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Article

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Assessing the performance of the Latin American and Caribbean banking industry: Are domestic and foreign banks so different?

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Abstract: This paper studies the relative performance of domestic and foreign banks in the Latin American and Caribbean banking industry. *Data Envelopment Analysis* is used to compute technical efficiency scores for the years 2001 and 2013. Our main contribution is twofold. On the one hand, we assess performance at the level of the management of specific production factors. On the other hand, we distinguish program efficiency from managerial efficiency, which allows us to evaluate whether the differences in technical efficiency between national and foreign banks are due to the use of different technologies (program efficiency) or, conversely, differences in the managerial capacities of managers in both categories of banks (managerial efficiency). The results show that foreign banks are more efficient than domestic ones, and provide evidence that the greater efficiency of foreign banks is mostly due to the superior technology they use.

Subjects: Banking; Operational Research/Management Science; Management of Technology & Innovation

Keywords: Latin American and Caribbean banking industry; efficiency; foreign capital

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PUBLIC INTEREST STATEMENT

The financial crises experienced by the Latin American and Caribbean region in the 1980s and the first half of the 1990s boosted reforms in the banking system aimed at adapting banks to international solvency standards, liberalizing their operational capacity, opening to international competition, and increasing their efficiency and productivity. Foreign banks were encouraged to enter these countries and were also meant to play a leadership role in the process of modernization; however, the role they actually played still remains a cause for debate. This paper contributes to this ongoing debate by analyzing performance in the regional banking industry. Our results show that foreign banks are managed more efficiently than their domestic counterparts; furthermore, this superiority is determined to a great extent by the use of more efficient technologies. Accordingly, our results appear to support the opening up of the Latin American industry, and the positive role of foreign banks in its modernization.

1. Introduction

It is well known that the Latin American and Caribbean (LAC) countries began to overhaul their banking systems from the mid-1990s onwards, in order to adapt them to international solvency standards, liberalize their operational capacity, open them to international competition, and increase their levels of efficiency and productivity (De Carvalho, De Paula, & Williams, 2015). The financial crises experienced by the region in the 1980s and the first half of the 1990s boosted these reforms, which counted on the full support of international organizations, such as the *International Monetary Fund* and the *World Bank*, in the context of the increasing globalization that the world economy was experiencing (World Bank, 2008). Foreign banks were encouraged to set up operations in these countries and were expected to play an important role in the modernization of LAC banking, within the framework of the privatization process initiated by many governments in the region (Chortareas, Garza-Garcia, & Girardone, 2011; Yildirim & Philippatos, 2007).

The process of liberalization and the opening up of the sector to foreign competitors appear to have had positive results in the light of the financial stability achieved by the region over the last few years, the growth and extension of financial services to a broader section of society, and the overall performance of LAC banks over this period (Manuelito & Jiménez, 2010). Nevertheless, the role that foreign banks have played in this process of modernization in both LAC and in other emerging regions has been and continues to be a point of contention, especially in the context of the controversy of "competition-efficiency" versus "competition-inefficiency" (see Schaeck & Čihák, 2008; also Bang, Pía, & Wu, 2011; Levy & Micco, 2007).

Advocates of the introduction of foreign banks argue that increased competition in local markets leads to improvements in the operational efficiency of domestic entities in a number of different ways, i.e. the implementation of more modern technologies, and the development of new products and services lead to reduced margins and lower costs for financial services (CEPAL, 2012). Furthermore, they argue that foreign banks tend to act more cautiously than their domestic counterparts and they also boost economic growth by improving resource allocation efficiency as well as making the sector less vulnerable to internal and external disturbances (Olivero, Li, & Jeon, 2011). Lastly, they also contend that foreign banks have greater access to capital markets, the loans they provide tend to be more stable, and they are less dependent on national economic cycles (Chortareas et al., 2011; Clarke, Cull, Martínez Pería, & Sánchez, 2003; Dages, Goldberg, & Kinney, 2000; Wu, Bang, & Luca, 2010).

Conversely, other authors maintain that foreign banks develop selective strategies to penetrate target markets, leaving the least profitable and least solvent customers to the local banks, which in turn makes these entities less efficient and less competitive (CEPAL, 2003; Green, Murinde, & Nikolov, 2004; Moguillansky, Studart, & Vergara, 2004). Furthermore, it is said that foreign banks encourage capital outflows and that the integration of international financial markets increases the impact of exogenous shocks on credit or domestic interest rates. Lastly, foreign banks tend to apply greater margins, thus making the whole of the domestic banking market less competitive (de la Torre, Martínez Pería, & Schmukler, 2010; Galindo, Izquierdo, & Rojas-Suárez, 2010).

This paper contributes to this ongoing debate by analyzing the performance of the banking industry in LAC countries, and by assessing the relative technical efficiency of national and foreign banks in the region using non-parametric *Data Envelopment Analysis* (DEA) techniques. The contribution of this paper to existing literature is twofold. On the one hand, by accounting for slacks in the calculation of efficiency scores, we assess performance at the level of the management of specific production factors. On the other hand, we distinguish program efficiency from managerial efficiency, which allows us to evaluate whether the differences in technical efficiency between national and foreign banks are due to the use of different technologies (program efficiency) or, conversely, differences in the managerial capacities of managers (managerial efficiency) in both categories of banks. Our main finding is that foreign banks perform better than national ones, and the difference is statistically significant; moreover, this difference is based to a great extent on the superior technology that the foreign banks use.

The paper is structured as follows: following the introduction, Section 2 describes the recent trends in costs and margins of the banking industry in LAC countries; Section 3 reviews the literature on the assessment of banking efficiency in the LAC region; Section 4 describes the data and the methodology; Section 5 presents and discusses the results, while the final Section 6 contains summaries and conclusions.

2. Background information about the LAC banking sector

Although it is by no means homogeneous, the LAC banking market does have certain common features that are specific to developing economies. Even though the regional banking market is still not sufficiently mature, it has experienced high rates of expansion and has multiplied its activities over the last decade, diversifying its range of financial services and progressively penetrating new sectors of Latin American society. Moreover, after almost two decades of opening up to foreign competitors, regional banks are notably more stable, with significant improvements to their efficiency and profitability indicators (Bank for International Settlements, BIS, 2007).

The strong economic performance of the region has led to a growth in financial activity of a similar intensity to that observed in other emerging regions and much greater than the growth registered in any developed countries. The growth in banking activity has been accompanied by a very significant improvement in the indicators of access to financial services. Therefore, the number of customers and banking branches has increased substantially with a diversification in the channels used to offer products and services, although again, these indicators are far removed from the levels seen in more advanced countries (World Bank, 2012).

The role played by foreign entities in this process may represent one of the most noteworthy features of the evolution of the Latin American banking market during the last two decades. At the end of the 1980s, the international banking sector began to expand into emerging markets all over the world and particularly in LAC. Within a short period of time, the biggest banks in the USA, the UK, Spain, Canada, and the Netherlands had strengthened their presence in the Latin American banking market. The local authorities in LAC countries, with strong support from different international financial organisms, expected the arrival of foreign banks to contribute to the recapitalization of those local entities that had been badly damaged by previous crises, to encourage competition in the sector and to facilitate the incorporation of new technologies and more advanced management procedures, all of which would help to ensure stability and improve the efficiency and productivity of regional banks (Minda, 2007).

At the beginning of the twenty-first century, the process of implantation of foreign banks in LAC was practically complete. However, after nearly a decade in which foreign banks had obtained over 50% of the market share in most of the countries in the region, from 2001 onwards, there has been a gradual yet irregular recovery of market share by domestic banks (Figure 1).

The slow but continued fall in the power of foreign banks can primarily be explained by a sharp increase in the activity of domestic banks, which in the period 2001–2013 managed to increase their assets more quickly than foreign banks. Foreign banks, in turn, have started to reorganize their

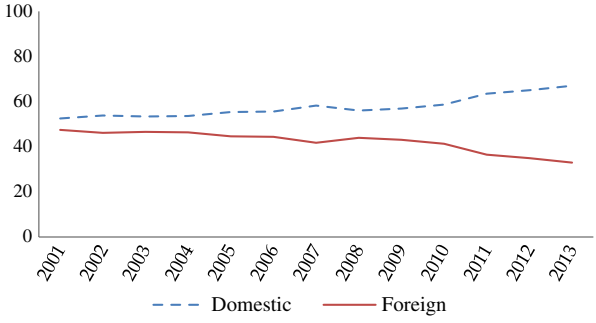

Figure 1. Share of domestic banks (dashed line) and foreign banks (continuous line) in the LAC banking industry.

Source: BankScope and own elaboration.

subsidiaries in the region and, since the financial crisis that began in 2007, have partially returned to their original markets in order to strengthen the liquidity and solvency of the parent companies (Fender & McGuire, 2010).

Despite the strategies developed by foreign entities, it is primarily the strong performance of domestic banks that is behind the positive evolution of their market share (CEPAL, 2012). Costs, margins, and profits are the most important variables where competition has had an impact, and reflect the main changes to have taken place in banking.

The arrival of foreign banks to LAC was expected to bring about significant reductions in intermediation costs and margins (Jeon, Olivero, & Wu, 2011).[1] It was estimated that increased competition accrued from the process of opening up to foreign companies and the supposedly superior technological and management skills of these companies would guarantee this [Levy and Micco (2007) and Bang et al. (2011) analyze competition and concentration in the LAC banking sector]. Regarding margins, with the exception of specific cases such as Mexico, the interest differential of lending and deposit rates has remained relatively high throughout the period, at levels which are far removed from the narrower margins observed in advanced economies such as the USA or the Eurozone (Table 1).[2] Consequently, it seems that, in this respect, increased competition has not significantly affected regional banking practices (Gelos, 2009). It is also striking that foreign entities have displayed higher interest differentials than those of domestic entities', except for the years in the middle of the decade (Figure 2(a)).

On the other hand, operating costs have been significantly reduced in terms of the total assets for the period, which could be explained, among other reasons, by the increase in competition and technological, organizational and managerial modernization that took place after the arrival of foreign banks (Carvallo & Kasman, 2005). The reduction in costs has been particularly intense in the case of domestic banks, which have outperformed foreign ones and have displayed a great ability to adapt to the new institutional framework and a more competitive scenario (Figure 2(b)). Nevertheless, the levels of relative costs among Latin American banks are still notably higher than those observed in the USA and especially those in the Eurozone (see Table 1).

Regarding profitability performance, the growth of the banking business in the region and the increases in efficiency and productivity should boost profit levels, although the increase in competition could also negatively influence these levels due to the narrowing of margins (Claessens, Demirgüç-Kunt, & Huizinga, 2001). Nevertheless, as has been noted, banking margins remained

Table 1. Performance indicators of the LAC banking industry, 2001–2011

	Net interest margin (%)		Overhead cost (% total assets)		Return on assets (ROA, %)	
	2001	2011	2001	2011	2001	2011
Argentina	6.3	7.1	10.1	7.2	−0.1	2.8
Brazil	5.4	5.0	5.5	3.4	1.0	1.2
Chile	0.1	3.6	2.9	4.6	1.5	7.8
Colombia	3.6	6.1	9.1	8.0	0.7	2.2
Mexico	5.6	3.0	4.5	2.5	0.8	0.6
Peru	4.2	6.2	4.7	4.2	0.4	2.6
Uruguay	3.2	4.9	6.3	4.4	−2.1	1.2
LAC	3.9	5.9	4.8	4.3	0.9	1.8
United States	3.0	3.6	3.2	2.9	1.1	0.8
Eurozone	2.1	1.4	1.5	1.3	0.5	0.1

Note: Figures of capital for Argentina in 2001 refer to year 2003.
Source: World Bank.

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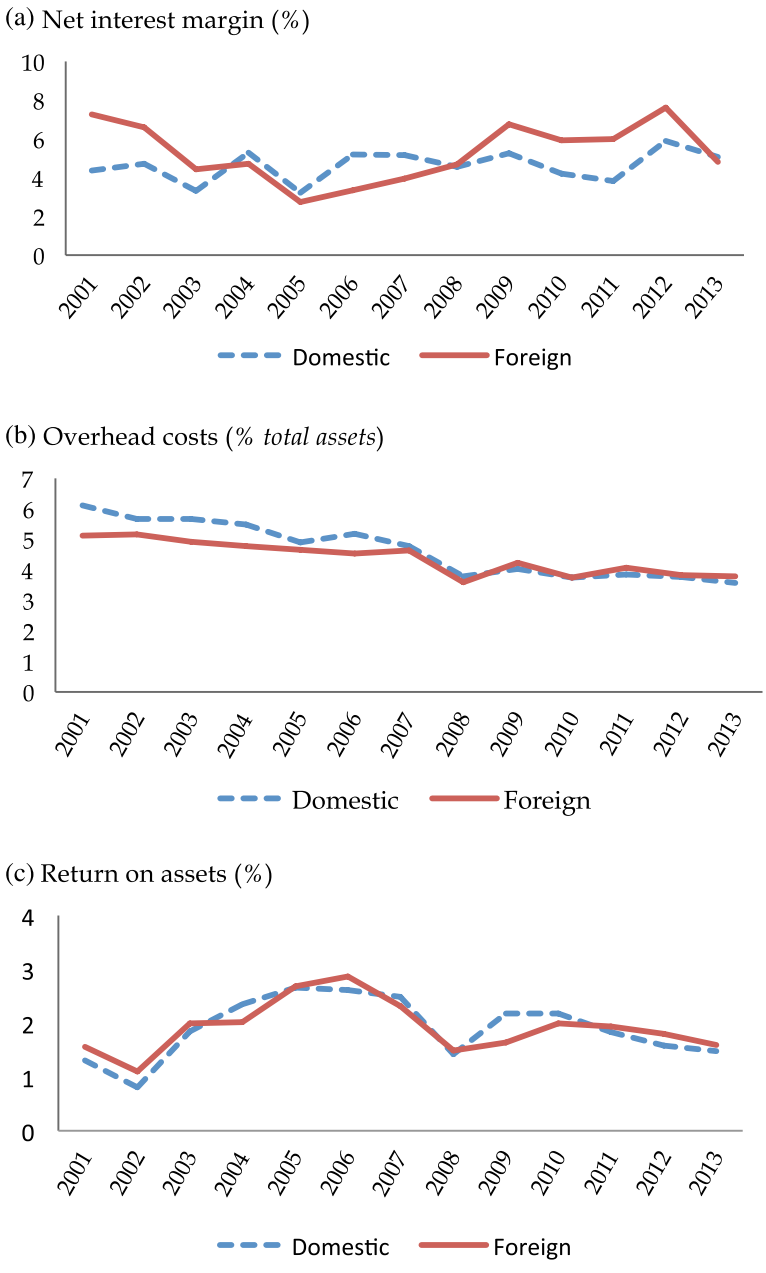

Figure 2. Performance indicators of the LAC banking industry: domestic banks (dashed line) versus foreign banks (continuous line).

Source: BankScope and own elaboration.

relatively high during the 2000s, and therefore one would expect the opening up of the sector to foreign competitors to have led to an increase in profit levels derived from the growth of business as well as improvements in efficiency. Indeed, over the period analyzed, the rate of return on assets in the LAC banking market increased substantially, while it fell considerably in the USA and even more so in the Eurozone (see Table 1). The profiles of the rate of return of domestic and foreign banks are very similar, although the financial crisis that started in 2007 has had a greater impact on the profits of foreign entities (Figure 2(c)).

In summary, the different indicators analyzed above show that the LAC banking industry has evolved favorably between 2001 and 2013; furthermore, domestic and national banks have performed in a very similar way. This would seem to suggest that the presence of foreign banks has boosted

competition and modernization in the regional banking system, which was the original aim behind the decision to liberalize and open up the sector.

Given the similarity of the developments observed, it might be worthwhile asking if there are currently any significant differences in the comparative levels of efficiency and, therefore, if it is reasonable to expect even greater changes in the LAC banking scenario over the coming years. The next sections aim to provide partial answers to these questions.

3. Efficiency in the LAC banking industry: a brief review of literature

Over the last few decades, a great deal of literature has addressed efficiency analysis in the banking industry. A variety of different methodological approaches have been used that include both parametric and non-parametric techniques (Berger & Mester, 1997; Carbó, Humphrey, & López del Paso, 2007; Duygun, Sena, & Shaban, 2013). Different concepts of efficiency have also been analyzed, including technical, cost and profit efficiency (Wheelock & Wilson, 2013), as well as the impact on efficiency of different environmental variables, i.e. public or private ownership of capital, the origin (domestic or foreign) of investors, or the nature of the regulations that govern banking activity (Chortareas, Girardone, & Ventouri, 2012, 2013; Servin, Lensink, & van den Berg, 2012). Lastly, there has been analyses at a global scale (Barth, Lin, Mac, Seade, & Song, 2013; Kösedağ, Denizel, & Özdemir, 2011), as well as in terms of developed countries (Brissimis, Delis, & Tsionas, 2010; Feng & Serletis, 2010; Tabak, Boueri, & Fazio, 2013), and emerging countries or regions (Ariss, 2010; Assaf, Matousek, & Tsionas, 2013; Ray & Das, 2010), and economies in transition (Bonin, Hasan, & Wachtel, 2005; Koutsomanoli-Filippaki, Margaritis, & Staikouras, 2009).

Regarding studies specifically focused on the banking industry in LAC countries, several papers over the last decade have assessed the relative performance of domestic and foreign banks. The results obtained using different methodological approaches are mixed, although many papers indicate that the performance of domestic and foreign banks is currently very similar (CEPAL, 2012). Using regression analysis, Micco, Panizza, and Yañez (2007) found that foreign banks in developing countries have higher profit margins and lower costs than domestic banks. Furthermore, Figueira, Nellis, and Parker (2009) estimated several stochastic and non-stochastic frontiers and found only slight differences in performance between domestic and foreign banks in LAC countries.

In the case of Brazilian banks, Tecles and Tabak (2010) estimated both stochastic and non-parametric frontiers and found that large foreign banks are somewhat more efficient than domestic banks. Moreover, using non-parametric DEA techniques, Staub, da Silva e Souza, and Tabak (2010) showed that Brazilian state-owned banks are more efficient than foreign banks and private domestic banks, with or without minority foreign participation. Nevertheless, these results should be no surprise, given the functions of the wholesale banking sector and the important role that public banking plays in this emerging economy. Garza-García (2012) conducted a two-stage performance analysis for Mexican banks and concluded that GDP growth, loan intensity, and foreign ownership are the main factors that influence banking efficiency. Finally, Sanchez, Hassan, and Bartkus (2013) measured allocative, technical, and scale efficiency in seven Latin American banking industries, and suggested that the source of inefficiency is regulatory (allocative), rather than managerial (technical), and that financial liberalization has led to productivity increases throughout Latin America as a consequence of technological progress, rather than enhanced technical efficiency.

In summary, literature in this field of research suggests that the origin of capital, either domestic or foreign, might be one of the factors that influence banking efficiency. In the following sections, we go one step further by assessing the technical efficiency of foreign and domestic LAC banks in terms of how they manage specific production factors. We also investigate the relative efficiency of the production technologies used by foreign and domestic banks.

4. Efficiency assessment: data and methodological issues

4.1. Data and sample

In order to evaluate the efficiency of the banking industry in LAC countries, we use data from the *BankScope* database, a widely used source of accounting and financial statistics in recent years (Soares, 2011). Our data-set includes banks from Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Peru, Paraguay, Trinidad and Tobago, Uruguay, and Venezuela. To avoid any distortions that productive specialization (commercial or investment banks) or the legal status of institutions (banks, saving banks, and cooperative banks) might have on our analysis, the sample only includes commercial banks. We assess the relative efficiency of domestic and foreign banks in the years 2001 and 2013. After eliminating observations with missing information on relevant variables for the purpose of our research, our sample includes 164 banks for 2001, 91 of which are domestic and 73 foreign; and 145 banks for 2013, 87 of which are domestic and 58 foreign. It should be noted that Mexican banks are not present in the sample, given the lack of available information on staff costs.

The characterization of the production technology in the banking industry is based on the financial intermediation approach (Sealey & Lindley, 1977), according to which banks use basic production factors (physical capital and labor) and gain resources through different means, such as deposits or capital (inputs), to invest in different financial products, including credits, loans, or securities (outputs). This approach has been widely used in previous literature (see Berger, Hasan, & Zhou, 2009; Chiu, Jan, Shen, & Wang, 2008; Koutsomanoli-Filippaki, Margaritis, & Staikouras, 2009, among others). More specifically, the inputs considered in our analysis are staff costs as a proxy of labor, non-profitable assets as a proxy of physical capital, and customer deposits and own resources as financial inputs. On the other hand, outputs are gross loans, interbank credits, and investment in securities (Ray & Das, 2010). Table 2 shows some descriptive statistics.

4.2. Methodological issues

For the methodology, let us assume that the $k = 1, \dots, N$, banks in our sample, either 164 in 2001 or 145 in 2013, use a vector of inputs x_{ik} ($i = 1, \dots, 4$), i.e. non-profitable assets, customer deposits, own resources, and staff costs, to produce a vector of outputs y_{rk} ($r = 1, \dots, 3$), i.e. gross loans, interbank credits, and investment in securities, through a technology that is given by:

$$T = \left[(x, y) \,|\, x \text{ can produce } y\right] \tag{1}$$

Table 2. Sample description: averages in current millions US$

	Year 2001			Year 2013		
	All banks (164)	**Domestic banks (91)**	**Foreign banks (73)**	**All banks (145)**	**Domestic banks (87)**	**Foreign banks (58)**
Outputs						
Gross loans	1,116	1,387	779	7,261	8,758	5,016
Interbank loans	284	318	240	3,102	4,378	1,187
Securities	651	918	318	2,203	2,735	1,404
Inputs						
Non-profitable assets	348	494	167	2,053	2,463	1,438
Customer deposits	1,178	1,478	804	6,143	7,239	4,500
Own resources	459	576	312	2,785	3,519	1,685
Staff costs	72	98	40	229	280	153

This reference technology provides a complete description of all feasible relationships between inputs and outputs, and it is assumed that it satisfies the standard axioms proposed by Shephard (1970). These properties include the possibility of inaction, no free lunch, free disposability of inputs, and strong disposability of outputs; furthermore, outputs and inputs are assumed to be non-negative.

Based on this characterization of the production technology, the technical efficiency of banks in our sample is assessed using DEA techniques. DEA is a well-known approach to measuring efficiency based on mathematical programming that was pioneered by Charnes, Cooper, and Rhodes (1978), and it has been used in hundreds of empirical papers (see Cook & Seiford, 2009 for a review). In essence, this technique allows the comparison of the position of each bank in our sample, i.e. its input and output vectors, with the best observed practices in the sample in terms of a performance indicator (the details are in Cooper, Seiford, & Tone, 2007).[3] Formally, assessing the technical efficiency of bank 0 requires solving the following program:

$$
\begin{aligned}
&\text{Minimize}_{\varphi_0,\lambda_k} && \text{Technical efficiency} = \varphi_0 && \\
&\text{subject to:} && \varphi_0 x_{i0} \geq \sum_{k=1}^{N} \lambda_k x_{ik} && i = 1,\ldots,4 \quad \text{(i)} \\
& && y_{r0} \leq \sum_{k=1}^{N} \lambda_k y_{rk} && r = 1,\ldots,3 \quad \text{(ii)} \\
& && \lambda_k \geq 0 && k = 1,\ldots,N \quad \text{(iii)}
\end{aligned}
\tag{2}
$$

where x_{i0} and y_{r0} stand for the observed values of input i and output r for bank 0, and λ_k represents the weighting of each bank k in the sample in the composition of the efficient frontier. Moreover, all inputs are assumed to be variable, which means that we carry out an analysis of long-run performance; constant returns to scale are also imposed (see Banker, Charnes, & Cooper, 1984).

The solution to program (2) assesses the maximum feasible proportional reduction in all inputs that bank 0 could achieve without decreasing its outputs, thus providing a measure of conventional *Farrell-type* input-oriented technical efficiency, i.e. it assesses technical efficiency in a *Farrell–Debreu* sense (Farrell, 1957). This score ranges from zero to one, with one indicating best performance. For instance, a figure of 0.85 would mean that bank 0 could produce the same vector of outputs using only 85% of inputs; in other words, all inputs could be proportionally reduced by 15%.

However, once the maximum proportional reduction of all inputs has been attained, additional reductions may still be feasible for some particular inputs while maintaining the vector of outputs; the so-called input *slacks* measure these input-specific potential reductions. The existence of *slacks* means that the extent of inefficiency cannot be fully assessed by simply computing radial measures, as non-radial reductions also need to be considered in order to provide a complete picture of efficiency (Torgersen, Førsund, & Kittelsen, 1996). Formally, these additional shrinkages are measured for bank 0 from the solution to the following program (Ali & Seiford, 1993):

$$
\begin{aligned}
&\text{Minimize}_{\varphi_0,\lambda_k} && S_0 = \left(\sum_{i=1}^{4} S_{i0} + \sum_{i=1}^{3} S_{r0} \right) && \\
&\text{subject to:} && \varphi_0^* x_{i0} - S_{i0} = \sum_{k=1}^{N} \lambda_k x_{ik} && i = 1,\ldots,4 \quad \text{(i)} \\
& && y_{r0} + S_{r0} = \sum_{k=1}^{N} \lambda_k y_{rk} && r = 1,\ldots,3 \quad \text{(ii)} \\
& && S_{i0}, S_{r0} \geq 0 && i = 1,\ldots,4 \text{ and } r = 1,\ldots,3 \quad \text{(iii)} \\
& && \lambda_k \geq 0 && k = 1,\ldots,N \quad \text{(iv)}
\end{aligned}
\tag{3}
$$

with S_{i0} and S_{r0} standing for the *slacks* in inputs and outputs, respectively, i.e. input excesses and output shortfalls; φ_0^* is the solution for proportional efficiency obtained for bank 0 from program (2).

Potential proportional reductions in inputs computed from mathematical program (2) and input-specific *slacks* arising from program (3) can be used to assess *Pareto–Koopmans* input-specific technical efficiency (Koopmans, 1951). Accordingly, the *Pareto–Koopmans* efficient use of input *i* on behalf of bank 0 is computed by subtracting its aggregate potential reduction, i.e. proportional plus input-specific reduction, from its observed use:

$$x_{i0}^{\text{Pareto–Koopmans efficient}} = x_{i0} - \left[\left(1-\varphi_0^*\right)x_{i0} + S_{i0}\right] = \varphi_0^* x_{i0} - S_{i0} \tag{4}$$

Finally, *slack*-adjusted scores for the input-specific technical efficiency of bank 0 in the management of input *i* are computed as the quotient between the *Pareto–Koopmans* efficient level of that input and its observed level:

$$\text{Input-specific technical efficiency} = \frac{x_{i0}^{\text{Pareto–Koopmans efficient}}}{x_{i0}} = \varphi_0^* - \frac{S_{i0}}{x_{i0}} \tag{5}$$

The input-specific efficiency scores are, by construction, always equal to or lower than the radial scores and have a similar economic interpretation. Furthermore, as input *slacks* enter expression (5) as a percentage of observed inputs, input-specific measures of technical efficiency are unit invariant. While the inclusion of information on input-specific reductions when assessing technical efficiency reveals the full potential of banks in our sample to reduce inputs while maintaining outputs, the importance of *slacks* in explaining inefficiency can be evaluated by calculating the weight of potential input-specific reductions on aggregate potential input reductions. Formally, for input *i*:

$$\text{Importance of slacks}_i = \frac{\sum_{i=1}^{N}\left(x_{ik}^{\text{radial}} - x_{ik}^{\text{Pareto–Koopman efficient}}\right)}{\sum_{i=1}^{N}\left(x_{ik} - x_{ik}^{\text{Pareto–Koopman efficient}}\right)} = \frac{\sum_{k=1}^{N} S_{ik}}{\sum_{k=1}^{N}\left[\left(1-\varphi_k^*\right)x_{ik} + S_{ik}\right]} \tag{6}$$

with $x_{ik}^{\text{radial}} = \varphi_k^* x_{ik}$.

Once both proportional and input-specific technical efficiency of all banks in our sample have been evaluated, the statistical significance of differences between domestic and foreign banks can be assessed using a number of non-parametric tests of hypotheses. A standard test is the *Kolmogorov–Smirnov* distribution test (see Conover, 1999); in addition, we also use the *Simar–Zelenyuk-adapted-Li* test (Li, 1996; Simar & Zelenyuk, 2006), which is more appropriate to our case study because it is specifically designed for statistical inference with efficiency scores computed with DEA.

Nevertheless, some possible differences in technical efficiency between domestic and foreign banks in LAC countries might be due either to the fact that they are using different production technologies or to what we might call a concentration of good/bad managers in a given category of banks. In order to distinguish between these two sources of inefficiency in the case of our radial technical efficiency scores, in the second stage of our research, we use the *program approach* first proposed by Charnes, Cooper, and Rhodes (1981) and later further developed by authors, such as Silva Portela and Thanassoulis (2001) and O'Donnell, Rao, and Battese (2008). Essentially, this approach suggests that production units belonging to different programs or groups within the same economic activity might have access to different production technologies. Furthermore, in our case study, it would allow us to assess *managerial* or *intra-program efficiency* by comparing banks in our sample to best observed practices in the group they belong to, either domestic or foreign banks, and also to assess *inter-program efficiency*, or simply *program efficiency*, which identifies differences in performance between both groups that stem from technological differences.

In practice, assessing *program efficiency* in the LAC banking industry requires the following four steps to be taken. Firstly, all banks in the sample need to be grouped according to their type, either domestic or foreign, and then program (2) must be run separately for each group K_h ($h = 1, 2$) in order to assess *managerial efficiency*, namely $\varphi^{\text{managerial}}$; i.e. banks are compared to best observed practices

in the group they belong to. Secondly, observed data on inputs are projected onto the technological frontier of their own group in order to clean up managerial inefficiencies. This can be formally done for bank k in group K_h and input i by means of the expression:

$$x_{ik}^{\text{projected } K_h} = \varphi_k^{*\text{ managerial } K_h} x_{ik} \quad k \in K_h \text{ and } h = 1, 2 \tag{7}$$

The third step requires solving program (2) again using the joint sample of banks and the *projected* data obtained in the previous step instead of the original observed data. This provides an estimation of *program efficiency*, represented by φ^{program}, which, for each group, is equivalent to the distance between the technological frontier of this group and the joint technological frontier. Finally, the significance of differences in program efficiency between domestic and foreign banks needs to be tested using appropriate statistical procedures, such as those mentioned above.

In summary, the aforementioned procedure allows us to decompose scores for radial technical efficiency into the result of the product of scores for managerial efficiency and program efficiency. Formally:

$$\begin{aligned}\text{Technical efficiency}\,(\varphi_k) = \text{managerial efficiency}\,\left(\varphi_k^{\text{managerial}}\right)\\ \times\ \text{program efficiency}\,\left(\varphi_k^{\text{program}}\right)\end{aligned} \tag{8}$$

5. Results and discussion

Using the characterization of the technology in the banking industry described in Section 4.1, we have assessed the performance of the LAC banks in the years 2001 and 2013 separately. To do so, we firstly computed radial or proportional scores of technical efficiency from mathematical program (2) using the joint sample of banks as the reference to construct the technological frontier. The results are shown in Table 3.

Computed scores of efficiency in 2013 suggest that, on average, in the long run, the banks in the sample could reduce their use of inputs by almost 27%, while maintaining their levels of outputs, i.e. the average radial efficiency is 0.731. This potential proportional reduction of inputs reaches 28% for domestic banks and 25% for foreign banks, i.e. technical efficiency scores are 0.719 and 0.750, respectively; furthermore, results from the *Kolmogorov–Smirnov* and *Simar–Zelenyuk-adapted-Li* tests show that this difference is statistically significant at standard confidence levels. Accordingly, a first conclusion from our results is that, from a technical point of view, foreign banks in the LAC banking industry are more efficiently managed than their domestic counterparts. These results contradict those of Figueira et al.'s (2009), which found that in LAC countries, the local banks are slightly more efficient; however, they are similar to those of Garza-García (2012) and Berger et al.'s (2009), which found that foreign banks were more efficient than domestic ones in Mexico and China, respectively.

However, a relevant issue is whether or not higher efficiency of foreign banks in LAC countries holds true when it comes to the management of specific production factors. In order to answer this question, we have computed input-specific technical efficiency scores according to expression (5) using figures on input excesses from program (3). The results appear in Table 3. The averages for all banks are 0.511, 0.727, 0.723, and 0.645 for non-profit assets, customer deposits, own resources, and staff costs, respectively. Moreover, the weight of *slacks* in explaining potential input-specific reductions, which is assessed from expression (6), ranges from scarcely 1% for customer deposits to nearly 47% for non-profitable assets, highlighting the relevance of taking them into consideration when assessing the technical efficiency of the LAC banking industry.

Regarding the economic interpretation of the averages of input-specific efficiency, the greatest inefficiencies arise in the management of non-profitable assets and staff costs, i.e. basic production factors, while the best-managed production factors are customer deposits and own resources, i.e. financial inputs. Furthermore, the higher performance of foreign banks holds true for the specific

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Table 3. Radial and input-specific technical efficiency: domestic versus foreign banks

	All banks		Domestic banks		Foreign banks		Kolmogorov–Smirnov test[a] KS-statistic (*p*-value)[c]	Simar–Zelenyuk–Li test[b] Li-statistic (*p*-value)[d]
	Mean	SD	Mean	SD	Mean	SD		
	Year 2013							
Radial technical efficiency	0.731	0.213	0.719	0.195	0.750	0.237	0.224 (0.041)**	4.978 (0.000)***
Input-specific technical efficiency								
Non-profitable assets	0.511	0.320	0.481	0.354	0.556	0.294	0.201 (0.086)*	0.639 (0.261)
Customer deposits	0.727	0.212	0.715	0.235	0.746	0.196	0.200 (0.087)*	1.519 (0.064)*
Own resources	0.723	0.221	0.710	0.254	0.742	0.197	0.224 (0.040)**	2.626 (0.004)***
Staff costs	0.645	0.263	0.615	0.272	0.689	0.255	0.195 (0.103)	0.891 (0.186)
	Year 2001							
Radial technical efficiency	0.655	0.226	0.620	0.199	0.699	0.249	0.235 (0.023)**	4.087 (0.000)***
Input-specific technical efficiency								
Non-profitable assets	0.544	0.291	0.488	0.261	0.614	0.313	0.237 (0.020)**	2.821 (0.002)***
Customer deposits	0.634	0.228	0.602	0.207	0.675	0.247	0.218 (0.042)**	1.988 (0.023)**
Own resources	0.652	0.228	0.614	0.202	0.699	0.249	0.259 (0.009)***	4.352 (0.000)***
Staff costs	0.524	0.299	0.458	0.269	0.607	0.316	0.284 (0.002)***	4.214 (0.000)***

[a]The null hypothesis is that the two samples have the same distribution.

[b]The null hypothesis is that the two samples have the same probability distribution function.

[c]Corrected *p*-value.

[d]Original estimates of technical efficiency are smoothed using the algorithm II in Simar and Zelenyuk (2006, p. 508).

*Significant at 10%.

**Significant at 5%.

***Significant at 1%.

management of all inputs included in the analysis, with the exception of staff costs, where the difference with domestic banks is not statistically significant according to the results from the *Kolmogorov–Smirnov* and the *Simar–Zelenyuk-adapted-Li* tests.[4]

In addition to the above-mentioned results for 2013, we also assessed efficiency of the LAC banking industry in 2001. The results appear in Table 3. Before commenting on them, let us point out that the efficiency scores, whether radial or input-specific, computed in 2001 and 2013 are not directly comparable to each other. The reason for this is that efficiency is a *relative* concept that is assessed with respect to a technological frontier constructed from observations of best practices in a given data-set of observations (see Cooper et al., 2007), and the 2001 and 2013 data-sets are different.[5]

That said, efficiency scores computed with data for 2001 also point to the greater efficiency of foreign LAC banks compared to their domestic counterparts; for instance, while the average radial efficiency is 0.699 for foreign banks, i.e. they could maintain their output levels with a 30% reduction in inputs, for domestic banks this figure stands at 0.620, with the difference being statistically significant. Our results also reveal that in 2001, foreign banks were more efficient than domestic ones in the specific management of all production factors considered in our analysis, with the differences being statistically significant in all cases. Lastly, it is worth noting that in 2001, both domestic and foreign LAC banks were operating further away from their contemporaneous technological frontiers than in 2013.

As previously noted, the differences in performance between domestic and foreign banks within the LAC banking industry may be due to differences in the capabilities of their respective managers and/or to differences in the technology they use. In order to shed some light on this issue, we have considered that domestic and foreign banks belong to different groups or programs and have decomposed radial efficiency into the product of managerial efficiency and program efficiency,

which, in our case study, might also be referred to as *ownership* efficiency, since it identifies differences in performance between domestic and foreign banks. The results for years 2001 and 2013 appear in Table 4.

On the one hand, the average managerial efficiency score of domestic banks in 2013 is 0.818, which means that when compared to the best observed practices in their group, they could proportionally save around 18% of their consumption of inputs. Average managerial efficiency for foreign banks is 0.773, suggesting a potential reduction of inputs of almost 23%. However, the managerial efficiency scores of domestic and foreign banks are not directly comparable because they have been obtained in relation to different technological frontiers and, as mentioned above, efficiency is a relative concept.

On the other hand, program efficiency averages 0.916 for domestic banks and 0.969 for foreign ones, indicating that, on average, the group of foreign banks performs closer to the joint technological frontier than the group of domestic banks. Moreover, the difference between both distributions is statistically significant according to both the *Kolmogorov–Smirnov* and the *Simar–Zelenyuk-adapted-Li* tests. In addition, Figure 3 represents the *Kernel* density estimation functions of the radial technical

Table 4. Decomposition of radial efficiency into managerial and program efficiency: domestic versus foreign banks

	Domestic banks		Foreign banks		Kolmogorov–Smirnov test[a]	Simar–Zelenyuk–Li test[b]
	Mean	SD	Mean	SD	KS-statistic (*p*-value)[c]	Li-statistic (*p*-value)[d]
	Year 2013					
Radial efficiency	0.719	0.195	0.750	0.237	0.224 (0.041)**	4.978 (0.000)***
Managerial efficiency	0.818	0.194	0.773	0.221	–	–
Program efficiency	0.916	0.417	0.969	0.110	0.667 (0.000)***	11.997 (0.000)***
	Year 2001					
Radial efficiency	0.620	0.199	0.698	0.249	0.235 (0.023)**	4.087 (0.000)***
Managerial efficiency	0.800	0.188	0.725	0.247	–	–
Program efficiency	0.774	0.158	0.962	0.065	0.649 (0.000)***	20.127 (0.000)***

[a]The null hypothesis is that the two samples have the same distribution.

[b]The null hypothesis is that the two samples have the same probability distribution function.

[c]Corrected *p*-value.

[d]Original estimates of technical efficiency are smoothed using the algorithm II in Simar and Zelenyuk (2006, p. 508).

*Significant at 10%.

**Significant at 5%.

***Significant at 1%.

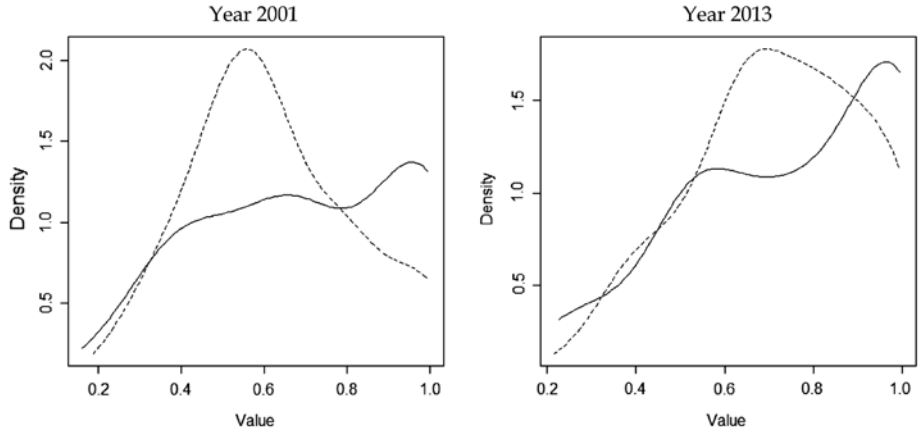

Figure 3. Kernel density estimation functions of radial efficiency scores: domestic (dashed line) versus foreign (continuous line) banks.

efficiency scores for the groups of domestic and foreign LAC banks, providing a graphical illustration of the difference between both distributions. These results suggest that the technology used by foreign banks in LAC countries is more technically efficient than that used by domestic banks. In 2001, the group of domestic banks was also operating further away from the contemporaneous joint frontier when compared to the group of foreign banks; however, in 2013, their distance from that year's joint frontier decreased noticeably.

In terms of the relative efficiency of domestic and foreign banks in LAC countries, the results appear to partially support the policy measures taken in the 1980s by the national governments in the region aimed at opening up the banking industry to international competition. Accordingly, our empirical evidence supports the hypothesis that foreign banks, equipped with more advanced technologies, greater experience, and management capacity, in addition to having better access to financial international markets, are more efficiently managed than their domestic counterparts, and could potentially have contributed to the modernization of the LAC banking sector.

6. Summary and conclusions

The LAC banking industry opened up to international competition in the mid-1980s. Judging by the financial stability and the expansion that the banking sector in the region achieved in the years after first opening up the market to foreign competitors, it seems that the arrival of foreign banks had a positive effect. Nevertheless, there is no consensus in the literature as to the role played by foreign banks in this process. In the context of this debate, this article studies the performance of domestic and foreign banks in LAC countries, analyzing their levels of relative efficiency. One of the most relevant contributions made is the assessment of efficiency related to the management of specific production factors; moreover, analysis is carried out in order to determine whether or not the differences in efficiency between domestic and foreign banks are due to the difference in abilities between their managers and/or the restrictions imposed by the use of different technologies.

Firstly, the performance of the banking industry in the region during the period 2001–2013 showed a significant improvement in cost and profit indicators. In this sense, it seems that domestic banks adapted quickly to the new competitive environment and even recovered a good proportion of the market share that they lost in the years immediately following the arrival of foreign banks. The performance indicators analyzed also show a certain convergence between domestic and foreign banks, particularly in terms of costs; nonetheless, these indicators are still more favorable for foreign banks.

Secondly, the efficiency analysis results show that foreign banks are more efficient in their technical management than their domestic counterparts, and the difference is statistically significant. Furthermore, a noteworthy result of the research is that the superiority of foreign banks in terms of technical efficiency is determined to a great extent by their technology, which is more efficient than that used by domestic banks. Finally, in 2013, domestic banks were closer to their contemporaneous joint technological frontier than they had been in 2001.

On balance, the results obtained from this research appear to support the position adopted by LAC governments when they decided to open up their banking markets to international competition. In this sense, the empirical evidence provided supports the hypothesis that foreign banks, with more advanced technology, greater experience and management ability, and better access to international financial markets, might well have played an important role in the process of modernization of the LAC banking industry.

Finally, we would like to highlight some limitations of our research, as well as several topics that, in our opinion, merit further investigation. Firstly, commercial banks produce *good outputs* but also *bad outputs,* such as impaired loans, and for these to be reduced requires increased expenditure on evaluating customers' credit risk; however, this issue is not accounted for in our efficiency analysis.

Concerning areas for further research, it might be interesting to explore differences in performance between foreign commercial banks and foreign investment banks. In addition, using dynamic modeling to assess the contribution of changes in efficiency to productivity growth of LAC banks, or using multidirectional efficiency analysis techniques to examine in more depth the nature of inefficiencies relative to input-specific improvement potentials are also interesting methodological challenges that could be dealt with in future research.

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Notes
1. Compared to domestic banks, the large size of foreign banks allows them better access to international financial markets, e.g. reducing liability costs and investing in superior technology. Foreign banks can also develop the same marketing policy for different national markets and centralize bureaucratic tasks in international centers, thus reducing unit costs.
2. Although our analysis covers the period 2001–2013, the latest available information in the *Global Financial Development Database* of the World Bank used in Table 1 corresponds to 2011.
3. In addition to DEA techniques, *Stochastic Frontier Analysis* (see Aigner, Lovell, & Schmidt, 1977; Meeusen & van Den Broeck, 1977) is a parametric technique widely employed to assess efficiency. However, we have decided in favor of DEA because it allows the calculation of input-specific efficiency scores that account for slacks, which are an important source of inefficiency in our case study. Moreover, DEA techniques facilitate the modeling of production processes with multiple outputs, as is the case of the banking industry.
4. In the case of non-profitable assets, results from these two tests are, however, contradictory.
5. The entry of new banks in the LAC banking industry from 2001 and the exit of others means that there are differences between the 2001 and 2013 samples. Additionally, observations on banks in both data-sets also belong to different moments of time.

References
Aigner, D., Lovell, C. K., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics, 6*, 21–37. http://dx.doi.org/10.1016/0304-4076(77)90052-5
Ali, A., & Seiford, L. (1993). The mathematical programming approach to efficiency analysis. In H. Fried, C. A. K. Lovell, & S. Schmidt (Eds.), *The measurement of productive efficiency: Techniques and applications* (pp. 120–159). Oxford: Oxford University Press.
Ariss, R. T. (2010). On the implications of market power in banking: Evidence from developing countries. *Journal of Banking & Finance, 34*, 765–775.
Assaf, A. G., Matousek, R., & Tsionas, E. G. (2013). Turkish bank efficiency: Bayesian estimation with undesirable outputs. *Journal of Banking & Finance, 37*, 506–517.
Bang, J., Pía, M., & Wu, J. (2011). Do foreign banks increase competition? Evidence from emerging Asian and Latin American banking markets. *Journal of Banking & Finance, 35*, 856–875.
Bank for International Settlements. (2007, February). *Evolving banking systems in Latin America and the Caribbean: Challenges and implications for monetary policy and financial stability* (BIS Papers, No. 33). Monetary and Economic Department, Basel.
Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30*, 1078–1092. http://dx.doi.org/10.1287/mnsc.30.9.1078
Barth, J. R., Lin, Ch., Mac, Y., Seade, J., & Song, F. M. (2013). Do bank regulation, supervision and monitoring enhance or impede bank efficiency? *Journal of Banking & Finance, 37*, 2879–2892.
Berger, A., Hasan, I., & Zhou, M. (2009). Bank ownership and efficiency in China: What will happen in the world's largest nation? *Journal of Banking & Finance, 33*, 113–130.
Berger, A., & Mester, L. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions? *Journal of Banking & Finance, 21*, 895–947.
Bonin, J. B., Hasan, I., & Wachtel, P. (2005). Bank performance, efficiency and ownership in transition countries. *Journal of Banking & Finance, 29*, 31–53.
Brissimis, S. N., Delis, M. D., & Tsionas, E. G. (2010). Technical and allocative efficiency in European banking. *European Journal of Operational Research, 204*, 153–163. http://dx.doi.org/10.1016/j.ejor.2009.09.034
Carbó, S., Humphrey, D. B., & López del Paso, R. (2007). Opening the black box: Finding the source of cost inefficiency. *Journal of Productivity Analysis, 27*, 209–220.
Carvallo, O., & Kasman, A. (2005). Cost efficiency in the Latin American and Caribbean banking systems. *Journal of International Financial Markets, Institutions and Money, 15*, 55–72. http://dx.doi.org/10.1016/j.intfin.2004.02.002
CEPAL. (2003). *Foreign direct investments in Latin America and the Caribbean, 2002*. Santiago de Chile: CEPAL.
CEPAL. (2012). *Foreign direct investments in Latin America and the Caribbean, 2011*. Santiago de Chile: CEPAL.
Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research, 2*, 429–444. http://dx.doi.org/10.1016/0377-2217(78)90138-8

Charnes, A., Cooper, W. W., & Rhodes, E. (1981). Evaluating program and managerial efficiency: An application of data envelopment analysis to program follow through. *Management Science, 27*, 668–697. http://dx.doi.org/10.1287/mnsc.27.6.668

Chiu, Y., Jan, Ch, Shen, D. B., & Wang, P. (2008). Efficiency and capital adequacy in Taiwan banking: BCC and super-DEA estimation. *The Service Industries Journal, 28*, 479–496. http://dx.doi.org/10.1080/02642060801917604

Chortareas, G. E., Garza-Garcia, J. G., & Girardone, C. (2011). Banking sector performance in Latin America: Market power versus efficiency. *Review of Development Economics, 15*, 307–325. http://dx.doi.org/10.1111/rode.2011.15.issue-2

Chortareas, G. E., Girardone, C., & Ventouri, A. (2012). Bank supervision, regulation, and efficiency: Evidence from the European Union. *Journal of Financial Stability, 8*, 292–302. http://dx.doi.org/10.1016/j.jfs.2011.12.001

Chortareas, G. E., Girardone, C., & Ventouri, A. (2013). Financial freedom and bank efficiency: Evidence from the European Union. *Journal of Banking & Finance, 37*, 1223–1231.

Claessens, S., Demirgüç-Kunt, A., & Huizinga, H. (2001). How does foreign entry affect domestic banking markets? *Journal of Banking and Finance, 25*, 891–911. http://dx.doi.org/10.1016/S0378-4266(00)00102-3

Clarke, G., Cull, R., Martínez Pería, M., & Sánchez, S. (2003). Foreign bank entry: Experience, implications for developing economies, and agenda for further research. *The World Bank Research Observer, 18*, 25–59. http://dx.doi.org/10.1093/wbro/lkg002

Conover, W. J. (1999). *Practical nonparametric statistics* (3rd ed.). West Sussex: Wiley.

Cook, W., & Seiford, L. (2009). Data envelopment analysis (DEA)—Thirty years on. *European Journal of Operational Research, 192*, 1–17. http://dx.doi.org/10.1016/j.ejor.2008.01.032

Cooper, W., Seiford, L., & Tone, K. (2007). *Data envelopment analysis: A comprehensive text with models, applications, references and DEA-Solver software*. Boston, MA: Springer Verlag.

Dages, G., Goldberg, L., & Kinney, D. (2000). Foreign and domestic bank participation in emerging markets: Lessons from Mexico and Argentina. *Economic Policy Review, 6*, 17–36.

De Carvalho, F., De Paula, L., & Williams, J. (2015). Banking in Latin America. In A. N. Berger, P. Molyneux, & J. O. S. Wilson (Eds.), *The oxford handbook of banking* (2nd ed.). (pp. 984–1016). Oxford, UK: Oxford University Press.

de la Torre, A., Martínez Pería, M., & Schmukler, S. (2010). Bank involvement with SMEs: Beyond relationship lending. *Journal of Banking and Finance, 34*, 2280–2293. http://dx.doi.org/10.1016/j.jbankfin.2010.02.014

Duygun, M., Sena, V., & Shaban, M. (2013). Schumpeterian competition and efficiency among commercial banks. *Journal of Banking & Finance, 37*, 5176–5185.

Farrell, M. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General), 120*, 253–281. http://dx.doi.org/10.2307/2343100

Fender, I., & McGuire, P. (2010, September). Bank structure, funding risk and the transmission of shocks across countries: Concepts and measurement. *BIS Quarterly Review,* 63–79.

Feng, G., & Serletis, A. (2010). Efficiency, technical change, and returns to scale in large US banks: Panel data evidence from an output distance function satisfying theoretical regularity. *Journal of Banking & Finance, 34*, 127–138.

Figueira, C., Nellis, J., & Parker, D. (2009). The effects of ownership on bank efficiency in Latin America. *Applied Economics, 41*, 2353–2368. http://dx.doi.org/10.1080/00036840701222546

Galindo, A., Izquierdo, A., & Rojas-Suárez, L. (2010). *Financial integration and foreign banks in Latin America: How do they impact the transmission of external financial shocks?* (IDB Working Paper Series 116). Washington, DC: Inter-American Development Bank.

Garza-García, J. G. (2012). Determinants of bank efficiency in Mexico: A two-stage analysis. *Applied Economics Letters, 19*, 1679–1682. http://dx.doi.org/10.1080/13504851.2012.665589

Gelos, R. G. (2009). Banking spreads in Latin America. *Economic Inquiry, 47*, 796–814. http://dx.doi.org/10.1111/ecin.2009.47.issue-4

Green, Ch, Murinde, V., & Nikolov, I. (2004). The efficiency of foreign and domestic banks in central and eastern Europe: Evidence on economies of scale and scope. *Journal of Emerging Market Finance, 3*, 175–205. http://dx.doi.org/10.1177/097265270400300205

Jeon, B. N., Olivero, M., & Wu, J. (2011). Do foreign banks increase competition? Evidence from emerging Asian and Latin American banking markets. *Journal of Banking & Finance, 35*, 856–875.

Koopmans, T. (1951). Analysis of production as an efficient combination of activities. In T. Koopmans (Ed.), *Activity analysis of production and allocation* (pp. 33–97). New York, NY: Wiley.

Kösedağ, A., Denizel, M., & Özdemir, Ö. (2011). Testing for convergence in bank efficiency: A cross-country analysis. *The Service Industries Journal, 31*, 1533–1547. http://dx.doi.org/10.1080/02642060903580565

Koutsomanoli-Filippaki, A., Margaritis, D., & Staikouras, Ch. (2009). Efficiency and productivity growth in the banking industry of central and eastern Europe. *Journal of Banking & Finance, 33*, 557–567.

Levy, E., & Micco, A. (2007). Concentration and foreign penetration in Latin American banking sectors: Impact on competition and risk. *Journal of Banking & Finance, 31*, 1633–1647.

Li, Q. (1996). Nonparametric testing of closeness between two unknown distribution functions. *Econometric Reviews, 15*, 261–274. http://dx.doi.org/10.1080/07474939608800355

Manuelito, S., & Jiménez, L. (2010). *Los mercados financieros en América Latina y el financiamiento de la inversión: hechos estilizados y propuestas para una estrategia de desarrollo* [Financial markets in Latin America and funding of investments: stylized facts and proposals for a development strategy] (Serie Macroeconomía del Desarrollo, 107). Santiago de Chile: División de Desarrollo Económico, CEPAL.

Meeusen, W., & van Den Broeck, J. (1977). Efficiency estimation from Cobb–Douglas production functions with composed error. *International Economic Review, 18*, 435–444. http://dx.doi.org/10.2307/2525757

Micco, A., Panizza, U., & Yañez, M. (2007). Bank ownership and performance. Does politics matter? *Journal of Banking & Finance, 31*, 219–241.

Minda, A. (2007). The entry of foreign banks into Latin America: A source of stability or financial fragility? *Problemas del Desarrollo. Revista Latinoamericana de Economía, 38*, 43–71.

Moguillansky, G., Studart, R., & Vergara, S. (2004). Comportamiento paradójico de la banca extranjera en América Latina [Foreign banks in Latin America: A paradoxical result]. *Revista de la CEPAL, 82*, 19–36.

O'Donnell, C., Rao, D., & Battese, G. (2008). Metafrontier frameworks for the study of firm-level efficiencies and technology ratios. *Empirical Economics, 34*, 231–255. http://dx.doi.org/10.1007/s00181-007-0119-4

Olivero, M., Li, Y., & Jeon, B. (2011). Consolidation in banking and the lending channel of monetary transmission: Evidence from Asia and Latin America. *Journal of International Money and Finance, 30*, 1034–1054. http://dx.doi.org/10.1016/j.jimonfin.2011.06.006

Ray, S., & Das, A. (2010). Distribution of cost and profit efficiency: Evidence from Indian banking. *European*

Journal of Operational Research, 201, 297–307. http://dx.doi.org/10.1016/j.ejor.2009.02.030

Sanchez, B., Hassan, M. K., & Bartkus, J. R. (2013). Efficiency determinants and dynamic efficiency changes in Latin American banking industries. *JCC: The Business and Economics Research Journal, 6*, 27–52.

Schaeck, K., & Čihák, M. (2008). *How does competition affect efficiency and soundness in banking. New empirical evidence* (Working Paper Series, 932). Frankfurt: European Central Bank.

Sealey, C., & Lindley, J. (1977). Inputs, outputs, and a theory of production and cost at depository financial institutions. *The Journal of Finance, 32*, 1251–1266. http://dx.doi.org/10.1111/j.1540-6261.1977.tb03324.x

Servin, R., Lensink, R., & van den Berg, M. (2012). Ownership and technical efficiency of microfinance institutions: Empirical evidence from Latin America. *Journal of Banking & Finance, 36*, 2136–2144.

Shephard, R. (1970). *Theory of cost and production functions*. Princeton, NJ: Princeton University Press.

Silva Portela, M., & Thanassoulis, E. (2001). Decomposing school and school-type efficiency. *European Journal of Operational Research, 132*, 357–373. http://dx.doi.org/10.1016/S0377-2217(00)00157-0

Simar, L., & Zelenyuk, V. (2006). On testing equality of distributions of technical efficiency scores. *Econometric Reviews, 25*, 497–522. http://dx.doi.org/10.1080/07474930600972582

Soares, P. (2011). Using accounting data to measure efficiency in banking: An application to Portugal. *Applied Financial Economics, 11*, 527–538.

Staub, R., da Silva e Souza, G., & Tabak, B. (2010). Evolution of bank efficiency in Brazil: A DEA approach. *European Journal of Operational Research, 202*, 204–213. http://dx.doi.org/10.1016/j.ejor.2009.04.025

Tabak, B. M., Boueri, R., & Fazio, D. M. (2013). A geographically weighted approach to measuring efficiency in panel data: The case of US saving banks. *Journal of Banking & Finance, 37*, 3747–3756.

Tecles, P., & Tabak, B. (2010). Determinants of bank efficiency: The case of Brazil. *European Journal of Operational Research, 207*, 1587–1598. http://dx.doi.org/10.1016/j.ejor.2010.06.007

Torgersen, A., Førsund, F., & Kittelsen, S. (1996). Slack-adjusted efficiency measures and ranking of efficient units. *Journal of Productivity Analysis, 7*, 379–398. http://dx.doi.org/10.1007/BF00162048

Wheelock, D. C., & Wilson, P. W. (2013). The evolution of cost-productivity and efficiency among US credit unions. *Journal of Banking & Finance, 37*, 75–88.

World Bank. (2008). *Global development finance: The role of international banking*. Washington, DC: Author.

World Bank. (2012). *Financial development in Latin America and the Caribbean: The road ahead*. Washington, DC: The World Bank, Office of the Chief Economist Latin America and the Caribbean Region.

Wu, J., Bang, J. N., & Luca, A. (2010). Foreign bank penetration, resource allocation and economic growth: Evidence from emerging economies. *Journal of Economic Integration, 25*, 167–193. http://dx.doi.org/10.11130/jei.2010.25.1.167

Yildirim, H., & Philippatos, G. (2007). Restructuring, consolidation and competition in Latin American banking markets. *Journal of Banking & Finance, 31*, 629–639.

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