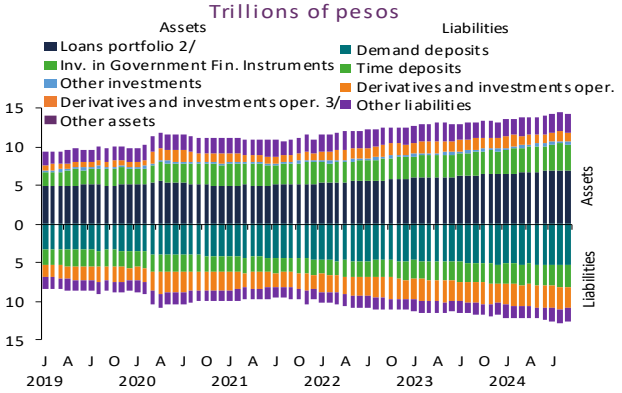
IV.3.1. Commercial Banks

Between March and September 2024, commercial banks' assets expanded, mainly due to the growth of the loan portfolio and, to a lesser extent, investments in financial instruments. On the one hand, derivative transactions recorded a reduction (Graph 74). The growth in liabilities is explained by the increase in term deposits and, to a lesser extent, in demand deposits (Graph 1).

Graph 74

Assets and liabilities from commercial banks 1/

Trillions of pesos



Data as of September 2024.

Source: CNBV.

1/ Unbound commercial banks.

2/ Net loans portfolio includes allowances for credit risks, deferred items and acquired collection rights.

3/ Includes purchase operations value considering to receive cash at maturity, when the entity act like a buyer.

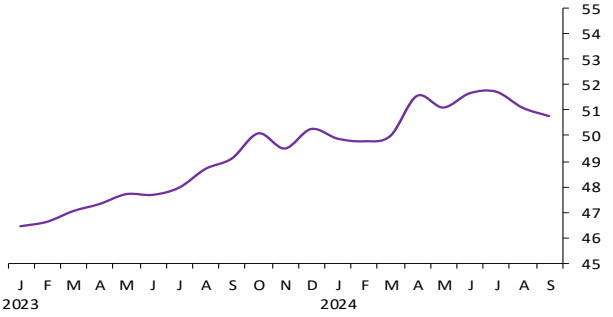
The commercial banks' net interest margin, as a proportion of stockholders' equity, decreased in August and September 2024, after having registered an increasing trend in preceding months (Graph 75).

Graph 75

Flow financial margin cumulative

12 months-to-total equity ratio 1/

Percentage



Data as of September 2024.

Source: Banco de México with data from CNBV.

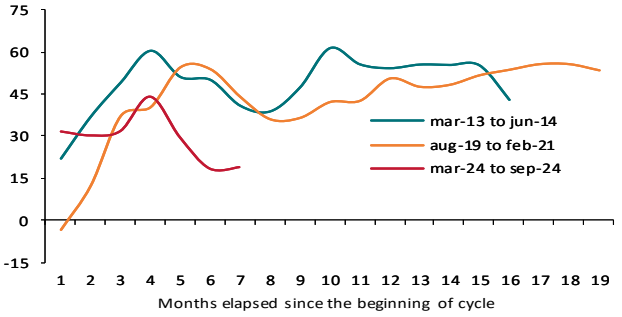
1/ Includes banks loans and linked sofomes loans.

In response to monetary policy, starting in March of this year, the interest rates paid by banks for their deposits declined, although this adjustment was not uniform among institutions. It is worth mentioning that the degree of response observed in this initial phase of the cycle was lower than that observed during the last easing cycles (Graph 76). In particular, this degree of response reflected a lower adjustment in the funding costs of the group of locally systemically important banks, both in terms of funds received from the general public and from other banking institutions. In this backdrop, it is noteworthy that, within term deposits, the yield of the Yield-Liquid Promissory Notes (PRLV) showed a smaller adjustment relative to the reduction in the target rate between March and September 2024, compared to previous easing cycles.

Graph 76

Target rate-to-average cost in local currency ratio 1/

Percentage



Data as of September 2024.

Source: Banco de México.

1/ Consider 3 target rate downwards reviews, first since March 8 of 2013 to June 6 of 2014 (-150 bp), second since August 15 of 2019 to February 12 of 2021 (-425 bp), and third since March 22 of 2024 to end of September 2024 (-75 bp). The average cost in local currency of commercial banks includes demand deposits, time deposits, credit securities and interbank loans.

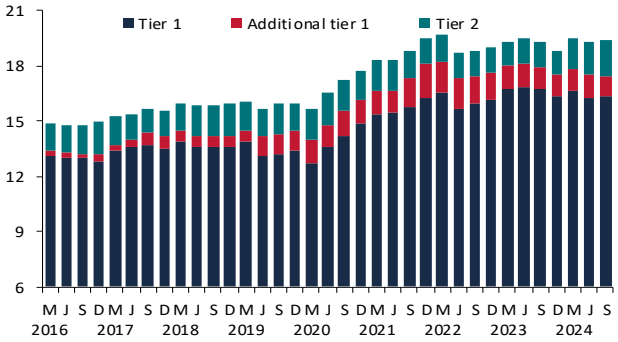
Solvency

Between March and September 2024, commercial banks presented capitalization levels that comfortably exceeded the minimum levels contemplated by regulation. However, the capitalization index (CAR) decreased during the period, from 19.49% in March to 19.39% in September. This behavior mainly reflected an expansion of risk-weighted assets, particularly those related to credit risk, which more than compensated for an increase in regulatory capital (Graph 77 and Graph 78). Furthermore, although there was an expansion of earned capital, this was partially offset by dividend payments made by some institutions.

Graph 77

Breakdown of banks' Capital Adequacy Ratio (CAR) by regulatory commercial banks capital [1/]

Percentage



Data as of September 2024.

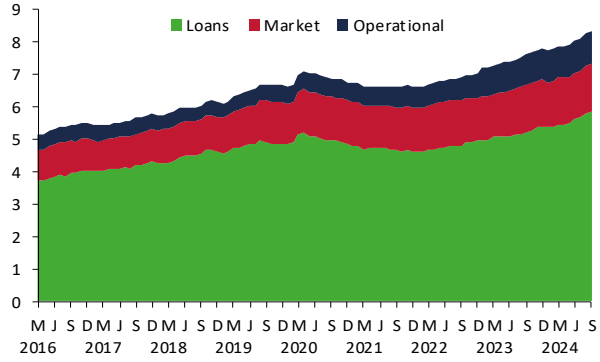
Source: Banco de México.

1/ Capital Adequacy Ratio, is calculated by dividing net capital by risk weighted assets. Net capital is the regulatory capital thtat includes the Tier 1, Additional tier 1, and the Tier 2 capital. Tier 1 includes earned capital and shareholder contributions, and has the major ability to absorb potenial losses. Additional tier 1 includes perpetual subordinated bonds and surplus reserves, and therefore has a lower ability to abosorb potential losses, while Tier 2 includes specif term subordinated bonds, and therefore has a lowest ability to absorb possible losses.

Graph 78

Risk weighted assets [1/]

Trillions of pesos



Data as of September 2024.

Source: Banco de México.

1/ Credit Risk weighted assets reflect the associated risk of the loan portfolio and other credit exposures. Market risk weighted assets are a risk measure that a banking institution holds due to market factors to which are their assets exposed; while operational risk weighted assets are a risk measure for possible losses due to inadequacies or failures in internal processes, personal and internal systems or due to external factors.

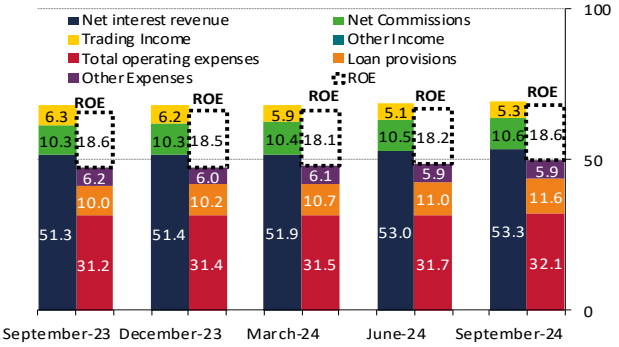
Profitability

As of September 2024, commercial banks' profitability, measured as the ratio of 12-month net income to average return on equity (*ROE*), has increased since the last *Report* and is at a similar level to a year ago (Graph 79**).** Both net interest revenue and other income increased with respect to average stockholders' equity. In addition, on the expenditure side, loan-loss provisions and administrative expenses increased slightly, but at a lower rate than revenues. The heterogeneity in profitability levels of the system's banks suggests that institutions with higher profitability will be better positioned to accumulate capital if necessary.

Graph 79

Commercial Banks Profitability Components (12-month flow)

Percent of 12-month average capital



Data as of September 2024.

Source: CNBV.

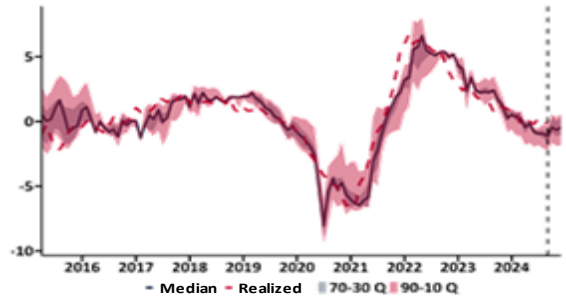
Financial Indicators at Risk

Historical information on financial indicators for the banking sector can help identify risks and build forecasts by applying the methodology described in Box 6 of the June 2022 *Financial Stability Report.* It is possible to construct a distribution that reveals which indicators present greater uncertainty in their estimates, which often translates into increased risk levels going forward.[55]

Profitability indicators reveal that both the ROE indicator (Graph 80a) and the financial margin (Graph 80b) show an increasing trend, both have returned to levels close to their historical averages, after some oscillations caused by the pandemic.

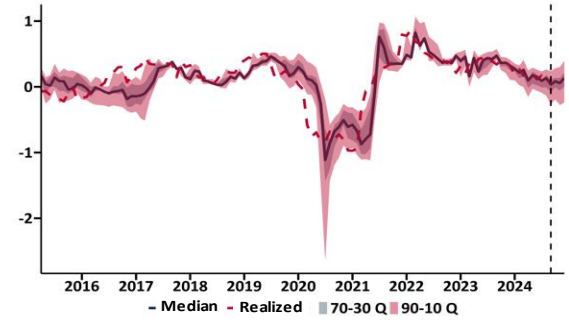
[55] For each of the indicators, forecasts are presented for a three-month horizon based on quantile regressions.

Graph 80
Three month horizon out of sample forecast
a) ROE
Percentage points



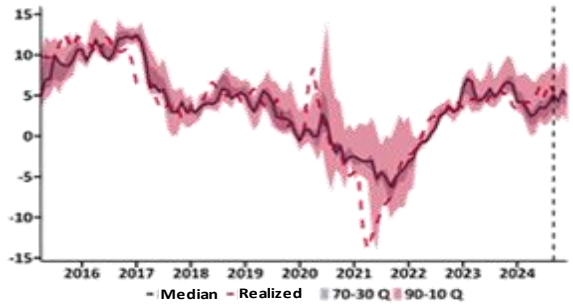
Data up to September 2024 and forecasts through December 2024.
Source: Banco de México

b) Net interest margin
Percentage points



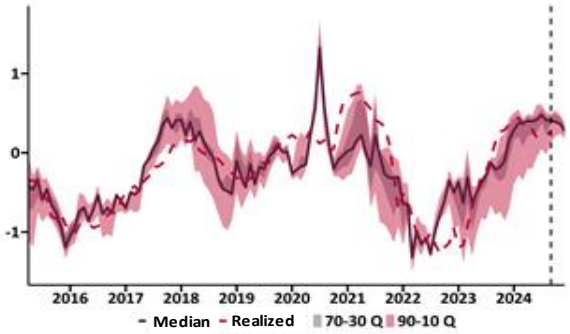
Date up to September 2024 and forecasts through December 2024.
Source: Banco de México

c) Real credit growth
Percentage points



Date up to September 2024 and forecasts through December 2024.
Source: Banco de México

d) Adjusted non-performing ratio
Percentage points



Date up to September 2024 and forecasts through December 2024.
Source: Banco de México

The portfolio growth projection (Graph 80c) shows an accelerated rise in the indicator culminating in a peak, followed by a slowdown phase, albeit with a high degree of uncertainty.

Finally, the indicators of the Adjusted non-performing loans ratio (Adjusted Loss Index) are shown. This indicator in turn shows a slowdown in growth (Graph 80d).

These indicators point to portfolio growth accompanied by a moderation in revenues and non-performing loan ratios in the coming months, unless events occur that change this expected trajectory.

Credit Risk

Banking credit risk measured by the Conditional Value at Risk (*CVaR*) at the 99.9% confidence level as a proportion of the credit portfolio, remained at low[56] and stable levels during the period of this *Report* (Graph 81a).[57,58] Although default probabilities of the portfolios have increased, default correlations have decreased, which explains the stability in the portfolio risk levels (Graph 81b).[59]

[56] *CVaR* as a proportion of the portfolio is within the lowest levels of at least the last thirteen years.

[57] Conditional Value at Risk (CVaR) allows the analysis of losses in the tail of the distribution, since it represents the expected value of the loss when it is greater than the VaR, which, in turn, represents the percentile that corresponds to a given confidence level in a loss probability distribution of a portfolio of assets subject to credit risk.

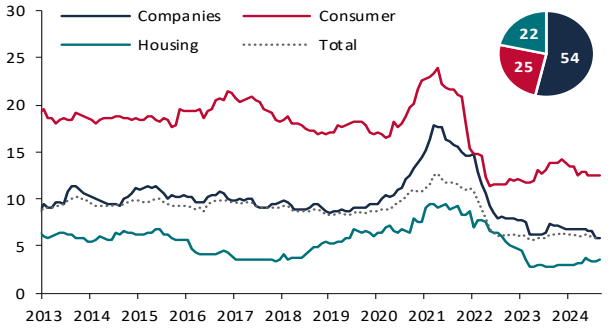
[58] Credit *VaR* is calculated using the "Capitalization and Credit Risk" (CYRCE) model. The main elements of this model are the probability of default of each loan, the structure of variances and covariances of potential defaults, and the structure and concentration level of the loans in the portfolio. An explanation of the model can be found in Banco de México (2006), Report on the Financial System May 2007, pp. 64- 67, and in Javier Márquez Diez-Canedo, *Una nueva visión del riesgo de crédito*, third edition, Limusa (2024).

[59] The probabilities and correlations of default used in the model are estimated through the observed historical default rates of loans, whose reference can be found in Banco de México (2006). "Estimation of Probabilities and Correlations of Default". Report on the Financial System May 2007, Box 10, pp 66.

Graph 81

a) Conditional Value at Risk (CVaR) by type of portfolio [1/]

Percent of portfolio



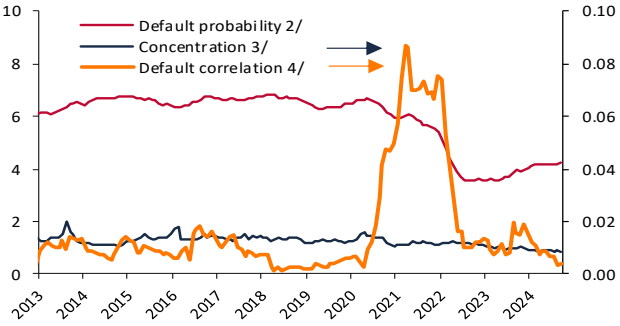
Data as of September 2024.

Source: Banco de Mexico, CNBV and Credit Bureau.

1/ Using a time period of one year and a confidence level of 99.9%. The pie chart shows the total percentage of the current balance for each portfolio segment.

b) Portfolio concentration, probabilities and default correlation[1/]

Percent



Data as of September 2024.

Source: Bank of Mexico, CNBV and Credit Bureau.

1/ Components used as inputs to compute the CVaR of the portfolio.

2/ Average default probability of the portfolio on annual horizon.

3/ Portfolio concentration measured using the Herfindahl-Hirschman Index.

4/ Average default correlation of the portfolio on annual horizon.

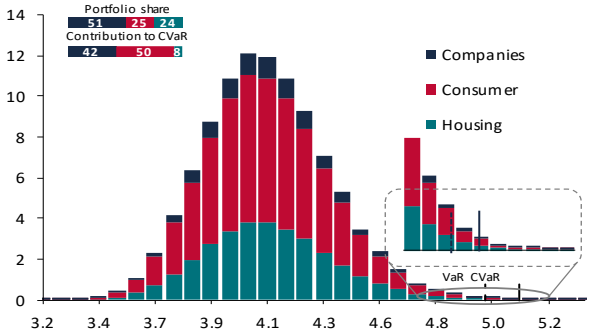
When considering all commercial banks' credit portfolio exposures and their distribution of potential credit losses,[60] it is found that, although the consumer portfolio is more atomized, it has a relatively higher probability of default than the other portfolios which makes its contribution to *CVaR* considerably higher than its share of the total portfolio balance (50% vs. 25%), a contribution that has been increasing since mid-2021 (Graph 82). Although the contribution of consumer portfolio risk has increased, the aggregate level of banking credit risk has remained constrained. Its capital levels are high and above regulatory minimums; however, it is important to maintain adequate granting criteria in order to prevent systemic risk from increasing.

Graph 82

Simulated credit loss distribution of the system

Horizontal axis: Percent of portfolio [1/]

Vertical axis: Percent



Data as of September 2024.

Source: Banco de Mexico, CNBV, and Credit Bureau.

1/ The percentage of loss for each portfolio is relative to the total loss, within each interval. The VaR and CVaR levels are

Bank Credit Risk Map

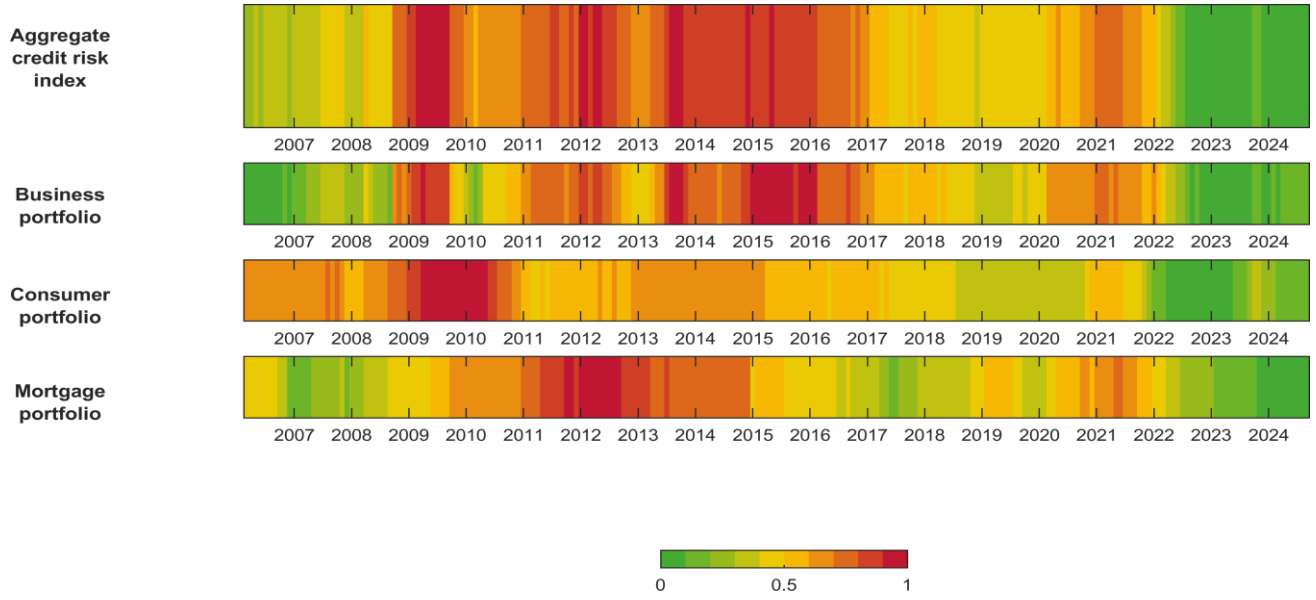
Aggregate credit risk, as represented in the heat map,[61] is at historically low levels. Despite the strong growth of the corporate portfolio, the risk associated with this sector remains under control. Throughout 2024, the consumer portfolio has shown a slight improvement, driven by lower funding costs and a reduction in expected losses under extreme scenarios. Finally, mortgage portfolio risk remains minimal, with a reduced concentration of loans issued in recent months.

[60] This distribution is generated using the loss simulation methodology for a loan portfolio. Available from Banco de México (2022). "Measuring the credit risk of a portfolio through Monte Carlo simulation." Financial Stability Report June 2022, Box 7, pp 74.

[61] For more details on the methodology used to determine the heat map, see: Banco de México (2024). "Bank credit risk map". Financial Stability Report June 2024, Box 4, pp 62-63.

Graph 83

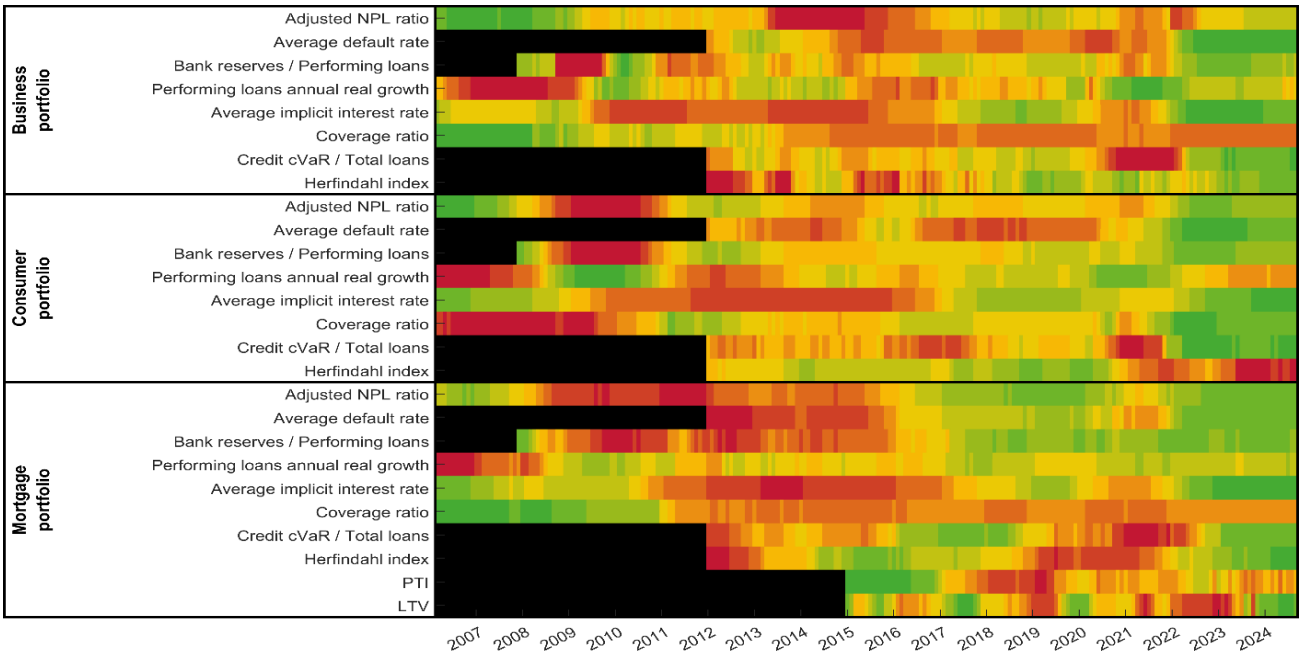
Bank credit risk map



Data as of September 2024.
Source: Banco de México, CNBV and Credit Bureau.

Graph 84

Disaggregated bank credit risk map



Data as of September 2024.
Source: Banco de México, CNBV, and Credit Bureau.

Box 2: Indicator of the Risk Profile of Commercial Portfolio Loans

I. Introduction

Credit risk is the most relevant risk incurred by banking institutions. The evaluation and monitoring of this risk in the Mexican financial system is fundamental to preserve financial stability and prevent systemic crises. For these reasons, there are several indicators for monitoring this risk, from *ex post* indicators, such as non-performing loan ratios, to indicators that measure this risk in advance, such as expected loss. High credit risk can reduce the supply of loans, slowdown economic growth and generate knock-on effects that impact different sectors, with significant consequences for the entire economy.

This box examines the credit risk profile of the commercial portfolio by estimating the probability of default at the individual level for each loan in conjunction with macroeconomic indicators[1] . A robust machine learning algorithm, *XGBoost* (*Extreme Gradient Boosting*), was used to estimate the probability of default (PI) for each loan originated during the study period. From these estimates, weighted by the exposure of the loan, the Relative Expected Loss (PER) indicator was calculated for the loan portfolio in each month of the analysis. This approach allows for the evaluation of the risk level in the commercial loan portfolio at different levels of aggregation.

This research covers four different economic phases, which allows us to identify risk trends and their evolution in different sectors, states and regions of the country over time. These findings contribute to a better understanding of credit risk exposure in Mexico and to identify trends in risk taking under different aggregation criteria.

II. Methodological description: data and model

This study uses detailed information on all loans registered in the banking system along with their associated characteristics. Among these variables are the interest rate, the total exposure to default, the years of operation of the borrower company (in the case of legal entities) or the age of the borrower (for individuals), the economic activity to which the loan is directed, the type of interest rate, the contracting currency and the activity sector to which the loan is destined.

In addition, other variables are incorporated, such as the Quarterly Indicator of Economic Activity by Federal Entity (ITAEE), annual inflation and the monthly unemployment rate by state, the exchange rate, the Consumer Price Index (CPI), the US Industrial Production Index, the Federal Funds Rate and the 3-month US Treasury Bond rate, all of them at a monthly level. The selection of variables was made based on a preliminary analysis that took into account factors such as their possible predictive capacity and their availability throughout the time period studied.

Due to imbalance in the data (with a significantly lower proportion of defaulted loans), the balancing technique known as *Synthetic Minority Over-sampling Technique* was used. For analysis, the data were divided into training, validation and test sets. Since the main objective of this study is prediction, the machine learning algorithm *XGBoost* was used, a particularly robust technique for classification tasks. [2]

The model was trained and validated by cross-validation, obtaining an outstanding performance in the validation data[3]: accuracy (0.94), sensitivity (0.96), specificity (0.91), F1 Score (0.94) and AUC-ROC

[1] These results can complement other approaches to credit risk analysis, such as Survival Analysis (SA) (Bátiz Zuk et al, 2021).

[2] *XGBoost* is highly computationally efficient and stands out for its ability to identify nonlinear patterns and complex interactions in the data, outperforming traditional econometric models such as logistic regression (Chen and Guestrin, 2016), given that, no explicit functional form is assumed between the covariates and the response variable. This algorithm builds decision trees sequentially, where each new tree is trained to correct the prediction errors of the previous trees. Initially, the first tree generates a basic prediction, while subsequent trees focus on improving performance on more challenging data points (Xia et al., 2023).

[3] Accuracy measures the proportion of correct predictions out of the total, assessing the overall performance of the model. Sensitivity measures how well positive cases are identified, while specificity measures the ability to correctly detect negatives. The F1 Score combines sensitivity and precision into a harmonic mean. Finally, the AUC-ROC measures the area under the ROC curve, assessing how well the model distinguishes between positives and negatives at different thresholds of the probability of default. Values close to 1 are ideal for all metrics.

(0.98). Using the trained model, default probabilities (PI) were calculated monthly for newly originated loans in each month of the period covered by the R04 series.

III. Relative Expected Loss

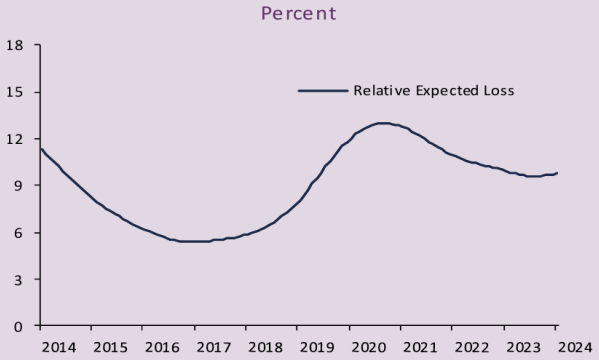
Considering that in month m, a set of n loans is issued into the banking system, each associated with an exposure given default (EDI_i), loss given default (PDI_i), and probability of default (p_i); the Expected Loss (*EL*) represents the potential loss that the system anticipates when defaults occur and is defined as $PE_m = \sum_{i=1}^{n}(p_i \times PDI_i \times EDI_i)$. On the other hand, the PER represents the fraction of the total exposure (E_m) that the system could lose in the event of default, $PER_m = \frac{PE_m}{E_m}$ where $E_m = \sum_{i=1}^{n}(PDI_i \times EDI_i)$. Higher values of *PER* indicate higher risk in the system attributed to new loans issued.

IV. Results

This section presents the results of the PER analysis for the banking system as a whole, broken down by industry and state. To facilitate the analysis and discussion, the study period was divided into three phases: Period 1 (July 2014-March 2020); Period 2, associated with the COVID-19 pandemic (April 2020-March 2023); and Period 3, defined as the post-pandemic period (June 2023-July 2024).

The Graph 1 depicts the trend of PER, the aggregate risk level index. The first phase shows a reduction in the portfolio's risk profile after the period of the global financial crisis. The indicator spiked during the pandemic period and recently, the risk profile of the portfolio has rebounded.

Graph 1
Relative Expected Loss Trend

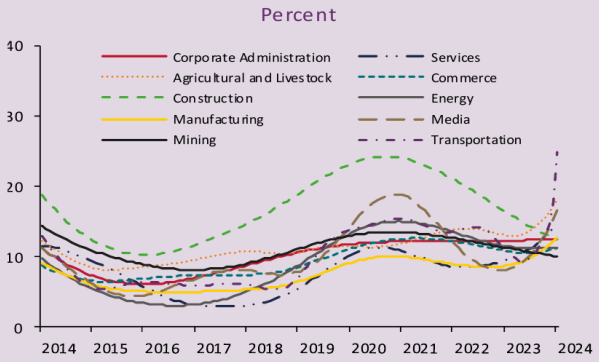


Data as July 2024

Source: Banco de México

The disaggregated analysis by industry, illustrated in Graph 2 reveals a pattern similar to that of the aggregate indicator. However, there are sectors, such as construction, that maintain a higher risk profile relative to other activities. Also, in recent times, there is a higher level of risk in credit to the agricultural-livestock and transportation sectors.

Graph 2
Expected Loss Trend by Industry



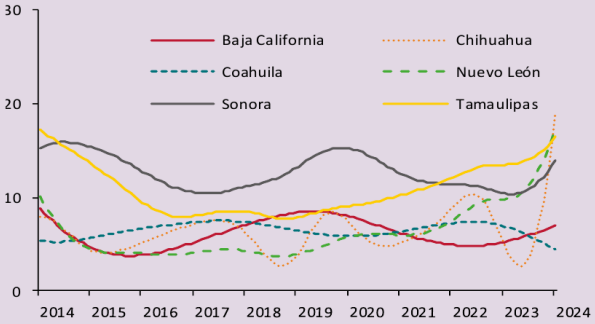
Data as July 2024

Source: Banco de México

Graphs 3-6 present the trends by state and region. The results indicate higher variance in the Northern region, in contrast to the Central region, which presents lower variability. This behavior suggests structural differences between regions in terms of credit risk exposure and resilience to adverse events. These results highlight regional differences in the intensity of the financial impact, possibly associated

with economic, productive and social factors specific to each entity.

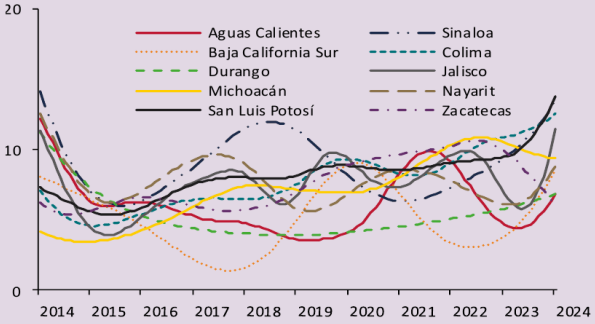
Graph 3
Expected Loss Trend by Industry
Northern Region
Percent



Data as July 2024

Source: Banco de México

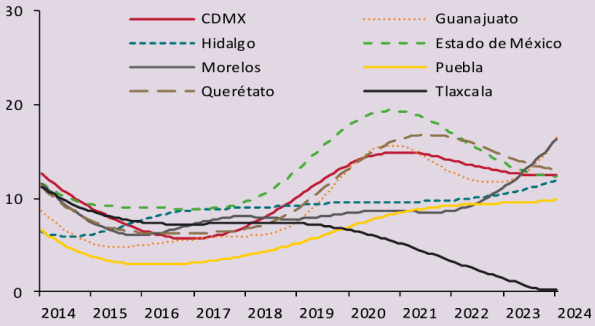
Graph 4
Expected Loss Trend by Industry
North Central Region
Percent



Data as July 2024

Source: Banco de México

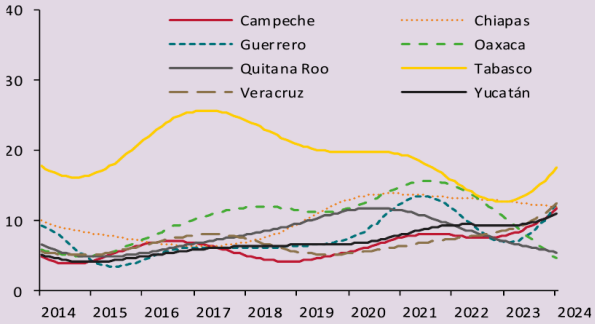
Graph 5
Expected Loss Trend by Industry
Central Region
Percent



Data as July 2024

Source: Banco de México

Graph 6
Expected Loss Trend by Industry
Southern Region
Percent

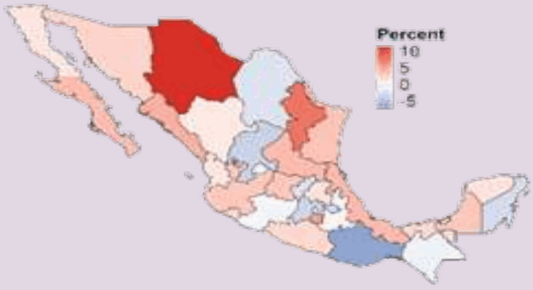


Data as July 2024

Source: Banco de México

Finally, Graph 7 shows the average PER for the last 36 months of the analyzed period and the PER as of July 2024. Chihuahua was the entity where PER increased the most, with an increase close to 10%, driven mainly by the increase in risk in the Transportation sector (see Graph 2). In contrast, Oaxaca decreased 5% compared to the average values of the previous 36 months.

Graph 7
Relative Expected Loss Difference
Last 3-years average



Data as of July 2024.
Source: Banco de México.

V. Final Considerations

The analysis of the risk profile of the commercial portfolio by means of the PER reveals patterns in its evolution throughout different phases.

The regional and sectoral analysis also shows differences in risk profile. For example, Chihuahua recorded the largest increase in PER as of 2024, especially in the transportation sector, indicating a growing risk in specific areas of the country. In contrast, Oaxaca experienced a decrease in PER, suggesting a relative recovery or better risk management in certain sectors.

These results underscore the importance of monitoring the dynamics of the credit risk profile not only at the national level, but also at the regional and sectoral levels. The variability observed in the PER index over the different periods and in the different regions highlights the usefulness of having tools that allow for a more detailed and segmented approach in identifying the risk profile.

References

Bátiz, E., Mohamed, A., Sánchez, F. (2021), Exploring the sources of loan default clustering using analytics. of survival with fragility, Banco de México Research Paper No. 2021-14.

Chen, T., and Guestrin, C. (2016). XGBoost: A scalable tree boosting system. In Preceedings of the 22nd International Conference on Knowledge discovery and data mining, 785-794.

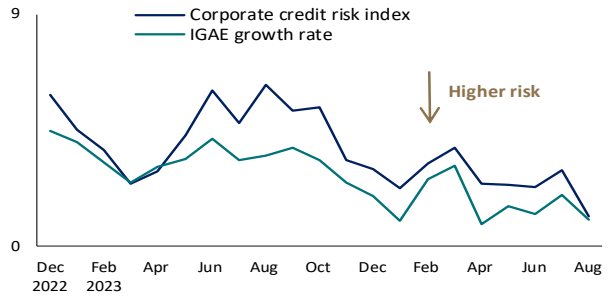
Xia, H., An, W, and Zhang, Z. J. (2023). Credit risk models for financial fraud detection: A new outlier feature analysis method of xgboost with smote. Journal of Database Management, 34, 1, 1-20.

Banks' Exposure to Changes in Inflation, Economic Activity and Formal Employment

In this section, we construct indicators that assess how the performance of economic activity, formal employment, and inflation affect the risk of corporate, payroll, mortgage, automotive, personal and for the acquisition of durable consumer goods (ABCD) credit.

For the analysis of the corporate portfolio, an indicator is used to show a higher credit risk when the economic growth rate declines, either in aggregate terms or in those sectors that have more credit participation.[62] As in the previous *Report*, the indicator continued to decrease, reflecting more credit risk for this portfolio (Graph 85). The decline was greater than that of the annual growth rate of the Global Economic Activity Index (IGAE). This was largely because the economic slowdown experienced in certain sectors, such as construction, which more than offset the higher growth rates observed in other sectors, such as professional services, that also have a greater share in credit than production.

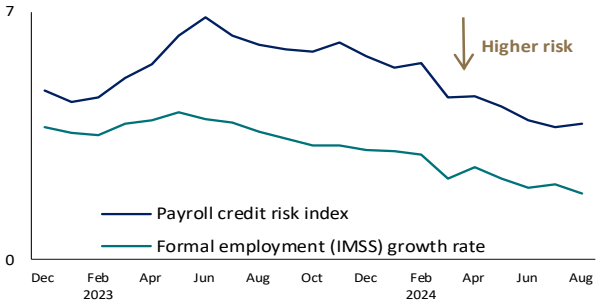
Graph 85
Corporate portfolio credit risk due to changes in economic activity
Annual variation in percent



Data as of August 2024.
Source: Banco de Mexico and INEGI.

In the payroll, mortgage and automotive portfolios, the indicator shows more credit risk when the growth rate of formal employment falls, either in aggregate terms or in the labor markets with greater participation in these portfolios.[63] Compared to the previous *Report*, the indicators decreased, reflecting a higher credit risk for the three portfolios under consideration (Graph 86).[64] The decline in the indicators surpasses the slowdown in employment growth. This is attributable to the fact that the slowdown was concentrated in higher-wage workers, who have a higher share in these portfolios than in formal employment as a whole. In addition, the sharper slowdown in this type of employment led to a greater increase in risk for mortgage loans, followed by automotive and payroll credit, in line with the participation of these workers in each of these portfolios.

Graph 86
Payroll portfolio credit risk due to changes in formal employment
Annual variation in percent



Data as of August 2024.
Source:Banco de Mexico and IMSS.

In the personal and ABCD portfolios, the indicator reflects the credit risk arising from changes in the inflation rate, measured through the National Consumer Price Index (INPC). Inflation is selected as the risk factor because in these portfolios the borrowers possess less purchasing power compared to other credit segments, thereby rendering them more vulnerable to rising prices.[65] Consequently, the indicator reflects higher risk when the annual inflation rate increases, whether general inflation or inflation within the categories in which these borrowers spend proportionally more.[66] Since the last version of this

[62] The risk indicator is constructed as the weighted average of economic growth in the different sectors. The weight received by each sector is equal to its share of corporate credit.

[63] In order to construct the indicators related to formal employment, the proportion of loans in each state is obtained, by gender and wage level, according to the information of workers affiliated to the IMSS. The threshold for high-wage formal employment is defined as the median of the historical wage distribution of borrowers.

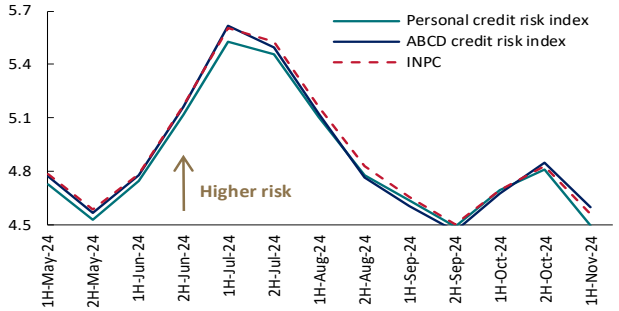
[64] The largest deterioration occurred in the mortgage portfolio, followed by the automotive and the payroll portfolios.

[65] See Box 1 Inflation and non-performing loan ratio in non-revolving consumer credit in the *Financial Stability* Report-December 2022.

[66] To construct the personal and ABCD portfolio indicators, the inflation exposure of each municipality is estimated, and then a national average is calculated, weighting each municipality by its share in each portfolio. The classification by object of expenditure of the INPC and economic activity by state is used, which provides detailed information on spending components such as food, education, leisure and housing, among others. This classification allows for a detailed analysis at the state level and type of expenditure component. This information differs from that provided by the CPI, its core and non-core subindices, and their respective disaggregates. An illustrative example is the housing

Report, the indicators have decreased, reflecting lower levels of risk (Graph 87). In the ABCD portfolio, this decrease was smaller than that of headline inflation because: (i) borrowers in this portfolio spend proportionally more on food, beverages and tobacco; and (ii) in this category the increase in inflation was greater than that of the INPC (which, in fact, decreased). In the personal portfolio, the decline in the indicator was, in the opposite direction, greater than that of headline inflation because: (i) in this portfolio, borrowers spend proportionally more on housing; and (ii) in this category, the decrease in inflation was greater than that of the INPC.

Graph 87
Credit risk in personal and ABCD portfolios due to changes in inflation
Annual variation in percent

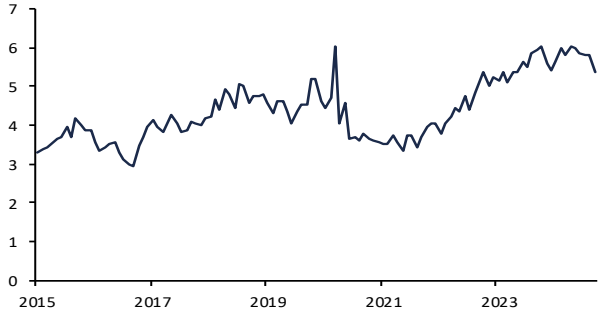


Data as of the first half of November 2024.
Source: Banco de Mexico and INEGI.

Market Risk

Banks' market risk, measured by the *CVaR* as a proportion of net capital, stood at 5.38% in September 2024, lower than the level prevailing in March 2024 (5.81%). This is due to changes in the composition of the portfolios, particularly in the positions with foreign exchange risk (Graph 88).[67]

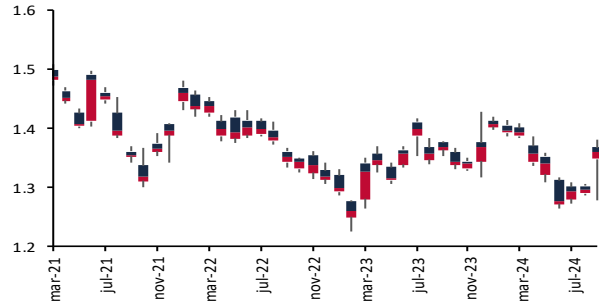
Graph 88
99.9% CVaR for commercial bank's market risk
Net capital percent



Data as of September 2024
Source: Banco de Mexico, CNBV, BMV, Bloomberg and Valmer

The sensitivity of the debt instruments portfolio to changes in interest rates, as measured by duration based on market data, decreased in the second and part of the third quarter of 2024.[68] This follows a two-year period in which they had increased marginally. This change is mainly due to the rebalancing of the institutions' portfolios towards variable rate securities. As of September 2024, duration stood at an average level of 1.35 years, which is below the level prevailing in March, which was 1.40 years (Graph 89).

Graph 89
Average monthly duration of commercial bank's position
Years



Data as of September 2024.
Source: Banco de Mexico and Valmer.

component: in the classification by object of expenditure, this component includes generics such as electricity and fuels. However, in the core and non-core classification of the INPC, the housing category (in the core subindex) excludes these items, which are classified in the non-core subindex as energy.

[67] The *CVaR* represents the 99.9% quantile of the loss distribution generated by historical simulation, which is generated with the observed 20-day changes in risk factors since 2004, applied to the positions of the date considered. Given the number of observations, the behavior of the Conditional *Value at Risk* is almost entirely explained by changes in portfolio composition, with a marginal effect of recent changes in risk factors.

[68] The increase in the system's duration in September was due to the rebalancing of debt portfolios in some institutions, which was reflected in an increase in the position of long-term debt instruments.

Box 3: Technological Advance, Social Networks and Depositor Perceptions

I. Introduction

The objective of this Box is to analyze the impact that social networks and technological advances may have on the stability of bank deposits. In particular, it analyzes the role of social networks and technology in relation to the speed of news dissemination and the ease of making bank withdrawals that could lead to a bank run, as well as their implications for financial stability. In addition, this box discusses the possible solutions to the challenges posed by these new trends, and explores the importance of a robust regulatory framework to maintain the stability of the financial system.

II. Background: Stress Events in the United States' Banking System in 2023

In March 2023, after facing significant withdrawals by depositors, three US regional banks, *Silicon Valley Bank (SVB), Signature Bank (SB) and First Republic Bank (FRB)*, were intervened and placed under disposal for resolution by the Federal Deposit Insurance Corporation *(FDIC*), representing the most severe disturbance of the US banking sector over a decade.[1]

In general terms, these events were attributed to the tightening of financial conditions and various factors related to inadequate risk management, resulting in the accumulation of significant vulnerabilities.[2]

These events were characterized by the speed and magnitude of massive withdrawals of deposits. For example, *SVB* and *SB* experienced daily average withdrawals of between 20-30% as a proportion of their total deposits prior to the run.[3] Most of these deposits were comprised of immediately demandable, uninsured deposits, from high-net-worth individuals (*FRB*), from a specific niche as they were depositors related to virtual assets (*Silvergate* and *SB*), and from accounts of large companies and *start-ups (SVB* and *SB*).

While the financial conditions and risk management of these institutions played an important role, the evidence points to the fact that social networks and the banks' digital platforms may have contributed to these events.

III. Information in the Age of Social Networks

Social networks have the potential to transform the dynamics of the financial sector by amplifying the speed and scope of information, even generating disruptions in the markets. In particular, they have revolutionized the generation and dissemination of information. News, ideas, rumors, and trends, such as the possible instability of a bank, can spread around the world through digital platforms in a highly interconnected system.

Likewise, sentiment on social networks influences the depositor confidence. Research indicates that negative sentiment regarding banks can lead to a decline in their retail deposits, which has a greater impact on less capitalized financial intermediaries.[4] Furthermore, it highlights that banks not directly affected by negative comments may be harmed if they are perceived as linked to those affected, i.e. there are contagion effects stemming from negative sentiments on social networks.

Bank runs are a phenomenon that may also be influenced by the increased use of social networks. Evidence suggests that exposure to social networks may amplify the risks associated with a bank run. For example, the failure of *SVB* was preceded by a surge in activity on the Twitter platform (now *X*) by apparent depositors who openly used words such as "withdraw" or "contagion" in their posts.[5] From the opening of the markets on March 6, 2023 at 9:00 a.m. until their closing on March 10 at 4:00 p.m. mentions of *SVB* on the X social network increased rapidly (Graph 1). Likewise, internet searches about the banks affected by the aforementioned deposit runs increased considerably at the start of these events (Graph 2).

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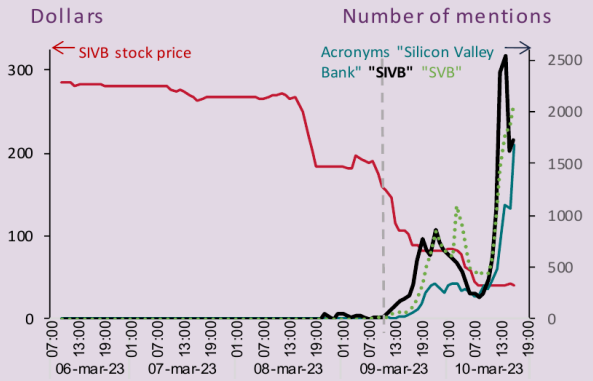
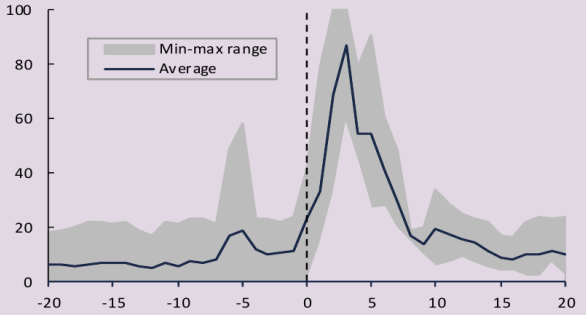
[1] See Box 6 "*Recent Developments in the US government debt ceiling*" of the Financial Stability Report - June 2023 for more detail.
[2] FSB (October 2024).
[3] FSB (October 2024).
[4] Accornero and Moscatelli (2023) show that a 1% drop in the sentiment index reduces retail deposit growth by 0.15% for banks with average capitalization, and up to 0.4% for less capitalized banks.
5 Cookson et al. (2024).

Graph 1
Silicon Valley Bank stock price and mentions on Twitter



Data as of March 2023.
Source: Cookson et al. (2023) with data from Twitter/X and FirstRate Data.
Note: The dotted line corresponds to March 9, 2023 9:00 hrs.

Graph 2
Banks with massive deposit withdrawals[1/]



Source: Google Trends; own calculations.
1/ Includes banks involved in the March 2023 events centered around the start of the bank run (SVB: 08/03/2023; Signature Bank: 10/03/2023; First Republic Bank: 10/03/2023; and Silvergate: 08/03/2023).

It is also important to note the key differences between open platforms (e.g., Facebook, Instagram, LinkedIn and X) and private groups (e.g., WhatsApp, Signal and Telegram). On the one hand, open platforms can be reviewed by everyone (including other banks or regulators) but quickly reach mass audiences, which could make damage control difficult. On the other hand, the dissemination of information in private groups is difficult to control, limiting the ability of banks and regulators to react effectively.[6] In particular, the creation of content on novel platforms typically is not subject to the accountability mechanisms or verification processes employed by traditional media, such as editorial filters, legal responsibility, and supervision by press councils and regulatory bodies,[7] which could mitigate uncertainty regarding the veracity of the information.[8]

Cookson et al. (2024) highlight the multifactorial nature of bank runs. On the one hand, X-posts might serve as an early warning indicator for banks already exhibiting vulnerabilities. On the other hand, emphasizes that the type of *SVB* and *SB* depositors likely influenced the severity of the runs, since they were mostly members of the technology community in the United States, who are more likely to utilize technological platforms for the dissemination of their perspectives. However, it is plausible that corporate depositors and high-net-worth clients possess alternative information sources, suggesting a need for caution regarding the role of social media.

Mexico is at a point of high digital interconnection and has a high capacity for immediate dissemination. Regarding the use of social networks and digital media, according to data from DataReportal, at the beginning of 2024, Mexico had 107 million Internet users and 90 million social network users,[9] along with 125 million active mobile phone subscriptions.[10]

IV. Technological Advances and the Speed of Deposit Transfer

In recent years, technological innovation has enabled banks to expand their services offering. Among these, real-time transfers are particularly relevant, enabling the mobilization of funds without time restrictions.

6 S&P Global (2024).
7 Newman et al. (2019).
8 Vosoughi et al. (2018).
9 DataReportal et al. (2024).

10 The same person may have more than one mobile subscription (for example, one for personal use and another for work), so the data is not necessarily indicative of the number of individuals with an active cellular line.

Digital wallets, which permit instantaneous payments without the use of cash or physical cards; or immediate access to savings accounts, which enables swift resource transfers, are also noteworthy.

Globally, there has been a notable increase in the adoption of mobile banking and online banking applications among retail depositors. The advent of novel technologies, facilitated by open banking,[11] banking-as-a-service (*BaaS*)[12] and artificial intelligence (AI), is poised to enhance the efficiency and speed of liquidity management and deposit transfers for large companies.

However, increasing the speed with which depositors can withdraw or transfer their money also increases the risk that, in the event of a loss of confidence on an institution, there will be a sudden and massive withdrawal of deposits. The search for yield, the ease of transferring resources, and the absence of a solid relationship with institutions may result in a heightened propensity among clients to withdraw their deposits.[13] Koont et al. (2024) estimated that banks with digital platforms have fewer stable deposits, thereby reducing their deposit franchise value by 40%.[14] In addition, demonstrated that the sensitivity to interest rate changes of banks based on digital platforms is more than twice that of traditional banks.

Digitalization may have played a significant role in facilitating the rapid outflow of funds prior to the failure of *SVB* and other regional banks in the United States. Withdrawals in regional banks exceeded, both in magnitude and speed, withdrawals during similar past crises (Table 1). However, these withdrawals were massive in terms of amounts, but not in terms of number of depositors.

Table 1

Deposit outflows in different stress episodes

Bank	Date run started	Deposit Insurance Coverage (%)	Total outflow (%)	Duration of outflow
Continental Illinois	07/05/1984	15	30	10 days (7 bus. days)
Washington Mutual	08/09/2008	74	10.1	16 days (12 bus. days)
Wachovia	15/09/2008	61	4.4	19 days (15 bus. days)
Silvergate	2022 Q4	11	52	7 days or less
Silicon Valley Bank	09/03/2023	6	25 +62*	1day + expected next day
Signature Bank	10/03/2023	10	20 +9*	1day + expected next day
First Republic	10/03/2023	32	57	7-14 days (5-10 bus. days)

Source: Rose, J. (2023).

Note: *Figures with asterisks are the expected amount of outflows that were scheduled to go out the next business day, but did not actually occur because the banks were closed.

In Mexico, increased digitalization has been observed in recent years. As of the second quarter of 2024, there were 94 million accounts linked to cell phones, representing a growth of 115% since the beginning of the pandemic (43.8 million accounts as of the first quarter of 2020).[15] These accounts constitute 60% of the total deposit and savings accounts (156.8 million), while in the first quarter of 2020 this proportion was only 35% of the total.[16]

Another innovation in recent years has been the introduction of AI into financial decision-making processes. These technologies, which operate with pre-established parameters and are fed by external information such as news or financial events, allow the automatic mobilization of resources, thereby enhancing the efficiency of depositors' decision-making.

However, it is essential to acknowledge the potential risks associated with the emergence of generative AI within the context of social networks and bank runs. This technology has the potential to facilitate the manipulation of social networks by rendering it difficult to distinguish between generated and real

[11] Open banking is defined as the sharing and leveraging of customer-permissioned data by banks with third party developers and firms to build applications and services. *BCBS* (2019).

[12] Banking-as-a-Service refers to the provision of banking products through third-party distributors, such as Fintech companies. Deloitte (2021).

[13] *EBA* (2021).

[14] The value of the deposit franchise is a function of deposit stability: how much and for how long depositors are willing to tolerate a return on deposits below the reference rate.

[15] CNBV. Financial Inclusion Database. Accounts correspond to the sum of commercial banks, Socaps and Sofipos.

[16] It is important to mention that not necessarily all accounts linked to the cell phone or with internet access use mobile banking. According to the National Survey on Availability and Use of Information Technologies in Households (Endutih), conducted by INEGI, the number of people who have a smart mobile device (*smartphone*) with internet access and who use mobile banking reached 24.8 million in 2022 (an increase of 3.5 million over 2021), and that figure was projected to reach 27.5 million users by 2023.

content, for both users and automated detection tools. For example, generative AI could be used to create high-quality fake messages and *deepfakes* that increase the spread of disinformation.[17] The risk could intensify if malicious actors use these technologies to discredit or undermine the credibility of financial institutions. Large-scale manipulations, such as false information about a bank's solvency, or advanced *astroturfing* strategies,[18] could generate uncertainty, incentivize the massive withdrawals of funds, and undermine the confidence in the financial system.

On the upside, while new technology may increase the risk of massive withdrawals, financial institutions can, in turn, develop AI tools to improve liquidity management and monitor withdrawal patterns.[19] Depositors can also take advantage of new technologies for decision-making and mobilizing resources.

However, in times of high volatility, these technologies may be inefficient to assess a longer horizon based on more fundamental economic and financial characteristics and, instead, respond mechanically to high-frequency movements in the markets. Thus, these characteristics of AI could increase the risk of massive withdrawals and generate a liquidity crisis that would otherwise not occur.[20]

V. Relevant Elements to Strengthen Perception and Confidence in a Digitalized Environment

In order to address the vulnerabilities delineated in this Box, as well as to respond promptly to liquidity shocks associated with these vulnerabilities, the following recommendations are proposed, some of which have been deliberated in various international financial organizations:

1. Innovation and Regulatory Oversight

The Financial Stability Board (FSB) proposes a regulatory framework proportional to the size and risk profile of digital banks with more stringent measures for larger entities, thereby enabling innovation without compromising financial stability by adhering to minimum security and solvency standards.[21]

2. Real-time Monitoring of Liquidity

The International Monetary Fund (IMF), the FSB and the Bank for International Settlements (*BIS*) have highlighted the importance of private financial intermediaries to adapt their liquidity oversight practices to the contemporary digital banking era. In this context, the implementation of advanced systems employing AI that facilitate real-time monitoring of deposit behavior stands out.[22]

Banco de Mexico requires the submission of daily information by institutions to calculate their liquidity indicators. In addition, institutions are obligated to immediately notify Banco de México in the case of a liquidity event or the anticipation thereof.

3. Communication Strategies and Collaboration Schemes

Effective communication by authorities can mitigate the likelihood of deposit withdrawals during crises.[23]

Financial institutions and authorities should assess and revise their crisis management frameworks, as well as manage the public perception and ensure clear and timely communication. The *FSB* also advises financial institutions to establish continuous communication protocols with financial authorities and their depositors. For example, implementing specialized social media monitoring systems and having teams that closely monitor conversations, trends, and perceptions about the financial system. In addition, they should provide depositors and

[17] Marcellino et al. (2023).
[18] *Astroturfing* seeks to create the fictitious appearance of broad social consensus on very specific issues. According to the Harvard Technology and Social Change Project, it is defined as "attempt[ing] to create the false perception of grassroots support for an issue by concealing [actor] identities and using other deceptive practices, like hiding the origins of information being disseminated or artificially inflating engagement metrics".
[19] Krogstrup et al. (2024).
[20] The *FSB* (October 2024) notes that the integration of AI into the decision-making processes of bank depositors can accelerate the transfer of funds. In addition, innovations in payments, such as the tokenization of money and assets or the increased use of digital wallets, could increase the propensity of depositors to move funds between financial institutions.
[21] See FSB (October 22, 2024).
[22] See IMF (2018), World Bank (2021), *FSB* (2019), BIS (2024), *BCBS* (2024) and Rainone (2024).
[23] Shakina et al. (2018); Sandri et al. (2023).

financial authorities with reliable information in real time, particularly in times of uncertainty.[24]

In Mexico, commercial banking institutions are obligated to devise and submit contingency plans to the CNBV, wherein they stipulate the measures to be implemented in the event of encountering solvency or liquidity challenges, along with communication strategies to address stress events.

The financial authorities, with the support of the IMF, have also conducted crisis simulations to test the communication strategies of both the authorities and the institutions.

4. Additional Tools to Quantify Risks

In addition, the *BIS* and the *FSB* emphasize the need to update stress tests, traditionally focused on macroeconomic shocks, to encompass scenarios where information dissemination, whether verified or unverified, could jeopardize financial stability. They also recommend that regulators, in collaboration with financial institutions, develop advanced technologies, such as the use of artificial intelligence, to enhance supervision and risk management. For example, Khan et al. (2024) employ advanced machine learning and deep learning models for analyzing the sentiment of investors who communicate through social networks. These tools would enable real-time monitoring and help identify and mitigate potential threats before they compromise the stability of the financial system.[25] Furthermore, the development of interoperability standards between digital banking platforms to facilitate seamless transactions and improve competition is included.[26]

In this regard, Banco de México has developed several projects based on the exploitation of information extracted from digital media and social networks, predominantly text-based, to develop indicators that facilitate the identification and tracking of pertinent events within the financial system, as well as the early identification of potential risk sources.

5. Ability to Access Central Bank Liquidity Facilities in a Timely Manner

It should be encouraged that banks be prepared to access central bank liquidity facilities in a timely manner in the event of massive deposit withdrawals.[27] This implies having a well-defined governance process for identifying liquidity needs and determining funding request. It is essential to be familiar with the relevant provisions, have signed contracts and have the necessary documentation, in addition to ensuring tested access to such facilities. Banco de México has implemented simulations to assess its own liquidity access, enabling institutions to evaluate their capacity to utilize these facilities.

6. Financial Education

The promotion of financial education within the population is paramount, particularly in distinguishing between traditional and digital banking institutions.

Banks are subject to stringent prudential regulations, and their deposits are protected by deposit insurance, whereas Non-Banking Financial Institutions (IFNB, its acronym in Spanish), which can also raise funds from the public, are also subject to proportional regulatory frameworks and have smaller deposit insurance coverage.

Conversely, regulatory authorities must constantly evaluate and modernize the regulatory framework to ensure that it is responsive to the risks associated with each type of institution and the evolution of the financial system, without impeding the integration of technological advancements, thereby facilitating the provision of more and better financial services.

VI. Conclusions and Final Comments

The digital era presents significant challenges regarding best practices to respond promptly to shocks or stress events. Technological advances and social media have accelerated the dissemination of information, which suggests the potential for these

[24] *FSB* (April 2024).
[25] *BCBS* (2024). Also, the IMF (October 2024) recommends that financial brokers disclose the use of AI, implement volatility management mechanisms and regularly map the interdependence between data, models and technological infrastructure.
[26] *FSB* (October 22, 2024).
[27] *FSB* (October 2024).

phenomena to contribute to mass deposit withdrawal events in the future.

To address these challenges, financial institutions and regulators must adapt their risk management and supervisory strategies, strengthen depositor confidence, implement advanced technologies to monitor deposit flows in real time, and develop rapid communication strategies to mitigate contagion effects.

The development of novel risk measurement tools, such as stress tests adapted to the challenges of digitalization and the rapid spread of information on social networks, is imperative.

Additionally, institutions and central banks must be prepared for expedited access to liquidity facilities, without compromising institutions' responsible management of liquidity risk.

Furthermore, central banks and regulatory authorities must promote financial education, as more educated users take better advantage of digital banking services and are less susceptible to technological risks.

It is important to emphasize that the March 2023 events in some regional US banks were not caused by technology or social media, but rather by inadequate risk management, which consequently gave rise to vulnerabilities and, ultimately, to bank runs. It is noteworthy that social media and technology may have served to intensify the velocity and magnitude of these runs. This highlights the need for a robust regulatory framework and its compliance, in order to timely manage liquidity and solvency vulnerabilities that could lead to massive deposit withdrawals.

References

Accornero, M. and Moscatelli, M. (2018). *Listening to the buzz: social media sentiment and retail depositors' trust*. Temi di discussion. Economic working papers. 1165, Bank of Italy, Economic Research and International Relations Area.

World Bank (2021). *The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19*. Washington, D.C.: World Bank.

Bank for International Settlements (2024). *Digitalisation of finance*. Basel: *BIS*.

Basel Committee on Banking Supervision (2019): *'Report on open banking and application programming interfaces',* November 2019.

Basel Committee on Banking Supervision (2024). *The 2023 banking turmoil and liquidity risk: a progress report*. Bank of International Settlements (*BIS*)

Cookson, J. A., Fox, C., Gil-Bazo, J., Imbet, J. F., and Schiller, C. (2023). *Social mean as a bank run catalyst*. Available at SSRN, 4422754.

DataReportal, We Are Social & Meltwater (2024): *"Digital 2024 Mexico",* retrieved from: https://datareportal.com/reports/digital-2024-mexico in November 2024.

De Fiore, F., Cornelli, G., Gambacorta, L., and Manea, C. (2024). *Big Tech, financial intermediation, and the macroeconomy*. Bank for International Settlements. Paper presented at the 68th Research Conference of the Federal Reserve Bank of Boston.

Deloitte (2021): *"Banking as a Service, Explained: What it is, Why it's important and How to Play",* October 2021.

Duran and Schmaus (2024, February 29). *Your Three Minutes In Fintech: Social Media Could Catalyze Bank Runs.* S&P Global.

European Banking Authority (2021): *"Report on the use of Digital Platforms",* EBA/REP/2021/26, September 2021.

Federal Reserve Board (2023). *Review of the Federal Reserve's Supervision and Regulation of Silicon Valley Bank*. April.

Financial Stability Board (2019). *FinTech and market structure in financial services: Market developments and potential financial stability implications*. Basel: *FSB*.

Financial Stability Board (April 2024). *Key Attributes of Effective Resolution Regimes for Financial Institutions: Revised edition*.

Financial Stability Board (October 2024). *Depositor Behaviour and Interest Rate and Liquidity Risks in the Financial System: Lessons from the March 2023 banking turmoil*.

Financial Stability Board (October 22, 2024). The Financial Stability Implications of Tokenisation.

International Monetary Fund (October 2024). *Global Financial Stability Report*.

International Monetary Fund (2018). *The Bali Fintech Agenda*. Washington, D.C.: IMF.

Hermida, A. (2010). "*Twittering the News: The Emergence of Ambient Journalism*." Journalism Practice, 4(3), 297-308.

Jaume, D., Tobal, M. and Yslas, R. (2023). *Vertical Differentiation, Risk-Taking and Retail Funding*, Journal of Financial Services Research, Springer; Western Finance Association, vol. 64(1), 133-153.

Kahn, C. M. (2024). *FedNow and faster payments in the US*. Gies College of Business, University of Illinois at Urbana-Champaign. Paper presented at the 68th Federal Reserve Bank of Boston Research Conference.

Khan, W., Ghazanfar, M. A., Azam, M. A., Karami, A., Alyoubi, K. H., and Alfakeeh, A. S. (2022*). Stock market prediction using machine learning classifiers and social media, news*. Journal of Ambient Intelligence and Humanized Computing, 1-24.

Koont, N., Santos, T., and Zingales, L. (2024). *Destabilizing digital "bank walks".* No. w32601. National Bureau of Economic Research.

Landoni, M., and Wang, J. C. (2024). *Regulation meets technology: Evolution of small business lending in underserved areas since 2007.* Federal Reserve Bank of Boston.

Marcellino, W., Beauchamp-Mustafaga, N., Amanda Kerrigan, A., Navarre, L. & Jackson S. (2023): *"The Rise of Generative AI and the Coming Era of Social Media Manipulation 3.0: Next-Generation Chinese Astroturfing and Coping with Ubiquitous AI",* Expert Insights, RAND Corporation, September 2023.

National Audit Office (2009). *Annual Report 2009*. National Audit Office of the United Kingdom.

Newman, N., Fletcher, R., Kalogeropoulos, A., and Nielsen, R. K. (2019). "*Reuters Institute Digital News Report 2019.*" Reuters Institute for the Study of Journalism.

Rainone, E. (2024). *Real-time identification and high-frequency analysis of deposits outflows*. Journal of Financial Econometrics, 22(4), 868-907.

Rose, J. (2015). *Old-fashioned deposit runs*. Federal Reserve Board Finance and Economics Discussion Series, 2015-11.

Rose, J. (2023), *Understanding the Speed and Size of Bank Runs in Historical Comparison*, Economic Synopses, No. 12.

S&P Global Ratings (2024): *"Your Three Minutes in Fintech: Social Media Could Catalyze Bank Runs," Research Article,* February 2024.

Vosoughi, S., Roy, D., & Aral, S. (2018). *The spread of true and false news online*. Science, 359(6380), 1146-1151.

Williams, E. (2024). *Fintech, financial inclusion, and the future of finance*. Harvard Business School.

Zeissler, A, T Piontek and A Metrick (2019). *Ireland and Iceland in crisis c: Iceland's Landsbanki Icesave*. Journal of Financial Crises, vol 1(3), pp 27-43.