The impact on wages, employment and exports of backward linkages between multinational companies and SMEs

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Abstract

Policymakers often look for ways to attract foreign direct investment (FDI) by multinational corporations (MNCs). This paper estimates the impact of a programme, *Costa Rica Provee*, that seeks to increase backward linkages between small and medium-sized enterprises (SMEs) and MNCs in Costa Rica. The impacts were measured by reference to real average wages, employment demand and the probability of exporting, using a combination of fixed effects and propensity score matching with panel data on treated and untreated firms for 2001-2011. Programme beneficiaries evinced higher average wages, labour demand and export probabilities than untreated firms, with dose and duration also having a major influence.

Keywords

Transnational corporations, foreign direct investment, small enterprises, medium enterprises, employment, wages, exports, case studies, Costa Rica

JEL classification

G28, L53, O25

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I. Introduction

The literature indicates that the impact of foreign direct investment (FDI) by multinational corporations (MNCs) on host-country economic development can materialize in a number of ways (Spencer, 2008).

Backward linkages are one of these ways, and they are important for host economies because they provide a channel through which knowledge, skills and technology can spread to local firms. The empirical evidence is mixed (Liu, 2011), but Giroud, Jindra and Marek (2012) find evidence that foreign affiliates' technological capability, embeddedness and autonomy are positively related to knowledge transfer via backward linkages.

Taking a different approach, Prashantham and Dhanaraj (2014) find that MNC relational capital is positively associated with the internationalization capability of new local ventures. For their part, Kim and Li (2014) investigate whether inward FDI contributes to entrepreneurial activity within the host country and find that the positive benefits for business creation are strongest in regions with weak institutional infrastructures and low overall educational attainment.

Domestic firms' absorptive capacity is an enabler of positive externalities through backward FDI linkages (Crespo and Fontoura, 2007; Ferragina and Mazzotta, 2014). Specifically, knowledge spillovers from foreign firms substantially depend on the absorptive capacity and productivity levels of individual firms in the host country (Damijan and others, 2013).

In sum, the empirical evidence on FDI-induced knowledge spillovers is mixed (Liu, 2011). It seems that the way backward linkages are measured matters greatly when it comes to establishing whether or not FDI is beneficial to host countries (Barrios, Görg and Strobl, 2011). Lastly, the heterogeneity of firms in terms of absorptive capacity, size, productivity and technology levels affects the results (Damijan and others, 2013).

In pursuit of the positive effects of FDI, policymakers in many developing countries have developed strategies to tempt MNCs to invest. Their main goal has often been to increase exports and FDI inflows, leading them to neglect backward linkages and technology transfer and absorption (Padilla-Pérez and Gaudin, 2014). For this reason, some developing countries, including Chile, Colombia, Costa Rica and Mexico, have created specific programmes to promote backward linkages.

However, the emergence of policies to foster linkages, knowledge spillovers and technology transfer has not been matched by actions to measure their impact. For example, López-Acevedo and Tan (2010) identified 23 rigorous impact evaluation studies, of which only 3 looked at measures to promote backward linkages from investment.

In these cases, the authors found that participation in any programme produced statistically significant and generally positive impacts on several firm performance measures, although some programmes were more effective than others. In Chile, for example, the greatest impact on final outcomes was found to come from technical assistance programmes, followed by cluster programmes and those to promote technology development and adoption.

This paper aims to help close the knowledge gap by assessing the impact of a specific programme, *Costa Rica Provee*, which promotes backward linkages between multinationals and local small and medium-sized enterprises (SMEs) in Costa Rica, a developing country. Specifically, the research focuses on the identification of timing or dynamic effects (how long it takes for results to come through) and treatment intensity (dosage effects).

Costa Rica Provee, a name that translates as "Costa Rica Supplies", was created in 1998 when the country's authorities recognized the need to develop suppliers, given that MNCs operating in export processing zones (EPZs) were poorly integrated with local companies, and to improve Costa Rica's investment climate. After several revisions and adjustments, *Costa Rica Provee* is now more driven by MNC demand, identifying the main input and raw material requirements of MNCs and matching these with local suppliers.

Both public and private organizations have influence over *Costa Rica Provee*. The institutional framework includes actions for policy implementation, monitoring, accountability and consultation or lobbying.

Our results indicate that *Costa Rica Provee* has had positive and significant impacts on the performance of beneficiary firms, specifically on their real average wages, labour demand and probability of exporting.

The article is structured as follows. Following this introduction, section II presents a literature review, section III provides an overview of the *Costa Rica Provee* programme, section IV describes the methodology employed to estimate its impacts, section V discusses the findings and section VI concludes.

II. Literature review

Knowledge spillover at the firm level is defined as knowledge created by one firm (in this case an MNC) and used by a second firm (a host-country firm) which does not (fully) compensate the MNC for this. It is thus a positive externality. In the case of technology transfer, conversely, the MNC is compensated. It also entails different kinds of costs (Smeets, 2008; Javorcik, 2004).

As noted earlier, policymakers in many countries have devised strategies to persuade MNCs to make investments in the form of FDI. MNCs have the potential to contribute to increased productivity among local firms, and the literature indicates that the impact of FDI on host-country economic development can materialize in various ways, such as through knowledge spillovers and technology transfer, although the evidence on this is mixed.

Some previous studies have shown negative results, with limited linkage effects and a low level of integration into host economies (Liu, 2011). By contrast, Damijan and others (2013) suggest that horizontal spillovers have become increasingly important over the past decade.

Amendolagine and others (2013) investigate the determinants of backward linkages between foreign manufacturing firms and domestic suppliers in 19 sub-Saharan African countries, finding that the time since entry of the foreign firm, the presence of a local partner in the ownership structure and a final market orientation are associated with stronger local linkages. They distinguish between the backward linkages associated with different types of FDI: resource-seeking, efficiency-seeking and market-seeking.

Damijan and others (2013) present a comparative study of the importance of direct technology transfer and spillovers via FDI for a group of 10 transition economies, using a dataset of over 90,000 firms. This study concludes that outcomes are affected by absorptive capacity, size, productivity and technology levels. The spillover effects produced by foreign firms depend substantially on the absorptive capacity and productivity of individual local firms, with only the most productive and absorptive being able to benefit from knowledge spillovers.

Giroud, Jindra and Marek (2012) analyse backward linkages between foreign affiliates and local suppliers in five transition economies using survey data on 809 foreign affiliates. They find a non-linear relationship between the extent of local sourcing and knowledge transfer to domestic suppliers, but their evidence shows that foreign affiliates' technological capability, embeddedness and autonomy are positively related to knowledge transfer via backward linkages.

Kiyota and others (2008) examine determinants of the backward vertical linkages of Japanese foreign affiliates in manufacturing for the period 1994-2000, finding that unobserved affiliate-specific characteristics explain much of the variation in backward linkages among foreign affiliates and that an affiliate's experience has positive and sometimes non-linear effects on local procurement.

Finally, Javorcik (2004) finds evidence of positive productivity spillovers from FDI for local suppliers when investment projects are co-owned by domestic and foreign firms.

From a different perspective, Alfaro and others (2004) provide evidence that only countries with well-developed financial markets gain adequately from FDI in terms of growth rates.

The main point, then, is that success in attracting FDI does not automatically generate benefits through backward linkages. For a host country, there may be a case for government intervention to remove the obstacles limiting the interaction of foreign firms with local suppliers and buyers, particularly SMEs. Backward linkage development must be approached from both the demand side (MNCs) and the supply side (local firms), because success depends both on the interest of MNCs in sourcing inputs in the host country and on the host's domestic linkage capability.

On the demand side, there are various points to consider, beginning with the sophistication of the MNC subsidiary's production processes: more advanced operations could create more and higher-value local linkages. Secondly, the chief executive officers of new MNC subsidiaries do not necessarily pursue linkages with local firms as part of corporate policy, since building facilities and launching operations are the main initial priorities. In their procurement policy, local managers often look to global suppliers rather than local firms for security reasons (robust production processes). In addition, newly arrived local procurement managers usually lack knowledge of local capabilities. The high costs associated with identifying local suppliers represent an information asymmetry that limits local linkages (i.e. a market failure) (Wanga and others, 2012; Hallin and Holmström, 2012; Liu, 2011; Zhang and others, 2010; Smeets, 2008; Saggi, 2002).

On the supply side, local firms are not necessarily capable of delivering goods and services to multinationals because of a lack of firm-level capabilities in areas such as entrepreneurship, technology, production scale, risk management and financing. Even when local firms are successful in becoming MNC suppliers, the absorptive capacity of the host country also depends on systemic learning infrastructure, institutions and government policies (Wanga and others, 2012; Zhang and others, 2010; Paus and Gallagher, 2008).

Local firms, especially SMEs, face significant obstacles in pursuing and identifying better business opportunities with more advanced companies (incomplete information). Potential high-value transactions and contracts with advanced MNCs are often out of reach for SMEs, even if they have basic production skills that could be enhanced through specific investments. They may also find it too costly to engage in identification of market opportunities (coordination failures). The need to carry out and finance the required investment in technological upgrading to comply with MNC requirements can be yet another structural obstacle to the cluster development of local suppliers.

On the basis of the foregoing, a national plan to promote productive linkages between MNCs and local firms may be seen as a response to specific market failures (coordination failures among local companies) and externalities (from FDI). Thus, there are arguments in favour of government action. For this reason, some developing countries, including Chile, Colombia, Costa Rica and Mexico, have created specific programmes to promote backward linkages.

However, the emergence of policies to foster linkages, knowledge spillovers and technology transfer activities has not been matched by action to measure their impacts. For example, López-Acevedo and Tan (2010) identified 23 rigorous impact evaluation studies, of which only 3 looked at measures to promote backward linkages from investment.

Generally speaking, although earlier evaluations of SME programmes were pessimistic about their impacts, recent studies have found positive impacts on intermediate outcomes such as research and development expenditures, worker training, new production processes and quality control programmes, as well as networking with other firms and with different information and funding sources. However, evaluations continue to yield mixed results for impacts on firm performance (López-Acevedo and Tan, 2010).

Specifically, programmes involving backward linkages are few. In Chile, Tan (2010) evaluated 603 firms, of which 207 reported having participated in one or more programmes (the treatment group) and 396 stated that they had never participated in any (the control group). The programme categories were: supplier development; technical assistance; support for business clusters; technology development; technology transfer; working capital; debt rescheduling; and other types.

Using propensity score matching combined with difference-in-difference models, Tan found evidence that programme participation was causally related to improvements in a range of intermediate outcomes (training, adoption of new technology and organizational practices) as well as positive gains in sales, labour productivity, wages and, to a lesser extent, employment. Positive treatment effects were also found by type of programme. However, only 2% of the firms evaluated had participated in a supplier development programme.

In Colombia, Duque and Muñoz (2010) evaluated the impact of the Colombian Fund for Modernization and Technological Development for Micro, Small, and Medium-sized Enterprises (FOMIPYME). FOMIPYME promotes modernization and technological change, including new business start-ups, entrepreneurship training, innovation and technology upgrading, marketing strategies, network-building, product commercialization, export promotion, productivity improvements and mini-clusters. One line is supplier development, but the impact evaluation did not analyse this separately.

Using a fixed effects model that controlled for programme impacts over time, Duque and Muñoz (2010) detected a generally positive effect on wages in the first two years of treatment, turning negative thereafter. Total factor productivity also showed a large and positive effect, diminishing in the second and third year after treatment but increasing significantly in the fifth year.

In Mexico, López-Acevedo and Tinajero (2010) found a huge array of programmes, numbering about 150. One of them, the Fund for the Promotion of Production Chains (FIDECAP), sought to encourage and strengthen the vertical and horizontal linkages of SMEs with other firms. Their findings indicate that participation in certain types of programme is associated with higher value added, sales, exports and employment. However, the assessment does not individualize each programme.

In another context, Görg, Hanley and Strobl (2011) investigate whether government subsidies encourage MNCs to create linkages with domestic suppliers in Ireland. Their results indicate that while foreign plants from Europe and the United States develop backward linkages independently of grant receipt, multinationals from other parts of the world respond positively to government support. They conclude, therefore, that governments should avoid taking a one-size-fits-all approach to incentivizing MNCs to develop local linkages.

III. The Costa Rica Provee programme

Since the creation of the export processing zone (EPZ) regime in the early 1980s, the promotion of productive linkages has been a subject of public concern in Costa Rica because of the weakness of vertical integration in industry, itself the result of an inward-looking development strategy based on import substitution during the 1960s and 1970s, which promoted the manufacture of final goods rather than raw materials and intermediate goods.

The National Programme of Science and Technology 1986-1990 made reference to this topic. Notwithstanding the interest in the public sector, the first efforts to develop local suppliers came from the private sector. Baxter Health Care, Inc., one of the first major MNCs established in Costa Rica, created a technical assistance programme to develop local suppliers in the mid-1990s as part of the firm's business strategy for the country.

In 1998, a group of public and private organizations created the Local Industry Improvement Programme to help local companies do more business with high-technology MNCs. Later, in 1999, the Supplier Development Project for High-Technology Multinational Companies was created. The next step was the creation of *Costa Rica Provee*, a national supplier development office legally constituted in early 2002. The programme was delayed for almost two years because of organizational and administrative difficulties. In 2004, the Executive Committee transferred *Costa Rica Provee* to the Foreign Trade Corporation of Costa Rica (PROCOMER) in order to provide continuity for the programme by consolidating it within a well-funded organization and to strengthen indirect exports to MNCs.

Costa Rica Provee explores the needs of multinational companies, identifies business opportunities and recommends partner suppliers that comply with the production, technical and quality specifications and characteristics required by MNCs. The programme has directed its services toward three strategic business areas: (i) the information and communications technology, electrical and electronics and metallurgical industries, (ii) the medical, chemical and pharmaceutical industries and (iii) agribusiness and textiles.

Costa Rica Provee has become more oriented towards demand from MNCs, identifying their main input and raw material requirements and matching these with local suppliers. It has also created business opportunities by means of small projects between SMEs and MNCs aimed at helping local suppliers to rise in the value chain and ultimately become global suppliers.

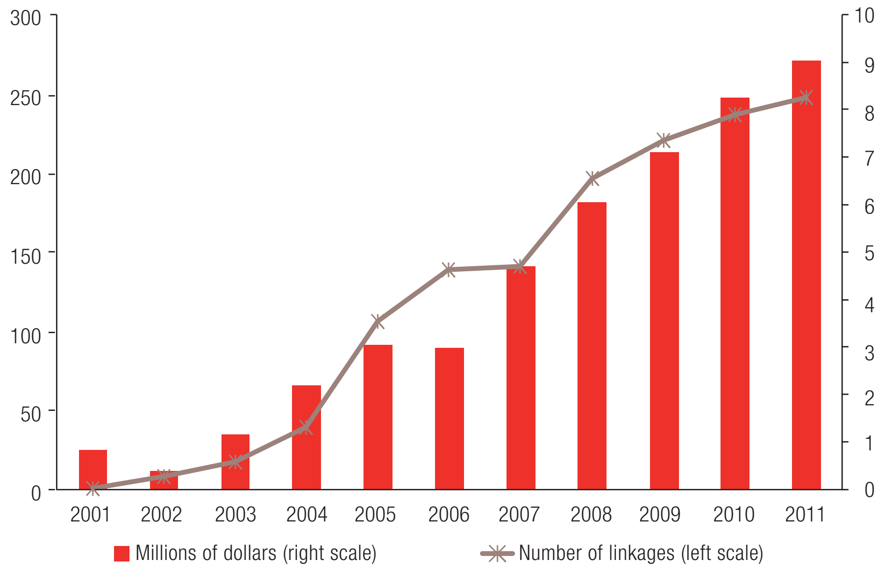
Costa Rica Provee was not created by law, but its activities are influenced by the EPZ Act and its regulations, particularly as regards customs procedures. In fact, the Act regulates commercial relations between EPZ firms and local companies through two mechanisms: (i) direct purchase, when an EPZ company buys a final good or service from a local firm without the MNC contributing any raw materials, machinery or equipment to the local supplier, and (ii) outsourcing, when the EPZ company provides the local supplier with raw materials and even machinery and equipment to produce the final goods.

The EPZ Act has undergone three major linkage-related reforms (in December 1999, June 2006 and August 2008) that have made these mechanisms more flexible. The most recent made substantial changes to outsourcing procedures: the outsourcing cap was raised from 25% to 50% of total MNC value added, simultaneous contracting with different suppliers was permitted, and the one-year limit on contract duration was eliminated. In addition, the movement of machinery and equipment outside EPZs was allowed, enabling local suppliers to integrate them into the production process. Red tape and burdensome administrative procedures were also eliminated: the number of steps involved in registration was reduced from 10 to 2, and approval time was cut from between 15 and 20 days to just 3.

Both public and private organizations have influence over *Costa Rica Provee*. The institutional framework is as follows. PROCOMER is responsible for the design and reform of *Costa Rica Provee*, influenced by Ministry of Foreign Trade regulatory actions applying to EPZs. Implementation, monitoring and accountability are also a PROCOMER responsibility. A sizable group of private and public organizations with an interest in promoting production linkages between MNCs and local suppliers are connected to *Costa Rica Provee*.

A summary of the programme's results is shown in figure 1. Between 2001 and 2011, the number of backward linkages registered each year by *Costa Rica Provee* increased from 1 to 248, representing a rise in sales from US$ 0.8 million in 2001 to US$ 9.0 million in 2011. Groote (2005) found that only 17.3% of the linkages created by *Costa Rica Provee* were incorporated into MNCs' high-technology final products, meaning that most linkages were associated with non-specialized inputs. There was a significant jump in the number of backward linkages created each year over the period 2007-2009, from 141 in 2007 to 197 in 2008 and 220 in 2009. Over the whole period 2001-2011, the programme generated a total of 1,355 linkages between local firms and MNCs.

Figure 1
Productive linkages created yearly by *Costa Rica Provee*, 2001-2011
(Number of linkages and millions of dollars)



Source: Prepared by the authors, on the basis of data from the Ministry of Foreign Trade (COMEX) and the Foreign Trade Corporation of Costa Rica.

Although the results are positive and show that linkages are increasing, the operations involved are of a small magnitude in relation to the size of the Costa Rican economy and MNC purchases. For instance, local purchases by MNCs in Costa Rica totalled US$ 591.1 million in 2007, while those made under *Costa Rica Provee* auspices in the same year were just US$ 4.7 million, or less than 1% of the total. According to data from the Ministry of Finance, approximately 9,654 local companies supplied different types of goods and services to MNCs operating under the EPZ regime from 2001 to 2011. This number of local suppliers contrasts with the small number of *Costa Rica Provee* beneficiary firms (just 403) during the same period. Thus, *Costa Rica Provee* beneficiary firms made up only 4% of all MNCs' local suppliers.

Flores (2011) investigates whether *Costa Rica Provee* has helped to develop backward linkages between high-technology MNCs and local firms. He uses empirical evidence to evaluate the relationship between being part of *Costa Rica Provee* and having achieved linkages involving higher asset specificity, and he estimates some econometric models with data from a panel of 94 high-technology MNCs from 2001 to 2008. The empirical results provide no robust evidence of a positive effect of *Costa Rica Provee* on the generation of backward linkages between high-technology MNCs and local suppliers. Paus and Gallagher (2008) claim that Costa Rica has not fully realized the potential of FDI for economic development, since backward linkages between MNCs and local firms are not as robust as they should be.

IV. Methodology

We follow a quasi-experimental approach that requires specific data on the programme under consideration, including data on firms affected by the measure or participating in the programme and data on a control group of similar firms which are not affected or participating. A panel of companies treated and untreated by *Costa Rica Provee* between 2001 and 2011 was built for this purpose.

Since *Costa Rica Provee* beneficiaries are not randomly selected, the participation or selection of firms in the treatment and control groups should be based on observable and unobservable characteristics that can be controlled for (quasi-experimental design). The technique we use in carrying out the impact evaluation is a combination of regression methods and propensity score matching that explicitly controls for differences in observable variables between groups and fixed effects models, which use data from before and after the programme (treated and control groups) to account for certain types of unobserved heterogeneity.

As is well known, the challenge of impact evaluation is to be able to compare a firm's performance after programme intervention to what would have happened if the firm had not participated. Since the hypothetical scenario cannot actually be studied, it is necessary to identify a group of firms that are similar to the group receiving the treatment (programme beneficiaries) in all respects except for their participation in the programme. The way this control group is selected is critical because any difference in performance between the control group and the treatment group, in terms of observed or unobserved attributes, affects the accuracy of the estimates of the programme's net impact. For this reason, it is important to explain the strategy used to correct potential selection biases and thus provide an assurance that the results obtained from the impact evaluation are actually attributable to the programme intervention under analysis.

1. The strategy for identifying the control group

Since none of the firms in the panel received support from *Costa Rica Provee* between 2001 and 2003, these are taken as the baseline or pre-treatment years for the purposes of this analysis.

To estimate the impact of support on SME performance, we combine propensity score matching with a fixed effects model. Propensity score matching makes it possible to control for selection bias attributable to firms' observable characteristics, while the fixed effects method controls for unobservable attributes which are considered to be fixed over time (time-invariant firm characteristics) and which may affect a firm's decision to seek support from *Costa Rica Provee* or its performance over time.

Selecting the control group involves an analysis of the variables characterizing all the firms before they became programme beneficiaries, i.e. between 2001 and 2003. Since beneficiary firms received support from *Costa Rica Provee* at different times during the period studied, estimation of the propensity score matching for the panel data requires calculation of a dummy variable D taking the value 1 if a firm was a beneficiary of *Costa Rica Provee* at least once during the period 2004-2011 and 0 if it was never a beneficiary. In other words, D takes a value of 1 when a firm starts participating in the programme.

Propensity score matching estimates the probability of a firm participating in *Costa Rica Provee* as a function of a set of observed variables. The first estimation is of the probability of participation as the matching criterion between beneficiary firms (treatment) and non-beneficiaries (control). Given the large number of variables characterizing firms, their values have to be reduced to a scalar $p(x)$, defined below, to allow matching. As pointed out by Bernal and Peña (2011), it is important not to omit any variable or to overspecify the model. Careful attention must be paid to the choice of variables to include.

The propensity score is defined as the conditional probability that a firm will become a beneficiary of *Costa Rica Provee*, given the values of a set of observed variables X, which is expressed as:

$$px = PD = 1|X = x = ED|X = x \quad (1)$$

where X is a vector of individual characteristics or variables of the firm and its environment.

Rosenbaum and Rubin (1983) show that if the fact of being a beneficiary or not is the result of a random selection process in the neighbourhood defined by the multidimensional vector X, this selection is also random in the region defined by the scalar $p(x)$. Therefore, the average treatment effect on the treated (ATT) in the case of the treatment given by *Costa Rica Provee* to beneficiary firms may be specified by the equations:

$$ATT = E[Y_1 - Y_0] = E[E[Y_1 - Y_0 | p(x)]] \tag{2}$$

and

$$E[Y_1 | p(x), D=1] - E[Y_0 | p(x), D=0] = E[Y_1 - Y_0 | p(x)] \tag{3}$$

where Y_i is the outcome variable on which the impact of the *Costa Rica Provee* programme is being measured, while subscript i indicates the year of observation of the outcome variable.

The impact of *Costa Rica Provee* may then be estimated as the difference between the average of the outcome variable for the treatment group (beneficiaries) and that for the control group in the area of common support (where the data show an overlap in the characteristics of beneficiaries and non-beneficiaries) defined by the propensity score matching.

A problem with the estimation (ATT) is that it does not take into account the possibility of selection bias due to unobserved variables, and this is compounded by the fact that, according to the panel data, treatment did not occur within the same year for all firms and was not continuous once a business entered the programme. We therefore estimate the programme's impact by using the propensity score matching results to define the treatment and control groups in a way that meets the common support condition, while estimating the impact equations by means of a regression method that follows the fixed effects approach.

2. Specification of the models and estimation procedure

To estimate the impact of *Costa Rica Provee* on SME performance, we applied a set of regression models to one set of panel data from 2004 to 2011, relating the outcome variable (wages, employment or exports) to a set of covariates, including a dummy variable (D) to indicate whether or not the firm was a beneficiary of the programme at some time in that period. For the case of wages and employment, we derived the model specifications on the assumption that Costa Rican SMEs displayed profit-maximizing behaviour.

The estimation was conducted using the ordinary least squares (OLS), propensity score matching and fixed effects approaches. In the case of exports, a linear probability model was used to estimate the impact of the programme on the probability that a firm exported at some time between 2004 and 2011. In this latter case, both the fixed effects and propensity score matching approaches were also used.

In short, the following three equations were estimated:

$$(w-p)_{it} = \beta_0 + \beta_1(PREM*SE)_{it} + \beta_2 D_{it} + \beta_3 D_{it\text{-}1} + \beta_4 D_{it\text{-}2} + \beta_5 X_{it} + \varepsilon_{it} \qquad (4)^2$$

$$l_{it} = \gamma_0 + \gamma_1 D_{it} + \gamma_2 D_{it\text{-}1} + \gamma_3 D_{it\text{-}2} + \gamma_4 X_{it} + \sigma_{it} \qquad (5)^3$$

$$exp_{it} = \delta_0 + \delta_1 D_{it} + \delta_2 D_{it\text{-}1} + \delta_3 D_{it\text{-}2} + \delta_4 X_{it} + \rho_{it} \tag{6}$$

[2] See annex A1 for the derivation of equation (4).

[3] See annex A2 for the derivation of equation (5).

where $(w-p)$ is the average real wage paid by the firm (in logs), $PREM * SE$ the wage premium received by skilled workers, L the number of workers hired by the firm (in logs), exp a dummy variable equal to 1 if the firm exported in year t and 0 otherwise, and X the covariates. Each error term in equations (4), (5) and (6) is a two-component term, with one component relating to an unobserved specific effect of the firm which does not vary over time (production sector, managerial capacity, etc.) but which may have an impact on the outcome variable, and another component which is purely stochastic.

We estimated another specification of equation (3) that included lag values of the dependent variable. This was because a firm's exports in year t are explained by its export performance in years $t-1$, $t-2$ and $t-3$. Thus, a dynamic linear probability model was estimated. Following the literature, we did not use the fixed effect approach in the estimation of this new specification.

In addition to estimating the three equations mentioned above, we explored the timing of the effects and whether dosage was really important, following Crespi and others (2011). For these purposes, we modified the above three equations, substituting for the impact variable D another dummy called D_timing that takes a value of 1 in every year from the first intervention and 0 if there has been no intervention. For the dosage effect, we substituted for the impact variable D another variable called D_dosage that takes a value of 1 in every year from the year the firm was first treated up to the year before the second treatment, 2 from the year the firm was treated for the second time up to the year before the third treatment, and so on successively, and 0 if there has been no treatment. In other words, this covers cases in which a firm was a beneficiary in more than one year.

3. Data

We collected information on beneficiaries and linked this to social security and export data in order to obtain microdata on final outcomes (total employment, average wages and exports) and on each firm's industry sector, location and legal status. These are official data from various government sources (ministries, the social security institute and foreign trade figures). We were thus able to construct the panel of companies with and without treatment under the *Costa Rica Provee* programme between 2001 and 2011.

V. Results

Before presenting the results of the *Costa Rica Provee* impact evaluation, we shall present those from the propensity score matching technique used to identify the firms belonging to the control group, specifically the common support.

1. Estimation of the propensity score and construction of the common support

Table 1 shows the variables used to estimate the propensity score for the sample firms and the results of the estimation. We estimate the probability of firms participating in the programme between 2004 and 2011 with reference to their characteristics between 2001 and 2003, i.e. before any of the firms in the sample participated in the programme.

Table 1
Estimation of the probit function for propensity score matching measured for the period 2001-2003
(Coefficients and p-values)

Variable	Coefficient
Firm is located in San José	0.6280***
	(0.1544)
Firm is located in Cartago	0.8718***
	(0.1894)
Firm is located in Heredia	0.7408***
	(0.1846)
Lithographic process	0.8663***
	(0.2429)
Firm exported in 2002	0.5457***
	(0.1312)
Real wage in 2001 (log)	0.1369***
	(0.0323)
Workforce growth from 2001 to 2003	0.2010*
	(0.1058)
Constant	-4.2812***
	(0.5299)
Number of observations	1 670
Wald chi-squared (7)	100.20
Prob>chi-squared	0.0000
Pseudo R-squared	0.1058

Source: Prepared by the authors.
Note: *Statistically significant at 10%; **statistically significant at 5%; ***statistically significant at 1%.

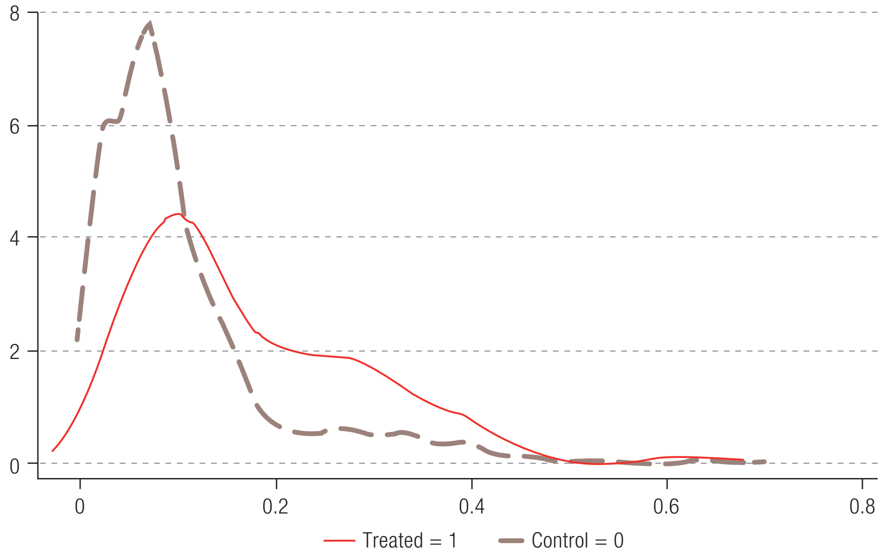
Propensity scores estimated by means of the participation model presented in table 1 are used to identify firms that did not participate in the *Costa Rica Provee* programme but that have the closest propensity score values to firms that did. Participation model variables include: geographic location (the three provinces where MNCs have the most local suppliers), sector of economic activity (the lithographic process, since this is the most common input provided by local suppliers to MNCs) and some firm characteristics such as the number of workers, average wage and a dummy variable indicating whether the firm exported in 2002.

All the coefficients included in the equation are significant. In addition, the model as a whole is significant, which means it is appropriate for estimating the probability of firms participating in the *Costa Rica Provee* programme and allocating them to either the treatment group or the control group. To achieve common support, it is necessary to eliminate the 20% of observations with the lowest density in the participation probability.

Figure 2 shows the distribution of the propensity scores after the matching of firms, i.e. it shows the propensity score matching results for firms in the treatment and control groups previously selected within the common support.

After identifying the firms to be included in the control group, i.e. firms with similar propensity score values, it was necessary to check that the characteristics of the firms in the control group were equal to those of the firms participating in the programme (Rosenbaum and Rubin, 1983). We did this by analysing t-tests for equality of means in the treated and untreated groups before and after matching (t-tests are based on a regression of each variable on the treatment indicator).

Figure 2
Density of treated and untreated firms resulting from propensity score matching in the common support for the *Costa Rica Provee* impact evaluation
(Probabilities)



Source: Prepared by the authors.

Table 2 shows the balance in the observable variables before and after matching for the firms in the common support. After matching, it is not possible to reject the null hypothesis that differences in means between firms in the programme and in the control group are zero for all the variables simultaneously. Therefore, the treated and untreated groups in the sample after the matching procedure are statistically comparable for the observable variables included in the participation model.

Table 2
Balance in observable variables before and after matching for the *Costa Rica Provee* impact evaluation

Variable	Sample	Treated	Control	Difference	Standard error	T-statistic
Firm is located in San José	Unmatched	0.61074	0.53386	0.07688	0.04276	1.80
	Matched	0.61667	0.62500	-0.00833	0.06786	-0.12
Firm is located in Cartago	Unmatched	0.14765	0.09599	0.05166	0.02581	2.00
	Matched	0.15000	0.14167	0.00833	0.04945	0.17
Firm is located in Heredia	Unmatched	0.18121	0.12032	0.06089	0.02844	2.14
	Matched	0.15833	0.20000	-0.04167	0.05338	-0.78
Firm exported in 2002	Unmatched	0.26846	0.08284	0.18562	0.02529	7.34
	Matched	0.17500	0.15833	0.01667	0.04846	0.34
Lithographic process	Unmatched	0.07383	0.01512	0.05870	0.01204	4.87
	Matched	0.00833	0.00000	0.00833	0.00833	1.00
Real wages in 2001	Unmatched	16.72404	15.81788	0.90617	0.13314	6.81
	Matched	16.59053	16.59801	-0.00749	0.20257	-0.04
Workforce growth from 2001 to 2003	Unmatched	0.10335	0.08817	0.01518	0.03800	0.40
	Matched	0.12301	0.05486	0.06815	0.05586	1.22

Source: Prepared by the authors.

2. The impact of Costa Rica Provee on real average wages

For the impact of the *Costa Rica Provee* programme to be correctly estimated, as mentioned previously, it is necessary to control not only for firms' participation but also for observable and unobservable variables whose behaviour may affect the result variable. Since the beneficiary firms of *Costa Rica Provee* are SMEs, the study sample for both beneficiary and control group firms was limited to businesses with up to 100 employees.

Results for real wages (equation (4) in the methodology) are presented in table 3. The second column shows a positive and significant result for the treatment variable, D_t (0.1212), which suggests that firms' participation in *Costa Rica Provee* has a positive and significant impact on the real wages they pay their employees. A comparison of the first and second columns of table 3 also shows that the wage premium for differences in labour categories ($Prem*SE$) has a positive and significant coefficient (0.0775).

It is also interesting to note in column 3 that the impact of participating in *Costa Rica Provee* is experienced not only during the actual year the treatment is applied, but also one and two years later (the coefficients associated with D_{t-1} and D_{t-2} are positive and significant at 0.1462 and 0.1473, respectively).

Table 3
Impact of *Costa Rica Provee* on real average wages
(Fixed effects and cluster-robust standard errors)

Variable	(1) fixed effects	(2) fixed effects	(3) fixed effects	(4) fixed effects	(5) fixed effects
D_t (dummy equal to 1 if firm was treated in year t and 0 if never treated)	0.0780***	0.1212***	0.1304***		
	(0.0181)	(0.0157)	(0.0155)		
D_{t-1} (treatment dummy lagged one year)			0.1462***		
			(0.0173)		
D_{t-2} (treatment dummy lagged two years)			0.1473***		
			(0.0207)		
$Prem*SE$ (wage premium for different labour categories)		0.0775***	0.0781***	0.0793***	0.0792***
		(0.0052)	(0.0052)	(0.0053)	(0.0053)
D_timing_t (dummy equal to 1 from the first year the firm was treated and so on successively, 0 if never treated)				0.3300***	
				(0.0201)	
D_dosage_t (dummy equal to 1 for all years from the first year the firm was treated until the year before the second treatment, 2 from the year the firm was treated until the year before the third treatment and so on, 0 if never treated)					0.1659***
					(0.0139)
Constant	13.8197***	13.4258***	13.4188***	13.4057***	13.4080***
	(0.0003)	(0.0263)	(0.0267)	(0.0275)	(0.0274)
Observations	26 082	26 082	26 082	26 082	26 082
R-squared	0.0006	0.1627	0.1658	0.1716	0.1712
Number of observations	4 628	4 628	4 628	4 628	4 628

Source: Prepared by the authors.
Note: *Statistically significant at 10%; **statistically significant at 5%; ***statistically significant at 1%.

When the treatment variable is replaced by *D_timing* and the dynamic (non-linear) effects of participation in *Costa Rica Provee* are analysed (column 4), the results indicate that the longer a firm is treated, the greater the impact. In fact, the coefficient associated with *D_timing* is positive and significant (0.3300). This finding may suggest that *Costa Rica Provee* beneficiary firms continue to take advantage of the knowledge acquired from their commercial relationship with MNCs, with a permanent impact on their performance.

Finally, the results in column 5 for treatment dosage (*D_dosage*) suggest that for a *Costa Rica Provee* beneficiary firm to have been treated several times during the period analysed (2004-2011) helps it to increase real wages for its employees (the coefficient associated with *D_dosage* is positive and significant at 0.1659). A possible interpretation of this result is that the more commercial relationships (linkages) with multinational corporations the SMEs participating in the *Costa Rica Provee* programme have, the greater the knowledge they acquire, the result being a positive impact on their future performance.

Bearing in mind that the comparison group taken for the table 3 estimations can be improved by using firms whose probabilities of participating in the programme are similar to those of firms in the control group, the table 3 models were estimated again, controlling for fixed effects, but using only the common support firms. These new estimations are considered to be more robust because firms which are not good "clones" of beneficiary firms were eliminated from the control group by means of propensity score matching. Table 4 shows the impact of *Costa Rica Provee* on real wages, using the fixed effects and propensity score matching approaches.

The results presented in table 4 are consistent with those in table 3, indicating that the participation of SMEs in the *Costa Rica Provee* programme certainly has a positive and significant impact on real wages at beneficiary firms (columns 1 to 5). However, when we tested whether the parallel pre-treatment trend assumption was valid, we found that using fixed effects was an invalid approach in this case. In fact, the results for all the coefficients associated with pre-treatment variables (*PD_*) in column 6 are significant and different from one another. For this reason, we carried out propensity score matching with a least squares dynamic model, the results of which are presented in column 7. The coefficient associated with the treatment variable (*D*) in this specification is positive and significant (0.0377), so we can conclude that the participation of firms in *Costa Rica Provee* has a positive and significant impact on real wages.

Finally, all the coefficients associated with the pre-treatment variables are negative. One possible interpretation of this result is that firms facing a negative shock before the treatment were the ones that sought to participate in the *Costa Rica Provee* programme.

Table 4

Impact of the *Costa Rica Provee* programme on real average wages

(Propensity score matching, fixed effects, dynamic least squares and cluster-robust standard errors)

Variable	(1) propensity score matching and fixed effects	(2) propensity score matching and fixed effects	(3) propensity score matching and fixed effects	(4) propensity score matching and fixed effects	(5) propensity score matching and fixed effects	(6) parallel pre-treatment trends test	(7) propensity score matching and dynamic least squares
D_t (dummy equal to 1 if firm was treated in year t and 0 if never treated)	0.0355***	0.0619***	0.0641***			0.0409***	0.0377***
	(0.0244)	(0.0210)	(0.0212)			(0.0213)	(0.0146)
D_{t-1} (treatment dummy lagged one year)			0.0596***				
			(0.0211)				
D_{t-2} (treatment dummy lagged two years)			0.0758***				
			(0.0240)				
$Prem*SE$ (wage premium for different labour categories)		0.0313***	0.0317***	0.0327***	0.0326***	0.0314***	0.0115***
		(0.0030)	(0.0030)	(0.0031)	(0.0031)	(0.0030)	(0.0027)
D_timing_t (dummy equal to 1 from the first year the firm was treated and so on successively, 0 if never treated)				0.1909***			
				(0.0278)			
D_dosage_t (dummy equal to 1 for all years from the first year the firm was treated until the year before the second treatment, 2 from the second year the firm was treated until the year before the third treatment and so on, 0 if never treated)					0.0938***		
					(0.0159)		
PD_1 (pre-treatment dummy equal to 1 for the first year before the firm was treated and 0 if never treated)						-0.0708***	
						(0.0245)	
PD_2 (pre-treatment dummy equal to 1 for the second year before the firm was treated and 0 if never treated)						-0.0642***	
						(0.0206)	
PD_3 (pre-treatment dummy equal to 1 for the third year before the firm was treated and 0 if never treated)						-0.1147***	
						(0.0227)	
$(w-p)\_{t-1}$ (real wages variable lagged one year)							0.7567***
							(0.0390)
$(w-p)\_{t-2}$ (real wages variable lagged two years)							0.0451***
							(0.0321)
$(w-p)\_{t-3}$ (real wages variable lagged three years)							0.0883***
							(0.0107)
Constant	13.9604***	13.7796***	13.7754***	13.7647***	13.7664***	13.7801***	1.4811***
	(0.0004)	(0.0171)	(0.0176)	(0.0182)	(0.0180)	(0.0172)	(0.1903)
Observations	12 450	12 450	12 450	12 450	12 450	12 450	12 349
R-squared	0.0003	0.0798	0.0816	0.0883	0.0889	0.0814	0.1712
Number of observations	1 626	1 626	1 626	1 626	1 626	1 626	1 620

Source: Prepared by the authors.

Note: *Statistically significant at 10%; **statistically significant at 5%; ***statistically significant at 1%.

3. The impact of Costa Rica Provee on labour demand

The results for the impact of *Costa Rica Provee* on labour demand (number of workers) are presented in tables 5 and 6. The table 5 results are for estimations using only the fixed effects method. From column 1 of table 5 it can be concluded that participation in *Costa Rica Provee* has a positive and significant impact on labour demand at beneficiary firms, given that the coefficient associated with the treatment variable, D_t, is positive and significant (0.1124).

Table 5

Impact of *Costa Rica Provee* programme on labour demand

(Fixed effects and cluster-robust standard errors)

Variable	(1) fixed effects	(2) fixed effects	(3) fixed effects	(4) fixed effects
D_t (dummy equal to 1 if firm was treated in year t and 0 if never treated)	0.1124***	0.1208***		
	(0.0264)	(0.0256)		
D_{t-1} (treatment dummy lagged one year)		0.1429***		
		(0.0269)		
D_{t-2} (treatment dummy lagged two years)		0.1398***		
		(0.0316)		
D_timing_t (dummy equal to 1 from the first year the firm was treated and so on successively, 0 if never treated)			0.0293***	
			(0.0347)	
D_dosage_t (dummy equal to 1 for all years from the first year the firm was treated until the year before the second treatment, 2 from the second year the firm was treated until the year before the third treatment and so on, 0 if never treated)				0.1616***
				(0.0209)
Constant	2.0003***	1.9965***	1.9916***	1.9915***
	(0.0005)	(0.0009)	(0.0014)	(0.0014)
Observations	26 082	26 082	26 082	26 082
R-squared	0.0009	0.0032	0.0054	0.0074
Number of observations	4 628	4 628	4 628	4 628

Source: Prepared by the authors.
Note: *Statistically significant at 10%; **statistically significant at 5%; ***statistically significant at 1%.

The data in column 2 indicate that the impact of participating in *Costa Rica Provee* arises during the initial year of treatment, as well as one and two years afterwards; the coefficients associated with the treatment variables D_t, $D_t - 1$ and $D_t - 2$ are positive and significant (0.1208, 0.1429 and 0.1398, respectively). On the other hand, when D_timing is substituted for the treatment variable and the dynamic (non-linear) effects of participation in *Costa Rica Provee* are analysed (column 3), it may be concluded that the longer a firm is treated, the greater the impact on labour demand. The coefficient associated with D_timing is positive and significant (0.2693).

Lastly, the results in column 4 for the treatment dosage (D_dosage) suggest that the more times a firm is treated under the *Costa Rica Provee* programme during the period analysed (2004-2011), the greater its labour demand. The coefficient associated with D_dosage is positive and significant (0.1616).

The results for the impact of *Costa Rica Provee* on labour demand, using only common support firms and controlling for fixed effects, are presented in table 6. These estimations are considered to be stronger because firms which are not good "clones" of beneficiary firms are eliminated from the control group by means of propensity score matching.

The results in table 6 confirm that *Costa Rica Provee* has a positive and significant impact on labour demand at beneficiary firms, as the coefficient associated with the treatment variable (D_t) is positive and significant (0.0958, column 1). The impact is observed in the year the treatment is applied and one and two years later. The values of the coefficients associated with treatment variables D_t, $D_t - 1$ and $D_t - 2$ are positive and significant (0.0984, 0.1117 and 0.0829, respectively).

When the dynamic results of treatment (D_timing) are analysed, a positive and significant coefficient is obtained (0.2081), indicating that a longer period of treatment has a greater impact on labour demand. In addition, the coefficient associated with dosage (D_dosage) is positive and significant (0.1062), indicating that successive treatments have a greater impact on the performance of beneficiary firms than a single treatment.

When it comes to testing whether the parallel pre-treatment trends assumption holds, the results in column 5 show that using fixed effects is a valid approach in this case. In fact, the results for all the coefficients associated with pre-treatment variables are non-significant, except for PD_3. But given that the significance of this last coefficient is very low and the first two pre-treatment variable coefficients are not significant, we consider there is strong evidence for accepting the parallel pre-treatment trends assumption.

Table 6
The impact of the *Costa Rica Provee* programme on labour demand
(Propensity score matching, fixed effects and cluster-robust standard errors)

Variable	(1) propensity score matching and fixed effects	(2) propensity score matching and fixed effects	(3) propensity score matching and fixed effects	(4) propensity score matching and fixed effects	(5) parallel pre-treatment trends test
D_t (dummy equal to 1 if firm was treated in year t and 0 if never treated)	0.0958***	0.0984***			0.0913***
	(0.0305)	(0.0299)			(0.0328)
$D_t - 1$ (treatment dummy lagged one year)		0.1117***			
		(0.0343)			
$D_t - 2$ (treatment dummy lagged two years)		0.0829**			
		(0.0350)			
D_timing_t (dummy equal to 1 from the first year the firm was treated and so on successively, 0 if never treated)			0.2081***		
			(0.0461)		
D_dosage_t (dummy equal to 1 for all years from the first year the firm was treated until the year before the second treatment, 2 from the second year the firm was treated until the year before the third treatment and so on, 0 if never treated)				0.1062***	
				(0.0217)	
PD_1 (pre-treatment dummy equal to 1 for the first year before the firm was treated and 0 if never treated)					0.0058
					(0.0520)
PD_2 (pre-treatment dummy equal to 1 for the second year before the firm was treated and 0 if never treated)					0.0023
					(0.0381)
PD_3 (pre-treatment dummy equal to 1 for the third year before the firm was treated and 0 if never treated)					-0.0770*
					(0.0409)
Constant	2.3123***	2.3097***	2.3054***	2.3065***	2.3127***
	(0.0005)	(0.0011)	(0.0019)	(0.0015)	(0.0009)
Observations	12 450	12 450	12 450	12 450	12 450
R-squared	0.0009	0.0025	0.0045	0.0052	0.0011
Number of observations	1 626	1 626	1 626	1 626	1 626

Source: Prepared by the authors.
Note: *Statistically significant at 10%; **statistically significant at 5%; ***statistically significant at 1%.

4. The impact of Costa Rica Provee on the probability of exporting

The results obtained with equation (6) for the impact of *Costa Rica Provee* on the probability of exporting are presented in tables 7 and 8. Table 7 shows the results of the analysis using a linear probability model with only the fixed effects approach. The data in column 1 of table 7 show that the coefficient associated with the treatment dummy (D_t) is positive and significant (0.0315), indicating that the participation of SMEs in the *Costa Rica Provee* programme increases the probability of exporting for beneficiary firms as compared to firms in the control group. In addition, participation in *Costa Rica Provee* seems to have an impact on the export performance of beneficiary firms not only in the year they receive the treatment but also two years later. The coefficients associated with these effects are positive and significant (0.0372 and 0.0942, respectively), as shown in column 2 of table 7.

Table 7
Impact of the *Costa Rica Provee* programme on the probability of exporting: linear probability model
(Fixed effects and cluster-robust standard errors)

Variable	(1) fixed effects	(2) fixed effects	(3) fixed effects	(4) fixed effects
D_t (dummy equal to 1 if firm was treated in year t and 0 if never treated)	0.0315*	0.0372**		
	(0.0171)	(0.0170)		
$D_t - 1$ (treatment dummy lagged one year)		0.0046		
		(0.0164)		
$D_t - 2$ (treatment dummy lagged two years)		0.0942***		
		(0.0191)		
D_timing_t (dummy equal to 1 from the first year the firm was treated and so on successively, 0 if never treated)			0.0613***	
			(0.0174)	
D_dosage_t (dummy equal to 1 for all years from the first year the firm was treated until the year before the second treatment, 2 from the second year the firm was treated until the year before the third treatment and so on, 0 if never treated)				0.0585***
				(0.0123)
Constant	0.0981***	0.0969***	0.0962***	0.0948***
	(0.0003)	(0.0005)	(0.0007)	(0.0008)
Observations	26 062	26 062	26 062	26 062
R-squared	0.0005	0.0035	0.0020	0.0068
Number of observations	4 625	4 625	4 625	4 625

Source: Prepared by the authors.
Note: *Statistically significant at 10%; **statistically significant at 5%; ***statistically significant at 1%.

Another interesting result from this exercise is that the longer a firm has been treated, the greater the impact on its probability of exporting. The coefficient associated with the dynamic effect of intervention (D_timing), shown in the third column of table 7, is positive and significant (0.0613). In addition, it seems that the more times a firm participates in the *Costa Rica Provee* programme, the more its probability of exporting increases. The coefficient associated with the dosage treatment variable (D_dosage) is positive and significant (0.0585). In other words, it seems that the greater the number of linkages with multinational corporations created by this programme for beneficiary firms, the greater their probability of placing their products in international markets.

When the propensity score matching and fixed effects approaches are used together to estimate the impact of *Costa Rica Provee* on the probability of exporting by beneficiary firms, the results are similar to those obtained when only the fixed effects approach is used, although these new results are more robust than those shown in table 7. Thus, as shown in table 8, all the coefficients associated with treatment variables (D_t, D_timing and D_dosage) turn out to be positive and significant in this case (0.0485, 0.0891 and 0.0676, respectively), confirming the importance of SMEs' participation in the *Costa Rica Provee* programme for improving their probability of exporting.

Finally, we tested whether the parallel pre-treatment trend assumption was valid and found that using fixed effects was an invalid approach in this case. In fact, the results for all the coefficients associated with pre-treatment variables ($PD\_$) in column 5 are significant, except in the case of PD_3, where the coefficient is very significant. For this reason, we estimate a propensity score matching with a least squares dynamic model, the results of which are presented in column 6. The coefficient associated with the treatment variable (D) in this specification is positive and significant (0.0586), so we can conclude that firms' participation in *Costa Rica Provee* has a positive and significant impact on the probability of exporting, with the probability of exporting being 5.9 percentage points higher for a treated firm than for an untreated firm.

Table 8

The impact of the *Costa Rica Provee* programme on exports: linear probability model

(Propensity score matching, fixed effects, least squares dynamic and cluster-robust standard errors)

Variable	(1) propensity score matching plus fixed effects	(2) propensity score matching plus fixed effects	(3) propensity score matching plus fixed effects	(4) propensity score matching plus fixed effects	(5) parallel pre-treatment trends test	(6) propensity score matching plus dynamic least squares
D_t (dummy equal to 1 if firm was treated in year t and 0 if never treated)	0.0471	0.0485*			0.0428	0.0586**
	(0.0290)	(0.0285)			(0.0295)	(0.0233)
$D_t - 1$ (treatment dummy lagged one year)		-0.0071				
		(0.0271)				
$D_t - 2$ (treatment dummy lagged two years)		0.1111***				
		(0.0263)				
D_timing_t (dummy equal to 1 from the first year the firm was treated and so on successively, 0 if never treated)			0.0891***			
			(0.0291)			
D_dosage_t (dummy equal to 1 for all years from the first year the firm was treated until the year before the second treatment, 2 from the second year the firm was treated until the year before the third treatment and so on, 0 if never treated)				0.0676***		
				(0.0190)		
PD_1 (pre-treatment dummy equal to 1 for the first year before the firm was treated and 0 if never treated)					0.0138	
					(0.0344)	
PD_2 (pre-treatment dummy equal to 1 for the second year before the firm was treated and 0 if never treated)					0.0039	
					(0.0277)	
PD_3 (pre-treatment dummy equal to 1 for the third year before the firm was treated and 0 if never treated)					-0.0876***	
					(0.0310)	

Table 8 (concluded)

Variable	(1) propensity score matching plus fixed effects	(2) propensity score matching plus fixed effects	(3) propensity score matching plus fixed effects	(4) propensity score matching plus fixed effects	(5) parallel pre-treatment trends test	(6) propensity score matching plus dynamic least squares
exp_{t} – 1 (export variable lagged one year)						0.5454***
						(0.0236)
exp_{t} – 2 (export variable lagged two years)						0.2561***
						(0.0299)
exp_{t} – 3 (export variable lagged three years)						0.1158***
						(0.0212)
Constant	0.1166***	0.1154***	0.1138***	0.1127***	0.1170***	0.0172***
	(0.0005)	(0.0009)	(0.0012)	(0.0013)	(0.0006)	(0.0014)
Observations	12 450	12 450	12 450	12 450	12 450	12 450
R-squared	0.0009	0.0048	0.0036	0.0091	0.0023	0.0533
Number of observations	1 626	1 626	1 626	1 626	1 626	1 626

Source: Prepared by the authors.
Note: *Statistically significant at 10%; **statistically significant at 5%; ***statistically significant at 1%.

VI. Analysis and conclusions

This study has attempted to help close the knowledge gap by assessing the impact of one specific programme (*Costa Rica Provee*) that promotes backward linkages between multinationals and local firms (SMEs) in a developing country, namely Costa Rica. Impacts were estimated on the assumption that beneficiary firms were trying to maximize their profits and that *Costa Rica Provee* aimed to increase these firms' productivity, and three performance variables were taken: real average wages, labour demand and the probability of exporting.

The *Costa Rica Provee* programme was found to have positive and significant impacts on the performance of beneficiary firms, specifically on their real average wages, labour demand and probability of exporting. Average wages paid by firms treated by *Costa Rica Provee* were found to be higher than those paid by untreated firms (0.04) and labour demand was found to be higher than at untreated firms (0.10). These benefits were observed up to two years beyond the initial year in which firms participated in the programme. The amount of time elapsing from the initial participation in *Costa Rica Provee* also had a positive impact on the performance of beneficiary firms, as did the number of times that SMEs were able to generate linkages with MNCs. The probability of exporting was found to be about 5.9 percentage points higher for a treated firm than for an untreated firm.

While earlier evaluations of SME programmes were pessimistic about their impacts, recent studies have found positive impacts of programme participation on intermediate outcomes but mixed results for impacts on firm performance (López-Acevedo and Tan, 2010). Our study points to positive impacts on firm performance.

This finding is in line with the result obtained by Tan (2010) in Chile, Duque and Muñoz (2010) in Colombia and López-Acevedo and Tinajero (2010) in Mexico, as they all found positive impacts on firm performance from SME programmes that included backward linkages. The contribution of our research is the evaluation of one specific backward linkages programme. Additionally, our evidence on positive programme impacts over time adds to existing evidence from Duque and Muñoz (2010) in Colombia.

The limitations of this study are a stimulus to future research. On the demand side, it would be interesting to explore MNC characteristics such as the size and age of firms, their mode of establishment and the type and nature of their production processes. On the supply side, absorptive capacity is a matter that could be worth investigating. This combination of factors influences the nature (in terms of type, depth and quality) of linkages and can be expected to impact the outcomes of *Costa Rica Provee*. The way backward linkages are measured also matters.

Our study also suggests policy implications. As mentioned previously, success in attracting FDI does not automatically generate the benefits of backward linkages. Costa Rica has been successful in attracting FDI (World Economic Forum, 2013), but its development model has weaknesses, including limited success in tying the new economy (dynamic sectors such as MNCs) to what can be a sluggish old economy, as in the case of some SMEs. Programmes like *Costa Rica Provee* can help with this, and it is important to maintain an MNC demand-driven programme and help local suppliers rise in the value chain. Indeed, the scope of the programme could be expanded.

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Annex A1

Estimating the impact of programme participation on real wages

Let us assume a modified Cobb-Douglas production function:

$$Y = K^{\alpha} L^{1-\alpha} exp(\delta D + \varepsilon) \quad (1)$$

where Y is output, K capital, L the number of workers and D a dummy variable equal to 1 if the firm participated in the programme and 0 otherwise. The coefficient on this dummy variable allows us to test whether participation in an innovation or linkage development programme such as PROPYME or *Costa Rica Provee* affects total factor productivity.

Under a profit maximization assumption, the first-order condition tells us that:

$$PK^{\alpha}(1-\alpha)L^{-\alpha} exp(\delta D + \varepsilon) - W = 0 \quad (2)$$

Taking logs and arranging terms, we get:

$$w - p = ln(1-{}^{\alpha}) + {}^{\alpha}(k-l) + \delta D + \varepsilon \quad (3)$$

Thus, real wages depend on $(k-l)$ and total factor productivity $(\delta D + \varepsilon)$.

On the other hand, if we add a mix of workers with different qualities, we get:

$$L^* = L_1 + \theta_2 L_2 + \ldots = L(1+q) \quad (4)$$

But it is likely that labour input is the result of the services provided by workers of different qualities. Let us replace L by effective labour L^*. Then equation (2) can be expressed as follows:

$$PK^{\alpha}(1-\alpha)(L)^{-\alpha}(1+q)^{1-\alpha} exp(\delta D + \varepsilon) - W = 0 \quad (5)$$

Taking logs:

$$w - p = ln(1-\alpha) + \alpha(k-l) - (1-\alpha)ln(1-q) + \delta D + \varepsilon \quad (6)$$

Supposing that there are only two types of workers, skilled and unskilled, we have a difference in productivity θ and a premium $PREM$, so that $\theta - 1 = PREM$.

Let WO and WE be the average wages of unskilled and skilled workers and LO and LE the number of unskilled and skilled workers, respectively. The average wage of the firm can be written as:

$$W = (WO^*LO + WE^*LE)/(LO + LE) \quad (7)$$

This expression is equal to:

$$W = WO^*(1 - LE/(LO+LE)) + WE^*(LE/(LO+LE)) = WO^*(1 + (WE + WO - 1)(LE/(LO+LE)) \quad (8)$$

Let $PREM$=(1+(WE+ WO–1) be the skilled worker premium. Additionally, let us define $(LE/(LO+LE))$ as the share of skilled workers and use SE as the abbreviation for this term (i.e. $SE=(LE/(LO+LE))$). Taking logs on (7) and substituting terms, we get:

$$lnW \approx lnWO + (PREM^{*}SE) \tag{9}$$

The principal idea here is that the average wage of the firm is equal to the wage of unskilled workers plus a term that takes into account the premium charged by skilled workers times the share of this type of worker in the total number of workers.

Let $L^{*}= LO + \theta^{*}LE = L(LE/L + \theta\ LE/L)$

where $L = LO + LE$

given that $LO/L = 1–LE/L$, then:

$$L^{*}= LO(1+(\theta-1)SE) \tag{10}$$

Taking logs:

$$l^{*}=(\theta-1)SE \tag{11}$$

Therefore, from (4) we know that $(\theta-1)SE = q$.

From the discussion above, we know that when the firm is maximizing profits, we also have a premium called $PREM=\theta-1$.

$$q=(\theta-1)SE= PREM^{*}SE \tag{12}$$

This means that differences in productivity are equal to the wage premium. Substituting (12) in (6), we have:

$$w-p = ln(1-\alpha)+\alpha(k-l)-(1-\alpha)(PREM^{*}SE)+\delta D+\varepsilon \tag{13}$$

To operationalize (13), we can write:

$$(w-p)=\beta_0+\beta_1(k-l)+\beta_2(PREM^{*}SE)+\beta_3 D+\tau \tag{14}$$

As discussed in the body of this paper, equation (14) can be estimated using a combination of two techniques: fixed effects and propensity score matching. Due to problems with data availability for capital (K), we assume that fixed effects let us control the effect of $(K-l)$. Although we are assuming that the effect of the programme occurs in the same year as the intervention, we will test whether that is actually the case or whether we have to wait one or two years after the firm received the treatment to see any effect. This is the reason for including lags for variable D.

For the purposes of estimation, equation (14) can be expressed as follows:

$$(w-p)_{it}=\beta_0+\beta_1(PREM^{*}SE)_{it}+\beta_2 D_{it}+\beta_3 D_{it\text{-}1}+\beta_4 D_{it\text{-}2}+\varepsilon_{it} \tag{15}$$

Finally, given data availability constraints, we use as a proxy for $PREM^{*}SE$ the ratio between the firm’s average wages and the industry’s average wages for each year included in the analysis, all of them in nominal values.

Annex A2

Estimating the impact of programme participation on labour demand

Let us assume a modified Cobb-Douglas production function:

$$Y = K^{\alpha} L^{1-\alpha} exp(\delta D + \varepsilon) \tag{1}$$

where Y is output, K capital, L the number of workers and D a dummy variable equal to 1 if the firm participated in the programme and 0 otherwise. In this formulation, participation in an innovation or linkage development programme such as PROPYME or *Costa Rica Provee* might affect total factor productivity.

From the first-order conditions of profit maximization, and taking logs, we get:

$$p + \alpha k + ln(1-\alpha) - \alpha l + \delta D + \varepsilon - w = 0 \tag{2}$$

where p is the price of the output produced by the firm (in logs).

Arranging terms, we have:

$$\begin{gathered} l = \frac{p}{\alpha} + \frac{\alpha k}{\alpha} + \frac{ln(1-\alpha)}{\alpha} + \frac{\delta D + \varepsilon}{\alpha} + \frac{w}{\alpha} \\ l = \frac{1}{\alpha} p + k + \frac{1}{\alpha} ln(1-\alpha) + \frac{1}{\alpha}(\delta D + \varepsilon) - \frac{1}{\alpha} w \\ l = \frac{1}{\alpha} ln(1-\alpha) + k - \frac{1}{\alpha}(\delta D + \varepsilon) \end{gathered} \tag{3}$$

As discussed in the main body of this paper, equation (3) can be estimated using a combination of two techniques: propensity score matching and fixed effects. Due to problems with data availability for capital (K), we assume that fixed effects let us control the effect of this variable.Once again, we assume that the effect of the programme arises in the same year as the intervention, but also test to determine whether this is actually the case or whether we have to wait one or two years after the firm received the treatment to see any effect. This is the reason for including lags for variable D. Thus, equation (3) can be expressed as follows:

$$l_{it} = \gamma_0 - \gamma_1 (w-p)_{it} + \gamma_2 D_{it} + \gamma_3 D_{it-1} + \gamma_4 D_{it-2} + \sigma_{it} \tag{4}$$

Annex A3

Variable definitions (in alphabetical order)

Chemicals: Dummy variable taking the value 1 if the firm has economic activity in chemicals and 0 otherwise.

Employment: Number of employees hired by the firm per year.

Exports (t): Dummy variable taking the value 1 if the firm has exported during year t and 0 otherwise.

Geographic location: Dummy variable taking the value 1 if the firm is located in province i of Costa Rica (San José, Cartago or Heredia) and 0 otherwise. We take six of the seven provinces in Costa Rica (Alajuela, Cartago, Guanacaste, Heredia, Puntarenas and San José).

Legal status: Dummy variable taking the value 1 if the firm is legally registered as a commercial entity and 0 otherwise.

Lithographic: Dummy variable taking the value 1 if the firm engages in lithographic processes and 0 otherwise.

Manufacturing: Dummy variable taking the value 1 if the firm engages in manufacturing and 0 otherwise.

Wages or salaries in real terms: Total amount of wages and salaries paid by the firm per year, deflated by the industrial price index at the two-digit level of the Standard Industrial Classification (SIC) in the case of manufacturing firms and by the consumer price index otherwise to obtain real wages.