The first issue to consider is the integration of the institutional frameworks of innovation and e-business policymaking. In that regard, many of the developed countries, particularly in Europe, have entrusted overall policymaking for innovation and e-business to the same organizations. However, this does not imply that policies are necessarily coordinated. Interestingly, when one considers the case of the European Union, it is noticeable that among the newer member States the dominant trend is to give institutional pre-eminence (in the form dedicated ministries or commissions) to the issues of ICTs, the Information Society or e-business, while in the older member States – the EU 15 – those matters are more likely to be placed in the hands of the institutions generally in charge of innovation, scientific R&D and industry.

Norway and Iceland are examples of countries in which two different ministries are involved in those matters (in Norway the ministries of trade and industry and of education and research; in Iceland the ministries of education, science and culture and of industry and commerce). In other countries innovation and e-business policies are addressed in parallel. This is the case of the Netherlands, where the Ministry of Economic Affairs has responsibility for both policy types, but e-business issues are delegated to an external agency, while other ministries are also involved. This does not, however, ensure policy coordination and the linkage of innovation and e-business policies. As a response to the challenge of integrated governance an Interdepartmental Committee for Science, Innovation and Informatics (CWTI) has been to created to prepare the overall policy strategies on science, research, technology and innovation policy.

An example that has been regarded as representing best practice, addressing both the innovation and the ICT policy areas is the Italian Action Plan for ICT Innovation in Enterprises, which was launched in 2003 by the Ministry for Innovation and Technologies and the Ministry for Productive Activities. In addition to questions of ICT and innovation, the Plan dealt with other elements that play a role in improving the development potential of enterprises, such as education and training, R&D and entrepreneurship. It also included a consultative e-business committee composed of representatives of academia, business associations, financial institutions and trade unions.

Malaysia, a leading performer in terms of innovation and e-business adoption among developing countries, provides an example of efforts to integrate ICT and innovation policymaking. ICT policy-making was transferred from the former Ministry of Energy, Communication and Multimedia to the Ministry of Science, Technology and Innovation (MOSTI). MOSTI's mission statement reads as follows: "harnessing Science, Technology and Innovation (STI) and human capital to value-add the agricultural and industrial sectors and to develop the new economy, particularly through information and communications technology (ICT), and biotechnology".[18] Thus, ICT policy is conceived as an integral part of STI policies. Among other aspects of ICT policymaking, MOSTI is responsible for the formulation and implementation of national policy on ICT and the encouragement of R&D and commercialization in ICT.

The case of Mexico illustrates a different approach to the relationship between innovation and ICT policymaking. In response to strong competition from other developing countries, Mexico has undertaken a number of initiatives to upgrade the innovative potential of its economy. Many of those initiatives to expand its science and technology base are undertaken under the leadership of the National Council for Science and Technology (CONACYT), an agency that reports directly to the President of the Republic. Other government agencies are also implementing programmes to enhance the productivity and competitiveness of the private sector, enhancement being considered one of the strategic objectives of the national development plan. Several of those programmes relate to ICT and e-business issues. There are several other ministries and agencies, in addition to CONACYT, that have responsibilities connected to ICT policies. They include the Ministry of the Economy, the Ministry of Communications and Transport, the Ministry of Education, the development bank and the 32 State governments.

The role of the State governments in the Mexican case is an example of a situation that is found across developing and developed countries. Regional and local governments play an important role in implementing

innovation and e-business policies, although in most countries the largest role in policy definition and coordination remains at the national level. Regional and local levels of policy delivery often seem to be highly relevant, as in most countries most enterprises are of local or regional size and only relatively few operate at the national level. Programmes commonly rely on local or regional networks of stakeholders or communities of practice for the delivery of support measures. While many factors influence the ability of firms to innovate, some of the most direct ones are often not easily handled at the national level. Clusters, for example, are a powerful instrument in innovation policies which is normally managed at the regional level. This does not mean that there is no role for policy at higher levels of aggregation: the operation of clusters can be improved through networking, the identification of best practice and common learning. National frameworks provide useful support for those aspects of innovation and e-business policies.

Major support instruments for e-business innovation

Innovation takes place primarily within firms. The priority concern of Governments therefore is to establish and implement sound innovation policies that enable firms to maximize innovation. As mentioned in the introduction to this chapter, creating an environment that facilitates innovation often requires the addressing of a number of market failures that may result in suboptimal levels of innovative activity by the private sector. Those failures may relate to the operation of markets (financial or goods and services) or limit the presence of knowledge spillovers. Instruments commonly used to address such problems include the direct funding and subsidizing of R&D activities, the provision of support for venture capital funds, the facilitation of transfer of technology and partnership networking mechanisms, incubators and clusters, demand-side management, the provision of data, analysis and studies, and the establishment of centres for demonstration and testing. E-business policy interventions are very frequently present in most if not all of those categories of instruments. For example, in R&D funding, public funding is frequently granted for research in areas such as software, expert systems or Internet technologies. E-business is also frequently chosen as a field in which multi-stakeholder partnerships involving enterprises, business associations, educational institutions and government agencies aim at facilitating transfer of technology and innovation.

Funding of R&D activities tends to be the innovation policy instrument most frequently used. Technology transfer, partnerships and networking are other policy tools that are frequently used. Frequently, programmes supporting e-business and innovation cover more than one policy area in scope. Projects and funding for the support of feasibility studies are also well represented, possibly as a consequence of the ongoing experimental nature of e-business and e-commerce development. Box 4.3 presents some examples of specific programmes that link e-business and innovation.

In some cases policy interventions do not establish a clear-cut distinction between e-business goals and broader societal objectives such as the improvement of e-skills, e-government initiatives or ICT infrastructure and access issues. In that context, e-business is sometimes perceived not so much as a policy area in itself but as rather an instrument to achieve goals in respect of a number of Information Society issues.

From the point of view of the relationship with innovation policies, the traditional approach still tends to see e-business more as part of the ICT policy field than as a component of the innovation policy set. One reason for this is that ICT has been a major force for change in many policy areas beyond innovation (health, employment, security, education and so forth). In practice, however, the application of policies that may a priori be categorized as coming within the scope of either innovation or e-business policy often results in the development of responses to economic problems that involve a subject crossing from one policy field to the other. It is increasingly difficult to establish a clear-cut distinction between those two cross-sectoral groups of policies. As empirical evidence for the impact of ICT and e-business on economic performance mounts, the logic of reinforcing innovation policy by incorporating e-business and ICT support policies becomes stronger.

While it can be expected that e-business and innovation policies will tend to become more closely integrated in the medium and long term, it also clear that the connection between e-business policies and general ICT policies will remain stronger in many countries for some time. A reason for this is that the implementation of ICT and e-business investment by a company or government agency may not translate into an immediately noticeable improvement in their capacity to innovate. In fact, the potential to transform business operations may not even be the explicit policy objective of ICT adoption, although in the end their application may generate very significant innovations. Cost-

Box 4.3

Examples of programmes linking e-business and innovation

In Chile the Innova programme, which is coordinated by the Ministry of the Economy and involves several other ministries and agencies, has the general objective of promoting technological innovation and includes significant ICT and e-business components. Together with instruments addressing issues of infrastructure and access to ICT, the programme also provides incentives and technical support to help enterprises undertake the process of innovation and organizational change that is needed to successfully absorb information technology and develop innovative business models.[19]

"Webworks" is an Enterprise Ireland regional development scheme. It aims to expand existing clusters of technology-based companies in order to achieve a critical mass in informatics, e-business, digital media or health sciences. This model gives preference to start-ups with R&D capabilities and a large potential for export sales. As part of cluster-building, it provide flexible, highly wired office accommodation and management support.[20]

In Singapore, the Infocomm@SME programme of the Infocomm Development Authority explicitly aims at accelerating both the adoption of ICTs and their innovative use by SMEs. Its action plan combines initiatives to facilitate ICT access and use by enterprises with other instruments aimed at using ICT to catalyse sectoral transformation in specific growth sectors, as well as with programmes targeting SMEs that can use ICT and e-business to improve their innovative performance and become role models for other enterprises.[21]

The United Kingdom's ICT Carrier programme is an example of an initiative aimed at transferring ICT into UK engineering industries and driving its uptake. This is a programme where the tool is ICTs but the objective is to "promote enterprise, innovation and increase productivity". Particular emphasis is placed on the integration of e-business and e-manufacturing into engineering industries and their immediate supply chains.[22]

cutting, improving the relationship with customers or many other straightforward business needs may be the explicit reasons for e-business adoption. Sometimes the objective can be of a more strategic nature, such as driving and facilitating profound changes in the organization.

Getting the SMEs on board

Given the huge weight of SMEs in developing economies, particularly from the point of view of employment, the question of how to address their particular needs in the field of ICT and innovation should be carefully addressed.

The first point to consider is the way in which innovation and e-business affect the competitive and innovative behaviour of SMEs. In that respect it is important that policymakers keep in mind the need to adapt their instruments as ICT-driven innovation spreads in the economy and creates network business models that may affect the relevance of policies and interventions. A related business environment factor to consider in the design of innovation support programmes targeting SMEs is that as e-business practices generalize, SMEs find that innovation becomes more easily visible to, and eventually imitable by, competitors.

Another consideration that is specific to SMEs and may require special efforts from innovation support policies concerns the need to make clear to the SMEs the relevant benefits that a particular intervention delivers to them and the specific manner in which their competitive potential will be enhanced as a result of it. The amounts involved may be significant.

Helping SMEs identify how innovating through e-business can be actually done in their particular environment can be a time-consuming and expensive exercise that needs to be conducted in an individualized manner. Policies should aim at helping SMEs integrate ICT and e-business considerations as a fundamental element of their enterprise development plans. This means that programmes need to focus on what ICT and e-business can do to solve real problems that SME managers can easily identify. An adequate outreach strategy in that regard needs to make extensive use of the language that enterprises understand best: the financial performance benchmarks that they are used to. When SMEs can make a clear connection between their performance benchmarks against those of their competitors and their relative position in terms of ICT, e-business use and innovation the vital importance of the questions involved comes across to managers immediately.

An important lesson that countries which are considering putting in place support programmes in this field need to keep in mind is that for initiatives to succeed they need to remain in place for a reasonable period of time. The value of any set of ICT innovation support measures can be judged on a rational basis only once some impact measurement has been undertaken, and this takes time. However, it is not uncommon that programmes in this field are terminated before their effects on enterprises can be assessed. This makes it difficult to replicate and scale up successful initiatives, and to accumulate and disseminate best practice. At the same time, it is also important that policies adapt and change in response to practical experience. Striking the right balance between the needs for policy stability and flexibility and evolution calls for mechanisms that allow feedback from end-users to reach policymakers, and frequent and meaningful interaction between all stakeholders.

D. Conclusions and policy recommendations

The main purpose of this chapter was to present the case for a much closer relationship between policies to promote innovation and policies to facilitate the adoption and use of ICT by enterprises. This is based on the premise that in today's innovation paradigm ICTs play a central role. In a growing number of sectors the capacity to implement e-business practices is a fundamental determinant of competitiveness, which is the ultimate purpose of innovation policies. Bringing innovation policies closer to ICT and e-business policies will require the development of a framework in which the relationships between the concepts of ICT, e-business and innovation become clearer to the stakeholders.

As discussed in section B, an innovation policy framework that fully takes into consideration the changes generated by ICT must give prominence to open approaches to innovation, which present significant advantages for developing countries. In order to support open innovation, which relies on cooperation, policymakers need to take into account the trade-offs that exist between the competitive incentives to innovate and the ability to cooperate with other enterprises. Partnerships and alliances, between the private and the public sector and between enterprises, become particularly useful in that regard and ICT provides platforms that make them easier to implement.

Another area in which policy can support the development of open innovation is the intellectual property regime, a topic that is far too complex to be dealt with in the context of this chapter. However, it should be noted that while in a closed innovation framework intellectual property is used to capture value by excluding competitors from knowledge, in an open innovation approach intellectual property instruments can be used to create a "knowledge commons" in which collaboration can generate value. Policymakers should pay attention to the balance between the use of intellectual property to protect market positions and the need to facilitate cooperation.

An open innovation approach requires some adaptation of innovation support policies. The emphasis should move from supporting individual firms to providing more assistance to innovation networks. Many funding or incentive instruments to support innovation currently orient firms towards building closed, in-house R&D capacity and do not encourage them to look for networking opportunities. In many countries, enterprises that rely on cooperation with external networks in order to innovate are not eligible for innovation support measures, which are geared to firms with internal R&D facilities only. Supporting networks of innovation also involves strengthening networking skills, particularly among SMEs; this includes aspects such as human capital management, intellectual property management and trust-building.

Public research institutions and academic centres have a key role to play in advancing open innovation. The academic incentive system may benefit from reconsidering how to stimulate the emergence of collaborative strategies, to foster knowledge-sharing and to engage with industry.

User-driven innovation is a form of ICT-enabled open innovation that is increasingly important. Policy can support it in a number of ways. One is to promote the use of open standards, particularly through public procurement policies. Another one is to undertake efforts to assess the extent to which user innovation is actually implemented in order to adapt overall innovation policy. Policymakers should also consider the possible negative effects on user-driven innovation that may result from imposing restrictions on the ability of users to modify products that they own.

Finally, general environment conditions that are frequently mentioned as necessary for the development of an information society are also important for the development of open innovation. These include an

educated population, IT infrastructure of good quality, efficient capital markets and the creation of a high-trust business environment.

The overall conclusion of this chapter is that as the effects of e-business adoption spread across the economy and affect most sectors and aspects of business process an integrated approach to e-business and innovation policies is needed. Experience shows that the effectiveness of innovation policy and e-business-related policies improves when they are conceived and implemented in a closely coordinated manner. But the changes that ICT have introduced in the functioning of modern economic systems are such that this coordination between both policy areas is likely to gradually lead to a significant level of integration among them.

In practice, the integration and coordination of policies in those two fields amount to the creation of an institutional framework of cooperation among the different ministries and different levels of government that are often involved in them. Coordination can be achieved by integrating all instruments for e-business and innovation support into a single ministry or agency, although this does not always result in closer coordination. It can also be achieved by creating institutional mechanisms that allow the full involvement of all stakeholders, with the right balance between bottom-up and top-down policymaking.

Enough experience of policy approaches and instruments is already available to suggest that for developing countries ICT-enabled innovation policies provide an opportunity to explore open innovation approaches that may be more suited to their concerns than traditional ones. Sharing of experiences and learning to learn from others will be crucial in that regard. This is a process that UNCTAD may be well placed to facilitate at the global level as part of its work in the field of science, technology and innovation, in cooperation with other relevant organizations at the regional level.

References and bibliography

Archibugi D and Iammarino S (2000). Innovation and globalisation: Evidence and implications. In Chesnais F, Ietto-Gilles G and Simonetti R (eds.), European Integration and Global Technology Strategies. Routledge. London.

Archibugi, D and Pietrobelli, C (2002). The globalisation of technology and its implications for developing countries: Windows of opportunity or further burden? *Technological Forecasting and Social Science*, vol. 70, no. 9, November, pp. 861–884.

Booz Allen Hamilton (2005). *The Booz Allen Hamilton Global Innovation 1000: Money Isn't Everything* (by Barry Jaruzelsky, Kevin Dehoff and Rakesh Bordia). Available at http://www.boozallen.com/media/file/151786.pdf.

Brown J and Hagel J (2003). Letter to the Editor. *Harvard Business Review* July 2003.

Cantwell J A (1999). Innovation as the principal source of growth in the global economy. In: Archibugi D, Howells J and Michie J (eds.), *Innovation Policy in a Global Economy*. Cambridge: Cambridge University Press.

Carr N (2003). IT doesn't matter. *Harvard Business Review*, May.

Cassiman B and Veugelers R (2004). Foreign subsidiaries as channel of international technology diffusion: some direct firm level evidence from Belgium. *European Economic Review*, 48:2, pp. 455–76.

Chesbrough H (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press.

Criscuolo C and Martin R (2004). Multinationals and US productivity leadership: evidence from Great Britain. CEP Discussion Paper No. 672, http://cep.lse.ac.uk/pubs/download/dp0672.pdf.

Criscuolo C, Haskel J and Slaughter M (2005). Global engagement and the innovation activities of firms. National Bureau of Economic Research Working Paper No. 11479.

Freeman C and Perez C (1988). Structural crises of adjustment, business cycles and investment behaviour. In: Dosi G et al. (eds.), *Technical Change and Economic Theory*, Pinter, London.

Hall B and Mairesse J (2006). Empirical studies of innovation in the knowledge driven economy. *Economics of Innovation and New Technology*, pp. 15, 289–299.

Huston L and Sakkab N (2006). Connect and develop: inside Procter and Gamble's new model for innovation. *Harvard Business Review*. March

Koellinger P (2005). Why IT matters: an empirical study of e-business usage, innovation and firm performance. German Institute for Economic Research Working Paper 495. Berlin.

Mowery DC and Rosenberg N (1978). The influence of market demand upon innovation: a critical review of some recent empirical studies. *Research Policy*, April.

Narula R and Sadowski M (2002). Technological catch-up and strategic technology partnering in developing countries. *International Journal of Technology Management*, vol. 23, no. 6.

National Science Foundation (2000). Science and Engineering Indicators, Washington, DC: National Science Board.

Schumpeter J A (1943), *Capitalism, Socialism and Democracy*. Allen and Unwin, London.

Serapio MG and Dalton DH (1999). Globalization of industrial R&D: an examination of foreign direct investment in R&D in the United States. *Research Policy*, 28, 303–316.

Serapio MG and Hayashi T (eds.) (2004). *Internationalization of Research and Development and the Emergence of Global Research and Development Networks*. Elsevier Research in International Business, vol 8.

UNCTAD (2001). *E-commerce and Development Report 2001*.

UNCTAD (2003). *E-commerce and Development Report 2003*.

UNCTAD (2004). *E-commerce and Development Report 2004*.

UNCTAD (2005). *World Investment Report 2005*.

UNCTAD (2006). *Information Economy Report 2006*.

UNCTAD (2007). *The Least Developed Countries Report 2007*.

Von Hippel E (2005). Democratizing innovation. Available at http://web.mit.edu/evhippel/www/democ1.htm.

Wired.com (2006). The rise of crowdsourcing. Issue 14.06, June http://www.wired.com/wired/archive/14.06/crowds.html.

Notes

1. There is a rich and growing literature on the effects of ICT on productivity and overall economic performance. Contributing to it from the viewpoint of trade and development, UNCTAD (2001) includes a simulation of the effects of various hypotheses about e-business adoption on the performance of developing economies, UNCTAD (2003) includes a summary review of the most relevant literature on the question of ICT and productivity and growth, while UNCTAD (2006) outlines the major features of national ICT policies for the development of the information economy, as well as their poverty-reduction dimensions. UNCTAD (2005) focuses on transnational corporations and the internationalization of R&D, including its implications for innovation and development.

2. See UNCTAD (2007).

3. See, for example, Criscuolo and Martin (2004) and Criscuolo, Haskel and Slaughter (2005).

4. See, for example, Cassiman and Veugelers (2004).

5. See UNCTAD (2005) for an extensive discussion of the role of FDI in research, development and innovation in a developing country context.

6. See http://www.trendchart.org.

7. See chapter 2 in UNCTAD (2004) for a survey of the major SME-specific issues of e-business in developing countries.

8. See for example UNCTAD (2004) or the results of the OECD Electronic Commerce Business Impacts Project available at http://www.oecd.org/document/21/0,3343,en_2649_34449_2539157_1_1_1_1,00.html.

9. Carr (2003).

10. See National Science Foundation (2000) for data on the growth of strategic technological alliances.

11. It should be borne in mind that some modalities of innovation that may be more prevalent among developing country enterprises are more difficult to capture with patent statistics. For example, this can be the case of "creative imitation", whereby an existing product is introduced into a new market, it being adapted to the needs and environment of a lower-income market.

12. Cost considerations as a factor in favour of FOSS are all the less important in view of the fact that in many countries most software used was actually obtained at zero cost of acquisition, because of piracy. See for example the 2006 global piracy study conducted by the Software Business Alliance and IDC: w3.bsa.org/globalstudy//upload/2007-Global-Piracy-Study-EN.pdf.

13. See www.chinaeconomicreview.com/cer/2007_03/Problem_solvers.html.

14. See www.businessweek.com/innovate/content/jun2007/id20070611_139079_page_2.htm.

15. See www.openbusiness.cc

16. See Wired.com (2006).

17. See http://www.forum.nokia.com.

18. See www.mosti.gov.my.

19. See http://www.innovacion.cl/chileinnova/sec_chile.php?id_seccion=9.

20. See http://www.webworkscork.com.

21. See http://www.ida.gov.sg/Programmes/20060926120315.aspx?getPagetype=34.

22. See http://www.ictcarrier.co.uk/