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Micro-data as a Key Input to Designing Macro-prudential Policy: The Mexican Experience

by Agustín Carstens

Governor, Banco de México

1. Introduction

Statistics are essential in any field of public policy. In particular, they are important to identify and diagnose problems which the authorities need to address. They also play an important role in the design of public-policy responses. For many decades, technological restrictions and general practices conditioned policy makers to concentrate on aggregate statistics. However, advances in computational technology have brought to the fore the fact that having more granular data allows analysts to identify many other factors that must be taken into account in policymaking.

Micro-data enhance the understanding of the drivers of systemic risk, increasing the chances of identifying behavioral patterns and potential sources of contagion. In this regard, the use of micro-data has become significantly more important for the design of regulatory and supervisory policies. It is also especially valuable for monitoring and assessing the impact of different policies.

Depending on each country's institutional arrangements, financial authorities have to design and implement a thoughtful and comprehensive system to collect, disseminate, and analyze micro-data with the aim of enhancing their analytical and research capabilities. The information model developed by Banco de México for the financial system was one of the responses to the challenges stemming from the Mexican 1994-1995 crisis.[1] The information used by Mexican financial authorities before the 1994-1995 crisis had several shortcomings. Data was non-structured and dispersed among different supervisory entities. Information requests were often duplicated. The frequency, granularity, and timeliness of the information were inadequate, and a significant amount of it was obsolete.

With the benefit of hindsight, a wide-ranging effort took place to improve the quality and quantity of the information gathered by the financial authorities. As a first step, an agreement was reached to develop a common strategy with clear responsibilities and commitments. It was agreed to

[1] This crisis was a combination of a balance-of-payments, fiscal, and banking crisis triggered by large capital outflows taking place under a crawling-peg exchange-rate regime due to a massive speculative attack on the currency.

eliminate duplicated requests and obsolete data and to fully share all the information collected. The frequency, granularity and timeliness of the information was improved and its scope significantly expanded. New information, particularly on banks' credit and market-risk exposures, was added. Daily data on derivative, foreign exchange, and money market operations started being collected, as well as on borrowers' and credits' individual characteristics.

The micro-data collected after these reforms were fully in place and allowed the central bank to identify the increasing riskiness of the credit card sector in a timely manner in 2007. The deterioration in credit card portfolios was not evident in the aggregate data, as a high rate of credit growth prevented the ratio of nonperforming loans over total loans from increasing. However, the use of micro-data combined with information panels obtained from credit bureaus allowed the central bank to identify a significant increase in defaults by new credit card users, as well as by longer-history users obtaining several new credit cards. A surge in defaults resulted from a significant relaxation of banks' origination standards. Analysis of a similar data panel allowed the central bank to confirm that risk selection for mortgages by Mexican banks was adequate during the subprime turmoil, a time when several other countries were also taking a closer look at their domestic mortgage markets.

The micro-data collected by the financial authorities is generally associated with periodic information requests through pre-set layouts used for prudential regulatory monitoring (capitalization, liquidity, and foreign exchange position regulations), financial stability metrics, and to support on-site supervisions. This information not only consists of traditional financial statements or individual components of solvency and liquidity ratios, but also encompasses loan-by-loan records that reflect a great variety of dimensions relevant for risk analysis. This information has been traditionally obtained only from regulated financial entities that are within the supervisory scope of the financial authorities. Although the information usually covers a significant share of the entire financial system, it does not include data from unregulated financial entities or commercial companies. To fill this gap, the regulatory perimeter for information gathering has been significantly enlarged through time. Particular attention has been devoted to exploiting data from credit bureaus, which comprises information on the behavior of individual debtors of regulated as well as unregulated lenders.

Due to the great importance of this data source, financial authorities are currently regulating and supervising their activities and data quality, as well as encouraging all significant financial entities to report their data to credit bureaus.[2] Banco de México is currently receiving granular data from these institutions and using it to construct credit migration matrices, which may serve as an early-warning indicator for excessive indebtedness. It also uses credit bureau data to calibrate macro-prudential measures such as limits to loan-to-income or loan-to-value ratios.[3] Banco de México is also using

[2] In addition, the Mexican authorities have been encouraging the use of micro-data by regulated financial intermediaries in their own risk assessments and metrics. For instance, the reporting of micro-data credit operations to credit bureaus is compulsory for regulated entities. Moreover, some financial statement metrics such as loan-loss provisions have to be calculated on a loan-by-loan basis.

[3] Another project based on micro-data which is useful for monetary-policy purposes consists of following the evolution of the labor market. Micro-data from the social security system on the number of affiliated jobs and individual base salaries is useful for obtaining average aggregate wage indicators. In turn, these can be further analyzed according to gender, by sector (primary, secondary and tertiary), and economic activity.

micro-data for AML/CFT monitoring, as well as to identify and analyze financial- and economic-sector potential vulnerabilities.

The use of micro-data for macro-prudential purposes

The aim of this paper is to provide some examples from Banco de México's experience using micro-data for macro-prudential purposes and to share views on its potential benefits and complementarities with aggregated data.[4] Banco de Mexico's experiences discussed in this paper relate to both the time dimension[5] and the cross-sectional dimension[6] of systemic risk.

A first example illustrates how bank risk management could be enhanced through sectorial design of risk-weighted assets. The study explores how the regulator, by using micro-data, could identify changes in sectorial risk and hence request an adjustment in the risk weights of banking-system exposures to the sectors where risks have risen. This policy enhances banks' resilience—from a system-wide perspective—to shocks that originate within the non-financial sector. In essence, this study is particularly useful for limiting the impact of sectorial shocks stemming from housing, large-corporate, and the small- and medium-size enterprise sectors.

A second example focuses on the time dimension. The idea of this study is that the implementation of the countercyclical capital buffer (CCyB) is particularly challenging in an emerging economy with low levels of financial deepening. The study presented proposes that the CCyB should be activated only when credit growth is driven by supply factors. The paper finds that in Mexico, supply factors should not be ruled out as one of the drivers of the credit growth observed in the last two years. This paper contributes to the macro-prudential literature by refining the mechanisms required to activate a tool designed to mitigate the impact of pro-cyclicality in the financial system.

Finally, a third study provides empirical evidence on the importance of establishing limits to large exposures in the interbank market as a backstop to the capital framework to mitigate contagion risk among banks. The study calibrates the size of the limits for banks' interbank exposures with the use of information from the Mexican banking system and analyzes banks' behavioral responses and their impact on the size of bilateral exposures, the composition and degree of interconnectedness, the level of aggregate losses, the potential number of institutions defaulting due to contagion, and the network structure.

[4] Macro-prudential policy can still be regarded as a relatively new field, due to the fact that we still need to agree on basic issues, such as its definition, as well as complex matters, such as identifying the best instrument for achieving the intended goal. Moreover, to date, there is no single standard or framework for measuring effectiveness, and there are still unsettled issues at the country level on the governance of such a policy instrument. Finally, the discussion on how to coordinate monetary policy with macro- and micro-prudential regulation is ongoing.

[5] The time dimension involves the study of how systemic risk accumulates during episodes of credit expansion.

[6] Under the cross-sectional dimension of systemic risk, we examine the possibility of severe problems due to the interconnections among financial institutions, where the default of one may pose severe contagion risk to others.

2. Design of sectorial risk weights

Risk weights (RWs) constitute a cornerstone of the Basel capital framework. The risk-weighting functions for credit risk defined in the Basel Accords depend only on the individual characteristics of each exposure: type of credit, credit rating, probability of default (PD), etc. There is no explicit role for a systemic ingredient with a wide scope at a credit- or economic-sector level. Although it could be thought that internal models embed a systemic component within the obligor's PD, each bank has at best a sample of the population, which could generate biased parameter estimates. Given that the activation of the Countercyclical Capital Buffer of Basel III requires a generalized expansion of credit, its triggering could come too late to prevent excessive risk taking in certain sectors or credit products. A way to attack this problem is to identify how granular portfolios' expected losses are affected by changes in risk drivers and macroeconomic fundamentals.

A natural step to solve this identification problem is to estimate the PD of these portfolios. The PD is a helpful input for assessing the credit worthiness of an exposure and can also be useful for capturing significant risk factors within a given population.

Typically, in most jurisdictions, available data is limited both in granularity and extent, and hence PD estimation fails to disentangle the mixture between individual and systemic components. However, when there is enough detailed information at an individual level for a large set of agents, the PD estimation allows a better identification of both components. This highlights the reason micro-data are a valuable resource for identifying changes in the credit risk drivers of banks' exposures.

Identifying idiosyncratic and systemic effects separately provides financial authorities with a better perspective for policy implementation that goes beyond simply monitoring banking-system risk through aggregate indicators. At a system-wide level, this approach allows understanding of how underlying risk factors evolve and affect credit risk. The goal of this exercise is to estimate a system-wide sectorial PD that will identify common risk factors, e.g., key drivers of credit risk such as economic-sector performance, household indebtedness, and Loan to Value (LTV) ratios. These factors, along with creditor borrowing behavior, help to determine if capital requirements for a particular sector need to be adjusted. Financial authorities can use their system-wide estimates by economic sector to adjust the size of RWs especially when PD risk factors deteriorate.

The most significant effort to implement this approach is related to access to good-quality information sources. For instance, in Mexico, regulatory information collected from banks is full of micro-data detail across different credit portfolios. Table 1 provides an example of the information available to Mexican authorities on loans to large corporates and small and medium enterprises.

The information collected by Credit Bureaus (CBs) has a clear advantage compared to regulatory sources in that it contains homogenous micro-data from the totality of regulated credit institutions and from most non-regulated financial institutions. The credit bureau database contains information on approximately 60 million individuals who have at least one retail loan and 3 million corporates or SMEs with at least one loan. This information is updated on a monthly basis. The CB information also contains loan origination characteristics, payment experience, and foreclosure

status. Taking advantage of the complementarity of these sources and the joint use of them is a very useful byproduct of this effort.

Table 1

Financial conditions at origination	Payment experience	Resolution
Creditor/Loan ID	Outstanding Balance	Write-Offs
Origination date	Interest rate	Restructures
Economic Activity Sector	Remaining term	
Loan Amount	Payment amount	
Fix/Flexible Interest Rate	Performing status	
Currency	Expected loss parameters	
Term	Provisions	
Geographic location		
Guarantees/Collateral		
Class of Exposure: Simple/Revolving		

Mapping these micro-data sources into relevant risk dimensions could produce more risk-sensitive RWs and hence, allows a more targeted approach to identifying risks. Moreover, it may also serve as an early warning indicator for identifying and averting systemic threats.

Since 2008, Mexican authorities have gathered micro-data to estimate system-wide PDs for all relevant bank credit portfolios (i.e., loans to firms, households, and for consumption). Both public and private sources of information were integrated, and a large number of risk factors were analyzed. In what follows, three examples of the use of system-wide sectorial PDs are provided.

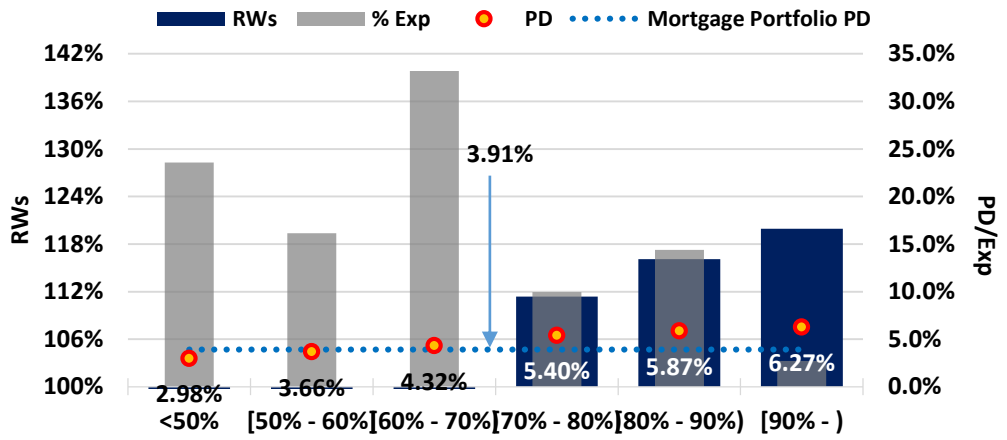
Residential mortgage exposures

To estimate the system-wide sectorial PD, a sample was collected from seven large banks representing 98% of individual mortgage exposures.[7] The first step involves an individual assessment of the relationship between risk factors and default experience. Standard exploratory data analysis shows that there are many empirical regularities useful for risk purposes. The most relevant factors identified were payment behavior history (current and past), capacity to repay (amount disbursed / required amount), Loan to Value (LTV), and loan denomination. [8]

RWs under the Basel II framework for Internal Rating Based (IRB) models are calculated as a function of risk parameters: PD and Loss Given Default (LGD). In this context, the PD parameter estimate is an input that transmits risk sensitivity to RWs. Figure 1 shows the positive relation between LTV and the corresponding average PD. If an increase in the average PD of the larger LTV buckets were detected, the RW of that segment could be increased for the banking system.

[7] The sample included information on more than 59,000 mortgages and the characteristics of the borrowers.
[8] Mortgages in foreign currency are relatively rare. However, loans denominated in inflation-indexed units and minimum wages are more common, especially in low-income housing.

Figure 1: LTV, PD and implied RWs for mortgage portfolios

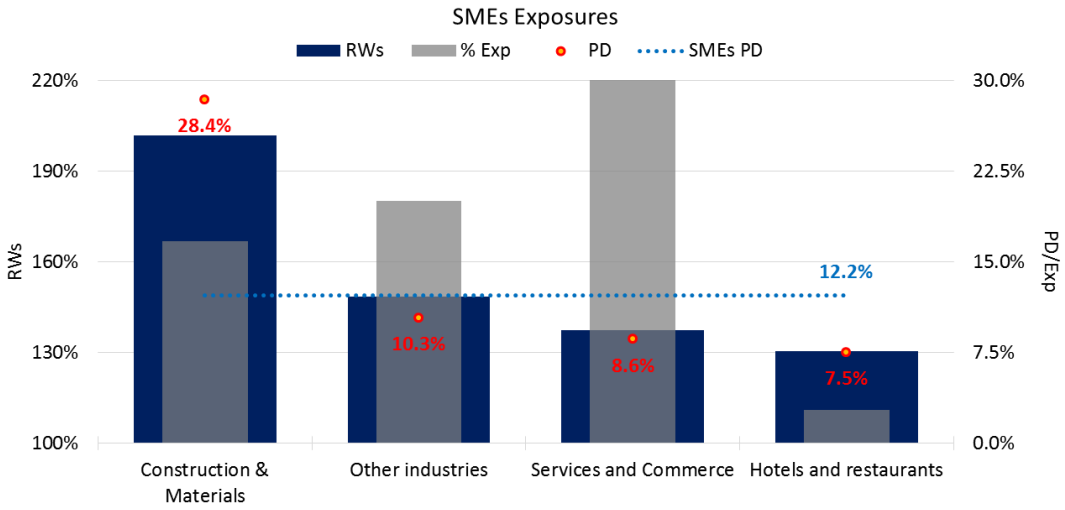


Source: Banco de México

Corporate Exposures

The system-wide sectorial PD allows computation of RWs by economic activity for corporate borrowers, revealing a clear risk differentiation and hence a potential rationale for differentiation of RWs according to the activity of the borrower. Figure 2 shows that the level of average PDs in a SME portfolio varies greatly in the system depending on the economic sector, thus making the case for adjusting the Basel II implied RWs for loans to corporates and SMEs in the construction sector.

Figure 2: Implied RWs for SME portfolios



Source: Banco de México

Credit Cards

The credit card model developed by Mexican financial authorities using micro-data shows that credit risk is mostly explained by the individual borrower's behavior independently of the lender's loan-granting process and standards. This means that there is no significant influence from idiosyncratic factors such as better data collection or origination practices from banks.

Table 2: Credit Card system-wide PD model

Individual bank PD model estimates						
	Intercept	**Current Non-Payment [1]**	**Historical Non-Payment [2]**	**Percentage of payment [3]**	**Credit Limit Use [4]**	**Maturity [5]**
Bank 1	-2.892***	0.470***	0.596***	-1.324***	1.140***	-0.017***
Bank 2	-3.595***	0.677***	0.522***	-0.646***	1.583***	-0.008***
Bank 3	-3.021***	0.509***	0.428***	-0.625***	1.104***	-0.005***
Bank 4	-0.908***	0.711***	0.405***	-0.743***	0.725***	-0.043***
Bank 5	-2.665***	0.553***	0.499***	-1.339***	1.676***	-0.076***
Bank 6	-2.381***	0.630***	0.536***	-1.084***	0.761***	-0.110***
Bank 7	-3.674***	0.643***	0.563***	-0.829***	1.864***	-0.004***
Bank 8	-3.146***	0.515***	0.529***	-1.400***	1.850***	-0.007***
Bank 9	-3.394***	0.570***	0.629***	-0.565***	0.856***	-0.006***
Bank 10	-1.448***	0.597***	0.351***	-0.273***	0.764***	-0.048***

Significance level: ***0.001, **0.01, *0.05.
Source: Elizondo et. al (2010).
1/ Consecutive periods, in which the minimum contractual payment obligation has not been paid
2/ Periods in which the minimum payment has not been covered in the last 6 months
3/ Payments made as a proportion of the outstanding balance of the credit card at the reference point
4/ Total outstanding balance as a proportion of the credit limit at the reference point
5/ Months elapsed since the issuance of the credit card by the bank

Table 2 shows that the conditional PD of a bank's credit card portfolio depends mainly on client payment behavior, and this implies that client-behavior risk factors play a pivotal role for these exposures, much more so than internal bank risk drivers like client selection. It is important to note that only the availability of micro-data allows for this type of analysis. Moreover, to test whether there were differences among the originating banks not captured by the sectorial variables, an econometric model including banks' fixed inputs was estimated and, as Table 3 shows, in most cases, the bank was not significant.

Table 3: PD model including bank dummy variables

Explanatory variables	**Bank dummy variables, PD-model**	**System PD-model**
Intercept	-2.826**	-2.970***
Current Non-Payment	0.675**	0.673***
Historical Non-Payment	0.486**	0.469***
Percentage of payment	-0.009**	-1.022***
Credit Limit Use	-1.063**	-1.151***
Maturity	1.008**	-0.007***
Dummy Bank 9	0.504*	
Dummy Bank 10	0.575**	

Significance level: ***0.001, **0.01, *0.05
Source: FSI 2010 – Regulatory use of system-wide estimations of PD, LGD, and EAD

In Mexico, system-wide input parameters of sectorial expected loss (i.e., PD, LGD, and EAD) have been in place since 2009 for provision purposes, either as part of a formula (i.e., PD) or as step functions (i.e., LGD) through the use of a regulatory model estimated by the authorities. For small,

medium-sized, and new banks, the parameters have been an important benchmark for calibrating their own first expected loan-loss estimates. Moreover, from the supervisory perspective, this framework has promoted transparency regarding the criteria for credit-loss provisioning and as an analytical tool for IRB approval within the Mexican framework. Constantly examining the drivers of system-wide sectorial PDs could provide information on the build-up of credit risk in certain sectors or products. This information is useful to the authorities to assess the convenience of RW increases in those sectors at a system-wide level.

3. The Countercyclical Capital Buffer

The Countercyclical Capital Buffer (CCyB) is the only macro-prudential instrument explicitly contemplated under Basel III. The rationale for the CCyB can best be described as follows. When an economy is going through a period of identifiable excessive credit growth, banks should build up an additional capital buffer. This is useful before credit expansion reaches its peak, because banks, as the main participants in the financial system, will have more capital to absorb potential losses. Enhancing their resilience minimizes the probability of a disruption to their main function, i.e., providing credit to the economy. From this perspective, the strategy to implement the CCyB is very simple, namely, apply it when a signal of excessive credit growth occurs in order to prevent banks from indirectly becoming amplifiers of a crisis. Thus, in principle, it is hard to counter high-level arguments that justify its use.

Although the CCyB provides a benefit for the banking sector, in practical terms its implementation is not straightforward. First, it is not entirely clear what "excess credit growth" means exactly. In this regard, the application of CCyB becomes even more critical, especially for economies such as Mexico's, which are going through a process of financial deepening, and for which identifying whether the observed process is due to "excess credit growth" or simply "catching-up" turns out to be of utmost importance.

Second, it remains unknown how much capital is a reasonable amount to build up. Third, it is not clear how to determine whether risks have crystalized or dissipated. These three issues lead to the conclusion that CCyB application needs refinement despite the fact that a number of implementation proposals and guidelines already exist.

From this discussion, one can easily infer that a key element for implementing the CCyB is to identify whether credit growth is driven by supply or demand factors. A supply-driven expansion is less likely to be based on economic fundamentals. Demand-driven expansions, by implication, would tend to have milder effects. In fact, rapid credit expansions do not always lead to a crisis. Since the 1970s, only about one in three credit expansions have ended in a crisis.[9]

To determine whether or not "excessive credit growth" as identified by the credit gap ratio is a supply-driven expansion, the paper prepared at Banco de México by Levin et al. (2016) relies on the methods developed in Khwajan and Mian (2008) and Jimenez et al. (2014). These methods provide an unbiased estimate of the supply-driven bank lending channel. The paper takes advantage of a detailed micro-data set that includes loan-level information. The data allows the determination of whether the change in firms' borrowing from banks is solely determined by demand factors, or

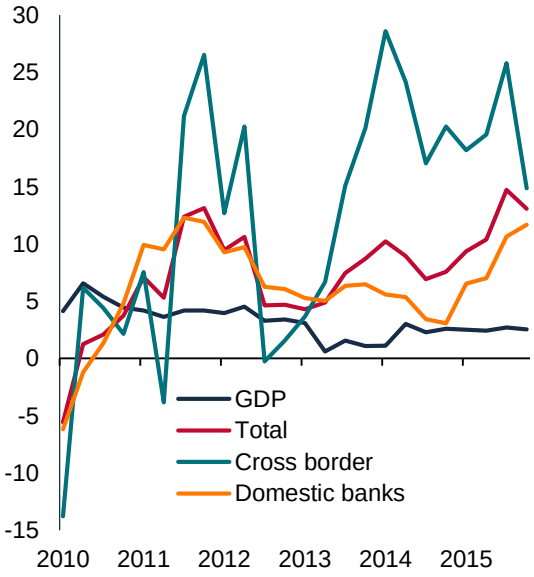
[9] See, for example, Freixas et al. (2015) or Dell'Ariccia et al. (2012).

whether a supply shock is involved. This is accomplished through the ability to monitor credit provided by different banks to the same firm. The results allow for better grounding of the activation of the CCyB.

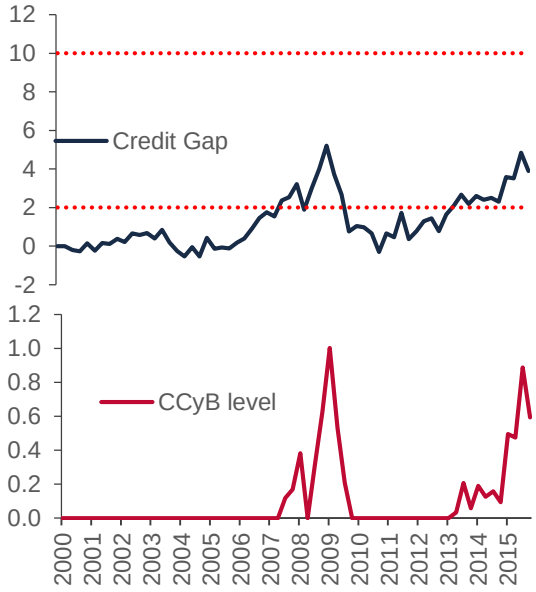
For countries like Mexico, where financial deepening is evolving, the activation of the capital buffer should not be guided solely by aggregate indicators such as the benchmark credit-to-GDP gap. Additional information such as a clear signal that the expansion is supply driven is key to guiding financial-authority decisions. When an expansion is demand driven, authorities can take a more cautious approach towards activation of the CCyB. This is a useful empirical finding, especially for emerging economies, where implementation costs associated with the CCyB may exceed the benefits. Figure 3a shows that between 2010 and 2015, total credit to the non-financial sector grew at a relatively rapid pace, and most of it corresponds to cross-border sources.[10] Moreover, in the last two years, the credit expansion could be considered excessive according to the Basel benchmark indicator (Figure 3b).

Figure 3

a) Credit to the non-financial sector by source and GDP
(year-over-year real growth rate)



b) Credit gap and CCyB using Basel III formulas
(%)



Data as of December 2015.
Source: Banco de México

As stated above, whether the credit expansion is supply driven (the bank-lending channel effect) or demand driven has different policy implications. In mathematical terms, the objective would be to identify supply and demand effects in credit separately. This task is generally complex, but when there is an exogenous event with a potential effect on banks' willingness to lend, then the methodologies described in Box 1 can be used for identification purposes. The main econometric

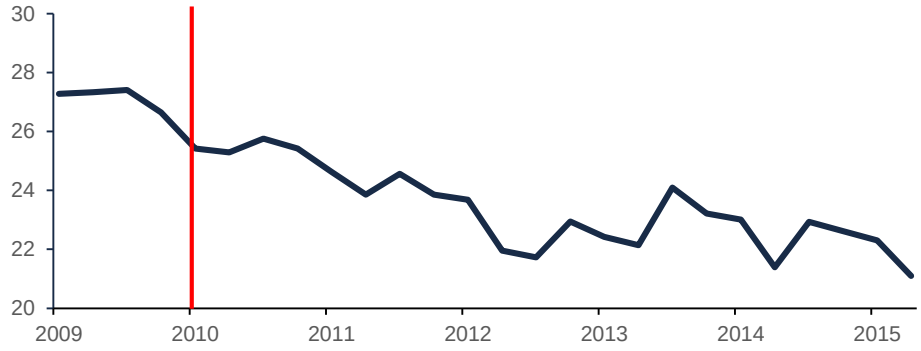
[10] Between the first quarter of 2010 and the fourth quarter of 2015, total credit to the non-financial sector grew 63 percent in real terms.

challenge for identifying supply effects is that the unobserved demand factor[11] is likely to be correlated with the supply shock.[12] Therefore OLS estimation will not be consistent and hence will not be an accurate measure of the bank-channel effect. However, taking advantage of the availability of detailed bank-firm credit information,[13] it is possible to use fixed effects on the firm-bank pair to consistently estimate the supply effects.[14]

To apply this methodology, the identification of a shock is necessary. The paper uses as a shock the exogenous positive liquidity shock sparked by the inclusion of Mexican government bonds in the Citibank World Government Bond Index (WGBI), which occurred in the fourth quarter of 2010. This move provided more depth to the Mexican bond market and spurred unprecedented demand from foreign investors. Some Mexican banks who were actively investing in this type of assets reduced their holdings in order to gain more liquidity for other uses.

Figure 4 shows the evolution of Mexican banks' holdings of government bonds. Holdings of Mexican government debt became a source of additional liquidity for banks when Mexican debt was included in the WGBI. This additional liquidity could have potentially contributed to triggering a credit expansion.

Figure 4: Bank holdings of government bonds as a share of total bank assets



Data as of December 2015.
Source: Banco de México.

Figure 5a shows the results of both the (inconsistent) OLS estimate of the bank-lending channel effect as well as the (consistent) fixed-effects estimate. Even though the magnitude of the coefficients itself is difficult to interpret, the main findings are that the coefficients are statistically greater than zero and over the last few quarters have been steadily increasing, suggesting a bank-

[11] Denoted as η_j in equation (1) in Box 1.

[12] If the unobserved omitted demand shock is correlated to the supply shock, the OLS estimates will be biased and inconsistent.

[13] Loan-level data on credit lent from banks to firms was obtained from the R-04C regulatory filing, which is a report submitted by banks to the National Banking and Securities Commission (CNBV) on a monthly basis, and shared with other financial authorities in real time under the information model described in the introduction. The report includes the main characteristics of the loan, such as lender, borrower, amount loaned, interest rate charged, term and collateral provided, as well as certain characteristics of the borrower, such as location, sectorial classification and firm size.

[14] When firms get credit from more than one bank, the fixed effect absorbs the demand component and allows for a consistent estimate of the bank channel effect.

lending channel effect in the credit increase induced by the liquidity shock. The effect is more significant for those banks that started with a larger stock of government securities and hence received a larger "liquidity" shock. The OLS estimate is upwardly biased due to the positive correlation between supply and demand shocks. Interestingly, the fixed-effect estimates of the bank-lending channel effects are statistically significant from 2013 onwards, and this corresponds to the period in which the Basel credit gap indicator would have activated the CCyB.

Box 1: Econometric Model (based on Jimenez et al. (2014))

The equation of interest is:

$$y_{ij} = \alpha + \beta \times \delta_i + \eta_j + \varepsilon_{ij} \quad (1)$$

Where y_{ij} represents the log change in credit from bank i to firm j, α is an economy-wide secular trend, δ_i is an observable credit supply shock, η_j is an unobserved change in borrower fundamentals (a proxy for credit demand shocks), and ε_{ij} an idiosyncratic shock. In a frictionless world, bank lending is independent of credit supply conditions and only depends on firm fundamentals (credit demand factors). Hence, $\beta = 0$. The presence of financing frictions may force banks to pass on their credit supply shocks δ_i to borrowing firms, thus making $\beta > 0$.

The equation cannot be estimated with OLS if the credit supply shock and unobserved demand shock are correlated. However, if one estimates the equation with fixed effects for firms that borrow from more than one bank, the firm fundamental shock is absorbed through firm fixed effects—that is, the demand shock in the equation is eliminated with the firm fixed effects, and therefore the estimated coefficient with fixed effects provides an unbiased estimate of β.

However, β does not give us a complete picture of the net firm-level effect of the bank lending channel on the economy. In particular, individual firms affected by some banks (in the loan-level channel due to a positive β) may seek alternative sources of bank financing to compensate for any loss of credit. Alternatively, if firms benefit from greater provision of credit via a positive credit supply shock to an individual bank, their borrowing from elsewhere may be cut either voluntarily or due to a crowding-out effect. What matters for real effects is this firm-level credit availability. Thus, in order to gain a complete picture of the bank lending channel effect, one must compute its consequences at the aggregate firm level. We can do so by estimating the related firm-level version of the above equation:

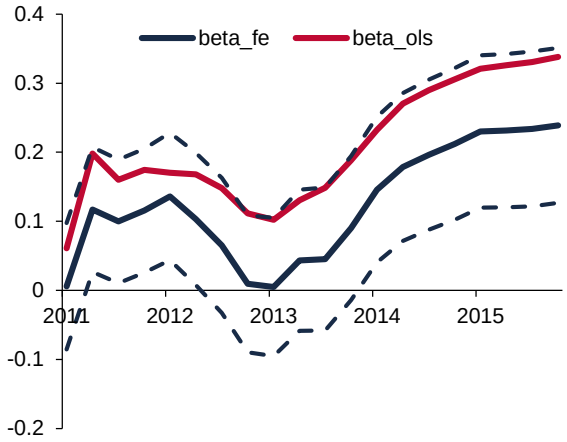
$$\bar{y}_j = \bar{\alpha} + \bar{\beta} \times \bar{\delta}_\iota + \bar{\eta}_J + \bar{\varepsilon}_j \quad (2)$$

Where $\bar{y}_j$ denotes the log change (t+1 over t) in credit for firm j across all banks, and the rest of the parameters are as above but in aggregated terms. The aggregate impact of the credit supply channel is captured by the coefficient $\overline{\beta}$ which we refer to as the firm-level aggregate lending channel. An OLS estimate of $\overline{\beta}$ will be biased, but we can use β and the variances of both $\bar{\delta}_\iota$ and δ_i to correct the bias.

There is a potential issue with the interpretation of the coefficient:[15] the positive and at the same time statistically significant estimate of the supply shock implies that the effect of banks having additional liquidity for firm *i* is a positive effect for credit growth. However, the aggregate effect on lending to each individual firm could be potentially misestimated.[16] The latter could occur when firms receiving more credit from some banks would be borrowing less from others. Hence, at the firm level, the effects can partially cancel each other out. To solve this problem, the paper focuses on the overall amount of credit received by firms and estimates the multi-bank-lending-channel effect, using equation (2) of Box 1 and the correction suggested in Jimenez, et al (2014). Figure 6b shows the corresponding results of applying this alternative approach.

Figure 5

a) Credit channel effects by credit (log change in firm-bank credit)



b) Credit channel effects at the firm level (log change in total firm credit)

Data as of December 2015
Source: Banco de México.

These results indicate there has been a supply-driven component during the recent credit expansion phase, which started in 2014. The Basel indicator also picked up this credit expansion. The firm-level effect also indicates that the increase in firms' credit from some banks was not compensated for by a decrease from others, signaling that a supply-driven credit expansion started in 2014 and has continued since then.

The conclusion of this analysis is that the recent credit expansion has been driven by both supply and demand effects, and that the firm-level effect is still positive.[17] Disentangling supply and demand factors in the credit expansion was only possible because of the availability of micro-data, which provides additional information for the deployment of a macro-prudential tool such as the CCyB.

[15] This has also been pointed out by Jiménez et al. (2014).
[16] This is described in the estimation strategy for equation (2) in Box 1.
[17] Other proxies for supply shocks were used, such as the share of large-firm credit and the capital adequacy ratio of the banks at the end of 2011. The results were largely the same.

4. Limits for large interbank exposures

One of the most significant shortcomings of the regulatory framework before the global financial crisis was the lack of global harmonization for large-exposure (LE) regulation.[18] As defined by the BCBS (2014), it is of the utmost importance for banks to measure, aggregate and control exposures to single counterparties or to groups of connected counterparties. In a nutshell, the idea of LE regulation is to complement and serve as a backstop to capital requirements. The ultimate goal is to limit the size of the maximum loss a bank could face in the event of the failure of a single counterparty or group of connected counterparties.

Importantly, the impact of the LE framework on the safety of the financial system will take time. First, full implementation is not foreseen until January 1, 2019. Second, an observation period to conclude in 2016 was defined to study the benefits of introducing adjustments to the framework.[19] Third, some exposures are exempted from the framework, such as sovereigns, central banks and intraday interbank exposures.[20] Fourth, some exposures receive a differentiated, specific treatment for LE purposes, such as covered bonds and collective investment undertakings, securitization vehicles, and other structures. Time is necessary to ascertain if this specific treatment is adequate for these exposure types. Fifth, it could be argued that some significant exposures were not included in the LE standards, namely, the intragroup exposures. If as a result of the Basel Committee's assessment, there is any evidence that these exposures are a source of increasing concentration risk, the possibility exists that they will be included in future revisions. Finally, the framework addresses a single type of concentration risk, that is, the risk coming from the sudden default of a large counterparty. As stated in BCBS (2014), other types of concentration risk, such as sectorial and geographical factors, are also important, and they have been omitted, but as illustrated above, the use of micro-data could help to overcome these omissions.

From a prudential perspective, the LE framework is definitely one of the most important tools available in the quest to promote global financial stability. The global financial crisis underscored the pivotal role of Systemically Important Financial Institutions (SIFIs) in spreading and amplifying shocks. Since their default threatens the solvency of other players in the financial markets, and hence the proper functioning of the system, the need to impose stricter measures such as tighter limits to restrain the degree of interconnection among them is fundamental to mitigate contagion risk. The current LE framework includes relatively tighter limits for Global Systemically Important Banks (G-SIBs).

[18] The Committee published supervisory guidance for large exposures in 1991 and a core principle that stated that the supervisor was responsible for setting prudential limits to bank exposures to single counterparties or groups of connected counterparties.

[19] In particular, issues of concern center on limits on some interbank exposures that may have adverse consequences for the implementation of monetary policy or introducing limits for banks' exposures to qualifying central counterparties.

[20] These exposures were exempted to avoid distortions to payment and settlement processes.

The current calibration of the LE limit applied to a G-SIB's exposure to another G-SIB deemed to be adequate by the Committee was put at 15% of Tier 1.[21] It should be said that calibrating limits for large interbank exposures from a system-wide perspective was a challenging task.

- First, the literature on how to calibrate limits is very scarce. Although there is much literature on how to calibrate regulatory models, the issue of calibration is not free of criticism, as there is no single correct way of doing it, and the data-generating process used for analytical purposes is subject to a regime switch once the new regulation has been implemented.

- Second, when a new limit is introduced, there is a need to take into account banks' behavioral responses. This means that banks' strategic reactions and optimization processes under a new constraint may either reduce or stimulate contagion processes.

- Third, the structure of the interbank market plays an important role in the propagation of contagion risk. Moreover, the structure of the banking system may vary through time, and this has to be taken into account when modelling the impact of introducing limits.

- Fourth, it is important to define and understand exactly how the contagion process works. Broadly, there are two channels that may lead to contagion. The first is the direct mechanism, wherein large interbank direct exposures between G-SIBs exist and one of them fails. The second is an indirect mechanism, wherein a panic ensues from the perception that all G-SIBs have a similar nature, potentially leading to herd behavior—i.e., a bank run. Most counterfactual simulation models address the first issue, while the second remains an issue of further study.

- Fifth, it is hard to argue against the direct benefits of introducing or tightening limits, since they clearly contribute to reducing systemic risk. However, this comes with an efficiency cost as it may distort banks' funding requirements. Moreover, small banks' funding may be especially affected, and this, from a system-wide view, may lead to a higher degree of interconnection, to the detriment of a competitive environment.

- Sixth, the state of the banking system differs greatly in normal and stressed periods. In this regard, we need to assess the benefits of introducing limits under both normal and stressful conditions.

A study done at Banco de México[22] based on micro-data on interbank exposures incorporates these six issues. Overall, it shows that large interbank exposure limits are useful in containing contagion and excessive interconnectedness among banks. This contributes to the discussion of global standards to define and regulate the LE regime, and it was based on exploiting network theory and banks' behavioral responses in the presence of tighter limits. The main findings are the following:

- First, a cap of 25 percent of Tier 1 capital is enough from a system-wide perspective to limit the risk of contagion under normal conditions.

[21] According to BCBS (2014), this limit applies to G-SIBs previously identified by the Basel Committee. In fact, the list identified by the BCBS is updated every year and is published by the FSB.
[22] Bátiz Zuk, et al. (2015).

- Second, for some specific banks' behavioral responses, there is evidence that the risk of contagion in the Mexican interbank market can be significantly reduced by introducing a tighter limit solely for SIB-to-SIB exposures (a cap of 20 percent).[23]
- Third, a limit on exposures of small banks to SIB banks is adequate in reducing contagion risk, specifically when applied jointly with a limit on SIB-to-SIB exposures.
- Fourth, tighter LE regulation may increase the risk of contagion in the case of some specific banks' behavioral responses.
- Fifth, given the exposure network analyzed, stress test results confirm that a generalized 10 percent limit fully eradicates contagion risk for all of the analyzed scenarios.

While this paper is highly technical and uses complex methodologies, it is important to highlight the fact that the analysis was made possible by the availability of data on bilateral interbank exposures. Banco de México has access to comprehensive data, including detailed actual daily aggregated bilateral interbank exposures (i.e., both on- and off-balance-sheet exposures), for all banks that form part of the financial system.

Figure 6 shows Banco de Mexico's proprietary data on daily bank bilateral exposures[24] as a percentage of Tier 1 capital grouped per type of counterparty during March 2008 to July 2012. There are four types of exposures: (i) SIB-to-SIB, (ii) SIB-to-non-SIB, (iii) non-SIB-to-SIB, and (iv) non-SIB-to-non-SIB. Interbank aggregate exposures are loans, securities, and derivative positions. In Mexico, there is a generalized limit on interbank exposures of 100 percent of Tier 1 capital which applies equally to all banks. The advantage of micro-data on banks is that the exposure size matters in the banking system, as evidenced by the fact that the exposures of SIBs to any bank are relatively lower when compared to those of non-SIBs to any bank. This could imply that given the relatively larger capital base of SIBs, the application of a tighter limit on their bilateral exposures is needed in order to constrain their degree of interconnectedness, especially on SIB-to-SIB exposures.

From an information perspective, the paper's contribution is significant because it has the virtue of providing actual micro-data covering the period related to the recent global financial crisis. Moreover, data is comprehensive in that it covers 100 percent of total banking system assets. In addition, as highlighted by Cerutti et al. (2011), the type of data is of utmost importance because the structure of the network in the payments system network is not similar to that of the interbank market. This means that regulators should not use data from one type of network as a substitute

[23]The term "Systemically-Important-Banks (SIBs)" in the context of the study is used as a short form to designate the largest banks in the Mexican system as measured by the size of their assets. The Mexican banking system has seven SIBs.

[24] Each exposure is a bilateral aggregated interbank exposure. In other words, each exposure represents the sum of gross bilateral current exposures. For each point in time under consideration, each inter-bank exposure is computed as the sum of the amount of concerted exposures during the day plus any remaining current exposure from previous periods. This measurement process takes into account the fact that outstanding interbank exposures may have a term of more than one day. Exposures in the Mexican interbank market include uncollateralized interbank lending, holdings of securities issued by bank counterparties, and credit components that arise in derivative transactions. All exposures are measured after credit risk mitigation. It is important to point out that FX transactions are not included as most are cleared through Continuous Linked Settlement (CLS). There is no consideration of any netting agreements among banks.

for the other for the purposes of the calibration of limits. At the same time, this contribution is limited because Mexico has data only on Mexican-chartered banks and none on interconnections between large, internationally active banks.

5. Concluding remarks

The aftermath of the global financial crisis cast a spotlight on the importance of financial stability and on macro-prudential policy as the spearhead thrust of authorities towards achieving this important goal. Along with the emphasis on financial stability, significant improvements in computation, data processing capacity, and new data analysis techniques have fueled the use of micro-data in several ways.

In this paper, three examples were presented showing how the use of micro-data enhances the authorities' capacity to detect and potentially deal with systemic risks. The first case exemplifies the importance of adjusting risk weights to mitigate sectorial credit risks in a timely fashion, giving banks the right incentives to price risk accurately. The second case exemplifies the importance of ancillary indicators for deploying system-wide measures, and in turn the relevance of micro-data for constructing indicators that signal the build-up of potential risks posed by excessive credit growth to banks' balance sheets. Finally, the third example provides a concrete application of the use of micro-data to fine-tune measures that help prevent contagion risk.

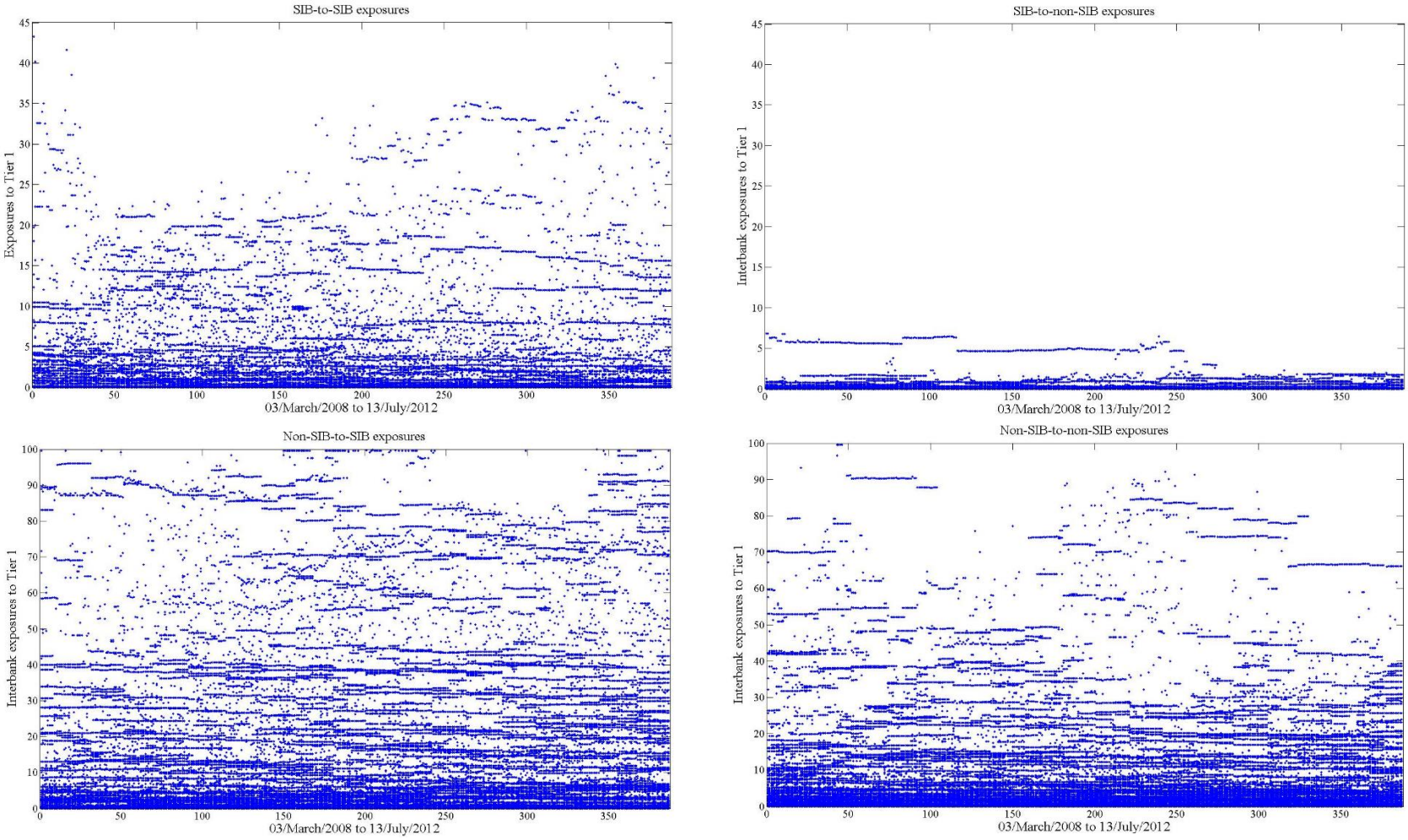
There are a few takeaways from these examples. When dealing with high-level, broad policy measures, authorities typically face a trade-off between applying general "one-size-fits-all" measures and specific, tailor-made, focused measures. The availability of micro-data gives authorities flexibility to reach some middle ground in this trade-off, as shown in the first example.

Whenever authorities intervene, a distortion is created. What justifies the intervention is the improvement of welfare as a net effect of such a distortion with respect to the scenario of non-intervention. Micro-data allow authorities to assess the extent of such effects more accurately, as can be seen in their application to the CCyB.

Often the general direction of policy measures is clear, but fine-tuning the main parameters of the policy measure is more complicated. More detailed and specific information can lead to a more accurate and robust determination of parameters such as large exposure limits. Finally, the use of micro-data could be helpful in evaluating the success of macro-prudential measures and whether unintended effects will arise.

Authorities are not only expected to have macro-prudential policies in their toolkit, but also to use them effectively. This poses formidable challenges that include more precise design of macro-prudential policies, a better understanding of the risks they aim to reduce, and a better assessment of the potential interactions between new and standard prudential policies, with the objective of limiting unintended consequences. One way to confront such challenges is through better analysis and research, of the type that can be enriched through the use of micro-data.

Figure 6: Interbank exposures to Tier 1 capital for the period March 2008 – July 2012



Source: Banco de México

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