Monetary Policy Pass-through under Internet-Only Banks:The case of Mexico

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Abstract

Recently, there is a surge in business models to provide services through the internet. Banking is no exception yet the advent of internet-only banks may induce unexplored challenges to monetary policy decisions. We contribute to the economic literature by implementing a difference-in-difference analysis of the monetary policy pass-through under the presence of internet-only banks for Mexico. Our identification strategy relies in two pillars, first we focus on an unexpected monetary policy shift as an exogenous shock and secondly, we inspect credit across different banks for the same firm. Our findings suggest that internet-only banks tend to be more sensitive to monetary policy and riskier than both traditional banks and small banks.

JEL classification: E53.

Keywords: Internet-only banks, Monetary policy transmission.

Disclaimer: All views do not represent that of Bank of Mexico...

1 Introduction

The advent of technological improvement, particularly the internet, has disrupted many industries including, up to some laggard, the banking industry. In fact, the main approach which has been followed by traditional banks is to employ the internet as a new distribution channel of their banking services by allowing certain processes to be made (conveniently) online.

However, a relatively new trend has aroused in banking. Rather than providing *some* services through a website, *internet-only banks*[1] (or *IOB*s) supply *every* service through its internet portal. At first glance, this new agents should not pose any different mechanism of the monetary policy relative to traditional banks yet a common feature across IOB worldwide is the need of higher passive rates to attract skeptic customers. Up to our knowledge, there is no study which delves in the pass-through of monetary policy shifts to IOB's higher passive rates.

Unfortunately, to assess the monetary policy effect on IOB lending is not a trivial task since at least two main challenges arise straightforwardly. First, a monetary policy decision may be influenced by the motion of active rates and its effect on nonperforming loans, second, even if a monetary policy does affect credit, we are not certain if the observed shift in lending is due to changes in credit supply, credit demand or a combination of both.

Hence, our contribution to the economic literature is to abridge the gap by providing for the first time, an assessment of the monetary policy pass-through on loan rates between traditional banks and IOBs which is robust to both critiques. Our identification relies in two pillars. First, we focus around an unexpected monetary policy announcement to avoid endogeneity between the monetary policy decision and the supply of credit.

Our second pillar is to apply a similar Kwhaja & Mian methodology to analyze the effect of a credit supply shock to firms by inspecting the variation of the several loan conditions given to the same firm across multiple banks to insulate our findings from credit demand.

Our results are economically and statistically significant. We find evidence that for a firm that has more than two loans, one granted by an IOB and another given by a No-large

[1] Also known as *virtual banks*, *digital banks*, *direct banks*. Up to our knowledge, there is no consensus in the term, so in this paper we will refer to them as *internet-only banks* (IOB)

banks, the IOB bank offers the loan with 250 basis points more expensive relative to the credit given by the No-large bank after the unexpected monetary policy tightening.

Moreover, we find that most of the surge of IOB rates can be explained by the difference in the share of the interbank market relative to the wholesale funding . Specifically, for every additional percentage point in the share of interbank ratio, interest rate in the IOB increase 3 basis points higher than its No-large bank counterparts. Since the interbank ratio of an IOB is around 40 percentage points greater than No-large traditional banks, that implies that the interbank ratio accounts for 120 basis point of the change.

Our results are robust to different specifications. For instance, a statistically significant increase of the interest rate of an IOB after Monetary Policy tightening is preserved whenever we move the treatment date around a 3-month neighborhood. We also include a Placebo test in which the difference-in-difference estimator is not statistically significant. Finally, we include different control groups like New banks, Stressed banks and a combination of the three control groups. In all our results, the rates of IOB were increased around 200 basis points.

The paper is divided into five sections. Section II offers an overview of financial innovation to understand both the scope and relevance of internet on bank lending. Afterwards, Section III contains the literature review of both research on IOB and on monetary policy transmission. Section IV outlays our identification strategy, econometric model, main results and robustness checks while section V concludes.

2 An overview of financial innovation

Finance is no stranger to innovation. In 1989, First Direct was the first virtual bank in the world which provided services to its clients by telephone rather than through a physical branch. In 1996, the Federal Deposit Insurance Commission granted permission to Security First Network Bank, Pineville to become a new bank and acknowledged their new bank business model. In their own words:

Security First (Network Bank, Pineville) is unique in that it plans to do most of its business on-line, and will use the Internet for actual checking account transactions, not just information.[2]

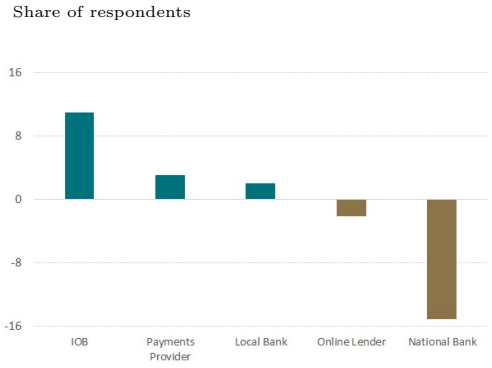
By early 2000s, the first internet-only bank appeared with limited transactions on its web-site while fully online IOB started to appear after the Global Financial Crisis. In contrast for its phone-based or physical-based counterparts, an internet-only bank has no branches, ATMs or any other physical infrastructure through which a customer may interact but its website. Usually payments, deposits and withdrawals are processed by inter-bank transfers, electronic wallets, mobile payments or paid services from traditional banks such as cash withdrawals at ATMs. Some examples of IOBs can be found in the appendix.

The market has welcomed this new business models on finance. In North America, for two consecutive years there has been an outflow from national banks and online lenders (e.g. crowdlending) towards IOB's and payment providers (e.g. Paypal) while IOBs usage is below only to mobile payments and above controversial cryptocurrencies. See Figure 1.

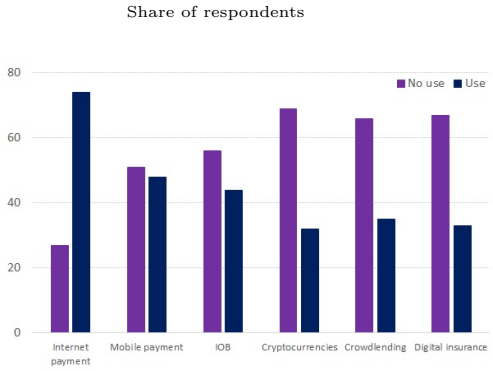
[2]FDIC Banking Review, Vol. 8, No. 3, February 1996

Figure 1. Internet-only Banks have been welcomed by the Market

(a) Net Flows of Main Bank to New Financial Institutions*



(b) IOBs are preferred to other financial innovation†



*. Share of respondents to the question: In the past 12 months, have you switched to a new financial services provider or other company from your main bank. †. Share of respondents to the question: which of these products or services of an alternate provider (i.e. fintechs) are you familiar with? Source: North America Consumer Digital Banking Survey, Accenture.

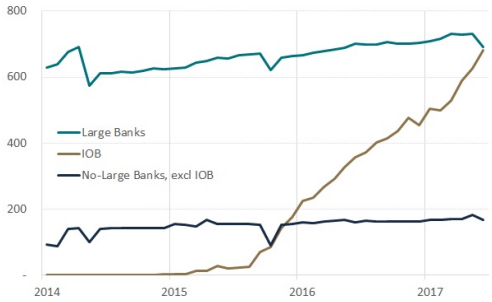
In Mexico, the only IOB which started operations in 2013, has achieved an outstanding performance. Despite not being a large bank, the Mexican IOB achieved the same efficiency in number of accounts and lending per employee performance similar to large banks in just two years. An accomplishment which no-large bank has ever attained. See Figure 2.

However, this aggressive expansion was not fueled by a bold and healthy gain of depositors but rather through an expansion of interbank lending. The Loan to Deposit ratio measures how many loans are funded by a dollar in deposit. A high number implies that the bank is recurring to alternative, and usually also more expensive, source of funding. Although there is no regulation from Basel III, historically in Mexico it is been around 70% while Mexico IOB has been historically above an average bank surpassing 500%. See Figure 3a.

Figure 2. Internet-only Banks have an outstanding performance in Mexico

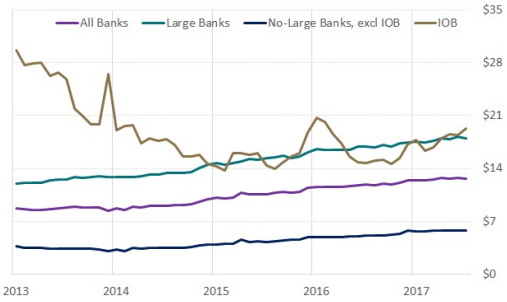
(a) Accounts per Employee*

Number of Accounts



(b) Commercial Lending per Employee*†

In million of pesos



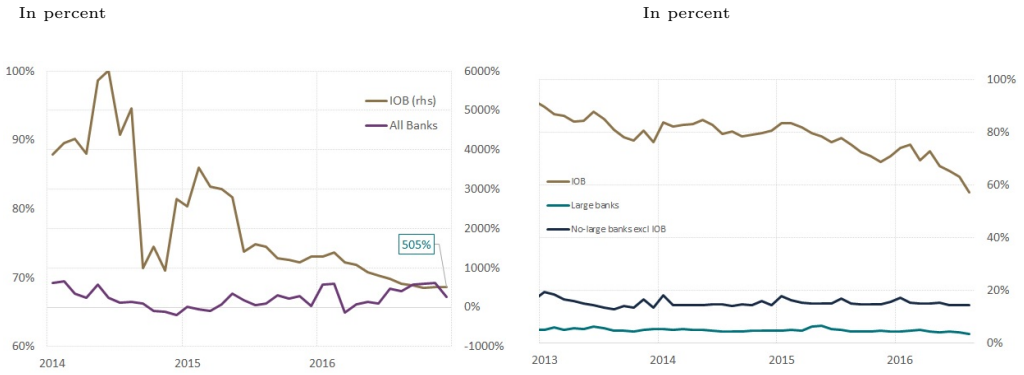
*. Includes directly hired and indirectly hired employees. †. We only consider commercial lending since the IOB only lends to businesses. Source: CNBV.

This lack of depositors made the Mexican IOB heavily dependent on the interbank market. Between 60 to 90% of IOB's funding was obtained at the interbank market which in turn made IOB interest expenses due to interbank loans at 55% of all interest expenses from 2013 and 2016. In comparison, interest expenses due to interbank loans of no-large banks amounted 9% of interest expenses. Although IOB's share of interest expenses due to interbank loans abated after 2016, it did so by an increase in losses. See Figure 3b.

Hence, Mexico's IOB was susceptible to a monetary policy tightening which suggest the existence of a new monetary policy mechanism. Namely, when IOBs are more (less) trustworthy than its traditional counterparts, it is likely that the IOB will be less (more) affected by an increase in funding cost, say at the interbank market, and hence less (more) sensitive to monetary policy fluctuations due to the large (small) size of its depositors. We can name this mechanism as the IOB Trust Channel.

Figure 3. Internet-only Banks and Interbank Lending

(a) Loan to Deposit Ratio* (b) Interbank Funding Relevance†



* Deposits include Long term deposits. †Share of Interbank Funding to all Funding Sources. Source: CNBV.

3 Literature Review

The economic literature on Internet-only bank has found, albeit in very limited amount of studies, mixed evidence of several mechanism through which the Internet has affected banking. Perhaps surprisingly, Akishar, Tunay and Tunay (2015) use a dynamic panel data model to find that internet banking actually *decreases* profitability. Moreover, the economic literature has more broadly address the effects of monetary policy transmission. We provide a succinct review of both strings of literature.

3.1 Review on Internet Banking

The economic literature first envisioned the internet as a *new distribution* channel of traditional banks through which a bank can provide easier access to its clients. Sullivan (2000) concludes that there is no competitive edge from banks using the internet as a new distribution channel. In contrast, Hernando and Nieto (2006) compares traditional banks with *multichannel* banks and finds that providing services through a website is a complement rather than a substitute of physical branches for banks. Similarly, Hasan et al. (2005) argues that *multichannel* banks are more profitable than traditional banks in Italy.

A second channel through which internet affects banking is by enhancing *economies of scale*, which can be roughly derived from a lower overhead or an improved customer experience. De Young (2005) was the first to directly compare online banking made by traditional banks and IOBs for identification and finds that IOB startups are less profitable than traditional bank startups, mainly due to a tighter interest rate spread and higher noninterest

expenses especially higher wages.

Yet, DeYoung also finds that IOBs enjoy greater economies of scale which allowed them to grow 24% faster than traditional bank startups. Interestingly, the economies of scale of IOBs can be observed when considering that larger survivor IOBs tend to be more profitable that traditional banks since IOBs have offer clients with lesser fees and grant fewer nonperforming loans relative to traditional banks.

Following DeYoung, Arnaboldi & Claeys (2008) compares clusters of IOB banks and traditional banks across different countries. A main feature of their work relative to the previous papers is that it also includes technological features across different regions. The most important conclusion, which is also consistent with our insights from the previous section is that *'internet banks have trouble in keeping under control of additional clients with deposit accounts'*.

Furthermore, Arnaboldi & Claeys argue that IOB need to engage in higher value added products in order to survive. Specifically, short term deposits excluding interbank loans as share of total assets do not have any effect on profitability, which may signal that IOB have poor reward from intermediation activities. In fact, noninterest income is a main driver of profitability and cost control, and it is tipically outside the scope of IOB business models.

Trust is not smaller issue. Kaabachi et al (2017) tests several definition of trust for IOB in France. Initial assurance by brand association of previously established banks as well as perceived benefits by the client, seem to be the main motives of customers to trust IOB. The last finding is consistent with our preeliminary analysis since we observed that Mexico's IOB consistently paid higher passive rates.

In summary, internet has provided the banking industry with a new distribution channel, lower costs, lower fees for clients and overall better customer experience. However, attracting new customers for a brand-new IOB may be costly and make it prone to alternative funding sources such as interbank loans and hence, make it susceptible to monetary policy tightening. Since this is the case in Mexico, we proceed to focus on the interaction of interbank dependent banks and monetary policy.

3.2 Review on Monetary Policy Transmission

Regarding monetary policy transmission, the standard approach to achieve identification and disentangle the credit supply effect from credit demand is attained by exploiting the variation of credit conditions across different banks for exactly the same firm. Khwaja & Mian (2008) formulates this technique and finds that politically owned firms did not suffer a credit drought in Pakistan after international sanctions decreased credit supply.

Iyer et al (2013) uses Khwaja & Mian methodology (KM methodology henceforward) and finds that Portuguese banks which rely more in the interbank market reduce credit supply to smaller and younger firms, as well as firms with lower banking relationships, after an exogenous spike in the interbank interest rates in the USA. Additional findings include that highly interbank indebted banks are less likely to start new lending relationship with small firms and that firms are not able to substitute bank's credit shortage.

Similarly, Kapan & Minoiu (2013) focus on the syndicated loan market which by definition includes several banks providing a loan to the same firm. Banks with high wholesale funding, such as that obtain from the interbank and other bank related deposits, decrease loan supply after a sharp and exogenous increase in rates on the Global Financial Crisis of 2008. These findings are in line with Disyatat (2011) which argues that nowadays the transmission of monetary policy is mainly perceived by the impact on the bank's balance sheet.

Regarding emerging economies, Schnabl (2012) is the first paper to apply KM methodology. Their findings are that the credit extended to Peruvian banks from international banks after the Russian crisis was substantially decreased on domestic banks which borrowed internationally from other banks and that smaller and younger firms are more affected.

Lastly, Morais, Peydró, Roldán & Ruíz (2017) employs KM methodology to discover evidence of the effects of foreign (both conventional and unconventional) monetary policy decisions on Mexico's domestic banking system through foreign banks and its effects on the real economy. This paper also finds evidence of search for yield, that is, foreign banks tend to lend to ex-ante riskier firms after the shock.

4 Empirical Findings

4.1 Data

Our database merges two distinct datasets. The first database consist on *every* credit loan given to non-financial private businesses by *all* commercial banks on a monthly basis from January 2014 to July 2017. Our time frame matches the launch of the IOB and the release of the the new version of the database.

The data is compiled by Mexico's Financial Supervisor, the National Banking and Securities Commission (CNBV), and processed by the Bank of Mexico's Financial Stability Directorate. Data reporting is mandatory for all financial institutions, formally, the database is known as R04.

To classify the credit as new, a credit has to equate its origination date with the observation month. We also keep those banks with greater than 10 new credits on the database. Firms are identified by its tax number (RFC, in Spanish). In occassions, specially when the bank has a new credit with a firm that has never lent before, banks filed a dummy tax number on the database. Hence, we take special care to match the tax number reported by the bank with the tax number of the authorities. Note that if a group of firms has two firms with two tax numbers, then they are considered as separate entities.

Our variable of interest is the annual interest rate and the loan's size since both variables are of uttermost importance for monetary policy decision. We also include three different bank variables which are the growth in assets as a proxy of bank's size and the net interest income as a proxy of bank's profitability.

The last bank's variable to be included is related to IOB behavior, it is the ratio of interbank funding with respect to wholesale funding, which consists on large loans given by other banks, the central bank or other financial institutions.

Descriptive statistics can be found in Table 1. For reasons which will become clearer in the following section, we take spread of bank variables relative to Large banks rather than levels. Hence a positive number implies that the group of banks has a larger outcome than Large banks. In addition we include two averages, the first goes through all the time periods while the latter only includes the periods 9 months after the monetary policy (referred as

After MPT).

Surprisingly we observe that for the same firm No-large banks actually gave interest rates that on average were superior to those given by Large banks while IOBs gave lower interest rates. Yet this behavior was changed after the monetary policy tightening. Particularly, for the same firm, IOB offered loans which were 165 basis points more expensive than Large banks on average, while No-large banks actually offered cheaper loans.

Regarding our main hypothesis, No-Large banks had a roughly stable interbank ratio which was in a range between 15 to 30 per cent greater than Large banks, but IOB had an astonishing difference of 49 percent relative to Large banks which grew after the Monetary Policy Tightening to become 65 percent greater than Large banks. In other words, once the central bank started to raise its reference rate, IOB also started to fund more at ever more increasing costs.

The remaining variables reported a stable behavior. Although IOB gave larger loans when compared to Large banks, loan size was unaffected after the monetary policy decision to increase rates, while No-large traditional banks marginally decreased the average loan size relative to large banks.

Lastly, the spread of growth on assets imply that IOB in general had a lower growth in assets relative to large banks but after the monetary policy tightening their assets surged and grew further than Large banks. Regarding net interest income, No-large bank closed the gap between themselves and Large banks after the monetary policy tightening while IOB actually diverged. See Table 1.

4.2 Econometric Model

In this section, we explain our identification strategy to disentangle credit supply effects due to monetary policy tightening on IOBs from credit demand.

To explain better our identification strategy and its comparison with KM methodology, take the basic regression between the change of a variable of interest, say loan's interest rate from bank b, to firm f at time t, $i_{b,f,t}$, on a (change of) bank's characteristic of interest $Z_{b,t}$,

Table 1: **Mean of Selected Bank Variables across Bank Groups***

Spread of	**No-Large + IOB Banks**		**No-Large Banks**		**Internet-only Bank**	
	Overall Period	After MPT**	Overall Period	After MPT**	Overall Period	After MPT**
Interest rate	0.08	-0.64	0.08	-0.64	-0.37	1.65
Loan size	0.07	-0.02	0.07	-0.02	0.08	0.08
Interbank Ratio	15.17	29.17	15.12	29.11	49.03	64.04
Net Interest Income	-8.23	-8.00	-8.23	-8.00	-8.14	-8.44
Assets	-0.61	-0.28	-0.61	-0.28	-0.27	1.07

* A positive reading implies that the group has higher mean that Large banks. ** MPT stands for Monetary Policy Tightening. Source: Bank of Mexico and CNBV.

$$i_{b,f,t} - i_{b,f,t-1} = \beta_0 + \beta(Z_{b,t} - Z_{b,t-1}) + e_{b,f,t}$$

We wish to identify β since it measures how a bank's characteristic interacted with a monetary policy rate is passed through to the firm. Unfortunately, $\hat{\beta}$ is biased since a monetary policy shock does not only affect the ability of the bank to lend, that is $(Z_{b,t} - Z_{b,t-1})$, but also affects at the same time the firm willingness to borrow, which is contained in $e_{b,f,t}$. In other words, $Cov((Z_{b,t} - Z_{b,t-1}), e_{b,f,t}) \neq 0$.

KM methodology attains identification of β by exploiting the shifts of credit conditions across banks *for the same firm*. Particularly, it groups banks that lend to the same firm according to their exposure to a shock of interest, say an unexpected credit tightening may have more effect on banks that rely heavily in the internet bank, and compares the difference in behavior across the bank's group. Since the banks are lending to exactly the same firm, any difference in lending conditions cannot be attributed to a fall in credit demand, but rather to a restrain on supply due to the shock.

Econometrically, KM methodology includes firm fixed effects β_f to rule out any endo-

geneity between the proposed mechanism and credit demand.

$$i_{b,f,t} - i_{b,f,t-1} = \beta_f + \beta(Z_{b,t} - Z_{b,t-1}) + u_{b,f,t} \tag{1}$$

Unlike our basic regression, if a shock which affects the (growth of the) bank's characteristic of interest, $(Z_{b,t} - Z_{b,t-1})$ is also correlated to the firms credit demand, then the impact on the latter will be absorbed by the fixed effect β_f. Therefore, we can restore the equality $Cov(\Delta Z_{b,f,t}, u_{b,f,t}) = 0$.

However, if we only focus on new loans, KM methodology cannot be implemented[3]. Hence, we propose a new methodology for identification. First, suppose that loan's interest rate $i_{b,f,t}$ can be expressed as a function of firm characteristics $X_{f,t}$ and bank characteristics, $Z_{b,t}$. In other words, we can split the error $e_{b,f,t}$ into a demand component $\gamma X_{f,t}$ and an orthogonal residual $\tilde{u}_{b,f,t}$. Note that, by construction, $Cov(X_{f,t}, \tilde{u}_{b,f,t}) = 0$ Then, we can rewrite rates as,

$$i_{b,f,t} \quad = \quad \beta_b + \gamma X_{f,t} + \beta Z_{b,t} + \tilde{u}_{b,f,t} \tag{2}$$

The first term on the right hand side of (3) is the effect of the shock on credit demand while the second term is the effect on supply which is our identification goal. Now, suppose we have another bank from a group of interest, say bank b' who at the same time lends to firm f at an interest rate $i_{b',f,t} = \beta_{b'} + \gamma' X_{f,t} + \beta' Z_{b',t} + \tilde{u}_{b,f,t}$. Note that the fact that bank b' belongs to a different group may imply that $\gamma \neq \gamma'$ and $\beta \neq \beta'$.

Note that the assumption that $\gamma = \gamma'$ implies that any bank has a insider knowledge on the firm or, in other words, any bank observes exactly the same information about the firm so that changes on the firm's fundamentals are priced equally by banks. Although restrictive, this assumption may be justified by the existence of a credit bureau and if the loan is granted to small and medium size firms.

[3]Unless a firm receives multiple *new* loans from different banks every month.

Mathematically, the assumption of same information across banks implies that for any bank pair b and b' and any firm f, we have $\gamma = \gamma'$. Then by subtracting both interest rates we obtain,

$$i_{b,f,t} - i_{b',f,t} = \beta_b - \beta_{b'} + \beta Z_{b,t} - \beta' Z_{b',t} + \tilde{u}_{b,f,t} - \tilde{u}_{b',f,t} \tag{3}$$

Whenever we consider a difference-in-difference analysis, we test if a bank from control group and a bank from a treated group, behave similarly before treatment was applied and that the same behavior would have been preserved if there was no treatment. A technical condition known as unconfoundedness. If unconfoudedness holds, then we would have that the response or pass-through of monetary policy is the same across banks, that is $\beta = \beta'$ and equation 3 becomes

$$\begin{aligned} i_{b,f,t} - i_{b',f,t} &= \beta_b - \beta_{b'} + \beta(Z_{b,t} - Z_{b',t}) + \tilde{u}_{b,f,t} - \tilde{u}_{b',f,t} \\ &= \beta_{b,b'} + \beta(Z_{b,t} - Z_{b',t}) + \nu_{b,b',t} \end{aligned} \tag{4}$$

If we contrast equation (1) with (4), it becomes clear that rather than exploiting variations across the time dimension, we concentrate on variations at the bank dimension for a loan granted to the *same firm at the same period of time*. Hence, any shift on credit demand from the firm f will be differenced out when we compare lending conditions at both banks.

Furthermore, unlike equation (1), equation (4) includes bank fixed effect rather than firm fixed effects. The heterogeneity of outcome variables across different banks allows us to get rid off the firm fixed effect yet the presence of niche banks or market share imply the use bank fixed effects for the average difference in lending conditions across banks.

We now proceed to explain our econometric model. We are interested in the extensive margin and focus on loan's interest rate and, to a lesser extent, loan size for new loans. For interest rates, we apply a difference-in-difference regression over repeated cross-sections.

Rather than panel data, we chose repeated cross-section since the existence of firms who inquire for new loans across every month in our database would have greatly reduce our number of observations.

To construct our control and treated group we first classify banks in three different partitions; Internet-only Banks, Large traditional bank and No-large traditional bank. Note that if a firm has one loan, this division is mutually exclusive but for multiple loans, it is not mutually exclusive. In other words, for a firm with 2 or more loans, one loan may belong to one partition and the other loan to another partition.

By dividing the banks in three different partitions, we can generate a new partition of the set of firms accordingly. Without loss of generality assume that all firms have only two loans from different banks. Let $\mathcal{F}$ be the universe of firms with two loans across different banks. If a loan from firm f is issued by the IOB bank, we say that firm f belongs to set $f \in \mathcal{T}$. Moreover, if a loan from firm f is granted by a No-large traditional bank, we say firm f belongs to set $f \in \mathcal{C}$. Lastly if a loan from firm f is given by a Large traditional bank, we say firm f belongs to set $f \in \mathcal{L}$.

Thus, we can define our control group as those firms from which at least one loan was granted from a No-large traditional bank and another loan from a Large traditional bank, i.e. $f \in \mathcal{C} \cap \mathcal{L}$. Conversely, we can also define our treated group as those firms with multiple loans from which at least one loan was given from an IOB and another one from a Large traditional bank, that is $f \in \mathcal{T} \cap \mathcal{L}$

Whenever firm f has more than 2 loans across more than 2 banks, we take all possible pairs that can be formed by taking one loan of each partition. For example, say that firm f has 1 loan from IOB (L_1), no loans from No-large traditional banks and two loans from Large traditional banks (L_2, L_3) . Then we form 2 pairs, namely (L_1, L_2) and (L_1, L_3) where both pairs belong to the treated group.

We define our treatment, T^*, as the following months after the unexpected announcement of Mexico's monetary authority in February 2016 where the monetary policy rate was raised on an extraordinary and unscheduled meeting. Namely, we proceed with 4 different treatments; March 2016, April 2016, May 2016 and February 2017.

Once our definition of control and treated groups is in place, we can present our regres-

sion equation. For firm f with two loans from bank $b \in \mathcal{T} \cup \mathcal{C}$ and another loan from bank $b' \in \mathcal{L}$. Define $\mathbf{1}(IOB_b)$ as an indicator function which equals one if the loan b is given by an IOB, $\mathbf{1}(T_t^*) = \mathbf{1}(t > T^*)$ as an indicator if the time of reference is post-treatment. As before $Z_{b,t}, Z_{b',t}$ stand for bank's characteristics of interest. Then, our difference-in-difference analysis for the spread of interest rates can be specified as,

$$\begin{aligned} i_{b,f,t} - i_{b',f,t} &= \beta_{b'} b' + \beta_1 \mathbf{1}(IOB_b) + \beta_2 \mathbf{1}(T_t^*) + \beta_3 \mathbf{1}(IOB_b) * \mathbf{1}(T_t^*) \\ &+ \beta(Z_{b,t} - Z_{b',t}) + \lambda t + u_{f,b,t} \end{aligned} \tag{5}$$

Where $\beta_{b'}$ is the coefficient for the bank effect, excluding both the internet-only bank and the traditional banks. On the other hand, λ is the coefficient for time effect, excluding some months to avoid multicollinearity. Although we can not perform panel data and given the size of our database, we choose to include these variables to have an equivalent result to panel data and control for unobserved heterogeneity.

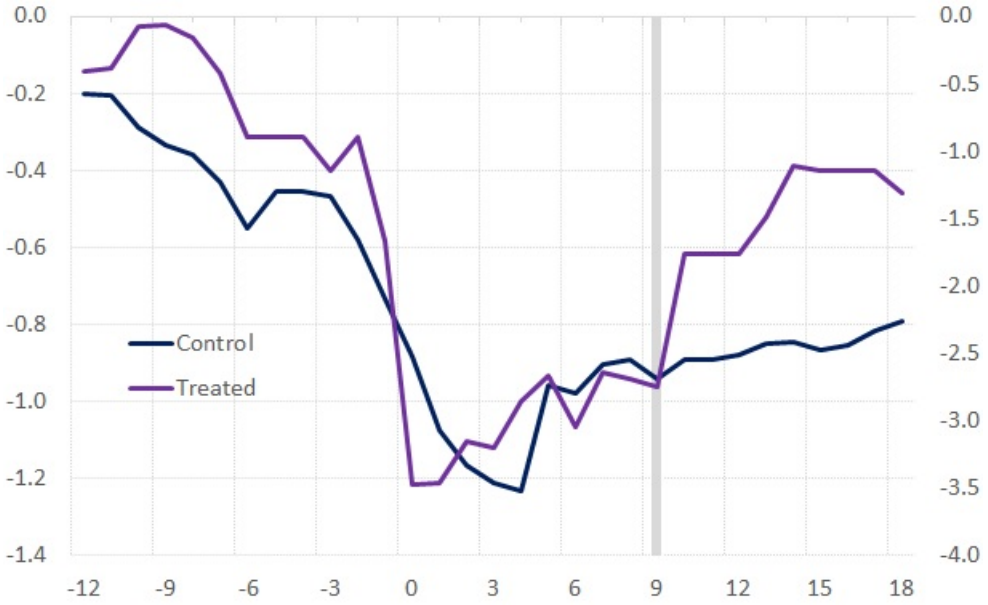
On Figure 4, we can find the average spread of interest rates across control and treated groups. We see that both groups behaved similarly before treatment (signaled at time 0), while their dynamics started to diverge 9 months later. While the control group further lowered the spread 3 months after the tightening of monetary policy and took 3 additional months to bounce back, it became marginally increasing from the sixth month afterwards. Similarly, the spread with the treated group took six months to recover but it tend to increase significantly following the monetary policy tightening.

Lastly, we also test whether the unconfoundedness assumption holds for loan size (figure is not depicted but available upon request) to no avail and hence we ommit the difference-in-difference analysis for loan size from our research.

4.3 Results

Our findings for the interest rates are summarized in Table 2. We include separate regressions for the control-only, treated-only and all observations. We include bank dummies to account for any unobserved heterogeneity. We also clustered standard errors by banks to

Figure 4. Unconfoundedness: Spread of Interest rates before and after treatment



Source: Author's calculation.

avoid any possible heterogeneity across banks.

The treatment coefficient suggests that IOB charged on average greater interest rate to exactly the same firm who also borrowed from a Large bank. In other words, for exactly the same firm, IOB banks lent with a 192 basis points more expensive rate relative to Large banks after the start of the monetary policy tightening. The converse behavior was observed by the No-large traditional banks which lent 46 basis points cheaper than Large banks after the unexpected monetary policy decision.

We can indirectly compare the behavior between No-large traditional banks and IOB through the difference-in-difference estimator. In general, we can see that the difference-in-difference coefficient is statistically significant and indicates a strong divergence of the spread between IOB and Small traditional 9 months after the start of the monetary policy tightening.

A possible explanation of the increase in interest rates after the monetary policy tightening is due to the heavily dependence of IOB in the interbank market. Table 3 to 4 include the results of regressing the spread of interest rates and loan size with different banks for the same firm on bank variables including the interaction between the spread of Interbank Ratio and the start of the monetary policy tightening for IOBs. In addition to bank dummies, we

Table 2: Difference-in-Difference Estimates for Interest rates

	(1) Control	(2) Treated	(3) All
Internet Only Bank			-0.48
			(0.46)
Difference-in-Difference			2.50***
			(0.46)
Treatment	-0.46***	1.92***	-0.45***
	(0.12)	(0.48)	(0.12)
Spread in Growth of Assets	-0.02	0.09	-0.02
	(0.02)	(0.15)	(0.02)
Spread in Net Interest Income	-0.12	-1.49***	-0.13
	(0.10)	(0.52)	(0.10)
Spread of Interbank Ratio	-0.00	-0.02	-0.00
	(0.00)	(0.03)	(0.00)
Bank Dummies	Yes	Yes	Yes
N	202,199	325	202,524
r2	0.05	0.13	0.05
aic	1205293.14	1946.20	1207251.73

Clustered standard errors by bank in parentheses. * $p < 0.10$, ** $p < .05$, *** $p < .01$

also include time dummies and clustered errors by banks.

Our results suggest that an increase of the interbank ratio before the start of the monetary tightening had no effect on the spread of interest rate but soon after the Central Bank hiked its reference rate then every percentage point of difference on interbank ratio between IOB and Large banks yielded an additional 0.03% increase of interest rates.

Although 0.03% can be considered rather a dismal change, recall that the actual difference on assets between IOB and Large banks is about 65% and hence, our estimations predict an almost 200 basis points difference in the interest rate of a loan given to a firm from an IOB relative to a loan given to exactly the same firm but from a Large bank. See Table 3.

Table 3: Transmission Mechanism for Interest rates

	(1) Control	(2) Treated	(3) All
Interacted Interbank Ratio		0.04***	0.03***
		(0.01)	(0.00)
Spread of Interbank Ratio	0.01	-0.00	0.01
	(0.01)	(0.02)	(0.01)
Spread in Growth of Assets	-0.02*	0.25***	-0.02*
	(0.01)	(0.08)	(0.01)
Spread in Net Interest Income	-0.27***	-0.61	-0.27***
	(0.09)	(0.50)	(0.09)
Bank Dummies	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes
N	202,199	325	202,524
r2	0.07	0.39	0.07
aic	1202875.53	1866.94	1204823.71

Clustered standard errors by bank in parentheses. * $p < 0.10$, ** $p < .05$, *** $p < .01$

Results for loan size are starkly different. The coefficient of the interaction of Interbank Ratio, the start of the monetary policy tightening and the dummy for IOB banks as not statistically significant in the second regression suggests that IOB banks left their loan size relatively uncorrelated with their interbank ratio before and after the Monetary policy tightening. Yet the presence of a statistical change of the interacted interbank ratio coefficient

hints that the change in loan size is probably due to the behavior of No-large banks. See Table 4.

Table 4: Transmission Mechanism for Loan Size

	(1) Control	(2) Treated	(3) All
Interacted Interbank Ratio		-0.01	0.03***
		(0.01)	(0.01)
Spread of Interbank Ratio	0.01*	-0.03*	0.01*
	(0.00)	(0.02)	(0.00)
Spread in Growth of Assets	0.01	0.09	0.01
	(0.02)	(0.09)	(0.02)
Spread in Net Interest Income	0.14	-0.41	0.13
	(0.10)	(0.91)	(0.10)
Bank Dummies	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes
N	202199.00	325.00	202524.00
r2	0.12	0.26	0.12
aic	1028738.51	1543.58	1030407.28

Clustered standard errors by bank in parentheses. * $p < 0.10$, ** $p < .05$, *** $p < .01$

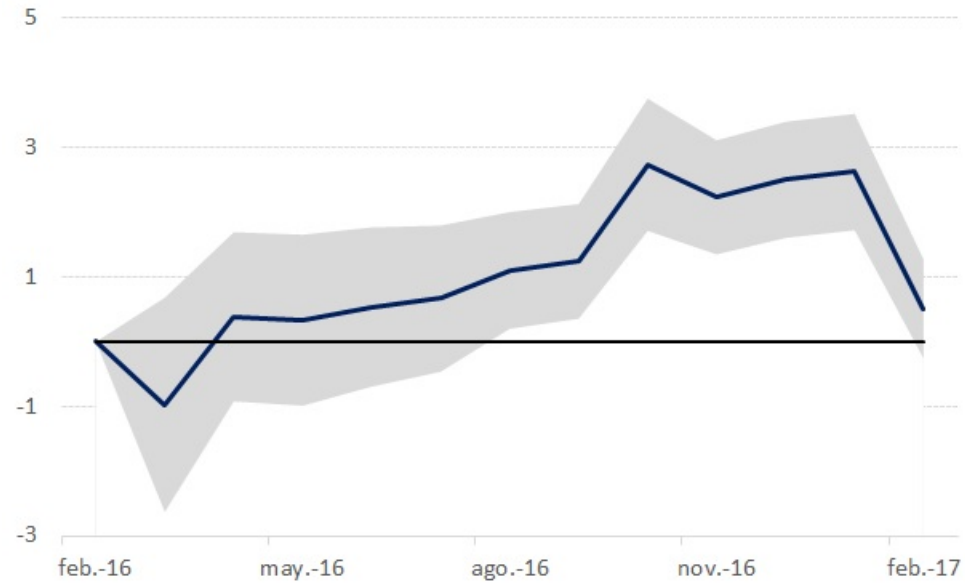
4.4 Robustness Check

4.4.1 Time Selection

As a first robustness check, we consider different time horizon for our treatment. Recall that we define as treatment date nine months after the unexpected monetary policy rate. Now, we run the same regression but we allow ourselves to modify the definition of treatment from 6 to 12 months after the monetary policy decision.

Our findings for interest rates are summarized in Figure 4. In general, there is a positive and statistically significant increase in interest rates after 6-months of the monetary policy announcement and which last for about additional 6-months with a range of 100 to 250 basis points. Moreover, the trend is slightly growing and achieving a peak at 10 months after the Monetary Policy decision afterwards it smooth outs.

Figure 4. Repeated Cross Section Difference in Difference Analysis for Interest Rates



Source: Author calculation.

4.4.2 Placebo Effect

As an additional robustness check, we introduce a placebo test and run our regressions when there was no unexpected change in monetary policy, that is two years before the announcement. Our timeframe roughly allows to have 12 months, before and after the placebo treatment date on January 2015.

Results are depicted in Table 5. IOB in general lent at higher rates to exactly the same firm which also borrowed from a large bank and at shortly after the placebo treatment both, IOB and No-large banks lent at cheaper rates. However, as suggested by the difference-in-difference coefficient, their behavior was not statistically different from No-large banks.

In contrast to interest rates, difference-in-difference coefficient for loan size is statistically significant in the Placebo test, just in line with our main results, and hence casts reasonable doubt for using difference-in-difference analysis on loan size. See Table 5.

4.4.3 Alternative explanations

Our final robustness check is to explore alternative explanations to the divergence on behavior of Internet Only Banks. For instance, a plausible explanation of the difference in

Table 5: Difference-in-Difference Estimates for Placebo Test

	(1) Interest rates	(2) Loan Size
Internet Only Bank	1.14**	-0.01
	(0.56)	(0.06)
Treatment	-0.37*	-0.13***
	(0.22)	(0.03)
Difference-in-Difference	-0.70	0.18***
	(0.81)	(0.05)
Spread in Growth of Assets	-0.04*	0.01*
	(0.02)	(0.01)
Spread in Net Interest Income	-0.18	0.04
	(0.13)	(0.04)
Spread of Interbank Ratio	-0.01	-0.00
	(0.00)	(0.00)
Bank Dummies	Yes	Yes
N	145975.00	145975.00
r2	0.06	0.08
aic	769304.84	75451.56

Clustered standard errors by bank in parentheses. * $p < 0.10$, ** $p < .05$, *** $p < .01$

behavior of IOB with respect of the banks may lay in the fact that IOB is rather a new bank.

In the case in which the alternative explanation actually is the driver of the spread in interest rates, then we can expect that the difference in difference coefficient is not statistically significant since both groups, IOB and the control group, would move in parallel.

We proceed by comparing the actual behavior of New Banks with IOB. For a bank to be classified as new, it had to be constituted after 2010, which is roughly 3 years before IOB started operations. Fifteen banks fitted this definition, out of which 5 were foreign subsidiaries.

Note that our group comparison is now changed. Rather to be compared to Large banks, our results are now relative to not new banks. Hence, there is an increase on the number of observations for the treated group which considers all firms whose loans were given by No-large bank which also happens to be an old bank and that also borrowed from an IOB.

Results are depicted on Table 6. Similar to our previous findings, for a firm that borrowed from an old bank and from Mexico's IOB, the latter lent at 210 basis points higher rates and the rate increased an additional 188 basis points after the Monetary policy tightening.

The last alternative explanation, we test whether IOB behave differently than stressed banks. As explained before, the main reason for IOB to be more sensitive to monetary policy decision is the fact that they rely heavily on interbank loans.

For a bank to be stressed, we picked all banks that had a Loan-to-Deposit ratio greater than 2 on average from 2013 onwards. As a comparison, Mexico's IOB registered almost 7 loans per deposit at the specified timeframe. Nine banks were classified as stressed out of which 3 were a foreign subsidiary. Note once more, the reference group is changed to not-stressed banks.

Results are depicted in Table 7. For a firm that had a new loan with an IOB and a stressed bank at exactly the same month, the former charged 158 basis points higher interest rate and they after the monetary policy decision, the difference in rate was 223 basis points.

In other words, neither the fact that IOB was a small, new or a stressed bank explains the spread of interest rates.

Table 6: Diff-in-Diff Estimates for Interest rates for New Banks

	(1) New Banks	(2) IOB	(3) New+IOB
Internet Only Bank			2.10***
			(0.41)
Difference-in-Difference			1.88***
			(0.40)
Treatment	0.14	2.15***	0.13
	(0.18)	(0.36)	(0.18)
Spread in Growth of Assets	0.04***	0.02	0.04***
	(0.01)	(0.06)	(0.01)
Spread in Net Interest Income	-0.39***	-0.96***	-0.41***
	(0.11)	(0.28)	(0.11)
Spread of Interbank Ratio	-0.02***	-0.01	-0.02***
	(0.00)	(0.02)	(0.00)
Bank Dummies	Yes	Yes	
N	17,543	428	17,971
r2	0.30	0.13	0.29
aic	94509.21	2581.98	97247.90

Clustered standard errors by bank in parentheses. * $p < 0.10$, ** $p < .05$, *** $p < .01$

Table 7: Difference-in-Difference Estimates for Interest rates

	(1) Stressed Banks	(2) IOB	(3) Stressed+IOB
Internet Only Bank			1.58***
			(0.44)
Difference-in-Difference			2.23***
			(0.44)
Treatment	-0.09	1.94***	-0.13
	(0.19)	(0.46)	(0.18)
Spread in Growth of Assets	0.01	0.06	0.01
	(0.01)	(0.05)	(0.01)
Spread in Net Interest Income	0.06	-0.49*	-0.00
	(0.10)	(0.26)	(0.10)
Spread of Interbank Ratio	-0.01***	0.01	-0.01***
	(0.00)	(0.01)	(0.00)
N	9,089	432	9,521
r2	0.39	0.12	0.36
aic	45617.06	2614.38	48641.23

Clustered standard errors by bank in parentheses. * $p < 0.10$, ** $p < .05$, *** $p < .01$

5 Conclusion

In this paper we focus on a new business model prompted by technological innovation in finance, the Internet-Only Banks (IOBs). Unlike its conventional counterparts, IOBs process each and every transaction online, from simple interbank transfer and payments to setting up accounts and running anti money laundry techniques.

A problematic feature of IOB is that it lacks depositors and hence must of its daily needs its cover through wholesale funding. We comment that this is a generalized phenomenon but it is also particularly true for Mexico's IOB.

The heavy reliance on interbank funds rather than deposits, makes IOB banks specially susceptible to monetary tightening. Indeed we propose a new econometric methodology to assess the impact of an unexpected monetary policy shock over the loans interest rates and loan size.

Unlike previous papers, we focus on the difference in lending features across the same firm and at the exactly same time between an IOB and several control groups. We comment on how this technique differences out endogeneity. Note that previous research compares the difference on bank's outcome variables through the difference on average growth over time.

Our findings are robust to several time specifications and suggest that IOB increased the interest rate of its loans between 150 and 250 basis points depending on the control group for which the IOB is compared to. We also provide a Placebo test a year before the tightening of Monetary Policy and there was no evidence of a shock.

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