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2021

BANCO DE ESPAÑA
Eurosistema

Documentos de Trabajo
N.º 2132

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(*) The views expressed herein are those of the authors only and do not represent the position of the Banco de España or the Eurosystem. We are grateful for comments received from Sergio Mayordomo, Sonia Felix, Bing Xu, participants in the IBRN meeting at Federal Reserve Bank of New York and the Banco de España research seminars, and an anonymous referee. We also thank Luis Guirola, Jesús M.ª Martínez Moreno, Guillermo Ruiz Cavero and Jorge Sarachu for their help with the data.
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Documentos de Trabajo. N.º 2132

August 2021

ISSN: 1579-8666 (on line)

## Abstract

Using Spanish confidential supervisory data, this paper examines the effect of geographic and business complexity, their interaction and relative importance for banks' risk, where the degree of complexity stems from the corporate structure of banking groups affiliates. The results show that while business complexity results in higher risk, geographic complexity gives rise to diversification benefits, thus lowering risk. However, geographic complexity alone is not enough, as its effect depends on how it interacts with business complexity. Higher business complexity abroad in relation to that at home may counterbalance the benefits of diversification. In the same vein, focusing abroad on areas in which the group does not have expertise at home also results in higher risk.

**Keywords:** risk, global banking, bank complexity, diversification benefits.

**JEL classification:** F21, F23, G21, G32.

## Resumen

Utilizando datos confidenciales españoles de supervisión, este trabajo examina el efecto sobre el riesgo bancario de la complejidad geográfica y empresarial, y su interacción e importancia relativa, donde el grado de complejidad se basa en la estructura corporativa de las filiales del grupo bancario. Los resultados muestran que, mientras la complejidad empresarial genera un mayor riesgo, la complejidad geográfica genera beneficios de diversificación, por lo que reduce el riesgo. Sin embargo, la complejidad geográfica no es buena por sí sola, ya que depende de cómo se desarrolle. Una mayor complejidad empresarial en el extranjero en relación con la nacional puede contrarrestar estos beneficios de diversificación. En la misma línea, centrarse en el extranjero en áreas en las que el grupo no tiene experiencia en el ámbito nacional también se traduce en un mayor riesgo.

**Palabras clave:** riesgo, bancos globales, complejidad bancaria, beneficios de diversificación.

**Códigos JEL:** F21, F23, G21, G32.

# 1. Introduction

Recent trends in banking show increased bank concentration in terms of business lines and geographic coverage (CGFS, 2010a). In fact, there seems to be a return to traditional banking and a home bias as far as the geographical location of activity is concerned (CGFS, 2010b). The reasons are varied: efficiency and profitability, institutional change, organisational simplicity and regulation. The resolution framework, the segregation of activities or ring-fencing, among other regulatory changes, are forcing banks to reconsider their organisational structure and whether their expansion abroad and their business diversification strategy are the most appropriate (Ichiue and Lambert, 2016). The assessment of the effects on risk of such retrenchment and refocusing have not been widely analysed. Given that some regulatory proposals aim to reduce such complexity to address systemic risk, it is important to contribute to the provision of evidence on the relationship between bank complexity and bank risk.

Increased complexity may lead banks to either assume higher risk stemming from heightened agency problems or lower risk as a result of diversification benefits. The available empirical literature is inconclusive on whether one effect predominates over the other. Moreover, complexity is multidimensional, with different dimensions giving rise to different effects (Krause et al. 2017).

In this paper, we empirically investigate the relevance of banks' complexity for banks' risk. We consider both the geographic and the business dimension, focusing on the number and types of subsidiaries of banking groups, including those which are not financial institutions.[1] The distribution of affiliates across different geographical locations and/or different business types within a banking organisation can make management and monitoring more difficult, thus resulting in higher risk. Less expertise can be associated with lending in a new sector or location thus giving rise to reduced monitoring or lower monitoring effectiveness (Acharya et al., 2006). On the other hand, the concentration of activity in business areas where the banking group has expertise or with low cycle correlation should lessen agency problems if diversification is in activities entailing higher risk. If, moreover, affiliates abroad are located in countries with low synchrony with the business cycle of the country of the parent bank, diversification benefits may result, giving rise to lower risk. The combination of both types of complexity may either reinforce or mitigate the effects.

[1] See Cetorelli and Goldberg (2014), for a definition of organisational and business complexity. The designation of global systemically important banks proposes different metrics of complexity linked to what an entity does.

Since 1997, the Spanish banking system has undergone a major consolidation process, leading to a large reduction in the number of operating banks. It has resulted in larger, more complex financial groups, including some of the most internationalised among their peers (De Haan et al., 2009). However, there is substantial heterogeneity in complexity across Spanish banking groups, which include not only G-SIBs, but also medium-sized and small banks with activity abroad and covering different business lines.

We empirically test three different hypotheses: a) the combination of geographic complexity with business complexity would result in higher risk; b) the higher the business complexity abroad in comparison to the business complexity at home, the higher the risk, and c) the higher the difference between the business model at home and the business model abroad, the higher the risk.

We find evidence that supports all three hypotheses. While business complexity results in higher risk, geographic complexity gives rise to diversification benefits, and thus, to lower risk. However, geographic complexity alone is not enough. High business complexity abroad in relation to that at home may counterbalance the diversification benefits. In the same vein, focusing abroad on areas in which the group does not have expertise at home also results in higher risk. The evidence gathered clarifies the dimensions of complexity that give rise to higher risk, thus contributing to the discussion on designing regulation aimed at reducing complexity at the banks' level as a means of strengthening overall financial stability and promoting sustainable profitability.

The remainder of the paper is structured as follows. Section 2 lays out the framework and the hypotheses that we wish to test. Section 3 introduces the data and the complexity measures. The empirical approach and the results are in Section 4. Section 5 presents the robustness tests and Section 6 concludes with implications for policy.

## 2. Framework and hypotheses

The degree of complexity of banking groups stems from the corporate structure of their affiliates, where the term *affiliate,* with respect to bank *i*, refers to any company that bank *i* controls *I* and any other company that is controlled by a company that bank *i* controls, as long as the effective control of bank *i* is above the 50% threshold. In line with Cetorelli and Goldberg (2014), we proxy complexity

by the number of affiliates or the degree of concentration of the affiliates along two different dimensions: i) geographic location; and ii) business activities.

According to previous literature, geographic and business diversification can generate different effects on risk, as a result of different factors such as governance (Correa and Goldberg, 2020) or control (Argimón and Rodríguez-Moreno, 2021). Here, we formulate a set of three hypotheses that try to establish the interaction between these two types of complexity and their relative importance.

First, we analyse the impact on risk of complexity along the geographic and business dimensions and their combination. To this end, we study the role played by the geographic and business complexity of the overall group as regards risk. We aim to establish if the effect of these two types of complexity on risk is similar, whether they enhance each other or whether one has a mitigating role vis-à-vis the other, given that heterogeneity of location and business lines in affiliates may help diversify risk. We define a multiplicative variable of geographic complexity and overall business complexity to test for the interaction of the two types of complexity. We expect the combination of both types of complexity to result in lower monitoring and thus higher risk.

Therefore, we formulate our first hypothesis as follows:

*H1. The combination of geographic complexity and business complexity would result in higher risk*

Second, regarding the internationalisation strategy, we analyse the different effects that business complexity at home and abroad may have on risk. We use the ratio of business complexity abroad over business complexity at home to test for the difference. The larger the value of the ratio, the larger the complexity abroad in relation to complexity at home, and thus the higher the agency problems. Our a priori assumption is that the greater the business complexity abroad vis-à-vis complexity at home, the higher the bank's risk, as a result of poorer monitoring.

Our second hypothesis can be formulated as follows:

*H2. The higher the business complexity abroad compared with business complexity at home, the higher the risk*

Finally, we analyse whether the differences between the business line abroad and the business line at home have an effect on risk. We construct variables that measure the relative importance of the different business lines at home and abroad. In particular, we measure the relevance of retail banking

at home and abroad, but also of other business lines. The larger the difference, the higher the risk that we can expect, as a result of poorer monitoring.

Our last hypothesis reads as follows:

*H3. The higher the difference between the business line at home and the business line abroad, the higher the risk*

## 3. Data

We have used confidential supervisory data at the highest bank consolidated level for all Spanish commercial, saving and mutual banks from 2005Q1 to 2016Q4,[2] a period characterised by major changes in the Spanish banking system which had a direct impact on their complexity structures.

Figure 1 depicts the number of banks in our sample. Before 2011, there were around 80 Spanish banking groups in operation, half of them with affiliates abroad. In 2011, a sizeable reduction in the number of banks took place as a consequence of the consolidation process undergone by Spanish banks. From 2012 onwards, the number of groups continued to fall, from 46 in 2012 to 31 at the end of the sample period. To address this intense period of mergers and acquisitions, we have conducted the analysis in such a way that the acquiring bank's code is maintained and the target bank is dropped from the sample. In addition, as a robustness test, we have followed Meslier et al. (2016) and present the results obtained after dropping the observations of banking groups whose total assets have grown by more than 30% between any two consecutive quarters (see Section 5).

A bank's affiliate structure is garnered from the confidential report on the equity instrument portfolio. For every member of the banking group, the report contains the identification code, sector code (CNAE), residence country, voting rights, portfolio type and net worth of the entities that belong direct or indirectly to the group. To identify those affiliates which are relevant for the group, we keep all the shares in entities in the economic group, multi-group and associates (thus we exclude the trading portfolio or financial assets available for sale, among others) and we restrict our analysis to those entities in which the parent has 50% or more of the voting rights.[3] We use the information on

[2] We only consider banks that are the parent bank of a group, or single banks not belonging to a group and with no banking affiliates. Hereafter, we will indistinctly use the term bank or banking group to refer to them.
[3] This criterion is consistent with Cetorelli and Goldberg (2014).

net worth to proxy the size of each affiliate inside the banking group. Thus, we report two types of complexity measures, one based on the number of affiliates and another based on net worth. Net worth can be a good proxy for the relevance in quantitative terms of each affiliate in the overall group. Indeed, it has the advantage over other balance sheet measures that it is not subject to intra-group accounting factors, either for liquidity or solvency support. We group the business activities into five categories: i) bank; ii) other financial;[4] iii) real estate; iv) insurance; and v) non-financial activities.

*Definitions of variables*

We proxy risk by the negative value of the natural logarithm of the z-score, which can be interpreted as a negative distance-to-default measure.[5] The z-score of bank *i* at time *t* is calculated as:

$$z-score_{i,t} = \frac{\left(ROA_{i,t-k+1,t} + (E/A)_{i,t-k+t}\right)}{\sigma ROA_{i,t-k+1,t}} \quad (1)$$

where ROA is the average return on assets, E/A, is the average equity to assets ratio and $\sigma ROA$ is the standard deviation of ROA, which proxies ROA's volatility. They are all computed over the *k* periods from *t-k+1* to *t*, where k is 12 quarters, in keeping with the empirical literature (Berger et al., 2016). A higher z-score indicates a safer bank (the higher the value of the chosen variable, the higher the risk). As we use data from consolidated statements, these series reflect the ex-post risk generated by all the operations of the banking group in both their home countries and those of their affiliates, both local and cross-border. Although this indicator has limitations as a risk measure, it has the advantage that it can be defined for non-listed institutions, which constitute the majority of our sample. Table 1 reports the descriptive statistics of the z-score along with other bank groups' key variables, such as profitability, size or efficiency.

We next define the set of complexity measures. Table 2 describes these measures and Table 3 reports the main descriptive statistics. Complexity measures are grouped into three categories: i) counts; ii) HHI based on net worth; and iii) Deviation in activity. In the first category we define the complexity of a bank group based on the number of countries (geographical areas) or the number of business activities. In the second category we construct normalised HHI where the size of each affiliate is given by its net worth. The HHI ranges between 0 and 1, where 0 represents the lowest complexity

[4] This category covers different activities such as investment funds, venture capital companies or securitisation funds.

[5] Since the z-score is highly skewed, we use the natural logarithm of the z-score which is normally distributed (Laeven and Levine, 2009).

and 1 the highest complexity. Complexity measures based on counts and HHI have been previously used in the literature (see Cetorelli and Goldberg, 2014). However, in contrast to previous studies, we use the affiliate size to construct the HHI instead of using the simple counts. The last category of complexity indicates deviation, in absolute terms, in certain business activities in and out Spain. This measure ranges between 0 and 1, where 0 indicates that there are no differences in the business model developed in the home country and abroad while 1 indicates completely different business models.

Complexity measures based on net worth provide a more accurate description of the bank group's activity, as they capture how the affiliates contribute to the group. However, the dynamics in affiliates' activity are similar using counts and net worth and thus, we do not expect large discrepancies across the different categories.

# 4. Empirical approach and results

## 4.1. Empirical approach

Our empirical analysis is focused on the effect of different types of complexity on banks' risk. We estimate, with OLS, equations of the form:

$$-\boldsymbol{ln}\,(\boldsymbol{z}-\boldsymbol{score_{it}}) = \boldsymbol{\beta_j ComplexityIndex_{it-k}} + \boldsymbol{\Gamma X_{it-k}} + \boldsymbol{\Theta Z_{t-k}} + \boldsymbol{\delta_t} + \boldsymbol{\xi_{it}} \qquad (2)$$

where the right-hand side variables are measured at period *t-k* to ensure that they are predetermined in relation to the dependent variable and *k* is the period over which we compute the risk variable. In general, we are interested in the sign and statistical significance of the complexity index coefficients ($\beta_j$). We include a set of control variables at bank group ($\boldsymbol{X_{it-k}}$) and macroeconomic ($\boldsymbol{Z_{t-k}}$) level. In addition, we include year fixed effects. We estimate all the equations with heteroskedasticity robust standard errors.

Among the bank controls we include a set of proxies of bank size (logarithm of total assets), efficiency (bank's operating expenses over total income), size of traditional activity (loan to asset ratio), liquidity (liquid assets over total assets) and asset quality (NPL). Table 1 reports their descriptive statistics.

We include a vector of time-varying macro variables to control for supply conditions in the home country. We proxy the financial cycle with the credit-to-GDP gap in the home country and business conditions with annual GDP growth.

## 4.2. Results

***H1. The combination of geographic complexity and business complexity results in higher risk***

Testing for H1 requires that we use, for each specification, a complexity index for business, one for geography and a combination of the two indices to capture the interaction. We thus define D.HighComplexity_CountryBusiness as a dummy variable that takes value 1 if the group has combined high geographic and business complexity, and zero otherwise. We consider that a banking group has high complexity in a given dimension if it presents values of the index at or above the median of the quarterly distribution.

Figure 2 reports the net worth HHI complexity indices that we use to test for this hypothesis and which are aligned with the patterns observed with count measures and already discussed in Section 3. The increase in dispersion in 2011 is also reflected in the HHI business, which also temporarily increases its dispersion at higher values (Panel A) in 2011 and 2012. The overall evolution shows that median business complexity in 2016 is higher than in 2005. Thus, the consolidation process that has taken place over these twelve years has generally resulted in higher complexity as measured by our index. We also observe larger median complexity in geographical terms between 2005 and 2016, with a large increase in dispersion, especially in the upper percentile, since 2011. However, complexity in geographic terms is much lower than in business terms, although they are not really comparable, as many banks have little or no activity abroad for most of the period under analysis (46 out of 97). It is only when restructuring has taken place that complexity in the geographic dimension grows.

Under H1 we are interested in the sign and statistical significance of the coefficients for the geographic and business complexity indices as well as in the coefficient of the interaction dummy. A positive sign would imply that agency costs predominate, while a negative sign indicates that diversification benefits predominate. The sign and statistical significance of the coefficient of the dummy captures the joint effect of geographic and business complexity. Thus, if our hypothesis holds, we can expect the coefficient to be positive. Table 4 reports the results of this analysis.

First, we consider the effects of business complexity on risk. According to the results recorded in column (1), when we use simple count indices, and in column (2) when we use net worth HHI, banks that show higher business complexity have higher risk. The more dispersed banking groups are in

relation to their activities, the higher their risk, a result which is aligned with the hypothesis that banks operating in business areas where they have less expertise become less effective in monitoring risk. Therefore, agency costs predominate when we consider diversification in business lines.

When we consider the effects of geographic complexity, we find that diversification benefits predominate. It therefore seems that the more geographically dispersed the affiliates of a bank are, the lower the risk. Such a result is aligned with empirical evidence that geographic expansion reduces risk when banks expand into areas with low macroeconomic correlation (Goetz et al., 2016), which is probably the case when the activity in a particular country is low, as captured by a high HHI. This finding is in keeping with the fact that most of the activity carried out by Spanish banking groups with affiliates located abroad is in countries whose synchrony with the Spanish business cycle is rather low. This less than perfect correlation could be the driver of diversification benefits (Argimón, 2017).

The interaction between the two complexity measures shows that agency costs predominate. Banking groups with high complexity in both geographic and business terms show higher risk. The estimated effects of the dummy variables are consistently positive, in both specifications, which is the expected direction under our hypothesis: the combination of geographic and business complexity results in higher risk.[6]

***H2. The higher the business complexity abroad in comparison to at home, the higher the risk***

To test for H2, comparing business complexity abroad and at home, we build the ratio of the complexity measure based on the affiliates located outside Spain relative to the complexity measure based on the affiliates located in Spain. The larger the ratio of the indices, the more complex the activity abroad in relation to the activity at home. Under H2 we expect the estimated coefficient of the ratio to be positive, if the hypothesis of loss of influence capacity associated with complexity holds.

We report the results in Table 5. Columns (1) – (2) report the results using the simple counts while columns (3) – (4) use the net worth HHI. The number of observations reported in columns (3) – (4) has been reduced to one third of the total, as the complexity at business level in Spain in two thirds

[6] The results are qualitatively the same when using the complexity measures at geographical level based on geographic areas instead of countries.

of the observations is zero. Columns (1) and (3) report the results when we only include the business complexity ratio in the regression and columns (2) – (4) when we also consider the complexity in the geographical dimension. Again, we obtain that geographic complexity reduces risk. Moreover, the positive sign estimated for the coefficient of the ratio of the indices confirms our hypothesis that more complexity abroad than at home reinforces agency problems and thus increases risk.

***H3. The higher the difference between the business line at home and the business line abroad, the higher the risk***

Finally, testing for H3 requires comparing the business model abroad and at home, using the *Deviation in Activity Indices* defined in Table 2. The larger the value of the complexity index, the more divergent are the activities carried out abroad in relation to those carried out at home. It does not matter whether the deviation is an upward one, with the affiliates abroad having more banking activity than the affiliates located in Spain, or a downward one, with the affiliates abroad having less banking activity than the affiliates located in Spain. In fact, there is no specific direction in the difference between the two weights, except in real estate, where the weight of affiliates abroad seems to be generally higher, as shown in Figure 3, which plots for each business activity, showing, in the vertical axis, the weight that the affiliates located abroad give to each activity relative to total activity abroad. The horizontal axis shows the same weight obtained for the affiliates located in Spain. We observe that for all activities, the distribution of observations above and below the 45-degree line, depicted in red, is rather similar, except for the concentration above the line in the real estate sector.

What matters for H3 is the size of the difference, as we expect that the larger the divergence is, the lower the influence capacity, and thus the higher the risk. We thus expect the sign of the coefficient to be positive. We have included in the equation to be estimated, besides the deviation index, and as an additional control, the weight that the net worth of affiliates located abroad has in total net worth. This variable captures the direct relevance of foreign activity on risk, thus complementing the effect provided by the complexity of such activity.[7]

Deviating from the activity that is carried out at home results in higher risk, as recorded in Table 6, while the higher the activity abroad, the lower the risk. The estimated coefficients for four out of the five complexity indices defined for each of the business lines are positive and significant. Only the

[7] The results hold if this control is removed.

coefficient for other financial activities is negative, but not statistically significant. The results are thus aligned with H3, in that the higher the difference between the business model at home and the business model abroad, the higher the risk.

## 5. Robustness checks

We have carried out two different robustness checks. The first one addresses the issue of outliers arising in relation to the timing of the merger processes, which could be driving the results. The second one addresses concerns in relation to ownership structure.

### 5.1. Relevance of timing of mergers

As already mentioned, during the period under analysis a widespread consolidation process took place in Spain, fostered either by public authorities or pushed by the reforms affecting the banking system. Part of the consolidation process involved the restructuring and rationalisation of deposit-taking institutions. Mergers and acquisitions were also part of the process and they took place mostly among domestic banks and only a very small number of large mergers were cross-border.[8] As we have used balance sheet data, the information recorded at the time of the merger may contaminate the analysis of how complexity affects risk, as there may be outliers driving the results that we have obtained. This could happen if the merger is large enough to deeply affect the balance sheet data. To deal with such concerns, we present the results obtained after dropping the observations of banks whose total assets have grown by more than 30% between any two consecutive quarters, in line with Meslier et al. (2016).

We have run tests for the same hypothesis as before. The results recorded in the first two columns of Table 7 and in Panel A of Tables 8 and 9 are qualitatively similar to the results presented so far. The only difference is that under H3 (Table 9), the coefficient for the difference between insurance activities at home and abroad is not statistically significant. Therefore, these results also support the hypothesis that a reduction in monitoring associated with increased complexity results in higher risk.

### 5.2. Relevance of ownership

The relevance that saving banks and, to a lesser degree, mutual funds, have had in Spain calls into

[8] See Berges et al. (2012) for a description of the internationalisation process of Spanish banks and Banco de España (2017) for a report on the financial and banking crisis in Spain.

question whether the results obtained in our analysis reflect the relationship between risk and complexity for these types of institutions. We tend to regard them as not being complex institutions and, consequently, the relationship between complexity and risk seems to be more difficult to establish. In particular, Spanish saving banks barely had any foreign subsidiaries in 2009 (around 5.6% of the total, Berges et al., 2012). Moreover, they underwent a process of transformation, first expanding their areas of activity both geographically and in business terms and then merging. They thus significantly changed their structure and increased their complexity.

We have run the same regressions as before, but including only saving banks and mutual funds in the estimation. Those saving banks that chose to pursue their activities through instrumental banks are treated, for the sake of this analysis, as saving banks over the whole period.

The results presented in columns (3) – (4) in Table 7 and in Panels B of Tables 8 and 9 are consistent with those obtained so far. The main differences stem from the lower relevance of the activity carried out by saving banks abroad in relation to banks, and from the countries in which they have affiliates. So, having excluded banks from the analysis, we have estimated a positive effect of geographic complexity on risk (columns (3) and (4) in Table 7; columns (2) and (4) in Panel B of Table 8). For the overall sample we have found a diversification benefit from having affiliates abroad. In fact, in Panel B of Table 9, we find that the share of foreign activity has a statistically significant positive impact on risk in some cases. The high share of saving banks' activity abroad which takes place in EU countries (Berges et al., 2012) may explain the different results, as it does not allow us to capture the diversification benefits arising from low business cycle correlation.

## 6. Conclusions

In this paper we empirically examine the effect on banks' risk of geographic and business complexity, taking into account their interaction and their relative importance. The use of Spanish confidential supervisory data and more specifically, the equity instrument portfolio, enables us to investigate how geographic and business complexity at home and abroad affect risk. We have found that while business complexity results in higher risk, geographic complexity gives rise to diversification benefits, thus to lower risk. However, geographic complexity alone is not enough: its effects depend

on how it interacts with business complexity. High business complexity abroad in relation to that at home counterbalances the benefits of diversification. In the same vein, focusing abroad on business areas in which the group has no expertise at home also results in higher risk.

We have provided evidence of the type of geographic or business diversification or consolidation that would increase distance-to-default and thus sustain profitability in the long run. Our analysis is relevant given the current concerns regarding the European banking sector's low profitability in a low interest environment and how to improve it to make it sustainable. Our analysis provides support for the view that geographic and business complexity needs to be treated separately for regulatory purposes. Geographic complexity may generate diversification benefits depending on how and where it takes place. Higher complexity abroad or focusing abroad on business areas in which banks have no expertise at home may counterbalance any benefits arising from the less than perfect correlation of business cycles.

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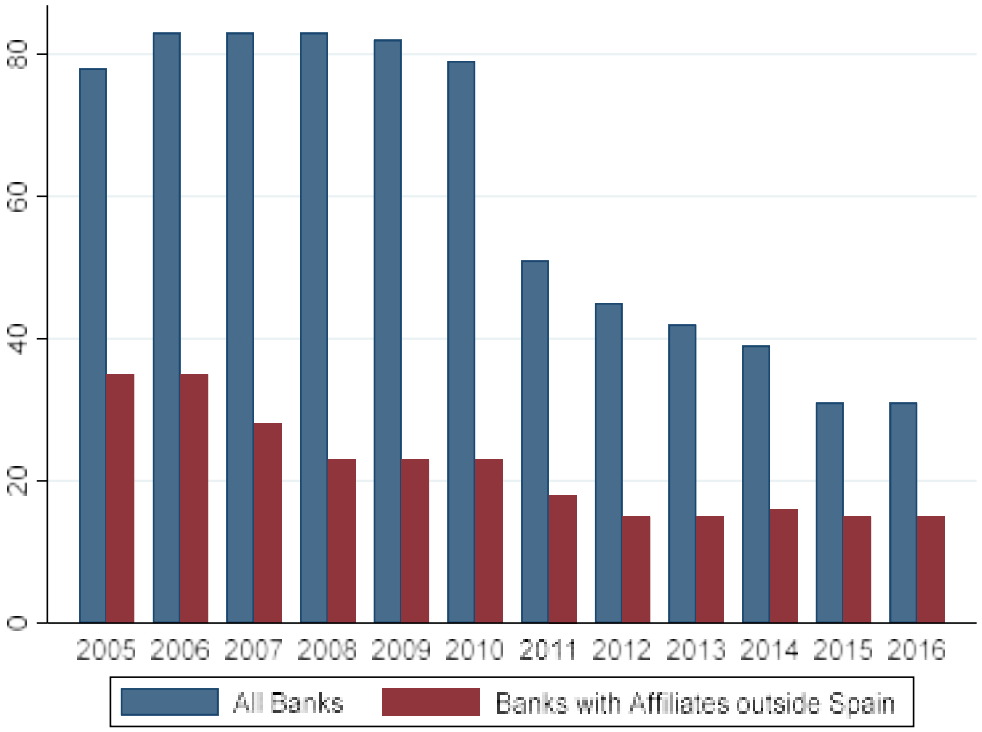
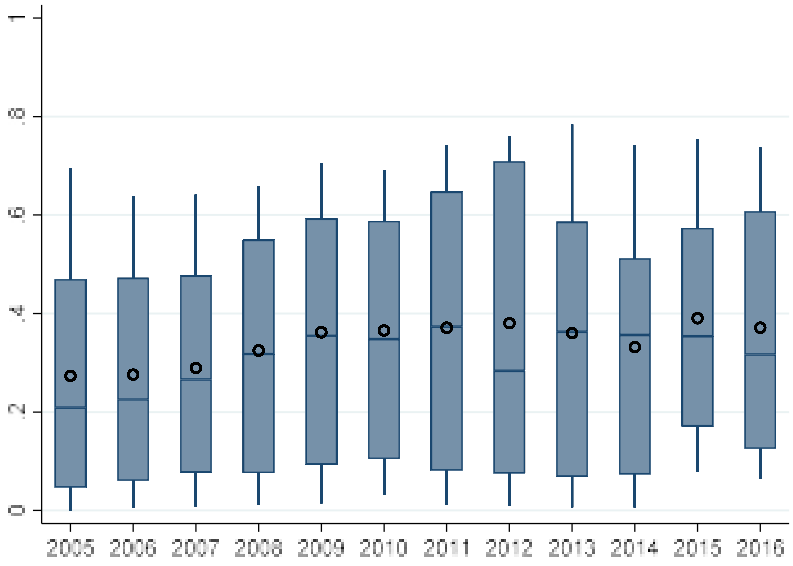



**Figure 1: Number of Banks**

Figure 1 depicts the number of banks over the period 2005 - 2016 for all banks and for banks with affiliates (including non-financial affiliates) located outside Spain.

**Panel A: HHI by Business Line**




**Panel B: HHI by Country**

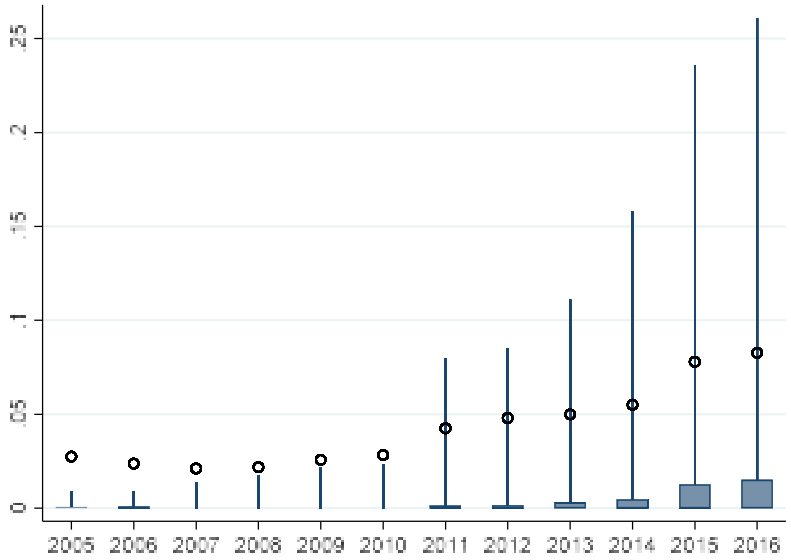



**Figure 2:HHI Net Worth**

Figure 2 depicts the box plot of the Herfindahl-Hirschman Index (HHI) weighted by net worth from 2005 to 2016. Each box plot represents the 10th, 25th, 50th, 75th and 90th percentiles while the circle represents the mean of the distribution. Panel A represents the HHI based on the distribution of affiliates among business lines (*HHI_NW_Business*). Panel B contains the HHI based on the distribution of affiliates among countries (*HHI_NW_Country*).

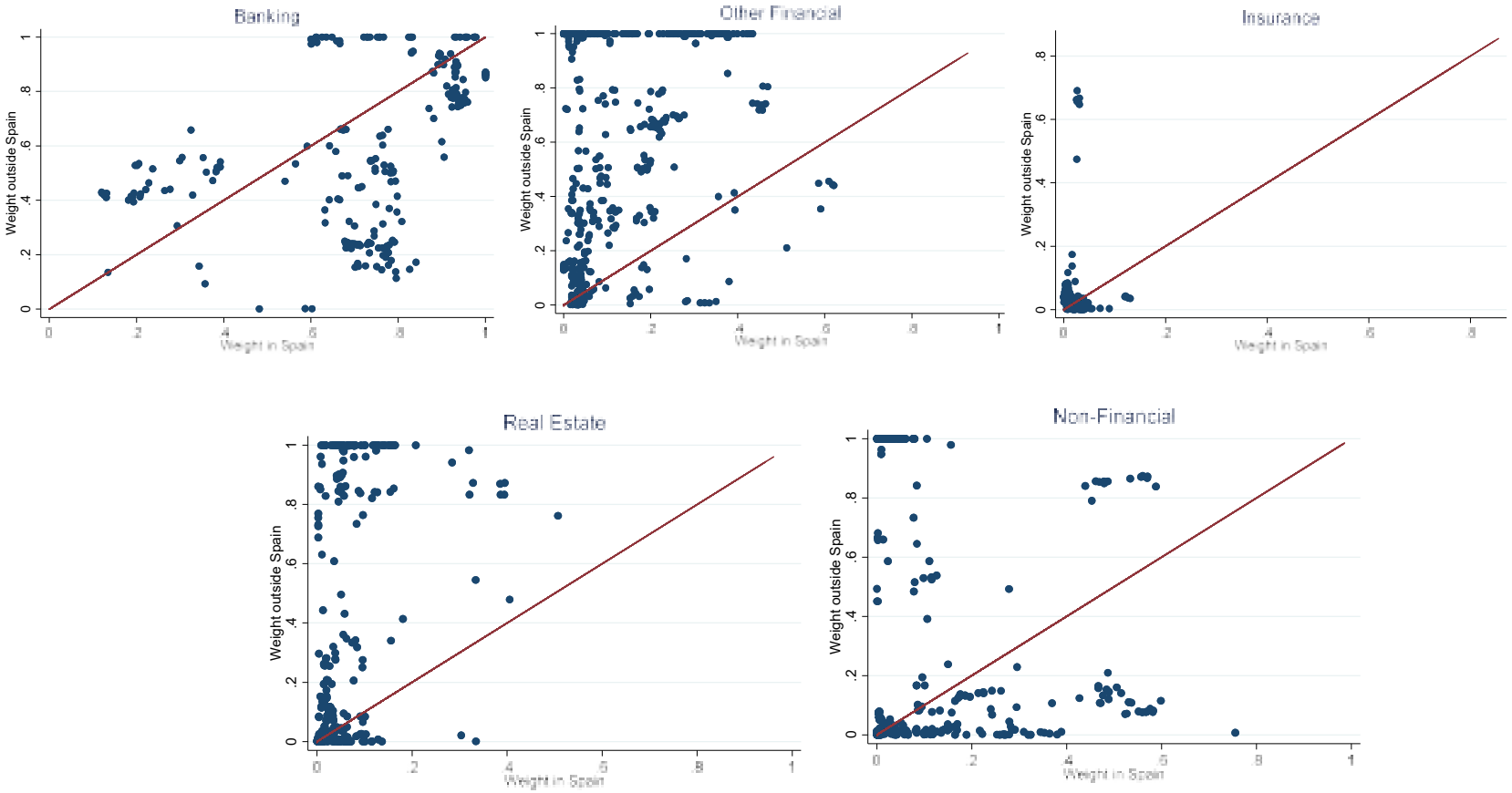



**Figure 3: Deviation in Activity**

Figure 3 depicts the scatter plot of each bank group weight of a specific business line located in Spain versus its weight outside Spain. The red lines represent the 45-degree line. We consider 5 categories: i) banking; ii) other financial; iii) insurance; iv) real estate; and v) non-financial.

**Table 1: Descriptive Statistics**

Table 1 shows the main descriptive statistics of banks' characteristics and the macroeconomic factors. It provides information about the measurement units, mean, median, standard deviation (SD), 10th percentile (P10) and 90th percentile (P90).

| **Panel A: Bank's characteristics** | | | | | | |
|---|---|---|---|---|---|---|
| | **Units** | **Mean** | **Median** | **SD** | **P10** | **P90** |
| z-score | - | 50.00 | 42.32 | 39.72 | 11.04 | 98.27 |
| ROA | **%** | 0.55 | 0.54 | 1.21 | 0.13 | 1.16 |
| ROE | **%** | 7.54 | 8.12 | 15.61 | 2.04 | 16.52 |
| *Total assets (TA)* | Million € | 56,607.10 | 9,273.68 | 171,396.70 | 778.74 | 95,037.08 |
| *Loan/TA* | % | 65.03 | 70.40 | 20.69 | 39.67 | 82.49 |
| *NPL* | % | 4.14 | 2.76 | 4.56 | 0.43 | 9.61 |
| *Efficiency ratio* | % | 56.17 | 54.60 | 14.76 | 38.82 | 73.48 |
| *Liquid assets/TA* | % | 1.91 | 1.23 | 2.77 | 0.41 | 3.50 |
| **Panel B: Macroeconomic factors** | | | | | | |
| *Credit-to-GDP gap* | % | 13.45 | 25.95 | 28.80 | -34.68 | 41.35 |
| *GDP growth (y-o-y)* | % | 0.86 | 1.20 | 2.84 | -3.40 | 4.00 |

**Table 2: Definition of Complexity Measures**

| **Panel A: Counts** | |
|---|---|
| *Num. Affiliates* | Number of affiliates. |
| *Num. Countries* | Number of countries in which a bank group has affiliates. |
| *Num.Business* | Number of business lines in which a bank group has affiliates. |

**Panel B: Herfindahl-Hirschman Index (HHI) based on net worth**

$$HHI\_NW_{i,t} = \frac{R}{(R-1)}\left(1 - \sum_{j=1}^{R}\left(\frac{net\ worth_t^j}{total\ net\ worth_t}\right)^2\right)$$

| | |
|---|---|
| *HHI_NW_NetWorth* | HHI based on the affiliates' structure. R corresponds to the maximum number of affiliates observed by a bank group in the database and *net worth* to the net worth of the affiliate *j* of bank *i* at time *t*. |
| *HHI_NW_Business* | HHI based on the business lines. R corresponds to the maximum number of categories and *net worth* to the aggregate net worth of affiliates of bank *i* in business line *j* at time *t.* |
| *HHI_NW_Country* | HHI based on the location of the affiliates at country level. R corresponds to the maximum number of countries observed by a bank group in the database and *net worth* to the aggregate net worth of affiliates of bank *i* located in country *j* at time *t.* |
| *HHI_NW_Business_Spain* | HHI based on the business lines located in Spain. R corresponds to the maximum number of categories and *net worth* to the aggregate net worth of affiliates located in Spain of bank *i* in business line *j* at time *t.* |
| *HHI_NW_Business_Abroad* | HHI based on the business lines located outside Spain. R corresponds to the maximum number of categories and *net worth* to the aggregate net worth of affiliates located outside Spain of bank *i* in business line *j* at time *t.* |

**Panel C: Deviation in Activity**

$$Deviation\_Business_{j,i,t} = abs\left(\frac{net\ worth\ abroad_t^j}{total\ net\ worth\ abroad_t} - \frac{net\ wort\ Spain_t^j}{total\ net\ worthSpain_t}\right)$$

| | |
|---|---|
| *Deviation_Banking* | Absolute value of the difference in the weight of banking activity of affiliates in and out of Spain. |
| *Deviation_OtherFinancial* | Absolute value of the difference in the weight of other financial activity of affiliates in and out of Spain. |
| *Deviation_Insurance* | Absolute value of the difference in the weight of insurance activity of affiliates in and out of Spain. |
| *Deviation_RealEstate* | Absolute value of the difference in the weight of real estate activity of affiliates in and out of Spain. |
| *Deviation_NonFinancial* | Absolute value of the difference in the weight of non-financial activity of affiliates in and out of Spain. |

**Table 3: Complexity Measures Descriptive Statistics**

Table 3 shows the main descriptive statistics of the complexity measures. Complexity measures are grouped into three categories: i) counts (panel A); ii) HHI based on the affiliates' net worth (panel B); and iii) Deviation in activity (panel C). It provides information about the mean, median, standard deviation (SD), 10th percentile (P10) and 90th percentile (P90).

| | **Mean** | **Median** | **SD** | **P10** | **P90** |
|---|---|---|---|---|---|
| Panel A: Counts | | | | | |
| *Num. Affiliates* | 39.239 | 13.000 | 84.565 | 2.000 | 79.000 |
| *Num. Countries* | 3.056 | 1.000 | 6.301 | 1.000 | 5.000 |
| *Num. Business* | 3.954 | 4.000 | 1.207 | 2.000 | 5.000 |
| Panel B: HHI using Net Worth | | | | | |
| *HHI_NW_NetWorth* | 0.332 | 0.286 | 0.271 | 0.010 | 0.719 |
| *HHI_NW_Business* | 0.336 | 0.296 | 0.262 | 0.011 | 0.724 |
| *HHI_NW_Country* | 0.037 | 0.000 | 0.144 | 0.000 | 0.035 |
| *HHI_NW_Business_Spain* | 0.330 | 0.295 | 0.258 | 0.010 | 0.703 |
| *HHI_NW_Business_Abroad* | 0.194 | 0.000 | 0.271 | 0.000 | 0.633 |
| Panel C: Deviation in Activity | | | | | |
| *Deviation_Banking* | 0.590 | 0.644 | 0.290 | 0.140 | 0.940 |
| *Deviation_OtherFinancial* | 0.464 | 0.389 | 0.377 | 0.011 | 0.990 |
| *Deviation_Insurance* | 0.035 | 0.018 | 0.087 | 0.000 | 0.071 |
| *Deviation_RealEstate* | 0.160 | 0.024 | 0.292 | 0.000 | 0.838 |
| *Deviation_NonFinancial* | 0.186 | 0.039 | 0.297 | 0.000 | 0.758 |

**Table 4: Combination of Complexity at Different Dimensions**

Table 4 reports the results of hypothesis 1. The dependent variable is the negative log of z-score computed over 12 quarters. Each specification contains three complexity measures: i) complexity measure relative to the business line; ii) complexity measure relative to the location of affiliates at country level; and iii) a dummy variable that takes value 1 when the previous complexity measures are above the median of the quarterly distribution, simultaneously, and which is the variable of interest. Column (1) use counts as complexity measures while column (2) use HHI based on the affiliates' net worth. For the complexity relative to the business line we use Num. Business and HHI_NW_Business measures. Heteroskedasticity robust standard errors are reported in brackets. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

| | (1) | (2) |
|---|---|---|
| Type of Complexity Measure: | Counts | HHI_NW |
| Dependent Variable: | -ln(z-score) | |
| *Complexity_Business*$_{t-1}$ | 0.143*** | 0.432*** |
| | (0.000) | (0.003) |
| *Complexity_Country*$_{t-1}$ | -0.026*** | -1.074*** |
| | (0.000) | (0.000) |
| *D.HighComplexity_CountryBusiness*$_{t-1}$ | 0.573*** | 0.402*** |
| | (0.000) | (0.000) |
| Bank Controls | Yes | Yes |
| Macroeconomic Controls | Yes | Yes |
| Year FE | Yes | Yes |
| Observations | 1,428 | 1,428 |
| R-squared | 0.243 | 0.234 |

**Table 5: Relative Business Line Complexity**

Table 5 reports the results of hypothesis 2. The dependent variable is the negative log of z-score computed over 12 quarters. The variable of interest is the ratio between the complexity measure at business lines located in Spain and out of Spain. Columns (1) - (2) report the results using the simple counts to define the complexity measure while columns (3) - (4) use the HHI based on the affiliates' net worth. Additionally, we control in columns (2) and (4) by the complexity measure based on the location of the affiliates at country level. Heteroskedasticity robust standard errors are reported in brackets. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Type of Complexity Measure: | Counts | | HHI_NW | |
| Dependent Variable: | -ln(z-score) | | | |
| *Complexity_Business_Abroad*$_{t-1}$/*Complexity_Business_Spain*$_{t-1}$ | -0.000 | 0.005*** | 0.006*** | 0.005*** |
| | (0.001) | (0.002) | (0.000) | (0.000) |
| *Complexity_Country*$_{t-1}$ | | -0.032*** | | -0.788*** |
| | | (0.005) | | (0.009) |
| Bank controls | Yes | Yes | Yes | Yes |
| Macroeconomic Controls | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Observations | 1428 | 1428 | 494 | 494 |
| R-squared | 0.213 | 0.231 | 0.297 | 0.306 |

**Table 6: Deviation in Business Activity**

Table 6 reports the results of hypothesis 3. The dependent variable is the negative log of z-score computed over 12 quarters. In each specification the variable of interest is the deviation in the size of the activity *j* inside and outside Spain. Column (1) refers to banking; column (2) to other financial; column (3) to insurance; column (4) to real estate; and column (5) to non-financial activities. As an additional control variable we include the weight of the affiliates outside Spain in terms of their net worth (NW_Abroad/NW). Heteroskedasticity robust standard errors are reported in brackets. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Dependent Variable: | | | -ln(z-score) | | |
| *Deviation_Banking*$_{t-1}$ | 0.574** | | | | |
| | (0.010) | | | | |
| *Deviation_OtherFinancial*$_{t-1}$ | | -0.063 | | | |
| | | (0.656) | | | |
| *Deviation_Insurance*$_{t-1}$ | | | 0.626* | | |
| | | | (0.095) | | |
| *Deviation_RealEstate*$_{t-1}$ | | | | 0.632** | |
| | | | | (0.018) | |
| *Deviation_NonFinancial*$_{t-1}$ | | | | | 0.704*** |
| | | | | | (0.006) |
| *NW_Abroad/NW*$_{t-1}$ | -0.621* | -0.778** | -0.705** | -0.566* | -0.758** |
| | (0.064) | (0.022) | (0.040) | (0.093) | (0.025) |
| Bank Controls | Yes | Yes | Yes | Yes | Yes |
| Macroeconomic Controls | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 461 | 461 | 461 | 461 | 461 |
| R-squared | 0.292 | 0.281 | 0.284 | 0.295 | 0.299 |

**Table 7: Combination of Complexity at Different Dimensions (Robustness)**

Table 7 reports a variation of Table 4 with respect to the observations included in the analysis. Panel A excludes those mergers in which we observe an increase of more than 30% in the bank's total assets. Panel B excludes institutions classified as banks before the reform of the Spanish banking system. The dependent variable is the negative log of Z-score computed over 12 quarters. Each specification contains three complexity measures: i) complexity measure relative to the business lines; ii) complexity measure relative to the location of affiliates; and iii) a dummy variable that takes value 1 when the previous complexity measures are above the median of the quarterly distribution, simultaneously. Columns (1) uses counts as complexity measures while column (3) uses HHI based on the affiliates' net worth. For the complexity relative to business lines we use Num. Business and HHI_NW_Business measures. For the complexity relative to location, we use the definition for country (Num. Country and HHI_NW_Country in column (1) and (2), respectively)). Heteroskedasticity robust standard errors are reported in brackets. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

| | Excluding Mergers | | Excluding Banks | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Type of Complexity Measure: | Counts | HHI_NW | Counts | HHI_NW |
| Dependent Variable: | -ln(z-score) | | | |
| *Complexity_Business*$_{t-1}$ | 0.145*** | 0.495*** | 0.287*** | 0.814*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| *Complexity_Country*$_{t-1}$ | -0.026*** | -1.192*** | 0.112*** | 4.338*** |
| | (0.000) | (0.000) | (0.000) | (0.001) |
| *D.HighComplexity_CountryBusiness*$_{t-1}$ | 0.580*** | 0.476*** | 0.301** | 0.399*** |
| | (0.000) | (0.000) | (0.015) | (0.001) |
| Bank Controls | Yes | Yes | Yes | Yes |
| Macroeconomic Controls | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Observations | 1.414 | 1.414 | 1,002 | 1,002 |
| R-squared | 0.243 | 0.237 | 0.394 | 0.365 |

**Table 8: Relative Business Line Complexity (Robustness)**

Table 8 reports a variation of Table 5 with respect to the observations included in the analysis. Panel A excludes those mergers in which we observe an increase of more than 30% in the banking group's total assets. Panel B excludes, instead, institutions classified as banks before the reform of the Spanish banking system. The dependent variable is the negative log of z-score computed over 12 quarters. The variable of interest is the ratio between complexity measure based on the business lines located in Spain and out of Spain. Additionally, we control by the complexity measure based on the location of the affiliates. Columns (1) – (2) use the complexity measure based on counts while columns (3) – (4) the measures based on the HHI of the affiliates' net worth. Heteroskedasticity robust standard errors are reported in brackets. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

| Panel A. Excluding Mergers | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Type of Complexity Measure: | Counts | | HHI_NW | |
| Dependent Variable: | -ln(z-score) | | | |
| *Complexity_Bus_Abroad$_{t-1}$/Complexity_Bus_Spain$_{t-1}$* | 0.000 | 0.005*** | 0.006*** | 0.005*** |
| | -0.001 | (0.002) | (0.000) | (0.000) |
| *Complexity_Country$_{t-1}$* | | -0.032*** | | -0.790*** |
| | | (0.005) | | (0.009) |
| Bank Controls | Yes | Yes | | Yes |
| Macroeconomic Controls | Yes | Yes | | Yes |
| Year FE | Yes | Yes | | Yes |
| Observations | 1414 | 1414 | 488 | 488 |
| R-squared | 0.212 | 0.230 | 0.298 | 0.306 |
| Panel B. Excluding Banks | | | | |
| Type of Complexity Measure: | Counts | | HHI_NW | |
| Dependent Variable: | -ln(z-score) | | | |
| *Complexity_Bus_Abroad$_{t-1}$/Complexity_Bus_Spain$_{t-1}$* | 0.011*** | 0.004*** | 0.007*** | 0.006*** |
| | (0.002) | (0.002) | (0.000) | (0.000) |
| *Complexity_Country$_{t-1}$* | | 0.089** | | 2.030** |
| | | (0.037) | | (0.024) |
| Bank Controls | Yes | Yes | Yes | Yes |
| Macroeconomic Controls | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Observations | 1002 | 1002 | 332 | 332 |
| R-squared | 0.377 | 0.382 | 0.514 | 0.519 |

**Table 9: Deviation in Business Activity (Robustness)**

Table 9 reports a variation of Table 6 with respect to the observations included in the analysis. Panel A excludes those mergers in which we observe an increase of more than 30% in the banking group's total assets. Panel B excludes, instead, institutions classified as banks before the reform of the Spanish banking system. The dependent variable is the negative log of Z-score computed over 12 quarters. In each specification the variable of interest is the deviation in the size of activity j inside and outside Spain. Column (1) refers to banking; column (2) to other financial; column (3) to insurance; column (4) to real estate; and column (5) to non-financial activities. As an additional control variable we include the weight of the affiliates outside Spain in terms of their net worth. Heteroskedasticity robust standard errors are reported in brackets. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

| Panel A: Excluding Mergers | | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Dependent Variable: | | | -ln(z-score) | | |
| *Deviation_Banking*$_{t-1}$ | 0.568** | | | | |
| | (0.013) | | | | |
| *Deviation_OtherFinancial*$_{t-1}$ | | -0.062 | | | |
| | | (0.661) | | | |
| *Deviation_Insurance*$_{t-1}$ | | | 0.577 | | |
| | | | (0.138) | | |
| *Deviation_RealEstate*$_{t-1}$ | | | | 0.630** | |
| | | | | (0.019) | |
| *Deviation_NonFinancial*$_{t-1}$ | | | | | 0.709*** |
| | | | | | (0.006) |
| *NW_Abroad/NW*$_{t-1}$ | -0.624* | -0.780** | -0.718** | -0.564* | -0.761** |
| | (0.065) | (0.023) | (0.038) | (0.098) | (0.026) |
| Bank Controls | Yes | Yes | Yes | Yes | Yes |
| Macroeconomic Controls | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 455 | 455 | 455 | 455 | 455 |
| R-squared | 0.294 | 0.283 | 0.285 | 0.296 | 0.301 |
| Panel B: Excluding Banks | | | | | |
| *Deviation_Banking*$_{t-1}$ | 0.808*** | | | | |
| | (0.000) | | | | |
| *Deviation_OtherFinancial*$_{t-1}$ | | -0.174 | | | |
| | | (0.287) | | | |
| *Deviation_Insurance*$_{t-1}$ | | | 0.732** | | |
| | | | (0.029) | | |
| *Deviation_RealEstate*$_{t-1}$ | | | | 0.509** | |
| | | | | (0.032) | |
| *Deviation_NonFinancial*$_{t-1}$ | | | | | 0.500** |
| | | | | | (0.026) |
| *NW_Abroad/NW*$_{t-1}$ | 3.125*** | 1.552 | 1.673 | 2.300* | 1.535 |
| | (0.007) | (0.375) | (0.316) | (0.091) | (0.363) |
| Bank Controls | Yes | Yes | Yes | Yes | Yes |
| Macroeconomic Controls | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 299 | 299 | 299 | 299 | 299 |
| R-squared | 0.513 | 0.500 | 0.502 | 0.507 | 0.508 |

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