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Foreign bank diversification and  
efficiency prior to and during  
the financial crisis: Does one  
business model fit all?

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# Foreign bank diversification and efficiency prior to and during the financial crisis:

## Does one business model fit all?

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### Abstract

Diversified and focused business models may affect foreign bank efficiency differently in branches or subsidiaries. We investigate whether there is a unique optimal business model in three dimensions: assets, funding and income. We apply recently developed bootstrap methods to estimate group efficiency separately for diversified and focused banks and to test for differences across groups. We further analyze the link between bank efficiency and bank-specific characteristics including diversification measures. Using Luxembourg bank data that includes the financial crisis, we find there is no unique business model as diversified and focused foreign banks coexist and compete in all three dimensions. The most efficient business model appears to be diversified with regard to assets and focused with respect to funding and income. Over time, we find a shift to more focused assets and funding but not income.

**JEL classification:** C14; G21; G28; G32; G34

**Keywords:** foreign banks; asset, funding and income diversification; financial crisis; DEA group-efficiency; heterogeneous bootstrap.

## 1. Introduction

Bank diversification has long concerned policy-makers since the increasing size and scope of bank activities introduces a “cost of complexity,” which at some point may outweigh the benefits (Rajan et al., 2000). The EU Second Banking Directive (1989/646/EEC) prompted many banks to revise their business models, increasing their share of noninterest income and non-traditional activities. However, the financial crisis led policy-makers, bankers and academics to reevaluate the risks associated with non-traditional activities.

In addition to bank asset and income strategies, bank funding strategies are also important for performance, as the financial crisis revealed that weaknesses on the asset side can trigger changes in funding strategies (Borio, 2009). The recent global financial crisis led regulators, policy-makers and scholars to ask how different business models affect performance in the banking industry. This could be even more important for foreign banks, which were generally seen as beneficial because they add to domestic competition, increase access to financial services, enhance financial and economic performance and bring greater financial stability (see Clarke, Cull, Martinez Peria and Sanchez, 2003; Claessens, 2006; Chopra, 2007; Cull and Martinez Peria, 2011). Until the crisis, it was generally believed that foreign banks following an inefficient business model would be compelled by market forces to change their diversification strategy or exit the market, given the important impact of foreign banks on financial stability and economic growth.

The main goal of this paper is to provide empirical evidence on the optimal business model for foreign banks and evaluate whether the business model has needed to be adjusted during the financial crisis. Although foreign banks often operate as universal banks, providing both commercial bank and investment bank services, some choose to diversify while others choose to specialize in a limited number of business lines. The nature of foreign banks also raises difficult policy questions regarding the choice of business models. While poor management might lead to “failure” of a foreign bank in the host country, the resulting spillovers could threaten financial stability in the home country as well (Dell’Ariccia and Marquez, 2010). This link can create a systemic crisis requiring the coordinated intervention of several states. For instance, the cross-border rescues of Fortis and Dexia during the financial crisis required several governments to agree *ex post facto* to burden-sharing agreements.

To identify an efficient or “optimal” business model, we use technical efficiency measures to assess how well management deploys technology, staff and other resources to produce a given level of output. Technical efficiency has also been closely linked to the likelihood of bank default

(Wheelock and Wilson, 1995), so we assume that better business models will be associated with higher technical efficiency. We follow the academic literature in using diversification measures to analyze bank business models. However, most existing studies analyze bank business models in terms of the asset mix and/or income mix. In this paper, we also consider the funding mix adding a third dimension.

When analyzing foreign banks, it is important to take into account their organizational form (branches vs. subsidiaries). Fiechter et al. (2011) noted that integrated cross-border banking groups may provide efficiency gains from the scale and diversification of their operations, but that their failure can threaten financial stability in countries where they operate. This trade-off between efficiency and stability could depend on whether foreign banks set up abroad as branches or subsidiaries. Despite the clear legal distinction between branch and subsidiary,<sup>1</sup> in practice, they may be operated and managed similarly. However, it is not yet clear how cross-border banking groups choose between these different forms to organize their business model. From an operational point of view, a subsidiary bank is typically a self-sufficient structure subject to local regulatory and liquidity requirements. This raises the cost of capital and funding compared to branch banks. The firewall between subsidiary and parent bank, while reducing the risk of contagion, restricts movements of funds within the group. This raises the costs of external funding if subsidiaries must borrow in their own name rather than through the parent bank. Thus, “efficiency arguments” may favor branches relative to subsidiaries, though they have different financial stability implications. In practice, cross-border bank groups may choose between these structures depending on cross-country differences in regulation, tax regime and the business model at the parent bank.

This creates different incentives to diversify (or specialize) their activities in different fields, reducing market discipline and allowing inefficient banks to survive. From an economic point of view, branches and subsidiaries may not benefit equally from diversification, which has consequences for the optimal corporate structure. Thus, given the differences between these two forms of foreign bank organization, a second question addressed in the paper is whether the trade-off between diversification and specialization depends on the bank’s organizational form.

Finally, few studies analyze the diversification-performance link within foreign-owned banks, as most adopt the perspective of global banks (at the consolidated level). Since foreign-owned banks in financial centers operate both as specialized and diversified banks, the present paper

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<sup>1</sup>A subsidiary is a separate legal entity, which is licensed and supervised by local regulators, with the parent having no obligation to support it if it falls into distress. In contrast, a branch is legally inseparable from the parent, which is fully responsible for its financial commitments.

focuses on the diversification-performance link in this special case. In particular, we analyze the financial center of Luxembourg, which has the highest presence of foreign banks and foreign banks assets in Europe (Claessens and van Horen, 2012). Initially encouraged by tax and regulatory advantages, the Luxembourg financial center increasingly concentrated expertise in different aspects of international banking (OECD, 2010). Most recently, it developed as a center for private banking, investment fund domiciliation and liquidity management within multinational banking groups. We test whether there is a single business model that improves performance for all foreign-owned banks within this financial center. We also ask whether the financial crisis led foreign banks to alter their business model.

Our empirical approach relies on a combination of the non-parametric test on equalities of distributions, group-based Data Envelopment Analysis (DEA), truncated regression and the bootstrap method. These combined methodologies allow for possible heterogeneity of the bank business model, while providing statistically rigorous tests of the results obtained. First, we study the cross-section distribution of bank diversification to assess the extent of divergence in business models across banks. Since our analysis spans from 1995 to 2009, we also check whether the cross-section distribution changed over time by using the Li test adapted to the DEA context (Simar and Zelenyuk, 2006). When different business models appear, we group banks and estimate their group efficiency and relative confidence intervals by combining DEA and the group-wise heterogeneous bootstrap (Simar and Zelenyuk, 2007). We also test for equal group efficiency using the adapted Li test. Finally, in order to quantify the relationship between business model and efficiency and to disentangle the possible effects of other variables, we employ a semi-parametric approach using DEA with truncated regression and bootstrap (Simar and Wilson, 2007) linking individual technical inefficiency scores to bank-specific characteristics including the degree of diversification and the organizational form.

The remainder of the paper is structured as follows. Section 2 reviews the prior literature on diversification in banking and on financial centers. Section 3 describes the empirical research strategy while Section 4 presents the data sample and variables. Section 5 discusses the empirical results and Section 6 concludes.

## **2. Literature review**

We separate the literature review into two sections: (i) literature on the effect of business model on bank performance and (ii) literature on the banking industry in financial centers.

### *2.1. Literature on the effect of business model on bank performance*

The existing literature on bank performance using diversification measures to identify the business model is characterized by two important limitations: (i) it has used a wide variety of bank performance measures and (ii) it has used many measures of bank diversification. Perhaps as a result, there is still no consensus despite the volume of literature.

Some studies explore whether markets value diversified banks more highly by using asset and income-based measures of diversification. The empirical evidence is mixed. Baele et al. (2007) find a strong positive relation between franchise value and the degree of functional diversification for European banks over the period 1989-2004. However, Laeven and Levine (2007) find that worldwide financial conglomerates have lower market value than stand-alone institutions producing the same financial services. Schmid and Walter (2009) support this finding for U.S. financial conglomerates (including non-bank institutions). Elsas et al. (2010) reach the opposite conclusion, finding that income diversification does not reduce shareholder value and actually improves bank profitability.

Other studies explore whether diversification can reduce earnings volatility by combining traditional intermediation and non-interest income activities. For the U.S. banking sector, several authors provide evidence that there are no significant benefits for earnings or earnings volatility (risk) (e.g., DeYoung and Roland, 2001; Stiroh, 2004; Stiroh and Rumble, 2006). This is because fee-based activities increase the volatility of bank income and because net interest income and non-interest income are increasingly correlated. For European banks, the evidence is mixed. Some find that increased reliance on non-interest income has stabilized profits (Smith et al., 2003; Chiarozzo et al., 2008). However, Lepetit et al. (2008) show that expanding into non-interest income activities raises volatility and insolvency risk. This positive link with risk is most clear for small banks and is essentially driven by commission and fee activities.

In terms of asset measures of diversification, findings are also mixed concerning the impact on bank returns and risk. Acharya et al. (2006) find no evidence that diversification in loan mix is associated with higher return and/or lower risk, while Rossi et al. (2009) find that asset diversification raises profit efficiency by reducing bank risk and cost efficiency. Curi et al. (2013) find evidence that asset diversification is positively associated with the technical efficiency of foreign banks operating in a financial center. However, Elyasiani and Wang (2012) show the opposite for a sample of U.S. bank holding companies over the period 1997-2007.

Finally, a few recent papers extend the diversification concept to bank funding strategies. Demirgüç-Kunt and Huizinga (2010) use the share of non-deposit funding to measure

diversification and find risk benefits from raising this from low levels. However, at higher levels of non-interest income and non-deposit funding, further increases in diversification result in higher bank risk. Berger et al. (2010) found that specialization in deposits (as well as loans and assets) was associated with higher profit and cost efficiency for a sample of Chinese banks; however, this paper neglects the income diversification.

In the above literature, no paper uses technical efficiency to measure bank performance, and none jointly analyzes the three dimensions we consider (asset mix, income mix and funding mix). Considering the importance of bank funding strategies on their performance, few papers have extended the diversification concept to consider the funding mix and have only analyzed some funding sources. Finally, most papers focus on bank holding companies. The financial crisis has not—to our knowledge—been systematically examined.

## *2.2. Literature on the banking industry in financial centers*

The empirical literature analyzing banking in financial centers is limited and focuses on international financial centers located in Europe (Switzerland, Liechtenstein and Luxembourg) or in Asia (Hong Kong and Singapore). All of the studies mentioned below focused on analyzing the production process -mostly operational, cost and profit efficiency and more rarely productivity.

Rime and Stiroh (2003) found that both specialized and universal banks in Switzerland operate with relatively large cost and profit inefficiencies. Size plays a crucial role; while small and mid-size banks experience cost scale economies, the largest universal banks do not. Larger banks do not benefit substantially from economies of scale or product diversification. Burgstaller and Cocca (2011) find that banks in Liechtenstein perform better than their Swiss counterparts. In the two financial centers, relatively large technical and scale inefficiency are linked to specialization and investment, but not to bank size. Curi et al. (2013) link technical efficiency in Luxembourg banks to specific characteristics such as size, organizational form, as well as home- and host-country characteristics. They found that the organizational form plays a crucial role and that banks have higher technical efficiency on average if their parent bank is located in the euro area. Kwan (2006) finds that cost inefficiency of Hong Kong banks is quite large but declines over time. Large banks seem less cost efficient than small banks, although the former tend to converge with the latter over time. Finally, Sufian and Majid (2007) find that scale inefficiency outperforms pure inefficiency in Singapore banks, although the average efficiency level is high. Increasing bank size has become the greatest source of bank inefficiency in Singapore.

The only work analyzing bank productivity in a financial center has been undertaken with respect to Luxembourg. Mixed results reflect different econometric approaches as well as sample periods. Guarda and Rouabah (2007, 2009) analyzed the quarterly productivity growth of Luxembourg banks prior to the financial crisis and found positive productivity growth since the mid-1990s, with persistent and pro-cyclical dynamics. Larger banks are found to be more productive and a Malmquist index analysis suggests that efficiency change dominates technical change. Curi and Lozano-Vivas (2013) examine the productivity of Luxembourg banks, accounting for organizational form, size and nationality. Results indicate that banks responded to the financial crisis with technological improvements. In normal times (before the crisis), branches and subsidiaries followed a similar productivity path. Technical change seems to be the main source of productivity improvements.

None of the papers above considered the business model of foreign banks in financial centers or whether the type of organizational structure can affect the impact of diversification on performance.

### **3. Empirical research strategy**

In a nutshell, this paper aims to unveil evidence on the most efficient business model for foreign banks operating in a financial center. To do so, we apply a multi-step methodology.

First, we study the cross-section distribution of bank diversification to assess the extent of heterogeneity in business models across banks. The cross-section distribution is estimated using the kernel density estimator with optimal bandwidth selected by the Sheather and Jones (1991) method, and banks are categorized as either focused or diversified using thresholds located between peaks in the estimated distributions. This analysis distinguishes whether there is a single business model that can fit all banks.

Further, since the sample covers different periods, we also check whether the cross-section distributions changed over time, using an adaptation of the Li test. The analysis of change over time is particularly interesting to test whether banks adjusted their business models during the crisis.

In our second step, we use the concept of technical efficiency to identify the most efficient or “optimal” business model. We estimate operational efficiency<sup>2</sup> at the bank level using a non-

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<sup>2</sup> Berger (2007) notes that economic efficiency may be misleading for foreign banks since externalities affecting their parent bank may prevent them from optimally choosing their strategies.



parametric estimator referred to as Data Envelopment Analysis (DEA).<sup>3</sup> Operational efficiency for each bank is the distance from actual observation to the DEA-estimated, best-practice production frontier (of technology), computed using the Farrell-type, output-oriented measure.<sup>4</sup> This measure provides a score that is bounded between unity and infinity, where a score of unity indicates a bank on the estimated technology frontier (technical efficiency 100%) while a score greater than unity represents a bank below the frontier. The reciprocal of the Farrell-type, output-oriented efficiency measure indicates the efficiency level of the bank relative to the estimated best-practice frontier. This measure can also be used as the relative efficiency rank of the bank within the sample.

If different banks in the sample operate with several business models, it is relevant to estimate aggregate or group efficiency and their confidence intervals by combining DEA with the group-wise heterogeneous bootstrap (Simar and Zelenyuk, 2007). Specifically, to test whether banks with different business models are equally efficient, we construct a weighted efficiency score ( $WGE$ ) for each group (i.e., each business model), with “within” weights derived from the aggregation structure based on economic optimization (see Färe and Zelenyuk, 2003; Simar and Zelenyuk, 2007). For each  $WGE$ , we then study sensitivity to sampling variation, estimating confidence intervals and corrections for the bias inherent in the DEA procedure by implementing the heterogeneous sub-sampling bootstrap algorithm. Lastly, we perform the pairwise tests of the null hypothesis that  $WGE$  are equal across bank business models. For instance, suppose we have diversified and focused business models, then the null hypothesis of interest is  $H_0: WGE^F = WGE^D$ , where  $WGE^F$  is the aggregate technical efficiency score for the group of “focused” banks and  $WGE^D$  is that for the group of “diversified” banks. These tests are based on the relative difference (RD) statistic, defined as:

$$\widehat{RD}^{F,D} = WGE^F / WGE^D, \quad (1)$$

and the null hypothesis (equal efficiency) is rejected (at a selected level of confidence) if the bootstrapped confidence interval for  $\widehat{RD}^{F,D}$  does not contain unity. If so, the null hypothesis would be rejected in favor of the alternative hypothesis that the diversified banks are more inefficient

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<sup>3</sup> DEA avoids assumptions on the functional form of the production technology and allows multiple inputs and outputs.

<sup>4</sup>The Farrell measure (Farrell 1957) satisfies a set of desirable mathematical properties for an efficiency measure, requires relatively simple computation and allows straightforward interpretation of technical efficiency. This measure is the reciprocal of the Shephard (1970) output distance function.

(more efficient), as a group, than focused banks if  $\widehat{RD}^{F,D} < 1$  (if  $\widehat{RD}^{F,D} > 1$ ). This analysis is then extended to distinguish between different organizational forms.

Finally, the third step of our empirical strategy is to estimate a multivariate relationship between business model and efficiency controlling for other bank-specific characteristics including organizational form. To do so, we follow the truncated regression with bootstrap approach, suggested by Simar and Wilson (2007), to analyze the following relationship:

$$TE_{k,t} = \alpha + DIV_{k,t}\beta + OF_{k,t}\gamma + CSV_{k,t}\delta + u_{k,t}, \quad k = 1, \dots, n; \quad t = 1, \dots, T \quad (2)$$

where  $TE_{k,t}$  is the technical efficiency of bank  $k$  at time  $t$ ,  $DIV_{k,t}$  is the diversification variable,  $OF_{k,t}$  is a dummy variable for the organizational form and  $CSV_{k,t}$  is a vector of control variables capturing bank-specific characteristics or structural variables that might have an impact on the efficiency. Lastly,  $u_{k,t}$  is a random error that must satisfy the theoretical restriction that  $TE_{k,t} \geq 1$ , and so  $u_{k,t}$  is a truncated random variable such that  $u_{k,t} \geq 1 - Z_{k,t}\beta$ , for all  $k = 1, \dots, n; t = 1, \dots, T$ . To handle such a truncation problem, we use the truncated regression approach, assuming  $u_{kt} \sim N(0, \sigma_u^2)$  such that  $u_{k,t} \geq 1 - Z_{k,t}\beta$ ,  $k = 1, \dots, n$  and  $t = 1, \dots, T$ , where  $\sigma_u^2$  is estimated along with the estimation of  $\beta$  using the maximum likelihood method. To improve accuracy of inference, confidence intervals around each element in  $\beta$  are obtained by bootstrap Algorithm II from Simar and Wilson (2007), where further details can be found.<sup>5</sup>

## 4. Data sample and construction of variables

### 4.1. Data sample

The data for this study was provided by the Luxembourg Central Bank (BCL) and encompasses both balance sheet and profit and loss data on a quarterly basis from 1995Q1 to 2009Q4. This data has two major advantages relative to Bankscope. First, reporting data gives information on both subsidiary and branch banks, while Bankscope does not. Second, reporting data contains more detailed information than Bankscope. We convert data from quarterly frequency to annual

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<sup>5</sup> Note that the dependent variable in the regression is inefficiency, so a negative value of the parameter implies a positive effect on efficiency (i.e., negative effect on inefficiency).

frequency to avoid seasonality variations, which may bias efficiency estimates.<sup>6</sup> We use the GDP deflator to convert to constant prices with base year 1995.

We exclude domestic banks (two state-owned banks and two cooperative banks), a central securities depository with bank status and some banks from emerging economies with a very limited market share. Lastly, for each period we remove banks that have just entered operation.<sup>7</sup> The final sample is more homogenous and focuses on established foreign banks, as domestic banks operate on the local markets instead of the international market, and consists of 2087 bank-year observations, of which 1698 are subsidiary banks and 389 are branch banks, for the years 1995-2010.

#### 4.2 Construction of variables

##### Measures of diversification

We measure asset, funding and income diversification with a modified Herfindahl-Hirschman Index (HHI). Following Elsas et al. (2010), we define diversification (DIV) by subtracting HHI from unity so that it increases with diversification. For asset diversification (ADIV), we focus on the most significant categories for foreign banks operating in financial centers, namely interbank loans (IBLOAN), customer loans (CLOAN), government securities (GSEC), fixed income securities (FISEC) and other securities (OSEC) including shares, participations and other variable income securities.<sup>8</sup> Therefore, for each bank  $i$  at time  $t$ , we calculate:

$$ADIV_{i,t} = 1 - \left( \left( \frac{IBLOAN_{i,t}}{EA_{i,t}} \right)^2 + \left( \frac{CLOAN_{i,t}}{EA_{i,t}} \right)^2 + \left( \frac{GSEC_{i,t}}{EA_{i,t}} \right)^2 + \left( \frac{FISEC_{i,t}}{EA_{i,t}} \right)^2 + \left( \frac{OSEC_{i,t}}{EA_{i,t}} \right)^2 \right) \quad (3)$$

where earning assets (EA) is the sum of the five numerators.

For funding diversification (FDIV), we consider equity (EQUI), short-term interbank deposits (IBDEP), customer deposits (CDEP), short-term money market funds, such as certificates of deposit (CERDEP), and long-term capital market funding, such as subordinated debts (SDEBT). Therefore, for each bank  $i$  at time  $t$ , we calculate:

$$FDIV_{i,t} = 1 - \left( \left( \frac{EQUI_{i,t}}{FUND_{i,t}} \right)^2 + \left( \frac{IBDEP_{i,t}}{FUND_{i,t}} \right)^2 + \left( \frac{CDEP_{i,t}}{FUND_{i,t}} \right)^2 + \left( \frac{CERDEP_{i,t}}{FUND_{i,t}} \right)^2 + \left( \frac{SDEBT_{i,t}}{FUND_{i,t}} \right)^2 \right) \quad (4)$$

<sup>6</sup> Stock variables from the balance sheets are averaged, while flow variables from the profit and loss statement are reported year-to-date.

<sup>7</sup> DeYoung and Hasan (1998), among others, argue that banks often suffer initial losses and low earnings during the first years of operation.

<sup>8</sup> Previous studies used other disaggregations, reflecting different research purposes as well as data availability. For instance, Berger et al. (2010) disaggregate loans into industry, commercial, real estate, agricultural and consumer loans. They disaggregate total assets into total loans, loans to other banks, financial investments, total fixed assets and other assets.

where FUND is the sum of the five numerators.

Lastly, for income diversification we consider interest income (II), and commission income (CI), net profit from other operations (NPFO), and other non-interest income (ONII), such as fiduciary income, service charges, trading income and other fees, as in Elsas et al. (2010). The denominator, total operating income (TOI), is the sum of the four numerators. Therefore, for each bank  $i$  at time  $t$ , we calculate:

$$IDIV_{i,t} = 1 - \left( \left( \frac{II_{i,t}}{TOI_{i,t}} \right)^2 + \left( \frac{CI_{i,t}}{TOI_{i,t}} \right)^2 + \left( \frac{NPFO_{i,t}}{TOI_{i,t}} \right)^2 + \left( \frac{ONII_{i,t}}{TOI_{i,t}} \right)^2 \right) \quad (5)$$

#### Banking outputs and inputs for measuring technical (in)efficiency

We model bank production with a modified version of the intermediation approach (Sealey and Lindley, 1977), which is common in the bank efficiency literature (Berger and Humphrey, 1997). Since our sample of foreign banks operate in financial markets and/or in the internal capital markets within multinational groups, we distinguish wholesale from retail lending (and funding). Thus, we include interbank loans, customer loans and securities (including government securities, fixed income securities, shares, participations and other variable income securities) as outputs. Since Luxembourg foreign banks devote significant resources to off-balance sheet activities (Curi et al., 2013) and this source of income is as important as the interest margin (Guarda and Rouabah, 2007), we extend the set of outputs to include directly charged services (summing commission income, gains from financial operations and other non-interest income). As inputs, we include (i) labor, measured by total labor expenses, (ii) capital, measured by fixed assets, (iii) interbank deposits, including other liabilities, such as debt certificates and subordinated debts and (iv) customer deposits. To account for the cost of producing the directly charged services, we extend the set of inputs to include purchased materials and services (including non-wage administrative costs and commissions paid).

#### Definition of other variables

While we first explore the link between bank efficiency and diversification (along the three dimensions), we then test whether this link varies with organizational form, other bank-specific characteristics or through time (given structural change in the industry).

Foreign banks are present in Luxembourg in two different forms: branch and subsidiary banks. Branch banks are a direct emanation of a parent bank abroad. Diversification strategies are often determined at the level of the parent bank and few (or no) restrictions on intra-group transfers are established. On the other hand, the parent bank is directly responsible if the branch becomes

distressed. Subsidiary banks, instead, are separate legal entities, financially and operationally self-sufficient, locally capitalized and under direct control of local regulators (Fiechter et al., 2011). Since the implications for diversification are likely to be different, we use a dummy variable equal to 1 for branches to control for these effects (*Branch*).

In addition to the organizational form, the banking literature suggests that diversification increases with the size of bank balance sheets (Demsetz and Strahan, 1997). We therefore include the logarithm of total assets (*Size*), as well as its square (*Sizesq*) to control for a potentially nonlinear relationship between bank size and efficiency. We also use a dummy variable (*Big*) to identify the four largest banks in terms of total assets. These global players have privileged access to international capital and money markets.

The literature suggests that higher capital ratios are associated with better management. We use the ratio of equity book value to total assets (*ETA*) as a proxy for risk. This is approximately equal to the bank's tier 1 capital ratio (Berger et al., 2010). A high ratio suggests low leverage and therefore lower risk (see Pasiouras, 2008, among others). Empirical evidence suggests that regulators may allow relatively efficient banks to operate with higher leverage (Hughes and Moon, 1997; Hughes and Mester, 1993; Hughes and Mester, 1998). Other studies, such as Altunbas et al. (2007) find that financial capital can significantly influence bank cost and profit efficiency. Curi et al. (2013) find that well-capitalized banks in Luxembourg tend to score higher in terms of technical efficiency.

Lastly, mergers and acquisitions (M&A) may affect the impact of diversification on bank efficiency, and this is the case for Luxembourg banks as they underwent a broad consolidation process (Curi et al., 2011). There is extensive literature on the efficiency gains from European and U.S. bank deals (for an overview, see DeYoung et al., 2009). In addition, there is a substantial amount of literature that highlights possible time lags between the completion of a merger and the realization of gains (e.g., Rhoades, 1998; Calomiris and Karceski, 2000; Houston et al., 2001). For instance, according to Berger et al. (1998) a three-year gestation period is needed (on average) to restructure a merged bank, given difficulties in refocusing lending policies, integrating data processing systems and operations, etc. Following Focarelli and Panetta (2003), we distinguish the short-run and long-run impact of bank mergers on operational efficiency. Thus, we include a dummy variable (*merge\_trans*) equal to 1 in the transitory period leading up to the merger (the two preceding years and the year of the merger) and another dummy variable (*merge\_compl*) equal to 1 in the completion period (three to five years after the merger).

## 5. Empirical results

We structure our summary of the empirical analysis into three sections: (i) analysis of distribution, (ii) analysis of group efficiencies and (iii) regression analysis.

### 5.1. Analysis of distribution

First, we assess the evolution of the diversification indexes over time. This analysis will give us insights about two important issues: (i) whether there is a unique business model for foreign banks and (ii) whether due to the crisis and/or structural changes over the period under analysis, foreign banks have adjusted their business model.

Our first step is then to analyze the cross-section distributions of three diversification indexes over time using the kernel density estimator, where we use the Gaussian kernel and optimal bandwidth selected by the Sheather and Jones (1991) method. We categorize banks into either focused or diversified using the thresholds in the estimated distributions located between peaks. Figure 1 plots the cross-section distributions. More focused banks will appear on the left and more diversified banks on the right in each of the three dimensions (assets, funding and income).

In the statement of the results, we will split the time period into three sub-periods in order to detect more accurately the possible changes in bank diversification given that structural changes might have occurred in the environment where the foreign banks under analysis are operating. Specifically, we divide the periods into the period of the consolidation process in the banking industry of Luxembourg (1995-2000), the pre-crisis period (2001-2006) and the recent financial crisis period (2007-2009).

Observing Figure 1, in the asset dimension, in plot (a) the first sub-period (1995-2000) is characterized by two peaks suggesting one group of asset-diversified banks (peak near 50%) coexisting with another group of focused banks (secondary peak near 20%). During 2001-2006, the right peak appears to split into two groups of diversified banks while the left tail flattens indicating more heterogeneity within the industry. During the financial crisis of 2007-2009, the main peak falls and shifts left to around 37%, suggesting less diversification. The threshold for activity diversification is around 0.35.

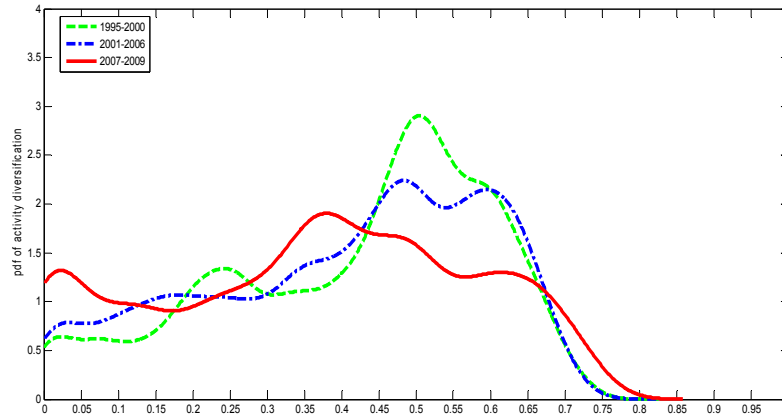
In the funding dimension, the more peaked pattern in plot (b) suggests more diversification than in the asset dimension. However, here also the distribution becomes flatter over time, suggesting increasing heterogeneity across banks. The main peak around 50% drops sharply from the 1995-2000 period to the 2001-2006 period and a bit further during the crisis, gradually shifting left each

time (less diversification). The compensating rise in the left tail also suggests many banks reduced their funding diversification. Thus, the threshold of funding diversification is also around 0.35.

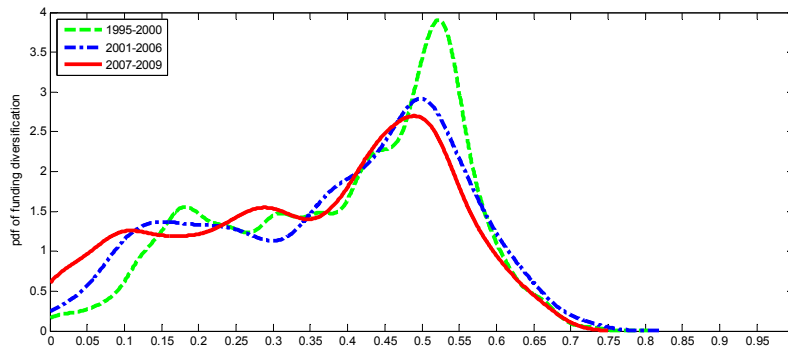
Lastly, turning to the income dimension, plot (c) suggests the opposite pattern, with banks shifting towards higher diversification. The peak at the left in 1995-2000 has dropped dramatically in 2001-2008, as some banks moved to higher diversification apparent as a new peak to the right around 50%. During the financial crisis, the new peak on the right is virtually unchanged but more mass has shifted from the left tail to higher levels of diversification. Thus, the threshold of income diversification is around 0.30.

Overall, for each panel we can observe that there is no unique business model for all foreign banks in Luxembourg since diversified and focused foreign banks coexist in all three diversification dimensions. That is, all foreign banks do not fit one unique business model. Moreover, regarding the evolution of the diversification index over time, a shift can be observed to a more focused bank strategy in assets and funding, but not in income.

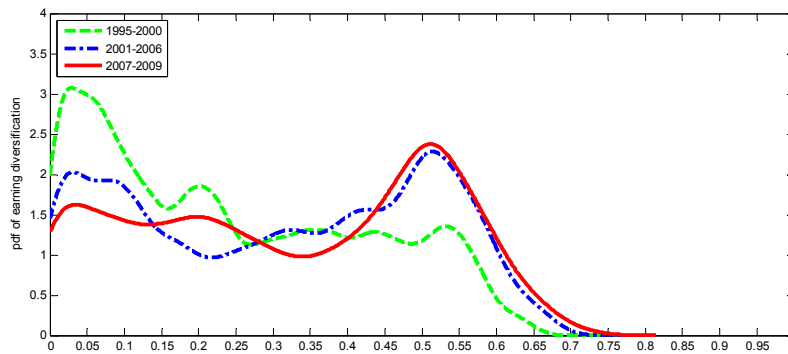
Figure 1: DIV Index Distributions



(a) Asset diversification (ADIV)



(b) Funding diversification (FDIV)



(c) Income diversification (IDIV)



To test whether these changes in the estimated distribution are statistically significant, Table 1 reports Li statistics,<sup>9</sup> along with their bootstrapped  $p$ -value under the null hypothesis of equal distributions.

**Table 1: Test for Equality of Distributions Across Three Periods**

Null Hypothesis ( $H_0$ )	Li Statistic	$p$ -value	Decision on $H_0$
<b>Asset diversification</b>			
$pdf(1995-2000)=pdf(2001-2006)$	2.885	0.009	<i>Reject</i>
$pdf(2001-2006)=pdf(2007-2009)$	6.356	0.000	<i>Reject</i>
<b>Funding diversification</b>			
$pdf(1995-2000)=pdf(2001-2006)$	4.184	0.002	<i>Reject</i>
$pdf(2001-2006)=pdf(2007-2009)$	0.702	0.344	<i>Do not reject</i>
<b>Income diversification</b>			
$pdf(1995-2000)=pdf(2001-2006)$	12.432	0.000	<i>Reject</i>
$pdf(2001-2006)=pdf(2007-2009)$	0.040	0.957	<i>Do not reject</i>

Note:  $pdf$  stands for probability density function.

The first two rows of Table 1 indicate that the changes over time in the distribution of asset diversification across banks are statistically significant (rejection of the null hypothesis with  $p$ -value equal or close to 0.000). The middle panel reports that the distribution of funding diversification changed significantly during the periods from 1995 to 2000 and from 2001 to 2006, but that evidence of change during the financial crisis is not statistically significant. The bottom panel reflects the same result for the distribution of income diversification. In other words, the distribution of diversification in all three dimensions changed during the periods from 1995 to 2000 and from 2001 to 2006, but only asset diversification changed significantly in the 2007 to 2009 period. Thus, it appears that most of the changes observed from Figure 1 are supported by the Li test. Interestingly, the Li statistic shows that the three distributions (assets, funding and income) change over time, but for the financial crisis only asset distribution changes.

The results obtained encouraged us to analyze the sample further, to investigate whether the diversification strategy followed by the two organizational forms that foreign banks decide to adopt when they operate cross-borders is different. In other words, we next analyzed the likely trade-off between diversification and organizational form. To check for this research question, the share of subsidiaries and branches in the diversified and focused categories (based on our thresholds) is reported in Table 2. In all three periods, about half of all banks are diversified subsidiaries. However, a significant share of subsidiaries is also focused. Prior to the financial

<sup>9</sup> See also Curi et al. (2011, 2013). For an alternative approach, see Maasoumi et al. (2007).

crisis, Luxembourg branch banks developed both diversification and focused strategies in terms of assets and funding mix, while they maintained focused strategies in terms of income mix. However, during the financial crisis, most of the branch banks refocused their strategies in assets and funding.

**Table 2: Breakdown into Organizational Form for Each Period**

Period	Bank	Focused			Diversified		
		ADIV	FDIV	IDIV	ADIV	FDIV	IDIV
Consolidation Period (1995-2000)	All	32.78%	35.87%	62.48%	67.22%	64.13%	37.52%
	Subsidiary	24.66%	26.31%	46.24%	54.78%	53.13%	33.20%
	Branch	8.12%	9.56%	16.24%	12.44%	11.00%	4.32%
Pre-crisis (2001-2006)	All	35.78%	38.66%	46.40%	64.22%	61.34%	53.60%
	Subsidiary	28.44%	32.63%	33.16%	55.70%	51.51%	50.98%
	Branch	7.34%	6.03%	13.24%	8.52%	9.83%	2.62%
Crisis (2007-2009)	All	43.02%	45.02%	46.15%	56.98%	54.99%	53.84%
	Subsidiary	28.49%	31.34%	32.19%	52.14%	49.29%	48.43%
	Branch	14.53%	13.68%	13.96%	4.84%	5.70%	5.41%

Overall, this preliminary analysis suggests that branches and subsidiaries run similar business models, despite their legal and regulatory differences. Thus, it appears that, contrary to the general wisdom that branches usually follow a focused business model, we see that many branches also adopt a diversified business model just as subsidiaries usually do.

## 5.2. Analysis of group efficiencies

The findings obtained in the previous subsection regarding the coexistence of different business models, focused versus diversified, led us to address the main research question of the paper—the effectiveness of business model by using technical efficiency. As we point out in the empirical research strategy section, when different business models appear, it is more appropriate to group banks and estimate their aggregate or group efficiency and corresponding confidence intervals. In particular, and based on the results obtained in our first step, we now turn to estimate group-efficiency for the diversified and focused banks in the three diversification dimensions.

Table 3 reports the weighted group-efficiency estimates for diversified and focused banks. The weighted group-efficiency estimates and their confidence intervals and bias corrections are obtained following the Simar and Zelenyuk (2007) group-wise heterogeneous sub-sampling bootstrap approach, with 2000 bootstrap replications. As the aim of the analysis is to explain inefficiency, group-efficiency scores are reported à la Farrell; scores closer to unity are banks that are more efficient. However, in the discussion we use brackets to report efficiency scores à la

Shepard (1970), which are the reciprocals of Farrell-type efficiency scores and represent the relative level of efficiency in percentage terms. Table 4 presents the Li statistics and relative  $p$ -values to test for efficiency equality between focused and diversified foreign banks.

In terms of asset diversification, the weighted group efficiencies (bias-corrected) show that during the consolidation period diversified banks benefitted from higher efficiency (83.7%) compared to more focused banks (71.0%). Moving to the pre-crisis period, we observe that, in contrast to the previous period, focused banks showed higher efficiency levels (88.2%) compared to diversified banks (84.6%). However, both groups improved their efficiency. During the financial crisis, both bank groups experienced an inefficiency increase; however, focused banks reached about 60% while diversified banks limited deterioration to 43.5%. The analysis of the related confidence intervals suggests little overlap for each pairwise comparison, except for the pre-crisis period. This finding is confirmed by the RD statistics (Table 4) as the confidence intervals of this statistic do not include 1 during the consolidation period and the financial crisis. On the other hand, such confidence intervals include 1 during the pre-crisis period, suggesting there is no evidence of statistically significant difference in efficiency performance between the two groups.

Turning to the funding diversification, the weighted group efficiencies (bias-corrected) show that focused banks benefitted with higher efficiency levels compared to diversified banks over the three periods. During the consolidation period, focused banks are characterized by 87.9% efficiency compared to 79.6% among diversified banks. During the pre-crisis period, focused banks improved their efficiency to 94.2% compared to 83.2% for diversified banks. Both groups of banks suffered from efficiency loss during the financial crisis, but diversified banks reached 49.4% efficiency compared to 64.7% for focused banks. In this case, the RD statistics confirm that the differences among focused and diversified banks are statistically significant in all three periods. Thus, banks with focused funding strategies are found to be persistently more efficient, although they also saw their performance deteriorate during the financial crisis.

**Table 3: Weighted Group Efficiency**

Prospective	Period	Orientation	Weighted Group Efficiency (bias-corrected)	Lower Bound (95%)	Upper Bound (95%)	
Asset	Consolidation Period (1995-2000)	Focused	1.290	1.254	1.313	
		Diversif.	1.163	1.116	1.197	
	Pre-crisis (2001-2006)	Focused	1.118	1.074	1.146	
		Diversif.	1.154	1.130	1.169	
	Crisis (2007-2009)	Focused	1.593	1.491	1.644	
		Diversif.	1.435	1.323	1.494	
Funding	Consolidation Period (1995-2000)	Focused	1.121	1.079	1.147	
		Diversif.	1.204	1.160	1.232	
	Pre-crisis (2001-2006)	Focused	1.058	1.020	1.084	
		Diversif.	1.168	1.136	1.187	
	Crisis (2007-2009)	Focused	1.353	1.226	1.415	
		Diversif.	1.506	1.404	1.557	
	Income	Consolidation Period (1995-2000)	Focused	1.139	1.097	1.166
			Diversif.	1.363	1.326	1.385
		Pre-crisis (2001-2006)	Focused	1.116	1.079	1.141
			Diversif.	1.199	1.168	1.218
		Crisis (2007-2009)	Focused	1.322	1.218	1.371
			Diversif.	1.709	1.596	1.769

*Note:* Group-efficiency estimates are obtained by the Simar and Zelenyuk (2007) group-wise heterogeneous subsampling bootstrap method, with 2000 bootstrap replications both for bias correction and confidence intervals.

**Table 4: Relative Difference Statistics Comparing Group Efficiency**

Period	Prospective	RD (bias- corrected)	Lower Bound	Upper Bound	Decision on $H_0$
Consolidation Period (1995-2000)	Asset mix	1.115	1.08	1.151	Reject $H_0$
	Funding mix	0.926	0.89	0.963	Reject $H_0$
	Income mix	0.811	0.773	0.844	Reject $H_0$
Pre-crisis (2001-2006)	Asset mix	0.966	0.922	1	Do not reject $H_0$
	Funding mix	0.899	0.86	0.936	Reject $H_0$
	Income mix	0.925	0.885	0.96	Reject $H_0$
Crisis (2007-2009)	Asset mix	1.126	1.046	1.211	Reject $H_0$
	Funding mix	0.877	0.779	0.956	Reject $H_0$
	Income mix	0.723	0.643	0.81	Reject $H_0$

*Note:* The relative difference statistic is the ratio of the group-efficiency estimate of diversified banks over that of focused banks. Values above unity suggest diversified banks are more efficient.

From the income diversification point of view, the weighted group efficiencies (bias-corrected) show that focused banks, as a group, attained higher efficiency levels compared to diversified banks over the three periods. During the consolidation period, focused banks are characterized by 86.1% efficiency compared to 63.7% among diversified banks. During the pre-crisis period, focused banks improved their efficiency to 88.4% compared to 80.1% for diversified banks. Both groups of banks suffered from efficiency loss during the financial crisis, but diversified banks reached 29.1% efficiency compared to 67.8% for focused banks. Also in this case, the RD statistics confirm that the differences among focused and diversified banks are statistically significant in all three periods. Thus, banks with focused income strategies are persistently more efficient, although they also saw their performance deteriorate during the financial crisis.

Overall, the results suggest that foreign banks operating in a financial center benefit from higher efficiency when they focus their funding and income strategies but diversify their asset mix. Thus, the more efficient business model for foreign banks in Luxembourg appears to be focused with regard to funding and income, and diversified with respect to assets.

In conclusion, we find Luxembourg foreign banks underwent two opposite movements in technical efficiency. Prior to the financial crisis, Figure 1 suggests that foreign banks evolved towards more focused asset and funding strategies and a more diversified income strategy. Tables 3 and 4 suggest that funding-focused and income-focused banks reach higher efficiency than funding- and income-diversified banks, while less evidence of technical efficiency superiority is found among asset-focused banks. During the financial crisis, Figure 1 suggests that banks adopted

a more focused asset mix while funding and income diversification remained largely unchanged. This led to an increase in inefficiency among funding- and income-diversified banks as well as asset-focused banks.

The above results suggest that while foreign banks in Luxembourg choose their optimal business models in terms of funds over time, they decline to operate under their optimal business model in terms of income and assets since they opt for diversifying their income and focusing their assets although both strategies seem to be non-optimal.

### *5.3. Regression analysis*

Since the efficiency analysis performed in the previous subsection indicates significant differences between diversified and focused foreign banks, our third step is to estimate the relationship between diversification and technical inefficiency to disentangle possible mitigating effects related to the bank organizational form, along several other bank-specific characteristics. To perform this analysis, the truncated regression with bootstrap, proposed by Simar and Wilson (2007) is used, and the results are presented in Table 5 for the three periods, estimated separately for diversification in the assets, funding and income dimensions. Since DEA bias-corrected estimates are expressed à la Farrell (greater than unity), negative coefficients indicate a positive impact on efficiency.

The first thing to note is that prior to the financial crisis, the coefficient of the ADIV index is negative and significant at the 5% significance level, while FDIV and RDIV are positive and significant. These results are consistent with the results based on testing for aggregate efficiency equality of diversified and focused foreign banks (Table 3) where there were no controls for other factors. In fact, a diversified asset mix appears to increase foreign bank efficiency although this impact appears to be decreasing over time. This clarifies previous evidence of not significantly different group efficiency between focused and diversified banks. During the financial crisis, the coefficient on asset diversification is positive but not statistically significant. This is consistent with the scope economies explanation for asset diversification and the finding by Berger et al. (2010) according to which asset diversification increases cost and profit efficiency in foreign banks in China. Turning to diversification in the funding dimension, estimated coefficients are positive and statistically significant at the 1% level in all periods, including the period that included the financial crisis. This suggests that funding diversification reduces technical efficiency, confirming the results in Table 3. Finally, the coefficients on income diversification are also positive and

statistically significant at the 1% level in all periods. In addition, the negative impact of income and funding diversification appears to increase over time.

Thus, an interesting novel finding of this work is the evidence that diversification plays different roles depending on the strategy dimension considered. More specifically, while asset diversification could have a positive impact on the foreign banks' efficiency (in line with some findings in Stiroh, 2004; Demirgüç-Kunt and Huizinga, 2010), diversification in funding and income does not appear to be beneficial for the technical efficiency of the banks.

Turning to the other bank-specific characteristics, the regressions in Table 5 provide support for the argument that diversified and focused banks may coexist because diversification is more efficient for some bank types and specialization for others.

Note that the coefficient on the *Branch* dummy variable is negative and statistically significant in all three diversification dimensions and in all periods, including the financial crisis. While diversification in the different dimensions may increase or decrease efficiency, the effect might be mitigated, or expanded, for branches compared to subsidiaries. However, since Table 2 suggests that some branches diversified their business model while others made it more focused over time, we attempt to disentangle such interaction with the organizational form by crossing the *Branch* dummy with the diversification variable (DIV x Branch). The results before the crisis provide evidence that for branches there is a lower improvement in efficiency if they diversify their assets and a higher deterioration in efficiency if they diversify their funding. For income diversification, the coefficient on this interaction term is not significant. During the crisis, the interaction term on funding diversification is significant and changed sign (diversified branches were more efficient). Thus, the results suggest that asset diversification is used more often by subsidiaries while branches exercised more asset-focused strategies. There is no clear evidence that the funding or income-focus hypothesis applies more to branches or subsidiaries.

The estimated coefficient on the *Big* dummy variable suggests that the four largest banks enjoyed a statistically significant efficiency advantage only in the period from 1995-2000. When the *Big* bank dummy is crossed with the diversification variable (DIV x Big), these large banks appear to suffer a relatively larger loss of efficiency from increased funding diversification during the periods from 1995-2000 and 2001-2006. For the other diversification dimensions, this interaction term is not statistically significant. This suggests that, contrary to the general wisdom, the combination of size and diversification does not necessarily lead to operational efficiency gains.

The estimated coefficients on the logarithm of total assets (*Size*) suggest that banks with larger size benefited from higher technical efficiency (lower inefficiency) in the period from 2001-2006. However, during the financial crisis, the coefficient changed sign (the variance of the estimated coefficient also increased). The square of total assets (*Sizesq*) has a negative impact on efficiency in the period from 2001-2006, suggesting a non-monotonic relationship, and it switches sign during the financial crisis. The ratio of equity to total assets (*ETA*) has a positive impact on efficiency in most cases, suggesting that well-capitalized foreign banks tend to run better. The coefficient increased substantially during the financial crisis.

Finally, the dummy variables separating the M&A process into short-run (*merge\_trans*) and long-run (*merge\_compl*) effects gives some evidence on the “merger puzzle” concerning operational efficiency. Our results suggest that, in the short run, mergers reduce operational efficiency (significantly in most cases), but this inefficiency dissipates quickly as is evidenced by the statistically insignificant coefficient on the *merge\_compl* dummy in most cases or significant with opposite sign in a few cases.



**Table 5: Truncated Regression Results**

Variable	Consolidation Period (1995-2000)			Pre-crisis (2001-2006)			Financial Crisis (2007-2009)		
	ADIV	FDIV	IDIV	ADIV	FDIV	IDIV	ADIV	FDIV	IDIV
Constant	0.519**	0.874	0.112	7.690**	4.277**	7.855**	-1.830	-4.258	1.082
DIV	-0.274**	0.265***	0.778***	-0.115**	0.341***	0.645***	0.037	0.881***	1.624***
Branch	-0.293***	-0.524***	-0.124***	-0.503***	-0.670***	-0.057***	-0.629***	-0.389***	-0.139
Big	-3.331***	-1.611***	-0.396***	-0.885	-1.978***	0.021	-2.620	-0.539	0.506
DIV x Branch	0.036***	0.548***	0.016	0.713***	0.991***	0.009	0.310	-0.430***	-0.159
DIV x Big	5.546	3.457***	1.879*	1.809	3.954***	0.480	4.675	1.568	-1.129
Size	0.170	0.133	0.113	-0.558***	-0.238***	-0.642***	0.522*	0.757***	0.100
Sizesq	-0.007	-0.006	-0.004	0.011***	0.003***	0.014***	-0.018*	-0.025***	-0.006
ETA	-0.196***	-0.563***	-0.121***	-0.149***	-0.153***	0.021	-1.466*	-1.958***	-0.729
merge_trans	0.120***	0.132	0.073***	0.117***	0.076***	0.077***	0.302	0.281***	0.258***
merge_compl	0.076	-0.048***	-0.058	-0.010	-0.069	-0.023	0.123	0.112	-0.042
$\sigma_u^2$	0.038***	0.038***	0.023***	0.044***	0.039	0.037	0.032	0.031	0.026

Note: \*\*\*, \*\*, \* stand for statistically significant at 1%, 5% and 10%, respectively.

Source: own calculations

## 6. Conclusions

In this work we analyzed the business models adopted by foreign banks operating in financial centers both before and during the financial crisis. Such analysis is potentially both policy relevant and of independent research interest, given the stability implications of foreign banks for both home and host countries. To our knowledge, there is no study in the literature that investigates foreign bank diversification from their asset, funding and income dimensions and links them to their efficiency scores.

We focus on a unique data set of foreign banks in Luxembourg over the period from 1995-2009. First, we analyze diversification in the assets, funding and income mix across banks and across time and document the evolution of business models among foreign banks. Then we estimate technical efficiency separately for focused and diversified banks and test for differences in aggregate efficiency across groups. Finally, we estimate a truncated regression linking individual technical efficiency scores to bank-specific characteristics and diversification in different dimensions. The empirical research strategy combines recently developed bootstrap techniques applied to the Li test, weighted DEA and truncated regression.

Our main results reveal that no single business model fits all foreign-owned banks in Luxembourg's financial center. Branches and subsidiaries adopt both diversified and focused business models. The most efficient business model for foreign banks in Luxembourg appears to be a strategy combining diversified assets with focused funding and income. The diversified-asset strategy seems consistent with the traditional banking theory based on delegated monitoring, which suggests that bank efficiency increases with diversification. However, we also find that greater funding diversification or income diversification is generally associated with lower technical efficiency and their impact became more negative during the financial crisis.

Prior to the financial crisis, foreign banks in Luxembourg appear to have followed an efficient business model based on asset diversification. However, during the financial crisis they adopted a focused-asset strategy. For funding, they became more focused over time, but for income they remained diversified although this was not efficiency enhancing.

Our results suggest that bank branches may benefit from greater efficiency more than bank subsidiaries, even during the financial crisis. Prior to the crisis, asset-focused branches and asset-diversified subsidiaries enjoyed efficiency advantages. Neither branches nor subsidiaries benefitted from greater diversification in funding or income. Overall, while the choice of business model matters for technical efficiency, there is no single business model that fits all foreign banks when we distinguish between branch and subsidiary banks. Thus, neither structure is obviously preferable. Banks appear to have changed their business model during the financial crisis, but mostly by adjusting their asset mix.

The evidence obtained contrasts with the general belief that increasing both diversification and size benefits banks in terms of better efficiency. The results apparently suggest that large foreign banks are also less efficient. Finally, well-capitalized banks appear to be more efficient, and mergers cause short-term efficiency losses, which may be compensated in the long term.

The analysis suggests that branches may be preferable to subsidiaries from a technical efficiency point of view, but only if they focus their business model. Bank subsidiaries can also be efficient if they diversify their asset mix. Thus, local authorities may wish to encourage foreign banks to enter via branches, while imposing restrictions on their activities. Irrespective of the organizational form, we find evidence that funding and income diversification affect foreign bank efficiency. This implies possible limits to how far foreign banks should diversify away from their traditional deposit taking activities and interest income.

Overall, our empirical evidence suggests that the EU Second Banking Directive may not provide the right incentives for banks operating in the financial center of Luxembourg to develop efficient business models, at least on the income and funding side. In particular, the results suggest that organizational form affects the impact of diversification on foreign bank efficiency. From a policy point of view, this may contribute to the discussion of how foreign banks should be regulated in Luxembourg and other financial centers. A natural extension for future research would be to study whether foreign bank business models oriented towards focused funding and income are sustainable for the host country.

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