Asset Specialization as a Long-Term Strategy for Banks in Mexico

Luis Felipe Llanos[1] - Universidad Anáhuac México, México
César Vela-Beltrán-del-Río - Universidad Anáhuac México, México

Abstract

Our objective is to establish whether the level of assets, liabilities, and income diversification of the Mexican banks is related to their profitability and risk levels. Using the financial information of the 15 key banks, between 2010 and 2021, along with the Herfindahl-Hirschman Index and a series of polynomial regression analyzes, we calculated the diversification level of each bank. We also computed a series of inflection points suggesting that Mexican banks need to adopt an asset specialization long-term strategy, but to a point because a radical transformation would be detrimental to both return and risk. Similarly, we do not recommend venturing into a radical income diversification strategy, for the same reason. On the other hand, the liability diversification strategy is difficult to apply for achieving the mentioned objectives. Furthermore, we would like to emphasize that our analysis takes into consideration the high presence of foreign banking affiliates in Mexico.
JEL Classification: M40, M21, M16.

Keywords: asset diversification, liability diversification, income diversification, banking diversification, banks in Mexico.

La especialización de activos como estrategia de largo plazo para la banca en México

Resumen

El objetivo del artículo conocer si el nivel de diversificación de activos, pasivos o ingresos, de los bancos mexicanos está relacionado con su rentabilidad o riesgo. Con información financiera entre el 2010 y 2021, de los 15 principales bancos, se recurrió al Índice Herfindahl-Hirschman para calcular el nivel de diversificación de activos, pasivos o ingresos de cada uno de los bancos, y a partir de una serie de análisis de regresión polinomial sobre las variables de rentabilidad y riesgo, se obtuvieron una serie de puntos de inflexión que sugieren que los bancos mexicanos requieren adoptar una estrategia de largo plazo de especialización de activos, pero solo hasta cierto punto, ya que si se quiere una transformación radical sería perjudicial para la rentabilidad y el riesgo. Por otra parte, se sugiere no incursionar en una modificación radical de sus fuentes de ingresos. Mientras que los pasivos son más difíciles de manipular para lograr los objetivos mencionados. Lo interesante del estudio es el alcance sobre el sistema bancario mexicano, el cual tiene una la alta presencia de filiales extranjeras.
Clasificación JEL: M40, M21, M16.

Palabras clave: diversificación de activos, diversificación de pasivos, diversificación de ingresos, diversificación bancaria, bancos en México.

---

[1] Corresponding author. Professor – Researcher at Facultad de Economía y Negocios. E-mail: luis.llanos@anahuac.mx; orcid.org/0000-0002-8984-6314.

1. Introduction

Asset, liability, and income diversification is a management required skill, directly related to the business´s results and the strategic and financial development of companies (Campa, and Kedia, 2002; Denis, et al., 1997), for over three decades.

Furthermore, due to a greater degree of financial liberalization throughout the world and access to the internet telecommunication tools, the banking industry has experienced significant changes throughout the world (Ghosn, 2019; Muñoz, et al., 2020). This financial liberalization and the internet telecommunications tools have had a significant impact on its performance (Shim, 2019; Verlekar, 2019); therefore, the interest to revisit the topic, now from the Mexican perspective, to evaluate their effect over profitability, and/or its risk.

In an effort to understand the magnitude of such effects, we analyzed the worldwide banking diversification experiences and research in relation to **a)** bank profitability (Trujillo Ponce, 2013; Sanya, and Wolfe, 2011; Chavarín Rodríguez, 2015) and (Jara, et al., 2011); and **b)** bank risk (Stiroh, 2004; Stiroh, 2006; Lepetit, et al., 2008; Sanya, and Wolfe, 2011; Kim, et al., 2020), and (Marinho, and de Araújo, 2016). The mentioned above authors agree that the income diversification is beneficial for banks. As examples of income diversification, we can mention, in addition to the interest-bearing securities, collecting non-interest income: such as fee income, trading revenue, and other types of non-interest income (Stiroh, 2004).

This research paper´s objective is to increase the level of analysis of the Mexican banking industry and to empirically test if diversity, related to their assets, liabilities, and income, affects or benefits Mexican banks in relation to its profitability and /or risk. Some of the questions that we would like this paper to answer: Are the effects of income, assets, and liabilities diversification permanent on the banks' performance? Are the effects of income, assets, and liabilities diversification permanent on the banks´ risk? And / or, on the other hand, is there a turning point where diversification is no longer convenient, for the banks' performance and / or risk? And is it necessary to think more about banks' specialization?

The Mexican banking system is an interesting case study, especially because of the high presence of foreign affiliates (65% of the total banking assets held in Mexico). Forty years ago, the Mexican banking sector was made up mainly of specialized local intermediaries and limited foreign competition. After the 1982 bank expropriation, the industry became wholly state-owned for less than two decades. The structural changes in the banking sector were catalyzed by the post-crisis reforms in 1995 and the North American Free Trade Agreement (NAFTA). These reforms accelerated the local expansion of international banking intermediaries, which led to the consolidation of the local banking system. Today, this industry is populated by both foreign and domestic financial institutions.

We will structure the article with the following sections: 1. Introduction, 2. Theoretical framework, 3. Study´s hypothesis, 4. Methodology, 5. Empirical results, and 6. Conclusions and discussions.

2. Theoretical framework

The banking diversification literature in the developed countries is extensive; however, in the case of Latin America the literature is uncommon, and in the Mexican case of we only identified two articles.

The first author that studied the diversification effects on the banking sector was Xu (1996), who analyzed five Canadian banks, between 1978 and 1985. His main result suggests that the Canadian banks benefited from an international diversification strategy, generating an increased performance stability because it was linked to the systematic risk reduction of the national market. A second related article was that of Allen, and Jagtiani (2000), who analyzed 729 American banks, between 1986 and 1994. For these authors, bank diversification was accomplished by linking "security trading," a non-banking activity, to the traditional banking activities. This diversification linkage and its relationship to the banks' profitability, suggests that non-banking operations increase the systematic market risk, which reduces the capacity of the company for additional, traditional business. In other words, banks that financed their assets with traditional deposits were less exposed to the interbank environment and were, to a lesser extent, affected by financial crises. A third related article was Archaya, et al. (2002), who analyzed 105 Italian banks, between 1993 and 1999. The authors´ findings suggest that the optimal bank strategy would be the specialization into few banking products.

We started using "diversification" and "banking" as keywords in specialized search engines, in both English and Spanish. We obtained 29 articles and performed an in-depth literature review, on the banking diversification effects. In various countries and regions of the world. The analyzed articles, spanned their analysis from 1978 to 2019 (Annex A shows the details of the 29 studies identified and related to banking diversification.)

Our first bibliographic finding was the identification of five different diversification strategies, or independent variables, used to improve performance and reduce risk: 20 articles (69.0%) used Income as an independent variable; six (20.7%) used Market; four (13.8%) used Portfolio; one (3.4%) used Assets as a variable, and one (3.4%) used Geographic diversification. (It is important to notice that the summation percentage is larger than 100%, since there are three articles that each presented two diversification strategies.)

As a second finding, the results of diversification, or the dependent variables, we identified five outcomes that affected the banks´ outcomes: the effect of the independent variables resulted in impacting the Yield in 17 articles (58.6%); the Risk in 14 articles (48.3%); the Costs in one article (3.4%); the Management in one article (3.4%); and the Revenue in one article (3.4%) %. (Again, as explained in the previous paragraph, it is important to notice that the percentage summation is larger than 100%, since there are five articles that analyzed both risk and return).

When we talk about bank income diversification options, we mean, in addition to the traditional interest income securities, non-interest income: such as fee income, trading revenue, and other types of non-interest income (Stiroh, 2004). The same author points out that the income diversification strategy means a structural change of the bank´s operation, where the income increases are not related to credit operations increases. However, studies confirm that income diversification, produces both positive and negative results (Astrid Martínez, 2016).

Income diversification studies with positive results: Smith, et al. (2003) in Western European found that, there is a positive relationship related to income diversification. In Italy, Chiorazzo, et al. (2008), identified that increases in non-banking income positively influences profitability, adjusted for risk. However, this benefit decreases as banks grow. Similarly, Elsas, et al. (2006), explored the banking systems in nine developed countries, and confirmed that income diversification, either by via organic growth or via a merger, increases profitability and that such profitability is associated with a higher market valuation. Sanya, and Wolfe (2011) analyzed the banking system of 11 emerging countries and found that diversification from both interest income and interest-free income delivers positive results. Likewise, Jara, et al. (2011) compared banks from six Latin American countries against the American banking, and found that diversification through non-traditional banking activities, which is a predominant factor in Latin American banking system, has positive effects on the banks´ performance. Carrera (2019) in Ecuador, identified that when income diversification increases the risk of insolvency tends to decrease. Furthermore, Chavarín Rodríguez (2015), looking for the main profitability determinants of the Mexican commercial banks, found that the main explanatory factors are the collection of commissions and fees, regardless of the nationality of the capital ownership.

Studies that describe negative results when income diversification is applied: Stiroh (2004) suggests that there is little benefit from using an income diversification strategy, basically shifting towards interest-free income. This research, conducted on more than 14,000 American banks. Additionally, Palomino (2015) reviewed the diversification path of the Spanish banks and corroborated that there is an inverse relationship between income diversification and profitability, risk adjusted. Moreover, Marinho, and de Araújo (2016) performed their research in Brazil, identified that the income diversification strategy did not influence the insolvency risk. In addition, Abuzayed, et al. (2018) found a negative relationship between income diversification and Islamic bank stability. Allen and Jagtiani (2000) suggested that the diversification benefits, when considered in isolation from the traditional bank operations, is not large enough to justify its diversification expansion. Lepetit, et al. (2006) found that European banks when diversify their income, from new business lines, must anticipate and prepare for the upcoming operational challenges. This is particularly the case for income diversification strategies since they represent a greater risk than for those banks that concentrate on interest-bearing securities, and / or participate on the small banks segment. Furthermore, Mercieca, et al. (2007), analyzed the European banking system and did not find a direct benefit for their new business lines, from an income diversification strategy; they did find though an inverse association between non-interest income and bank performance. In this sense, Lepetit, et al. (2008), in a detailed investigation showed that there is a positive relationship between risk and product diversification; such relationship is stronger for small banks and that in all cases, risk is mostly positively correlated with the participation in commission-based activities, but not with trading activities. Finally, Lastre-Valdés (2015) points out that the entities that divert from their main objectives, to increase profits and generate value, show a higher risk associated with insolvency.

Income diversification recent studies: Escobar (2019) analyzed the effects of income diversification. This research showed an improved bank performance, via higher returns in a multiproduct industry. However, the results also indicate that the income diversification benefit is reversed in periods of economic or financial crises. Kim, et al. (2020) found a significantly non-linear

effect (inverted U-shaped) between the applied income diversification strategy and the bank´s financial stability. This research suggest that a moderate degree of bank diversification increases bank stability, but excessive diversification has an adverse effect. On a continuing analysis, considering periods with and without crisis, the authors suggest that it is better for banks to concentrate on traditional intermediation functions (deposits and loans), instead of diversifying their activities and investments. Paltrinieri, et al. (2021) not found some relationship between income diversification and stability for both conventional and Islamic banks. Finally, Muñoz, et al. (2020) showed that income diversification had a positive and non-linear effect on the banks´ performance. The non-linear link suggests that the positive effect is reversed if the banking industry is highly diversified. Furthermore, on a continuing analysis, considering periods with and without crisis, the authors suggest that, during crisis periods, the banking industry must reduce its degree of diversification to obtain a higher performance.

Studies related to the effects of asset, portfolio, and other diversification strategies: Archaya, et al. (2002), using data from Italian banks, compared the specialization effect, portfolio diversification, geographical operations, and sectorial terms against the banks´ level of performance and risk. They found that for banks with low levels of risk and geographical diversification resulted in an improved risk-return ratio. Whereas, banks with high risk levels, no type of diversification – regardless of the considered factor such as industry, sector, or geographic location - produced an adequate level of compensation. Moreover, in the Peruvian study of Cortez (2014), the author found that the asset-based portfolio diversification strategy, by credit type (such as direct, consumer, and mortgage), has a positive effect on the banks´ performance. However, also in Peru, expanding the scope of the previous study, Serpa (2020) found that diversification by economic sector and / or geographical area, does not have any performance effect. Regarding the liability diversification literature review, we did not detect any relevant article.

3. Study hypothesis

To stablish if the assets, liabilities, and / or income diversification distresses or benefits Mexican banks on its profitability and /or risk, we partially replicated the methodological footsteps of Muñoz, et al. (2020). Their mentioned research analysis showed that diversification has a positive and non-linear effect on bank performance. We also partially replicated the Kim, et al. (2020) study, which suggested that a moderate degree of bank diversification increases banking stability, but excessive diversification has an adverse effect. Taken into consideration the mentioned above studies, we came up with the following hypotheses, proposed for the segment of larger Mexican banks, those that hoard approximately 80% of the Mexican banking market.

> *H1. Asset diversification increases will have a non-linear relation (inverted u-form) that translates into increases on its profitability (risk adjusted).*
> *H2. Liability diversification increases will have a non-linear relation (inverted u-form) that translates into increases on its profitability (risk adjusted).*
> *H3. Income diversification increases will have a non-linear relation (inverted u-form) that translates into increases on its profitability (risk adjusted).*

These hypotheses suggests that a moderate degree of diversification, on the larger banks operating on the Mexican sector, would increase their profitability, but excessive diversification would have an adverse effect.

We followed too the methodological footsteps of Kim, et al. (2020), who found a significantly nonlinear (U-shaped) effect between income diversification and financial stability. Additionally, we did too partially replicate the Archaya, et al. (2002) study, whose authors proposed that asset portfolio diversification by credit type, (such as direct, consumer, and mortgages), improved the risk-return banks´ ratio. Based on these latter studies, we proposed the following three hypotheses for the same market segment.

H4. Asset diversification increases will have a non-linear relation (U-shaped) that translates into increases on its level of risk.
H5. Liability diversification increases will have a non-linear relation (U-shaped) that translates into increases on its level of risk.
H6. Income diversification increases in will have a non-linear relation (U-shaped) that translates into increases on its level of risk.

These last three hypotheses suggest that a moderate degree of diversification, on the larger banks Mexican sector, would increase their risk profile - but excessive diversification would also impact the risk profile.

There are other kind of bank diversifications, such as market and / or geographical segmentation, higher levels of corporate governance, and / or the host country´s economic level of development (Hsieh, et al., 2013). However, for the purpose of this paper, we will be exclusively focusing on asset, liability, and income diversification strategies and their effects.

4. Methodology

For each of the six mentioned above hypotheses (*H1.* to *H6.*), two regression analyzes will be applied; we used both linear and second-degree polynomial equations. Furthermore, we will validate too which of them generates a significant relationship and which presents a greater variance explanation. For example, for the first 3 hypotheses on profitability or performance, the following models will be compared with the following lineal equation (1) and polynomial (2):

$$(\text{Profitability }_t - \text{Profitability }_{t-1}) = \beta(\text{Diversification }_{jt} - \text{Diversification }_{jt-1}) + c \qquad (1)$$

$$(\text{Profitability }_t - \text{Profitability }_{t-1}) = \beta_1(\text{Diversification }_{jt} - \text{Diversification }_{jt-1})^2$$
$$+ \beta_2(\text{Diversification }_{jt} - \text{Diversification }_{jt-1}) + c \qquad (2)$$

Where: diversification j=1 refers to assets´ diversification , diversification j=2 to liabilities´ diversification, and diversification j=3 to income´s diversification; and t is the year of measurement of the variables. For the risk related hypotheses, the models will be evaluated with the following lineal equation (3) and polynomial (4):

$$(\text{Risk}_t - \text{Risk}_{t-1}) = \beta(\text{Diversification}_{jt} - \text{Diversification}_{jt-1}) + c \qquad (3)$$

$$(\text{Risk}_t - \text{Risk}_{t-1}) = \beta_1(\text{Diversification}_{jt} - \text{Diversification}_{jt-1})^2$$
$$+ \beta_2(\text{Diversification}_{jt} - \text{Diversification}_{jt-1}) + c \qquad (4)$$

For this research paper, we collected for each considered bank: diversification, profitability, and risk data, for a total observation period of 11 years, and grouped the data within a cross-sectional regression. The operational definition of variables is presented later in this section.

4.1 Bank Sample for the Study

In Mexico there are 50 banks operating within the Multiple Banking segment, which is the segment encompassing financial intermediaries, entities dedicated to attracting financial resources and placing them into credit operations, such as financial loans. At the end of December 2021, the total assets held in the Multiple Banking sector reached $11,078 billion pesos, which represented a real annual decrease of 7.8%. The total assets of the Mexican commercial Banks system, valuated in US dollars, at the year-end exchange rate of $20.51 pesos per US dollar, are equivalent to $540 billion US dollars, which represents 42.43% of Mexico´s GDP[2]. Meanwhile, the current credit portfolio of the Multiple Banking sector stood at $5,435 billion pesos (CNBV, 2022) [3].

The largest banks operating in Mexico are BBVA (Spanish shareholding), Santander (Spanish shareholding), Banorte (Mexican shareholding), Citi Banamex (United States shareholding), HSBC (British shareholding), Scotiabank (Canadian shareholding) and Inbursa (Mexican shareholding). This group of banks is locally known as the group of seven or G7, and together hold almost 80% of the sector's total assets.

For this study, we included a sample of the 15 largest banks in the country, which control $9,712 billion pesos in assets, representing 87.7% of the total assets of banking system in Mexico. With the information of the 15 Mexican banks, for a 11-year study, we formed a 165-data entry database. The following Table 1 presents the main characteristics of the sample.

Table 1. Main accounts of the sample, as of 12/31/2021 (in billions of Mexican pesos)

Bank	Total assets	Commercial loan portfolio	Consumer loan portfolio	Mortgage portfolio	Expired credit portfolio	Traditional collection	Stock holders' equity
BBVA	$2,453	$712	$303	$273	$23	$1,561	$283
Santander	$1,640	$431	$118	$186	$16	$869	$166
Banamex	$1,372	$313	$157	$69	$11	$899	$183
Banorte	$1,236	$481	$122	$200	$8	$806	$145
HSBC	$714	$207	$72	$100	$10	$500	$66
Scotiabank	$675	$222	$35	$164	$17	$442	$67
Inbursa	$417	$218	$28	$5	$4	$253	$119

---

[2] Using World Bank figures, Mexico's GDP was 1,272.84 billion US dollars in 2021. Consulted on 01/05/2023 at https://tradingeconomics.com/mexico/gdp

[3] Release from the National Banking and Securities Commission (CNBV) Consulted on 07/15/2022 at https://www.gob.mx/cnbv/articulos/informacion-del-sector-de-banca-multiple-al-cierre-   de-decembre-de-2021?idiom=es#:~:text=As%20close%20de%20december%20de%202021%2C%20los%20assets%20total%20del, decrease%C3%B3n%20annual%20real%20de %207.8%25.

B. Bajío	$275	$189	$3	$6	$2	$185	$38
Banco Azteca	$257	$43	$74	$0	$6	$184	$26
Afirme	$178	$33	$8	$9	$2	$63	$7
Banregio	$167	$98	$6	$12	$2	$109	$24
BanCoppel	$117	$15	$15	$0	$2	$102	$14
Invex	$96	$13	$9	$0	$0	$22	$7
B. of America	$77	$22	$-	$-	$-	$40	$12
Compartamos	$37	$1	$26	$-	$1	$14	$11

Source: Our own, based on CNBV (2021) annual information

Table 1. depicts our 2021 selected information sample, containing the 15 largest banks, integrating the Mexican multiple banking sector. It also depicts the relevance of the four largest banks operating in Mexico. For instance, the four largest banks, BBVA, Banamex, a Citibank's subsidiary, Banorte, and Santander, hold 69.0% of the sample total assets, 64.6% of the commercial loans, 71.7% of the consumer loans, 71.1% of the housing loans, and 68.4% of all the deposits of the entire Mexican banking industry.

On an individual basis, BBVA's size is notable, as its assets are greater than 3.79 times and its stockholders' equity is 5.29 times the average of large banks segment, in Mexico. Furthermore, BBVA hoards 24% of the commercial credit portfolio, 31% of consumer credit portfolio, and 27% of mortgage portfolio, as well as 26% of total deposits of the sample. Some financial ratios of these banks are presented in Table 2.

Table 2. Financial ratios of the 15 banks in the sample as of 12/31/2021

Bank	Liquidity	Delinquency or past due rate (IMOR)	Portfolio Annual Variation (net)	Traditional Deposits Annual Variation	Capitalization Index (ICAP)	Return on Assets (ROA)	Return on equity (ROE)
Afirme	0.91	3.4%	5.3%	9.8%	15.3	0.43	11.01
Banamex	0.69	2.0%	0.5%	-1.3%	17.0	1.64	12.49
Banco Azteca	0.58	4.7%	17.0%	6.8%	14.2	0.60	5.91
B. Bajío	0.68	1.1%	0.1%	2.7%	18.5	1.73	13.41
BanCoppel	0.84	7.8%	32.0%	20.6%	19.9	1.40	11.23
B. of America	1.00	0.0%	27.9%	16.3%	22.1	0.93	6.29
Banorte	0.47	1.0%	2.9%	-4.4%	24.7	2.10	18.59
Banregio	0.40	1.8%	6.7%	6.6%	16.0	2.21	15.50
BBVA México	0.58	1.7%	6.5%	10.1%	19.2	2.41	23.25
Compartamos	1.81	2.0%	24.5%	25.8%	37.1	6.09	20.54
HSBC	0.59	2.6%	6.6%	0.4%	13.6	0.39	4.16
Inbursa	0.68	1.4%	12.5%	7.2%	21.5	3.51	12.94
Invex	1.03	0.8%	6.2%	-10.1%	17.9	0.67	10.44
Santander	0.68	2.2%	7.4%	2.8%	21.6	1.06	11.12
Scotiabank	0.69	3.9%	5.8%	8.8%	15.4	1.42	15.38

Note: ICAP calculation figures (as of November 30, 2021). Similarly: Liquidity = Demand deposits + Bank securities with a term of less than 30 days + Government securities with a term of less than 30 days / short-term liabilities; IMOR = Overdue loan portfolio / Total portfolio; ROA = Net Income (12-month cash flow) / Total Assets, 12-month average; ROE = Net Income (12-month cash flow) / Stockholders' Equity, 12-month average. Source: our own, based on CNBV´s data (2021).

The main ROE ratios, of the large Mexican banks sample, in 2021 are: Banamex with 12.49%, Banorte with 18.59%, BBVA México with 23.25%, and Santander with 11.12%. The banking results are, in general, outstanding for 2021. All the banks have a liquidity index higher than 0.4; significantly higher than the CNBV's acceptable minimum of 0.10. The delinquency rate, except in 4 cases, is less than 3%. Moreover, all banks grew their portfolio and five of them grew it over 10%. Regarding traditional deposits, 13 out the 15 banks increased them; four banks even presented growths larger than 10%. All banks covered the minimum capitalization index of 10.5 and presented high assets´ return (from 0.39 to 6.09) and a capital high return (from 4.16 to 23.25); all of which are extremely positive for the banks´ sample.

4.2 Operational definition of the assets, liabilities, and income diversification variables

The Herfindahl-Hirschman Index (HHI) was initially devised as a measurement for economic studies. It is considered the most suitable estimate for measuring the industries´ concentration levels. The existing concentration levels is the number of companies operating within a certain market and their control power (Kwoka, 1985). The HHI index values go from 1/N to 1. As the index approaches a 1/N value, the more diversified the portfolios is. On the other hand, the closer it is to 1, the higher the concentration level is (Martínez, et al., 2016).

The HHI has been used in the banking industry to estimate the concentration level within certain countries. For example, Alves, et al. (2011) used it in their Brazilian study, Levy Orlik, and Domínguez (2014) in their Mexican study, and finally Martínez, et al. (2016) in their Colombian research.

Moreover, the HHI has also been used to calculate the concentration or diversification levels of a certain type of income and / or asset within banks (Mercieca, et al., 2007; Chiorazzo, et al., 2008; Carrera, 2019; Paltrinieri, et al., 2021). Other authors used the HHI, as well, to study the portfolio concentration of banks (Cortez, 2014; Serpa, 2020).

Like Berger, and Bouwman (2013), we used the HHI to construct three potential diversification measures for each bank: 1) Assets (including the portfolio), 2) Liabilities, and 3) Income. The accounting records of the assets of the Mexican commercial banks are listed in 9 accounts, described in Table 3. We can observe that commercial loans, investing securities, consumer loans, and mortgages represent the main asset accounts for the large Mexican banks, 31.0%; 25.5%; 10.4%; 9.1%, respectively.

Table 3. Average asset type proportion of the sample (2011 to 2021)

Asset type	Variable	Participation
Commercial loans	A1	31.0%
Securities investing	A2	25.5%
Consumer loans	A3	10.4%
Mortgage	A4	9.1%
Cash	A5	8.5%
Derivatives	A6	6.3%

Other accounts receivable (Net)	A7	4.3%
Expired credit portfolio	A8	1.3%
Property, Furniture and Equipment (Net)	A9	1.3%
Other accounts		2.3%
Total assets		100.0%

Note: The asset participation type is calculated by dividing the sum of respective asset type of all banks by the sum of the total assets of all banks. Source: our own, based on CNBV information as of December 31, 2011 - 2021.

The HHI asset diversification index (HHIA) of each bank, for each *t* year, is calculated by adding the amounts of each account, and then dividing it by the total assets, using following formula 5:

$$HHIA_t = \sum_1^9 \left(\frac{A_{ti}}{Total}\right)^2 \qquad (5)$$

With respect to the liability's diversification of the large Mexican banks, which account records are mainly concentrated into seven accounts, described in Table 4. It can be observed that the Deposits payable on demand with interests (sight accounts), term deposits, credit instruments issued, immediate demand deposits (sight) without interests, and creditors from repurchase agreements represent the main liabilities accounts of the large Mexican banks, (23.9%, 21.3%, 18.1%, and 14.4%, respectively).

Table 4. Average liability type Proportion (2011 to 2021)

Liability type	Variable	Participation
Deposits payable on demand with interests (sight accounts)	L1	23.9%
Term deposits and credit instruments issued	L2	21.3%
Immediate demand deposits (sight) without interests	L3	18.1%
Creditors from repurchase agreements	L4	14.4%
Derivatives	L5	7.4%
Other accounts payables	L6	6.8%
Interbank loans	L7	3.7%
Other accounts		4.4%
Total liabilities		100.0%

Note: The participation of the liabilities´ type is calculated by dividing the sum of the respective liabilities of all banks by the sum of the total liabilities of all banks. Source: our own, based on CNBV´s information, as of December 31, 2011 - 2021.

The HHIL liability diversification index of each bank, for each *t* year, is calculated by adding the amounts of each account, and then dividing it by the total liabilities, using the following formula 6:

$$HHIL_t = \sum_1^7 \left(\frac{L_{ti}}{Total}\right)^2 \qquad (6)$$

With respect to the income diversification of the large Mexican banks, it is mainly concentrated into 9 accounts, described in Table 5. It can be observed that interest from consumer loans represents the main source of income for large Mexican banks (28.2%).

Table 5. Average income type Proportion (2011 to 2021)

Income Type	Variable	Participation
Interest on the consumer loan portfolio (current and overdue)	I1	28.6%
Interest on the commercial loan portfolio (current and overdue)	I2	22.2%
Commissions and fees charged	I3	16.7%
Interest and yields in favor for investments in securities	I4	11.2%
Interest on the mortgage home loan portfolio (current and overdue)	I5	8.8%
Interest and yields in favor for repurchase agreements	I6	4.5%
Cash interest	I7	1.9%
Commissions for the initial credit granting or opening	I8	0.9%
Income from hedging operations	I9	0.7%
Other income		4.5%
Total income		100.0%

Note: The participation of the income types is calculated by dividing the sum of the respective income sources of all banks by the sum of the total income of all banks. We did not consider some income accounts: Other income (expenses) from operations; profits from foreign currency trading; and participation in the results of subsidiaries and associates, because they present negative figures in some years. Source: our own, based on CNBV´s information, as of December 31, 2021 - 2021.

The income diversification index HHII for each bank, for each *t* year, is calculated by dividing each income type by the total income, using the following formula 7:

$$HHII_t = \sum_1^9 \left(\frac{I_{ti}}{Total}\right)^2 \tag{7}$$

4.3 Profitability and Risk variable operational definition

For the operational definition of a bank's profitability, according to the criterium established by the international studies on banking diversification (Archaya, et al., 2022; Paltrinieri, et al., 2021; Carrera, 2019; Chiorazzo, et al., 2008; Mercieca, et al., 2007), we will be using the ROA a the relevant criterium. It is calculated by dividing the profits of year t, after risk reserves, between the average of the total assets of years *t* and *t-1.*

According to Lepetit, et al. (2008), there are five risk standard measures used to compare the banks´ risk level. The standard risk measures are: 1. The standard deviation of return on average assets (SDROA); 2. The standard deviation of the return on the average stockholders' equity (SDROE); 3. The coefficient of variation of the return on average assets (CVROA); 4. The coefficient of variation of the return on average stockholders' equity (CVROE); and 5.The ratio of loan loss provisions to net loans (LLP).

Using the same criterion of the reviewed literature, Lepetit, et al. (2008), and considering the size of our sample, we decided to use the LLP index, as an indirect yearly measure, to calculate the

financial risk of the large Mexican banks (Hannan, and Hanweck, 1988; Stiroh, 2006; Laeven, and Levine, 2007), using the following formula 4:

$$\text{LLP}_t = \frac{Preventive\ estimate\ for\ credit\ risks_t}{Portfolio_t - Portfolio_{t-1}} \tag{4}$$

Using a metric to calculate the financial risk of banks, LLP, we observed that during the study period (2011 to 2021), that the average estimate for credit risks was 5.54% per year (with a standard deviation of 7.76%); with a minimum of 0.00% and a maximum of 42.71% - meaning that a bank wrote off more than 40% of its entire portfolio in one year.

To analyze and test, where appropriate, the hypotheses, we performed six regressions of the ROA and LLP criterion variables, which included three linear and three second-degree polynomials equations (U-shaped), to determine which predictive model was more appropriate.

5. Empirical results

As the reader is aware, as the diversification values approach 0.00, there is greater diversification; on the other hand, the closer the diversification value is to 1.00, it means a higher level of concentration – or business specialization. This rule applies to all diversification variables considered (Asset, Liability, and Income), in the present paper.

Regarding the Asset diversification strategy followed by the large Mexican banks, we observed diametrically different strategies. Santander presents the highest asset diversification value, with an HHIA index of 0.175; while Compartamos presents the highest specialization, with an HHIA index of 0.743 (85.9% of all Compartamos´ assets were concentrated on consumer loans, during 2013).

In terms of Liability diversification, HSBC presents the highest liability diversification with an HHIL of 0.161; while BanCoppel presents the highest HHIL concentration with an of 0.901 (94.9% of all BanCoppel's liabilities, in 2021, where placed in the interest-bearing deposit account).

Regarding Income diversification, Banorte presents the greatest income diversification, with an HHII index of 0.172; while Compartamos concentrates its income, with an HHII index of 0.921 (96.0% of Compartamos´ income, during 2011, where placed in its interest-bearing consumer loan portfolio).

In relation to the ROA of the large Mexican banks, during our 11-year study, there were only five entry cases recording accounting losses: In 2020, the year of the world pandemic beginning, Compartamos presented a ROA ratio of -4.0%, Banco Azteca of -2.7%, and HSBC of -0.1%. In 2016, Bank of America recorded a ROA ratio of -0.4%, and in 2015 HSBC recorded a ROA ratio of -0.1%. These five data entries represent only 3% of the sample; all other cases or entries, of the 11-year collected sample, including 2021 a complete pandemic year, presented positive rations, representing 97% of the sample. During the study period, Compartamos presented an exceptional profitability, between 2011 and 2016; its ROA ratios were between 11.9% and 15.6% annually.

Now switching gears, to the banks´ risk, some of them recorded practically no provisions, preventive estimates for the value of the credit risks. For instance, Banco del Bajío in 2019; Bank of America in 2011, 2019 and 2021; and Banregio in 2012 and 2013. For this reason, during these years,

their LLP risk ratio was zero. On the other hand, BanCoppel, in 2011 and 2014, provisioned more than 40% of its entire loan portfolio. The variables statistics, of the sample, are depicted in the following Table 6.

Table 6. Statistics of diversification, profitability, and risk of the large banks in Mexico

Variable	N (Sample)	Mean	Standard deviation	Mean standard error	Min	Max
Asset diversification (HHIA)	165	0.34	0.15	0.01	0.18	0.74
Liability diversification (HHIL)	165	0.35	0.18	0.01	0.16	0.90
Income diversification (HHII)	165	0.35	0.21	0.02	0.17	0.92
Profitability (ROA)	165	2.0%	2.7%	0.2%	-4.0%	15.6%
Risk (LLP)	165	5.5%	7.8%	0.6%	0.0%	42.7%
$(HHIA_t - HHIA_{t-1})$ Increase	150	-0.04%	4.68%	0.38%	-23.0%	20.0%
$(HHIL_t - HHIL_{t-1})$ Increase	150	-0.27%	4.34%	0.35%	-18.0%	15.0%
$(HHII_t - HHII_{t-1})$ Increase	150	-0.51%	3.98%	0.33%	-21.0%	16.0%
$(ROA_t - ROA_{t-1})$ Increase	150	-0.03%	1.54%	0.13%	-11.0%	10.0%
$(LLP_t - LLP_{t-1})$ Increase	150	-0.24%	3.51%	0.29%	-18.0%	17.0%

Source: Our own

An index HHI value = 1 describes a maximum concentration and a HHI value = 0 describes a maximum diversification. This convention fact applies regardless of the variable type considered: Asset, Liability, and Income. Therefore, the observed reductions in the HHI values seem to indicate a long-term reduction of the diversification strategies.

The above table highlights the risk´s volatility values of the banks considered in the sample, in the sense that the standard deviation of the LLP risk variable (7.8%) is significantly higher than its mean (5.5%); which means that some banks in Mexico lend to risky endeavors and / or sectors, while others are extremely conservative.

It is important to realize that we identified three non-significant correlations regarding the study´s variables. First, the relationship between a liability diversification increase (HHIL) and a return increase (ROA) indicates that they are independent variables. Second, the relationship between the liability diversification (HHIL) increase and risk (LLP) increase are also practically independent variables. Third, and finally, the relationship between an income diversification increase (HHII) and a risk (LLP) increase is not relevant either. The following Table 7 contains the detail of the mentioned correlations (gray marked cells).

Table 7. Correlations between diversification, profitability, and risk

	1	2	3	4
1: Increase $(HHIA_t - HHIA_{t-1})$	1			
2: Increase $(HHIL_t - HHIL_{t-1})$	0.280 ** *0.000*	1		
3: Increase $(HHII_t - HHII_{t-1})$	0.235 ** *0.000*	0.107 *0.192*	1	

4: Increase (ROA$_t$ - ROA$_{t-1}$)	0.468 ** *0.000*	-0.024 *0.774*	0.088 *0.286*	1
5: Increase (LLP$_t$ - LLP$_{t-1}$)	-0.295 ** *0.000*	-0.048 *0.560*	-0.046 *0.577*	-0.602 ** *0.000*

Note: Cell content: Pearson correlation and p-value. **. The correlation is significant at the 0.01 level (bilateral). Source: Our own.

These results seem to indicate that an increase in the asset concentration is significantly related to a profitability increase (0.468 with p=0.000) and a risk reduction (-0.295 with p=0.000). However, a liability and income diversification policies change does not reflect a significant relationship with neither, profitability nor risk.

Now we will verify the nature of the relevant equations: if the variables' relationships are linear and/or polynomial. In relation to the ROA profitability, the regression equations, their adjustments, and the results hypothesis tests, we summarized them all in the following Table 8.

Table 8. Coefficients Statistics for the profitability equation.

Strategic of diversification	Regression	Regression equation	R^2 (adj)	F Val	T Val	KS	Durbin Watson
Asset Increase	Linear	(ROA$_t$ - ROA$_{t-1}$) = 0.000 +0.1541(HHIA$_t$ - HHIA$_{t-1}$)	0.214	41.532 *0.000*	6.445 *0.000*	0.176 *0.000*	2.589
	Polynomial	(ROA$_t$ - ROA$_{t-1}$) = +0.001 - 0.618 (HHIA$_t$ - HHIA$_{t-1}$)^2 +0.140 (HHIA$_t$ - HHIA$_{t-1}$)	0.281	30.186 *0.000*	-3.864 *0.000* 6.031 *0.000*	0.190 *0.000*	2.428
Liability Increase	Linear	(ROA$_t$ - ROA$_{t-1}$) = +0.000 - 0.008 (HHIL$_t$ - HHIL$_{t-1}$)	-0.006	0.083 *0.774*	-0.288 *0.774*	0.223 *0.000*	2.751
	Polynomial	(ROA$_t$ - ROA$_{t-1}$) = +0.000 - 0.086 (HHIL$_t$ - HHIL$_{t-1}$)^2 - 0.011 (HHIL$_t$ - HHIL$_{t-1}$)	-0.013	0.080 *0.923*	-0.277 *0.782* -0.354 *0.724*	0.223 *0.000*	2.748
Income Increase	Linear	(ROA$_t$ - ROA$_{t-1}$) = +0.000 + 0.034 (HHII$_t$ - HHII$_{t-1}$)	0.001	1.147 *0.286*	1.071 *0.285*	0.233 *0.000*	2.765
	Polynomial	(ROA$_t$ - ROA$_{t-1}$) = +0.000 + 0.015 (HHII$_t$ - HHII$_{t-1}$)^2 + 0.035 (HHII$_t$ - HHII$_{t-1}$)	-0.006	0.571 *0.566*	0.055 *0.957* 1.021 *0.309*	0.234 *0.000*	2.765

Note: We indicate – in italics – the p-value of the F Val, T Val, and the Kolmogorov-Smirnov (KS) columns. Source: Our own

The normality values of the Kolmogorov – Smirnov (KS) disturbances test indicate that the errors do not conform to a normal distribution (p < 0.050). However, this assumption is not essential if the objective of the investigation are the estimates. This is particularly the case when the T and F tests continue to be valid asymptotically, for large samples (Gujarati, 1992). The Durbin Watson test values indicate that there is no spatial serial correlation, which occasionally occurs in cross-sectional analyses; therefore, the assumption of the classical model is not violated.

We calculated the three ROA profitability polynomial regression analyzes (HHIA, HHIL, and HHII). In relation to the Asset diversification variable equation, HHIA, presents an inverted U –

shaped graph (R^2 adj= 0.281), presented in the Figure 1. This equation allows to calculate the turning point at which the asset diversification HHIA maximizes the ROA return. When deriving the regression function with respect to the asset diversification, a ROA maximum increase point is obtained by promoting an asset specialization allocation (HHIAt - HHIAt-1) of 11.32%.

$$(ROA_t - ROA_{t-1}) = 0.001 - 0.618\,(HHIA_t - HHIA_{t-1})^2 + 0.140\,(HHIA_t - HHIA_{t-1})$$
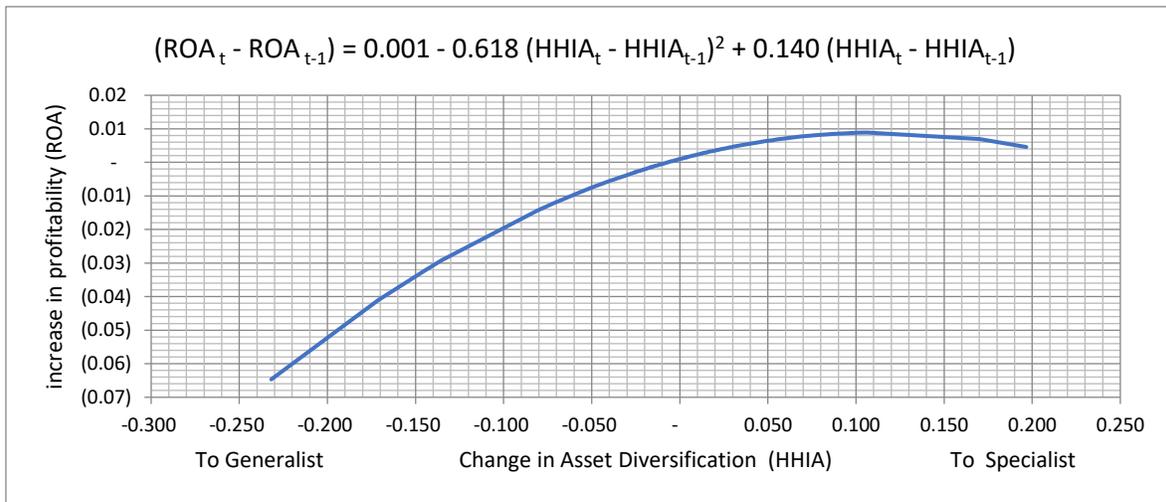
Figure 1. The ROA return with respect to an asset diversification HHIA strategy.
Source: Our own.

With respect to the asset HHIA and income HHII diversifications strategies, we obtained linear and curvaceous regressions that did not present meaningful values to predict the ROA.

In summary we only approved H1; H2 and H3 were discarded. We approved H1 because we found that a higher asset concentration is better for the banks´ return, up to a 11.33% inflection point, up to which the banks' profitability begins to decrease. We were not able to approve H2 and H3; situation that implies that a higher or lower, income and / or liability concentration no it's enough to determine a better return strategy.

We presented in the Table 9 the following regression equations related to risk LLP, their adjustment, and the results of the hypothesis tests.

Table 9. Risk equation Coefficients Statistics

Strategic of diversification	Regression	Regression equation	R^2 (adj)	F Val	T Val	KS	Durbin Watson
Asset Increase	Linear	$(LLP_t - LLP_{t-1}) = -0.002 - 0.221\,(HHIA_t - HHIA_{t-1})$	0.081	14.103 *0.000*	-3.755 *0.000*	0.222 *0.000*	2.325
	Polynomial	$(LLP_t - LLP_{t-1}) = -0.004 +0.779\,(HHIA_t - HHIA_{t-1})^2 - 0.203\,(HHIA_t - HHIA_{t-1})$	0.097	8.992 *0.000*	1.905 *0.059* -3.433 *0.001*	0.231 *0.000*	2.255
Liability Increase	Linear	$(LLP_t - LLP_{t-1}) = -0.003 - 0.039\,(HHIL_t - HHIL_{t-1})$	-0.004	0.342 *0.560*	-0.584 *0.560*	0.246 *0.000*	2.380
	Polynomial	$(LLP_t - LLP_{t-1}) = -0.003 + 0.246\,(HHIL_t - HHIL_{t-1})^2 - 0.032\,(HHIL_t - HHIL_{t-1})$	-0.010	0.231 *0.794*	0.350 *0.727* -0.458 *0.647*	0.238 *0.000*	2.377

Income Increase	Linear	$(LLP_t - LLP_{t-1}) = - 0.003 + 0.041 (HHII_t - HHII_{t-1})$	-0.005	0.313 *0.577*	-0.560 *0.577*	0.252 *0.000*	2.349
	Polynomial	$(LLP_t - LLP_{t-1}) = - 0.005 + 1.650 (HHII_t - HHII_{t-1})^2 + 0.031 (HHII_t - HHII_{t-1})$	0.039	3.994 *0.020*	2.768 *0.006* 0.414 *0.679*	0.227 *0.000*	2.344

Note: We indicate – in italics – the p-value of the F Val, T Val, and the Kolmogorov-Smirnov (KS) columns. Source: Our own

Like the outcome obtained for the profitability analysis, the risk related results provided by the Kolmogorov – Smirnov (KS) and Durbin Watson tests, the obtained values are adequate and, therefore, statistically valid.

With respect to the three LLP risk polynomial regression analyzes (HHIA, HHIL, and HHII), we obtained the following two adjusteded determination coefficient values. These values are related to assets HHIA (R^2 adj= 0.097) and income HHII (R^2 adj= 0.039) variable diversification; if it presents a U-shaped graph, as shown in Figures 2 and 3, it will allow us to calculate the turning point where the assets diversification minimizes LLP risk. By deriving the regression function with respect to asset diversification (HHIA), we obtained a minimizing point related to LLP risk that promotes an asset specialization allocation at 13.02%. With respect to income diversification (HHII), a minimizing point in LLP risk is obtained by promoting an income specialization allocation at 0.93%.
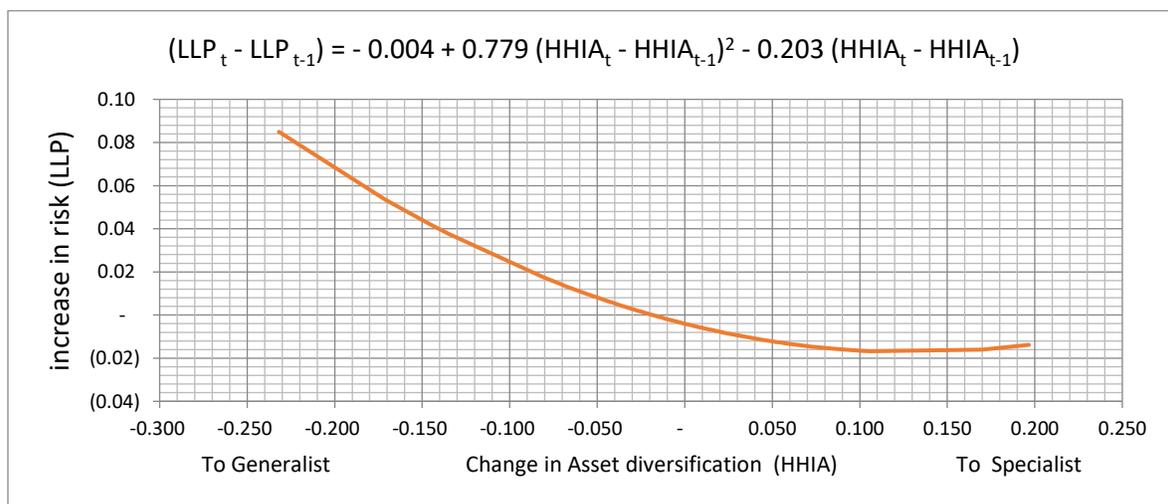

$(LLP_t - LLP_{t-1}) = - 0.004 + 0.779 (HHIA_t - HHIA_{t-1})^2 - 0.203 (HHIA_t - HHIA_{t-1})$

Figure 2. LLP risk return with respect to liability diversification HHIL strategy
Source: Our own

$$(LLP_t - LLP_{t-1}) = -0.005 + 1.650\,(HHII_t - HHII_{t-1})^2 + 0.031\,(HHII_t - HHII_{t-1})$$
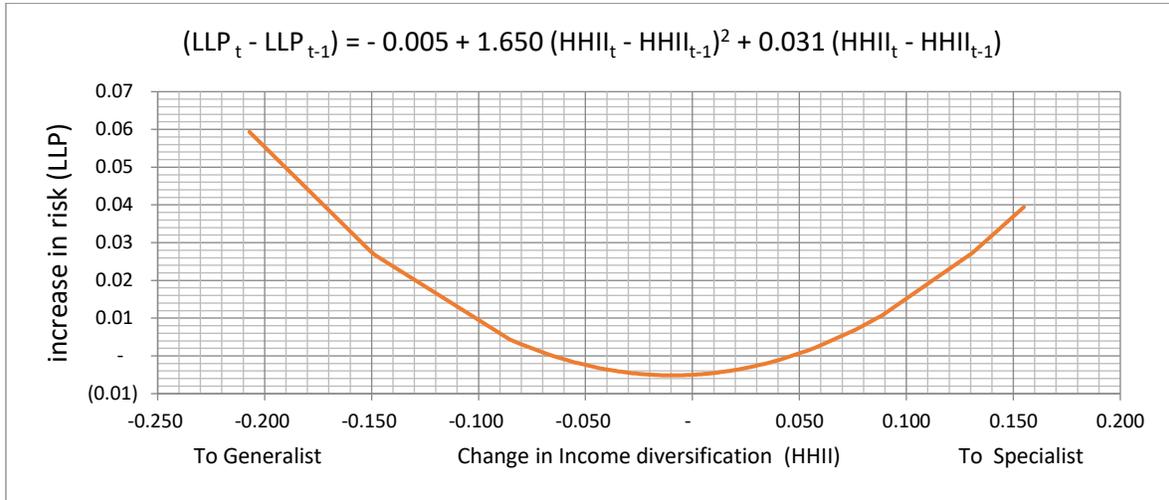

Figure 3. LLP risk return with respect to income diversification HHII strategy.
Source: Our own

With respect to the Liability HHIL diversifications, we obtained regression curves that were U-shaped to be able to predict the risk LLP. Summarizing: We approved the H4; we found that a higher asset concentration is better for the risk´s return ratio, up to a turning point (at 13.02%), from where the risk begins to increase. We did not approve the H5, which implies that a higher or lower liability concentration no it's enough to determine a better strategy for the bank´s risk. We approved the H6. We found a U-shaped equation with an inflection point close to zero (0.94%), which implies that any strategy to modify the income participation percentage is related to a risk increase.

6. Conclusions and discussions

Based on the regression equations that we obtained, from our 11-year sample of the 15 largest and most important banks in Mexico, the best diversification strategies in Mexico for banks would be of a mixed nature, as presented in Table 10.

Table 10. Diversifcation strategy outcomes

Objective	Asset Strategy	Liability Strategy	Income Strategy
Increase profitability	Specialize up to 11.3% per year	Inconclusive	Inconclusive
Financial stability	Specialize up to 13.0% per year	Inconclusive	Do not change the income mix

Source: Our Own.

In short, asset specialization grants greater profitability and lower risk – but up to a certain point, because a further radical transformation can be detrimental to the banks´ profitability and risk. However, with respect to the liability's specialization or diversification strategy, it is not possible to identify an optimal strategy point, that at the same time increases profitability and reduces risk.

Our findings are consistent with the convenience of using an asset specialization strategy; fact that it is consistent with the Patrón (2015) studies of Bolivia, Archaya, et al. (2002)´s Italian study, and Serpa (2020)´s Peruvian study of high-risk banks; However, Xu (1996)´s Canadian study obtained conflicting results in relation to our results. In our opinion, the difference in results may be due to the long time span between the studies.

Regarding the convenience of whether specialize or diversify banks´ income, the only study in Mexico that addresses this phenomenon is that of Chavarín Rodríguez (2015). The author found that one of the profitability determinants was fee related charges; associated with income diversification. However, our study did not find any direct and significant relationship between income diversification and profitability. In our opinion, the difference in the results lies in the fact that the database used by Chavarín Rodriguez (2015) covers a period of a deep banking crisis, from 2007 to 2013, with an ROA of -0.64% on average, where the commission collection could be a relief, while ours cover a longer period (2011 – 2021) and it includes a different crisis type with a +2.0% ROA.

A contribution of our investigation is the use of non-linear regressions, which allow us to identify inflection points for the three mentioned strategies - needed for maximizing and minimizing risk and return, expanding the methodology used by Kim, et al. (2020).

It is difficult to answer the diversification vs. especializtion questions without limiting the circumstances surranding their effects. The proposal, identified at empirical tests, indicate that in order to increase their performance, banks have to specialize. However, to reduce risk, banks have to diversify. Higher performance and risk reduction can no be simoultaneously achieved. However, under normal circumstances, not during crises, the effects of specialization are recomended. Nevertheless, during crises, diversification will produce better results – by not assuming the concentration risk associated with a problematic product and / or guild.

From our perspective, one of the main limitations for a deeper analysis of the Mexican Banking system has to do with the way the local regulatory authority groups together information in general, including several types of income interest. For instance, consumer, mortgages, and auto loans' interest is reported under the same interest category. This does not allow researchers to figure out whether a particular loan type is profitable and by how much more. The past due portfolio is also reported together with interest income, situation that does not allows to figure out the actual health of each individual loan portfolio.

Another potential limitation has to do with the fact that we did not analyze all the potential sources of diversification. For instance, we did not analyze market and geographic diversification.

A third potential limitation has to do with the selected time frame of the study. Even though, it was an eleven-year study, the analyzed time does not include several financial crises. 2020, the pandemic year was included in the analysis, was an extraordinary event. We would have liked to be able to analyze a period with "normal" financial crisis.

A fourth potential limitation has to do with the fact that we treated all banks similarly, when in fact they are not. For instance, the Mexican banking is integrated by several different type members; there are banks and financial groups, not all banks offer the same products, for instance. It is for this reason and the fact that their diversification achieved might come from grouping together the current business – after the 1982 national banking expropriation.

For us, a better understanding of the interest level of the different banks and loan types would provide a deeper understanding of the profitability levels of the largest banks, in relation to others, and therefore it would be something desirable. For instance, we would like to understand why BBVA has a disproportionate net income allocation, in relation to the portfolio it carries, of the whole Mexican banking system.

A first attractive alternative and complementary research line would be the use of the Capital Asset Pricing Model (CAPM), in addition to the ROA analysis, to determine the profitability of banks since it would include the effect of the local markets. Another potential research line would be linking the specialization vs. diversification analysis with the stickiness effect of costs and expenses. This is important because, even though banks´ fixed assets are a requirement for their operations, many of the brank offices are rented, making the investing in facilities riskier during crises periods.

References

[1]   Abuzayed, B., Al-Fayoumi, N., & Molyneux, P. (2018). Diversification and bank stability in the GCC. *Journal of International Financial Markets, Institutions & Money, 57*, 17-43. https://doi.org/10.1016/j.intfin.2018.04.005

[2]   Allen, L., & Jagtiani, J. (2000). The Risk Effects of Combining Banking, Securities, and Insurance Activities. *Journal of Economics and Business, 52*(6), 485-497. https://doi.org/10.1016/s0148-6195(00)00033-3

[3]   Alves, J., Ribeiro, O., & Paulo, E. (2011). Relação entre concentração e rentabilidade no setor bancário brasileiro. *Revista Contabilidade & Finanças, 22*(55), 5-28. https://doi.org/10.1590/s1519-70772011000100002

[4]   Archaya, V., Hasan, I., & Saunders, A. (2002). *The Effects of Focus and Diversification on Bank Risk and Return: Evidence from Individual Bank Loan Portfolios.* CEPR Discussion Paper No. 3252, 1 - 49. Sourced from Available at SSRN: https://ssrn.com/abstract=306768 https://doi.org/10.2139/ssrn.293295

[5]   Bátiz-Lazo, B., & Wood, D. (2003). Strategy, competition, and diversification in European and Mexican banking. *International Journal of Bank Marketing, 21*(4), 202-216. https://doi.org/10.1108/02652320310479196

[6]   Berger, A. N., & Bouwman, C. H. (2013). How does capital affect bank performance during financial crises? *Journal of financial economics, 109*(1), 146-176. https://doi.org/10.1016/j.jfineco.2013.02.008

[7]   Campa, J., & Kedia, S. (2002). Explaining the diversification discount. *The Journal of Finance, 57*, 1731-1761. https://doi.org/10.1111/1540-6261.00476

[8]   Carrera, Y. (2019). *La diversificación de ingresos y el riesgo de insolvencia en el sector bancario del Ecuador.* Ecuador: Universidad Técnica de Ambato (Tesis). https://doi.org/10.48082/espacios-a21v42n04p03

[9]   Chavarín Rodríguez, R. (2015). Determinants of commercial bank profitability in Mexico. *EconoQuantum, 12*(1), 97-123. https://doi.org/10.18381/eq.v12i1.4855

[10] Chiorazzo, V., Milani, C., & Salvini, F. (2008). Income diversification and bank performance: Evidence from Italian banks. *Journal of financial services research, 33*(3), 181-203. https://doi.org/10.1007/s10693-008-0029-4

[11] Córdoba, F., & Neira, Y. (2017). *Competencia y diversificación en el sector bancario: ¿Puede el entorno institucional condicionar sus efectos sobre la estabilidad financiera?* Los Ángeles: Universidad de Concepción (Tesis).

[12] Cortez, G. C. (2014). Diversificación de la Cartera de Activos de la Banca Múltiple en el Perú: 2001-2011. *Pensamiento crítico, 18*(1), 43-55. https://doi.org/10.15381/pc.v18i1.8748

[13] Denis, D., Denis, D., & Sarin, A. (1997). Agency Problems, Equity Ownership and Corporate Diversification. *Journal of Finance, 52*(1), 135–160. https://doi.org/10.1111/j.1540-6261.1997.tb03811.x

[14] Elsas, R., Hackethal, A., & Holzhäuser, M. (2006). *The anatomy of bank diversification*. Ludwig-Maximilians Universität München, Discussion Paper, No. 2006-01, 1-30. https://doi.org/10.2139/ssrn.968214

[15] Escobar, N. A. (2019). *Estructura del mercado y diversificación bancaria ¿Puede el entorno institucional condicionar su efecto en el desempeño bancario?* Concepción, Chile: Universidad de Concepción (tesis). https://doi.org/10.32457/12728/9842201992

[16] Ghosn, F. (2019). Testing Z-Score Model on Lebanese Listed Banks. *Research Journal of Finance and Accounting, 10*(12), 78 - 85. https://doi.org/10.7176/rjfa/10-12-10

[17] Gujarati, D. (1992). *Econometría* (2 ed.). McGraw Hill, México.

[18] Hannan, T. H., & Hanweck, G. A. (1988). Bank Insolvency Risk and the Market for Large Certificates of Deposit. *Journal of Money, Credit and Banking, 20*(2), 203–211. https://doi.org/10.2307/1992111

[19] Hsieh, M. F., Chen, P. F., Lee, C. C., & Yang, S. J. (2013). How does diversification impact bank stability? The role of globalization, regulations, and governance environments. *Asia-Pacific Journal of Financial Studies, 42*(5), 813-844. https://doi.org/10.1111/ajfs.12032

[20] Jara, M., Arias, J. T., & Rodríguez, A. (2011). Diversificación y determinantes del desempeño bancario: una comparación internacional. *Estudios de Administración, 18*(2), 1-48.

[21] Kim, H., Batten, J. A., & Ryu, D. (2020). Financial crisis, bank diversification, and financial stability: OECD countries. *International Review of Economics & Finance, 65*, 94-104. https://doi.org/10.1016/j.iref.2019.08.009

[22] Kwoka, J. E. (1985). The Herfindahl index in theory and practice. *The Antitrust Bulletin, 30*(4), 915 - 947. https://doi.org/10.1177/0003603x8503000405

[23] Laeven, L., & Levine, R. (2007). Is there a diversification discount in financial conglomerates? *Journal of financial economics, 85*(2), 331-367. https://doi.org/10.1016/j.jfineco.2005.06.001

[24] Lastre-Valdés, M. M. (2015). (). Predicción de insolvencia, confiabilidad y calidad de los sistemas organizaciones. *Ciencias Holguín, 21*(4), 1-14.

[25] Lepetit, L., Nys, E., Rous, P., & Tarazi, A. (2006). *Product diversification in the European banking industry: Risk and loan pricing implications*. 87031, págs. 1 - 34. Limoges Cedex, France: Université de Limoges. Sourced from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=873490 https://doi.org/10.2139/ssrn.873490

[26] Lepetit, L., Nys, E., Rous, P., & Tarazi, A. (2008). Bank income structure and risk: An empirical analysis of European banks. *Journal of Banking and Finance, 32*(8), 1452 - 1467. https://doi.org/10.1016/j.jbankfin.2007.12.002

[27] Levy Orlik, N., & Domínguez Blancas, C. (2014). The foreign banks in Mexico: diversification of activities and his effect in the structure of income. *Economía UNAM, 11*(32), 102-119.

[28] Lozano - Vivas, A. (1992). Un estudio de la eficiencia y economías de diversificación del sistema bancario español. *Revista Española de Financiación y Contabilidad, 21*(73), 855-880. https://doi.org/10.1080/02102412.2013.11102928

[29] Marinho, C. A., & de Araújo, L. F. (2016). Diversificação das receitas e risco de insolvência dos bancos brasileiros. *Revista De Contabilidade E Organizações, 10*(28), 3-17. https://doi.org/10.11606/rco.v10i28.111758

[30] Martínez, A., Zuleta, L., Misas, M., & Jaramillo, L. (2016). *La competencia y la eficiencia en la banca colombiana*. Bogotá: Fedesarrollo y Asobancaria.

[31] Mercieca, S., Schaeck, K., & Wolfe, S. (2007). Small European banks: Benefits from diversification? *Journal of Banking & Finance, 31*(7), 1975-1998. https://doi.org/10.1016/j.jbankfin.2007.01.004

[32] Muñoz, J. A., Sepúlveda, S. M., Veloso, C. L., & Delgado, C. (2020). ¿ Son persistentes los efectos de la concentración de mercado y la diversificación de ingresos sobre el desempeño bancario? *Ecos de Economía , 24*(50), 25-44. https://doi.org/10.17230//ecos.2020.50.2

[33] Palomino, M. (2015). *Estructura de ingresos y riesgo bancario en España*. Málaga: Universidad de Málaga (Tesis).

[34] Paltrinieri, A., Dreassi, A., Rossi, S., & Khan, A. (2021). Risk-adjusted profitability and stability of Islamic and conventional banks: Does revenue diversification matter? *Global Finance Journal, 50*, 100517. https://doi.org/10.1016/j.gfj.2020.100517

[35] Patrón, L. (2015). *Efectos de la diversificación de cartera sobre la rentabilidad de la banca comercial en Bolivia empleando el monitoreo como factor educativo: un modelo de teoría de juegos*. La Paz, Bolivia: Universidad Andina Simón Bolívar (Tesis). https://doi.org/10.4000/books.irdeditions.19547

[36] Sanya, S., & Wolfe, S. (2011). Can banks in emerging economies benefit from revenue diversification? *Journal of Financial Services Research, 40*(1), 79-101. https://doi.org/10.1007/s10693-010-0098-z

[37] Serpa, B. (2020). *Los efectos de la diversificación de la cartera de préstamos en el rendimiento y riesgo del sistema bancario peruano*. Lima: Universidad Peruana de CIencias Aplicadas (Tesis). https://doi.org/10.19083/tesis/648693

[38] Shim, J. (2019). Loan portfolio diversification, market structure and bank stability. *Journal of Banking & Finance, 104*, 103-115. https://doi.org/10.1016/j.jbankfin.2019.04.006

[39] Smith, R., Staikouras, C., & Wood, G. (2003). Smith, R., Staikouras, C. y Wood, G. (2003). *Non-interest.* Sourced from Bank of England: https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2003/non-interest-income-and-total-income-stability.pdf https://doi.org/10.2139/ssrn.530687

[40] Stiroh, K. (2004). Diversification and Banking: Is Noninterest Income the Answer? Journal of Money, *Credit and Banking, 36*(5), 853-882. https://doi.org/10.1353/mcb.2004.0076

[41] Stiroh, K. (2006). A Portfolio View of Banking with Interest and Noninterest Activities. *Journal of Money, Credit, and Banking, 38*(5), 1351-1361. https://doi.org/10.1353/mcb.2006.0075

[42] Trujillo-Ponce, A. (2013). What determines the profitability of banks? Evidence from Spain. *Accounting & Finance, 53*(2), 561-586. https://doi.org/10.1111/j.1467-629x.2011.00466.x

[43] Verlekar, R. (2019). An Application and Comparison of Bankruptcy Models in the Indian Banking Sector. *International Journal of Financial Management, 9*(4), 42 - 53.

[44] Xu, J. (1996). An Empirical Estimation of the Portfolio Diversification Hypothesis: The Case of Canadian. *The Canadian Journal of Economics, 29*(1), 192-197. https://doi.org/10.2307/135985

Annex A. Theoretical research on academic articles that study banking diversification

Country Sample	Period	Bank sample	Diversification strategy	Dependent Variable	Diversification Stretegy Outcome	Author
Spain	1985 - 1990	170	Income	Costs	+	(Lozano - Vivas, 1992)
Canada	1978 - 1985	5	Assets	Yield	+	(Xu, 1996)
USA	1986 - 1994	729	Income	Risk	-	(Allen & Jagtiani, 2000)
Italy	1993 -1999	105	Portfolio	Risk and Yield	-	(Archaya, Hasan, & Saunders, 2002)
			Geographic	Risk and Yield	+	
Europe	1994 - 1998	2,655	Income	Risk	+	(Smith, Staikouras, & Wood, 2003)
7 countries	1996	78	Market	Management	+	(Bátiz-Lazo & Wood, 2003)
USA	1984 - 2001	15,000	Income	Risk and Yield	-	(Stiroh K. , 2004)
Europe	1996 -2002	951	Income	Risk	-	(Lepetit, Nys, Rous, & Tarazi, 2006)
Europe	1997 - 2013	755	Income	Risk and Yield	-	(Mercieca, Schaeck, & Wolfe, 2007)
Italy	1993 - 2003	85	Income	Yield	+ (profit is limited as banks grow)	(Chiorazzo, Milani, & Salvini, 2008)
Europe	1996 - 2002	734	Income	Risk	-	(Lepetit, Nys, Rous, & Tarazi, 2008)
9 countries	1996 - 2003	380	Income	Yield	+	(Elsas, Hackethal, & Holzhäuser, 2006)
Brazil	2000 - 2009	201	Market	Yield	+	(Alves, Ribeiro, & Paulo, 2011)
11 countries	2000 - 2007	266	Income	Risk and Yield	+	(Sanya & Wolfe, 2011)
6 countries vs. USA	1997 - 2010	111	Income	Yield	+	(Jara, Arias, & Rodríguez, 2011)
Peru	2001 - 2011	6	Portfolio	Yield	+	(Cortez, 2014)
Mexico	2000 - 2011	44	Market	Income	Neutral	(Levy Orlik & Domínguez Blancas, 2014)
Bolivia	2002 - 2013	15	Portfolio	Yield	-	(Patrón, 2015)
Spain	2005 - 2013	1,070	Income	Yield	-	(Palomino, 2015)
Mexico	2007 - 2013	45	Income	Yield	+	(Chavarín Rodríguez, 2015)
Brazil	1997 - 2015	88	Income	Risk	It does not influence	(Marinho & de Araújo, 2016)
134 countries	1994 - 2011	Not available	Market	Risk	-	(Córdoba & Neira, 2017)
6 countries	2001 - 2014	107	Income	Risk	-	(Abuzayed, Al-Fayoumi, & Molyneux, 2018)
Ecuador	2016	24	Income	Risk	+	(Carrera, 2019)
206 countries	1994 - 2015	Not available	Market	Yield	- for developing countries	(Escobar, 2019)
					+ for developed countries	
			Income		+ in non-crisis periods	
					- for crisis periods	
Peru	2010 - 2019	14	Portfolio	Yield	Neutral, for banks with low risk	(Serpa, 2020)
					-, for banks at risk	

Annex A. Theoretical research on academic articles that study banking diversification

Country Sample	Period	Bank sample	Diversification strategy	Dependent Variable	Diversification Stretegy Outcome	Author
34 OECD members	2002 - 2012	Not available	Income	Risk	+ for non-crisis periods	(Kim, Batten, & Ryu, 2020)
			Income	Risk	- for crisis periods	
11 coutries	2007 - 2016	201	Income	Yield	+	(Paltrinieri, Dreassi, Rossi, & Khan, 2021)
				Risk	Neutral	
134 countries	1994 - 2011	Not available	Market	Yield	+ (is non-linear, at high concentration levels)	(Muñoz, Sepúlveda, Veloso, & Delgado, 2020)
			Income	Yield	+ (is non-linear, at high concentration levels)	