

Foreign direct investment in developing economies

A study on the productivity spillover effects in Latin America

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Abstract

Purpose – The aim of this study was to investigate how the productivity spillover effects of foreign direct investment (FDI) in the Latin American economies are manifested. Specifically, the paper sought to identify the role of foreign presence and government intervention through an industrial policy on total factor productivity in Latin American countries.

Design/methodology/approach – The analyses in this study were performed in two stages. The first step consisted of decomposing the total factor productivity growth, in technical efficiency change (EC) and technological efficiency change (TC), using the Malmquist Productivity Index (MPI). In the second stage of this research, the specific EC and TC indexes of each country – obtained with the MPI – are used alternately as a dependent variable in a regression analysis with dynamic panel data. The variables were collected from the World Development Indicators database, available in the World Bank database, and cover the period from 1994 to 2014.

Findings – FDI has contributed to not only the catch-up effect – i.e. to continuous improvements in production processes and products using the same technology – but also in terms of productivity, due to technological innovations and the frontier-shift effect. Industrial policies, such as the FDI attraction, when established in isolation, are not able to contribute to the generation of productivity spillovers, measured in terms of technical and technological efficiency.

Research limitations/implications – The limitation of the present study lies precisely in the nature of data aggregation that actually limits a more in-depth analysis of the object of study. The available data set for the analysis in this study does not provide a detailed examination of the domestic corporations' characteristics, the sectors and motivations of multinational corporations of each one of the analyzed economies.

Practical implications – The outcomes of this research present several practical implications, as its development is based on the recognition that productivity is essential for the development of a country. It remains the Achilles' heel of the Latin American economies, and therefore, it is necessary and essential to move toward a change in its development model and, more specifically, in its industrial policies, with a focus on investment and innovation to achieve the new sustainable development objectives. Among the main challenges presented to governments in the region is the emergence of policies aimed at establishing a sustainable development path through industrial policies capable of accelerating productivity growth.



Social implications – The evidence presented in this study highlights the importance of better understanding the real effects of state intervention through the use of industrial policy instruments and how they affect foreigners' investment decisions, as the lack of clear industrial policy orientation that is systematically integrated with MNEs' operations may result in economic development opportunities below the ideal.

Originality/value – The research results corroborate the foundations of spillover effects theory and with the recognition that the intensity of the effect of the foreign participation on the performance of economies will depend on the absorption capacity of host economies.

Keywords Spillover effects, Latin American countries, Foreign direct investment, Total factor productivity

Paper type Research paper

1. Introduction

Spillover effects arising from foreign direct investment (FDI) are generated by non-commercial transactions involving multinational corporations (MNCs), particularly when knowledge spills over domestic corporations (DCs) in the host country without a contractual relationship (Buckley, Clegg, & Wang, 2010; Meyer, 2004). These beneficial effects are related to efficiency gains that stem from pro-competitive effects, the adoption of superior technologies and management practices and technology transfer that occurs when the presence of foreign companies provides advanced technology access to DCs (Buckley, Clegg, Zheng, Siler, & Giorgioni, 2010).

This international capital movement, which takes place through FDI and MNC operations, represents a physical and human capital movement, as well as the transfer of ideas, technologies and even culture, which are potentially subjected to national policies formulated by governments and that potentially affect the ability of trade and investment of DCs beyond the geographical borders of their countries of origin (Narula, 2014). It is a movement inherent to capitalist competition and is an important strategic tool for competitiveness in globalized environments. For this reason, it has received special attention from researchers who are concerned about the effects of MNC operations, especially in developing countries.

The present study aimed to answer the following research question:

RQ1. How do the productivity spillover effects of FDI in the Latin American economies are manifested?

The aim of the present study was to investigate how the productivity spillover effects of FDI in the Latin American economies are manifested. Specifically, the article sought to identify the role of foreign presence and government intervention through an industrial policy on total factor productivity (TFP) in Latin American countries, which was divided into technical efficiency change (EC) and technological efficiency change (TC).

The central element underlying this analysis is based on the identification that capital investment – encompassing physical and human capital – generates effects of positive externalities or spillovers that increase the productive capacity of companies, contributing not only to the increase of their own productive capacity but also of other DCs. In this study, TFP was broken down into technical efficiency components – which corresponds to the movements of an economy toward the production frontier – and the component that identifies technical progress – which refers to the frontier shift.

The development of this research was based on the recognition that the accumulation of physical capital is not capable of sustaining the growth for long periods due to the decreasing yields. Therefore, the TFP arises as a measure of the most efficient use of inputs

that reflects the evolution and economic prosperity in the long-term, suggesting a greater influence of human capital, in which technological variation and new knowledge assume a central role in the process of capital accumulation and long-term growth (Marinho & Bittencourt, 2007).

Given the growing share of FDI in developing economies, it is important to understand whether these foreign capital flows have actually contributed as a boost to the TFP improvement in Latin American economies. The choice of these countries as an object of study is particularly relevant in the current economic context and in the context of international technology diffusion, as even considering that they are heterogeneous economies, their distinct characteristics and dynamics enable the creation of a relevant comparative table.

2. Foreign direct investment and spillover effects

In recent decades, developing countries have established a number of policies aimed at promoting the opening of their protected national markets to international trade and FDI (Narula, 2014). Since then, FDI attraction policies have become a priority on the developing country policy agenda, especially because it is considered a potential source of new jobs and capital injections in the domestic economy, which usually is accompanied by new technologies and innovation (Newman, Rand, Talbot, & Tarp, 2015).

Thus, according to Cohen (2007), there are at least four distinct ways to understand FDI:

- (1) It comprises the corporate activities that confer multinational character to certain companies.
- (2) It also comprises financial activities, consisting of an international capital flow that goes from the country of origin to the host country, for the purpose of acquiring partial or total ownership of a tangible entity, such as factories, facilities, or distribution systems.
- (3) It is the generic term used to designate the economic policies that governments establish and that are directed to MNEs and international investment flows.
- (4) Is the generic term used by official statistics agencies to measure, in monetary terms, the annual inflow and outflow, as well as the stock of direct investments on a basis that can be used for cross-country comparison purposes.

FDI is an important channel for international diffusion of advanced technology and capital transfer across national boundaries (Mao and Yang, 2016). FDI spillovers result from market operations in which resources – and especially knowledge – spillover DCs without any contractual relationship (Meyer, 2004).

In the literature about FDI spillovers, it is argued that MNEs that establish subsidiaries in other countries are different from the host economy's EPLs for two main reasons:

- (1) The first is that they bring superior knowledge about foreign markets and certain technological properties that are their specific advantages, which allow them to compete with other MNEs and local firms that generally have a better knowledge of the local market and consumer preferences; and
- (2) The second reason is that the entry or presence of multinationals alters the existing market equilibrium, forcing local firms to become more efficient in protecting their market share and profits (Bruhn & Calegario, 2014; Blomström & Kokko, 1998).

Evidences from studies (Griffith, Redding, & Reenen, 2004; Suyanto & Salim, 2010; Tomohara & Taki, 2011) suggest that the FDI impact on TFP at aggregate and industry

level may be different from that found at the individual company level. In the analysis at the industry level, FDI produces mainly indirect spillovers on the DC productivity, as the entry of foreign companies tends to force them to upgrade their technologies and management ability to remain competitive.

This discussion gives rise to the following hypothesis:

- H1.* There is a direct relationship between the FDI inflows and the productivity of Latin American economies, measured in terms of EC and TC.

Industrial policies can enhance the FDI effects whether, e.g. they are capable of enhancing not only horizontal and vertical linkages (forward and backward) involving MNCs and DCs in a given supply chain but also the spillover effects from operations of unrelated MNCs.

The positive effects of foreign presence can occur through the establishment of linkages when, e.g. there is an increase in the number of MNCs that results in a greater variety of intermediate goods produced locally, and as MNCs are only able to buy more inputs locally if they are locally produced, the chaining effect would increase with the variety of intermediate goods produced locally, resulting in an increased demand for upstream goods which in turn would induce firms not only upstream but also downstream (Pack & Saggi, 2006).

Dunning and Lundan (2008) argue that the greater the degree of synergies among the different stages of the value chain, the more likely firms are to engage in backward linkages, whereas it may be relevant to the MNC subsidiary to help the supplier improve the quality of their products or increase their productivity (Dunning & Lundan, 2008). In these specific cases, the lack of capability to establish linkages could be offset by specific policies, such as those formulated to assist industries involved in intermediate activities, as they have a strong potential for creating linkages between DCs and MNCs both backwards and forwards (Pack & Saggi, 2006).

It is also possible that DCs that are not directly related to MNC upstream may experience spillover effects through indirect relationships. Indirect spillover effects may also occur whether the increased foreign presence enhances competitive pressures in the industry, forcing local suppliers to eliminate inefficiencies in the production process or to use their inputs more efficiently to survive in the market (Newman *et al.*, 2015).

In fact, it is also possible that the relationship with MNCs in upstream sectors can generate negative externalities. For instance, where there are direct linkages between MNCs and domestic suppliers, it is possible that MNCs have more bargaining power in contract negotiation, resulting in lower profits and productivity losses for DCs (Newman *et al.*, 2015). To have positive backward externalities, policies need to be focused on meeting at least one precondition, i.e. that domestic suppliers be able to produce input varieties similar to the MNC input requirements. In contrast, the DCs may experience negative externality impacts whether they try to supply inadequate inputs for the MNC (Newman *et al.*, 2015; Rodriguez-Clare, 1996).

Thereby, based on these considerations, it is possible to state that:

- H2.* Industrial policies, such as the attraction of FDI, when established individually, are unlikely to generate productivity spillover effects in the form of technical and technological change for Latin American countries.

The fundamentally recognized reason for government intervention in the economy is the existence of the so-called market failures. However, the justifications for industrial policies go beyond the argument of market failure and incorporate dynamic factors, such as systemic failures related to the generation of learning opportunities, training,

experimentation and innovation, besides the incorporation of technical and technological changes for production diversification and export activities (Devlin, 2009).

According to Rodrik (2008), markets may not work well, whether with high or little government interference. According to the author, the omission of governments – the required interventions that were not offered – is partly a reaction to the strong emphasis placed on them when adopting previous import substitution policies such that more recently governments around the world have begun to seek a more balanced strategy, as market liberalization and privatization processes have also failed to deliver the expected performance in developing economies.

The different moments and intensity of government intervention, through an industrial policy in Latin American countries, are presented in the previous section. It is believed that these periods and different intensities of government intervention in Latin American economies through industrial policies can also have different effects on the productivity of countries of the region.

Thereby, based on these considerations, it is possible to state that:

- H3.* The different periods of government intervention, through industrial policies in Latin American countries, contributed to their productivity, measured in terms of EC and TC.

The literature on the spillover effects supports the premise that not all host economies have the capacity to exploit the advantages of FDI ownership because they simply do not have the absorptive capacity (Cohen and Levinthal, 1990). The concept of development, based on the assisted FDI, requires that DCs have the capacity to assimilate and apply a new knowledge and argues that where the DCs are in competition with the MNCs, they must have the capability to learn and to benefit from the presence of MNCs (Narula and Driffeld, 2012).

For Cohen and Levinthal (1990), the absorptive capacity of companies represents the ability to recognize the value of a new knowledge, the ability to assimilate it and to apply it, based on commercial purposes; such absorptive capacity is essential to the technological performance of EPLs and an essential condition for them to be able to absorb such knowledge or spillovers.

Wang, Liu, Cao, and Wang (2016) argue that the absorption capacity of EPLs includes the degree of regional innovation, education level, financial market development, economic development, the amount of human capital, as well as the level of technological gap in the market.

Absorptive capacity depends largely on the technological capabilities of the DCs and their operating sectors in the host economies (Rugman & Verbeke, 2001). Blomstrom, Globerman, and Kokko (2001) argue that the technical capability of domestic firms increases the probability of positive spillovers, and thus a lower technological gap between foreign and domestic firms would result in greater productivity gains.

Based on these findings, the following research hypothesis was constructed:

- H4.* The productivity spillover effects, in the form of technical and technological change, depend on the absorptive capacity of the DCs from the host economy.

3. Methodology

The analyses in this study were performed in two stages. The first step consisted in decomposing the TFP growth, in EC and TC, using the Malmquist Productivity Index (MPI). In the second stage of this research, the specific EC and TC indexes of each country –

obtained with the MPI – are used alternately as a dependent variable in a regression analysis with dynamic panel data.

In the first stage of the research, data envelopment analysis (DEA), a non-parametric analytical technique, was used to examine the relative efficiency of a particular DMU (Decision Making Unit). The construction of the analysis model was based on [Fare, Grosskopf, Norris, and Zhang, \(1994\)](#) and [Aik, Hassan, Hassan, and Mohamed \(2015\)](#). The DEA model of this study is input-oriented, assuming constant returns to scale (CRS). The DEA analysis was done year by year, considering, for each year of analysis, the DMUs under analysis. The analyses were performed using the statistical program PINDEA.

The MPI is the product of the change in relative efficiency (EC) and change in technology (TC). The decomposition process of the [Malmquist \(1953\)](#) Index can be represented, conforming to [Ferreira and Gomes \(2009\)](#), according to the following specifications.

Assuming, initially, a single product Y as a function of a single input X , such that:

$$PTF_{t,t+1} = \frac{Y_{t+1}/X_{t+1}}{Y_t/X_t} \quad (1)$$

Considering that the relations between inputs used and the maximum potential product in t and $t + 1$ are represented by the functions $f_t(X)$ e $f_{t+1}(Y)$, the observed product is defined in terms of a production function so that:

$$Y_t = \lambda_t f_t(X_t), \text{ onde } 0 \leq \lambda_t \leq 1 \quad (2)$$

Values of λ_t smaller lower than 1 suggest that the production unit is technically inefficient. Substitution of [equation \(2\)](#) in [equation \(1\)](#) gives:

$$PTF_{t,t+1} = \frac{\lambda_{t+1}}{\lambda_t} \left[\frac{f_{t+1}(X_{t+1})/X_{t+1}}{f_t(X_t)/X_t} \right] \quad (3)$$

Considering that input levels are different between two consecutive periods, we can express the input stock in a period $t + 1$ as a function of the stock of period t , as $X_{t+1} = k X_t$, so that if the quantity of input at $t + 1$ is higher than at t , k will be higher than 1. Considering that the production function is homogeneous of degree ε_{t+1} , in X_{t+1} , then we rewrite (3) as follows

$$PTF_{t,t+1} = \frac{\lambda_{t+1}}{\lambda_t} \left[\frac{f_{t+1}(kX_t)/kX_t}{f_t(X_t)/X_t} \right] = \left[\frac{\lambda_{t+1}}{\lambda_t} \right] [k^{\varepsilon_{t+1}-1}] \left[\frac{f_{t+1}(X_t)}{f_t(X_t)} \right] \quad (4)$$

Therefore, in [equation \(4\)](#), a complete decomposition of TFP is presented:

- The first term represents the variation of the technical efficiency.
- The second term represents the effect of the change in the production scale.
- The third term measures the technological change.

The decomposition of the MPI also requires the understanding of two other concepts: the production possibility set and the distance function. The production possibility set represents the set of all product vectors $Y \in \mathbb{R}_+^M$, which can be produced using the vector of inputs $X \in \mathbb{R}_+^N$, so that $P(X) = \{Y: X \text{ may produce } Y\}$ is the set of all combinations of inputs and feasible products.

The product-oriented Malmquist Index requires the identification of the function distances in two different time periods:

$$D_0^t(X^{t+1}, Y^{t+1}) = \min \left(\delta: (X^{t+1}, Y^{t+1} / \delta) \in P^t(x) \right) \quad (5)$$

$$D_0^{t+1}(X^t, Y^t) = \min \left(\delta: (X^t, Y^t / \delta) \in P^{t+1}(x) \right) \quad (6)$$

Thus, [equation \(5\)](#) measures the maximum proportional variation of the product vector necessary to make (X^{t+1}, Y^{t+1}) feasible with respect to the technology at t , while [equation \(6\)](#) measures the maximum proportional variation of the product vector needed to make (X^t, Y^t) feasible in relation to the technology at $t + 1$. Considering the reference technology of period t , the Malmquist Index can be defined as:

$$M_0^t = \frac{D_0^t(X^{t+1}, Y^{t+1})}{D_0^t(X^t, Y^t)} \quad (7)$$

With the reference technology of period $t + 1$, then the index can be defined as:

$$M_0^{t+1} = \frac{D_0^{t+1}(X^{t+1}, Y^{t+1})}{D_0^{t+1}(X^t, Y^t)} \quad (8)$$

The Malmquist Index is obtained by the geometric mean of the indices of [equations \(7\)](#) and [\(8\)](#):

$$M_0(x^{t+1}, Y^{t+1}, X^t, Y^t) = \left[\left(\frac{D_0^{t+1}(X^{t+1}, Y^{t+1})}{D_0^{t+1}(X^t, Y^t)} \right) \left(\frac{D_0^t(X^{t+1}, Y^{t+1})}{D_0^t(X^t, Y^t)} \right) \right]^{1/2} \quad (9)$$

Therefore, the decomposition of the Malmquist index, representing the product of the catch-up effect by the displacement of the frontier-shift effect, as suggested by [Fare et al. \(1994\)](#), can be represented by:

$$M_0(Y_{t+1}, Y_t, X_{t+1}, X_t) = \left[\frac{d_0^{t+1}(Y_{t+1}, X_{t+1})}{d_0^t(Y_t, X_t)} \right] \left[\frac{d_0^t(Y_{t+1}, X_{t+1})}{d_0^{t+1}(Y_{t+1}, X_{t+1})} \times \frac{d_0^s(Y_s, X_s)}{d_0^{t+1}(Y_t, X_t)} \right]^{1/2} \quad (10)$$

Where the first term in equation (10) measures the relative efficiency variation or the catch-up effect, that is the variation of how far the observed output is from the maximum potential product between periods t and $t + 1$. The second term measures the effect of technology shift (frontier-shift effect) between the two periods evaluated in X_{t+1} and X_t .

According to [Ferreira and Gomes \(2009\)](#), the catch-up effect is the result of continuous improvements in production processes and products that use the same technology. Advances in productivity may also result from frontier-shift effects. Thus, in addition to the pairing effect (EC), there may be a shift of the efficiency frontier (TC) resulting from the introduction of more advanced technologies ([Ferreira and Gomes, 2009](#)). That is, $EC > 1$ represents an improvement in terms of technical efficiency in period $t + 1$, but $EC < 1$

indicates that the DMU moved away from the efficiency frontier in period $t + 1$, while $EC = 1$ indicates that there is no change in period $t + 1$ compared to period t . The reasoning for TC is similar, that is, $TC > 1$ indicates that there was a shift of the efficiency frontier – the result of technological innovations – toward more efficient levels of outputs in period $t + 1$ compared to period t ; $TC = 1$ indicates that there was no change in period $t + 1$ when compared to period t ; and $TC < 1$ indicates that there was a shift of the efficiency frontier toward less efficient levels of outputs in period $t + 1$ compared to period t .

The consistency of the MPI, with the notion of average product or productivity, assumes constant returns to CRS scale (Aik *et al.*, 2015; Malquimist, 1953; Odeck, 2008). According to Aik *et al.* (2015), TFP growth would lead the economy to a higher production frontier, with more efficient use of inputs, and occurs because TFP is considered an important source of long-term sustainable economic growth.

3.1 Procedures for estimating the generalized method of moments

In the second step of the present research, following Javorcik and Lie (2013), Javorcik and Spatareano (2011) and Suyanto and Salim (2010), the country-specific EC and TC indexes obtained with the MPI are used alternately as a dependent variable in a regression analysis with panel data. The dynamic linear panel model can be represented, based on Arellano and Bond (1991), as follows:

$$PTF_{it} = \alpha Y_{i,t-1} + \beta' X_{it} + \eta_i + \nu_{it} \quad (11)$$

Here, Y_{it} is the dependent variable for the cross-section unit i in the period t ; X_{it} is a vector $1 \times k$ of independent variables, observed for units i in the period t and represent the internal structural conditions, international insertion and government interventions; β is a vector of parameters $k \times 1$; η_i is the specific unobservable effect; and ν_{it} is the random term. According to the specification, the dynamic panel regression is differentiated in the first order, which results in an equation with no fixed effects.

The generalized method of moments (GMM) model with corrected standard error, or GMM-System, is an extension of the original method developed by Arellano and Bond (1991), which addresses the endogeneity problem created by the inclusion of lagged dependent variables as covariates, treating the model as a system of equations, with an equation for each moment in time. The main idea of the differential estimator is to eliminate the individual effect through differentiation. The equation with the first differentiation can be represented as follows:

$$\Delta Y_{it} = \alpha \Delta Y_{i,t-1} + \beta' \Delta X_{it} + \Delta \nu_{it} = \gamma' W_{it} + \Delta \nu_{it} \quad (12)$$

The error term in equation (11) is, by construction, autocorrelated and correlated with the lagged dependent variable; thus, an estimator that considers both issues becomes necessary.

Endogeneity problem is solved by considering that all values of $Y_{i,t-k}$, with $k > 1$, can be used as instruments for $\Delta Y_{i,t-1}$.

A potential limitation in the Arellano-Bond estimator was revealed in Arellano and Bover (1995) and Blundell and Bond (1998). The authors have identified that lagged variables are often weak instruments for differentiated variables, especially if the variables are close to a random walk. The contribution of those authors was to present a modification of the estimator including lagged levels as well as lagged differences. The initial estimator is known as Difference-GMM, while the expanded estimator is called System-GMM.

To mitigate this potential problem of bias and imprecision associated with the usual GMM difference estimator, a dynamic panel was estimated. Thus, the dynamic panel models use the System-GMM method, which complements the differentiated data (with lagged levels used as instruments) with level data (using lagged differences as instruments).

3.2 Source and description of variables

The econometric model of productivity spillover analysis was based on TFP. The TFP estimation was performed by fitting the production function, defined as the relationship between the inputs of the productive process and the resulting product. The following variables were used:

- gross domestic product (constant), representing the outputs; and the following input variables;
- gross fixed capital formation (constant), representing the capital input;
- labor force (total), representing the labor input; and
- high-technology exports (current in US dollars), representing the technology input.

The variables included in the econometric model to represent the external insertion of Latin American countries are: High-technology exports and international trade. The internal structural conditions are represented by the variables: FDI inflows and gross fixed capital formation. The variables high-technology exports, international trade and gross fixed capital formation were included in the model as control variables. These variables were collected from the World Development Indicators database, available in the World Bank database and cover the period from 1994 to 2014 ([The World Bank, 2016](#)).

Two other variables of interaction with the foreign presence variable were included in the model. Interactions among variables are used to demonstrate the effect of a given variable, depending on the moderating effect of another variable. They are FDI inflows \times gross fixed capital formation and FDI inflows \times high-technology exports. These interaction variables were constructed to capture the effect of the countries' absorptive capacity.

Government intervention is represented by the dummy variable that characterizes the post-global financial crisis period, from 2008 until 2014, characterized by a rapid recovery of most economies in the region. Government intervention in this period – in response to the crisis – is based on the implementation of countercyclical fiscal and monetary policies that sought to relieve the impact of crisis on economic activity in the region. The post-2008 period marks a new phase for Latin American countries termed “guarded globalization” by [Bremmer \(2014\)](#), i.e. a more wary globalization in which the governments of developing countries have become more zealous when opening their industries for MNCs, according to local interests.

Latin American countries included in the sample are those belonging to the group of Latin American countries classified as upper-middle-income and high income countries, according to World Bank's analytical classifications, based on the per capita GDP of the countries participating in the Regulating FDI in Latin America survey, published by the World Bank. They are as follows: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru and Venezuela.

[Table I](#) presents a description of selected variables, for the period of analysis, covering the years 1994-2014. The analyses in this study were performed using GRETLL (Gnu Regression, Econometrics and Time-series Library) statistical software.

Table I.
Description of
selected variables

Variable	Description
Gross Fixed Capital Formation	Growth rate of gross fixed capital formation, represented by land improvements; facilities, machinery and equipment purchase; and construction of roads, railways and similar, schools, offices, hospitals, private residential housing and commercial and industrial buildings
FDI inflows	Growth rate of FDI inflows, represented by net investment inflows, to acquire a lasting organizational stake (10% or more of the voting capital) in a company operating in an economy other than that of the investor. Ownership of 10% or more of the common shares of the voting capital is the criterion for determining the existence of a direct investment relationship
International trade	Growth rate of international trade, represented by the sum of exports and imports of goods and services measured as a percentage of gross domestic product
High-technology exports	Rate of growth of high-technology exports of R&D intensive products, such as in the aerospace, computer, pharmaceutical, scientific instruments and electric machines, measured in terms of percentage of manufactured exports
Post-World Financial Crisis Period (2008-2014)	Post-World Financial Crisis Period. The state action in this period represents a reaction to the subprime crisis of 2008, being characterized by interventionist actions, through countercyclical fiscal and monetary policies

4. Results and discussion

To analyze spillover effects from FDI and state interventions through industrial policy, TFP values were initially calculated using Malmquist index, which is decomposed into EC and TC. The highest value found for technical change (EC) was identified for Peru, followed by Venezuela and Costa Rica (Table II). EC values greater than 1 represent improvements in technical efficiency in period $t + 1$. The minimum values of this statistic were found for Peru, Venezuela and Colombia (Table II). EC values of less than 1 indicate that the DMU has distanced itself from the efficiency frontier in period $t + 1$.

With regard to technological change (TC), the highest values of technological change were presented by Colombia and Venezuela, followed by Brazil and Ecuador. The reasoning for TC is similar, that is, these were the countries in which a greater shift of the efficiency frontier was observed, as a result of technological innovation, toward more efficient levels of outputs in period $t + 1$ compared to period t ($TC > 1$). The minimum values identified for this statistic were associated with Peru, Venezuela and Ecuador. In those countries, the greatest efficiency frontier shifts were observed, toward less efficient levels of output, in period $t + 1$ compared to period t (Table II).

Before estimating the GMM model, a Pearson correlation test was performed to determine the relationship between the analyzed variables and to identify problems associated with multicollinearity. In a complementary way, we have chosen to use the variance inflation factor (VIF) as a complementary measure of multicollinearity detection. The results indicated that there were no problems associated with multicollinearity.

To meet the requirements of robustness estimation, as argued in the methodology section, econometric estimates, based on both Difference-GMM and System-GMM estimators, are presented in Table III.

A central issue in panel data estimates is the selection of the model to be used in the regression. Two models were initially tested. Initially, a static longitudinal data analysis

Table II.
Descriptive statistics
for Technical and
Technological
Efficiency

Variable	Country	Minimum	Maximum	Mean ± Standard Deviation
TechnicalEfficiency	Argentina	0.89	1.20	1.00 ± 0.07
	Brazil	0.87	1.22	1.01 ± 0.90
	Chile	0.95	1.14	1.01 ± 0.04
	Colômbia	0.74	1.28	1.00 ± 0.08
	Costa Rica	0.75	1.33	1.01 ± 0.12
	Ecuador	0.84	1.29	0.98 ± 0.10
	México	0.88	1.20	1.00 ± 0.07
	Peru	0.50	1.85	1.03 ± 0.25
	Venezuela	0.54	1.70	1.00 ± 0.24
	Technological Efficiency	Argentina	0.94	1.10
Brasil		0.93	1.11	1.01 ± 0.09
Chile		0.94	1.01	0.98 ± 0.02
Colômbia		0.90	1.77	0.99 ± 0.01
Costa Rica		0.90	1.06	0.98 ± 0.04
Equador		0.89	1.11	0.99 ± 0.04
México		0.90	1.07	0.98 ± 0.04
Peru		0.79	1.10	0.99 ± 0.06
Venezuela		0.84	1.25	1.00 ± 0.08

Source: Search Results (2018)

Table III.
Estimates using
different estimators
for EC and TC
models for Latin
American countries
in the period from
1994 to 2014

Variables	VIF	Difference-GMM		System-GMM	
		EC	TC	EC	TC
Gross Fixed Capital Formation	3.88	-0.009	0.004	0.120***	0.065***
FDI inflows	8.64	0.023	0.021**	0.750**	0.283***
High-technology exports	8.35	0.003	-0.0001	0.014***	0.007***
Post-World Financial Crisis <i>Dummy</i>	1.21	0.017	0.027***	-0.007	-0.039
FDI* Gross Fixed Capital Formation	4.60	-0.001	-0.001**	-0.0336**	-0.012***
FDI* High-technology exports	9.79	-0.0002	-0.0003	-0.003***	-0.001***
EC _{t-1} /TC _{t-1}	-	-0.220***	-0.186***	-1.6696	-0.426
N° of groups		9	9	9	9
Sargan test		118.985 [0.285]	130.6 [0.098]	1.493 [1.000]	-1.404 [0.160]
Autocorrelation test AR(1)		-2.132 [0.033]	-2.084 [0.037]	-1.402 [0.160]	-0.8391 [0.401]
Autocorrelation test AR(2)		-1.667 [0.095]	1.594 [0.110]	-1.765 [0.077]	1.545 [1.000]

Notes: ***Significant at 1%; **significant at 5%; *significant at 10%; The *p*-values for Sargan test are presented and H₀ refers to the validity of the instruments used; VIF: variance inflation factor; values greater than 10.0 may indicate a collinearity problem

(Static Panel Data) was performed with both fixed effects and random effects; and then a dynamic longitudinal data analysis (Dynamic Panel Data) was performed. Thus, the F test proposed by [Greene \(2000\)](#) was performed, in which the null hypothesis refers to the joint significance of the fixed effect model. Evidence is contrary to the fixed effect for both the technical efficiency model (Test set in designated regressors: test statistic: F (6.144) = 1.52957 with *p*-value = P (F (6.144) > 1.52957) = 0.172501), and for the technological efficiency model (Test set in designated regressors: test statistic: F (6.144) = 1.5811 with *p*-value = P (F (6.144) > 1.5811) = 0.156697).

Then, the Breusch-Pagan test was performed, under null hypothesis of unit-specific error variance = 0. The results found for the technical efficiency model indicated the following results for the asymptotic test statistic: Breusch-Pagan – Null hypothesis: Unit-specific error variance = 0; Asymptotic test statistic: Chi-square = 2.73922 with p -value = 0.0979123. Considering a level of significance of 10 per cent, the homoscedasticity of errors hypothesis is rejected. For the technological efficiency model, the results were: Breusch-Pagan test – null hypothesis: Unit-specific error variance = 0 Asymptotic test statistic: Chi-square (1) = 2.66669 with p -value = 0.0904588. Considering a level of significance of 10 per cent, the homoscedasticity of errors hypothesis is rejected. We conclude that the estimators are inconsistent. To solve this problem, the dynamic panel, as reported in [Table III](#), is used.

The results presented in [Table III](#) refer to the estimates obtained using the Difference-GMM and System-GMM estimator for EC and TC models. The Sargan's test was used to test the validity of instruments, as well as to evaluate the robustness of estimates, by comparing the performance of the System-GMM estimator with alternative estimators, which have similar properties in dynamic panel applications. In both cases (Difference- and System-GMM), first and second order autocorrelation tests are provided, as well as the Sargan test. It is worth noting that, in the differential model, the first-order autocorrelation is not a threat to the validity of the model, but the second-order autocorrelation violates statistical assumptions.

The results indicate that the System-GMM model showed the best fit in both EC and TC models ([Table III](#)). For both, the null hypothesis that the overidentification conditions are valid was not rejected. In other words, the Sargan's test indicates that the instruments used are strong and that there is no evidence of problems associated with autocorrelation in terms of error in the models corresponding to the System-GMM. The International trade variable was removed from the analyses because it was not significant in none of the fitted models.

The results found for EC and TC models confirm $H1$, i.e. there is a direct relationship between FDI inflows and productivity of Latin American economies ([Table III](#)). These results demonstrate that FDI has contributed not only to the catch-up effect, i.e. to continuous improvements in production processes and products using the same technology, but also in terms of productivity, due to technological innovations and the frontier-shift effect.

However, the results also indicate the acceptance of $H2$ and reveal that industrial policies, such as the FDI attraction, when established in isolation, are not able to contribute to the generation of productivity spillovers, measured in terms of technical and technological efficiency.

The results suggest that, when considering the moderating effect of gross fixed capital formation and high-technology exports, the coefficients' sum still remains positive, only reducing (moderating) the spillover effect in high fixed capital or high technological content situations ([Table III](#)). These values indicate that FDI inflows, when associated with capital-intensive activities, provide lower productivity gains when compared to less intensive activities.

The results show that with regard to the moderating effect of gross fixed capital formation, EMN's ownership advantages in capital-intensive sectors limit the absorption capacity of the opportunities offered by EMNs to local firms. This relationship can be justified by the fact that MNEs' performance intensification may lead to an increase in the competition level among companies and that, in fact, local firms are not proving their capacity of competing or assimilating new knowledge in activities where MNCs have potentially greater property advantages.

Evidences show that with regard to the moderating effect of high-technology content exports, FDI benefits depend on the absorption capacity of the host economies and that a minimum level of absorption capacity is required for domestic companies to learn and obtain advantages of advanced technology and advanced management practices adopted by MNCs. Besides, domestic firms will only benefit from foreign presence whether the technological gap between MNCs and local firms is not very expressive. In other words, domestic companies may no longer benefit from foreign presence due to their limited absorptive capacity.

These results, for the variables of interaction with foreign presence, therefore confirm *H4* of the present research, in which the productivity spillover effects, in the form of technical and technological change, depend on the absorptive capacity of DCs from the host economy.

The results found for both models (EC and TC) do not confirm *H3*, in which the different government intervention periods, through industrial policies in Latin American countries – especially those that distinguish development phases outside the post-global financial crisis phase – contribute to the productivity of Latin America countries, as measured in terms of EC and TC.

5. Final considerations

The research results corroborate the foundations of spillover effects theory and with the recognition that the intensity of the effect of the foreign participation on the performance of economies will depend on the absorption capacity of host economies.

The outcomes of our research present several practical implications, as its development is based on the recognition that productivity is essential for the development of a country. It remains the Achilles' heel of the Latin American economies and, therefore, it is necessary and essential to move toward a change in the development model and, more specifically, in industrial policies, with a focus on investment and innovation to achieve the new sustainable development objectives. Among the main challenges presented to governments in the region are the emergence of policies aimed at establishing a sustainable development path through industrial policies capable of accelerating productivity growth. The evidence presented in this study highlights the importance of better understanding the real effects of state intervention, through the use of industrial policy instruments and how they affect foreigners' investment decisions, as the lack of clear industrial policy orientation that is systematically integrated with MNEs' operations may result in economic development opportunities below the ideal.

The limitation of the present study lies precisely in the nature of data aggregation that actually limits a more in-depth analysis of the object of study. The available data set for the analysis in this study does not provide a detailed examination of the DC characteristics, the sectors and motivations of MNCs of each one of the analyzed economies. Researches that identify the DC characteristics, the sectors, regions and complexity type and level of the transferred technology, besides the strategic motivations of MNCs and the influence of macroeconomic factors, are important in determining the spillover effects.

References

- Aik, N. C., Hassan, M. K., Hassan, T., & Mohamed, S. (2015). Productivity and spillover effect of merger and acquisitions in Malaysia. *Management Research Review*, 38, 320-344.
- Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, Stockholm, 58, 277-297.

- Arellano, M., & Bover, O. (1995). Another look at instrumental variables estimation of error-components models. *Journal of Econometrics, Amsterdam*, 68, 29-51.
- Blomström, M. & Kokko, A. (1998). Multinational corporations and spillovers. *Journal of Economic Survey*, 12, 247-277.
- Blomström, M., Globerman, S., & Kokko, A. (2001). The determinants of host country spillovers from foreign direct investment: Review and synthesis of the literature. In N. Pain, (Ed.), *Inward Investment Technological Change and Growth*. Palgrave Macmillan, London, 34-66.
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, Amsterdam*, 87, 115-143.
- Bremmer, I. (2014). The new rules of globalization. *Harvard Business Review*, 1, 1-15.
- Bruhn, N. C. P., & Calegario, C. L. L. (2014). Productivity spillovers from foreign direct investment in the Brazilian processing industry. *Bar - Brazilian Administration Review*, 11, 22-46.
- Buckley, P. J., Clegg, J., & Wang, C. (2010). Is the relationship between inward FDI spillover effects linear? An empirical examination of the case of China. In P. J. Buckley, (Ed.), *Foreign direct investment, China and the world economy* (pp. 192-215). London: Palgrave MacMillan.
- Buckley, P. J., Clegg, J., Zheng, P., Siler, P. A., & Giorgioni, G. (2010). The impact of foreign direct investment on the productivity of Chinas automotive industry. In P. J. Buckley, (Ed.), *Foreign direct investment, China and the world economy* (pp. 284-304). London: Palgrave MacMillan.
- Cantwell, J. A. (1989). *Technological innovation and multinational corporations* (p. 239). Oxford: Brasil Blackwell.
- Cohen, S. D. (2007). *Multinational corporations and foreign direct investment: avoiding simplicity, embracing complexity* (p. 371). Oxford: Oxford University Press.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 128-152.
- Devlin, M. (2009). Indigenous higher education student equity: focusing on what works. *The Australian Journal of Indigenous Education*, 38, 1-8.
- Dunning, J., & Lundan, S. (2008). *Multinational enterprises and the global economy* (p. 960). Cheltenham: E. Elgar.
- Fare, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. *American Economic Review*, 84, 66-83. www.jstor.org/stable/2117971
- Ferreira, C. M. C., & Gomes, A. P. (2009). *Introduction to data envelopment analysis: Theory, models and applications*, M. G., Viçosa (Ed.), Federal University of Viçosa, 389.
- Javorcik, B. S., & Lie, Y. (2013). Do the biggest aisles serve a brighter future? Global retail chains and their implications for Romania. *Journal of International Economics*, 90, 348-363.
- Javorcik, B. S., & Spatareano, M. (2011). Does it matter where you come from? Vertical spillovers from foreign direct investment and the origin of investors. *Journal of Development Economics*, 96, 126-138.
- Greene, W.H. (2000). *Econometric analysis* (4th ed.). Upper Saddle River, NJ: Prentice Hall.
- Griffith, R., Redding, S., & Reenen, J. (2004). Mapping the two faces of R&D: Productivity growth in a panel of OECD industries. *Review of Economics and Statistics*, 86, 883-895. <https://doi.org/10.1162/0034653043125194>
- Malmquist, S. (1953). Index numbers and indifference curves. *Trabajos de Estadística*, 4, 209-242.
- Mao, Y., & Yang, Y. (2016). FDI spillovers in the Chinese hotel industry: the role of geographic regions, star-rating classifications, ownership types, and foreign capital origins. *Tourism Management*, 54, 1-12.
- Marinho, E., & Bittencourt, A. (2007). Productivity and economic growth in Latin America: The frontier approach to stochastic production. *Economic Studies*, 37, 5-33.

- Meyer, E.K. (2004). Perspectives on multinational enterprises in emerging economies. *Journal of International Business Studies*, 35, 259-276.
- Narula, R. (2014). Foreign direct investment as a driver of industrial development: Why is there so little evidence? In R.V., Tulder, A., Verbeke, & R., Strange (Eds), *International business and sustainable development* (pp. 45-67). Bruxelles: Emerald.
- Narula, R., & Driffield, N. (2012). Does FDI cause development? The ambiguity of the evidence and why it matters. *The European Journal of Development Research*, 24, 1-7.
- Newman, C., Rand, J., Talbot, T., & Tarp, F. (2015). Technology transfers, foreign investment and productivity spillovers. *European Economic Review*, 76, 168-187.
- Odeck, J. (2008). The effect of mergers on efficiency and productivity of public transport services. *Transportation Research*, 42, 696-708.
- Pack, H., & Saggi, K. (2006). Is there a case for industrial policy? A critical survey. *World Bank Research Observer*, 21, 267-297.
- Rodriguez-Clare, A. (1996). The division of labor and economic development. *Journal of Development Economics*, 49, 3-32.
- Rodrik, D. (2008). *Normalizing industrial policy: the international bank for reconstruction and development* (pp. 1-36). Washington, DC: The World Bank.
- Rugman, A., & Verbeke, A. (2001). Subsidiary-specific advantages in multinational enterprises. *Strategic Management Journal*, 22, 237-250.
- Suyanto, S., & Salim, R. (2010). Sources of productivity gains from FDI in Indonesia: is it efficiency improvement or technological progress? *The Developing Economies*, 48, 450-472.
- The World Bank. (2016). *Latin America and Caribbean overview*. Retrieved from www.worldbank.org/en/region/lac/overview
- Tomohara, A., & Taki, S. (2011). Does globalization benefit developing countries? Effects of FDI on local wages. *Journal of Policy Modeling, Rhode Saint Genese*, 33, 511-521.
- Wang, H., Liu, H., Cao, Z., & Wang, B. (2016). FDI technology spillover and threshold effect of the technology gap: regional differences in the Chinese industrial sector. *Springer Plus*, 5, 1-12. <http://doi.org/10.1186/s40064-016-1962-6>

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