DO MULTINATIONALS HELP OR HINDER LOCAL FIRMS? EVIDENCE FROM THE COSTA RICAN ICT SECTOR

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Abstract[****]

This study explores the impact of ICT and IT-enabled multinational corporations (MNCs) operating in Costa Rica on the performance of domestic ICT firms. We explore the extent to which interactions between domestic firms and MNCs contribute to the survival and growth of existing domestic ICT firms, as well as the creation of new domestic ICT firms, and the generation of new high-quality employment (higher wages) in those firms. We also analyze the latter topic from a gender perspective. We used panel data for firms and a novel matched establishment-worker database, both for the years 2001-2012, to estimate several econometric models. We complement this information with data collected through three cross-sectional surveys (of domestic ICT firms, of ICT and IT-enabled MNCs, and of employees from domestic ICT firms that previously worked in MNCs). The results show low levels of linkages between domestic companies and MNCs in the ICT sector, as well as few benefits produced by such relationships. We also encountered little competition between MNCs and domestic firms in the Costa Rican market of goods and services. There are several important differences when we do the analysis by ICT subsectors (software, solutions providers, and telecommunications). Results also indicate that labor mobility can be an important channel for MNC knowledge spillovers to domestic ICT firms. We found a wage premium due to both knowledge acquisitions by workers of domestic ICT firms that previously worked in ICT and IT-enabled MNCs, and to high competition in the Costa Rican labor market. It was found a gender bias in that premium. Wage inflation is a concern for the future competitiveness of this country. Important policy recommendations arise from the results of the complete analysis.

Keywords: Costa Rica, ICT, IT-enabled, firms, employment, growth, foreign direct investment, linkages, multinationals, startups, survival, wages, gender.

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[***] This research was carried out by CAATEC for the project "ICT Sectors and Clusters, Local Firm Performance and Employment Generation in Latin America" of the International Development Research Centre of Canada (IDRC). We would like to thank Ben Petrazzini at the IDRC for his valuable comments. Our thanks also go to Ronald Lacayo and Minor Zúñiga of the Costa Rican Social Security System, Anabel González and Fernando Ocampo of the Ministry of Foreign Trade, Francisco Gamboa of PROCOMER, and Carlos Vargas and Amalia Ramirez of the Ministry of Finance, whose collaboration was crucial for obtaining access to firm-level data. We are also grateful to all of our Latin American partners in this project for their advice and valuable suggestions. Finally, we express our gratitude as well to Laura Torrentes for her valuable work. Any errors are solely the fault of the authors.

Introduction

The widespread use of information and communications technologies (ICTs) is highly important in maintaining and improving the quality of life of individuals and the economic competitiveness of developing countries participating in the modern globalized economy. The development, implementation and maintenance of ICT products and services within any country are facilitated by the specialized firms that make up national ICT sectors. A number of government policies and actions have the potential to assist domestic ICT firms to maintain and increase their competitiveness, and to promote the creation of new ICT firms and new high-quality employment, with benefits not only for the ICT sector itself, but for the economy at large.

Assessment of existing policies is therefore of great importance to governments to assure that the steps being taken in this area are effective in achieving their goals. However, as noted in the conclusion of a study of policies for the promotion of ICT sectors in the European Union, the amount of ICT sector policy-making generally exceeds the amount of policy assessment and evaluation (European Commission, 2004). Indeed, the authors point out that most policies are either not evaluated, or the results of the evaluations are not made public, while impact assessments, which typically require time series data extending beyond the life of policy programs, are usually impractical for cost reasons. These observations are also true of the state of ICT-related policies and their evaluation in Costa Rica. We therefore carried out an assessment of such policies in this country to help to remedy this deficiency, and provide results which are relevant not only for Costa Rica, but to other developing countries in similar circumstances, and with similar needs for a strong and dynamic ICT sector, around the world.

Since it would be impractical to carry out a systematic evidence-based assessment of all relevant policies and possible actions that can affect national ICT sectors, our research focused on the evaluation of policies and activities which are relevant to an especially important aspect of ICT sector dynamics – the interactions between domestic ICT firms and foreign multinational corporations (MNCs) with presences in Costa Rica. The MNCs that are included in the analyses are either direct producers of standardized ICT products and services, or "IT-enabled service providers" (ITES) that make intensive use of ICTs to offer their services to clients in other countries (such as outsourced services providers).

Costa Rica's strategy in the attraction of Foreign Direct Investment (FDI) has long been one of attracting multinational corporations (MNCs) operating in high-value-added sectors, explicitly including foreign ICT and IT-enabled companies. These latter companies are sophisticated users of ICTs whose presence has the potential to increase demand for ICT products and services from domestic ICT companies, and to create opportunities for linkages and knowledge spillovers to domestic ICT firms. The results of this strategy can be seen in statistics that show increasingly high percentages of Free Trade Zone (FTZ)

exportations coming from high technology MNCs, and studies that indicate the presence of some knowledge spillovers from these MNCs to domestic ICT firms (Monge-González and Hewitt, 2010).

In this paper, we explore the extent to which interactions between domestic ICT firms and ICT and IT-enabled MNCs contribute to the growth and survival of existing domestic ICT firms, to the creation of new domestic ICT firms, and to the generation of new high-quality employment (higher wages) in those firms. We also analyze the latter topic from a gender perspective.

The paper has six sections, including this introduction. The second section presents the main policies created by Costa Rican authorities that have in fact influenced the development of the ICT sector in this country. The third section presents the results of a review of literature relevant to the topic of our investigation – specifically, interactions between domestic ICT firms and foreign multinational corporations (MNCs). The fourth section discusses the conceptual framework and data used in the research to measure the impacts of ICT and IT-enabled MNCs on domestic ICT firms. In the fifth section, the overall results of our research are presented, and the sixth and final section summarizes our main findings and presents policy recommendations.

1 Policies affecting the development of the ICT sector

The Costa Rican government has seldom focused its policy making specifically on the development of the national ICT sector, but has rather been oriented towards the creation of policies intended to affect general aspects of the national society and economy, which may have important impacts on the ICT sector. We briefly discussed the more important of these policies below.

The government of Costa Rica has promoted widespread public education for more than a century; the country achieved universal primary education more than 50 years ago, and currently provides free primary and secondary education through 11th grade, with mandatory attendance until 9th grade. The public educational system was also a pioneer among developing countries in introducing public school students to the use of computers, through the creation of the National Program of Educational Informatics (PRONIE) supported by the Omar Dengo Foundation (FOD). Thus, since the 1980s these programs have provided primary students with basic "digital literacy" computer useage skills, as well as introductions to programming and logical problem solving; by 2011, these programs covered almost two-thirds of primary and secondary public schools (FOD, 2011). These efforts have created the foundations for an unusually well-educated workforce for a developing country, providing significant numbers of workers both for the ICT sector itself

and for other types of businesses which make use of ICT products and services. However, some studies have shown the need for further efforts to meet ever-increasing demands by domestic and foreign firms for technically skilled workers (see Monge-González and Hewitt, 2010). In order to respond to this need, the government of Costa Rica created a multi-sectorial Human Resources Working Group in 2011 led by the Costa Rican Investment Promotion Agency (CINDE) to develop new human resource strategies.

The creation of the PRONIE and the FOD demonstrates that the government has been clearly aware of the necessity of increasing the levels of access to, and use of, ICTs in all areas of Costa Rican society for several decades (Monge-González and Chacón, 2002). More recent elements of the national strategy for increasing access to and use of ICTs are the development of a national broadband plan; improved connectivity for the educational and health sectors and for disadvantaged segments of the population (including the extension of the national network of community telecenters [CECIs]); and increased use of ICTs in government institutions (Chinchilla Miranda, 2011). The government also worked to facilitate the wider use of "e-commerce" through the passage of a law recognizing the validity of digital signatures.

In addition, after more than 50 years of state monopoly control, Costa Rican authorities opened the national telecommunications market to competition in 2009 and new operators began to provide private network services, Internet access, and mobile telephony. As a result of this opening, the proportion of homes with Internet connectivity and the proportion of cellular telephony accounts almost doubled between 2010 and 2012 (SUTEL, 2013). All of these policies and actions have the potential to increase the size of the local market for ICT products and services, to the benefit of the national ICT sector.

The 1980s saw the beginnings of the implementation of a number of policies related to trade liberalization and access to international markets which have had extremely important implications for the development of the national ICT sector (Monge-González and Hewitt, 2010). These policies included the reduction of trade barriers to importing hardware and software, as well as reduction of internal taxes on local purchases of computers and software, thus increasing the use of, and demand for, these products and associated services. They also included a number of successful measures to promote trade in Costa Rican products and services, all of which have the potential to assist national ICT companies to increase their sales abroad. Among these policies are the creation of the Ministry of Foreign Trade (COMEX) and the Costa Rican Export Promotion Agency (PROCOMER), and participation in the General Agreement on Tariffs and Trade (GATT, 1990) and the World Trade Organization (WTO). In addition, the government has signed a number of Free Trade Agreements (FTAs) with the United States (USDR-CAFTA), Canada, Mexico, Chile, Panama, China, Singapore, and the European Union.

The government also cooperated with the private sector in the formation of the first investment promotion agency in Latin America in 1982 - the Costa Rican Investment Promotion Agency (CINDE; www.cinde.org). This agency continues to be one of the most effective organizations in the region in attracting FDI, and follows a strategy of attracting FDI in specific high-value-added sectors, including ICTs (software), advanced manufacturing (advanced electrical components, automotive components, aerospace), life sciences (medical instruments, pharmaceuticals and biotechnology, new materials), and clean technologies, as well as various types of services outsourcing provision (ITO, BPO, KPO, etc.) (OECD, 2012). This emphasis has the obvious effect of attracting companies which are highly sophisticated producers and/or users of ICTs, offering in both cases the opportunity for domestic ICT firms to provide them with a variety of products and services.

The first Export Processing Zones (EPZs – commonly referred to as "free zones") began operations in the 1980s, administered by PROCOMER and backed by legislation that grants incentives to foreign and domestic companies to invest in the country. To obtain the benefits provided for by the law, free zones must assure that those investments comply with certain conditions, which vary according to the type of company, investment amount, sector of investment and location (inside or outside the major metropolitan area in the center of the country, and inside or outside an industrial park)[1]. These incentives include exemption from all taxes and 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 further investments in the country after they have been operating for four years under the free zone regime.

It is important to note that in the implementation of the free zone regime, the Costa Rican government has not attempted to create special economic areas, zones, or industrial parks dedicated specifically to foreign and national ICT-related businesses, which have been associated with activities related to the attraction of FDI in many other countries (Mohan, 2006; Gregory, et al. 2009). Likewise, it has not made systematic efforts to promote the formation of a "national ICT cluster" in which domestic and foreign companies could interact in a mutually beneficial fashion among themselves and with academic and research organizations, financial institutions, and other vital actors in a true industrial cluster.

The free zone initiative has nonetheless been extremely successful, assisted by the country's long-standing reputation for well-educated workers and political stability (IADB, 1997). Most high-technology multinational corporations (MNCs) in the country operate under the free zone regime, where they generated almost 10.4% of GDP in 2014. In keeping with the government's emphasis on attracting investment in high-value-added sectors, the composition of free zone exports has evolved from natural resource-based and

[1] To comply with the provisions of the Agreement on Subsidies and Countervailing Measures (ASCM) of the WTO, existing subsidies contingent on export orientation will be removed in 2015.

low-skilled labor-intensive activities to more advanced high-technology production systems, based on highly-skilled labor. Thus, the electronic and electrical goods sector, and medical devices and pharmaceutical products sectors accounted for almost 74% of free zone exports in 2014, and exports of international services (BPO, call centers, etc.) increased rapidly as well.

While these results may benefit the national economy as a whole, it is not clear that FDI attraction has had a uniformly positive impact on domestic ICT firms. The literature reviewed provided some evidence that the increased presence of MNCs might actually have negative effects for local firms, such as the generation of shortages of technically trained human resources, with associated higher employee turnover rates and salary inflation (Gereffi, et al., 2012).

Other studies have concluded that even though Costa Rican authorities have made specific efforts to promote linkages between local and foreign companies in Costa Rica, few positive results have been obtained (Monge-González, Rivera, and Rosales, 2010). These authors claim that such results are due both to lack of coordination and proper program design on the part of the government, and to certain aspects of the MNCs and domestic firms themselves, including the globally-oriented strategy of MNCs, a weakly developed domestic production system, lack of international certifications and standards and concerns over economies of scope, trust, and quality control. On the other hand, there is some evidence of positive spillovers from MNCs to domestic ICT companies; Monge-González and Hewitt (2010) found that almost half of all domestic ICT firms had at least one owner that had previously worked for MNCs in Costa Rica, and significant numbers of managers, engineers, and programmers that had also done so, while some of these domestic ICT firms had also received substantial benefits from acting as value-added resellers of the products and services of MNC ICT companies.

The promotion of science, technology, and innovation has become increasingly important for Costa Rican authorities as the world economy becomes more globalized and competitive. This situation has created an environment in which the country cannot compete with other countries based on the availability of abundant natural resources, low salaries, or high productivity, but must rather compete based on the creation of innovative new products and services. One of the four principal axes of Costa Rica's National Development Plan for 2011-2014 was concerned with competitiveness and innovation, and the country's Science, Technology and Innovation (STI) National Plan for 2011-2014 acknowledged that the country is facing a problem of low economic growth and, in particular, low productivity (MICIT, 2011). The STI Plan therefore strongly recommended strengthening research and development, promoting business innovation, strengthening links between research centers and productive activities, and creating an ecosystem that enables entrepreneurship. ICTs have a clear role to play in this process through their contribution to information management and knowledge generation, and actions taken to

realize these goals can accordingly provide many opportunities to strengthen firms in the ICT sector.

In 1972, the Costa Rican government created the National Council for Scientific and Technological Investigation (CONICIT). This Council has a board of directors comprised of representatives from the largest public universities in the country, and counts among its responsibilities the promotion of research and the education of investigators. In 1990, the Costa Rican Legislative Assembly created the Ministry of Science and Technology (MICIT – more recently, the MICITT, or Ministry of Science, Technology, and Telecommunications) as the governing body of the National Science and Technology System (NSTS), responsible for promoting and coordinating science and technology activities and policies in the country. Both of these organizations, with the assistance of other government agencies such as the Ministry of the Economy, Industry and Commerce (MEIC), have responsibilities for the design, implementation, and administration of various programs intended to assist in the funding of research, development, and innovation in academic and research institutions and the private sector. Although none of these instruments is specifically oriented towards promoting research, development, and/or innovation in the ICT sector, many members of this sector could potentially benefit from such assistance.

Unfortunately, these programs have not produced significant positive results, due among other things to problems such as excessive bureaucratic requirements, small sizes of loans or awards, limited lack of awareness of the programs by potential beneficiaries, design flaws in the structure of the programs, and limited coordination between government agencies (Monge-González, Rivera, and Rosales, 2010). The MICITT is working to address shortcomings of these and other STI programs and policies, assisted by input from all sectors of Costa Rican society and the results of previous efforts such as the Estrategia Siglo XXI initiative (www.estrategia.cr).

Given this situation, it is clear that there is a pressing need for truly effective actions in critical areas which could have beneficial results for domestic ICT firms, among many others. These areas include new sources of financing for businesses; creation of technology parks which bring together the public, private, and academic sectors; improved access to intellectual property protection; business incubation; innovation in small businesses; improved cooperation between universities and the private sector; promotion of entrepreneurship; and the creation of a national innovation agency.

In 2011, the Costa Rican government created the Presidential Council on Competitiveness and Innovation, whose members include the president, the two vice presidents, and representatives of several key government ministries, the private sector, and academia. The creation of this council has for the first time provided a forum in which the highest government authorities regularly discuss innovation and its economic impacts. The

Technical Secretariat of the Council provides its members with diagnostics and other information that they may request, and assists in the design of solutions in priority areas and monitors the execution of policies, plans, and actions related to the promotion of innovation.

2 Literature review: the impact of MNCs on domestic firms

Our literature review showed that while there is ample discussion of the impacts of foreign MNCs on the economies of host countries, especially in the literature dedicated to the study of Foreign Direct Investment (FDI), there are far fewer studies that focus on the nature and impact of the interactions between ICT and IT-enabled MNCs and domestic ICT firms. In general, authors often stated that MNCs have technological superiority and strong management skills which can be transferred to local firms in the host country, especially in the case of developing countries. This phenomenon is referred to as *knowledge spillover*, defined as a positive externality for local firms stemming from the attraction of FDI, which may result in labor productivity growth for these firms (Blomström, 1986; Caves, 1974; Spencer, 2008).

MNCs may raise domestic productivity in the sectors where they are present through transfer of knowledge, organizational structures and practices, spillovers such as learning and demonstration effects, reverse engineering, or movement of personnel (Blomström and Kokko, 1998; OECD, 2003). However, their impact varies from country to country depending on host country conditions (Paus and Gallagher, 2008). Abramovitz (1979) used the term "absorptive capacity" to refer to domestic capabilities to absorb spillovers of foreign technologies, and some more recent papers highlight the complementarities between human capital and technology, both of which are influenced by endogenous policy choices (Paus, 2005; Paus and Gallagher, 2008).

Previous studies in this area have arrived at mixed or even contradictory results regarding knowledge spillovers related to FDI in developing countries or emerging economies. Some studies have found evidence of positive effects stemming from spillovers to local firms (e.g., Blomström, 1986; Buckley, Clegg, and Wang, 2007; Tian, 2007; Wei and Liu, 2006), while other studies have found that FDI has not produced any knowledge spillovers, or that if they do occur, their effects have been negative for local firms (Feinberg and Majumdar, 2001).

According to Zhang et al. (2010), these contradictory results can occur for at least two reasons. First, the approach adopted by the empirical studies about knowledge spillovers associated with FDI are focused simply on whether or not the presence of FDI affects local firms' productivity. In Görg and Strobl's (2005) words, one of the limitations of such studies is that they treat the range of specific mechanisms through which knowledge

spillovers are supposed to occur as a single "black box", although the importance and impact of different mechanisms may vary in different cases. Without evaluating the effects of particular mechanisms in different situations, studies with similar objectives may easily produce apparently contradictory results. Secondly, knowledge spillovers imply a process through which local firms learn from foreign firms, and the effects of knowledge spillovers associated with FDI may vary depending on local firms' capacity to absorb and adapt knowledge; without taking differences in this absorptive capacity into account, results may well appear to be contradictory; see Lim (2001).

In an effort to clarify this situation, Saggi (2002) identified three channels through which knowledge spillovers from multinational to local firms can occur. First, *demonstration effects*, which include emulation or reverse engineering of multinational companies' products and practices by local firms. Second, *labor mobility*, which allows for employees trained by multinational companies to apply their knowledge in local firms, once they leave those multinationals. Third, *forward and backward vertical linkages* between multinational companies and their local suppliers. The identification of these channels is important, since studies which have clearly identified the channel through which knowledge spillovers occurs offer the most solid results about the positive externalities of such spillovers.

In a recent work, Farole and Winkler (2014) present a comprehensive conceptual framework for the identification of mediating factors for FDI spillovers, and the channels through which these spillovers occur. Among other things, the authors point out that to understand how spillovers occur, it is necessary to take into account various characteristics of the MNCs, such as their motives for establishing operations in the host country, their global production and sourcing strategies, entry models, and the amount of time they have been present in the host country, all of which determine *MNC spillover potential*. It is also necessary to take into account the capacity of domestic firms to absorb knowledge and technology through their direct and indirect interaction with MNCs (*absorptive capacity of domestic firms*), as well as *host country factors and institutional framework*, such as labor market regulations, intellectual property rights, access to finance, and learning and innovation infrastructure. Finally, the authors argue that there are three channels through which FDI spillovers may make their effects felt: (i) supply chains, (ii) labor turnover, and (iii) market restructuring.

An important aspect of this framework is that the set of mediating factors influencing the relationship between MNCs and domestic firms is not static, but dynamic. This means that the composition of the set of factors (FDI spillover potential, domestic firm absorptive capacity, host country factors and institutional framework, and transmission channels) can change through time, which must be taken into account in any analysis of the relationship between multinationals and local firms.

There is little research dedicated specifically to the subject of the effects of ICT and IT-enabled MNCs on domestic ICT firms in their host countries. The body of literature related to the formation of ICT clusters is especially interesting because it is often assumed that the association of domestic firms with MNCs strengthens the former. However, the evidence shows that successful cluster formation depends heavily on the previous existence of favorable conditions such as market demand for the products or services produced by a cluster's members and the proximity of large numbers of skilled workers (Porter 1998, Wadhwa 2010). Thus, the simple act of placing MNCs and domestic ICT firms in proximity to each other in clusters, or technology or software parks, does not guarantee the formation of productive linkages or spillovers.

Mohan (2006) found that in Malaysia's Multimedia Super Corridor (MSC), ICT MNCs tended to be highly self-sufficient and generated few linkages with local suppliers. Gallagher and Zarsky (2007) also reported a similar result in the case of Mexican clusters centered on hardware manufacturing. Tessler *et al*. (2003) found that in Ireland, local employees of ICT MNCs tended to work in lower-level positions such as technical support and software testing, rather than in areas which would allow the workers to develop their own entrepreneurial capabilities. These authors also found that the most successful local companies forming linkages with MNCs were most often "low-margin, low-tech businesses like printing and packaging".

Governments in countries which are leaders in the promotion of large-scale ICT clusters have learned that they must make specific efforts to promote productive relationships of MNCs and domestic ICT firms. In the case of Malaysia, for example, the government required MNCs wishing to locate themselves in the MSC to provide benefits for domestic ICT firms through training, joint development projects, or other efforts. This led to actions such as the formation of a Technopreneur Development Center by Sun Microsystems to provide assistance to small domestic ICT firms that develop applications using the Java programming language (Blogspot 2005). In the case of China, admission of ICT MNCs to Special Economic Zones (SEZs) also often involves a commitment on the part of these MNCs to assist domestic ICT companies to develop their capacities (Gregory, et al. 2009).

In a particularly well documented study, Zhou and Xin (2003) analyzed the interactions between MNCs and local technology actors in China's leading information communication technology (ICT) service cluster in Zhongguancun, Beijing. They found that the relationship between MNCs and local firms is hierarchical, interdependent and evolutionary. Local firms' collaboration with MNCs provided them with vital technological and organizational training, which the local firms use strategically to develop their market networks and innovative capacities in their home markets. The learning capacity of local firms is greatly improved by the presence of other related enterprises, research and development facilities, and an advanced developmental state of the countries hosting market-oriented spatial clusters. Zhou and Xin's analysis shows the importance of dynamic

interactions between the micro and macro levels required for a country receiving high-technology FDI to achieve industrial upgrading.

Hewitt and Monge-González (2007) carried out the first mapping of the Costa Rican ICT sector. The authors analyzed 125 firms, both local and multinational, working in the areas of c*omponents/hardware, software products, direct ICT services and IT-enabled services* (ITES), with several of the multinationals operating in free zones. With respect to factors affecting the knowledge absorptive capacity of domestic firms, the authors found that most of these companies were exporters, employed high skilled workers, were involved in innovation activities, had certifications for quality control, and faced strong competition from other firms operating both in Costa Rica and abroad. The authors identified two main obstacles in this area: low labor availability, especially of highly-skilled workers, and access to various types of financial assistance. The scarcity of highly-skilled workers was viewed as a possible indicator of a crowding-out effect in the labor market due to the operation of MNCs in the country.

Ciravegna (2012) studied the linkages between MNCs and domestic ICT firms in Costa Rica during the year 2007. The author claimed that although some linkages were found which generate positive effects, such as providing access to new clients and opportunities to learn new organizational practices, linkages are still scare in the ICT cluster. He found that MNCs argue that local firms lack the necessary abilities to work with MNCs, and that since the MNCs operate in free zones they can import all of their inputs tax-free, echoing the findings of both Giuliani (2008), and Paus and Gallagher (2008).

Mata and Mata (2008) claimed that the FDI strategy followed by Costa Rica has had more negative than positive effects for domestic ICT firms, due especially to the lack of spillover effects from ICT MNCs to local firms. They point out two major negative effects of the FDI strategy on the domestic ICT firms. First, MNCs can pay higher wages than domestic ICT firms to recruit qualified human resources in a tight labor market. Second, domestic ICT firms are at a cost and infrastructure disadvantage compared to MNCs operating in the country: for example, MNCs operating in free zones benefit from streamlined government procedures and customs processes, while domestic ICT firms have to deal with the full range of bureaucratic procedures and processes. In short, the authors claim that domestic ICT firms face a more challenging business environment than MNCs operating in Costa Rica.

Nicholson (2008) described the human resource development policy of Costa Rica in the context of software exports. The author concludes that in general Costa Rica has a small labor pool and, compared to competing countries, relatively high labor costs. He also claimed that the English-speaking skills of technical workers in Costa Rica are generally weak, as were linkages between universities and industry. All of this supports the idea of a

potential for crowding out in the labor market as a result of attraction of FDI in the ICT sector.

Monge-González and González-Alvarado (2007), on the other hand, illustrate the contribution of ICT multinationals to skills development in Costa Rica, based on the cases of Intel, Microsoft, and Cisco, who worked cooperatively with businesses, universities, and training and research institutes to develop curricula that better respond to the demands of the productive sector.

In another study, Monge-González and Hewitt (2010) found that most domestic ICT companies have been involved in a wide range of product/services innovations, organizational innovations, and marketing innovations. Levels of activity in these areas ranged between 27% of domestic ICT firms in the case of introducing a new product/service in the international market, to 89% of domestic firms in the case of improving an existing product or service. Most of these companies are highly involved 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. This suggests that the absorptive capacity of domestic ICT firms may be relatively high.

These authors also found that domestic ICT firms interact very little with private and public educational and research institutions, and do so mostly for training purposes. On the other hand, they found a stronger relationship between domestic ICT firms and the suppliers and clients with whom they were involved in the productive chain. In fact, more than half of domestic ICT firms surveyed reporte having MNCs as clients in Costa Rica. A substantial portion of these local companies reported the need to carry out radical or significant changes in order to improve delivery of goods or services to MNCs, in areas such as 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, and/or expenditures on training.

With respect to knowledge spillovers through worker mobility between MNCs and domestic ICT companies, the authors found that almost half of all domestic ICT firms had at least one owner who had previously worked for MNCs in Costa Rica, while 26% of managers, 9% of engineers, and 5% of programmers in domestic ICT companies also had previous work experience in MNCs.

A final finding was that some of the domestic ICT firms reported having commercial relationships such as “channel partnering” with ICT multinationals, in which the domestic ICT companies become partners of ICT MNCs who compete in the local market, entering into formal relationships to sell and/or locally support the multinationals’ products and services, while often including their own products and services along with those of the

MNCs as part of the total offer to clients. Most of these local companies obtained important benefits from these commercial relationships with ICT MNCs, such as training in sales and marketing techniques, obtaining information about current or possible clients, participation in special events for network formation, and increased visibility in the marketplace (being featured in local advertisements by the multinational firms, for instance).

3 Estimating the impact of ICT and IT-enabled MNCs on domestic ICT firms

3.1 Conceptual framework

To investigate the degree to which the presence and activities of ICT and IT-enabled MNCs help or hinder domestic ICT firms we follow Farole and Winkler (2014) in considering three *channels* – supply chain, labor mobility, and market reorganization – for the generation and transmission of possible positive and/or negative impacts to domestic firms, and three general types of *mediating factors* which may determine the magnitude and nature of the impacts generated through these channels – characteristics of MNCs, of domestic ICT firms, and of host countries.

Transmission channels

Three principal activities that take place in the *supply chain* channel will be explored here: sales of domestic ICT firms' products and services to MNCs, purchases of MNC products and services by domestic ICT firms, and the formation of cooperative arrangements between domestic ICT firms and MNCs to jointly sell and support their products and services.

Several studies have found important FDI spillovers through the supply chain channel when local firms become input or service suppliers of multinational firms (backward spillovers), or when the goods and services provided by MNCs are used as inputs by local firms (forward spillovers). Among the most important of these studies are those of Giroud, Jindra, and Marek (2012), Javorcik and Spatareanu (2009), Jordaan (2011), Gentile-Lüdecke and Giroud (2012), Godart and Görg (2013), and Fu (2012). These spillovers may occur because MNCs help local producers to upgrade their technological capabilities directly through sharing of production techniques and product design and assisting with technology acquisition (Paus, 2005; Paus and Gallagher 2008). In addition, MNCs can help local firms with personnel training, advance payments, leasing of machinery, provision of inputs, help with quality assurance, and organization of product lines (Lall 1980; Crespo and Fontoura 2007; Javorcik and Spatareanu 2009). Since in all of these cases the supplying firm does not fully compensate the MNC for these benefits, it is clear that they constitute real spillovers, or, in other words, positive externalities (Farole and Winkler, 2014).

When considering the *labor mobility* channel, the importance of movement of MNC employees to domestic firms is explored, as well as the knowledge acquired and the capacities developed by these workers while they were working in MNCs, and subsequent use of these knowledge and skills in their new roles in domestic firms. The effect of previous experience in MNCs on salaries paid to domestic firms' employees will also be investigated. Lastly, this study examines whether there are gender biases in the jobs generated and in salaries paid by domestic firms that may be attributed to the presence of MNCs in Costa Rica.

Several studies have found important positive FDI spillovers resulting from labor turnover, since MNCs invest in providing their workers with knowledge and skills, and when workers move from these companies to domestic companies, they carry this knowledge with them to local firms (Markusen and Trofimenko, 2007). Thus, knowledge embodied in the labor force may move from multinational to local firms—either to existing local firms or when workers start their own firms (Fosfuri, Motta, and Ronde 2001; Glass and Saggi 2002; Crespo and Fontoura 2007). In the case of Costa Rica, Monge-González et al. (2012) characterized the types of knowledge and skills obtained by MNC workers who later moved to local industries. They also found that new firms created by former MNC employees show much lower death rates than other Costa Rican firms, which is interpreted by the authors as a result of the managerial skills acquired by local entrepreneurs when working for MNCs in Costa Rica. Likewise, Balsvik (2011) found a positive correlation between the share of workers with MNC experience in domestic firms and the productivity of these companies in the case of Norway.

Finally, when considering the *market reorganization* channel the impact on domestic ICT firms of competition between MNCs and domestic firms in both the labor market and the goods and services market will be explored, including an analysis of the levels of such competition and the responses of domestic firms to that competition. Kosová (2010) shows evidence of both *technology spillover* and *crowding out* effects on domestic firms caused by the presence of MNCs. According to the author, the existence of a *crowding out* effect is a short-term or static phenomenon: foreign entry initially increases the exit rates of domestic firms, but subsequently the growth of the foreign industry segment is accompanied by increases in both the growth rate and survival of domestic firms. This last result is important in pointing out that FDI spillovers are more likely to be realized in the medium to long term, since knowledge first needs to be absorbed by the local workforce.

A short-term crowding out effect may be also observed in the case of the labor market. As pointed out by Farole and Winkler (2014), in the short term, it is more likely that foreign firms will take away high-quality labor from domestic firms by offering higher wages and benefits, resulting in a potentially negative spillover effect (Sinani and Meyer 2004; Hoekman and Javorcik 2006; Crespo and Fontoura 2007). This loss of skilled labor can

also have a negative effect on the capacity of domestic firms to absorb benefits from FDI spillovers.

De la Peña (2010) presents evidence against the hypothesis that FDI is positively correlated with the creation of new firms, particularly in a setting in which the host country's economic structure is heavily characterized by micro- and small low-technology firms.

Farole and Winkler (2014) found that if MNCs sell to the local market, increased competition between MNCs and domestic firms may push the latter to improve productivity, quality, and reliability to keep up with foreign competitors and avoid becoming a part of the exit of the poorest market performers. The presence of MNCs may also increase competition among domestic firms that want to become their suppliers, resulting in higher quality and reliability of inputs (Crespo and Fontoura 2007; Javorcik and Spatareanu 2009). Other spillovers can arise from market restructuring due to direct imitation or reverse-engineering by domestic firms when the latter are exposed to MNC products, marketing strategies and production processes (Farole and Winkler, 2014).

Mediating factors

Both Paus and Gallagher (2008), and Farole and Winkler (2014) point out the importance of studying factors that may determine the extent of MNC impacts on local firms, specifically *characteristics of MNCs*, *characteristics of domestic firms*, and the *national environment* in which both types of companies carry out their operations in the host country.

In the case of *characteristics of MNCs*, it is important to study the structure of their ownership, as well as their motivations for investments in the host country, global production and purchasing strategies, intensity of use of technology, their countries of origin, their modes of entry into the country, and the length of time they have been operating in the country[2].

Various *characteristics of domestic firms* may affect the capacity of these firms to take advantage of the knowledge of MNCs that can be transferred or spill over to domestic firms through the three transmission channels mentioned previously. The most important of these include technological gaps with MNCs, amounts of investment in research and development, human capital formation, scale of production, firm location, experience with exportation, dynamism of the sector, levels of competition, and the type of ownership of the firm.

Finally, in terms of the *environment of the host country*, it is important to explore the strengths of the country in terms of labor market regulations, protection of intellectual

[2] See Farole and Winkler (2014, pp. 31-47) for further discussion of the importance of each of the mediating factors mentioned here in an analysis of MNC impact on domestic firms.

property rights, access to financing, learning and innovation infrastructure, industrial, trade and investment policies, and governance.

3.2 Data and methodology

Defining membership in the ICT sector

The task of creating an accurate inventory of businesses within a national ICT sector, and devising an informative categorization of the types of domestic businesses included in that sector, faces many challenges. One of the most serious of these is that modern ICT businesses rarely devote themselves to one or a very few ICT-related commercial activities. This can be clearly seen at a global level in the steady movement of the largest ICT companies (Microsoft, Apple, Google, IBM, etc.), towards providing their own hardware, software, consulting, services outsourcing, and a wide range of other products and services. The preliminary inventory of activities carried out by companies in the Costa Rican ICT sector for this investigation detected the same tendency. For instance, businesses that may have initially focused almost entirely on the production of standardized or "packaged" commercial applications now may also offer not only customized software solutions, consulting, and customer service, but also newer services such as remote data center services or outsourced business process support to their clients. An attempt to assign individual businesses to the ICT sector, or to subsectors within the ICT sector, thus faces the problem of determining the relative importance of each of these activities within a given business.

Just as "ICT businesses" have begun to offer types of products and services which are less and less directly related to the traditional activities of such businesses, it is also true that a very wide range of types of businesses which previously had little or nothing to do with the ICT sector are now offering products and services which depend very heavily on the presence and use of ICTs, and may actually be involved in the creation of hardware, software, and ICT support services to do so. Understanding the relative importance of "non-ICT" and "ICT" activities within a particular business thus becomes critical in deciding whether or not that business should now be regarded as belonging to the ICT sector, although its origins were clearly outside the sector. This same type of information would be necessary to decide whether entirely new types of businesses made possible by digital convergence of previously separate technologies, increased availability of high-speed and mobile connectivity, and a changing commercial landscape should be considered as belonging to the ICT sector or not.

The types of information necessary to meet these and other challenges was gathered as part of the present research project. It was decided to include in the group of domestic Costa Rican ICT firms only those firms which could be confidently assigned to one of four

standard “ICT subsector” categories, based on secondary information such as ISIC codes from government sources or descriptions of businesses in Web sites of industry associations, as well as on primary information gathered in our own surveys and interviews. These categories, which are considered to be particularly closely associated with the creation and implementation of ICTs, are:

- Telecommunications – companies which own, operate, and/or use voice and data networks to provide communications services between people and devices.
- Hardware – businesses which carry out activities related to the design, manufacture and/or assembly of electronic devices such as computers and their peripherals, telephones, network devices (routers, switches, etc.) and various types of integrated circuits.
- Software – businesses which are primarily dedicated to the creation and sales of relatively standardized applications and software tools (BIOS firmware, operating systems, application software, etc.) for horizontal or vertical market niches, or for individuals.
- Solutions providers – businesses which offer consulting, assistance, training, custom software development, systems integration, or any other of a large number of services which are closely related to the creation, implementation, and maintenance of information or telecommunications systems.

As data gathering for this project proceeded, it became obvious that while many “software companies” were also “solutions providers” (with the solutions they provide often making use of their own standardized software products), not all “solutions providers” were “software companies”. When considering the results of analysis presented in this document, it should be kept in mind that the consistent difference between “software companies” and “solutions providers” is that the former companies offer standardized software products, whereas the latter do not.

There were almost no domestic firms which were involved in the design and/or manufacture of hardware. At least in the case of hardware manufacture, this is to be expected, since such manufacturing typically requires very substantial investments in infrastructure which very few local firms are capable of making. The analysis whose results are reported here therefore did not include “hardware” companies in the case of domestic ICT firms, but only in the case of ICT MNCs.

Data

Information was collected from various sources to permit us to achieve the objectives of this project. Firstly, interviews were conducted with stakeholders to obtain insight on the possible impacts of MNCs on Costa Rican domestic firms. Secondly, three important surveys were designed and implemented: the first was for a sample of 83 domestic ICT firms, the second for a sample of 40 ICT and IT-enabled MNCs, and the third for a sample of 44 employees from domestic ICT firms that previously worked in MNCs. All of these surveys were carried out in the year 2014. Finally, we constructed a panel of data for both domestic firms and MNCs for the years 2001-2011, and a novel matched establishment-worker database for the same period, which were made possible by the support of the Costa Rican Social Security System (CCSS), the Ministry of Foreign Trade, and the Ministry of Finance.

Several data sources were consulted in order to carefully verify the classification of domestic and MNC ICT firms by the CCSS. These sources include the Chamber of Information and Communication Technologies (CAMTIC), the Foreign Trade Corporation (PROCOMER), the Costa Rican Investment Promotion Agency (CINDE) and the Costa Rican-American Chamber of Commerce (AmCham Costa Rica). All these institutions provided valuable information that assured that companies which were actually members of the ICT sector, but had not been identified as such in the CCSS databases, were included in the project's final database.

As a result of these efforts, the International Standard Industry Classification (ISIC) codes assigned to companies by the CCSS were found to be inaccurate in many cases, and a number of businesses which could not be reliably assigned to the ICT sector were found and eliminated from the list. The criteria used to justify this elimination began with a simple inspection of the names of the businesses, but also included a highly time-consuming process of searching for information on individual business on the Internet and in other sources; only companies which could be reliably assigned to the ICT sector were included in further analysis. In addition, many supposed companies were registered under personal names, with personal official identification numbers; these cases could have represented erroneous classifications by the CCSS, or one-person companies, but in any case, the information available on them from the CCSS did not permit us to obtain matching information from other sources, and these cases were therefore eliminated from consideration.

In order to complete the panel data for firms in the ICT sector with all the variables we need for the estimation of the econometric models discussed in the next section on methodology, we obtained additional data from other institutions. Thus, PROCOMER provided a list of MNCs operating under the free zone regime as well as information on whether or not the companies on the list (both domestic and MNC) exported during each of

the years in the period 2001-2011[3]. CINDE provided the list of MNCs that it had successfully attracted to the country, and AmCham provided a list of its members. Additionally, CAMTIC provided a list of its affiliates as well as ICT companies included in a recently completed mapping of the national ICT Sector. Finally, the Ministry of Finance (MH) provided information about commercial relationships between domestic ICT firms and MNCs operating in free zones.

The detailed consideration of domestic and foreign companies, together with information provided by the organizations mentioned previously provided sufficient information to be able to classify businesses as purely domestic or multinational, to divide foreign MNCs into ICT and IT-enabled categories, and to divide domestic ICT companies according to their specializations within the ICT sector – software, service providers, and telecommunications.[4]

Having taken these steps, we obtained panel data for 873 active and inactive domestic and multinational companies belonging to the Costa Rican ICT sector from 2001 to 2011, of which 587 are domestic ICT firms, 164 are ICT MNCs and 122 are IT-enabled MNCs.

The final database used for econometric analysis contains the following variables for each of these firms: identification number (ID), name, ISIC code, active or inactive, address, first payroll year, annual average employment, annual total wages, total social security payments, multinational or not, domestic or foreign firm, ICT or IT-enabled MNC, ICT subsector, year of creation, exporter, and linkages with MNCs.

The matched establishment-worker database consists of records for each of the persons registered as employed at any time between the years 2001 and 2011 in any of the firms included in the list of member firms of the ICT sector compiled for this project. The information in this database includes employee gender and age, monthly information on that employee's salary, and an indication of the business in which each person was employed during a given month, together with the ISIC code for that firm[5]. This allows an extremely interesting analysis of labor mobility, changes in salary, and gender aspects of employment within the Costa Rican ICT sector.

Methodology

Using the information collected in our surveys of MNCs and domestic firms, each of the channels of transmission of impacts of the presence and activities of ICT and IT-enabled

[3] An "exporter" is a company that made $10,000 or more of sales outside the country during a given year.

[4] We identified only one domestic ICT company that was assignable to the "hardware" subsector, and therefore excluded this company from further analysis..

[5] We assumed that workers without any indication of a firm in which they previously worked were entering the workforce for the first time, and verified that assumption by checking the ages of the workers in this category.

MNCs on domestic ICTs firms was studied, as were the mediating factors that might determine the extent of MNC impacts on local firms. In addition, the panel of data for the 2001 – 2011 period was used to analyze the dynamics of MNCs and domestic firms in the study, considering the firms' entries into and exits from the ICT sector, and their growth in terms of numbers of employees. Finally, using the same panel data, a set of econometric models were calculated which made it possible to better estimate the possible impacts of the presence and activities of MNCs on domestic firms. The present section describes the type of model used in each one of the impacts to be estimated.

MNC impact on local firm survival

To estimate the impact of ICT and IT-enabled MNCs on *survival* of ICT domestic firms, a Cox proportional hazard model was calculated (Cox, 1972):

$$h(t) = h_0(t)e^{X_t'\beta} \qquad (1)$$

where *h(t)* is the rate at which firms exit at time *t* given that they have survived at *t-1* and $h_0(t)$ is the baseline hazard function (the parametric form of which is not specified) when all of the covariates are set to zero. *X* is a vector of covariates that include firm and industry-specific characteristics which affect the survivability of firms, and β is a corresponding vector of regression coefficients to be estimated. Following the literature on firm survival we include two sets of explanatory variables in our model. The first is related to several characteristics of domestic ICT firms: firm employment size at time *t* (*lLogEmpH*), minimum efficient scale, defined as the log of median employment size in sector *j* (*logmedEmp*), and the sectorial Herfindahl index of sector *j* measured in terms of firms´ employment shares (*Herfindahl index*).

The second set of explanatory variables refers to the presence and activities of ICT and IT-enabled MNCs in Costa Rica: experience in years of domestic ICT firms selling to ICT MNCs (*ExperMNCICT*), experience in years of domestic ICT firms selling to IT-enabled MNCs (*ExperMNCIT_E*), presence of ICT and IT-enabled MNCs (*FOR*), and presence of ICT and IT enabled MNCs located outside free zones (*FORcompetence*). A detailed description of the variables used in model (1) is presented in Appendix A.

The coefficients associated with the last set of explanatory variables are those of interest when measuring the impact of MNCs on domestic firms in the ICT sector. We estimate Equation (1) for the whole sample of domestic ICT firms, as well as for the solutions providers, software, and telecommunications subsectors, using a panel of only domestic ICT firms from 2001 to 2011.

As pointed out by Ferragina, Pittiglio and Reganati (2010), there is no clear theoretical basis for presumptions about the nature of impacts of the presence of MNCs on exit

patterns at the firm level. In fact, as discussed in the presentation of the conceptual framework, this impact will depend on the channels through which MNCs relate to domestic firms, as well as on the characteristics of each type of companies, and the context in which they operate in the host country. For this reason it is not reasonable to assume beforehand the possible signs of the coefficients associated with the variables that are intended to measure the presence and activities of MNCs in equation (1).

MNC impact on local firm growth

In order to explore whether the presence of MNCs help or hinder the growth of existing domestic ICT firms, we estimate a model based on that developed by Haltiwanger, Jarmin and Miranda (2010). These authors analyzed the relationship between firm size and growth using a method developed by Davis, Haltiwanger and Schuh (1996) to measure the growth of a firm, which allows the analyst to avoid what is referred to in the literature as the regression fallacy – that is, the role of regression to the mean effects[6]. According to the discussion of the conceptual framework related to the impact of the presence of multinationals on the domestic firms, the model to be estimated can be specified as follows:

$$\text{DHSgrowth}_{\text{jt}} = Z_{jt}^{'}\delta + \mu_{\text{jt}} \qquad (2)$$

where DHSgrowth is the growth rate of firm j in year t according to Davis, Haltiwanger and Schuh (1996). *Z* is a vector of covariates that include firm and industry specific characteristics which affect the growth rate of firms and δ is a corresponding vector of regression coefficients to be estimated. We include in our model two sets of explanatory variables. The first one is related to several characteristics of domestic ICT firms: firm employment size at time *t* (*lLogEmpH*), age (*varage*), a dummy variable that takes the value of one if the firm *i* enters and leaves the market during the study period and zero otherwise (*flashing*), level of corruption (*CPIscore*), engineering graduates (*logEngGrad*), technology gap (*techgapICT95*), and sales to MNCs not belonging to the ICT and IT-enabled sectors (*MNCother provider* and *ExperMNCother*).

The second set of explanatory variables refers to the presence and activities of ICT and IT-enabled MNCs in Costa Rica: sales of domestic ICT firms to ICT MNCs (*MNCICT provider*, *ExperMNCICT,* and *timMNCICT3*), sells of domestic ICT firms to IT-enabled

[6] These authors point out that "businesses that recently experienced negatively transitory shocks (or even transitory measurement error) are more likely to grow while businesses recently experiencing positive transitory shocks are more likely to shrink. This effect alone will yield an inverse relationship between size and growth." (p. 6). Therefore, DHS proposes a classification based on current size, which is based on the average of employment (*L*) in years t-1 and t. Thus, the firm-level employment growth rate was measured as follows:

$$DHSgrowth_{jt} = [L_{jt} - L_{jt-1}]/[0.5 * (L_{jt} + L_{jt-1)})]$$

MNCs (*MNCIT_E provider*, *ExperMNCIT_E* and *timMNCIT_E3*), permanence of MNCs (*lengthMNCICT*), presence of ICT and IT-enabled MNCs (*FOR*), and presence of ICT and IT enabled MNCs located outside free zones (*FORcompetence*). A detailed description of the variables used in model (1) is presented in Appendix A.

The coefficients associated with the last set of explanatory variables are those of interest when measuring the impact of MNCs on domestic ICT firms. We estimate Equation (2) for the whole sample of domestic ICT firms, as well as for the solutions providers, software, and telecommunications subsectors.

The error term in equation (2) -μ_{jt}- is a two-component term with one component related to an unobserved specific effect of the firm which does not vary over time (productive sector, managerial capacity, etc.), but which may have an impact on the outcome variable, and another component which is purely stochastic.

The challenge in the estimation of equation (2) lies in estimating the coefficients associated with the impact of the presence and activities of ICT and IT-enabled MNC while controlling for any factor that might affect the growth rates of the firm j in year t. We therefore combine a method of regression with fixed effects and the inclusion of several control variables that might affect the growth rates (the first set with explanatory variables). We estimate equation (2) by OLS using both fixed-effects and cluster-robust standard errors, and consider a panel of only domestic ICT firms from 2001 to 2011.

MNC impact on local firm creation

To estimate the impact of ICT and IT-enabled MNCs on the *creation* of new ICT domestic firms, the entry model used by Görg and Strobl (2002) was followed. The model features two types of industries – intermediate and final consumer goods production – and three types of firms: domestic firms producing intermediate goods, domestic firms producing final consumer goods, and multinational firms producing final consumer goods. Both industries are assumed to be imperfectly competitive with increasing returns to scale of production.

According to the model and the previous discussion of the conceptual framework, the presence of multinationals can have three effects on the host economy. First, there may be competition effect as multinationals compete with domestic producers of final goods. Second, multinationals may create additional demand for domestically produced intermediate goods through linkages with local suppliers. Third, in an imperfectly competitive domestic supplier industry, this additional demand may lead to decreasing average costs, leading in turn to increases in profits for intermediate good producers, stimulating entry into the intermediate good producing sector. Customer firms can be either domestic or multinational final-good-producing firms, or both. Through these effects,

multinationals may stimulate the entry of domestic intermediate good producers as well as domestic final good producing firms. As stated by Görg and Strobl (2005), whether the latter two positive effects outweigh the potential negative competition effects remains an empirical question.

In order to test whether the presence and activities of ICT and IT-enabled MNCs help or hinder domestic ICT firms in Costa Rica, we run a simple entry rate model as follows:

$$E_{jt} = D_{jt}^{'}\vartheta + \omega_{\mathrm{jt}} \qquad (3)$$

where *E* is the entry rate, defined alternatively as the total gross and net number of domestic entrants over *t* to *t+1* relative to total firms population in industry *j* at time *t*, and *D* is a vector of firm and industry characteristics postulated to have an impact on a firm´s hazard rate. In accordance with authors as Acs and Audretsch (1989) and Mata and Machado (1996), *D* includes measures of firm employment size at time *t* (*lLogEmpH*), a minimum efficient scale defined as the log of median employment size in sector *j* (*logmedEmp*), the sectorial Herfindahl index of sector *j* measured in terms of firms´ employment shares (*Herfindahl index*), and the net sectorial (employment) growth rate. Most importantly, the model includes measures of the presence and activities of ICT and IT-enabled MNCs in Costa Rica: presence of ICT and IT-enabled MNCs (*FOR*), and average number of linkages that ICT and IT-enabled MNCs have with domestic ICT companies (L.avgChainsByMNCs). In addition, we include another variable that refers to the average number of linkages that other MNCs (neither ICT nor IT-enabled) have with domestic ICT companies (L.avgChainsByMNCno) as an additional control variable. A detailed description of the variables used in model (1) is presented in Appendix A. We estimate equation (3) using a panel of only domestic ICT firms from 2001 to 2011.

MNC impact on domestic ICT firm wages

To estimate impacts of ICT and IT-enabled MNCs on salaries of employees of domestic ICT firms, we begin by noting that MNC presence and activities may drive up salaries paid by domestic firms (a wage premium) due to two possible effects. First, MNC activities may increase demand for labor in a market in which, in general, the offer is relatively inelastic. Second, workers with experience in MNCs may have acquired knowledge during their time with these companies which will make them more attractive for other companies (for instance, domestic firms), and they may therefore expect to receive a better salary than those who have not gained such experience while working in an MNC. It should be noted that the present study is not intended to estimate the impact of this second effect (externalities, or knowledge spillovers) separately.

The methodological approach used by Balsvik (2011) was followed to estimate impacts of ICT and IT-enabled MNCs on *real wages* paid by domestic ICT firms (while also

considering the existence of a possible gender bias in these wages). In so doing, we use linked employer-employee data to construct firm-specific measures for the share of workers in domestic ICT firms with experience gained from working in ICT and IT-enabled MNCs. In short, we wish to explore to what extent the experience gained from working in ICT or IT-enabled MNCs is rewarded by domestic ICT firms. In order to do this, we estimate wage equations for workers in domestic ICT firms and compare the wages of the *movers* to those of *stayers*[7] in domestic ICT firms. We use dummies to indicate workers who are new to the firm and take the reference group to be stayers:

$$w_{it} = \beta_0 + \sum_{s=l,m,h} \beta_s \, ICT\_IT\_MNC_{is} + \sum_{s=l,m,h} \beta_s DomICT_{is} + \sum_{s=l,m,h} \beta_s Otherfirms_{is} + X_{it}^{'}\beta_4 + F_{j(it)}^{'}\beta_5 + v_j + v_t + v_t * v_I + \epsilon_{it} \quad (4)$$

where w_{it} is the log real wage of worker *i*, and X_{it} and $F_{j(it)}$ contain the observable individual and firm characteristics. $ICT\_IT\_MNC_{is}$ is a dummy equal to 1 if the worker is new to firm *j*, comes from a ICT_IT_MNC, and has a tenure of *s* in that MNC. We divide tenure into low, medium, and high and set the thresholds at less than one year, from one to less than three years, and three years or more, respectively. Similarly, $DomICT_{is}$ is a dummy for workers who are new to firm *j*, but come from a different domestic ICT firm. On the other hand, $Otherfirms_{is}$ is a dummy for workers who are new to firm *j*, but come from any other firm. Following the approach of Abowd, Creecy, and Kramarz (2002), we estimate equation (4) where firm fixed effects (v_j) can be identified[8]. This is highly important, because if domestic ICT firms make use of better technology, intermediate inputs, or management, this is a firm-specific advantage that may give rise to a wage premium through rent sharing with workers[9]. In addition, equation (4) includes time fixed effects (v_t), and industry-year interaction terms ($v_t * v_I$). Finally, we mention as a caveat that due to data limitations we do not include workers fixed effects in equation (4)[10].

[7] That is, workers who never change firms.

[8] The work by these authors has shown how the presence of labor mobility in linked employer-employee data sets makes it possible to identify both unobserved worker and firm fixed effects.

[9] If domestic ICT firms do not share rents with workers, a firm-specific advantage may exist even though we do not observe a wage premium in the data.

[10] In fact, if domestic ICT firms tend to a large extent to select workers with "better" unobserved (to the researcher) characteristics, this may explain part of the wage premium.

4 Results for the Costa Rican ICT sector

4.1 Characterization of the survey samples

In the fieldwork described in the section on data, it was possible to collect information on the possible population size of multinational ICT companies and IT-enabled companies, as well as the size of domestic ICT firms operating in Costa Rica as of 2013. It is estimated that in total there were 587 domestic firms and 286 ICT and IT-enabled MNCs. Of this population, data were gathered from a representative sample of 83 domestic and 40 multinational ICT and IT-enabled firms in face-to-face interviews.

Table 1: Distribution of sample firms according to sector and ownership

Subsector	Domestic ICT firms
Solutions	60.2%
Software	28.9%
Telecom	10.8%
Hardware	0.0%
N =	83
Subsector	**ICT and IT-enabled MNCs**
Solutions	20.0%
Software	17.5%
IT-enabled	30.0%
Telecom	17.5%
Hardware	15.0%
N =	40

Source: Surveys of domestic ICT firms, and ICT and IT-enabled MNCs

The distribution in the sample of domestic ICT firms by subsector indicates the far greater relative importance of solutions and software companies compared to telecommunications companies. Only one domestic hardware firm was found when evaluating the members of the Costa Rican ICT sector, and it was not included in this analysis. In the case of MNCs, it was found that IT-enabled firms constitute the largest subsector, followed by solutions companies, and that the relative proportions of MNC software, telecommunications and hardware companies is very similar (Table 1).

The distribution of domestic firms by size (number of employees) shows that the largest group of firms are small, followed by micro- and medium-sized businesses (Table 2); we may therefore summarize by saying that most ICT domestic firms in Costa Rica are micro-

to medium-sized (96.4%). Table 2 also shows that most MNCs have between 26 and 500 employees.

Table 2: Distribution of sample firms according to size and ownership

Size	Domestic ICT firms
Micro (1-5 emp.)	19.3%
Small (6-30 emp.)	63.9%
Medium (31-100 emp.)	13.3%
Large (101 + emp.)	3.6%
N =	83
Size	**ICT and IT-enabled MNCs**
1-25 employees	22.5%
26 - 100 employees	37.5%
101 - 500 employees	25.0%
501 or more employees	15.0%
N =	40

Source: Surveys of domestic ICT firms, and ICT and IT-enabled MNCs

When ICT sector companies (including IT-enabled MNCs) are classified according to their annual sales volumes, it may be seen that a great majority of domestic firms have annual sales of less than one million dollars (78.1%), while only 28.6% of MNCs have annual sales of less than one million dollars (Table 3). MNCs are clearly larger than domestic firms, measured in terms of either their number of workers or their annual sales.

Table 3: Distribution of sample firms according to sales and ownership

Sales 2013 (US $)	Domestic ICT firms
Less than US $ 100k	13.7%
US $ 100 - 249k	31.5%
US $ 250 - 499k	20.5%
US $ 500 - 999k	12.3%
US $ 1M+	21.9%
N=	73
Sector	**ICT and IT-enabled MNCs**
Less than US $ 1M	28.6%
US $ 1M to less than US $ 10M	35.7%
US $ 10M+	35.7%
N=	28

Source: Surveys of domestic ICT firms, and ICT and IT-enabled MNCs

4.2 Supply chains

There are several important ways in which domestic ICT firms may interact with MNCs through supply chains. Vertical linkages may be categorized as backward linkages, which occur when domestic firms become input or service providers to multinational firms, and forward linkages, which emerge when the goods and services provided by multinational firms are used as inputs in domestic companies. In addition, horizontal linkages may occur through the formation of cooperative arrangements between domestic firms and MNCs to jointly accomplish common goals. In what follows, we explore these types of relationships and the extent to which they provide channels through which effects are generated that affect the survival and growth of existing domestic ICT firms, and the entry of new domestic ICT firms into the Costa Rican ICT sector.

Backward linkages

Table 4 shows that 27.7% of domestic ICT firms sell products or services to ICT and IT-enabled MNCs in Costa Rica. This percentage is higher in the cases of domestic solutions (36%) and telecom (33.3%) firms, and substantially lower (8.3%) in the case of software firms. Another interesting result shown in this table is that less than one fifth of the local firms (16.9%) state that the product or service they sell to ICT and IT-enabled MNCs become part of the final product or service of these foreign firms. Again, the frequency of such relationships are higher in the case of domestic solutions (22.0%) and telecom (22.2%) firms than in the case of software firms (4.2%).

Table 4: Backward linkages between ICT and IT-enabled MNCs and domestic ICT firms, 2014

(percentages of all domestic firms in a given sector)

Backward linkages	Total	Software	Solutions	Telecom
Sells product or services to MNCs	72.3%	79.2%	72.0%	55.6%
-to ICT and IT-enabled MNCs	27.7%	8.3%	36.0%	33.3%
-to other types of MNCs	67.5%	79.2%	66.0%	44.4%
The product or service sold to MNCs become a part of the MNCs´ final product or service	16.9%	4.2%	22.0%	22.2%
Total sample	83	24	50	9

Source: Survey of domestic ICT firms

ICT and IT-enabled MNC spillovers can be generated through the demand of these MNCs for better and/or more diverse inputs which, if they are made available, would benefit all firms in the same industry. In fact, MNCs may expect compliance with international

standards from local input and service suppliers – for example, for product quality and delivery time, and technology efficiency – that increases their overall productivity (Paus and Gallagher, 2008). ICT and IT-enabled MNCs in Costa Rica might also help domestic producers to upgrade their technological capabilities directly through sharing of production techniques and product design and assisting with technology acquisition, or through personnel training, advance payment, leasing of machinery, provision of inputs, help with quality assurance, and organization of product lines (Lall, 1980; Crespo and Fortoura, 2007; Javorcik and Spatareanu 2008).

The results of the survey of domestic ICT firms (Table 5) show that very few domestic ICT firms are receiving these types of benefits through being local suppliers of ICT or IT-enabled MNCs. Importantly, few domestic firms indicate that MNCs help them to upgrade their technological capabilities directly through sharing of production techniques and production design (3.6% of the total domestic sample, and none of the domestic telecommunications firms in the sample).

Table 5: Assistance received by domestic ICT firms from MNCs, 2014

(percentages of all domestic firms in a given sector)

MNCs support local firms through…	Total	Software	Solutions	Telecom
Personnel training	4.8%	4.2%	6.0%	0.0%
Advance payment	4.8%	4.2%	2.0%	22.2%
Assistance with quality assurance	4.8%	4.2%	6.0%	0.0%
Sharing of production techniques and production design	3.6%	4.2%	4.0%	0.0%
Assistance with technology acquisition	1.2%	0.0%	2.0%	0.0%
Leasing of machinery	1.2%	0.0%	2.0%	0.0%
Assistance with organization of product lines	1.2%	0.0%	2.0%	0.0%
Provision of inputs	0.0%	0.0%	0.0%	0.0%
N =	83	24	50	9

Source: Survey of domestic ICT firms

There are three additional ways in which interacting with MNCs may provide benefits for domestic ICT firms: *personnel training* (4.8%), which is more frequently reported by solutions providers (6%) than software firms (4.2%); *advance payments*, which are most frequently reported among telecom firms (22.2%); and helping local firms with *quality assurance* (4.8%), which occurs only in the cases of solutions (6%) and software firms (4.2%).

In short, although it seems that there exist *demand and assistance effects* thanks to backward linkages between ICT and IT-enabled MNCs and domestic ICT firms in Costa Rica, few domestic firms actually benefit in this way.

Assistance by ICT and IT-enabled MNCs to domestic ICT suppliers might lead to unintentional knowledge spillovers in the supplying industry. This is the case of a *diffusion effect* when any assistance by the MNC to a local company (technological or otherwise) puts domestic suppliers in an advantageous position compared to other domestic firms which do not receive such assistance. Table 6 shows the added value that domestic ICT firms believe they receive through being local suppliers of MNCs of any type operating in Costa Rica. Most of the firms consider as the most important added value of such a relationship to be prestige (22.9%), followed by having a major customer (concentrated turnover - 16.9%), forcing the firm to be always be up to date technologically (14.5%), and helping the firm to be more integrated in international markets (6%).

Table 6: Other benefits received by domestic ICT firms from being local suppliers of MNCs, 2014

(percentages of all domestic firms in a given sector)

Benefits	Total	Software	Solutions	Telecom
Prestige	22.9%	8.3%	30.0%	22.2%
Having a major customer (concentrated turnover)	16.9%	8.3%	20.0%	22.2%
Forcing the firm to be technologically up to date	14.5%	8.3%	14.0%	33.3%
Greater international integration	6.0%	8.3%	4.0%	11.1%
Reduce the risk of losses from giving credit to clients	4.8%	4.2%	6.0%	0.0%
Other	0.0%	0.0%	0.0%	0.0%
N =	83	24	50	9

Source: Survey of domestic ICT firms

Forward linkages

Forward linkages may occur when goods and services provided by ICT and IT-enabled MNCs are used as inputs by domestic ICT firms. Table 7 shows the principal results related to this topic from the project survey of domestic ICT firms. Almost one-third of the local firms (32.5%) reported buying products or services from ICT and IT-enabled MNCs operating in Costa Rica. The figures are highest (37.5% and 55.6%, respectively) for domestic software and telecommunications firms. About one-fourth of the domestic ICT firms (24.1%) stated that they purchase technological inputs that they incorporate into their final products or services from ICT and IT-enabled MNCs. When analyzed by subsectors,

telecommunications firms report forward linkages far more frequently than do software and solutions firms.

Table 7: Forward linkages between ICT and IT-enabled MNCs and domestic ICT firms, 2014

(percentages of all domestic firms in a given sector)

Forward linkages	Total	Software	Solutions	Telecom
Local firms buy products or services from ICT and IT-enabled MNCs	32.5%	37.5%	26.0%	55.6%
Technological inputs incorporated into the final product of domestic ICT firms	24.1%	20.8%	22.0%	44.4%
N =	83	24	50	9

Source: Survey of domestic ICT firms

In summary, what we are seen in the case of forward linkages between ICT and IT-enabled MNCs and domestic ICT firms in Costa Rica is a case of *availability and quality effects*. That is, since MNCs are more productive and technology intensive than local producers, foreign entry increases the availability, variety, and reliability of higher-quality inputs. Farole and Winkler (2014), citing Javorcik and Spatareanu (2008), point out that the probability and extent of positive spillovers may be higher for services than for materials inputs for two reasons, both sector specific. "First, the availability effect may be economically more important, as larger availability of basic business services (for example, telecommunications, banking, information technology) benefits a wider range of domestic clients. Second, the performance of domestic firms in downstream sectors depends more critically on the availability and quality of service inputs, due to larger limitations on services imports" (p.27).

Horizontal linkages

Another channel for beneficial interactions appears when domestic ICT firms and ICT or IT-enabled MNCs enter into alliances or partnerships in which the domestic firms participate in various ways in the sales and support of MNC products and services; in this case, *assistance effects* can emerge from the relationship. Table 8, on the next page, shows the relative importance of this type of relationship between MNCs and local firms in the Costa Rican ICT sector, and Table 9 presents the benefits that local firms state that they receive from such linkages with MNCs.

According to Table 8, a little more than a quarter of domestic ICT firms (27.7%) report forming consortia or alliances with ICT and IT-enabled MNCs to sell products or services on a large scale, or to participate in large projects, which provides a potential channel for knowledge spillovers. On the other hand, a little more than a third of the local firms (36.1%) state that they have entered into cooperative commercial relations with MNCs that

involve helping to sell MNC products or services, often in conjunction with the sales of the domestic firm's own products and services ("value-added resellers").

Table 8: Horizontal linkages between ICT and IT-enabled MNCs and domestic ICT firms, 2014

(percentages of all domestic firms in a given sector)

Horizontal linkages	Total	Software	Solutions	Telecom
Local ICT firms form consortia or alliances with ICT and IT-enabled MNCs to sell products and/or services	27.7%	29.2%	26.0%	33.3%
Local ICT companies are distributors, vendors or representatives of ICT and IT-enabled MNCs' products and/or services	36.1%	29.2%	36.0%	55.6%
Type of commercial relations of local ICT firms with ICT and IT-enabled MNCs				
-Value-added reseller	22.9%	16.7%	24.0%	33.4%
-Representative	13.2%	8.4%	14.0%	22.2%
-Wholesale distributors	12.0%	12.5%	10.0%	22.2%
-Retailer	12.0%	8.4%	12.0%	22.2%
-Other	2.4%	4.2%	2.0%	0.0%
N =	83	24	50	9

Source: Survey of domestic ICT firms

Approximately one-fourth (22.9%) of the domestic ICT firms report being value-added resellers of MNC products or services, while somewhat more than ten percent of the local firms are representatives (13.2%), wholesale distributors (12.0%), or retailers (12.0%) for MNCs. In almost all cases, these activities are most frequently reported among domestic telecommunications firms.

The results in Table 9 show that domestic ICT firms experience positive *assistance effects* from participating in these relationships. Almost one-quarter (24.1%) of these firms report receiving training in technical aspects from ICT and IT-enabled MNCs, and somewhat less report receiving training in sales and marketing (18.1%). Other benefits reported include receiving information about customers and prospects (16.9%), participation in special events (18.1%), and assistance in quality certification of products and services (18.1%). With the exception of discounts on products and services (in which domestic telecom firms are far more frequently benefitted than solutions providers or software firms), frequencies of receiving such benefits are similar in all subsectors.

Table 9: Benefits received by domestic ICT firms from horizontal linkages with ICT and IT-enabled MNCs, 2014

(percentages of all domestic firms in a given sector)

Benefits for Local ICT firms	Total	Software	Solutions	Telecom
Discounts on products and services	26.5%	20.8%	24.0%	55.6%
Training in technical areas	24.1%	20.8%	24.0%	33.4%
Training in sales and marketing	18.1%	16.7%	18.0%	22.2%
Participation in special events for members	18.1%	20.8%	16.0%	22.2%
Quality certification of products and services	18.1%	16.7%	20.0%	11.1%
Information about customers and prospects	16.9%	16.7%	16.0%	22.2%
Increased visibility of local firm	13.2%	12.5%	14.0%	11.1%
Credits	8.4%	4.2%	10.0%	11.1%
Longer-term contracts	3.6%	4.2%	2.0%	11.1%
No benefits	3.6%	0.0%	6.0%	0.0%
N =	83	24	50	9

Source: Survey of domestic ICT firms

As a general conclusion to this discussion of supply chain relationships, we can say that domestic ICT firms receive benefits from their interactions with ICT MNCs most frequently in the cases of horizontal and forward linkages, and less frequently in the case of backward linkages. However, in none of these cases are more than approximately one-quarter of all domestic ICT firms benefitted, and the frequencies with which most benefits are received are far lower.

This is not surprising in the light of the lack of a public policy that actually supports domestic ICT firms in Costa Rica. In fact, only two of the 83 domestic firms in the survey (2.4%) indicated that they received support from some public institution to achieve productive linkages with multinational companies in general; one of these companies mentioned the Productive Linkages program managed by the Foreign Trade Promotion Office (PROCOMER), and another mentioned the support program for innovations managed by the Ministry of Science, Technology and Telecommunications (MICITT). Although both programs have had a positive impact on the performance of beneficiary firms (Monge-González and Rodríguez-Alvarez, 2013), neither of them are focused specifically on the ICT sector, and it is clear that the companies in this sector are not turning to these programs for support.

As we point out in more detail in Section 5.5, Costa Rica needs to improve the state of several critical mediating factors if beneficial interactions between domestic ICT firms and ICT and IT-enabled MNCs are to occur more frequently, especially in the case of backward

linkages; such improvements should include strengthening the absorptive capacity of domestic ICT firms and key areas of the institutional framework.

4.3 Market restructuring

The presence and activities of ICT and IT-enabled MNCs in Costa Rica can result in increased competition in product, labor, and credit markets between local and foreign producers, especially if foreign firms sell their products and services in the local market. According to the results of our survey of ICT and IT-enabled MNCs, the great majority of these firms decided to establish operations in Costa Rica because of the availability of a skilled and/or bilingual labor force, while only 12.1% of the MNCs interviewed stated that they located themselves in the country to sell products and services in the local market. We here discuss competition in the local market for products and services, leaving the discussion of competition in the labor market for a later section.

Table 10: Competition in the local goods and services market, 2014
(percentages of all domestic firms in a given sector)

	Total	Software	Solutions	Telecom
The local market is "highly competitive"	80.7%	79.2%	82.0%	77.8%
N=	83	24	50	9
Where does your main competition in the local market come from?				
- other domestic ICT firms	65.1%	70.8%	58.0%	88.9%
- ICT or IT-enabled MNCs operating in Costa Rica	27.7%	20.8%	34.0%	11.1%
- imports of ICT products or services	7.2%	8.3%	8.0%	0.0%
N =	83	24	50	9

Source: Survey of domestic ICT firms

The results of Table 10 are consistent with what was stated by ICT MNCs – most domestic ICT firms (80.7%) claim that although the level of competition for products and services in the local market is very high, this competition comes primarily from other domestic firms (65.1%), and only secondarily from ICT and IT-enabled MNCs (27.7%). It can therefore be expected that Costa Rican ICT firms will not be strongly driven to improve their productivity, quality, and reliability to better compete with MNCs (a "competition effect"), especially in the case of domestic software and telecommunications companies.

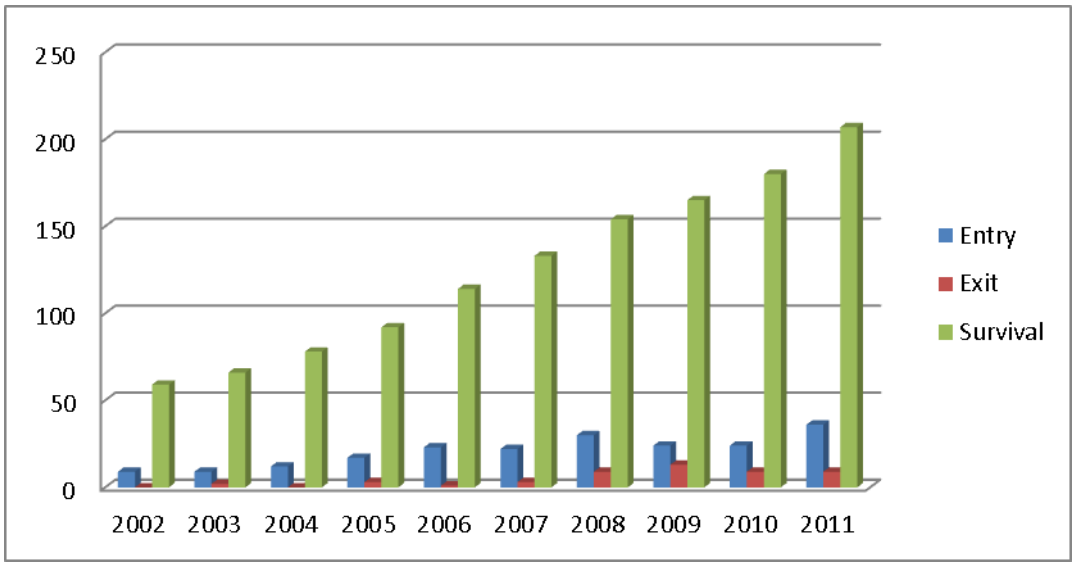
4.4 Impact of ICT and IT-enabled MNCs on domestic ICT firm performance

In Sections 5.2 and 5.3, we have discussed possible channels for MNC impacts on domestic firms based on the results of our surveys of domestic firms and multinationals, which are based primarily on the perceptions of the business representatives that we interviewed. In this section, we report the results of the estimation of the econometric models (1), (2) and (3), presented in Section 4, which pertain to the impact of MNCs on the survival, growth, and creation of domestic firms, respectively. This analysis makes use of additional "hard data" from secondary sources, which allows us to validate and extend the results we obtained from the survey data.

Impact of ICT and IT-enabled MNCs on the survival of domestic ICT firms

In this section we discuss whether the presence of MNCs have helped or hindered the *survival* of domestic ICT firms in Costa Rica, as well as what types of domestic firms have been helped or hindered. As a starting point, we present in Figure 1 the pattern of entry and exit of ICT and IT-enabled MNCs in Costa Rica between 2002 and 2011. It seems that the efforts of Costa Rican authorities to attract FDI has been successful, since the number of MNCs exiting is much lower than that of MNCs entering in this country, resulting in a sustained increased of the number of MNCs operating in the country through time.

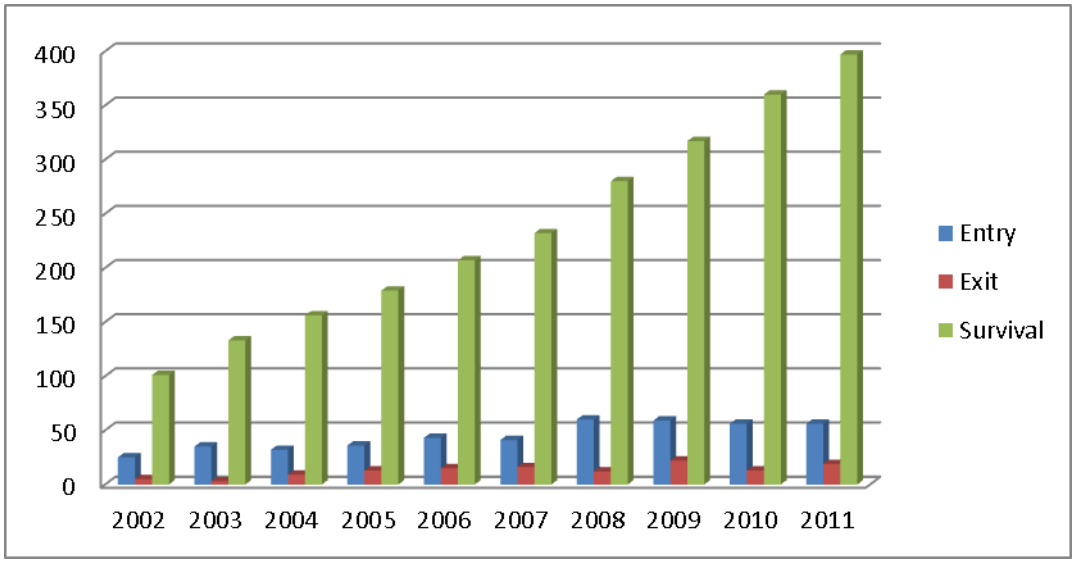
Figure 1: Entry, exit and survival of ICT and IT-enabled MNCs, 2001 – 2011
(numbers of firms in each category)



Source: Authors' elaboration based on data from the CCSS.

Figure 2 shows the pattern of entry, exit and survival of domestic ICT firms in Costa Rica from 2001 to 2011. As was the case for ICT and IT-enabled MNCs, the number of domestic firms has increased through time, as a result of more domestic firms entering the market than leaving it during the period analyzed.

Figure 2: Entry, exit and survival of domestic ICT firms, 2001 – 2011
(numbers of firms in each category)



Source: Authors' elaboration based on data from the CCSS.

These results can be interpreted as a preliminary indication that the presence of ICT and IT-enabled MNCs may not be hindering the survival of domestic ICT firms. To provide a firmer basis for this conclusion, and to identify the type of domestic firms that have been helped or hindered by MNCs' presences and activities, we estimate a Cox proportional hazard model, following the traditional approach in the literature in this case (Cox, 1972) as discussed in Section 4. It is important to bear in mind that the coefficients estimated in such a model are related to the possibility of encountering hazards for firm survival; therefore, negative coefficients indicate the unlikelihood of encountering such hazards, and have positive implications for survival.

Results

We estimated equation (1) considering a panel of domestic ICT firms from 2001 to 2011. The main estimation results are presented in Table 11. Two sets of explanatory variables were considered. The first is related to several characteristics of domestic ICT firms: firm employment size at time *t* (*lLogEmpH*), minimum efficient scale, defined as the log of median employment size in sector *j* (*logmedEmp*), and the sectorial Herfindahl index of

sector *j* measured in terms of firms´ employment shares (*Herfindahl index*). The second set of explanatory variables refers to the presence and activities of ICT and IT-enabled MNCs in Costa Rica: experience in years of domestic ICT firms selling to ICT MNCs in free zones (*ExperMNCICT*), experience in years of domestic ICT firms selling to IT-enabled MNCs in free zones (*ExperMNCIT_E*), presence of ICT and IT-enabled MNCs (*FOR*), and presence of ICT and IT-enabled MNCs located outside free zones (*FORcompetence*). The coefficients associated with the last set of explanatory variables are the coefficients of interest when measuring the impact of MNCs on domestic firms in the ICT sector.

Table 11: Effect of ICT and IT-enabled MNC presence on the survival of domestic ICT firms, by sector and for the total sample
(robust standard errors)

VARIABLES	Solutions	Solutions	Software	Software	Telecom	Telecom	All	All
lLogEmpH	-0.368***	-0.370***	-0.456**	-0.456**	-0.496**	-0.483**	-0.382***	-0.382***
	-0.131	-0.131	-0.179	-0.179	-0.237	-0.246	-0.0969	-0.0967
ExperMNCICT	-0.432	-0.447					-0.52	-0.522
	-0.756	-0.758					-0.757	-0.758
Herfindahl	-3.266	-5.662	14.8	14.35	19.15	10.39	0.38	0.0214
	-3.744	-4.118	-12.35	-12.25	-16.91	-7.837	-1.428	-1.244
logmedEmp	0.0768	-0.158	0.335	0.0718	0.14	-1.364	0.0499	0.0726
	-0.563	-0.562	-0.851	-0.707	-1.776	-1.489	-0.242	-0.246
FOR	-2.014		2.921		15.22		0.483	
	-1.598		-2.703		-15.56		-1.024	
FORcompetence		-8.191**		5.564		22.63**		0.166
		-4.011		-5.241		-11.27		-1.75
ExperMNCIT_E			-43.87***	-44.87			-0.843	-0.831
			-0.577	0			-0.701	-0.701
Observations	1231	1231	503	503	285	285	2019	2019
Chi-square	9.282	11.21	6280	9.069	5.374	8.861	20.25	19.86
Prob chi-square	0.0983	0.0474	0	0.0594	0.251	0.0647	0.0025	0.00294

Source: Authors' calculations.

** The coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not significantly different from zero.*

Based on the results presented in the last two columns of Table 11, it seems that the presence and activities of MNCs in Costa Rica do not hinder the survival of domestic ICT firms in general, given that the coefficients related to the variables *ExperMNCICT*, *ExperMNCIT_E*, *FOR*, and *FORcompetence* are not statistically different from zero. However, several interesting results are found when the model is calculated for ICT subsectors. First, the presence of ICT and IT-enabled MNCs operating outside of free trade zones (*FORcompetence*) increases the survival probability of solutions companies (-8.191), but decreases the survival probability of telecommunications companies (22.63). Secondly, the experience acquired by software companies when they sell their products and services

to IT-enabled MNCs in free zones (*ExperMNCIT_E)* increases their survival probabilities (-43.87).

A possible interpretation of these results is that in the case of solutions companies, competition from MNCs operating outside of free trade zones may be having a demonstration effect that encourages domestic ICT firms to improve their operations, and therefore become more successful. For domestic telecommunications companies, the increased presence of MNCs outside free zones may include the presence of large foreign telecommunications operators who compete strongly in the sale of products and services in the local market, thereby constituting a threat to the survival of their domestic counterparts. Finally, for software companies, it seems that commercial relations as providers of products and services to IT-enabled MNCs in free zones has positive results in terms of survival, perhaps due to some of the previously discussed benefits associated with this type of relation (see Section 5.2).

It is worth mentioning that these indications of positive impacts of MNC presence on the survival of domestic firms in the two largest subsectors in the domestic ICT sector are consistent with the dynamics of domestic ICT firms shown in Figure 2, which shows that the number of domestic ICT firms that have ceased to operate in each of the years studied is relatively low.

Impact of ICT and IT-enabled MNCs on the growth of domestic ICT firms

We are also interested in learning whether the presence and activities of ICT and IT-enabled MNCs affects the *growth* (in terms of numbers of employees) of domestic ICT firms in Costa Rica, especially at a sectorial level. To explore this topic, and to identify the type of domestic firms whose growth may have been affected by MNC presence, we estimated Equation (2), discussed in Section 4.

Results

We estimate Equation (2) by OLS using both fixed-effects and cluster-robust standard errors, and considering a panel of only domestic ICT firms from 2001 to 2011. As discussed previously, growth rates of firms were analyzed using DHS growth rates according to Davis, Haltiwanger, and Schuh (1996). The main estimation results are presented in Table 12, on the next page.

Table 12: Effect of ICT and IT-enabled MNC presence on the growth of domestic ICT firms, by sector

(fixed-effects and cluster robust standard errors)

VARIABLES	Telecom DHSGrowth	Telecom DHSGrowth	Software DHSGrowth	Software DHSGrowth	Solutions DHSGrowth	Solutions DHSGrowth
L.LogEmpH	-0.2113*	-0.2181*	-0.3129***	-0.3190***	-0.2488***	-0.2463***
	(0.1147)	(0.1103)	(0.0811)	(0.0826)	(0.0427)	(0.0425)
Varage	-0.1949*	-0.1937*	-0.2562***	-0.2537***	-0.2002***	-0.1991***
	(0.0986)	(0.0992)	(0.0609)	(0.0608)	(0.0388)	(0.0388)
Varage2	0.0092*	0.0089*	0.0208***	0.0210***	0.0214***	0.0213***
	(0.0050)	(0.0052)	(0.0049)	(0.0049)	(0.0028)	(0.0028)
Flashing	0.7817***	0.7851***			1.6712***	1.6667***
	(0.2286)	(0.2301)			(0.2297)	(0.2293)
MNCIT_E provider	0.0059		0.2509**			
	(0.1413)		(0.1156)			
L.ExperMNCIT_E	-0.0166		0.0399			
	(0.1298)		(0.0462)			
MNCother provider	-0.1038	-0.1005	0.1799**	0.1321*		
	(0.2332)	(0.2338)	(0.0757)	(0.0737)		
L.ExperMNC_other	0.0486	0.0516	0.0893**	0.0995**		
	(0.0339)	(0.0352)	(0.0440)	(0.0496)		
L.CPIscore	-0.0530	-0.0491	-0.1417	-0.1393	0.0458	0.0453
	(0.1583)	(0.1579)	(0.1023)	(0.1012)	(0.0625)	(0.0625)
L.logEngGrad	1.1040	1.0952	0.2705	0.2050	-0.4521	-0.4409
	(1.2745)	(1.2725)	(0.5344)	(0.5324)	(0.4824)	(0.4812)
L.lengthMNCICT	0.0486	0.0479	-0.0513	-0.0537	-0.1245***	-0.1256***
	(0.1063)	(0.1071)	(0.0512)	(0.0509)	(0.0297)	(0.0297)
techgapICT95	-0.1422	-0.1444	-0.3621***	-0.3647***	-0.2505***	-0.2508***
	(0.1161)	(0.1161)	(0.0773)	(0.0774)	(0.0436)	(0.0437)
L.FORcompetence	1.5843	1.6040	-1.3880	-1.1370	-2.5823	-2.6047
	(2.4460)	(2.4333)	(2.4291)	(2.4157)	(1.6073)	(1.6014)
timMNCIT_E3		0.0749		0.1208		
		(0.1369)		(0.1265)		
MNCICT provider					0.0218	
					(0.1226)	
L.ExperMNCICT					0.0578*	
					(0.0323)	
timMNCICT3						0.2276*
						(0.1204)
Constant	-7.4257	-7.3623	0.9742	1.4544	5.2347	5.1574
	(9.6251)	(9.6190)	(3.7521)	(3.7434)	(3.4825)	(3.4765)
Number of observations	294	294	509	509	1257	1257
R-squared	0.1213	0.1214	0.2682	0.2635	0.2326	0.2326
F value	2.3943	7.6070	4.6432	5.1178	18.5452	19.7155
Log likelihood	-220.4664	-220.4501	-300.2676	-301.9181	-764.9095	-764.8678
P value for F test	0.0489	0.0004	0.0038	0.0037	0.0000	0.0000

Source: Authors' calculations.

*Note: * The coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not significantly different from zero.*

As discussed in Section 4, two types of explanatory variables are included in equation (2). The second group, consisting of the impact variables, is discussed below. This second set of explanatory variables refers to the presence and activities of ICT and IT-enabled MNCs in Costa Rica: sales of domestic ICT firms to ICT MNCs in free zones (*MNCICT provider*, *ExperMNCICT*, and *timMNCICT3*), sales of domestic ICT firms to IT-enabled MNCs in free zones (*MNCIT_E provider*, *ExperMNCIT_E* and *timMNCIT_E3*), presence of ICT and IT-enabled MNCs (*FOR*), and presence of ICT and IT-enabled MNCs located outside free zones (*FORcompetence*).

Two interesting results emerge from a consideration of the estimated coefficients shown in Table 12 regarding the impact of ICT and IT-enabled MNCs on the growth of domestic ICT firms. Firstly, the growth rate of a provider of IT-enabled MNCs located in free zones (*MNCIT_E provider)* increases only in the case of software companies (0.2509), which is consistent with the positive impact of being a provider to IT-enabled MNCs has on the *survival* rate of local software companies, as discussed in the previous section. The second interesting result is that the growth rate of solutions companies increases as their experience in selling their services to ICT MNCs located in free zones increases (*ExperMNCICT* and *timMNCICT3)* (0.0578 and 0.2276), which is a complement to the positive effects on survival of these firms associated with the presence of ICT and IT-enabled MNCs operating outside free zones discussed in the previous section.

Impact of ICT and IT-enabled MNCs on the creation of domestic ICT firms

In order to explore the extent to which the presence and activities of ICT and IT-enabled MNCs help or hinder the creation of new domestic ICT firms in Costa Rica in the ICT sector as a whole and in individual subsectors, we estimate a model based on Markusen and Venables (1999), and Görg and Strobl (2002).

Results

We estimate equation (3) by OLS using both fixed-effects and cluster-robust standard errors, and considering a panel of only domestic ICT firms from 2001 to 2011. The main estimation results are presented in Table 13. As can be seen from the first column, the presence of ICT and IT-enabled MNCs (FOR) acts to decrease significantly the gross entry rate of domestic ICT firms. The magnitude of the coefficient associated with this variable suggests that a one percentage point increase in foreign presence decreases the gross entry rate by 12.8 per cent. If we include indicators of how many linkages MNCs already have with existing domestic ICT firms[11] in the analysis (second column) we find that the

[11] The average number of domestic providers that ICT and IT-enabled MNCs (avgChainsByMNC) and other types of MNCs (avgChainsByMNCno) have with domestic ICT firms. Greater numbers of existing providers imply that new domestic firms will face greater competition from existing domestic firms to become providers

coefficient associated with the variable FOR continues to be negative and significant (-0.199), reinforcing this conclusion. The coefficient associated with the existing ICT and IT-enabled MNCs linkages variable (avgChainsByMNC) itself is negative and significant, although close to zero (-0.00386); it appears that the presence of more existing domestic firm provider linkages with ICT and IT-enabled MNCs does in fact create levels of competition among domestic firms that make it more difficult to enter this niche. This is not the case when considering the impact of linkages with MNCs that are neither ICT nor IT-enabled companies (avgChainsByMNCno); the coefficient associated with this factor is positive (.00168) and significant, showing that increases in these linkages favor domestic firm formation.

Table 13: Effect of ICT and IT-enabled MNC presence on domestic ICT entry rate: All Firms
(fixed effects and cluster-robust standard errors)

Variables	All GrossEntryRate	All GrossEntryRate	All NetEntryRate	All NetEntryRate
Presence of MNCs (L.FOR)	-0.128***	-0.199***	0.0333	-0.0356
	(0.0191)	(0.0243)	(0.0286)	(0.0232)
Firm size (lLogEmpH)	-0.00149	-0.00216	-0.00160	-0.00275
	(0.00253)	(0.00245)	(0.00310)	(0.00289)
Herfindahl (L.Herfindahl)	0.906***	0.842***	1.040***	0.904***
	(0.0475)	(0.0428)	(0.0588)	(0.0468)
Minimum scale (L.logmedEmp)	0.0607***	0.0750***	0.0561***	0.0705***
	(0.00405)	(0.00495)	(0.00461)	(0.00555)
Sector growth	0.0783***	0.0840***	0.127***	0.144***
	(0.0145)	(0.0146)	(0.0144)	(0.0141)
ICT_IT enable MNCs linkages (L.avgChainsByMNC)		-0.00386***		-0.00740***
		(0.000272)		(0.000324)
Other MNCs linkages (L.avgChainsByMNCno)		0.00168***		0.00176***
		(0.000379)		(0.000352)
Constant	0.0460***	0.0788***	-0.0597***	0.0691***
	(0.0115)	(0.0154)	(0.0113)	(0.0192)
Observations	2,060	2,060	2,060	2,060
R-squared	0.507	0.528	0.333	0.389
Number of observations	472	472	472	472
F test	0	0	0	0

Source: Authors' calculations.

*Note: * The coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not significantly different from zero.*

When evaluating the effects of multinationals on domestic firm creation, the net, rather than gross, rate of creation of new firms is of greatest interest, since it better reflects firm exits due to competition. We therefore estimated the results of using the net entry rate as the dependent variable in the third and fourth column of Table 13.

As can be seen in the third column, the coefficient of FOR is not statistically significant, indicating that the presence of MNCs by itself does not have an effect on the net entry rate of domestic ICT firms. However, higher levels of existing ICT and IT-enabled MNC provider linkages with domestic ICT firms (avgChainsByMNC) apparently limit the net rate of domestic ICT firm creation (the coefficient in the fourth column is negative and significant), while higher levels of existing provider linkages with MNCs which are not ICT or IT-enabled companies (avgChainsByMNCno) generate a positive net incentive for domestic ICT firms to enter into the market (the coefficient in the fourth column is positive and significant, although again close to zero). These results may be reasonably interpreted as showing the impact of strong competition between domestic ICT firms for MNC clients in the relatively restricted ICT sector, which is relaxed as a larger number of MNC clients for domestic products and services outside the ICT sector becomes available.

As we did for the analysis of domestic ICT firm survival and growth, we also explored the effects of the presence of ICT and IT-enabled MNCs on the creation of domestic firms in different subsectors. Table 14 presents the results of estimating equation (3) for each of the three subsectors being considered in our analysis.

Table 14: Effect of ICT and IT-enabled MNC presence on domestic ICT entry rate by sectors

(fixed effects and cluster-robust standard errors)

Variables	Solutions GrossEntryRate	Solutions NetEntryRate	Software GrossEntryRate	Software NetEntryRate	Telecom GrossEntryRate	Telecom NetEntryRate
Presence of MNCs (L.FOR)	0.325***	0.813***	-0.549***	-0.822***	-0.154***	0.322***
	(0.0175)	(0.0271)	(0.00731)	(0.0125)	(0.0520)	(0.0764)
Firm size (lLogEmpH)	-0.00193	-0.00248	0.000717	0.00366***	0.0163***	0.0227***
	(0.00121)	(0.00162)	(0.000846)	(0.00136)	(0.00579)	(0.00823)
Herfindahl (L.Herfindahl)	2.105***	3.266***	4.136***	5.033***	-0.303***	0.700***
	(0.0589)	(0.0727)	(0.0503)	(0.0981)	(0.0545)	(0.0821)
Minimum scale (L.logmedEmp)	0.0350***	-0.0267***	0.0124***	0.00131	0.0143	0.0534***
	(0.00173)	(0.00253)	(0.00201)	(0.00308)	(0.0115)	(0.0184)
Sector growth	0.492***	0.775***	0.131***	0.151***	-0.282***	-0.0858***
	(0.00659)	(0.00864)	(0.00799)	(0.0121)	(0.0153)	(0.0218)
ICT_IT enable MNCs linkages (L.avgChainsByMNC)	-0.00399***	-0.00505***	0.0111***	0.0126***	-0.00290***	-0.00919***
	(0.000399)	(0.000535)	(0.000195)	(0.000319)	(0.000348)	(0.000531)
Other MNCs linkages (L.avgChainsByMNCno)	0.00426***	0.00833***	0.00765***	0.0126***	0.00579***	0.00261***
	(0.000564)	(0.000801)	(0.000125)	(0.000325)	(0.000352)	(0.000493)
Constant	-0.212***	-0.585***	-0.577***	-0.846***	0.109***	-0.0693
	(0.0366)	(0.0495)	(0.0143)	(0.0260)	(0.0407)	(0.0620)
Observations	1,257	1,257	509	509	294	294
R-squared	0.860	0.755	0.926	0.904	0.444	0.152
Number of observations	305	305	103	103	64	64
F test	0	0	0	0	0	0

Source: Authors' calculations.

*Note: * The coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not significantly different from zero.*

The figures in Table 14 show that the impact of the presence of ICT and IT-enabled MNCs on the creation of domestic ICT firms varies by subsector. In the case of *solutions providers* MNC presence (FOR) acts to significantly increase both the gross and net entry rate of firms (both coefficients are positive and significant), while in the case of *telecommunications*, it appears that while the presence of ICT and IT-enabled MNCs acts to decrease significantly the gross entry rate of firms, it significantly increases their net entry rate. Given that the net entry rate is a clearer indicator of the overall effects of MNC presence on domestic business formation, we can conclude that MNC presence has a positive effect on the formation of domestic telecommunications firms.

In the case of domestic *software* firms, MNC presence has a negative impact on both gross and net entry rates (both coefficients are negative and significant), which is consistent with the findings that, compared to domestic solutions and telecommunications firms, domestic software firms are much less frequent providers of these MNCs, have their products and services incorporated into MNC products and services less frequently, and receive fewer indirect benefits from being MNC providers (see Tables 4 and 6).

A consideration of the impact of higher levels of existing *provider linkages* with ICT and IT-enabled MNCs (avgChainsByMNC) on net rates of domestic firm creation shows that greater numbers of existing providers of MNCs make it more difficult for new domestic solutions providers and telecommunications companies to enter the sector, but facilitates the formation of new domestic software firms.

In general, increases in the number of ICT and IT-enabled MNCs could be a positive incentive for the formation of new domestic firms by providing possibilities for a range of supply chain relationships (as provider, buyer, or partner). On the other hand, greater competition to be providers as a result of high levels of existing provider linkages with these MNCs could be a disincentive for forming new domestic firms.

4.5 Labor turnover

With respect to labor mobility, the impacts of the presence and activities of ICT and IT-enabled MNCs on domestic ICT firms, especially in terms of wages, will depend on two different types of effects. On one hand, if the level of competition by MNCs in the labor market is too high, it may produce an upward pressure on real wages of workers in the sector, producing wage inflation (a negative effect). On the other hand, there may be knowledge spillovers as a result of worker mobility from MNCs to local firms. This mobility may also produce an increase in real salaries, in this case as a premium due to the knowledge and skills acquired by employees of domestic firms when they previously worked in MNCs (a positive effect).

In the case of competition in the labor market, Table 15 shows that 75.9% of domestic ICT firms stated that the labor market is highly competitive, and that this competition is perceived to come more frequently from ITC and IT-enabled MNCs (36.5%), than from other domestic firms of the ICT sector (31.7%), and from other MNCs operating in the country in other productive sectors (23.8%). These results vary between ICT subsectors, with the solutions providers subsector reporting the highest level of competition in the labor market, followed by the software and telecommunications subsectors.

Table 15: Competition in the ICT sector labor market
(percentages of all domestic firms in a given sector)

Is there competition for human resources between companies in the sector?	Total	Software	Solutions	Telecom
Yes	75.9%	66.7%	84.0%	55.6%
N =	83	24	50	9
What are the principal sources of this competition?				
- ICT MNCs	36.5%	43.8%	33.3%	40.0%
- Domestic ICT firms	31.7%	25.0%	33.3%	40.0%
- MNCs in other sectors	23.8%	25.0%	26.2%	0.0%
- Domestic firms in other sectors	7.9%	6.3%	7.1%	20.0%
N =	63	16	42	5

Source: Survey of domestic ICT firms

On the other hand, investment by ICT and IT-enabled MNCs in their workforce provides workers with knowledge and skills, the benefits of which may not be completely internalized, since knowledge may be carried over to domestic ICT firms through labor turnover – either to existing local firms, or to new firms started by ex-MNC employees (Fosfuri, Motta, and Ronde, 2001; Glass and Saggi, 2002; Crespo y Fontoura, 2007). As mentioned previously, Monge-González and González-Alvarado (2007) and Monge-González and Hewitt (2010) found evidence of knowledge spillovers from MNCs to domestic ICT firms through labor mobility in Costa Rica.

The information in Table 16 reinforces these findings. Almost half (48.8%) of the domestic ICT firms surveyed for the present investigation stated that some of their employees had previously worked for MNCs. This figure is higher in the case of solutions services firms (56.3%) than for telecommunications (44.4%) and software (34.8%) firms. The relative importance of this mobility can be measured by the average percentage of workers in each firm that previously worked for MNCs. Table 16 shows that on average, 15.6% of the employees of domestic ICT firms have worked previously in MNCs, with the percentage of ex-MNC employees especially high in domestic telecommunications firms (27.2%), and lowest in the case of software firms (10.8%).

Table 16: Relative importance of labor mobility from MNCs to domestic ICT firms, 2014
(percentages of all domestic firms in a given sector)

Labor turnover	Total	Software	Solutions	Telecom
Local ICT firms with employees that have worked previously in MNCs	48.8%	34.8%	56.3%	44.4%
average percentage of employees that have worker previously in MNCs	15.6%	10.8%	15.8%	27.2%
Manager of local ICT firm worked previously in a MNC	53.7%	33.3%	69.4%	22.2%
N =	82	24	49	9
- worked in a MNC for 0-2 years	20.9%	25.0%	21.2%	0.0%
-worked in a MNC for 3-5 years	39.5%	25.0%	42.4%	50.0%
-worked in a MNC for 6-10 years	14.0%	12.5%	15.2%	0.0%
-worked in a MNC more than 11 years	25.6%	37.5%	21.2%	50.0%
N =	43	8	33	2

Source: Survey of domestic ICT firms

Spillovers through labor mobility are more likely to be realized in the medium to long term, since knowledge first needs to be absorbed by the local workforce. Table 16 shows that a majority (53.7%) of domestic ICT firms report having a manager that previously worked in a MNC, and that the percentage of domestic firm managers that previously worked in MNCs is much higher for solutions firms (69.4%) than for software (33.3%) or telecommunications (33.3%) firms. In addition, most (79.1%) of these managers had more than three years of experience working in MNCs.

Since almost half of the domestic ICT companies surveyed had hired former employees of MNCs, an attempt was made to interview at least one ex-MNC employee in each company that reported having such employees to learn more about their experiences in MNCs, and whether they had transferred knowledge to the domestic ICT companies where they were later employed. The data in Table 17, on the next page, shows that most of the employees of domestic ICT firms that previously worked in MNCs interviewed had worked for ICT and IT-enabled MNCs (63.6%). As in the case of managers, discussed previously (see Table 16), most of these workers had more than three years of experience working in MNCs (59.1%).

Table 17: Relative importance of labor mobility from ICT and IT-enabled MNCs to domestic ICT firms, 2014
(n=44)

Previous experience	Total
Worked before in MNCs	
-in ICT or IT-enabled MNCs	63.6%
-in other MNCs	36.4%
Time worked in MNCs	
-worked in a MNC for 0-2 years	40.9%
-worked in a MNC for 3-5 years	38.6%
-worked in a MNC for 6-10 years	13.6%
-worked in a MNC more than 11 years	6.8%

Source: Survey of domestic ICT firm employees that previously worked in MNCs

Table 18 presents the type of knowledge or skills that employees in domestic ICT firms acquired when working for MNCs in Costa Rica. The knowledge gained was often not industry-specific, and could therefore be easily transferred to other companies; the types of knowledge acquired by these employees included not only technical knowledge, but also the development of such important skills as communication, management, problem solving, and teamwork.

Table 18: Knowledge acquired by former MNC employees and knowledge transferred to domestic ICT firms, 2014
(n=44)

Knowledge acquired and transferred	Total
Type of knowledge or skills acquired while working in MNCs	
-technical knowledge	45.4%
-communication skills	36.3%
-management skills	31.8%
-problem solving	31.8%
-teamwork	29.5%
Transferred knowledge to local ICT firms	97.0%
How is the knowledge transferred to local ICT firms?	
-training employees	37.2%
-improving the administration of the firm	34.9%
-transferring technical knowledge	9.3%

Source: Survey of domestic ICT firm employees that previously worked in MNCs

An especially important finding reported in Table 18 is that almost all workers (97%) from domestic ICT firms that previously worked for MNCs that were interviewed stated that they transferred the knowledge that they acquired when working for MNCs to local companies. They transferred this knowledge primarily through training other employees of domestic ICT firms, and improving the management of these firms.

Another area of possible knowledge spillovers was explored, having to do with whether or not the founders of domestic ICT firms had previously worked in MNCs, and whether or not these founders had founded more than a single domestic firm. Table 19 shows the results of this analysis, based on the results of the survey of domestic ICT firms.

Table 19: History of founders of domestic ICT companies, 2014

History of founders of local ICT companies	Total	Software	Solutions	Telecom
At least one founder worked in MNCs operating in Costa Rica before founding the domestic ICT firm	54.9%	37.5%	67.3%	33.3%
-These MNCs belonged to the ICT sector	21.7%			
The founders of the local ICT firms previously founded other companies	62.2%	66.7%	61.2%	55.6%
-These companies belong to the ICT sector	70.6%	75.0%	66.7%	80.0%

Source: Survey of domestic ICT firms

Consistent with previous results from Monge-González and Hewitt (2010), a majority of the domestic ICT firms (54.9%) have at least one founder that previously worked for an MNC in Costa Rica; this figure was lowest in the case of domestic software and telecommunications firms, and much higher in the case of solutions firms. It was also found that only one-fifth (21.7%) of the MNCs in which domestic ICT firm founders had previously worked belonged to the ICT and IT-enabled sectors. It is interesting to note that almost two-thirds (62.2%) of the founders of domestic ICT companies surveyed had previously founded another companies, and that in a substantial majority of these cases (70.6%) these other companies belonged to the ICT sector. These results did not vary substantially when analyzed by subsector.

It is also important to determine whether the presence and activities of ICT and IT-enabled MNCs have an impact on real wages of workers hired by domestic ICT firms in the specific case of domestic ICT employees with with previous experience in these types of MNCs. At the end of section 4 we presented a model to explore to what extent the experience from ICT or IT-enabled MNC is rewarded in domestic ICT firms. To do so, one can estimate a wage equation for workers in domestic ICT firms and compare the wages of the *movers* to

those of *stayers*[12] in domestic ICT firms. The results of the estimation of Equation (4) are presented in Table 20. In all cases, the control group consists of all stayers in domestic ICT firms.

Table 20: Movers versus Stayers in Domestic ICT firms: Wages after Moving

Variables	Coefficients
movers from ICT and IT-enabled MNCs, ICT and IT-enabled MNC tenure < 1 year	-0.104***
	(0.0213)
movers from ICT and IT-enabled MNCs, ICT and IT-enabled MNC tenure (1-3) years	0.130***
	(0.0230)
movers from ICT and IT-enabled MNCs, ICT and IT-enabled MNC tenure >= 3 years	0.213***
	(0.0310)
movers from domestic ICT firms, domestic ICT tenure < 1 year	0.0184
	(0.0228)
movers from domestic ICT firms, domestic ICT tenure (1-3) years	0.0944***
	(0.0198)
movers from domestic ICT firms, domestic ICT tenure >= 3 years	0.314***
	(0.0287)
movers from Other firms, Other firms tenure < 1 year	-0.292***
	(0.0113)
movers from Other firms, Other firms tenure (1-3) years	-0.0731***
	(0.0113)
movers from Other firms, Other firms tenure >= 3 years	0.0598***
	(0.0136)
gender (female=1, male=0)	-0.233***
	(0.00963)
Constant	12.72***
	(0.00975)
N of observations	503,424
R-squared	0.556

*Wage regression with firm fixed effects. Control variables include firm and individual characteristics (gender and age), as well as year and year-industry interaction dummies. *** p<0.01, ** p<0.05, * p<0.1*

Workers that move from ICT and IT-enabled MNCs to domestic ICT firms earned a *wage premium* relative to the stayers in domestic ICT firms, and the wage premium increases with the length of tenure in the MNC, if the worker's tenure in an MNC was more than one year. Compared to all stayers, employees of domestic ICT firms with previous experience of between 1 to 3 years in an ICT or IT-enabled MNC received a 13% premium the first

[12] That is, workers who never change firms.

year that they worked in a domestic firm; the premium rose to 21% for the first year for those domestic ICT firm employees with more than 3 years of previous experience in an ICT or IT-enabled MNC.

Employees of domestic ICT firms with 1-3 years of previous experience working in other domestic ICT firms also received a premium (9%) the first year they worked in a domestic firm; the premium rose to 31% for those workers of domestic ICT firms with previous experience with more than 3 years of previous experience in a different domestic ICT firm for the first year.

These findings are consistent with the results of analysis of data from surveys of both domestic ICT firms and ICT and IT-enabled MNCs, where we found that there are knowledge spillovers from MNCs to domestic firms due to labor turnover, as well as high levels of competition for employees both between MNCs and domestic ICT firms, and between different domestic ICT firms.

It is reasonable to assume that higher wage premiums will be associated with those positions or skill levels which are in shortest supply in the local labor market. Although we were not able to obtain information about the specific positions which workers occupied in the data used for our analysis of labor mobility and wages to support this assumption, we did collect information about the types of employees which domestic ICT firms believed to be the most difficult to recruit; this data is summarized in Table 21.

Table 21: Most difficult types of workers to recruit
(N=83)

Position	% "most difficult to recruit"
High-level technical staff	59.0%
Sales and marketing	16.9%
Mid-level technical staff	12.0%
Managers	6.0%
Other	3.6%
Administrative staff	1.2%
Infrastructure and ICT support	1.2%
N	**83**

Source: Authors´ calculations based on domestic ICT firm survey results

These results did not vary significantly between ICT subsectors, and show that domestic ICT firms encounter far more difficulty in recruiting the most highly skilled and experienced technical staff than in recruiting any other type of employee. Results from similar questions asked in the survey of MNCs also indicated a relatively strong demand

for the most highly-skilled technical workers, but it is clear from the MNC survey data that domestic firms are more worried about obtaining such workers than are MNCs.

The existence of a *wage premium* in domestic ICT firms for workers with previous experience either in ICT and IT-enabled MNCs, or in other domestic ICT firms, is a positive result from the point of view of experienced employees; this is a clear indication of the creation of better-paid jobs in the ICT sector. However, this same phenomenon can also be seen as the creation of *wage inflation* in the ICT sector as a consequence of high competition for labor (see Table 15), which is a negative result from the point of view of the owners of both domestic ICT firms and ICT and IT-enabled MNCs. In the case of MNCs, which have very frequently located themselves in the country for access to skilled workers, one of the most attractive aspects of the Costa Rican workforce is the relatively low salaries that skilled workers command compared to equivalent workers in more developed countries; as local wages rise, the possibility that the MNCs will consider relocating themselves in other countries with lower salaries may also increase, resulting in lower competitiveness of Costa Rica in attracting MNCs.

Therefore, increasing the offer of skilled human resources for this sector is clearly extremely important, and further findings of our analysis indicate that one of the most promising ways in which this increased offer may be generated is encouraging women to receive the types of training necessary to allow them to fill higher-level positions such as technicians or engineers.

Table 22: Percentage of female employees by position

	Domestic				MNC
Position	**Software**	**Solutions**	**Telecom**	**Total**	**Total**
Managers	21.0%	18.9%	7.7%	18.8%	33.8%
Administrative staff	50.0%	64.5%	37.5%	56.4%	43.3%
Sales and marketing	48.8%	41.3%	50.0%	44.4%	50.0%
High-level technical staff	21.5%	10.9%	2.2%	12.9%	30.8%
Mid-level technical staff	25.1%	18.3%	7.1%	20.7%	34.2%
Infrastructure and ICT support	18.2%	9.2%	6.3%	9.7%	24.4%
Other	30.8%	26.8%	1.4%	9.0%	32.3%
Total	**28.0%**	**21.5%**	**5.4%**	**20.2%**	**33.7%**
N =	23	48	9	80	38

Source: Authors´ calculations based on domestic ICT firm and MNC survey results

The first four columns of data Table 22 present a summary of the percentage of female workers in domestic ICT firms. As can be seen in the "Total" column of data for domestic firms, women constitute approximately half of employees in administrative (including secretarial work, executive assistants, etc.) and sales and marketing positions, but are very infrequently employed in managerial or technical positions, and domestic

telecommunications companies have especially low percentages of female managers and technical workers.

The fifth column of data in Table 22 presents the overall percentages of female employees in different positions in MNCs for comparative purposes, showing that women are far more frequently employed as managers and technical staff in MNCs than in domestic ICT firms. The simple fact that women are very infrequently employed in those positions which are in highest demand in the labor market is a compelling reason to emphasize the creation of more highly skilled female workers.

We may also note in Table 20 that the coefficient for the "gender" variable indicates that women receive salaries that are approximately 23% lower than those of men with similar characteristics in terms of previous experience in MNCs or domestic ICT firms when they move to new employment in domestic ICT firms. This finding does *not* imply that women receive less rewards for previous experience than men for doing the same jobs; rather, women are likely to be moving from one non-managerial or non-technical position to another, and these positions have lower salaries. However, it does emphasize that having women occupy higher-level technical positions will not only meet a pressing need for such workers in the sector, but will also create more workers who benefit from wage premiums in more highly-paid positions when changing employers.

4.6 Characterization of mediating factors

As noted in the discussion of the conceptual framework for our analysis in Section 4, various authors have emphasized the importance of studying the factors that can enhance the impact the impact of the presence and activities of MNCs in developing countries on domestic firms. The most important of these factors are *characteristics of the MNCs*, *characteristics of domestic firms, and characteristics of the national environment of the host country* in which both types of companies are operating (Paus and Gallagher, 2008; Farole and Winkler, 2014).

In order to assess the states of these factors, we estimated three indices based on the results from the two surveys carried out in Costa Rica among ICT and IT-enabled MNCs and domestic ICT firms, using the DP2 method (Pena Trapero, 1977) described in Appendix B. The results of these estimations are presented in Table 23, on the next page.

We first estimated an Absorptive Capacity Index (ACI) to measure the degree to which domestic ICT firms were likely to be able to *absorb knowledge and technology* from their interactions with ICT and IT-enabled MNCs (values range from 1 to 5, with higher index values indicating better absorptive capacities). The results from Table 23 show that the average score for Costa Rican domestic ICT firms' absorptive capacities is relatively low

(2.51), and that there is a relatively low dispersion in this index (a standard deviation of 0.70).

Table 23: Indices – Domestic ICT firms´ Absorptive Capacity, National Environment and MNC Spillover Potential

Indices	N	Median	Mean	Std. Dev.	Min.	Max.
Absorptive Capacity	72	2.45	2.51	0.70	0.91	3.91
National Environment	83	1.83	1.82	0.71	0.23	3.57
MNC Spillover Potential	33	2.09	2.01	0.57	0.6	3.39

Source: Authors´ calculations based on domestic firm survey results

According to the data in Table 24, we can conclude that the low absorptive capacity of local ICT firms is due to their relatively low levels of productivity, proportions of skilled labor in the workforce, levels of innovation, exports and scale. All of these factors make IT difficult for domestic ICT firms to take full advantage of opportunities offered by interactions with ICT and IT-enable MNCs operating in Costa Rica.

Table 24: Variables used in constructing Domestic ICT firms´ Absorptive Capacity Index

Variables	N	Mean	Std. Dev.	Min.	Max.
Research and development (0-100% of 10 possible R&D activities carried out by the firm)	82	0.51	0.22	0.00	0.90
Technology gap [13] ($ US)	73	3,842	33,759	-31,341	168,051
Sales 2013 ($ US)	73	783,733	1,481,780	50,000	11,300,000
Skilled labor as % of employees	80	0.66	0.25	0.05	1.00
Number of employees	80	21.52	29.92	3	185
Exports as % of sales	83	0.08	.15	0.0	0.8
Degree of competition (Ranking 1-5)	83	2.77	0.5	1	3
Exporter (Dummy)	83	0.49	0.5	0	1

We also estimated an index to measure the degree to which the national environment favored the emergence of positive impacts from the interactions between ICT and IT-enabled MNCs and domestic ICT firms, based on rankings of these factors provided by representatives of domestic ICT firms in the domestic firm survey. As was the case for the absorptive capacity index, values range from 1 to 5, with higher index values indicating better absorptive capacities. Table 23 shows a very low score (1.82) for the national environment of Costa Rica; according to the results shown in Table 25, which summarize the scores assigned to various environmental factors by the domestic ICT firms (again on a

[13] Domestic firms' productivity relative to a benchmark productivity level of MNCs from the same sector

scale of 1 to 5, with 5 representing the most positive score), access to finance, telecommunications infrastructure, promotion of innovation, human resource development, and all trade, investment and industry policies, require substantial improvement in Costa Rica to generate a favorable environment for domestic ICT firms to take advantage of the presence and activities of ICT and IT-enabled MNCs.

Table 25: Costa Rica: Variables used in constructing the National Environment Index

Variables	N	Mean	Std. Dev.
Labor market regulations	83	3.06	1.29
Intellectual property rights	83	2.94	1.24
Access to finance	83	2.17	1.10
Learning and innovation infrastructure			
Training	83	3.11	1.17
Telecom Infrastructure	83	2.81	0.99
Promotion of Innovation	83	2.43	0.99
Human Resource Development	83	2.89	1.07
Trade, investment, and industry policy			
Support to Start-ups	83	2.43	1.16
Clusters formation	83	2.12	0.99
Value chain development	83	2.05	0.90
Private Investment promotion	83	2.42	1.04
FDI attraction	83	2.84	1.2
Fiscal Incentives	83	1.73	0.91
Export promotion	83	2.42	1.09

Source: Authors´ calculations based on domestic firm survey results

A final index was constructed to measure the potential of ICT and IT-enabled MNCs to generate knowledge spillovers for local ICT firms (again, values range from 1 to 5, with higher index values indicating higher potential to generate spillovers; the variables used to construct this last index are presented in Table 26, on the next page). The low value of the index (2.01) indicates among other things that there is a clear need to better focus Costa Rica's foreign direct investment attraction policies to assure that the MNCs being attracted to the country will have profiles that are more conducive to the generation of spillovers into the host economy.

In summary, the values of the indices that were calculated to summarize the state of the three types of mediating factors introduced in our discussion of the conceptual framework, and of the values of the variables that were used to compute them, indicate that the absorptive capacity of domestic ICT firms, the potential of ICT and IT-enabled MNCs to generate spillovers, and the national environment in which domestic ICT firms and MNCs associate with each other are not favorable for promoting strong interactions between these

types of businesses which are beneficial to domestic ICT firms. This interpretation is supported by other findings discussed previously in this section, which clearly show that although such beneficial interactions do occur in the country, they are far less frequent than would be hoped for if Costa Rica is to take full advantage of the presence of foreign multinational corporations in the country.

Table 26: Variables used in constructing the MNC Spillover Potential Index

Variables [14]	N	Mean	Std. Dev.	Min.	Max.
Degree and Structure of Foreign Ownership	40	1.03	0.36	0	2
FDI Motive	33	0.94	0.83	0	4
Global Production and Sourcing Strategy	40	1.50	1.41	0	4
Technology Intensity	40	2.83	1.75	1	8
Entry Mode	40	0.73	0.45	0	1
Length of Foreign Presence (years)	40	13.05	10.81	3	53

Source: Authors´ calculations based on MNC survey results

5 Principal conclusions and policy recommendations

The main conclusions of the present study may be summarized as follows:

- We were able to document the composition of the Costa Rican ICT sector in unprecedented detail, and as a result were able to determine that the great majority of domestic ICT firms were dedicated to providing ICT solutions, and to the development of standardized software. There were very few domestic telecommunications companies, and almost no domestic hardware companies. Likewise, we were able to determine that the distribution of foreign multinational companies (MNCs) that play a key role in the ICT sector were more evenly distributed between different ICT subsectors, and that the largest single group of MNCs was dedicated to "IT-enabled" activities such as services outsourcing that required extensive and sophisticated use of ICT tools.

- We were also able to reliably document the sustained growth of the Costa Rican ICT sector during the period 2001-2011, as a result of high levels of entry of both MNCs and domestic firms into the market, as well as a very low mortality or exit rate from the sector of both types of businesses. There is little reason to suspect that this growth has decreased in the succeeding years.

[14] See Appendix C for a fuller description of how the variables were calculated.

- We did not encounter any support programs specifically intended to facilitate the development of the ICT sector in Costa Rica; the programs and policies that have the potential to assist in sector development are rather cross-sectorial, or "horizontal", in their orientation or effects.

  These include highly effective efforts to attract foreign direct investment (FDI) in this sector (based in part on tax incentives), as well as many decades of development of the national public educational system (including education in the use of ICTs and the widespread implementation of Internet in elementary and secondary schools), opening of the national telecommunications market to competition, a general economic opening which has encouraged free access to hardware and software for more than twenty years, a broad range of free-trade agreements, and a free zone regime. Other relevant initiatives are concerned with the promotion of science and technology, and of national competitiveness and innovation; however, these programs appear to have had little positive effects.

- Positive impacts from the presence and activities of MNCs on the *survival* and *growth* of domestic ICT firms were found in our survey results, stemming from the interaction of multinational ICT and IT-enabled companies with domestic ICT firms through the supply chain (vertical and horizontal linkages). In spite of this finding, it is important to emphasize that there are relatively few productive linkages between multinational companies and domestic firms in this sector (27.7% of domestic ICT firms participate in backward linkages, 32.5% in forward linkages and 36.1% in horizontal linkages), and only a very few non-monetary benefits (externalities) derived from this relation could be identified.

- According to the results of various econometric models calculated in this investigation, the effects of various factors expressed through different channels of interaction between MNCs and domestic firms in the ICT sector produces a net positive effect on the *survival* probability of domestic solutions and software companies, but a reduction of this probability for telecommunications companies.

  In terms of the *growth* of domestic ICT firms, the results of econometric modeling indicate positive impacts of the presence and activities of ICT and IT-enabled MNCs only on domestic software and solutions companies.

  Regarding the *creation* or entry of new domestic ICT firms into the national ICT sector, results of econometric modeling indicate that the presence of ICT and IT-enabled MNCs have a positive impact on the entry of domestic solutions and telecom companies, and a negative impact on the entry of new domestic software companies, while higher levels of linkages between ICT and IT-enabled MNCs and domestic ICT firms has a positive impact on the formation of new software companies, but a negative impact on domestic solutions and telecom companies

- The main reason for ICT and IT-enabled MNCs to establish themselves in Costa Rica was found to be the high availability of qualified technically trained and/or bilingual human resources, rather than access to the national or regional market for goods and services, consistent with MNC strategies of using the country as a platform for exporting to other markets.

  As a result, although domestic ICT firms indicate that the national market for goods and services is highly competitive, they also state that competition between MNCs and domestic companies in this market is relatively weak; in fact, they identify their main competitors here as other domestic ICT firms (65.1%) more than twice as often as ICT or IT-enabled MNCs (27.7%), while the effect of imports of ICT products or services is very low (7.2%). This means that there is little "competition effect" driving domestic firms to improve their offers to better compete with MNCs.

- On the other hand, there is clearly strong competition with MNCs in the labor market. Domestic ICT firms identify ICT or IT-enabled MNCs as the most frequent competitors for human resources,(36.5%), followed by other domestic ICT firms (31.7%), and by other domestic and foreign companies that are not in the ICT sector (also 31.7%).

  A positive result of this competition is that it favors employee turnover from MNCs to domestic firms. In this case, evidence was found showing that these workers take with them technical knowledge and soft skills acquired during their employment in MNCs to existing domestic firms and to new firms that they create. In other words, evidence was found of knowledge spillovers as a result of labor mobility – a positive externality of the presence and activities of MNCs on domestic firms.

- The greatest demand for workers by domestic firms is for high-level technical staff. While ICT or IT-enabled MNCs also rank the acquisition of such highly trained technical workers as especially desirable, they do not report as many problems in encountering them as do domestic firms. There is a very strong gender bias favoring male workers in technical positions, especially in domestic firms, which emphasizes the need to create more technically skilled female workers.

- Competition for human resources and acknowledgement of knowledge and abilities of workers of the ICT sector, especially of those with previous experience in ICT or IT-enabled MNCs or domestic firms, is clearly generating pressure on wages paid in Costa Rica. Employees of domestic ICT firms with previous experience of between 1 to 3 years in an ICT or IT-enabled MNC received a 13% premium the first year that they work in a domestic firm; the premium rose to 21% for the first year for those domestic ICT firm employees with more than 3 years of previous experience in an ICT or IT-enabled MNC.

It was also found that employees of domestic ICT firms with 1-3 years of previous experience working in other domestic ICT firms received a 9% premium the first year they work in a different domestic firm; this premium rose to 31% for those workers of domestic ICT firms with more than 3 years of previous experience in other domestic ICT companies for their first year with their new employer.

Finally, the wage premium for female employees with previous experience in MNCs or domestic ICT firms when they moved to a new job in a domestic ICT firm was found to be 23% less than that for men with similar years of experience in MNCs or domestic ICT firms. While this is primarily due to the fact that women are most likely to be moving from non-managerial or non-technical positions to similar positions with their new employer, it also highlights the need to create more technically-skilled female workers who may benefit from higher premiums when they change employers.

- While the existence of wage premiums that recognize the value of skills and experience developed through previous employment is a positive development from the point of view of experienced employees, it can also be seen as the existence of "wage inflation", which could be fostering a loss of competitiveness both for domestic ICT firms, and for Costa Rica as a whole as an attractive destination for MNCs to locate their offices. The creation of more skilled workers will do much to resolve these problems, as will steps taken to improve the competitiveness and profitability of domestic firms through increased productivity and innovation.

- Finally, an analysis of the mediating factors which act to facilitate or impede the transmission of beneficial impacts of MNC presence to domestic ICT firms was carried out. The results indicated that the current states of the absorptive capacity of domestic ICT firms, the potential of ICT and IT-enabled MNCs to generate spillovers, and the national environment in which domestic ICT firms and MNCs associate, will not permit the full realization of potential benefits of the presence of ICT and IT-enabled MNCs in the country. There is a clear need to improve the status of these factors.

The principal recommendations stemming from the analysis and discussion of the findings of the present study may be summarized as follows[15]:

- It is important to strengthen and make more effective efforts to support domestic firms in their interaction with multinational companies, with special emphasis on

[15] Many of these recommendations were stimulated or enriched by the results of the discussion of the study's preliminary results with public officials, academics, businesspersons and representatives of civil society who participated in the seminar-workshop "Impact of the presence and activities of ICT and IT-enabled MNCs on domestic ICT firms in Costa Rica", held in the National High Technology Center, Edificio Franklin Chang Díaz, on June 18, 2015.

the ICT sector. Existing efforts include the Productive Linkages program operated by PROCOMER, and the program to support innovative activities (PROPYME) operated by the MICITT, neither of which is currently being taken advantage of by domestic ICT firms; the empirical evidence we have gathered on the potential benefits of interactions with MNCs clearly indicates the importance of these and other initiatives for improving employment generation, business creation, and export capacities of Costa Rican ICT firms. There are roles for the government (ministries) and by the private sector (ICT industry associations) in this process.

- Costa Rican authorities must analyze the possibility of designing and implementing a specific policy to support domestic ICT firms, taking advantage not only the two programs mentioned in the previous point, but also programs such as those intended to promote exporting companies and the attraction of FDI. In this last case, there are clear advantages to focusing attraction efforts on multinational companies with the greatest potential to generate knowledge spillovers.

  It is likewise important to improve the absorptive capacity of domestic firms, so that they may better benefit from the opportunities offered by the presence of MNCs. Actions should be taken aimed at increasing levels of productivity and innovation within these firms, making more skilled workers available, and developing domestic firms' export capabilities.

- As indicated by domestic firms, greater access to financing and to the process for quality certification of their products and services is required to be able to participate more actively in supply chains of ICT and IT-enabled MNCs. It is recommended that the National Development Trust (FINADE) evaluate the possibility of participating as co-funder of some of the capital and training requirements of domestic ICT firms.

  The implementation of the Secured Transactions Law is likewise especially important to provide access to credit for smaller technology-based companies that do not the ability to provide traditional guarantees for such loans; while the Law has been passed, it has not been effectively implemented, and steps to promote this implementation are of vital importance.

- To improve the amount of labor required by domestic ICT firms and ICT and IT-enabled MNCs, the General Education Law must be revised with the aim of increasing the speed with which graduates from professional technical education can be created and employed. One of the most important steps that can be taken in this regard is the establishment of mechanisms for acknowledgement of degrees and courses between universities and technical institutes, following the example of the National Technical University.

It would also be desirable to improve the processes for acknowledging degrees and diplomas granted in foreign educational institutions, so that the recipients of these diplomas can practice their professional careers in Costa Rica without undue bureaucratic barriers.

- The criteria for granting visas to skilled foreign workers that allow them to reside and work in the country should revised in the light of existing human resource shortages and the demand for skilled workers in critical industries. Significant barriers to entry into the country for the types of workers that are found to be in short supply in the domestic labor force should be reduced.

- Given the increasing importance of developing soft skills (communication, problem solving, teamwork, etc.) in the labor force, Costa Rica must strongly promote a "dual" education system in which students combine classroom and workplace experience in their last years of education, so that more graduates will have these skills when they enter the labor market.

- Costa Rica must strongly promote the attractiveness of teaching and learning in the areas of science, technology, mathematics and engineering (STEM), so that more young people will undertake studies in careers of high demand in dynamic areas of the national economy such as the ICT sector. Specific actions in this area should include:

    - Improving the level of knowledge of teachers and professors in these subject areas.

    - Constantly updating curricula in mathematics, engineering and sciences courses at all educational levels.

    - Creating an online system that will allow students to obtain information about employment options in the country, as well as current wage levels in different industries and careers, so that young Costa Ricans will be better informed about demand for workers in the private sector and benefits of different careers, especially in dynamic productive activities such as the those carried out by ICT companies.

    - Overcoming biases against the study of mathematics, engineering and sciences, by female students, starting in elementary school.

    - Increasing enrollment of women in all public and private technical high-schools, as well as in universities, in careers which are in high demand in the ICT sector.

- It is imperative to systematically analyze the human resource requirements of both MNCs and domestic ICT firms, to more precisely identify areas in which it is especially important to provide more skilled workers. An especially useful initial action in this regard would be to have the Costa Rican Social Security system (CCSS) collect information about the different occupational categories of employees in the businesses that the CCSS covers, thus providing invaluable baseline information about the skills and responsibilities of employees in the Costa Rican economy.

- With respect to wage inflation, it is important to improve the innovative capacity of domestic ICT firms to permit them to increase their productivity, thus partially offsetting the negative effects of upward wage pressure. Programs such as PROPYME can play a very important role in this field.

- Given that domestic ICT firms have integrated themselves not only with ICT and IT-enabled MNCs, but also with many other types of MNCs operating in Costa Rica, efforts should be undertaken to define public policies to promote productive linkages of domestic ICT firms with MNCs operating in sectors such as medical accessories and aeronautics, which are important contributors to the Costa Rican economy.

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Appendix A: Variable definitions

Sector Study: Refers to all domestic and multinational companies in the ICT sector, as well as IT-enabled multinational companies operating in the country.

ICT subsectors: refers to subsectors *j*, where *j* = hardware, services solutions, software, and telecommunications.

Growth rates of firms (DHSGrowth): We use the definition of DHS growth rates according to Davis, Haltiwanger and Schuh (1996). DHS proposes a classification based on average employment in years *t-1* and *t*. We denote the variable employment with the letter *E*. Thus, we define the firm-level employment growth rate for firm *i* as follows:

$$r_{it} = (E_{it} - E_{it-1})/(0.5 * (E_{it} + E_{it-1}))$$

Firm size (L.LogEmpH): The average number of employees a firm has in year *t-1* and year *t*. In short, following Haltiwanger, Jarmin and Miranda (2010) we estimate an average size of the firm in year *t-1* and year *t*. We use this approach for new, for existing, and exiting firms. In the analysis, we used a lagged (by one year) value of the logarithm of size. Finally, using this figure, firms are classified as micro (less than 9 employees), small (10-49 employees), medium -sized (50-249 employees) or large firms (250+ employees).

Firm age (Varage): Starting in the year 2001, the firm *i* is assigned an age based on the first year the ID of the new firm was observed in the CCSS database. The firm *i* is then allowed to naturally age by one year for each additional year it is observed in the data. In the analysis, we used this value and the square of this value (varage2).

Flashing (Flashing): This is a dummy variable that takes a value of one if the firm *i* enters and leaves the market during the study period (flashing) and zero otherwise. For each firm *i* this variable assume a value of one from the first flash.

Corruption (CPIscore): This is the Transparency International Corruption Perception Index from 2001 to 2011. Comparison between years is problematic because according to their methodology report, the index is the result of combining existing reliable sources for that country during a given year, and these sources may change over time (see archive.transparency.org/policy_research/surveys_indices/cpi/2001).

Engineering graduates (l.logEngGrad): The number of graduates from professional engineering careers in Costa Rica, according to the National Council of Rectors, in year *t*. We used the logarithm of this variable with a lag of one year in the analysis.

Permanence of MNCs (l.lengthMNCICT): This is the median number of years that multinational ICT companies have operated in the country in year *t*. This variable is included in the analysis with a lag of one year.

Technological gap (techgapICT95): The difference between the logarithm of the 95th percentile of average salaries of ICT companies and the logarithm of the average wage of firm *i*. The analysis includes the variable with a lag of one year.

Presence of MNCs (For): The quotient of dividing the total number of employees working in ICT and IT-enabled multinationals from the subsector *j* by the total number of employees across the subsector *j* (i.e. ICT and IT-enabled multinationals plus domestic ICT firms) in year *t*.

Competition from MNCs (FORcompetence): The quotient of dividing the total number of employees of multinational ICT and IT enabled companies outside free zones in subsector *j* by the total number of employees of these multinational firms plus the number of employees in the domestic ICT subsector *j* in year *t*.

MNCICT Provider: A dummy variable that takes a value of 1 if the domestic ICT company was supplying at least one ICT multinational operating under the free zone regime in year *t* and zero otherwise.

TimMNCICT1 Provider: From the first time (year) than a domestic ICT company sells inputs to a multinational ICT company operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

TimMNCICT2 Provider: From the second time (year) than a domestic company sells inputs to a ICT multinational operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

TimMNCICT3 Provider: From the third time (year) than a domestic company sells inputs to a ICT multinational operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

L.ExperMNCICT: This variable measures for each year of the period under study the number of times (years) a domestic enterprise ICT sold inputs to a multinational ICT operating under the free zone regime (experience). In the analysis, we use this variable with a lag of one year.

MNCIT_E Provider: A dummy variable that takes a value of 1 if the domestic ICT company was supplying at least one IT-enabled multinational firm operating under the free zone regime in year *t* and zero otherwise.

TimMNCIT_E1 Provider: From the first time (year) than a domestic ICT company sells inputs to IT-enabled multinational operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

TimMNCIT_E2 Provider: From the second time (year) than a domestic ICT company sells inputs to IT-enabled multinational operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

TimMNCIT_E3 Provider: From the third time (year) than a domestic ICT company sells inputs to IT-enabled multinational operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

L.ExperMNCIT_E: This variable measures in each year of the period under study the number of times (years) a domestic ICT firm has sold inputs to a multinational IT-enabled operating under the free zone regime (experience). We used this variable in the analysis with a lag of one year.

MNCother Provider: A dummy variable that takes a value of 1 if the domestic ICT company was supplying at least one multinational that is not in the ICT or IT-enabled sectors (e.g. medical devices) but operated under the free zone regime in year *t*, and zero otherwise.

TimMNCother1 Provider: From the first time (year) that a domestic ICT company sells inputs to a multinational that is not in the ICT or IT-enabled sectors but operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

TimMNCother2 Provider: From the second time (year) that a domestic ICT company sells inputs to a multinational that is not in the ICT or IT-enabled sectors but operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

TimMNCother3 Provider: From the third time (year) that a domestic ICT company sells inputs to a multinational that is not in the ICT or IT-enabled sectors but is operating under the free zone regime, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

L.ExperMNCother: This variable measures for each year of the period under study the number of times (years) a domestic enterprise ICT sold inputs to a multinational that is not in the ICT or IT-enabled sectors but is operating under the regime free zone (experience). We used this variable in the analysis with a lag of one year.

Exporter (Exp): A dummy variable that takes a value of 1 if the firm was exporting in year *t* and zero otherwise.

ExporterTimexp1: From the first time (year) than a domestic ICT company has exported, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

ExporterTimexp2: From the second time (year) than a domestic ICT company has exported, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

ExporterTimexp3: From the third time (year) than a domestic ICT company has exported, this variable takes a value of 1 for all subsequent years of the period under study, and zero otherwise.

l.Exporterexp: This variable measures for each year of the period under study the number of times (years) than a domestic ICT company has exported (experience). We used this variable in the analysis with a lag of one year.

Herfindahl: The summation at the level of subsector j, of the squares of the quotients of the division of the number of employees of firm *i* by the number of employees in subsector *j*, for the entire period under study.

Minimum scale (logmedEmp): This variable is the logarithm of median firm size in the subsector *j*, in year *t*.

Gross entry rate: Quotient of the number of domestic ICT companies that started operations in year *t* divided by the total number of domestic ICT companies operating in year *t-1*.

Gross exit rate: Quotient of the number of domestic ICT firms that left the market in year *t* divided by the total number of domestic ICT companies operating in year *t-1*.

Net entry rate: This variable is the difference between the gross entry rate and the gross exit rate.

Sector growth: This variable measures the difference of the logarithm of the size of firms in sector *j*, between *t* and *t-1*.

ICT_IT enabled MNC linkages (avgChainsByMNC): This variable is equal to the average number of linkages of multinational ICT and IT-enabled companies with domestic ICT companies, in year *t*. That is, on average, how many domestic ICT firms have linkages with ICT and IT-enabled multinationals in year *t*.

Other MNC linkages (avgChainsByMNCno): This variable is equal to the average number of linkages of multinational companies that are not in the ICT or IT-enabled sectors with domestic ICT firms in year *t*. That is, on average, how many domestic ICT firms have linkages with other multinationals (not belonging to ICT or IT-enabled sectors) in year *t*.

Appendix B: Estimation of indices using the DP2 Technique

The DP2 technique is a methodology based on distances – that is, the difference between a given value of an indicator and another value used as a reference or target. Such techniques solve the problem of measurement unit heterogeneity.

Among these techniques, the most commonly used at the international level, and the most appropriate in our own case given the type of indicator to be calculated and the data available, is the DP2 technique.

This technique attempts to correct for the dependence among partial indicators, which would artificially increase the indicator's sensitivity to variations in a specific partial value. The correction consists of applying the same factor to each partial indicator, assuming a linear dependence function.

Given the partial indicators, the correction factors are determined by the complement of the coefficient of determination (R^2) of each indicator with respect to the remaining partial indicators.

For instance, if x_1, x_2, x_3,…, x_n are the partial indicators, and d_1, d_2, d_3,…, d_n, are the distances between the value of the indicator and a reference value of that indicator, then the indicator calculated using this technique is determined by the following formula:

$$DP_2 = \sum_{j=1}^{N} \frac{d_{ij}}{\sigma_j}\left(1 - R^2_{j,j-1,j-2,\ldots,1}\right) \qquad (1)$$

in which d_{ij} is the distance between the value of indicator j of dimension i and the unit of reference established for indicator j of the same dimension; σ_j is the standard deviation of indicator j; and $R^2_{j,j-1,j-2,\ldots,1}$ is the multiple coefficient of determination of the linear regression of indicator I_j with respect to the indicators that precede it in the order of input I_s, in which $s \in$ {j-1, j-2, …,1}, and $R_1^2 = 0$.

Similarly, the dimensions are aggregated in order to calculate the synthetic indicator:

$$Index = \sum_{i=1}^{N} \frac{d_i}{\sigma_i}\left(1 - R^2_{i,i-1,i-2,\ldots,1}\right) \qquad (2)$$

The advantages of this technique are as follows:

- It does not require a procedure for standardization of variables because, when dividing the distance by the standard deviation[16] of each indicator, the values are expressed in terms of a non-dimensional scale, such that the contribution of each distance to the value of the index is inversely proportional to its dispersion.

- The correction factor weights the differences between the indicators and their reference values by the proportion of "new" information that each indicator provides upon being included within a dimension (or a dimension of the synthetic indicator).

- It does not vary in different reference situations.

- It is easy to interpret the results.

However, when using this methodology, the value of the synthetic indicator may affected by the order in which the indicators are introduced, which may be controlled for by using an iterative process that makes it possible to establish an order based on the amount of information each indicator provides.

[16] In the case of dummy variables it is recommendable to standardize using ranges instead of standard deviations.

Appendix C: Variables used in constructing the MNC Spillover Potential Index

Degree and Structure of Foreign Ownership: Based on MNC responses to the question "*The capital of your business located in the host country is…?*" (1) 100% contributed by International headquarters; (2) more than 50% contributed by partners located outside the country.

FDI Motive: Based on MNC responses to the question "*What motivated your business to establish a presence in the host country?*" Responses are on a scale of 1-5, with 1 point given for an affirmative response to each of the following options: (1) Availability of skilled human resources; (2) access to the national market, (3) access to regional markets; (4) access to researchers and technological expertise; (5) existence of ICT clusters.

Global Production and Sourcing Strategy: Based on MNC responses to the question "*Who decides where to purchase goods and services for your local operations?*". (1) International headquarters only; (2) international headquarters after consulting with the local subsidiary; (3) Local subsidiary, after consulting with international headquarters; (4) Local subsidiary, without consulting with international headquarters.

Technology Intensity: Based on MNC responses to the question "*Which of the following activities has your business carried out in the country in the last two years?*". Responses are on a scale of 1-10, with 1 point given for an affirmative response to each of the following options: (1) Has made improvements to products in the domestic market; (2) Has made improvements to products in international markets; (3) Has introduced new product(s) in the domestic market; (4) Has introduced new product(s) in international markets; (5) Has introduced new brand(s) in the domestic market; (6) Has introduced new brand(s) in international markets; (7) Has made improvements in production processes; (8) Has made changes in marketing activities; (9) Has made organizational changes; (10) Has formed linkages with academic and research centers.

Entry Mode: MNC presence due to formation of a new business in the country, rather than through acquisition of existing businesses or joint ventures. (1) Yes; (0) No.

Length of Foreign Presence: Years of operation of the MNC in the host country.