IDB WORKING PAPER SERIES No. IDB-WP-189

Innovation, R&D and Productivity in the Costa Rican ICT Sector:

A Case Study

Ricardo Monge-González
John Hewitt

June 2010

Inter-American Development Bank
Department of Research and Chief Economist

Innovation, R&D and Productivity in the Costa Rican ICT Sector:

A Case Study

Ricardo Monge-González*
John Hewitt**

* Instituto Tecnológico de Costa Rica
and High Technology Advisory Committee (CAATEC)
** CAATEC

Inter-American Development Bank
2010

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Monge González, Ricardo.
Innovation, R&D and productivity in the Costa Rican ICT sector : a case study / Ricardo Monge-González, John Hewitt.
p. cm. (IDB working paper series ; 189)
Includes bibliographical references.
1. Technological innovations—Costa Rica. 2. Research, Industrial—Costa Rica. I. Hewitt, John. II. Inter-American Development Bank. Research Dept. III. Title. IV. Series.

HC79.T4 M66 2010

Abstract[*]

This paper addresses the relationships between innovation, research and development (R&D) and productivity in domestic ICT firms in Costa Rica. Factors considered were the types of innovation outputs produced by domestic ICT firms, the relative importance of innovation inputs, the impacts of innovation on firm productivity, the protection of innovations, and impediments to innovation. While most firms engaged in all types of output and input innovations, they appear to be driven by retaining or increasing market share rather than increasing productivity. Half of firms do not formally protect the intellectual property created by their innovations, are not familiar with methods for protecting innovation or the availability of government grants for such purposes, and face barriers associated with the Costa Rican Patent Office. Other impediments include lack of knowledge about financial resources available and scarcity of human resources. There is also evidence of knowledge spillovers through worker mobility from multinationals operating in Costa Rica to domestic ICT firms.

JEL Classifications: L20, L63, L86, O31
Keywords: Research and development, Information communications technology, Innovation, Costa Rica

[*] We wish to thank the representatives of the Costa Rican ICT companies whom we interviewed during our investigation. Without their help, our research would not have been possible. We also wish to thank the Costa Rican ICT Chamber (CAMTIC), especially Alex Mora and Otto Rivera, as well as the *Promotora de Comercio Exterior* (PROCOMER), especially Francisco Gamboa, for their support and advice. We owe a debt of gratitude to the members of the Research Department and the Science and Technology Division of the Inter-American Development Bank involved in the project on "Innovation, R&D Investment, and Productivity in Latin American and Caribbean Firms," especially Carmen Pagés-Serra, Juan Jose Llisterri, and Juan Carlos Navarro. We are also grateful to all of the Latin American partners in this project for their advice and valuable suggestions, which improved the final product. Finally, we want to thank Fernando Solano and Laura Torrentes for their invaluable research assistance.

1. Introduction

This paper presents the results of a case study of the Costa Rican Information and Communications Technology (ICT) sector by the High Technology Advisory Commission Foundation (CAATEC). It was carried out as a component of the project on "Innovation, R&D Investment, and Productivity in Latin American and Caribbean Firms" conducted by the Research Department of the Inter-American Development Bank (IDB).

This study aims to increase understanding about the relationship between innovation, R&D, and productivity in the domestic ICT sector of a small open economy. It is hoped that its findings will inform the development of well-grounded policy recommendations to support innovation of a type that can lead to increased ICT sector productivity and competitiveness in Costa Rica. Although the analysis is not guided by the results of a large-scale national econometric analysis of innovation and its effects—as is the case for case studies carried out in other countries for the regional IDB study—it will contribute to the understanding of the nature of innovation and its impact on productivity in ways which are often not possible when only the results of "high-level" econometric analysis are taken into account.

To structure the study, the researchers brought to bear their extensive experience with the ICT sectors of various countries in the region and their knowledge of the relevant literature and overarching conceptual frameworks. One of these frameworks, summarized in Porter, Ketels and Delgado (2007), posits that productivity ultimately depends on the *microeconomic* capability of the economy, which is based in turn on the sophistication of firms (both domestic and subsidiaries of multinationals), the quality of the national business environment, and externalities arising from the presence of clusters of related and supporting industries.

The starting point of the analysis is to consider *innovation* as a process that can occur in any or all areas of firm operations (cf. Drucker, 1974) and can involve advantageous changes in products, processes, organization and/or marketing. Our analysis includes a consideration of inputs to, and outputs from, this process, accompanied by an investigation of the impact of innovation on firm productivity. The paper is organized in five sections, including this introduction. The second section presents an overview of the Costa Rican ICT sector. Here we describe the type of firms that operate in that sector and discuss the main determinants (public policy) of Costa Rican ICT sector development. We briefly consider aspects of the development of ICT clusters in other developing countries that provide a useful perspective for the

development of the Costa Rican ICT sector. The third section discusses the main aspects of the data used in the research. The core of the paper and main findings from the research are presented in section four. Concluding remarks and policy recommendations are presented in the fifth section.

2. Overview of the Costa Rican ICT Sector

Following standard terminology, ICT firms can be divided into the following sub-sector categories, according to the products and services that they offer their clients (Monge-González and Hewitt, 2008):

- **Components/hardware**: firms that carry out activities related to the design, manufacture, assembly and/or sale of ICT hardware (for computers, telephones, network devices, etc.). In this study, the majority of companies assigned to this category are resellers of the products and services of multinational computer and network hardware companies, although some assemble and sell devices using components provided by other companies.
- **Software products**: firms that carry out activities related to the creation and sale of relatively standardized software applications and tools, which may be designed to be used by organizations operating in specific sectors of the economy ("vertical" applications), by a wide variety of organizations ("horizontal" applications), or by individuals. Both types of applications are sold by Costa Rican companies. The most frequent types of software products offered are administrative tools oriented towards office, customer, and financial management.
- **Direct ICT services**: firms that offer consulting, support, training, development of custom-made software components, systems integration and configuration, or any one of a large number of other services related to the creation, implementation, and maintenance of information and/or telecommunications systems. This is the most common type of ICT sector firm in Costa Rica.
- **ICT-enabled services (ITES)**: firms that provide services which are not necessarily directly related to ICT services and products (such as "business processes outsourcing") but whose delivery to clients is enabled by telecommunication and computer networks. Although the ITES market is now

well established at a global level, and there are a number of multinational ITES companies in Costa Rican Export Processing Zones (EPZs), there are still relatively few Costa Rican-owned and operated ITES companies operating outside these zones. Several of them are included in our study.

Although ICT companies often operate in more that one of these areas at the same time—a software company may offer standard products, design custom applications for large clients, and offer consulting and training services related to their products and services, for instance—it was possible to assign all companies involved in this study to a single category without any significant loss of precision. Companies that could not be so assigned were excluded from consideration.

Data from CAMTIC (the Costa Rican Chamber of ICT companies) and PROCOMER (the Costa Rican Trade Promotion Agency) give us an idea of the overall size and importance of the Costa Rican ICT sector as it is traditionally measured. It was estimated that 705 firms (domestic and Multinational) were operating in the ICT sector in Costa Rica in 2007, of which 350 (49.7 percent) were dedicated to direct services, 255 (36.2 percent) to software development, 65 to IT-enabled services (9.2 percent), and 35 (5 percent) to components. These companies employed 2.4 percent of the Costa Rican labor force and generated US$2.806 billion in sales; their production represented 10.6 percent of Costa Rican GDP and their exports accounted for 28.8 percent of Costa Rica's total exports in 2007.

Table 1 presents total sales from the Costa Rican ICT sector disaggregated by sub-sector categories based on CAMTIC data (this and all other tables and figures are included in an appendix to this document). Using the CAMTIC categorization of ICT firms, the components sub-sector is the most important in terms of sales, and all of the production from this sub-sector is sold to international markets. The great majority of these components sales involve products of multinational firms (MNC) operating in this country, including Intel.

The focus of this case study is on locally owned and operated ICT firms (*domestic firms*), not on multinationals. Multinational firms are excluded from consideration in our study, which explains why the component-oriented firms that do fall into this category in our sample are resellers or assemblers of hardware using components produced by larger foreign companies rather than themselves producers or designers of components.

The contribution of multinational firms' components exports explains why the Costa Rican ICT sector is regarded as an extremely important source of foreign exchange for the country. The high percentage of IT-enabled service sales exports shown in Table 1 is also influenced by the presence of large multinational firms operating in this sub-sector, but there are Costa Rican-owned firms that provide these types of services, some of which are included in our sample. Finally, although there are multinational firms operating in the direct ICT services and software products subsectors in the country, the majority of such companies is Costa Rican-owned and operated.

Monge-González and Hewitt (2007) carried out the first mapping of the Costa Rican ICT sector in a study done for CAMTIC using a sample of 125 companies, almost all domestic ICT companies. Most of the domestic ICT companies in the sample were small (58 percent) and micro (15 percent) firms (i.e. with less than 30 employees), and most of them (66 percent) were founded during the last decade. The average annual sales of these companies range between US$250,000 and US$1.5 million, and most of their production is destined for the domestic market. Most domestic ICT companies sell more than 70 percent of their products (direct services 83 percent, software development 72 percent, IT-enabled services 74 percent, and components 87 percent) in Costa Rica. Somewhat more than half of the firms make sales abroad, especially in Central America, Panama, and the Dominican Republic (82.5 percent of all exporters); less than one-third of the exporting firms have sold products or services to clients in the United States.

Most domestic ICT firms experienced significant growth (between 11 percent and 50 percent) in 2005-2006. These rates are comparable to those shown by data from the Central Bank of Costa Rica on the rate of growth of the value added for software, call center, and global business companies from 2001 to 2008. These sub-sectors experienced positive and relatively high rates of growth during most of that period. Software companies have been growing at an annual rate of 21 percent, call centers at 41 percent, and global business at 15 percent (see Figure 1).

We suggest that the rapid and sustainable growth of the ICT sector in Costa Rica as a whole has been facilitated by three public policies: i) a sustained emphasis on increasing educational opportunities for everybody in the country for more than a century (free primary and secondary education and an excellent public university system), which produced a large number

of highly educated workers; ii) the elimination of trade barriers to imports of both software and hardware during the last 30 years, facilitating access to modern ICT products from around the world; and iii) the successful implementation of an economic liberalization process beginning in the mid-1980s that attracted a significant amount of foreign direct investment in the Costa Rican ICT sector.

Costa Rica began a unilateral foreign trade liberalization process the mid-1980s which has continued to the present day. Export Processing Zones (EPZs) emerged in Costa Rica during the same period as a mechanism to attract FDI, thus promoting exports of non-traditional products, creating new employment opportunities, improving the balance of payments, and supporting diversification of the national productive base. The EPZ regime is a set of incentives and benefits granted by the Costa Rican government to companies (mainly MNCs) making new investments in the country. The most important incentive was an income tax exemption of up to 100 percent for 8 to 12 years, and 50 percent for an additional 4 to 6 years. There are other incentives, such as exemption from all taxes and consular duties on imports, exemption from all municipal taxes and licenses for a 10-year period, and additional exemptions from income taxes for those companies that make reinvestments in the country after they have been operating for four years under the EPZ regime. One important aspect of the EPZ regime is the possibility of generating knowledge spillovers from MNCs, an important type of positive externality for the Costa Rican economy.

Investigating Costa Rica's experience with MNCs, Monge-González, Rivera, and Rosales (2010) found that between 1985 and 1990, exports from EPZ firms rose from US$7 million to US$94 million. Annual EPZ investments did not show significant growth, but the FDI stock from EPZ companies almost quadrupled, from US$28.6 million to US$106.6 million. During the same period, total FDI inflows to Costa Rica were US$434 million. Between 1986 and 1995, on average, FDI in EPZs represented 20 percent of total FDI inflows.[1] At the beginning of the 1990s, EPZs started to grow significantly, and by the mid-1990s they had clearly established their importance to the Costa Rican economy. Between 1997 and 2007, annual FDI inflows from EPZ firms averaged US$286 million (1.5 percent of GDP on average).

Most high-technology MNCs are operating under this system. Intel is the largest of these companies. The firm's exports have represented, on average, more than 40 percent of total EPZ

[1] Estimates by the authors based on data from PROCOMER and the Central Bank of Costa Rica.

exports and over 20 percent of total Costa Rican exports since 1998. Intel's decision to establish a microchip factory in Costa Rica in 1997 marked a quantitative and qualitative change in FDI inflows, based on the demonstration effect it had for other potential foreign investors.

The composition of EPZ exports has changed significantly in the last decade. While textiles accounted for 35 percent of exports in the middle of the 1990s, their share dropped to less than 10 percent in 2007, while exports of electronic and electrical goods increased their share from 20 percent to nearly 50 percent during the same period. A similar trend may be seen in exports of medical devices and pharmaceutical products, which grew from 5.9 percent to nearly 15 percent during that same period. Exports of international services (such as back-office and call centers) increased more than fivefold over the last five years. This tendency changed the structure of EPZ (and overall domestic) exports from natural resource-based and low-skilled, labor-intensive activities to more advanced high-technology production systems, based on highly skilled labor and differentiated and scientifically based products.

Firms operating within EPZs increased their contribution to national output from 0.5 percent to 9.6 percent of GDP between the beginning of the 1990s and 2007. Thanks to EPZs, the structure of the Costa Rican industrial sector has moved considerably towards more high-tech production since the mid-1990s. This change is the result of growth in high-tech MNC production, rather than an increase in domestic productivity. While Costa Rican GDP per worker grew by 0.5 percent per year from 1997 to 2007, average labor productivity in EPZs grew at an average annual rate of 13.5 percent over the last ten years. That is, EPZs have been one of the main drivers of labor productivity growth in the country—a result that is highly influenced by Intel's operations.

Relative to the size of its population (approximately 4.5 million people), Costa Rica's ICT sector is larger than those of most other Latin American countries, and even those of the Czech Republic and New Zealand, which have important ICT sectors and higher per capita GDPs than Costa Rica. As shown in Table 2, Costa Rica has 156 ICT firms per million people, while Chile, Mexico, and the Czech Republic have 129, 12 and 20, respectively; available data also show that some countries, such as Uruguay and New Zealand, have relatively larger ICT sectors than Costa Rica (679 and 1,840 firms per million people, respectively).

However, the small absolute size of the Costa Rican population means not only that the national market for ICT products and services is small—so that sustained growth of the sector is

difficult to achieve within the country's borders—but also that the size of the workforce suitable for ICT businesses is small (although relatively high as a percentage of the total population compared to other countries in the region, thanks to the excellence of the national educational system).

The presence of large numbers of skilled programmers and other technical workers has, of course, been one of the most important factors involved in the successful development of ICT sectors in large developing countries such as Malaysia, China, and India (see Hanna, 2009, for comments on the development of Bangalore, for instance), while ICT companies in countries with small domestic markets and small pools of local talent, such as Singapore and Ireland, have tended to overcome these barriers through the development of specialized strategies such as supporting multinational corporations or their subsidiaries (*ibid*.). In the case of Ireland, ICT companies were greatly aided by the national government's ICT sector development strategy, which was based on the attraction of multinational ICT companies through financial incentives and heavy investment in education and telecommunications (Heeks and Nelson, 2002). As we shall see, many Costa Rican firms have taken advantage of the presence of multinational high-technology companies in the country to expand their client base.

The growth of strong ICT sectors in developing countries is usually associated with strong government initiatives based on the recognition of the sector as being of special strategic importance. The government-backed and -funded development of large technology parks oriented towards software and other ICT-related areas, with substantial representation of domestic businesses, has been vital in the development of ICT sectors in large and small Asian countries (infoDev 2008, Singh 2005). However, no such parks have been created in Costa Rica, which has emphasized the creation of EPZs whose principal impact has been the attraction of high-technology multinational corporations.

Likewise, the Costa Rican government has not been directly involved in the formation of small business incubators for startup ICT companies, although there are two small but effective incubators in the country: ParqueTec (www.parquetec.org), funded in part by the IDB, and CIETEC (www.cietec.org), associated with the Technological Institute of Costa Rica and funded in part by the World Bank. The IDB has also played a role in the creation of Link Inversiones (www.linkinversiones.com), one of the few existing sources of venture or angel capital in the country. Although new sources for seed, angel, and venture capital may appear as a result of a

new law strengthening the participation of the government in these areas (*Ley 8634; Sistema de Banca para el Desarrollo* [2008]), the regulation and institution building needed to make this a reality are still pending, and the direct support of this type of capital by government agencies, as has been done for some time by governments with more proactive approaches to ICT sector promotion (see CORFO, 2010 and SIDBI, 2010 for examples of such support by the governments of Chile and India, respectively), is still only a possibility.

Another important element in the promotion of ICT sector growth is the presence of a strong association representing the companies in the sector, such as India's National Association of Software and Services Companies (www.nasscom.in). CAMTIC, the Costa Rican Chamber of ICT Companies (www.camtic.org) has worked diligently for more than a decade to strengthen the national ICT sector, working closely with organizations in the public and private sectors and academia to develop a national ICT strategy, evaluate the current state of the ICT sector, promote the ICT sector outside the country, and develop training and other types of programs to assist ICT companies to improve their competitiveness.

The state of a country's existing ICT infrastructure has a strong influence on the size of the domestic market for ICT products and services and on the ability of domestic ICT companies to develop innovative products and communicate with clients and allies within and outside the country. The International Telecommunications Union's ICT Statistics Database (ITU, 2010) shows that Costa Rica is among the leaders in Latin America in the penetration of computers and the Internet, but that the penetration of cellular telephony—an area in which many of the most exciting developments in ICT are currently taking place—is among the lowest in the region, due to a previous state monopoly on telecommunications that did not place strong emphasis on this technology. Costa Rica also has a relatively low penetration of broadband connectivity compared to leaders in the region, with a 2009 broadband penetration rate of six broadband accounts for every 100 inhabitants. However, broadband penetration in the greater metropolitan area in the central highlands of the country, where the majority of the general population resides and almost all important ICT companies are located, is far higher than the national average. The telecommunications market was opened to competition in 2009, and the penetration of cellular telephony and broadband connectivity will undoubtedly increase very rapidly as competitors enter these markets.

3. Data

For the purposes of the current case study, we collected data from a group of 37 Costa Rican-owned and operated ICT companies that participated in the 2007 ICT sector study concerning, *inter alia*, relationships with the national innovation system, innovation success factors, details of a firm's intellectual property protection activities, and relationships with ICT MNCs. Although we had originally planned to gather information from a sample of ICT MNCs operating in Costa Rican EPZs on the assumption that they would be especially important *clients* of domestic ICT firms, we soon found that ICT MNCs in general were far more important to domestic ICT firms as *providers* of products and services that formed important parts of the domestic ICT firms' supply to their own clients, and of financial and other support to domestic ICT firms that enabled them to better sell and support the ICT MNCs' products and services. We therefore shifted our focus in this area towards gathering more information about the nature and perceived benefits for domestic ICT firms of associating with ICT MNCs in this way, and cross-checked our results through conversations with representatives of large ICT MNCs such as Microsoft, Cisco, Sun, and Epson.

We were greatly assisted in our data-gathering efforts by the support of the Costa Rican Chamber of ICT companies (CAMTIC), which views the current study as an important step towards improving the competitiveness of the sector. To assure that this study will indeed contribute to the activities of Costa Rican ICT companies, CAATEC investigators have made a commitment to make a presentation of final results to the full CAMTIC membership at the end of the of this effort.

Of the 37 companies interviewed for the current study, 17 (46 percent) provide direct services, 8 (21.6 percent) sell software products, 3 (8.1 percent) provide IT-enabled services, and 9 (24.3 percent) are assigned to the components/hardware category.

Previously gathered data that was also used in our analysis comes from earlier investigations carried out by the researchers of the current study. The most important of these sources is a 2007 study that provides information on innovation activities and relevant environmental factors for 125 Costa Rican ICT companies. We have also gathered relevant information about innovation activities and relevant environmental factors for 20 Costa Rican software businesses from a total sample of 277 innovative businesses for 2004, and basic information about 81 ICT multinationals operating in Costa Rica (ICT subsector, activities, size,

age, sales, etc.) from annual reports presented by these companies to the Foreign Trade Corporation of Costa Rica (PROCOMER) in 2007.

4. Innovation, R&D, and Productivity in Costa Rican ICT Firms: Results

Based on the results from 37 interviews with Costa Rican-owned ICT companies[2], this section discusses important findings about how innovation actually influences productivity in the sector at the firm level. This section is divided into five parts: i) a discussion of the type of innovation outputs that characterize domestic ICT firms in Costa Rica ii) a discussion of the relative importance of innovation inputs such as R&D, highly skilled workers, interactions with other firms and research institutions, and an organizational structure that is conducive to learning and exploiting knowledge; iii) a discussion of the impacts of innovation on firm productivity, sales, and efficiency; iv) protection of innovation outputs; and v) a discussion of factors that hinder innovation in the Costa Rican ICT sector.

4.1 Innovation Outputs

The data presented in Table 3 show that most domestic ICT companies interviewed were highly involved in innovations that encompass a wide range of changes in their activities during the period 2005-2006: product innovations (mostly introducing a new product or service in the domestic market, or improving an existing product or service), organizational innovations, and marketing innovations.

The Oslo Manual states that innovation activities in service-oriented sectors (including substantial parts of the ICT sector) can differ substantially from more manufacturing-oriented sectors, as they are often less formally organized and more incremental and less technological in nature than activities in manufacturing sectors. The data in Table 3 show that most ICT companies (including all subsectors) are not focused only on technological innovation, but also frequently engaged in various types of organizational and commercial innovations.

4.2 Innovation Inputs

In exploring the involvement of domestic ICT firms in innovation input activities, we found that most of these companies were highly engaged not only in R&D activities, but also in other

[2] Although we attempted to conduct more interviews, some domestic ICT firms were unwilling to participate in this study, stating that they had already been interviewed for other studies in the past and had no desire to participate in further investigations.

important innovation-input activities during 2005-2006 (see Table 4). The domestic ICT firms surveyed were engaged in R&D activities (84 percent), patenting (65 percent), training of human resources (100 percent), receiving technical assistance (73 percent) and consulting services (92 percent), product or process designing (87 percent), organizational changes (70 percent), reengineering processes (35 percent), and the use of on- and off-line quality control systems (59 percent and 54 percent, respectively).

Viewing innovation input activities at the sub-sector level, one can see that in the case of R&D activities, almost all software products and direct ICT services companies engaged in this kind of activity (100 percent and 94 percent, respectively). A higher percentage of software companies (87.5 percent) also sought and obtained patents.

With respect to R&D, product or process design, organizational changes, reengineering processes, and quality control systems, the Costa Rican ICT firms surveyed often carried out their actions inside the firm through a specialized department (see Table 5). Only in the cases of patenting and licensing, training of human resources, and technical assistance and consulting do these firms frequently use an outsourcing approach. This may imply that firms wish to maintain confidentiality in their core business areas to improve their competitiveness.

Most recent literature has emphasized that although R&D plays a vital role in the innovation process in a knowledge-based economy, much of innovation activity is not R&D-based; rather, it draws on highly skilled workers, interaction with other firms and public research institutions, and an organizational structure that is conducive to learning and exploiting knowledge.

It is clear from interviews with domestic ICT firms that access to highly skilled workers (qualified human resources) is a key issue in innovation (see Table 6). These data also show that input activities other than R&D are important for an ICT firm to be innovative. An entrepreneurial culture, access to financing, information systems, having an internal training program, design, market information, fiscal incentives for innovation, technology trails, access to technical assistance, and making organizational changes are, to varying degrees, important factors that enable ICT firms to engage in innovation output activities. The perceived relative importance of these factors varies somewhat between subsectors; the hardware subsector, for example, places notably higher emphasis on the importance of internal training, technology

trails, market information, organizational change, and availability of financing than other subsectors.

Having identified the main factors facilitating innovation output activities by ICT firms, we may discuss the extent to which an innovation cluster, as defined by De Ferranti et al. (2002),[3] is well developed or just beginning in the Costa Rican ICT sector, as well as its main characteristics. Porter (2000) defines clusters as geographic concentrations of interconnected companies, specialized suppliers, service providers, and associated institutions in a particular field that are present in a nation or region. In his opinion, clusters arise because they increase the productivity with which companies can compete. According to Meyer-Stamer, Harmes-Liedtke and McKenzie (2004), clusters of closely related industries take advantage of their common specialization in one product in order to reduce the costs of input provision and increase their productive efficiency through economies of scale and knowledge spillovers. These authors explain that clusters usually emerge in an unplanned way, driven by the invisible hand of the market, as a result of what they call "cumulative causation" (i.e., success breeds success).

Following Porter, it is important to point out that clusters are composed not only of producers of final products, but also input providers and supporting institutions. When a cluster is present, it is easier for firms to find inputs and machinery, as well as skilled labor, and marketing and sales are favored by the fact that customers will be drawn to this location.

However, the firms in the cluster are subject to strong rivalry, which drives cluster growth and competitiveness. It is precisely this strong competition, according to Meyer-Stamer et al. (2004), that stimulates an innovation-driven upgrading contest among the participating firms.

There are, of course, other ways in which clusters achieve important economies that increase their competitiveness: joint purchases and sales; jointly-maintained but organizationally independent supporting institutions that provide training, information technology services, and information; and active participation in forums.

Following the arguments outlined above, we discuss the degree to which Costa Rican ICT firms interact with private and public educational and research institutions, suppliers, clients

[3] These authors point out that one of the key elements in a shift from knowledge absorption to knowledge generation is the interaction between education and technology policies, which includes training processes and a set of sub-systems at the level of specific industries known as *innovation or knowledge clusters*.

and multinationals (the productive chain), public institutions and various funding organizations inside the country.

The relationship between ICT firms and educational and research institutions has to do primarily with receiving training and information (see Table 7). However, in most ICT sub-sectors, the frequency with which such relationships are reported is very low; for most institutions, less than one-third of the companies in a given sub-sector report such a relationship, and software companies report no training and/or informational relationships at all with public and private universities, technical colleges, or the National Learning Institute—a finding which warrants further investigation. Domestic ICT firms' levels of satisfaction with services that were received was acceptable in most cases, but not excellent (higher than 2.50 but less than 4 on a scale of 1 to 5; see the last column in Table 7).

A stronger relationship was found between domestic ICT firms and the suppliers and clients with whom they were involved in a productive chain than was the case for educational and research centers (see Table 8). Domestic ICT firms most frequently indicate that they have received support from suppliers and clients in training, technical assistance, information, R&D, and finance. Again, in most cases, less than one-third of the domestic ICT companies report receiving services from suppliers, clients, or MNCs. Hardware companies report relationships with their suppliers more frequently than the rest of the domestic ICT companies, especially with regard to training (55 percent), information (44 percent), R&D (44 percent) and finance (44 percent). On the other hand, companies in the software products sub-sector report relationships with clients more frequently than companies in the other sub-sectors, and were highly satisfied with these relationships. In general, degrees of satisfaction with services received ranged between 2.50 and 3.50 on a scale of 1 to 5 (see the last column in Table 8).

Although almost no firms reported significant relationships with a multinational that directly supported innovation, other relationships between domestic ICT firms and MNCs of all types located in Costa Rica were also investigated, including the possibility of the generation of *knowledge spillovers* from MNCs to domestic firms.

Twenty-three of the 37 domestic ICT companies surveyed (62 percent) report having MNCs of some type as *clients* in Costa Rica. While only 37 percent of software companies had MNC clients, the figures for components (77.8 percent), direct services (64.7 percent), and ICT-enabled services (66.7 percent) were much higher. Four of the 37 domestic ICT companies were

created specifically to supply MNC clients in the country—two from the components sub-sector and two from the direct ICT services sub-sector.

Of the 21 companies for which data on the number of MNC clients is available, 11 companies have eight or fewer MNC clients, while the other 12 have nine or more, and three of them report having more than 20 MNC clients each. The relationship between these firms is relatively recent. Two-thirds of the domestic ICT firms who have MNC clients have been selling their products or services to these clients beginning in or after 2000.

Slightly more than one-third (39.1 percent) of personnel in the domestic ICT firms from which relevant information is available have received training from MNCs to better sell their products or services to the MNCs themselves (i.e., they have been trained to participate in the supply chains of the MNCs). Almost three-quarters of components companies received training from MNCs, while only one-third of software products companies and one-quarter of direct ICT services did so (no IT-enabled services company reported receiving such training). Most (78 percent) of the companies that received training on selling to ICT MNCs use the knowledge acquired from this training to produce goods and services that are later sold to other companies in Costa Rica or abroad.

Since 62 percent of domestic ICT firms have MNCs of some type as clients in Costa Rica, it was of interest to know to what extent these firms had to carry out significant changes in their organizations, the variety of their products and/or services, production techniques, their levels of investment in new machinery and technological equipment, delivery times, levels of production and expenditures on training to be able to sell products and services to MNCs. The results, presented in Table 9, show that a significant portion of domestic ICT companies with MNC clients reported the need to carry out significant or radical changes in these areas to supply goods or services to these clients. When considering these results, it is important to bear in mind that domestic ICT companies face stiff competition from suppliers abroad when selling to MNCs, since MNCs (specifically those working under a free zone regime) can import anything under a duty-free regime and frequently have their own international suppliers.

There is another channel through which knowledge can be transferred from MNCs to domestic ICT firms—worker mobility (i.e., ex-MNC employees who either become employees of domestic ICT companies or form their own ICT firms). In both cases, it is important to remember that although the MNCs that previously employed these workers may not have been

ICT companies, the knowledge these ex-employees acquired in their previous jobs potentially allows them to improve the performance of their own ICT firms or the domestic ICT firms they are now working for.[4]

According to the interview results (see Table 10), labor mobility may be a significant channel for knowledge spillovers to domestic ICT firms. Almost half (47 percent) of all domestic ICT firms have at least one owner that previously worked for an MNC in Costa Rica (Table 10), with the lowest level of current ICT company owners previously employed in MNCs found in software products companies (25 percent).

In the case of current employees of domestic ICT firms that have previously worked in MNCs, interviews show that 26 percent of managers, 9 percent of engineers, and 5 percent of programmers in the domestic ICT companies surveyed worked previously for MNCs in Costa Rica. At the sub-sector level, the percentage of managers who have previously worked in MNCs is highest in the direct and IT-enabled services sub-sectors and lowest in the case of software products companies, while the IT-enabled services companies surveyed reported only a single engineer, and no programmers, who previously worked in MNCs.

In short, it seems that there is a strong possibility of knowledge spillovers occurring in the case of domestic ICT firms in Costa Rica, since a significant number of workers have moved from MNCs located in this country either to work in a domestic ICT firm or, importantly, to create their own ICT firm. However, determining the actual extent of knowledge spillover in Costa Rica exceeds the scope of this study.

Another area in which useful information that could promote innovation can pass between multinational and domestic ICT companies is that of commercial relationships, such as "channel partnering," in which domestic ICT companies are themselves clients of ICT MNCs, entering into formal relationships to sell and/or locally support the multinationals' products and services. Of the 29 companies that provided us with information on this subject, 16 of them had commercial relationships with ICT multinationals, with the number of relationships that each of these domestic ICT companies maintained with ICT multinationals ranging from six or more (in the case of five domestic ICT companies) to only one (in the case of four domestic ICT companies).

[4] There is some evidence that knowledge spillover is not necessarily industry specific. For a good discussion and empirical evidence on this subject see Poole (2008).

Data were collected on a total of 52 such commercial relationships (see Table 11). There were four types of relationships reported: (a) wholesalers or distributors, who sell ICT products and services to retailers of those products and services; (b) retailers, who sell the ICT products and services to final users; (c) value-added resellers ("VARs"), which provide third-party products and services to final users as parts of packages that also include the VAR's own products and services; and (d) representatives, who do not usually directly sell multinationals' products and services themselves, but provide local points of contact for firms and individuals that need information about, or support for, products and services that they have already purchased, or wish to purchase.

The most commonly reported benefits of commercial relationships with multinational ICT companies had to do with receiving discounts for products and services that were resold to end users, and training in the technical aspects of these multinational products and services. These two benefits, together with another financial benefit—credit to facilitate purchases—are not as clearly related to a potential for innovative activities by domestic ICT companies as are the other benefits summarized in Table 11, specifically those related to innovative commercialization: training in sales and marketing techniques, information about current or possible clients, special events for network formation between domestic ICT companies involved with the same multinational ICT companies, and increased visibility for local partners (being featured in local advertisements by the multinational firms, for example). As can be seen, wholesaler and VAR relationships tended to be associated with the widest range of benefits.

As was the case with relationships between domestic ICT firms and educational institutions, relationships between domestic ICT firms and industry associations or chambers, the national government's trade promotion agency (PROCOMER) and government ministries are infrequent (Table 12). Those relationships that exist are concentrated in the areas of training, information, organizational change consulting and, to a lesser degree, technical assistance, and there were no strong differences in the frequency of such relationships between ICT sub-sectors. The highest satisfaction levels were found in ratings by component and software companies for industry associations and chambers, and by software companies of the national government's trade promotion agency.

Since domestic ICT firms consider that access to financing is one of the main factors facilitating their involvement in innovation output activities, it was important to investigate the

degree to which these firms have access to sources of funding other than from suppliers and clients. Table 13 shows the results of interviews of domestic ICT firms related to this topic. The only sources of funding widely used by these companies are private and public banks, since government programs focused mostly on micro, small and medium-sized firms (SMEs) are almost completely unused, due either to lack of interest on the part of domestic ICT firms or lack of funding provided by the programs.

When analyzed by sub-sector, the data show that component (hardware) firms have the most frequent access to funding (78 percent have access to funding from public banks and 89 percent to funding from private banks). When these figures are compared to the very low frequency of funding of software and direct services companies, we may be seeing indications of a problem related to guarantees or collateral when asking for a loan; it is easier for a firm involved in hardware activities to present a guarantee to a bank than is the case for ICT-enabled or direct services companies or software companies. This may in turn suggest a need for Costa Rican authorities to explore new ways to provide funding for domestic ICT firms to permit them to engage in more innovative activities, which could require changes in the regulatory framework and a review of the way special government funds have been allocated to date.

4.3 The Impact of Innovation on Firm Performance

One of the main objectives of this paper is to explore the extent to which innovation (in all forms: product innovations, organizational innovations, and marketing innovation) may be producing a positive impact on firm performance, especially on productivity. In order to explore this subject, domestic companies were asked about: a) the main objectives they pursued when their firms engaged in innovative activities during 2007-2008, and b) the impacts that such innovations produced on the firms' performance. Tables 14 and 15 summarize the responses to these questions.

Considering only those objectives of innovative activities which received an average importance ranking of 4 or more (see Table 14), we see that the highest importance was assigned to reducing idle time; improving product quality, working conditions, and existing products; creating new product lines; making use of new scientific knowledge and technologies; maintaining and increasing market share; opening new markets; and increasing competitiveness to face high levels of competition. What we do not find among these highly ranked objectives is an indication that domestic ICT firms are explicitly attempting to increase productivity in the

sense of producing the same amount of goods (or services) with fewer resources, or producing more goods (or services) with the same amount of resources. We also see little indication that increasing economies of scale or scope or reducing costs are drivers of innovation by domestic ICT firms; rather, the greatest clustering of high importance rankings is found in the group of responses related to marketing and increasing local market share.[5]

The data summarized in Table 15 are consistent with these findings: the most frequent innovative activities carried out by domestic ICT firms during 2007-2008 were the introduction of a new product or service in the domestic market (87 percent), improving existing products or services (77.4 percent) and improving firm organization (61.3 percent). The interviewees also indicated that the most important impacts of innovation had to do with sales, service quality, and increased participation in the market (market share), rather than increased productivity. The innovations which the interviewees *did* consider to have a strong impact on productivity were primarily organizational—new or improved productive processes, extension of the ranges of product or services, and new or modified organization.

A final analysis of relationships between innovation and productivity in Costa Rican ICT firms involved a consideration the impact of innovative activities undertaken in 2005-2006 on reported labor productivity in 2007 and 2008,[6] and on the change in productivity between 2007 and 2008, to account for possible lag times between innovation activities and the realization of their benefits. Pearson's chi-square statistics summarized in Table 16 show no association between productivity levels (or changes in productivity from 2007 to 2008) and innovation activities.

These results may indicate a lack of awareness by Costa Rican entrepreneurs of the importance of innovation in improving firms' productivity to enable continuing growth, but they may also show—as other results cited previously also seem to suggest—that local entrepreneurs have other objectives in mind when they form their companies. Further research is called for to clarify this issue, but it is worth noting here that in interviews with local venture capital investors and representatives of local VC funds, a commonly expressed view was that Costa Rican

[5] As was pointed out in Section 2, most of the domestic ICT firms sell their products or services in the Costa Rican market; more than 70 percent of the firms state that they sell more than 70 percent of their products in the local market.

[6] Labor productivity (sales divided by number of workers) was used as a measure of firms' productivity rather than total factor productivity (TFP); labor productivity was considered to be more appropriate for short-term analyses, especially in the context of uncertainty about firms' growth processes and problems related to the availability of data, particularly on capital investment.

companies are more often founded with the goal of providing their owners a stable income than of growing into a large firm, and that founders are accordingly more concerned about survival than fostering the innovation that would be necessary to drive a continuous productivity-based growth process.

4.4 Protection of Innovation Outputs

Protecting innovation outputs by establishing intellectual property rights is an important way for an innovative firm to be able to exploit its innovations. Given the relatively high frequency of domestic ICT firms' participation in both innovation output and input activities (producing new products or services, investing in R&D, etc.), it is relevant to consider the extent to which these firms protect their innovations.

According to interview results, more than half of all domestic ICT firms (51 percent) protect their innovations through some kind of mechanism, including but not limited to patents,[7] most frequently in the case of software companies (75 percent) and components firms (55 percent), as compared to 41.2 percent of direct services companies and one-third of IT-enabled services companies. According to Hausmann and Rodrik (2002), the reason why some Latin American countries' investment in R&D is so low is that businesspersons in these countries learn what they are good at producing, rather than focusing on producing new goods which can be patented. These authors argue that while intellectual property regimes protect inventors of new goods by allowing a temporary monopoly (e.g., patents), a businessperson in a developing country that realizes that an already existing product can be produced profitably in his country usually does not obtain intellectual property protection, no matter how high the social return. In other words, some domestic ICT firms may not be protecting their innovations because they may be very simple adaptations, such as those described by Evenson and Westphal (1995), and may therefore not be suitable for protection through mechanisms such as patents.[8]

The results of interviews with domestic ICT firms show that in most cases (82 percent) these companies believe that their products and services have characteristics that could make

[7] Types of protection other than patents include copyrights, trademarks, industrial designs, layout designs of integrated circuits, geographical indications, undisclosed information, trade secrets and breeder's rights (regulated by the UPOV Convention).

[8] These authors indicate that the type of local adaptation required is rarely associated with discoveries that are patentable outside the country; these adaptations do not generate results that are innovative enough with respect to the current state of the art.

them suitable for protection. In fact, all software and ICT-enabled services firms, as well as 87 percent of direct ICT services companies, take that position, but only 45 percent of components firms do, since they see their products and services as relatively generic—consistent with Hausmann and Rodrik's point of view.

There may be other reasons why some domestic ICT firms do not protect their innovations even when they believe their products or services have characteristics that merit, and could receive, formal intellectual property protection. First, it is possible that the lack of patenting (or other type of protection) could be due to the relatively high cost of getting the patent, especially in the case of small and medium-sized firms. Second, firms might not know the processes involved in obtaining intellectual property protection for their innovations. Third, the institutional framework for getting protection inside the country may not work satisfactorily from the firms' point of view.

If domestic ICT firms are not using or cannot use government funds such as *Propyme* for innovation activities (including intellectual protection), as shown in Table 10, they may believe that protecting the results of innovation is expensive. In Costa Rica, the *Propyme* program was created to allow domestic firms to obtain grants to finance innovation output activities, including the protection of such innovations. Unfortunately, as was found by Monge-González et al. (2010), this government fund is not being used by many Costa Rican firms due to implementation problems. If the lack of resources (grants) is the reason why some firms do not protect their innovations, a good policy would be to correct the current situation and promote the use of *Propyme* by domestic ICT firms. This task must be undertaken as a joint effort between government authorities and the private sector (e.g., CAMTIC).

With regard to the degree of knowledge of domestic ICT firms that do not protect their output innovations about how to protect their innovations, the results in Table 17 show that more than half of these firms (61 percent) do not know about the different ways or forms available to protect their innovative product or services, almost 90 percent of these firms do not know how to protect their innovations in Costa Rica, and the same percentage does not know how to do so abroad. None of the IT-enabled services companies interviewed who responded to these questions reported knowledge of any of these mechanisms, but this may be due to some degree to the lack of clear guidelines at a global level for patenting or otherwise protecting services, as

opposed to physical products. Overall, we can see a clear need for training in intellectual property protection for Costa Rica's domestic ICT firms.

Finally, with regard to domestic ICT firms' perception of the adequacy of the institutional framework in this area, these firms consider the performance of the Costa Rican patent office to be slightly less than satisfactory. The average of individual ratings for the patent office was 2.90 on a scale of 1 (unsatisfactory) to 5 (excellent).

4.5 Factors Hindering Innovation

Firms engage in innovation for a number of reasons, related, *inter alia*, to products, markets, efficiency, quality and/or the ability to learn and to implement changes. Identifying firms' motives for innovating and their relative importance helps understand the forces that drive innovation activities, such as competition and opportunities for entering new markets.

The process of innovation can be also hampered by a number of factors. In fact, there can be valid reasons for not innovating at all, as well as factors that slow innovation activity or have a negative effect on expected results. These include economic factors, such as high costs or lack of demand, enterprise factors, such as lack of skilled personnel or knowledge, and legal factors such as regulation, as well as the ability of enterprises to realize the gains from their innovative activities.

When investigating the relative importance of the factors that hinder innovation by domestic ICT firms, we grouped such factors into three categories: environmental factors, factors inside the firm, and market factors (see Table 18).

In the first category, at an overall level, domestic ICT firms most frequently indicated the high cost of funding (92 percent), the cost of training, and the lack of financial resources for this type of activity (both 86 percent), the low quality of some training institutions (78 percent), the low efficiency of the intellectual protection system (69 percent), and the lack of human resources (65 percent) as factors that hinder their efforts to innovate. Noticeable differences between sub-sectors with respect to environmental impediments to innovation include: a greater frequency of viewing lack of clarity of regulations and lack of information about technologies as problems cited by hardware companies; a higher frequency of reporting low quality of training centers, and a lower frequency of mentioning training costs, cited as problems by software companies; more frequent mention of the lack of intellectual property protection by direct services companies; and less frequent mention of financing and lack of clarity of regulations as problems cited by IT-

enabled services companies (although the small sample size in this sub-sector makes the significance of such variations hard to evaluate).

In the case of factors inside the firm, domestic ICT firms most frequently indicated as obstacles for innovation the high cost of innovation activities (76 percent), the lack of appropriately trained workers (62 percent), and the long time that innovations take to produce returns (62 percent). Noticeable differences between sub-sectors in frequency of affirmative responses related to internal obstacles to innovation include relatively infrequent mention of periods of return on investments and worker turnover by hardware companies, and relatively frequent mention of lack of trained workers and problems with internal management of change by direct services companies.

Finally, in the case of market factors hindering innovation, the firms most frequently indicated high levels of competition and a frequently changing market environment (70 percent), the possibility of others imitating the firm's innovations (70 percent), frequent technological changes (57 percent), lack of cooperation among firms (56 percent), and lack of market information (54 percent). Hardware companies are notable for the frequency with which they cite a changing environment and the possibility of imitation of products and services by competitors as market barriers to innovation; direct services companies stand out for the frequency with which they report frequent changes in technology and lack of opportunities to cooperate as barriers; and software companies are likewise frequently concerned with lack of opportunities to cooperate, as well the small size of the market, and are notably unconcerned with lack of positive consumer response, lack of ability to obtain the latest technology, and resistance to change in the sector.

5. Conclusions and Policy Recommendations

We have attempted to contribute to the understanding of the relationships between innovation, R&D, and productivity in the ICT sector of a small open economy, Costa Rica. In doing so, we began by considering innovation as a process that can occur in any area, or all areas of firm operations, which can involve advantageous changes in products, processes, organization and/or marketing/commercialization. We have considered the types of innovation outputs that characterize domestic ICT firms in Costa Rica; the relative importance of innovation inputs such as R&D, highly skilled workers, interactions with other firms and research institutions, and an

organizational structure that is conducive to learning and exploiting knowledge; the impacts of innovation on firm productivity, sales, and efficiency; the protection of innovation outputs; and, factors which hinder innovation in this sector.

The main conclusions from this case study can be summarized as follows:

1. ICT sector development in Costa Rica has been fostered by a government strategy that differs in some respects from those followed by other developing countries with stronger ICT sectors, such as Singapore, Ireland, China, Malaysia, and India. Costa Rica has used only three main public policies in this area: free primary and secondary education and an excellent public university educational system; duty-free access to modern ICT products from around the world; and an economic liberalization process including an EPZ regime to attract a significant amount of foreign direct investment. Other countries have also used other public policies, such as guaranteeing access to financial instruments other than loans (seed capital, venture capital, and equity markets) for ICT firms, a demand-driven educational system, and government-funded technology parks.
2. Most Costa Rican-owned ICT companies have been highly involved in innovations that encompass a wide range of changes in their activities, including product innovations (introducing a new product or service in the market, or improving an existing product or service), organizational innovations, and marketing innovation. Levels of activity in these areas range between 27 percent in the case of introducing a new product/service in the international market to 89 percent in the case of improving an existing product or service.
3. The principal factors facilitating innovation output activities by ICT firms are access to highly skilled workers, entrepreneurial culture, access to loans and information systems, internal training programs, design, market information, fiscal incentives, technology trials, access to technical assistance, and organizational changes.
4. Most of these companies are highly engaged not only in R&D activities, but also in other important innovation-input activities such as training of human

resources, product or process design, receiving consulting services and technical assistance, carrying out organizational changes, and patenting.

5. Most innovation input activities are carried out inside domestic ICT firms, while only in the cases of patenting and licensing, training of human resources, and technical assistance and consulting do these firms frequently use an outsourcing approach.
6. Costa Rican ICT firms interact very little with private and public educational and research institutions, and do so mostly for training purposes. On the other hand, a stronger relationship was found between domestic ICT firms and the suppliers and clients with whom they were involved in the productive chain.
7. More than half of domestic ICT firms have MNCs as clients in Costa Rica. A substantial portion of these domestic companies reported the need to carry out radical or significant changes in their organization, the variety of their products and/or services, their production techniques, their levels of investment in new machinery and technological equipment, delivery times, levels of production, or expenditures on training in order to improve delivery of goods or services to this type of client.
8. With respect to knowledge spillovers through worker mobility between MNCs and domestic ICT companies, almost half of all domestic ICT firms have at least one owner that previously worked for a MNC in Costa Rica, while 26 percent of managers, 9 percent of engineers, and 5 percent of programmers in the domestic ICT companies had previously worked for MNCs in Costa Rica.
9. Sixteen of 37 domestic ICT firms reported having commercial relationships such as “channel partnering” with ICT multinationals, in which domestic ICT companies are themselves clients of ICT MNCs, entering into formal relationships to sell and/or locally support the multinationals’ products and services. The domestic companies report important benefits from these commercial relationships with multinational ICT companies, such as training in sales and marketing techniques, information about current or possible clients, special events for network formation between domestic ICT companies involved with the same multinational ICT companies, and

increased visibility for local partners (being featured in local advertisements by the multinational firms, for instance).

10. Costa Rican ICT firms do not often have relationships with industry associations or chambers, the national government's trade promotion agency or government ministries. When those relationships do exist, they are concentrated in the areas of training, information, organizational change consulting and, to a lesser degree, technical assistance.
11. The only source of funding widely used by domestic ICT companies are loans from private and public banks, while government programs, mainly grants for promoting innovation activities (such as the *Propyme* program), are almost completely unused, either from lack of interest on the part of domestic ICT firms or for lack of knowledge about such programs.
12. With respect to the objectives that domestic ICT firms pursue when they engage in innovative activities, only organizational innovations (i.e., new or improved productive processes, extension of the ranges of product or services, and new or modified organization) are considered to have an impact on productivity.
13. Consistent with the last conclusion, no statistically valid relationship between firms' productivity levels (or changes in productivity) and innovation activities of the type studied in this report were found.
14. Slightly more than half of domestic ICT firms protected their innovations through some kind of formal mechanism, including but not limited to patents—more frequently in the case of software companies and components firms than in the case of direct services companies and IT-enabled services companies.
15. When exploring why many domestic ICT firms do not protect their innovations, even though most of them claim that their products/services have characteristics that could make them suitable for protection, it was found that: (a) firms lack information about the availability of government funds to support them in obtaining protection for their innovations, which affects their perception of the cost of protecting innovations; (b) most of these firms are

not informed about the different methods available to protect their innovative products or services; and (c) the overall satisfaction rating given to Costa Rica's patent office by domestic ICT firms was not high, making clear the need of work in this area.

16. Some environmental factors appear to hinder innovation activities by domestic ICT firms. Among them are the high cost of funding, the cost of training and the lack of financial resources for these types of activities, the low quality of some training institutions, the inefficiency of the intellectual property protection system, and lack of human resources.
17. Domestic ICT firms most frequently indicate the high cost of innovation activities, the lack of appropriately trained workers, and the long time that innovations may take to produce returns as the principal factors hindering innovation inside the firm.
18. Finally, in the case of market factors hindering innovation, the firms most frequently mentioned high levels of competition and a frequently changing market environment, the possibility of others imitating the firm's innovations, frequent technological changes, lack of cooperation among firms, and lack of market information.

Some recommendations to support the type of innovation that can lead to increased ICT-sector productivity and competitiveness in Costa Rica can be derived from these conclusions:

1. Costa Rican authorities should move forward in the design and implementation of new financial instruments to support the development of domestic ICT firms. New sources for such instruments, such as seed capital, venture capital, and angel capitals are now possible thanks to a new law (*Ley 8634; Sistema de Banca para el Desarrollo*, 2008). However, the regulation and institution building needed to make these instruments available are still pending. A study of the experiences of other developing countries in this area may provide useful information for successfully undertaking these tasks. Moreover, more efforts must be made to develop the equity market in the country.

2. Costa Rica should move toward a demand-driven educational system to guarantee the appropriate supply of human resources needed for the development of its ICT sector. In doing so, the government must facilitate the coordination of efforts between the Chamber of ICT companies and public universities and other educational organizations.
3. Although Costa Rica has supported the development of EPZs in order to attract foreign direct investment in the ICT sector, it should explore moving from this regime to a more sophisticated one that includes the development of technology parks.
4. Costa Rican authorities should improve the operation of the system for funding innovation activities through grants (such as those from the *Propyme* program), and should better advertise its presence and potential benefits. Making the current system more flexible and creating alliances with ICT multinationals and newspapers can assist in achieving these goals. Monitoring and impact evaluation of these grants must be a priority for authorities.
5. The Chamber of ICT companies and Costa Rican authorities must work together to create awareness among domestic ICT firms of the importance of protecting their innovations, and of the different instruments available for this purpose.
6. Costa Rica must improve the operation of the patent office in order to support the protection of innovation activities by ICT firms. Studying successful experiences of other developing countries in this area should provide useful guidance for undertaking this task.

References

Corporación de Fomento de la Producción (CORFO). 2010. *Comenzar un negocio innovador*. Santiago, Chile: CORFO. Available at: (www.corfo.cl/lineas_de_apoyo/programas_por_necesidad/comenzar_un_negocio_innovador)

De Ferranti, D. et al. 2002. *Closing the Gap in Education and Technology*. Washington DC, United States: World Bank Latin American and Caribbean Studies.

Drucker, P. 1974. *Management: Tasks, Responsibilities, Practices*. London, England: Harper & Row.

Evenson, R. and L. E. Westphal. 1995. "Technological Change and Technology Strategy" in Jere Behrman and T.N. Srinivasan (editors.), *Handbook of Development Economics*. 3A: 2209-2229.

Hanna, N. 2009. *e-Transformation: Enabling New Development Strategies*. New York, United States: Springer.

Hausmann, R. and D. Rodrik. 2002. *Economic Development as Self-Discovery*, National Bureau of Economic Research. Discussion Paper No. w8952.

Heeks, R., and B. Nicholson. 2002. *Software Export Success Factors and Strategies in Developing and Transitional Economies*. Development Informatics Working Paper #12, University of Manchester Institute for Development Policy and Management. (www.sed.manchester.ac.uk/idpm/research/publications/ wp/di/documents/di_wp12.pdf)

Information for Development Program. 2008. *International Good Practice for Establishment of Sustainable IT Parks.* infoDev. (www.infodev.org/en/Document.557.pdf)

InnovaChile and Asociación Chilena de Empresas de Tecnologías de Información. 2008. *Estrategia Competitiva para la Creación en Chile de una Industria de Tecnologías de Información de Clase Mundial*. Santiago, Chile. (www.acti.cl/userfiles/file/Documentos E-Biblioteca/Estudio Estrategia Competitiva para la Industria TICs.pdf)

International Telecommunication Union. 2010. *ICT Statistics Database*. Geneva, Switzerland. www.itu.int/ITU-D/icteye/Indicators/ Indicators.aspx.

Meyer-Stamer, J., U. Harmes-Liedtke, and G. McKenzie. 2004. *Why and When are Clusters Important for Growth and Productivity?* Buenos Aires.

Monge-González, R. and J. Hewitt. 2007. *Mapeo del sector de las TICs de Costa Rica*. Document prepared for the Costa Rican Chamber of ICT Companies (CAMTIC) and FOMIN/BID.

---. 2008. *Innovación, Competitividad y Crecimiento: Desempeño de Costa Rica y de su Sector de las TICs*. Cartago, Costa Rica: Ediciones el Castillo.

Monge-González., R., L. Rivera, and J. Rosales. 2010. *Productive Development Policies in Costa Rica: Market Failures, Government Failures and Policy Outcomes*. IDB Working Paper Series No. IDB-WP-157. Inter-American Development Bank: Department of Research and Chief Economist.

Poole, J. 2008. *Multinational Spillovers through Worker Turnover.* Department of Economics, University of California, Santa Cruz.

Porter, M. 2000. "Location, Competition and Economic Development: Local Clusters in a Global Economy." *Economic Development Quarterly* 14(1): 15-34.

Porter, M., C. Ketels, and M. Delgado. 2007. *The Microeconomic Foundations of Prosperity: Findings from the Business Competitiveness Index 2007-2008* (www.weforum.org/pdf/Global_Competitiveness_Reports/Reports/gcr_2007/Chapter2.pdf).

Small Industries Development Bank of India. 2010. *SIDBI Venture Capital Ltd.: Mission*. SIDBI. (www.sidbiventure.co.in/svc-01r.htm)

Singh, A. 2005. *The Essential Ingredients of Bangalore's Success: Some Lessons from the Cluster*. (www.intracen.org/wedf/ef2005/10 - Bangalore IT Cluster_ADSingh_Tirupur.pdf).

Appendix

Table 1. Costa Rica: Total Annual Sales of ICT Sub-sectors during 2007, in Millions of US Dollars

Components			**1,926**
Local	0	0%	
Exports	1,926	100%	
Direct Services			**142**
Local	84	59%	
Exports	58	41%	
IT-enabled services			**517**
Local	26	5%	
Exports	491	95%	
Software development			**221**
Local	130	59%	
Exports	91	41%	
Totals			**2,806**
Local	240	9%	
Exports	2,566	91%	

Source: Authors' compilation elaboration based on CAMTIC data.

Table 2. ICT Sectors in Selected Countries

Indicators	Costa Rica	Uruguay	Chile	Mexico	Czech Republic	New Zealand
Population	4,533,162	3,334,052	16,134,219	103,263,388	10,241,138	4,099,000
Gross National Income (GNI) per capita (2006) in US$	4,950	5,310	9,770	7,870	12,680	27,250
Broad band penetration x 100 inhabitants	5	6.5	8.8	2.2	6.4	8.1
Number of ICT firms	705	2,263	2,084	1,289	200	7,544
ICT firms x 1,000,000 inhabitants	156	679	129	12	20	1,840

Source: Author's compilation based on data from Central Banks, ACTI, IMF, Cisco Broad Band Barometer.

Table 3. Costa Rica: Innovation Outputs in the Local ICT Sector 2005/06 (total N=37)

Innovation outputs	Components		Software		Direct Services		IT-enabled		Total	
	N	% of cases	N	% of cases	N	% of cases	N	% of cases	N	% of cases
Technological or product innovations										
Introduction of a new product or service in the local market	9	55.6	8	62.5	17	82.4	3	66.7	37	70.3
Introduction of a new product or service in the international market	9	11.1	8	37.5	17	35.3	3	0.0	37	27.0
Improvement of existing product or service	9	88.9	8	87.5	17	94.1	3	66.7	37	89.2
Organizational innovation										
Improvement of production process	8	50.0	8	37.5	17	76.5	3	33.3	36	58.3
Changes in business model or commercialization	9	66.7	8	62.5	17	64.7	3	66.7	37	64.9
Innovation in commercialization										
Development of a new brand	9	55.6	8	12.5	17	23.5	3	33.3	37	29.7
Implementation of Web site for internal or client use	9	66.7	8	50.0	17	82.4	3	66.7	37	70.3

Source: Authors' compilation based on interviews.

Table 4. Costa Rica: Innovation Input Activities by Domestic ICT Firms 2005/06 (N=37)

Innovation Inputs	Total		Components		Software products		Direct ICT Services		ICT-enabled services	
Research and development	31	83.8%	5	55.6%	8	100.0%	16	94.1%	2	66.7%
Obtaining patents and licenses	24	64.9%	4	44.4%	7	87.5%	11	64.7%	2	66.7%
Human resource training	37	100.0%	9	100.0%	8	100.0%	17	100.0%	3	100.0%
Technical Assistance	27	73.0%	7	77.8%	6	75.0%	13	76.5%	1	33.3%
Consulting	34	91.9%	8	88.9%	7	87.5%	16	94.1%	3	100.0%
Design of products or processes	32	86.5%	7	77.8%	8	100.0%	14	82.4%	3	100.0%
Organizational change	26	70.3%	7	77.8%	5	62.5%	12	70.6%	2	66.7%
Re-engineering and reverse engineering	13	35.1%	4	44.4%	1	12.5%	6	35.3%	2	66.7%
Quality control system (online)	22	59.5%	5	55.6%	5	62.5%	10	58.8%	2	66.7%
Quality control system (off-line)	20	54.1%	4	44.4%	4	50.0%	11	64.7%	1	33.3%

Source: Authors' compilation based on interviews.

Table 5. Costa Rica: Innovation Input Activities by Domestic ICT Firms, According to Location (N=37)

Innovation Inputs	Where							Internal unit						
	Always in the firm		Always contracted		Both		Total	Specific department		Multidisciplinary team		Responsible person		Total
Research and development	22	71.0%	2	6.4%	7	22.6%	31	12	38.7%	5	16.1%	14	45.2%	31
Obtaining patents and licenses	7	30.4%	9	39.1%	7	30.4%	23	6	26.1%	2	8.7%	15	65.2%	23
Human resource training	8	21.6%	9	24.3%	20	54.1%	37	7	20.0%	12	34.3%	16	45.7%	35
Technical Assistance	14	51.9%	5	18.5%	8	29.6%	27	10	38.5%	6	23.1%	10	38.5%	26
Consulting	9	27.3%	14	42.4%	10	30.3%	33	9	30.0%	10	33.3%	11	36.7%	30
Design of products or processes	23	74.2%	1	3.2%	7	22.6%	31	13	41.9%	7	22.6%	11	35.5%	31
Organizational change	17	68.0%	4	16.0%	4	16.0%	25	6	24.0%	9	36.0%	10	40.0%	25
Re-engineering and reverse engineering	8	66.7%	1	8.3%	3	25.0%	12	7	53.9%	6	46.2%	0	0.0%	13
Quality control system (online)	17	81.0%	1	4.8%	3	14.3%	21	7	35.0%	6	30.0%	7	35.0%	20
Quality control system (off-line)	13	65.0%	3	15.0%	4	20.0%	20	7	36.8%	6	31.5%	6	31.5%	19

Source: Authors' compilation based on interviews.

Table 6. Costa Rica: Main Factors Facilitating Domestic ICT Firms' Involvement in Innovation Output Activities

Facilitating factors	Total	Components	Software products	Direct ICT Services	ICT-enabled services
Qualified human resources	4.9	4.9	5.0	4.8	5.0
Entrepreneurial culture	4.3	4.6	4.3	4.3	3.7
Access to financing	4.2	4.8	3.9	4.3	3.3
Investment in research and development	4.2	3.6	4.8	4.2	4.3
Information systems	4.1	4.7	4.4	3.7	3.3
Internal training program	4.0	4.4	3.9	3.8	3.7
Design	3.9	4.1	4.0	3.8	3.7
Market information	3.9	4.6	3.5	3.7	4.0
Fiscal incentives for innovation	3.9	4.3	3.1	4.2	2.3
Carry out technology trials	3.6	4.4	3.1	3.4	3.3
Have technical assistance available	3.5	4.0	3.4	3.5	2.7
Organizational change	3.5	4.2	3.3	3.4	3.0
Have local suppliers	2.7	2.8	2.3	2.7	3.3

Note: Averages of rankings on a scale of 1 (not at all important) to 5 (very important); averages sorted in descending order (N=37).
Source: Authors' compilation based on interviews.

Table 7. Costa Rica: Relationship between Domestic ICT Firms and Educational/Research Institutions

Institutions	Subsectors	% responding affirmatively							Degree of Satisfaction*
		Technical trials	Information	Training	Research and development	Design	Technical assistance	Organizational change consulting	Finance	
Public universities	Hardware (N=9)			11.11%						2.00
	Software (N=8)									
	Direct services (N=17)	5.88%	5.88%	17.65%				5.88%		3.50
	ICT-enabled services (N=3)		33.33%	66.67%						3.00
	Total (N=37)	2.70%	5.41 %	16.22%				2.70%		3.14
Private universities	Hardware (N=9)			11.11%						2.00
	Software (N=8)									
	Direct services (N=17)			11.76%	5.88%					2.00
	ICT-enabled services (N=3)		33.33%	66.67%						3.50
	Total (N=37)		2.70%	13.51%	2.70%					2.50
INA (National Learning Institute)	Hardware (N=9)		11.11%	22.22%						3.00
	Software (N=8)									
	Direct services (N=17)			11.76%						3.50
	ICT-enabled services (N=3)		33.33%	33.33%	33.33%					3.00
	Total (N=37)		5.41%	13.51%	2.70%					3.20
Technical colleges	Hardware (N=9)		11.11%	11.11%				11.11%		1.50
	Software (N=8)									
	Direct services (N=17)		5.88%							3.00
	ICT-enabled services (N=3)	33.33%	33.33%	33.33%						3.00
	Total (N=37)	2.70%	8.11%	5.41%				2.70%		2.25
University colleges	Hardware (N=9)			11.11%						4.00
	Software (N=8)									2.00
	Direct services (N=17)			17.65%						4.00
	ICT-enabled services (N=3)									
	Total (N=37)			10.81%						3.60
Public investigation centers	Hardware (N=9)									
	Software (N=8)									2.00
	Direct services (N=17)		11.76%	5.88%			5.88%	5.88%		4.00
	ICT-enabled services (N=3)									
	Total (N=37)		5.41%	2.70%			2.70%	2.70%		3.33
Private investigation centers	Hardware (N=9)			22.22%		11.11%	22.22%			4.00
	Software (N=8)			12.50%						5.00
	Direct services (N=17)									
	ICT-enabled services (N=3)			33.33%	33.33%					1.00
	Total (N=37)			10.81%	2.70%	2.70%	5.41%			3.60

*"Satisfaction" is the overall average of responses on a scale of 1(unsatisfactory) to 5 (excellent).
Source: Authors' compilation based on interviews.

Table 8. Costa Rica: Relationship between Domestic ICT Firms and Productive Chain Actors

Institutions	Subsectors	% responding affirmatively								Degree of Satisfaction*
		Technical trials	Information	Training	Research and development	Design	Technical assistance	Organizational change consulting	Finance	
Suppliers	Hardware (N=9)	11.11%	44.44%	55.56%	44.44%	22.22%	33.33%	11.11%	44.44%	3.14
	Software (N=7)		28.57%	57.14%	14.29%		28.57%		14.29%	3.60
	Direct services (N=17)	5.88%	11.76%	35.29%	11.76%	11.76%	29.41%	17.65%	11.76%	2.50
	ICT-enabled services (N=3)			33.33%			66.67%			3.00
	Total (N=36)	5.56%	22.22%	44.44%	19.44%	11.11%	33.33%	11.11%	19.44%	2.96
Clients	Hardware (N=9)		33.33%						11.11%	2.00
	Software (N=8)	12.50%	37.50%	25.00%		12.50%	12.50%	12.50%	12.50%	4.33
	Direct services (N=17)	5.88%	35.29%	5.88%	5.88%	17.65%				3.00
	ICT-enabled services (N=3)			33.3%						1.00
	Total (N=37)	5.41%	32.43%	10.81%	2.70%	10.81%	2.70%	2.70%	5.41%	2.93
Multinationals operating in Costa Rica	Hardware (N=9)									
	Software (N=8)									
	Direct services (N=17)		5.88%	17.65%			5.88%			3.00
	ICT-enabled services (N=3)									
	Total (N=37)		2.70%	8.11%			2.70%			3.00

*"Satisfaction" is the overall average of responses on a scale of 1(unsatisfactory) to 5 (excellent)
Source: Authors' compilation based on interviews.

Table 9. Costa Rica: Percent of Domestic ICT Firms Reporting a Need to Carry Out Radical or Significant Changes to Supply MNCs

Activities	Hardware (N=7)	Software (N=3)	Direct services (N=11)	ICT-enabled services (N=2)	Total (N=23)
Changes in their organization	14	33	40	50	32
Changes in the variety of products/services	43	67	45		43
Modification of production techniques	43	67	40	50	45
Invest in new machinery and technological equipment	29	67	55		43
Reduce delivery times	14	100	73		52
Increase production level	57	50	50		48
Increase expenditures on training	14	67	45		35

Source: Authors' compilation based on interviews.

Table 10. Costa Rica: Worker Mobility from MNCs to Domestic ICT Firms

ICT sub sectors	1+ownwer(s) have worked for MNCs	Total 2008			Managers			Engineers			Programmer		
		Total 2008	Worked with MNCs	%	Total 2008	Worked with MNCs	%	Total 2008	Worked with MNCs	%	Total 2008	Worked with MNCs	%
Components	44.44%	79	19	24.05	8	2	25.00	9	1	11.11	5	1	20.00
Software products	25.00%	214	30	14.02	21	3	14.29	72	9	12.50	88	10	11.36
Direct services	56.25%	284	35	12.32	23	8	34.78	95	11	11.58	22	1	4.55
ICT-enabled services	66.67%	232	5	2.16	13	4	30.77	79	1	1.27	140		
Total	47.22%	809	89	11.00	65		26.15	255	22	8.63	255	12	4.71

Source: Authors' compilation based on interviews.

Table 11. Costa Rica: Benefits of Commercial Relationships between Local and Multinational ICT Companies

	Types and numbers of relationship between local and multinational ICT companies				
	Distributor / wholesaler	**Marketer / retailer**	**Value-added reseller (VAR)**	**Representative**	**TOTAL**
Benefit	**N=28**	**N=8**	**N=7**	**N=9**	**N=52**
Discounts for products/services	100.0%	62.5%	71.4%	33.3%	78.8%
Credit	75.0%	25.0%	42.9%	22.2%	53.8%
Training - technical aspects of products/services	92.9%	87.5%	85.7%	33.3%	80.8%
Training - sales and/or marketing techniques	75.0%	37.5%	85.7%	11.1%	59.6%
Information about current/potential clients	64.3%	37.5%	71.4%	22.2%	53.8%
Participation in special events for partners	75.0%	37.5%	71.4%	22.2%	59.6%
Certification	75.0%	50.0%	71.4%	22.2%	61.5%
Publicity/visibility for Costa Rican company	71.4%	25.0%	71.4%	22.2%	55.8%

Source: Authors' compilation based on interviews.

Table 12. Costa Rica: Relationships between Domestic ICT Firms and Selected Private and Public Organizations

Institutions	**Subsectors**	**% responding affirmatively**								**Degree of Satisfaction***
		Technical trials	**Information**	**Training**	**Research and development**	**Design**	**Technical assistance**	**Organizational change consulting**	**Finance**	
Associations and chambers	Hardware (N=9)		11.11	22.22						3.67
	Software (N=8)		37.50	12.50						3.50
	Direct services (N=17)		58.82	47.06	5.88		11.76	17.65	5.88	3.00
	ICT-enabled services (N=3)			66.67			33.33	66.67%		1.50
	Total (N=37)		37.84	35.14	2.70		8.11	13.51	2.70	3.05
Government trade promotion agency (Procomer)	Hardware (N=9)		11.11	11.11				11.11		1.00
	Software (N=8)		25.00	12.50			12.50	12.50		4.00
	Direct services (N=17)	5.88	23.53	29.41		5.88	11.76	5.88		3.14
	ICT-enabled services (N=3)									
	Total (N=37)	2.70	18.92	18.92		2.70	8.11	8.11		3.18
Government ministries	Hardware (N=9)		11.11	11.11				11.11		1.00
	Software (N=8)									
	Direct services (N=17)		17.65	11.76	5.88	5.88		11.76		2.33
	ICT-enabled services (N=3)									
	Total (N=37)		10.81	8.11	2.70	2.70		8.11		2.00

*"Satisfaction" is the overall average of responses on a scale of 1(unsatisfactory) to 5 (excellent).
Source: Authors' compilation based on interviews.

Table 13. Costa Rica: Relationship between Domestic ICT Firms and Finance Institutions

Institutions	Subsectors	% responding affirmatively								Degree of Satisfaction*
		Technical trials	Information	Training	Research and development	Design	Technical assistance	Organizational change consulting	Finance	
Government fund for innovation in SMES (*Propyme*)	Hardware (N=9)									
	Software (N=8)		12.50							1.00
	Direct services (N=17)									
	ICT-enabled services (N=3)									
	Total (N=37)		2.70							1.00
Public banks	Hardware (N=9)								77.78	3.71
	Software (N=8)								12.50	5.00
	Direct services (N=17)		11.76	5.88					23.53	3.20
	ICT-enabled services (N=3)									
	Total (N=37)		5.41	2.70					32.43	3.62
Private banks	Hardware (N=9)								88.89	3.50
	Software (N=8)		12.50						37.50	2.67
	Direct services (N=17)		5.88						11.76	3.33
	ICT-enabled services (N=3)								33.33	1.00
	Total (N=37)		5.41						37.84	3.13
Microfinance program at the National Bank of Costa Rica (BN-Desarrollo)	Hardware (N=9)									
	Software (N=8)									
	Direct services (N=17)		5.88						5.88	2.50
	ICT-enabled services (N=3)									
	Total (N=37)		2.70						2.70	2.50
Development fund for SMEs at Banco Popular (*Fodemipyme*)	Hardware (N=9)									
	Software (N=8)									
	Direct services (N=17)		5.88						5.88	5.00
	ICT-enabled services (N=3)									
	Total (N=37)		2.70						2.70	5.00

*"Satisfaction" is the overall average of responses on a scale of 1(unsatisfactory) to 5 (excellent)
Source: Authors' compilation based on interviews.

Table 14. Costa Rica: Objectives for Innovative Activities by Domestic ICT Firms 2007-2008

Objectives (# of responses)		Importance*
Production	Reduce idle times (27)	4.5
	Make production more flexible (26)	3.6
	Create economies of scale (25)	3.2
	Improve environmental management (25)	2.9
Quality	Improve product quality (27)	4.8
	Improve working conditions (29)	4.3
	Reduce environmental impact (27)	2.9
Product	Improve existing products (26)	4.3
	Create new product lines (27)	4.2
	Replace obsolete products (28)	3.9
	Increase traditional product lines (26)	3.8
	Create economies of scope (27)	3.4
	Introduce environmentally friendly products (24)	2.8
Opportunity	Make use of new scientific knowledge and technologies (30)	4.6
	Take advantage of unused capacity (27)	3.7
	Make use of new materials (25)	3.6
	Take advantage of public policies, fiscal incentives, funding (27)	3.6
Cost reduction	Reduce energy consumption (30)	3.4
	Reduce labor cost (29)	3.4
	Reduce materials consumption (28)	3.3
	Reduce inventory (21)	3.1
	Reduce product rejection (26)	2.9
Marketing	Increase market share (31)	4.8
	Maintain market share (31)	4.6
	Open new markets (30)	4.4
	Increase competitiveness to face high competition (31)	4.4

*"Importance" is the overall average of responses on a scale of 1(not at all important) to 5 (very important)
Source: Authors' compilation based on interviews.

Table 15. Costa Rica: Impacts of Innovative Activities Carried Out by Domestic ICT Firms in 2007-2008

% of implementers reporting positive effects

			Impacts of innovative activities							
Innovative activity	**Number and % of positive responses (Total N=31)**		**Improved service quality**	**Increased sales**	**Increased participation in the market**	**Increased employee satisfaction**	**Improved work environment**	**Increased productivity**	**Increased exports**	**Lower production costs**
New product or service in the national market	27	87.1	63.0	85.2	61.5	50.0	34.6	38.5	11.5	7.7
Improvements in existing products or services	24	77.4	75.0	83.3	52.2	43.5	39.1	47.8	25.0	17.4
New or modified organization	19	61.3	68.4	42.1	42.1	68.4	57.9	73.7	10.5	47.4
New or modified marketing strategies	14	45.2	50.0	78.6	42.9	64.3	28.6	50.0	35.7	21.4
New product or service in the international market	12	38.7	66.7	66.7	58.3	41.7	33.3	41.7	66.7	16.7
Extending the range of products or services	10	32.3	80.0	80.0	60.0	40.0	40.0	70.0	30.0	30.0
Improved productive process	9	29.0	66.7	55.6	33.3	55.6	55.6	66.7	22.2	44.4
New or improved package design, size, presentation	7	23.3	71.4	42.9	28.6	42.9	42.9	28.6	14.3	28.6
New productive process	6	19.4	83.3	50.0	33.3	66.7	83.3	83.3	16.7	66.7
Introduction of a new brand	6	19.4	66.7	83.3	83.3	50.0	66.7	50.0	16.7	16.7
Obtaining a patent	3	9.7	33.3	8.8	33.3	33.3	33.3	33.3	33.3	33.3

Source: Authors' compilation based on interviews.

Table 16. Costa Rica: Statistical Significance of the Associations between 2005-2006 Innovation Activities and 2007-2008 Productivity Levels

Innovative activities (2005/06)	Significance *		
	2007 productivity	2008 productivity	Change in productivity from 2007 to 2008
Technological or product innovations			
Introduction of a new product or service in the local market	0.238	0.238	0.694
Introduction of a new product or service in the international market	0.669	0.669	0.200
Improvement of existing product or service	0.544	0.544	0.544
Organizational innovation			
Improvement of production process	0.853	0.853	0.210
Changes in business model or marketing	0.710	0.710	0.710
Innovation in marketing			
Development of a new brand	1.000	1.000	0.446
Implementation of Web site for internal or client use	1.000	1.000	1.000

* Pearson Chi-Square significance statistics (2-tailed)
Source: Authors' compilation based on interviews.

Table 17. Costa Rica: Degree of Knowledge by Domestic ICT Firms That Do Not Protect Innovations on How to Get Intellectual Protection

knowledge for protecting innovations in the ICT sector	Hardware (N=4)	Software (N=2)	Direct Services (N=10)	ICT-enabled Services (N=2)	Total (N=18)
Know of different ways available to protect innovations	50.00%	0.00%	50.00%	0.00%	38.89%
Know procedures for getting intellectual property protection in Costa Rica	25.00%	0.00%	20.00%	0.00%	11.11%
Know procedures for getting intellectual property protection abroad	25.00%	0.00%	10.00%	0.00%	11.11%

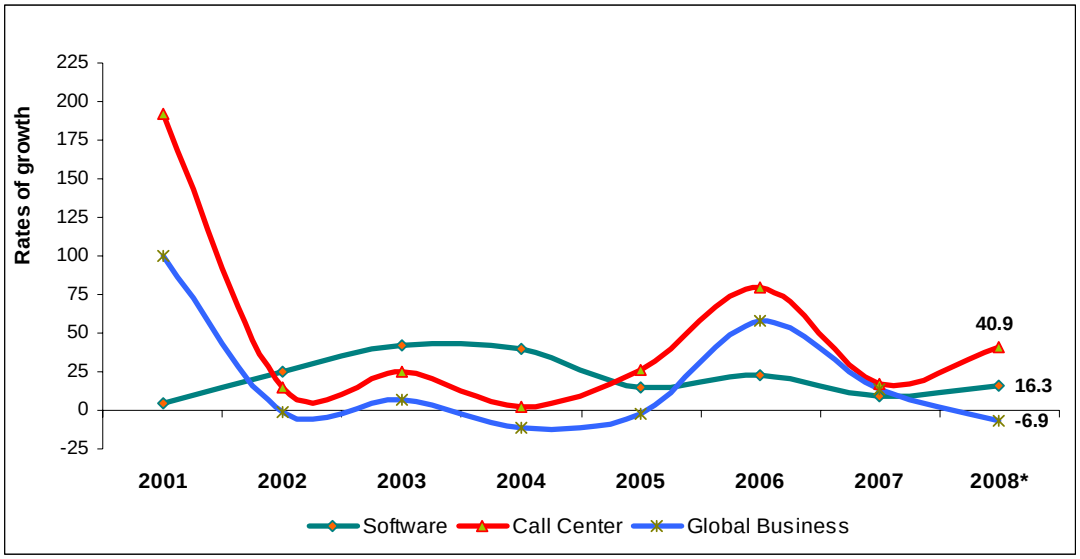
Source: Authors' compilation based on interviews.

Table 18. Costa Rica: Factors Hindering Innovation in the Local ICT Sector (percent)

Factors hindering innovation		Hardware (N=9)	Software (N=8)	Direct services (N=17)	ICT-enabled services (N=3)	Total (N=37)
Environment						
	High cost of financing	100	100	82	100	92
	High cost of training	89	63	94	100	86
	Low availability of financing	100	100	82	33	86
	Low quality of training centers	100	88	65	67	78
	Ineffective intellectual property protection	63	50	88	33	69
	Ineffective regulatory regime	78	63	59	67	65
	Low availability of trained workers	78	75	53	67	65
	Lack of training centers focused on my area	67	50	59	67	59
	Lack of support from public institutions	89	50	59	0	59
	Lack of science and technology institutions	78	63	41	67	57
	Low level of technology training	67	25	29	100	43
	Lack of physical infrastructure	44	25	29	67	35
Business						
	HIgh costs of investment in innovation	67	75	76	100	76
	Lack of appropriately trained workers	56	38	76	67	62
	Long periods of return on investments	44	75	65	67	62
	Worker turnover rates	22	50	53	100	49
	Lack of internal capacity to manage innovation	33	25	59	0	41
	Internal resistance to change	11	13	24	0	16
Market						
	HIghly competitive, frequently changing environment	89	63	59	100	70
	Ease with which others can copy our innovations	89	50	76	33	70
	Frequently changing technology in the sector	44	38	71	67	57
	Lack of opportunities to work cooperatively	44	63	63	33	56
	Lack of market information	44	50	59	67	54
	Small market size	33	63	47	33	46
	Clients impose conditions that impede change	67	13	35	67	41
	Lack of positive consumer response	44	13	41	67	38
	Lack of ability to obtain latest technology	33	13	47	33	35
	Sector is resistant to change	22	13	41	67	32
	Market resistance to new products or services	22	0	41	67	30

Source: Authors' compilation based on interviews.

Figure 1. Costa Rica: Value-Added Growth for Selected ICT Categories 2001-2008



** Preliminary data*

Source: Author's compilation based on data from the Central Bank of Costa Rica.