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Patterns and Drivers of Corporate Bonds in Latin America

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A Systemic Measure of Liquidity Risk

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Abstract

This paper analyzes systemic liquidity risk by assessing the behavior of aggregate banking variables and policies related to the management of liquid assets. The basic premise is that liquidity is not only related to the ability to meet interbank debt obligations, but also the availability of sufficient liquid assets to cover other short-term liabilities, such as those arising from commercial banks interaction with the central bank. To measure liquidity risk, we use the contingent claims approach of Merton (1974) and Gray, and Malone (2008). Data produced by the model (probability of default) explains and improves prediction of the amounts and interest rates negotiated in the interbank market. In the case of Venezuela, given the importance of fiscal expenditure in the

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primary creation of money, fiscally induced monetary expansion tends to reduce the likelihood of illiquidity events. Meanwhile, an increase in reserve requirements increases the probability of default by raising banks' short-term liabilities.

Keywords: contingent asset analysis, interbank market, systemic risk, macroprudential regulation.

JEL classification: G00, G13, G18.

1. INTRODUCTION

This paper aims to contribute to measuring systemic liquidity risk and understanding the factors influencing it.

Liquidity risk for an individual bank can be understood as the likelihood of it not being able to meet its payment obligations or cash flows with other banks as described by Cao (2015).[1] The literature typically describes systemic risk associated with liquidity issues as the contagion that takes place among institutions in the system after closely interconnected banks (or systemically important) report default problems. Given that network models allow analysts to understand to what degree a single event might cause domino type effects, they have become key to the analysis of systemic liquidity risk. A summary of this type of studies can be found in Upper (2011). Meanwhile, Smaga (2014), and Drehmann and Tarashev (2011) show that these estimations of individual risk contagion represent a bottom-up measure of systemic risk.

However, given the complexity of the factors contributing to systemic risk, Smaga (2014) also shows how there is still no consensus regarding its definition. This has opened up the possibility for measuring systemic risk from a bottom-up point of view, i.e., associating systemic risk to aggregate variables or

[1] This definition refers to the illiquid funds event, which differs from market illiquidity. The latter can be understood as the risk of an institution not being able to buy and sell assets immediately without forcing changes in their prices due to a lack of depth or distortions in the market.

macroeconomic factors, which can reveal the status of the financial system as a whole. This perspective is important if we consider the existence of exogenous factors that can affect the whole banking system but might remain invisible when analysis focuses on individual institutions just as pointed out in Elsinger et al. (2002). Moreover, Brunnermeier et al. (2009) argue that to properly regulate systemic risk it is necessary to abandon the predominant view which asserts that a system is sound if all the institutions within it are sound (macroprudential approach). In other words, it is essential to adopt a macroprudential approach that includes important macroeconomic data to analyze the stability of the system as a whole.

This paper estimates systemic liquidity risk based on the behavior of aggregate banking variables and policies related to banks' liquidity management. The basic premise is that liquidity is not only related to the ability to meet interbank debt obligations, but also the availability of sufficient liquid assets to cover other short-term liabilities, such as those arising from commercial bank interactions with the central bank. To pay any of these obligations banks typically reduce their liquid assets, be they those that are available immediately (such as cash) or less liquid assets that must first be sold in the market (such as Treasury bills). Given that the market value of less liquid assets fluctuates they are subject to possible losses. Hence, total liquid assets–the sum of highly liquid and less liquid assets–can be treated as a stochastic variable. Under this context, systemic liquidity risk arises due to the potential losses involved in market transactions that might jeopardize the fulfillment of short-term liabilities. This risk becomes greater as the need to transform less liquid assets into liquid ones in the market increases. Given that this idea of liquidity risk is systemic, it is also crucial to include the central bank's impact on commercial bank funds.

To measure the risks associated with changes in liquidity we apply the contingent claims approach originally developed for firms by Merton (1974) and applied to different microfinancial sectors by Gray and Malone (2008). This methodology rearranges the assets of an entity to define the probability of default as the likelihood that the (stochastic) value of its assets falls below that of the highest priority debt (or senior debt). The spread between the value of the assets and the value of the senior debt is named residual liability (or junior debt). Given that the value of assets is not clearly visible in this methodology the residual liabilities item is of utmost importance. In our study of the liquidity problem, we define residual liabilities as capital stocks and liquid asset flows that are available, such as cash and holdings in central bank policy instruments. We also include expected flows from new deposits related to the primary money creation. One characteristic of available liquid assets is that they can be immediately decumulated to meet short-term senior debt obligations if there are losses (expected or unexpected) in other assets. This definition of residual liabilities is in line with the fact that, during periods of liquidity shortage (when there are low levels of cash), adverse market conditions exist for selling assets and, therefore, the expected amount of total liquid assets tends to be low. On the other hand, short-term senior debt includes payments required by the central bank (such as legal capital requirements and disbursements for currency sales or other loans). We also consider withdrawals from the banking system as short-term liabilities.

The interpretation of default probability proposed here is that, if the desired accumulation of liquid assets (such as cash) exceeds the flow of new funds entering the banking system it increases the likelihood of an event that interrupts –to some extent– payments between banks or with the central bank. This likelihood reflects the risks (potential losses) arising from a generalized translation of less liquid assets into cash.

In the strict sense, default probability calculated in aggregate terms, more than an objective measure of risk, can be considered an indicator of overall banking system vulnerability, as suggested by Gapen et al. (2004) and Kozak et al. (2006). This is because there is no clear system-wide definition of a default event. Nevertheless, probability as a systemic risk concept can be useful for understanding the accumulation (observed) of highly liquid assets by the banking system as a whole. Such decisions are also linked to conditions seen in the interbank market, where banks seek to satisfy their immediate liquidity needs. We attempt to explain these ideas based on a stylized optimization problem that uses estimated default probability as an input for banks' decisions.

Our application to the case of Venezuela shows that the probability of default obtained from the model allows for explaining the aggregate amount of funds traded in the interbank market as well as their average agreed interest rate. In particular, a higher probability of default tends to signal larger transaction amounts due to the central bank's increased need for funds. Meanwhile, a higher probability of default explains higher interest rates, possibly reflecting larger risk premiums associated with the behavior of systemic liquidity. Furthermore, the mean squared error prediction for amounts and interest rate improves considerably when the results are included in the model.

According to the model presented in this paper, the vulnerability associated to changes in liquidity can be influenced to varying degrees by monetary, exchange rate and fiscal policy decisions, depending on their interactions inside a country's institutional framework. For Venezuela's case, given the importance of fiscal management in the creation of new money, we show that greater fiscal influence in the money supply tends to reduce the likelihood of illiquidity events. Conversely, when the central bank intervenes to a greater extent by selling currencies to the economy, illiquidity events tend to become more likely. Moreover, an increase in reserve requirements raises the probability of default by increasing banks' short-term obligations.

The paper is divided into four sections. The first corresponds to the introduction. The second describes the application of the contingent claims approach to liquidity management, interprets the probability of default obtained and outlines a stylized model to understand linkages with the interbank market. The third shows the application to the case of Venezuela, and the coherence and robustness of the outcomes, as well as counterfactual exercises that allow for understanding how changes in major policies (fiscal and exchange rate) would affect systemic liquidity risk. The fourth section presents some final remarks.

2. LIQUIDITY RISK

Assets and liabilities can be classified according to their planned maturity date. These classifications can provide central banks with an estimate of their maturity mismatch. However, referring to liquidity management means comparisons are not necessarily between total assets and liabilities, but rather between liquid assets and payment obligations with those liquid assets. Moreover, liquidity shortages can arise as a result of asset reallocations stemming from attempts to transform less liquid assets into more liquid ones. As a consequence, the ideas of senior and junior debt as traditionally applied in the liabilities or contingent claims approach (CCA) need to be reconsidered. Table 1 shows bank balance sheets classified according to the standard CCA. We will now analyze how the CCA should be applied to the liquidity management problem and how said problem can be framed. Annex A describes the mathematical approach related to implementing the contingent claims methodology.

Table 1

BANK BALANCE SHEET CLASSIFICATION ACCORDING TO THE STANDARD CONTINGENT CLAIMS APPROACH

Assets	*Liabilities*
Unobservable	*Senior debt:* Short-term deposits + a fraction of long-term deposits *Junior debt:* Capital at market value

Liquidity management tackles the problem of having sufficient liquid assets ready immediately to meet short-term obligations. There are two items that should be considered when applying the contingent claims approach to an analysis of liquidity. First, the amount of liquid assets is somewhat uncertain given that they are not clearly observable in the short term. Second, liquidity management needs to include the behavior of expected flows, which are related to changes in the central bank's balance sheet (monetary base) but are unobservable in commercial bank balance sheets.

Asset uncertainty. It is possible to think of two types of liquid assets. One part of them is readily available and clearly observable: Refers to cash holdings at banks, and all deposits at the central bank (such as reserves more than legal requirements and certificates of deposit). The other part is represented by assets that can be transformed into cash via market transactions, for instance, securities negotiated in secondary markets. The latter share is precisely the part of liquid assets whose value is uncertain. Estimation of said assets is generally subject to market conditions. Thus, total liquid assets can be treated as a stochastic variable just as in the standard contingent claims approach because of possible market losses (or gains).

Expected monetary base flows. Given that we try to study the problem of liquidity management from a systemic point of view, it is important to take into account the role played by the central bank. For instance, banks' positions in monetary policy instruments reflect funds lent by or requested from the central bank in the past. Although these balances have an impact on systemic liquidity, they are already considered in bank balance sheets. Expected inflows and outflows in a banking system are unobservable on bank balance sheets. These flows of funds (in domestic currency) take place through the primary money creation (changes in the monetary base) and should also be considered when assessing systemic liquidity. That is to say, banks' real liquidity is increased or reduced by the creation or destruction of domestic currency. These changes in monetary base typically refer to exchange rate interventions and money creation produced by disbursements or revenues of other organizations with accounts at the central bank, such as the central government. Our analysis only takes into account monetary base flows that are not related to specific monetary policy actions taken by the central bank to offset other flows. In other words, we only want to consider money creation stemming from currency flows or other entities other than the central bank. This is the reason why we assume banks' decisions to hold larger or smaller balances in monetary policy instruments will depend on the evaluation of systemic liquidity risk. Hence, changes in the amount of the monetary policy instrument cannot be used as an input for estimating said risk. This point is related to the description in Section 2.3.

2.1 Applying the Contingent Claims Approach to Liquidity Management

In the standard CCA, residual liabilities are modeled as a European call option because their value increases as the estimated value of assets with respect to the value of a senior debt rises. Just as in most applications presented in Gray and Malone (2008), the value of residual liabilities and senior debt are considered observable, while the implicit amount of assets has to be estimated.

In the liquidity management problem, we classify as residual or junior debt all cash and liquid flows banks can use immediately to meet short-term senior obligations when there are reductions (expected or unexpected) in other assets. The higher these residual liabilities, the greater the total liquid assets estimated by the model, given a fixed number of senior claims. This implies that the stochastic properties of residual liabilities are transferred to estimated total liquid assets. This idea is also consistent with the fact that during periods of liquidity shortage cash levels are low and there are adverse market conditions for selling assets. Hence, inadequate liquidity is associated with low expected amounts of total liquid assets.

What, therefore, are the specific components of those liquid residual liabilities and major obligations for liquidity management? Table 2 shows the balances and flows that should be considered.

One important component of residual debt is the balance of unlent cash deposits. Banks hold such cash deposits in their vaults or as excess reserves (to legal capital requirements) at the central bank. These two items represent the real amount of cash accumulated in the past and, potentially, an important buffer for unexpected increases in senior claims. Nonetheless, this cash inventory should be adjusted by the amount of funds in the interbank market in order to be able to estimate the part of reserves that are not committed during liquidity shocks. That is to say if interruptions occur in interbank debt payments by one or more institutions, only the net cash of loaned amounts can be considered as actually available. Meanwhile, subtracting the total amount of loans due also seeks to control for excessive cash accumulation during liquidity crises. For instance, during periods of liquidity shortage, but substantial banking activity, although cash reserves might seem high, unlent cash reserves might reflect systemic liquidity conditions more appropriately.

As for the monetary authority, the balance of funds loaned to the central bank, i.e., the balance of buffer instruments, is considered a residual liability because it is generally available for banks to use. On the other hand, the balance of funds borrowed from the central bank are considered a senior debt because they must be repaid to the monetary authority in the short-term.[2] Likewise, flows stemming from the primary money creation (changes in the sources of the monetary base) can be considered residual liabilities or senior claims, depending on whether they lead to newly available funds for banks or whether they represent payments to the central bank (or an entity with an account at the central bank).

[2] If there are different maturities for the instruments, only the portion of the balance related to the shortest maturities (or most important) should be considered.

Table 2

CLASSIFICATION OF SHORT-TERM LIABILITIES FOR LIQUIDITY MANAGEMENT

Total liquid assets	*Total liquid liabilities*
Unobservable	*Senior debt, D:* Balance + interest on monetary policy injection instruments Expected destruction of money in local currency (contraction of monetary base) Expected change in reserve requirements Interest on debt in the interbank market Expected cash withdrawals *Junior debt, E:* Balance + interest on monetary policy absorption instruments Expected money creation in domestic currency (expansion of monetary base) The balance of unlent cash reserves[1]

[1] Balance of unlent cash reserves = cash in the banks + excess reserves at the central bank − amount (past) of funds negotiated in the interbank market.

Concerning senior claims in liquidity management, interest payments owed in the interbank market represent additional funds the banking system needs to generate to keep the market functioning. Expected changes in legal or required reserves are considered liabilities because, despite representing assets for the banks, the central bank does not allow them to be used. This means that an increase in reserve requirements implies disbursements by banks that can increase the need for liquidity in the short-term, even if those reserves can be used as a contingency during liquidity shortages.

Another component of senior debt is the number of expected withdrawals from the banking system. This amount can be estimated by net cheque clearing and electronic transactions, which represent the amount of deposits leaving the system and immediately available deposits, respectively.

2.2 Interpreting Probability of Default

Due to the fact that the CCA is based on a reclassification of assets and liabilities, we can rewrite a simplified version of Table 2 as follows:

1 $$A_t - D_t = E_t,$$

2 $$A_t - E(\Delta RR_t) - E(R_t) - i^O_{t-1}Q^O_{t-1} = E(FBM_t) + BC^{abs}_{t-1} + + efectivo_{t-1} - Q^O_{(t-1)},$$

where A, D and E are liquid assets, senior claims and residual debt, respectively. RR, R, and FBM refer to reserve requirements, withdrawals and monetary base flows, respectively. BC^{abs} and *cash* are credits (net absorption) at the central bank and cash, respectively, and represent available balances (highly liquid). Q^O and i^O are the amounts negotiated and average interest rate in the interbank market (overnight). For any variable X, $\Delta X_t = X_t - X_{t-1}$. Expectations regarding the flows occurring in time t are formed with information available at $t-1$.

One direct interpretation of the probability of default *(PrD)* can be obtained indifferently from each one of the two sides of Equation 2:

3 $$PrD = Pr(A_t < D_t) = Pr\left[A_t < E(\Delta RR_t) + E(R_t) + i^O_{t-1}Q^O_{t-1}\right],$$

4 $$PrD = Pr(E_t < 0) = Pr\left[E(FBM_t) + BC^{abs}_{t-1} + efectivo_{t-1} < Q^O_{t-1}\right].$$

Equation 3 suggests that if the total value of liquid assets is lower than senior debt flows; then the probability of systemic default would increase. Equation 4, on the other hand, depicts that if the balance of available assets (BC^{abs} and *cash*) plus new funds is lower than the last amount negotiated in the interbank market, the probability of default will increase.

Another interpretation of default probability can be obtained by subtracting *desired* (not actual) amounts of cash and the central bank absorption commercial banks would wish to maintain at time t. Equation 2 can be rewritten as follows:

5
$$A_t - E(\Delta RR_t) - E(R_t) - i_{t-1}^{O} Q_{t-1}^{O} - efectivo_t - BC_t^{abs} = \\ = E(FBM_t) - \Delta BC_t^{abs} - \Delta efectivo_t - Q_{t-1}^{O}.$$

In this case the probability of default can be written as:

6
$$PrD = Pr(A_t < D_t) \\ = Pr\left[A_t - E(\Delta RR_t) - E(R_t) - i_{t-1}^{O} Q_{t-1}^{O} < efectivo_t + BC_t^{abs}\right],$$

7
$$PrD = Pr(E_t < 0) = Pr\left[E(FBM_t) - Q_{t-1}^{O} < \Delta BC_t^{abs} + \Delta efectivo_t\right].$$

Equation 6 suggests that if the remaining portion of total liquid assets–once debt flows have been paid–is lower than the desired amount of available assets (BC^{abs} and *cash*), then the probability of systemic default increases. This is due to the fact that reaching the desired amount of highly liquid assets would imply transforming less liquid assets into cash by selling them in the market. At the aggregate level, such conversions would tend to diminish the overall expected value of assets and, therefore, would increase the likelihood of the assets being insufficient to cover obligations.

Meanwhile, Equation 7 suggests that if banks' new fund flows (money creation) are insufficient with respect to interbank debts, cash or absorption should be reduced by at least the same amount in order to prevent an increase in the probability of default. In other words, if the desired accumulation of cash in highly liquid instruments exceeds the flow of new funds in the system, the probability of default increases due to risks stemming from a generalized transformation of less liquid assets into cash.

Assuming the existence of *desired amounts* of available assets is just one tool to obtain economic insight into an increase in aggregate probability of default. However, in the statistical model, probability of default is given by implied asset volatility and their distance to senior claims. In the strict sense, therefore, said probability does not depend on the desired amounts of available assets.

That said, can default probability be linked to aggregate accumulation (observed) of available (highly liquid) assets? Alternatively, can default probability be related to market variables, such as the amounts and rates negotiated in the interbank market? Below we propose a highly stylized model to answer these questions.

2.3 Stylized Model for Modelling Available Assets

Here we present an optimization problem for a period when aggregate amounts of available liquid assets (cash and central bank absorption) are determined based on a given liquidity risk. That is to say, given the (past) information on assets and on expected flows, a probability for systemic default is generated. This probability, in turn, defines two possible states of nature: one state with some degree of interruption to banks' payments (with other banks or the central bank), and another one of normal asset and interbank market functioning. In both states, the costs of holding available liquid assets are different. The total expected costs *E(CT),* for both states of nature, related to holding these liquid assets are:

8
$$E(CT_t) = PrD_t\left(LGD_t - \Delta efectivo_t - \Delta BC_t^{abs}\right) + \\ + \left(1 + PrD_t\right)\left[i_t^O efectivo_t + \left(i_t^O - i_t^{BC}\right) BC_t^{abs}\right],$$

where LDG is losses in assets traded in the markets in the event of an interruption to payments, and i^{BC} is the interest rate set by the central bank for its absorption instrument. Equation 8 reveals that, in the case of interruption of payments, expected losses include losses in less liquid assets (stochastic) and losses related to the reduction of available assets. The greater the accumulation of available liquid assets, the lower are the total losses associated to the payment interruption event. In the normal market functioning state, the observable costs of holding liquid assets are the opportunity costs with respect to the interbank rate. The aggregate optimization problem consists of minimizing the total expected cost when choosing the amount of cash and BC^{abs} in t, subject to the aggregate restriction: $\Delta efectivo_t + \Delta BC_t^{abs} \leq FBM$, which denotes that the actual accumulation of both available assets cannot exceed inflows of new funds to the system. This is due to the fact that once cash has been redistributed through the interbank market or the sale of less liquid assets by some banks, only money creation can translate into new available liquid assets.

We also assume that there is an implied positive function between i^O and the aggregate amount of cash, $i^O = f(cash)$. If $f'(cash) > 0$, it means that high aggregate levels of cash are associated with high interbank interest rates because banks, individually, try to increase their holdings of cash through the interbank market. That is to say, the behavior of the market reflects to a greater extent the behavior of those demanding funds. If $f'(cash) < 0$, it implies that high aggregate levels of cash are consistent with lower interest rates in the interbank market given that banks try to channel said cash as fund supply. In this case, the behavior of fund suppliers prevails to explain the interbank interest rate. We also assume that i^{BC} is related to BC^{abs}, i.e., for $i^{BC} = f\left(BC^{abs}\right)$, where $f'(BC) \lesseqgtr 0$.[3]

[3] Assumptions $f'(cash) > 0$ and $f'(BC) < 0$, or alternatively $f'(cash) < 0$ and $f'(cash) < 0$ satisfy both second order conditions for minimizing, if $f''(cash) = f''(BC) = 0$.

Because *PrD* and *LGD* in *t* are calculated with past information, the first order conditions for the optimization problem are given by:

9 $$i_t^O + f'(cash)\, cash_t = \frac{PrD}{1 - PrD},$$

10 $$i_t^O - i_t^{CB} + f'(BC)\, BC_t^{abs} = \frac{PrD}{1 - PrD}.$$

Equality Equation 9 shows that for $f'(cash) > 0$, a higher (relative) probability of systemic default implies observing a greater demand for cash and, consequently, higher interbank interest rates. In this case, because banks turn to the interbank market in an attempt to satisfy their demand for cash, interbank lenders would also be positively related to the probability of default.[4] Likewise, condition 10 shows that a higher probability of default implies a greater demand for the instrument, if $f'(BC) < 0$. In this case, greater demand for the instrument would lead to a reduction in the central bank's interest rate. Higher demand for cash, as well as for absorption instruments, could only materialize at the aggregate level if new funds enter the system, i.e., if $FBM > 0$, just as shown by the restriction of the optimization problem. Otherwise, an increase in the probability of default is only associated with upward movements in the interbank interest rate.

[4] Given the constant probability of default, the relation between aggregate cash and the interbank rate is negative, i.e., an increase in the interbank rate reduces the demand for cash.

3. APPLICATION TO VENEZUELA

3.1 Estimating Probability of Default

The application we perform for Venezuela uses weekly data from between January 2004 and December 2014. This selection was made in order to deal with a homogeneous period with regards to the exchange rate regime because Venezuela implemented exchange controls in 2003.[5]

In Venezuela's case, due to the institutional arrangement of public policies, monetary base creation and destruction flows are substantially conditioned by fiscal and exchange rate actions related to oil revenues. That is to say, the public sector (tax authorities and the oil industry) is responsible for the amount of money entering circulation in the economy. On the one hand, the oil industry converts a significant share of oil revenues into domestic currency by selling most of its foreign currency to the central bank. On the other, the tax authority, through domestic spending financed with resources from the oil business, channels the money back into the economy as transfers or in exchange for goods and services. The central bank, by becoming the main holder of foreign currency, reduces the amount of money circulating in the economy each time it agrees with private banks the sale of oil revenues.[6] These public-sector actions have their monetary counterparty

[5] At the start of 2003 the National Executive and the Banco Central de Venezuela adopted currency control measures where commercial bank transactions are channeled at a pre-established exchange rate regime and capital transactions can be financed at a parallel or unofficial exchange rate. In general terms, the implementation of currency controls can be understood as the appearance of dual foreign exchange markets, where the unofficial price of the currency represents a significant premium as compared to the official price.

[6] Foreign currency sales are generally not accompanied by sterilization operations. During foreign exchange controls, sales of currency are decided by the government.

in two variables (or monetary impacts): IF, which is the creation of money through the tax authority and oil industry, and IC, which refers to demonetization through the central bank's sale of currency. Whereas IF represents flows that increase residual liabilities, IC constitutes payments (senior obligation) banks must make to the central bank in domestic currency.

With respect to stocks of central bank instruments, for the period considered (2004-2014), absorption operations were only carried out through the central banks' own instruments. Thus, residual liabilities related to the central bank only include the balance of certificates of deposit (CD). Expected cash withdrawals from the system are estimated by using net cheque clearing among banks.

Table 3 presents a summary of the items used for calculating probability of default.

Table 3

COMPONENTS OF SHORT-TERM LIABILITIES FOR THE CASE OF VENEZUELA

Total liquid assets	*Total liquid liabilities*
Unobservable	Senior obligations Weekly currency sales (IC) Weekly variation in reserve requirements Interest on interbank operations from the previous week Weekly net cheque clearing Residual liabilities Previous week's balance of central bank certificates of deposit + weekly interest Weekly creation of fiscal money (IF) The balance of cash reserves from the previous week (adjusted by interbank operations)

The volatility of residual liabilities (σ_E) is calculated for the weekly growth of (log) E, which has a standard deviation equal to 2.5%. The average value of the risk-free rate (μ_A) is assumed to be equal to 0.3%, which corresponds to the weekly growth of (log) IF. This rate is calculated based on the annualized rate of growth of (log) IF, which is 14%. We use this risk-free rate because interest rates in Venezuela are controlled, while the central bank's policy rate is also fixed most of the time. Meanwhile, the average rate of growth of IF represents the rate at which primary money is created. For Venezuela this also represents the rate at which banks receive new deposits. Hence, this rate can be interpreted as a constant growth, representing commercial bank assets.

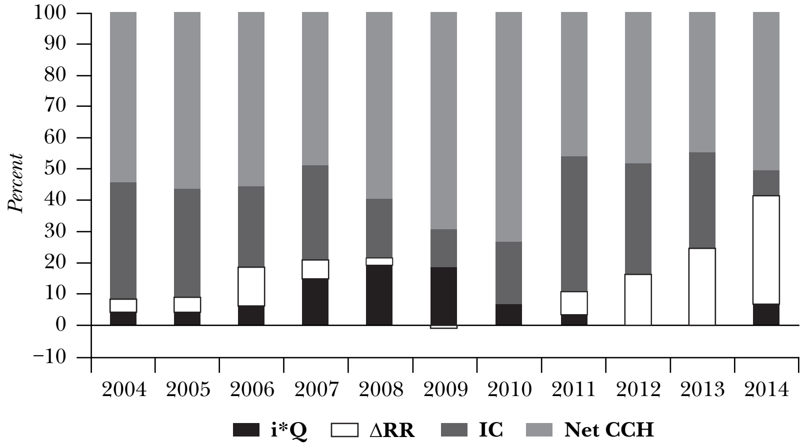
The time horizon used to calculate default probability is generally considered fixed and equal to $T = 1$, which in our case will be interpreted as one week. Default probability is calculated weekly. Balance values refer to those observed at the end of the preceding week. Flows are also measured on a weekly basis. We assume that expected flows are equal to those observed.

Figure 1 presents the composition of senior claims *(D)*. In senior debt, net cheque clearing and currency sales are the components mostly explaining its performance. As of 2012, the participation of reserve requirements in senior debt begins to grow in response to increases in the cash reserve ratio.

Figure 2 shows the composition of junior debt or residual liabilities *(E)*. Between 2004 and 2009, its performance follows the behavior of central bank certificates of deposit. During those years, absorption operations were important because of the implementation of foreign exchange controls in 2003 limited currency transactions and allowed liquidity in the economy to increase through higher government expenditure (increase in IF). This liquidity was channeled by banks towards central bank instruments. After 2009, the weight of CDs drops sharply due to restrictions (ceilings on the amounts) imposed on financial institutions' holdings of CDs. As of 2010, the behavior of junior

Figure 1

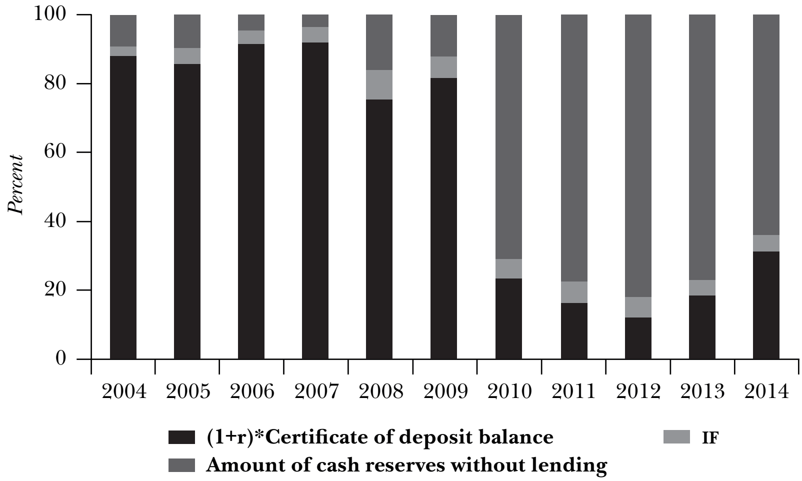
COMPOSITION OF SENIOR DEBT (*E*)[1]



[1] Each component is expressed as a percentage of the average total (in millions of bolivars) of each year.

Figure 2

COMPOSITION OF JUNIOR DEBT (*E*)[1]



[1] Each component is expressed as a percentage of the average total (in millions of bolivars) of each year.

debt mainly depends on the cash balances held by banks (in vaults or in excess reserves at the central bank).

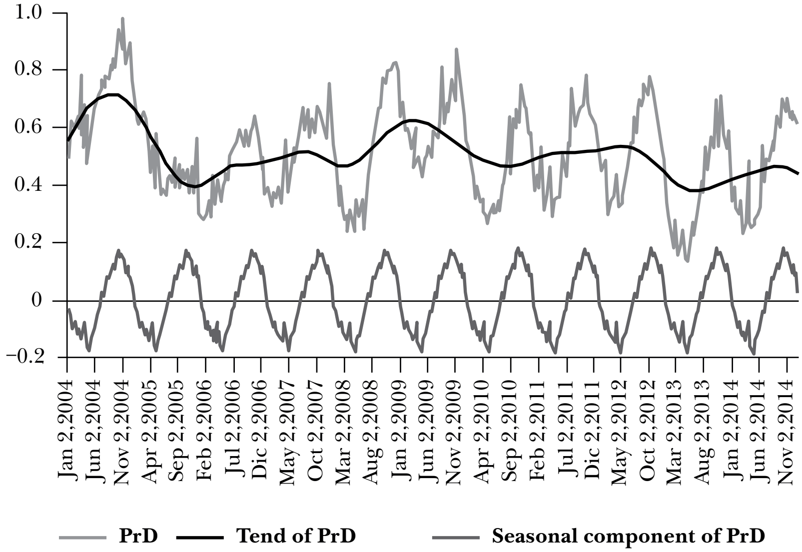
Figure 3 depicts the probability of default calculated, as well a breakdown of its holdings and seasonal component.

The path of default probability allows for identifying the periods in which structural changes take place in senior and junior debt. According to Figure 3, the periods of highest liquidity are 2004-2005 and 2008-2009. In 2004, economic activity and central bank currency sales began to grow substantially after having undergone a sharp contraction during the first year of currency controls (2003). Such increases in both variables generated significant growth in senior debt due to greater cash withdrawals (net cheque clearing), as well as higher exchange rate incidence (IC). Nevertheless, this increased demonetization in 2004, associated to foreign currency sales, was not offset until 2005, when higher fiscal expenditure began to materialize. In fact, during 2006 and 2007, the significant growth of fiscal impacts allowed high levels of liquidity that were reflected in a substantial growth of CDs (and residual liabilities) and a reduction in default probability. During 2008-2009, senior debt levels started to increase again, partly in response to interest rates and larger amounts negotiated in the interbank market. Although in this case a reduction in net money creation was not produced, the increase in the probability of default appears to be related to redistribution processes within the interbank market itself. After 2012, growth in junior debt, generated by greater money creation and cash accumulation by commercial banks, produce lower levels of default probability in the sample.

The seasonal component has a significant weight in the probability of default and represents approximately ±0.15 additional percentage points to the trend. Said component exhibits the following behavior: It tends to peak around October and then decreases gradually to minimum values in April the following year. This seasonality is associated to the seasonal behavior exhibited by net cheque clearing, which in turn reflects the

Figure 3

PROBABILITY OF WEEKLY DEFAULT FOR THE VENEZUELAN CASE



seasonal pattern of economic transactions. That is to say, the economy's cash requirements grow during the third quarter of the year, and decline substantially during the first, in parallel with economic activity. These cash requirements translate into an increase in default probability by raising the amount of senior debt.

3.2 Relation with the Interbank Market

According to the stylized model in Section 2.2, the banking system adjusts its holdings in cash and central bank instruments in order to minimize costs arising from situations defined by the probability of default. Our estimation of said probability contains all the data collected at the start of each period.

Assuming that the demand for funds in the interbank market is positively related to the demand for cash, it is possible to make two predictions. First, that interbank interest rates should be positively related to the probability (relative) of default. Second, that amounts negotiated in the market should also be positively associated with a growing probability of default. In this section, we attempt to verify these two predictions empirically by estimating models for average weekly interbank rates and amounts negotiated as functions of default probability. We then test whether these models improve the predictions as compared to the reference autoregressive models.

We begin by presenting diagrams of the dispersion between interbank variables and default probability estimated by the model (Figures 4 and 5)

Figure 4 depicts a positive relation between the overnight market interest rate and the probability of default. This might reflect that higher interest rates include greater risk premiums associated to the behavior of system liquidity.

Meanwhile, Figure 5 shows a positive relation between amounts traded in the overnight market and the probability of default. A higher probability of default might be associated with a greater need for available liquid funds by commercial banks and, therefore, increase the amounts traded in the interbank market.

Can the probability of default improve forecasting in models for interest rates and real amounts negotiated in the interbank market? To answer this question, we compare three alternative models for the variables: the weekly amount traded (Q^O) and average agreed rates (i^O).

First is the reference model that explains the overnight market variables only considering an autoregressive process in the mean. The second model includes the probability of default for modeling the mean and a GARCH (1,1) model for a variance.[7] The

[7] Generalized autoregressive conditional heteroscedasticity (GARCH) models are used because we are working with high frequency financial series in which volatility is an inherent characteristic and

Figure 4

CONTEMPORARY RELATION BETWEEN THE PROBABILITY OF DEFAULT (AXIS X) AND THE INTEREST RATE OF OVERNIGHT (Y AXIS)

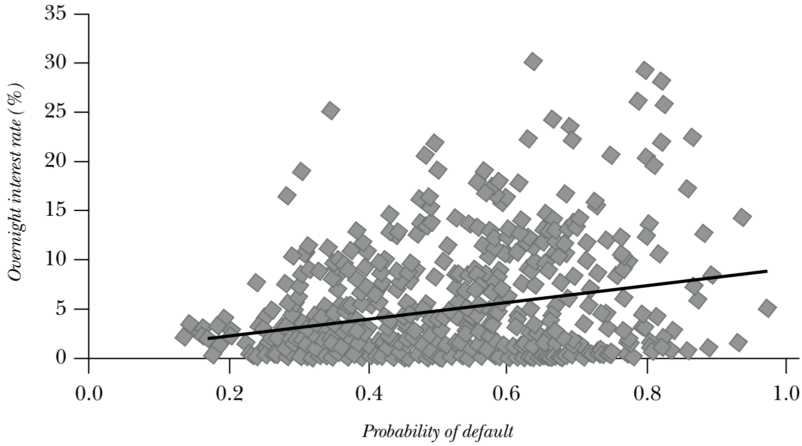
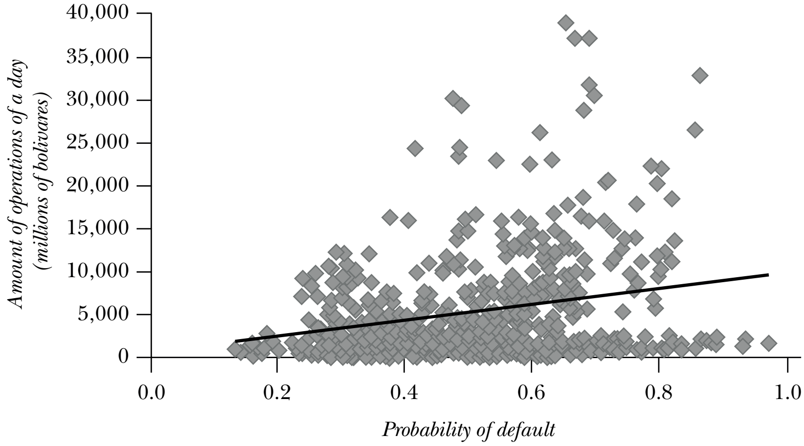


Figure 5

CONTEMPORARY RELATION BETWEEN THE PROBABILITY OF DEFAULT (AXIS X) AND THE AMOUNT AGREED ON ONE-DAY OPERATIONS (Y AXIS)



third model expands the second one by including the probability of default as an explanatory variable for a variance. In the case of interest rates those models are:

Model 1. Autoregressive in the mean (reference)

11 $$i_t = 0.01 + 0.63 i_{t-1} - 0.11 i_{t-2} + 0.13 i_{t-3} + 0.20 i_{t-4} + \varepsilon_{t.}$$

Model 2. With explanatory variables in the mean and GARCH for variance

12 $$i_t = 0.004 + 0.57 i_{t-1} - 0.05 i_{t-2} + 0.08 i_{t-3}$$

$$+ 0.25 i_{t-4} + 0.01 PrD_t + \varepsilon_t,$$

where $\varepsilon_t \sim D(0, h_t)$ with variance

$$h_t = -2.6 \times 10^{-5} + 0.07 \varepsilon_{t-1}^2 + 0.90 h_{t-1}.$$

Model 3. With explanatory variables in the mean and in the GARCH:

13 $$i_t = 0.005 + 0.56 i_{t-1} - 0.04 i_{t-2} + 0.061 i_{t-3}$$

$$+ 0.26 i_{t-4} + 0.01 PrD_t + \varepsilon_t,$$

where $\varepsilon_t \sim D(0, h_t)$ with variance

---

cannot be considered homoscedastic. For further information see Engle (1982) and Bollerslev (1986).

$$h_t = -2.2\times10^{-5} + 0.07\varepsilon_{t-1}^2 + 0.90h_{t-1} + 1\times10^{-4}PrD_t.$$

Models for amount traded only show two possible variations given that the probability of default was only significant for modeling the mean. The regressions estimated are:

Model 1. Autoregressive in the mean (reference)

14 $$Q_t = 46.51 + 0.65Q_{t-1} - 0.01Q_{t-2} + 0.09Q_{t-3} + 0.18Q_{t-4} + \varepsilon_t.$$

Model 2. With explanatory variables in the mean and GARCH for variance:

15 $$Q_t = 4.68 + 0.54Q_{t-1} + 0.05Q_{t-2} + 0.14Q_{t-3}$$

$$+0.18Q_{t-4} + 41.82PrD_t + \varepsilon_t,$$

where $\varepsilon_t \sim D(0,h_t)$ with variance $h_t = 190.3 + 0.1\varepsilon_{t-1}^2 + 0.8h_{t-1}$.

Tables 4 and 5 display mean absolute percentage errors (MAPE) of the different models. The forecasts (dynamic) were performed for the first three months of the subperiods: 2007, 2011 and 2015. The models are estimated using the above information in the prediction period, i.e., 2004-2006, 2004-2010 and 2004-2014, respectively. Moreover, and by way of comparison, we calculate the MAPE using static forecasts for the subsample 2005-2009.

A comparison of the equations' forecasts for the amount traded and agreed interest rate in the overnight market reveals successive improvements in the MAPE with respect to the reference forecast in the equation for the amount as well as that for the interest rate, especially when the default probability is included for modeling the mean.

To corroborate the above results, we apply the Diebold and Mariano (1995) test, which analyzes whether the difference

Table 4

EQUATION FOR OVERNIGHT RATES

Comparison of forecasts using the

MAPE ***adjustment indicator to forecast:***

	First three months (January to March) of years			*Subsample*
Cases	*2007*	*2011*	*2015*	*2005-2009*
Model 1	52.62025	12.46301	654.2557	121.1801
Model 2	48.06451	11.05222	108.8856	111.3088
Model 3	43.03569	11.04099	108.5249	111.2405

Table 5

EQUATION FOR THE OVERNIGHT AMOUNT IN MILLION 1997 BOLIVARS

Comparison of forecasts using the

MAPE ***adjustment indicator to forecast:***

	First three months (January to March) of years			*Subsample*
Cases	*2007*	*2011*	*2015*	*2005-2009*
Model 1	21.62721	61.04253	1757.320	32.10837
Model 2	20.40863	35.07300	1228.376	29.59481

between the loss functions (sum of absolute values) of the errors between two models is significantly different from zero. Details of this test can be found in Annex B.

Tables 6, 7 and 8 show the constant of the Diebold-Mariano test and corresponding p values. The comparison is performed in pairs.

When comparing Models 2 and 3 with Model 1 we find evidence to reject the null hypothesis of equal forecast accuracy between the models. In both cases, the value estimated for the constant is negative, i.e., forecast errors of Model 1 (autoregressive) are significantly larger than those of Models 2

Table 6

DIEBOLD-MARIANO TEST AND ASSOCIATED *P* VALUES

Model 2 against Model 1 for rates

H_0	*2007*	*2011*	*2015*	*2004-2009*
$\lvert e_{Model\ 2t}\rvert - \lvert e_{Model\ 1t}\rvert = 0$	-1×10^{-4} (0.11)	−0.003 (0.00)	−0.015 (0.00)	−0.002 (0.003)
$(e_{Model\ 2t})^2 - (e_{Model\ 1t})^2 = 0$	-2×10^{-5} (0.09)	-1×10^{-4} (0.00)	-1.25×10^{-4} (0.03)	-9.62×10^{-5} (0.01)

Table 7

DIEBOLD-MARIANO TEST AND ASSOCIATED *P* VALUES

Model 3 against Model 1 for rates

H_0	*2007*	*2011*	*2015*	*2004-2009*
$\lvert e_{Model\ 3t}\rvert - \lvert e_{Model\ 1t}\rvert = 0$	−0.001 (0.11)	-2×10^{-4} (0.00)	−0.015 (0.00)	−0.002 (0.001)
$(e_{Model\ 3t})^2 - (e_{Model\ 1t})^2 = 0$	-5.23×10^{-5} (0.10)	-1.2×10^{-5} (0.08)	-1.26×10^{-4} (0.03)	-1.04×10^{-4} (0.005)

Table 8

DIEBOLD-MARIANO TEST AND ASSOCIATED *P* VALUES

Model 2 against Model 3 for rates

H_0	*2007*	*2011*	*2015*	*2004-2009*
$\lvert e_{Model\ 3t}\rvert - \lvert e_{Model\ 2t}\rvert = 0$	-8.97×10^{-4} (0.2175)	-3×10^{-4} (0.00)	-2.56×10^{-4} (0.0092)	-9.5×10^{-5} (0.09)
$(e_{Model\ 3t})^2 - (e_{Model\ 2t})^2 = 0$	-2.55×10^{-5} (0.2344)	-1.6×10^{-5} (0.00)	−0.002 (0.042)	0.00 (0.00)

Table 9

DIEBOLD-MARIANO TEST AND ASSOCIATED *P* VALUES Model 2 against Model 1 for amounts				
H_0	*2007*	*2011*	*2015*	*2004-2009*
$\left\|e_{Model\ 2t}\right\|-\left\|e_{Model\ 1t}\right\|=0$	−27.75 (0.0008)	−56.55 (0.008)	−56.70 (0.0000)	−4.85 (0.10)
$\left(e_{Model\ 2t}\right)^2-\left(e_{Model\ 1t}\right)^2=0$	−3,380.334 (0.0234)	−17,755.23 (0.0057)	−15,359.61 (0.0000)	−3,003.031 (0.1244)

and 3 (GARCH). These outcomes prove the predictive gains from incorporating default probability into the mean. When we compare loss functions of Models 2 and 3, we find, in all the forecasts except 2007, that the null hypothesis of equal forecast accuracy between them is rejected.

We now perform a similar procedure for comparing the models presented in Table 5 with respect to amounts.

In the amount equation, we also find evidence to reject the null hypothesis of equal forecast accuracy between the GARCH model and the autoregressive one in the forecasts, except for the period 2004-2009.

3.3 Policy Exercises

In this section we perform simulations to calculate the probability of default, focusing on the impacts of monetary base components (IF and IC). To do this we assume that such flows of money creation or destruction not only affect default probability, but also cash holdings in the financial system (equations 20 and 21). We also include autoregressive equations for IF and IC to determine the differing impact of changes in the mean and variance of those variables (Equations 22 and 23). Given that interbank market amounts and rates are affected by the probability of (*PrD*), we also incorporate behavioral equations for said variables (equations 18 and 19). We do not model the behavior of CDs because of the low variability of monetary policy rates throughout the period as a whole. All the behavioral equations are estimated with data from between 2004 and 2007, which corresponds to the period with greatest interbank market depth. The simulation model is represented by equations 17 to 23.

The probability of default is given by:

17 $$PrD = f\left(A\left(E,\sigma_E\right), \sigma_A\left(E,\sigma_E\right), D, T, \mu_A\right).$$

Behavioral equations for overnight market amounts and rates in accordance with risk indicators are:

18 $$Q_t = a_0 + a_1 Q_{t-1} + a_2 DD_t,$$

19 $$i_t = b_0 + b_1 i_t + b_2 PrD_t - b_3 DD_t.$$

Autoregressive equations for variation of excess reserves (ΔRE) and cash in vaults (ΔEB) are:

20 $$\Delta RE_t = c_0 + c_1 \Delta RE_{t-1} + c_2 IF_{t-1} - c_3 IC_t,$$

21 $$\Delta EB_t = d_0 + d_1 \Delta EB_{t-1} + d_2 IF_t - d_3 IC_t,$$

Autoregressive equations for fiscal and exchange rate influence are given by:

22 $$IF_t = e_0 + e_1 IF_{t-1} + \mathcal{E}_{1t},$$

23 $$IC_t = \lambda_0 + \lambda_1 IC_{t-1} + \mathcal{E}_{2t},$$

where $a_j, b_j, c_j, d_j, e_j, \lambda_j > 0$ for all j = 1, 2, 3; y $\mathcal{E}_{1t}$ and $\mathcal{E}_{2t}$ have a normal distribution with mean zero and variance one. The reserve requirement ratio is considered as a multiple of monetary base in the preceding period. Monetary base is considered as the sum of excess and required reserves. Finally, to tie the model into the time horizon, the initial conditions were assumed as those observed at the beginning of 2006. The performed simulations are shown in Annex C.

The outcomes suggest that, on average, increases (reductions) in the unconditional mean and persistence of fiscal events tend to reduce (increase) the probability of default, while increases (reductions) of the ordinate and persistence in the equation for exchange rate effects imply an increase (reduction) in the probability of default. Changes in the variance of fiscal events have a greater impact on the probability of default than changes in the variance of exchange rate events. Finally, if the legal capital requirement ratio increases (decreases), the probability of default tends to rise (fall) by raising (lowering) banks' short-term obligations.

4. FINAL REMARKS

In this paper, we use risk indicators derived from the contingent claims approach (probability and distance to default) to evaluate liquidity risk in the banking system as a whole. These ideas are easy to calculate because they use readily available aggregate banking and monetary policy variables, in general.

The probability of default can be a useful instrument for central banks to improve predictions on the interbank market, as well as potentially contribute to modeling the behavior of some (or all) liquid assets available to commercial banks.

In the case of Venezuela, the behavior of default probability would seem to depend, among other factors, on the monetary impacts of fiscal and exchange rate actions. One interpretation that emerges from the counterfactual exercises performed on the properties of such policies is that the vulnerability of Venezuela's interbank market could increase substantially in the face of greater dynamism in currency sales and conservative fiscal expenditure trends. This outcome is consistent with another paper on the Venezuelan financial system: Carvallo and Pagliacci (2016). According to the latter, combinations of said policies that generate restrictive monetary conditions will tend to increase bank instability. In general terms, both outcomes point towards the necessity for performing a review of the framework of regulations that enhance the significant monetary effects of these policy actions.

ANNEXES

Annex A. Contingent Claims Approach

The contingent claims approach is a methodology that generalizes the Black-Scholes (1973) and Merton (1974) option pricing theory, combining market-based data and balance sheet information to obtain financial risk indicators such as distance to default and default probability.[8]

The conceptual framework can be represented mathematically as follows. Assets $A_t \in \mathbb{R}_+$, are assumed to follow a geometric Brownian motion with volatility, σ_A. Senior debt is $D_t \in \mathbb{R}_+$. Hence, the process governing the behavior of asset prices is assumed given by:

$$dA_t = A_t\left(\mu_A dt + \sigma_A dW_t\right). \tag{A.1}$$

Equivalently,

[8] Other financial risk indicators obtained using this methodology are: risk-neutral credit risk premia and expected losses on senior debt. For further information see Saldías (2012) and Gray et al. (2006)

A.2 $$A_t = A_o \exp\left(\left(\mu_A - \frac{\sigma_A^2}{2}\right)t + \sigma_A \varepsilon \sqrt{t}\right),$$

where $\varepsilon \sim \mathcal{N}(0, \Delta t)$; and μ_A is the expected average return on the assets. With the risk-neutrality hypothesis, μ_A means there can be no arbitrage in the financial derivative during an infinite period. W_t is a standard Brownian motion, i.e.:

A.3 $$W_{t+\Delta t} - W_t \sim \mathcal{N}(0, \Delta t).$$

This assumption considers that assets and senior debt (its derivative) follow a log-normal distribution.

However, D_t being the value of senior debt in t, the probability of default or system vulnerability at time T, conditional on known information in t, is defined as:

A.4 $$\text{Prob}(A_t \le D_t) = \text{Prob}\left(A_o \exp\left(\left(\mu_A - \frac{\sigma_A^2}{2}\right)(T-t) + \sigma_A \varepsilon \sqrt{T-t}\right) \le D_t\right).$$

This probability captures system vulnerability when assets are below the threshold represented by hard or high priority debt.

The two equations used for estimating assets and their volatility are as follows. The first comes from the basic formulation of the expected value of junior debt *(E),* which is obtained using Itō's lemma. This expected value is equal to the price of a European call option on the assets, so that:

A.5 $$E_t = A_t \sim \mathcal{N}(d_1) - D_t e^{-\mu_{A_t}} \mathcal{N}(d_2),$$

where

A.6 $$d_1 = \frac{\ln\left(\frac{A_t}{D_t}\right) + \left(\mu_A + \frac{\sigma_A^2}{2}\right)(T-t)}{\sigma_A \sqrt{T-t}} \text{ and}$$

A.7 $$d_2 = \frac{\ln\left(\frac{A_t}{D_t}\right) + \left(\mu_A - \frac{\sigma_A^2}{2}\right)(T-t)}{\sigma_A \sqrt{T-t}} = d_1 - \sigma_A \sqrt{T-t}.$$

Since, $\mathcal{N}(x)$ is the value of the cumulative standard normal distribution in x and $\mathcal{N}(0, \sigma^2)$ is the univariate normal probability density function with mean μ and variance σ^2.

But, Equation 5 has two unknown variables, A and σ_A; meaning a second equation is necessary. The model of Merton (1974) obtains an equation that links the volatility of junior debt, σ_E, and that of assets using:

A.8 $$\sigma_E = \frac{A_t}{E_t} \frac{\partial E}{\partial A} \sigma_A.$$

As well as,

A.9 $$\frac{\partial E_t}{\partial A_t} = \mathcal{N}(d_1).$$

Hence, the volatility of junior debt can be calculated as:

A.10 $$\sigma_E = \frac{A_t}{E_t} \mathcal{N}(d_1) \sigma_A.$$

Finally, using Equations 5 and 10 we obtain the following system of non-linear equations, formed by two equations and two unknowns.

A.11

$$f=\begin{bmatrix} A_t\mathcal{N}\left(d_1\right)-D_t e^{-\mu_{A_t}}\mathcal{N}\left(d_2\right)-E_t \\ \frac{A_t}{E_t}\mathcal{N}\left(d_1\right)\sigma_A-\sigma_E \end{bmatrix}.$$

Making $f\begin{bmatrix}0\\0\end{bmatrix}$ we can use quadratic optimization or similar techniques to estimate the value of assets and their volatility, $\hat{A}$ and $\hat{\sigma}_A$, respectively. Once these values have been calculated, the number of standard deviations (d_t) of insolvency is precisely, d_2.

A.12

$$d_1=\frac{\ln\left(\frac{A_t}{D_t}\right)+\left(\mu_A+\frac{\sigma_A^2}{2}\right)(T-t)}{\sigma_A\sqrt{T-t}}.$$

That is to say, in a single measure, distance to default combines the difference between the value of assets (A_t) and the distress barrier (D_t), standardizing with asset volatility.

Using Equations 4 and 7, we obtain that the probability of default or system vulnerability is, therefore, the standard normal cumulative distribution of negative distance to default:

A.13

$$pd_t=\mathcal{N}\left(-d_t\right).$$

That is, the one that intermediates between distance-to-default and probability of default is the normal distribution.

Annex B. Diebold and Mariano Test (1995) Methodology

We consider two forecasts, $\{y_{1t}\}_{t=1}^{T}$ and $\{y_{2t}\}_{t=1}^{T}$, of the series $\{y_t\}_{t=1}^{T}$ with T as a positive integer and define the prediction error as:

B.1 $$e_{it} = \hat{y}_{1t} - y_t, \quad i = 1, 2.$$

The loss associated with the forecast of model i will be a function of the forecast errors, e_{it}, and be denoted by $g(\cdot)$, which is typically considered as the absolute value function or quadratic function. Meanwhile, the function of the loss differential between two forecasts is given by,

B.2 $$d_t = g(e_{1t}) - g(e_{2t}).$$

According to the abovementioned, we can have

B.3 $$d_t = |e_{1t}| - |e_{2t}|,$$

B.4 $$d_t = (e_{1t})^2 - (e_{2t})^2.$$

Moreover we say that both forecasts have the same predictive ability if and only if the loss differential is expected to be 0 for all t. The null hypothesis is, therefore:

B.5 $$H_0 = E(d_t) = 0 \ \forall \ t.$$

Versus the alternative hypothesis:

B.6 $$H_a = E(d_t) \neq 0.$$

Annex C. Figures

Figure C.1

SCENARIOS OBTAINED BY MODIFYING THE UNCONDITIONAL AVERAGE IN TAX INCIDENCES

Probability of default

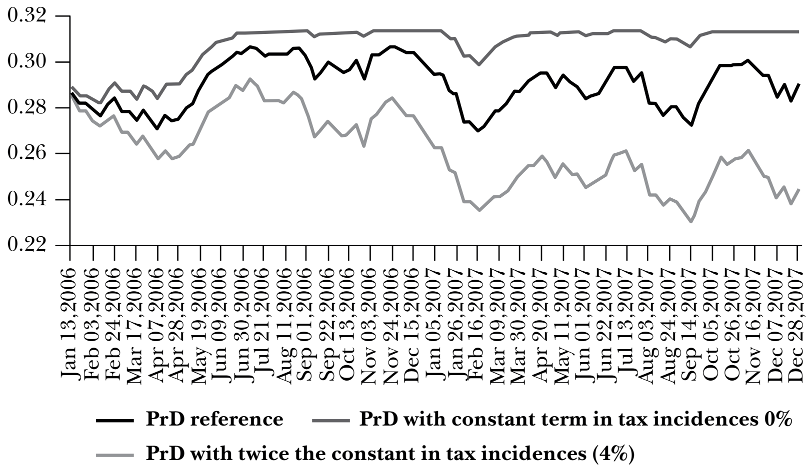


Figure C.2

SCENARIOS OBTAINED BY MODIFYING THE UNCONDITIONAL AVERAGE IN THE EXCHANGE RATE INCIDENCES

Probability of default

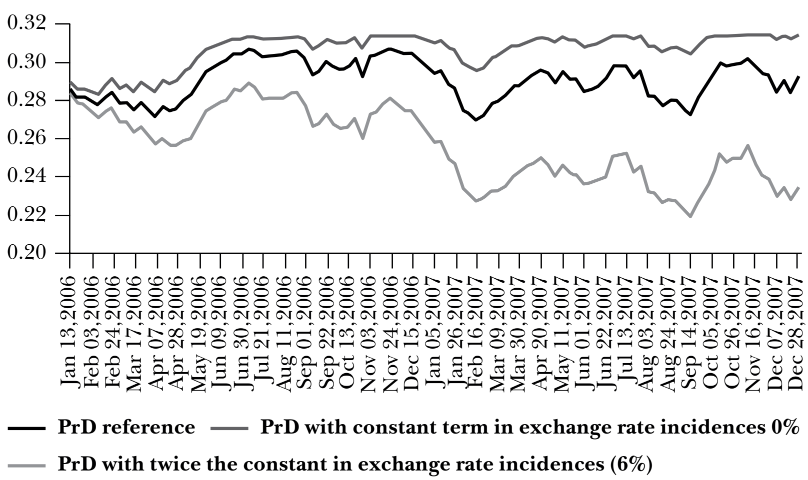
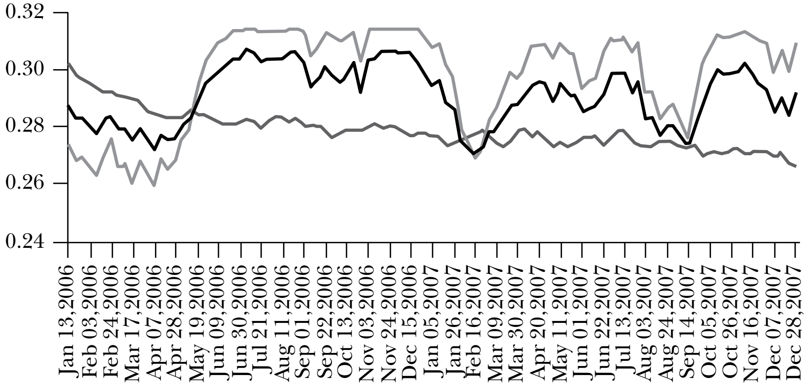


Figure C.3

SCENARIOS OBTAINED BY MODIFYING THE VARIANCE IN THE RESIDUALS OF THE TAX INCIDENCES EQUATION

Probability of default

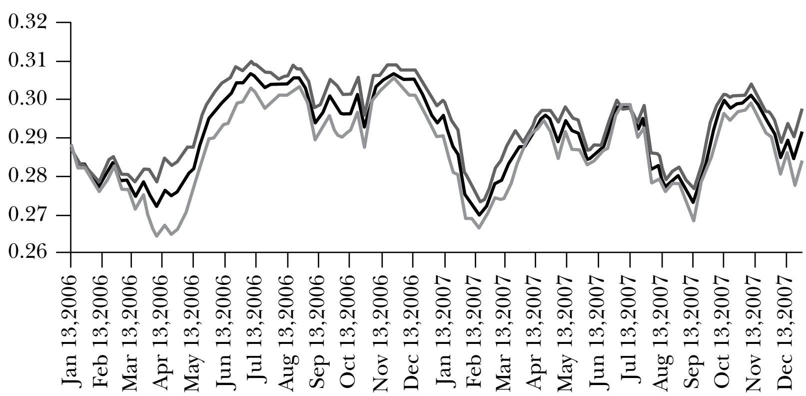


PrD reference: standard deviation of the residuals of tax incidences = 7%
PrD: std of the residuals of tax incidences = 0%
PrD: std of the residuals of tax incidences = 14%

Figure C.4

SCENARIOS OBTAINED BY MODIFYING THE VARIANCE IN THE RESIDUALS OF THE EQUATION OF THE EXCHANGE RATE INCIDENTS

Probability of default



PrD reference: std of the residuals of exchange rate incidences = 2%
PrD: standard deviation of the residuals of exchange rate incidences = 0%
PrD: standard deviation of the residuals of exchange rate incidences = 4%

Figure C.5

SCENARIOS OBTAINED BY MODIFYING THE PERSISTENCE IN THE TAX INCIDENCES EQUATION

Probability of default (PrD)

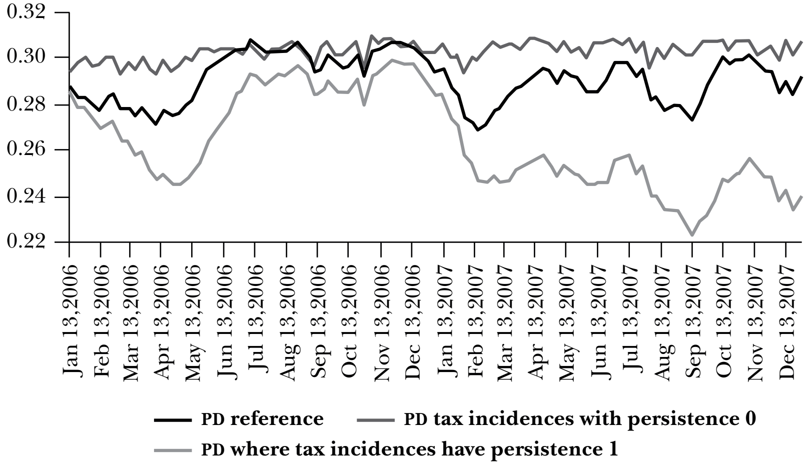


Figure C.6

SCENARIOS OBTAINED BY MODIFYING THE PERSISTENCE IN THE EQUATION OF EXCHANGE RATE INCIDENTS

Probability of default (PrD)

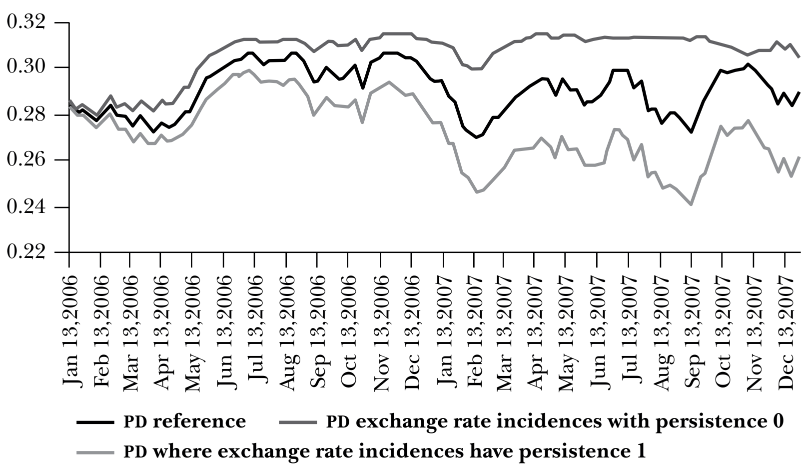
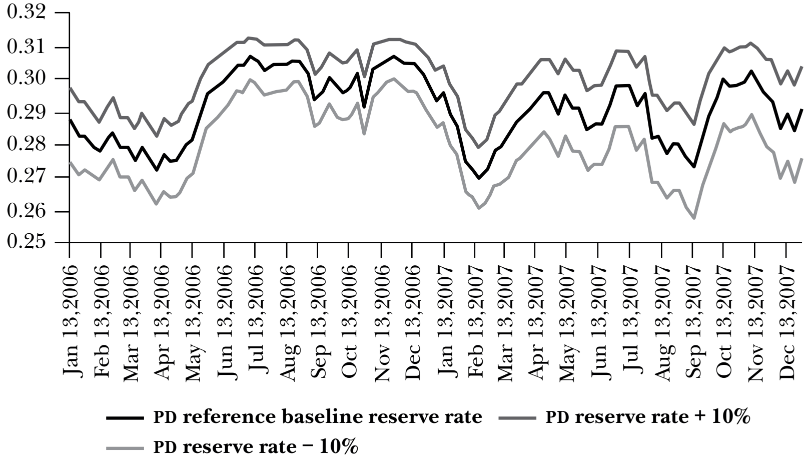


Figure C.7

SCENARIOS OBTAINED BY MODIFYING THE RESERVE RATE

Probability of default (PrD)



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How Disruptive are Fintechs?

Mario Bergara
Jorge Ponce

Abstract

Will the application of technological innovation to finance disrupt financial intermediation? Which are the foreseeable effects on financial markets efficiency, competition, organization of transactions and risks? Which are the challenges and opportunities facing prudential regulation and supervision? Based on the literature on Microeconomics of Banking, Industrial Organization and Transaction Cost Economics we discuss some potential impacts of the proliferation of fintechs.

Keywords: fintech, financial intermediation, efficiency and competition in financial markets, contractual risk, market-based and intermediary-based financial transactions, prudential regulation, supervision.

JEL classification: G10, G20, L10.

1. INTRODUCTION

The emergence of innovative technological platforms is challenging financial intermediation and financial markets practices through various modes and channels, as well as regulatory scopes and instruments not only in banking but also in other intermediaries. The Financial Stability Board defines fintech as a "technologically enabled financial innovation that could result in new business models, applications,

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processes, or products with an associated material effect on financial markets and institutions and the provision of financial services."

Fintech developments can be seen as disruptive innovations, particularly those which have the following sources: automated financial services that transform market liquidity and private markets that create alternatives for traditional financing and trading (for example: dark pools, trading platforms, crowdfunding websites, electronic networks, and so on). According to the World FinTech Report 2017 (Capgemini et al., 2017), the rise of fintech has been aided by a perfect storm, created by increasing customer expectations, expanding venture capital funding, reduced barriers to entry, and increased pace of technological evolution.

In order to analyze the potential impact of the fintech on banking, financial markets, and regulation, it is convenient to get back to conceptual fundamentals about the rationale for the existence of financial intermediaries, the reasons behind their coexistence with financial markets, and the justification of financial regulation and oversight. On those grounds, the microeconomics of banking literature may shed relevant light. Additionally, traditional industrial organization models may serve to foresee possible implications on the structure and efficiency of financial markets and intermediaries. Moreover, the transaction cost economics framework may be fruitful to contribute in the understanding of the process and the possible evolution of the governance structure of financial transactions. Issues such as asymmetric information and contractual risks, as well as the ability of adaptation by incumbent financial intermediaries, become crucial in the analysis.

Will the application of technological innovation to finance disrupt financial intermediation? Only time will tell. At this stage, however, one can stress that we are assisting to some kind of revolution in technological developments that may be applied to finance; mostly due to the speed of technical change and communication that are common to a more general digital revolution. No doubt financial systems, intermediaries like banks and insurances companies in particular, but also security markets, would need to evolve more or less quickly in response to the challenges imposed by technical advance, as well as to profit from the opportunities for it generated. But, so far it is not obvious that some of the fundamental rationales behind the existence of financial intermediaries will be disrupted by the kind of fintech developments we are seeing.

Relative to traditional financial intermediaries, fintech platforms' heavy digitalization of processes and specialized focus may lower transaction costs and entail convenience for end users. It may also increase access to credit and investments for underserved segments of the population or the business sector, particularly in less developed countries, where traditional financial intermediation (for example: banking and insurance services) keep uncovered an ample range of potential customers. Other things equal, a continuous reduction in transaction costs may impose increasing competitive pressure on traditional financial intermediaries. Moreover, competitive pressure would increase dramatically if fintech companies manage to growth and develop new varieties of financial products which are closer to consumers' needs. And it would be particularly the case if these companies start doing financial activities which are at the core of financial intermediation. However, incumbent financial intermediaries would react to the challenges introduced by fintech, since technological innovation also embodies opportunities on transaction costs reduction, which may be profited by traditional financial intermediaries. Yet, other possible outcome on the changing market structure is that traditional financial intermediaries vertically integrate fintech startups. Indeed, incumbent financial intermediaries have good incentives in so doing, as well as information about customers and deep pockets.

Taking into consideration the effects on reducing information asymmetries in some cases and informational costs and entry barriers in others, we analyze the declining benefits for conducting financial transactions with an intermediate level of contractual risk through traditional financial intermediaries and the increasing role of innovative financial arrangements which are closer to markets. Nevertheless, that does not necessarily imply that traditional intermediation (for example: banks, insurance or security markets) will reduce their participation in the financial arena, given their systematic ability to adapt to changing circumstances, particularly when driven by technological change. We also argue that those impacts will not be homogeneous among all kinds of financial activities, since the remaining contractual risk of some of them would be higher than others due to, for instance, the different needs for solving asymmetric information problems and monitoring different types of projects.

An additional relevant issue is related to financial regulation and supervision. Fintech poses several challenges to regulation and supervision of financial systems. But it may also represent opportunities for gaining efficiency on these activities. Among the main reasons why regulation and supervision in this new framework is particularly challenging are the high speed at which fintech developments occur and its experimental nature. A significantly large share of fintech activity in the financial system could present a mix of financial stability benefits and risks in the future. Hence, fintech regulation should adopt different forms in order to balance the potential tradeoffs between innovation, new products, new ways to deliver existing products, efficiency gains and financial inclusion in the one hand and, in the other hand, the market failures, externalities and systemic risk that justifies prudential regulation and supervision. The emergence of fintech challenges the scope and ability of regulatory frameworks and each new development has to be assessed from a regulatory standpoint; that is, understanding the object to protect, whether or not they constitute financial intermediation, and how they potentially affect systemic risk.

The rest of the paper is organized as follows. Section 2 presents a broad description of the most important fintech developments. In Section 3 we revise banking literature which is useful to assess whether fintech would or not disrupt financial intermediation. Section 4 analyses the potential impacts on the financial markets' efficiency and competition from an industrial organization perspective. Section 5 considers the financial transaction and its remaining contractual risk as the unit of analysis in order to foresee the fintech's effects from a transaction cost economics perspective. In Section 6, we discuss the challenges and opportunities in terms of risk management, financial regulation and supervision. Some concluding remarks are in Section 7.

2. FINTECH: WHAT ARE WE TALKING ABOUT?

Technologically enabled financial innovations (fintechs) are capturing large attention among practitioners, regulators and academics due to their material effect on financial markets and institutions. For centuries, technological progress has been an important force in the transformation and development of finance. For almost one thousand years technological innovation like bank deposits, double-entry book keeping, central banks and securitization have made finance to evolve. Nowadays, an apparent difference with previous processes is speed. Technological innovation has accelerated dramatically with the rapid advances in digital and communication technologies. As a result, the financial services landscape is transforming rapidly, which creates opportunities and challenges for consumers, service providers and regulators alike.[1]

[1] Total global investment in fintech companies reportedly increased from 9 billion dollars in 2010 to over 25 billion dollars in 2016 according to He et al. (2017). The phenomena is not only present in well stablished financial centers, like London, New York, and Singapore, but it is global. For example, a recent

Fintech activity varies significantly across and within countries do to heterogeneity in the business models of fintech platforms. Although fintech credit markets have expanded at a fast pace over recent years, they currently remain small in size relative to credit extended by traditional intermediaries. However, it may have much larger shares in specific market segments. For example, in the United Kingdom, fintech credit was estimated at 14% of equivalent gross bank lending flows to small businesses in 2015, but only 1.4% of the outstanding stock of bank credit to consumers and small and medium enterprises as of end-2016 (Zhang et al., 2016).

Recent years have witnessed a rise in automation, specialization, and decentralization, while financial firms have found increasingly efficient and sophisticated ways of leveraging vast quantities of consumer and firm data. Overall, the financial services sector is poised for change. However, it is hard to figure out whether the change will be disruptive, revolutionary or evolutionary. The final outcome would depend on the relative power of technological innovations not only to reduce transaction costs and improve efficiency in financial services, but also to challenge the fundamental rationales behind financial intermediation, risk management, and regulation.

At the individual service provider's level, the outcome would also depend on how companies incorporate technology as a way to enhance their business and keep flexible. The case of Kodak in the photography industry may help to illustrate this point. Kodak was a company founded in 1888 and considered a synonymous with taking pictures. In 1996 it was ranked the fourth most valuable brand in the United States, behind Disney, Coca-Cola and McDonald's. In 2012, Kodak filed for bankruptcy. So, what happened? Paradoxically, what happens was that they had invented the digital camera in 1975. Kodak focused on the product, that is film, instead of on the value customers got

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survey by the Inter-American Development Bank (2017) identifies 703 fintech startups in Latin America and the Caribbean.

from that product. When a new technology, the digital camera, replaced film, Kodak was so focused on film that they failed to recognize the value of digital until they had no other choice.

The last decades have witnessed the development of a broad range of technological innovations with potential applications to finance:

- *Artificial intelligence and big data* refers to the creation and maintenance of huge databases containing the characteristics and transactions of billions of economic agents, and their use through advanced algorithms to derive patterns. In turn, these patterns may be used to predict behavior and prices, to target offers, and to mimic human judgment in automated decisions. Applications to finance would include a series of new, more efficient processes for credit allocation and risk management (for example: automated investment advice and credit decisions), algorithm-based asset trading, as well as facilitate regulatory compliance and fraud detection.
- *Distributed ledger technology*, also known as *blockchain,* allows that ledgers, like records of transactions or ownership of assets and liabilities, be maintained, validated and updated securely by network's users themselves rather than by a central repository. All changes are encrypted in such a way that they cannot be altered or deleted without leaving a record of the data's earlier state. Although the blockchain originally sought a foothold in financial services, and digital currencies attracted early attention from investors, now interest in using the technology in the public sector is growing. Potential uses of this kind of technology largely exceed financial systems and include, for example, personal data recording and digital government. At the present, Estonia is the only country in the world in which its residents carry a public key infrastructure card, which grants access to over 1,000 electronic government services, ranging from public notary services to electronic patient records. But other countries are also starting blockchain programs; some

examples are Dubai, Georgia, Honduras, Sweden, and Ukraine. The distributed characteristic of this technology makes it inherently resilient to cyberattacks because all the copies of the database would need to be simultaneously hacked for the attack to be successful. Overall, distributed ledger technology provides a framework to reduce fraud, operational risk, and cost of paper-intensive processes at the same time of enhancing transparency and trust. Related applications to finance could drastically reduce the cost of back-office and recording activities. Its use may also transform payment and securities settlement, and allow direct business-to-business transactions competing with traditional intermediaries. One well known application of this technology are digital-, crypto- or virtual-currencies, as for example the bitcoin.

- *Cryptography and smart contracts*, together with biometrics, have the potential to create more robust security systems. Smart contracts set a collection of promises in digital form to be executed following certain procedures once some conditions are met; for example, to buy an asset at a certain price. Working together, these technologies may allow the automatic realization of transactions at the same time that security and identity protection are preserved.
- *Internet access and platforms* have spread the gains in transactions cost reduction due to new communications technologies could provide access to a full range of financial services to billions of people through their mobile phones and computers. This massive decentralization is opening the door to direct person-to-person transactions (des-intermediation), and to the direct funding of firms, as *crowdfunding*. The use of these technologies may also have deep implications for financial inclusion of excluded-from-traditional-intermediaries consumers, especially in less developed countries.[2]

[2] Most of the fintech developments in Latin America and the Caribbean fall into this category of financial innovation. In

Fintech innovations are traditionally overlapping and mutually-reinforcing. For instance, distributed ledger technology relies on big data and smart contracts for effective validation and distribution of ledgers, which in turn are used by online applications, as digital wallets through smart phones, to settle payments in points of sale. This kind of complementarities, which are common to finance and communications technologies, imply network effects that, in turn, may determine a non-linear growth of new applications.

3. FINANCIAL INTERMEDIATION: DISRUPTION, REVOLUTION OR EVOLUTION?

Will the application of technological innovation to finance disrupt financial intermediation? No doubt financial systems would need to evolve more or less quickly but at the current stage it is not obvious that some of the fundamental rationales behind the existence of financial intermediaries will be disrupted by the kind of fintech developments we are seeing.

As is true with any other institution, the existence of financial intermediaries is justified by the role they play in the process of resource allocation, capital allocation in particular. Financial intermediaries specialize in the activities of buying and selling (at the same time) financial contracts and securities. A first justification to the existence of financial intermediaries is the presence of frictions, as for example the transactions costs, in transactions technologies. If we think of financial intermediaries as other retailers (perhaps brokers and dealers operating on financial markets are the closer example), then fintech applications will challenge this rationale by drastically reducing transaction costs. The closer comparison to figure out the potential impact on this kind of intermediation is with internet retailers and e-commerce. It is conceivable that the

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particular, this is the particular case of Uruguay, where recently created fintech firms offer platforms for person-to-person lending and to online payment services.

full range of services currently offered by brokers and dealers could be at least partly supplanted by new technologies. It is also possible that new entrants increase competition in certain segments and even replace some of the incumbents.

However, the activities of other financial intermediaries are in general more complex. First, banks and insurance companies, for example, usually deal with financial contracts that cannot be easily resold as could be loans and deposits. Hence, these intermediaries must hold these contracts in their balance sheets until the contract expires. However, recent uses of securitization and structured products lead to an *originate and distribute* business model through which illiquid assets may be put off-balance sheet of financial intermediaries. Second, the characteristics of the contracts issued by borrowers are generally different from those of the contracts desired by depositors. Hence, financial intermediaries differ from common retailers because they also perform the transformation of financial contracts with regard to their denomination, quality and maturity.

According to Freixas and Rochet (2008), the simplest way to justify the existence of financial intermediaries is to emphasize the difference between their inputs and their outputs, and view their main activity as transformation of financial securities. Financial intermediaries can therefore be seen as coalitions of economic agents who exploit economies of scale or economies of scope in the transaction technology. The origin of these economies of scale and of scope may lie in the existence of transaction costs. For example, the management of deposits by banks starts in close relation to the more primitive activity of money changing. Having already a need for safekeeping places for their own money, old age bankers could easily offer the service to merchants and traders; that is, there are economies of scope between money-changing and safekeeping deposits. Economies of scale may be present because of fixed transaction costs, or more generally increasing returns in the transaction technology.

While transaction costs related to physical technologies may have played a historical role in the emergence of financial intermediaries, the progress experienced in digital technologies may deeply challenge this rationale for the existence of financial intermediaries. However, there is other form of transaction costs, maybe more fundamental, which are not clear to be reduced by fintech innovation to the point of disrupting financial intermediation. In finance, specific forms of transaction costs may stem from market imperfections generated by informational asymmetries; that is, adverse selection, moral hazard and costly state verification. Financial intermediaries may, at least partially, overcome these costs by exploiting economies of scope and of scale in information sharing, monitoring and providing liquidity insurance.

The existence of adverse selection, situations where borrowers are better informed than investors about the quality of the project they are looking to get financed, can generate economies of scale in the lending-borrowing activity. Leland and Pyle (1977) show that borrowers may partially overcome the adverse selection problem by self-financing part of the project. However, if borrowers are risk averse, this signaling is costly because they need to retain a substantial fraction of the risk. In this case, a financial intermediary under the form of a coalition of borrowers is able to obtain better financing conditions than individual borrowers by exploiting the economies of scale due to the transaction cost in information sharing: the signaling cost increases less rapidly than the size of the coalition. Still in the context of adverse selection, coalitions of heterogeneous borrowers can also improve the market outcome by providing cross-subsidization inside the coalition and exploit economies of scope in screening activities (Broecker, 1990). Some of the fintech developments we have been seeing to date may actually favor, rather than challenge, this view of financial intermediation by reducing the costs, in terms of time and money, of communication, information sharing and data verification. At the same time, it is difficult to visualize ways in which the new technologies described in the previous section may serve to circumvent by themselves the adverse selection problem.

Similar observation may follow when one considers other fundamental rationales for financial intermediation. For example, when borrowers are opportunistic agents, then moral hazard and costly ex post verification may be a concern. In this case, monitoring may be a solution. Monitoring activities typically involve economies of scale, which in turn imply that is more efficient that such activities be performed by specialized entities. Therefore, individual investors would like to delegate monitoring activities to such a specialized agency. The concern now is that, if monitors are self-interested, they have to be given incentives to do the job properly. Several explanations suggest that financial intermediaries provide solutions to this incentive problem. First, Diamond (1984) argue that the optimal arrangement will have the characteristics of a bank deposit contract and that, by diversifying the loan portfolio, the financial intermediary can make the cost of monitoring as small as possible, getting close to offering riskless deposits. Second, Calomiris and Kahn (1991) show that the potential of withdrawing demand deposits provides an adequate instrument for disciplining bankers. Third, Holmström and Tirole (1997) argue that there are informational economies of scope between monitoring and lending activities, which explain the role of bank capital. Diamond and Dybvig (1983) argue deposit contracts offered by a financial intermediary outperform the market allocation in an economy in which agents are individually subject to independent liquidity shocks.

Fintech developments may facilitate direct finance of firms, in particular small ones, and households, then increasing competitive pressure on financial intermediaries. It may also serve to incorporate to financial circles agents that were excluded to the moment. This may occur due to the reduction in costs of communication and data process, as well as record keeping. Big data and internet of things help providing targeted and differentiated financial product, making offers more attractive and effective. However, opportunistic behavior reasons which prevent firms without enough assets or reputation to obtain direct finance will continue to hold and intermediate finance seems to be the available alternative. In spite of fintech developments, financial intermediation is likely to continue coexisting with direct finance.

To date, most of the developments introduced by fintech firms are related to payment systems, electronic money and wallets and peer-to-peer lending. The enormous reduction in communication costs, the huge networks of users of social nets (where users are more fans that customers), and the image created by some *tech* firms put them in a strategic position to offer this kind of *financial* products. Examples are money transfers through Facebook Messenger, the electronic payments through Amazon Pay, and the electronic wallet of Alibaba. Certainly, these services directly compete with similar ones historically provided by banks and other traditional financial companies. But the latter still have the advantage of being visualized as more secure and trustful –in part thanks to huge investments in cybersecurity–, while the former still need to reinforce this issue, in particular because they would be a profitable objective to hackers. And banks are using fintech developments to reduce the cost of money transfer. Barclays, for instance, uses *Bitcoin* subsidiaries to transfer money between different jurisdictions, reducing considerably the time and cost of the transactions.

Other financial intermediation activities, as deposit and lending, require financial resources and information. Both traditional banks and internet companies, as Google, have both types of resources; perhaps one group has different kinds of maybe complementary information with respect to the other group. For the moment Google is providing payment services through Google Wallet and Android Pay, but the company also holds bank licenses in several countries. Should Google starts banking operations will increase considerably competition to traditional banking. Certainly, the way in which information is collected, processed and used to make financial decisions would change, the mechanisms through which the asymmetric information problems that justify financial intermediation are mitigated would be different, and the channels through which financial products are commercialize would be revolutionized. However, the rationales justifying the core banking activities seems not to be challenged by this evolution on banking practices and use of technology and information.

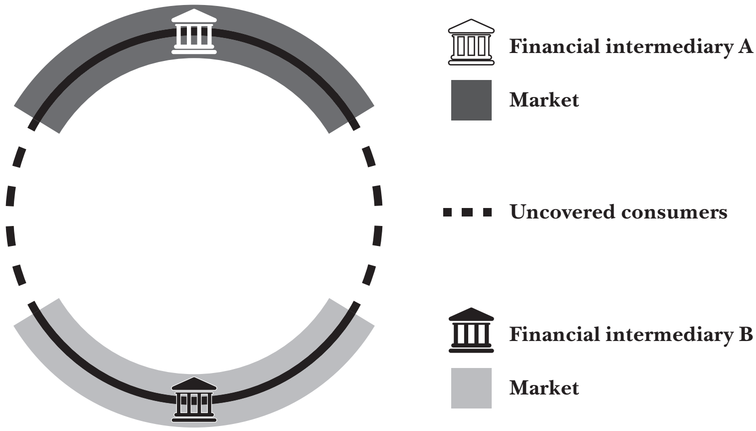
4. EFFICIENCY AND COMPETITION: AN INDUSTRIAL ORGANIZATION PERSPECTIVE

Relative to traditional financial intermediaries, fintech platforms' heavy digitalization of processes and specialized focus may lower transaction costs and entail convenience for end users. It may also increase access to credit and investments for underserved segments of the population or the business sector. Traditional financial intermediation –banking and insurance services, for example– keep uncovered an ample range of potential customers. This is particularly relevant in less developed countries. According to the Global Findex 2014 database of the World Bank, only 49% of the population holds bank accounts and other figures of bankarization fall considerably when bank credit and saving, as well as insurance instruments are considered. Costs, strategic decisions of financial services providers and market structure may explain the relatively low degree of financial inclusion. But preferences of potential customers and attitudes towards traditional banking and related financial services could also serve as explanation; sometimes, for instance, low income households perceive traditional financial services as being too far away of their needs or simply are unaware of their existence.

A modeling shortcut to represent this kind of situation is to assume that all customers get the same utility from consuming financial services but that customers are heterogeneous on the cost they borne to access the services. Hence, some customers

Figure 1

TRADITIONAL FINANCIAL INTERMEDIATION WITH UNCOVERED CUSTOMERS



are relatively closer than others to traditional financial services (although not necessarily in physical terms) in the sense that they have to pay lower transportation costs, or more generally, transaction costs. A simple way to graphically represent this situation is own to Salop (1979): an infinite number of consumers are uniformly distributed on a circle, while a finite number of traditional financial services providers are established equidistantly on the same circle, and the transaction cost of each customers to access financial services is proportional to the distance to the specific provider. Figure 1 represents a situation with two traditional financial intermediaries in a financial market where, as empirical evidence suggests, part of the market is uncovered.

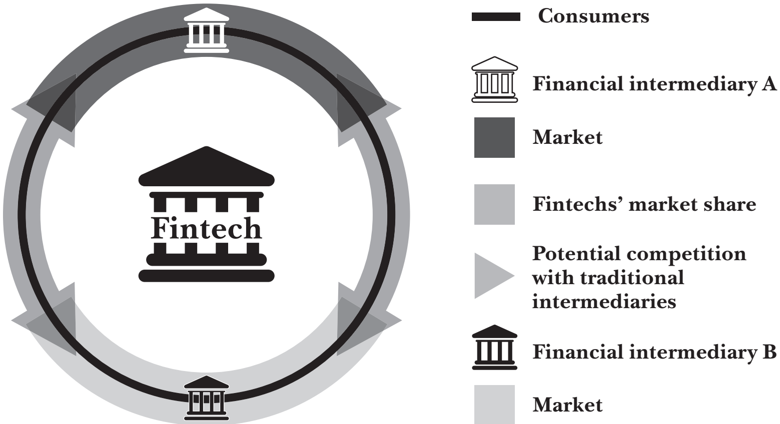
Digital technologies applied to financial services reduce transactions costs. In particular, internet access and mobile technologies have spread the gains in transactions cost reduction due to new communications technologies to billions of people. Mobile phones users could now reach access to a full range of financial services directly from their own devices. The familiarity on the use of internet, social networks and e-commerce facilitate the offer of financial products through similar channels. Moreover, big data analysis and internet of things help fintech companies to tailor financial products in order to better fix potential customer's needs. All these factors imply that fintech's offers seem to customers much closer to their demands than the substitute products offered by traditional intermediaries; so, transactions costs fall. In turn, this may have deep implications for financial inclusion of excluded-from-traditional-intermediaries consumers, especially for products that are closely related to payment systems, but also on peer-to-peer lending. This kind of situation is exemplified in Figure 2 where the reduction on transaction costs allows a fintech company to financially include customers at the same time of competing with the existing offers by traditional intermediaries.

Through the world, we have been living in this scenario in recent years, which is likely to continue deepening. A clear example of this can be found in the segment of payment systems and remittances. WeChat Pay, the mobile payment platform which is an extension of the messaging app WeChat, is big in China. M-Pesa, a digital wallet, makes possible the financial inclusion of thousands of people in Kenya by allowing them to send and receive money, pay bills and transact easily through mobile phones. In Latin America, the segments of payments and remittances, lending, scoring, identity and fraud lead the offer of fintech.[3] In recent years, Latin American fintech entrepreneurship has grown at a rate of around 50% to 60% and has drawn the attention of international investors and corporates through investment rounds in startups or strategic partnerships.

[3] See Finnovista at <https://www.finnovista.com/fintechradar-foreignstartupslatam2018/?lang=en>.

Figure 2

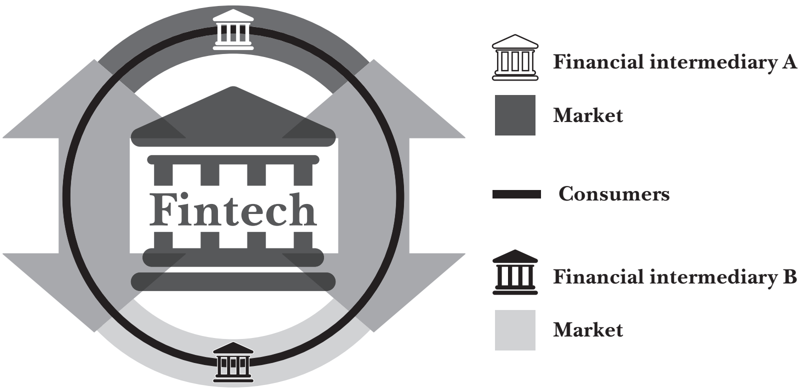
REDUCTION IN TRANSACTION COSTS DUE TO FINTECH ALLOWS FINANCIAL INCLUSION



Other things equal, a continuous reduction in transaction costs may impose increasing competitive pressure on traditional financial intermediaries. To start with, fintech innovation helps to reduce barriers to entry. Moreover, competitive pressure would increase dramatically if fintech companies manage to growth and develop new varieties of financial products which are closer to consumers' needs. And it would be particularly the case if these companies start doing financial activities which are at the core of financial intermediation. For instance, imagine that a company with access to large datasets about customers and technical capabilities to analyze this big data does enter in banking activities, for example: by granting loans financed with bank deposits. It is highly probable that the comparative advantage in the access and use of information determines a competitive advantage for this company due to a significant reduction on the transaction costs imposed by asymmetric information.

Figure 3

FINTECH'S ACTIVITIES MAY CHALLENGE TRADITIONAL INTERMEDIARIES

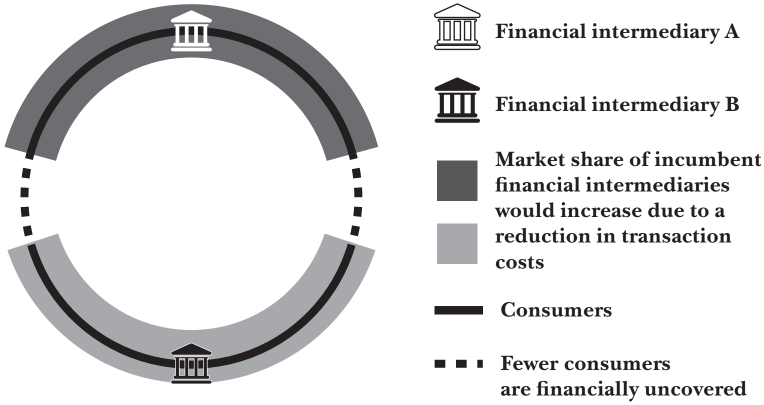


A situation like the detailed in the previous paragraph is represented in Figure 3. However, it is worth noticing that such a situation would challenge traditional intermediaries but not necessarily financial intermediation. In other words, we should assist to a different form of financial intermediation where the channels would be more digitally than physical, and the financial products more tailored than standard.

The world is not yet in this scenario of strong competition and big challenge to traditional intermediaries. Nevertheless, the rapid pace of financial innovation might imply the occurrence of a situation like this in the nearby future. Moreover, fully digital banks–that is, without physical branches– have started to appear in different jurisdictions recently, as in Argentina. This new form of financial intermediation plus new business models facilitated by fintech developments are starting to increase competitive pressure over traditional intermediaries.

Figure 4

TRADITIONAL FINANCIAL INTERMEDIARIES WOULD PROFIT FROM FINTECH INNOVATION



However, incumbent financial intermediaries would react to the challenges introduced by fintech companies. Technological innovation also embodies opportunities on transaction costs reduction, which may be profited by traditional financial intermediaries. For instance, distributed ledger technology offers a fast, reliable digital record keeping systems which may bring transformational change to the financial sector by: reducing the cost of small retail money transfer; improving financial inclusion and reducing the costs of remittances; improving back-office functions for securities transactions; and reducing settlement time and risks for securities transactions. In turn, lower transaction costs improve the competitive position of incumbent financial intermediaries. As a result, they would increase their market shares, instead of losing customers, when competition with the fintech companies becomes tougher; a situation represented in Figure 4.

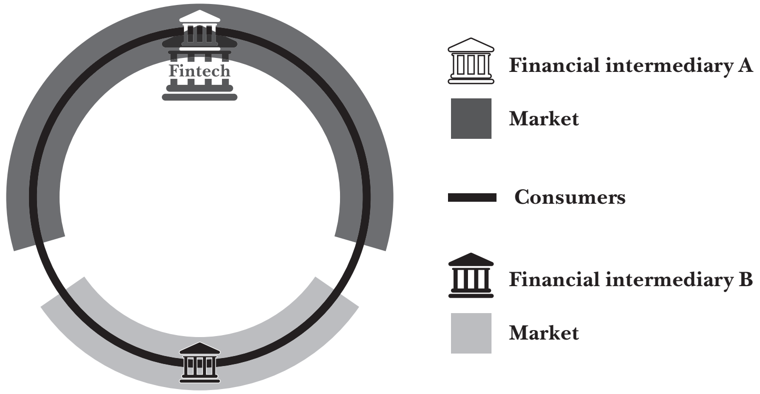
This is a scenario that we are also seeing in practice. Worldwide, traditional intermediaries like banks and insurance companies are incorporating technology and exploiting potential uses of digital innovation. More and more apps, online transactions, new digital products and client tailored offers are improving traditional intermediaries' customer experience.

The final outcome in terms of market structure is hard to anticipate because it will depend of the relative strength of all these competitive forces. Market competition will surely increase (as represented in Figure 3) but the reaction of traditional financial intermediaries may determine that the new market equilibrium will be some combination of the situations depicted in Figures 2 and 4. Overall, more users would be financially included, new digital forms of financial intermediation and new digital products will be available. Hence, new forms of prudential regulation and supervision may be necessary in order to control excessive risk taking that may harm financial customers and the entire financial system, a topic we will consider in Section 6.

Other possible outcome on the changing market structure is that traditional financial intermediaries vertically integrate fintech startups. Indeed, incumbent financial intermediaries have both information about customers and deep pockets. They should also be getting good incentives to change business models and to incorporate digital technologies to their offers. In addition to that, most of them also have long experience on cybersecurity. All these things put them in a very good position to support fintech innovation and to capture its profits through subsidiaries or associated *tech* companies; a situation represented in Figure 5. Indeed, Kelly et al. (2017) report that the relation between fintech and banks is more symbiotic than combative. With partnerships, fintech get to scale their technology and access capital to grow, while financial institutions gain assistance in their efforts to improve product offerings, increase efficiency, and lower costs.

Figure 5

INCUMBENT INTERMEDIARIES WOULD VERTICALLY INTEGRATE FINTECH



In practice, traditional intermediaries are following this way of vertically integrate fintechs. From a policymaker viewpoint, this process opens questions about competition policy and potential new forms of barriers to entry. Fintech's platforms interoperability with the systems of traditional intermediaries, and access and use of customers' information become extremely relevant in order to ensure a fear competitive field that fosters financial innovation in benefit of overall welfare. We will come back over this issue in Section 6.

The financial market landscape is in a state of flux. The final outcome in terms of the financial market structure and competition is certainly difficult to anticipate. However, as long as market power does not rise considerably, the reduction in transaction costs should translate into a more efficient financial system which, in turn, would provide financial services to a large number of customers. All in all, financial inclusion and transaction costs reduction due to fintech innovation would add efficiency and welfare to a larger number of customers.

5. CONTRACTUAL RISK: A TRANSACTION COST ECONOMICS PERSPECTIVE

In the previous section we analyze the financial market from an industrial organization perspective. In this section we consider financial transactions as the unit of analysis and assess the potential effects of fintech through the lens of a Transaction Cost Economics (TCE) perspective.

As developed by Williamson (1996), TCE adopts a contractual approach to the study of economic organization and makes transactions the basic unit of analysis. Refutable implications are derived from the discriminating alignment hypothesis: transactions, which differ in their attributes (frequency, uncertainty, and contractual risk), are assigned to governance structures (firms, markets and hybrid arrangements), which differ in their costs and competencies (incentive intensity, administrative control, use of contract law, and adaptation abilities) in a transaction cost economizing way. TCE places the principal burden of analysis on comparisons of transaction costs–which, broadly, are the "costs of running the economic system" (Arrow, 1969).

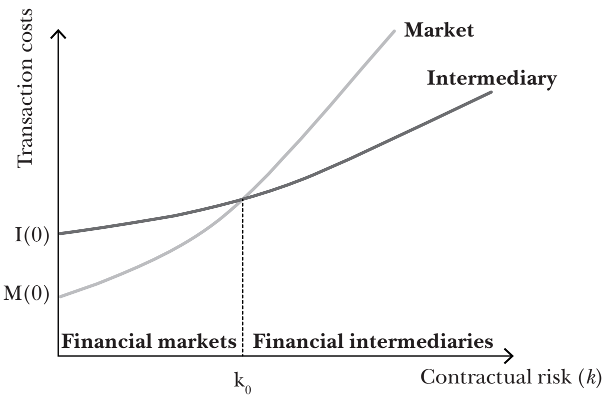
Taking the transaction as the unit of analysis, TCE constitutes an effort to identify, explicate, and mitigate contractual risks, which can be attributed to the twin behavioral assumptions: bounded rationality and opportunism. Both assumptions serve to refocus attention on distinguishing feasible and infeasible modes of contracting, since all contracts within the feasible set are inherently incomplete. In particular, bounded rationality (related to costly information) precludes the capacity to engage in comprehensive ex ante contracting, due to specification, monitoring and enforcement costs. Accordingly, the ex post side of a contract takes on special economic importance: governance responses to mitigate contractual hazards will be guided by the trade-offs between alternative mechanisms of governance with respect to their capacities for autonomous and cooperative adaptation, gap filling and dispute settlement.

Following Coase (1937), firm and markets are alternative forms of organization for managing the same transaction. A variety of factors support firms and markets as discrete structural forms of organizing transactions as opposed to a continuous variation over a spectrum. Williamson (1996) maintains that firms (that is, hierarchies) are not merely a contractual act but also a contractual instrument, a continuation of market relations by other means. The challenge to comparative contractual analysis is to discern and explicate the different means. In the case of financial transactions, whether the transaction is processed through a firm (a financial intermediary) or directly between agents in a financial market (although matched by a fintech) turns largely on the transaction costs of managing the transaction in the financial intermediary, as compared with mediating the transaction through the fintech. This analysis entails an examination of the comparative costs of planning, adapting and monitoring task completion under alternative governance structures. Which transactions go where depends on the attributes of transactions, on the one hand, and the costs and competence of alternative modes of organization, on the other. We will analyze these two dimensions in turn in a simple model inspired by Williamson (1996, Chapter 4).

Financial transactions may differ in several dimensions (for example, in frequency and uncertainty), but maybe the most relevant dimension is their relative contractual risk. Williamson (1996) assumes a reduced form and focus on this differential attribute of transactions. Its immediate consequence related to financial transactions is that a condition of bilateral dependency between lenders and borrowers builds up as contractual risk deepens. The ideal transaction–whereby the identities of lenders and borrowers are irrelevant–is obtained when contractual risk is zero. Identity matters as risk increases, since this determines that the financial assets involved in the transaction lose productive value when redeployed to best alternative uses and by best alternative users. Bounded rationality and opportunistic behavior in financial markets imply

Figure 6

FINANCIAL MARKETS AND INTERMEDIARIES COEXISTENCE AS A FUNCTION OF CONTRACTUAL RISK



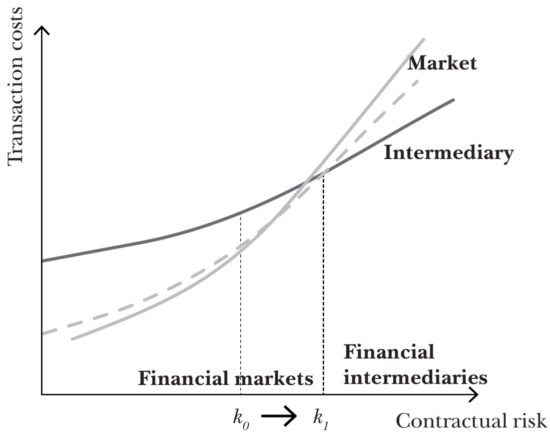
a direct relationship between the contractual risk of financial transactions and the importance of asymmetries of information. The more important the problems of adverse selection and moral hazard are, the more important the contractual risk of the financial transaction will be.

Following Williamson's analysis of the comparative forms of organizing transactions, when the contractual risk (k) of a financial transaction is low (assume it is nil to fix ideas) the bureaucratic costs of the internal organization of a financial intermediary, *I(0),* exceed those of the market, *M(0),* because the latter is superior in autonomous adaptation. Imagine a perfect information world where a potential lender knows exactly the type of each potential borrower. In this perfect information world, the contractual risk of lending transactions is negligible, so that the autonomous adaptation of the market through the high-powered incentives provided by the price– the interest rate– mechanisms will imply lower transactions costs than a financial intermediary. However, that changes as asymmetric information are relevant, and contractual risks implies that bilateral dependency sets in. Situations for which coordinated responses are required become more numerous and consequential as contractual risk deepen. The high-powered incentives of markets here impede adaptability, since each party to an autonomous exchange that has gotten out of alignment, and for which mutual consent is needed to do an adjustment, will want to appropriate as much as possible of the adaptive gains to be realized (formally $M'(k)>I'(k)$: transaction costs increase quicker with contractual risk in markets than in intermediaries). When bilaterally dependent parties are unable to respond quickly and easily, because of disagreements and self-interested bargaining, maladaptation costs are incurred. Although, the transfer of such transactions from market to financial intermediaries creates added bureaucratic costs, those costs may be more than offset by the bilateral adaptive gains that result. Figure 6 shows this situation where low contractual risk transactions are organized through financial markets whereas high contractual risk ones are canalized through financial intermediaries.

As we highlight in Section 2, fintech activity varies significantly across and within countries but the common pace is characterized by a rise in automation, specialization, decentralization, and the use of increasingly efficient and sophisticated ways of leveraging vast quantities of consumer and firm data. Internet platforms, smart contracts and blockchain, as well as other technological developments, facilitate matching among market participants and reduce considerably the relative cost of market transactions (that is, it reduces $M'(k)$). Big data and other data mining techniques reduce asymmetries of information. In turn, this makes possible the existence of peer-to-peer lending and other market-based transactions, even for some with intermediate levels of contractual risk that were previously carried out by financial intermediaries (from k_0 to k_1 in Figure 7).

Figure 7

THE EFFECT OF FINTECHS ON MARKETS

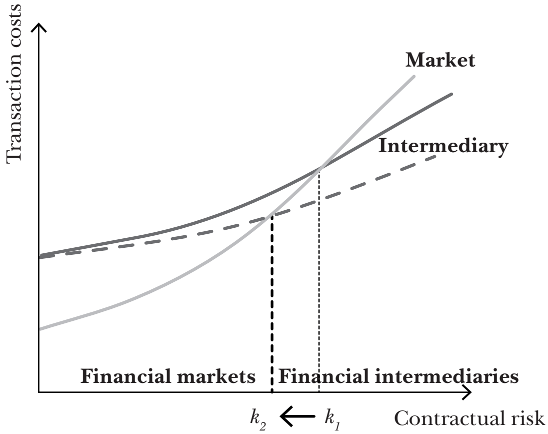


This scenario is consistent with the practical observation that the most active areas of fintechs are related to payments and remittances, peer-to-peer (P2P) lending, scoring, identity, and fraud control. In all these activities fintech innovation reduced transaction costs considerably, allowing that more of them may be conducted directly through markets (as P2P lending) instead of via financial intermediaries. From a regulatory viewpoint, this change on the institution through which transactions are conducted should not imply big challenges but, potentially, a stronger focus on customer protection (see Section 6).

This raise in the threshold value for the contractual risk that separates transactions organized through financial markets from those conducted by financial intermediaries due to the effects of fintech assumes a passive behavior of incumbent financial intermediaries. However, technological developments may also be incorporated by financial intermediaries, which

Figure 8

THE EFFECT OF INTERMEDIARIES' ADAPTATION



adapt their business models to the emerging competitive environment. In turn, the reduction in the transaction costs of incumbent financial intermediaries (the reduction in *I'(k)*) put them in a better position to be the cost minimizing organizational option for some intermediate levels of contractual risk (from k_1 to k_2 in Figure 8). As a result, the market's gain of terrain due to the effects of fintech would be (at least partially) offset by the adaptation of financial intermediaries to the new market conditions.

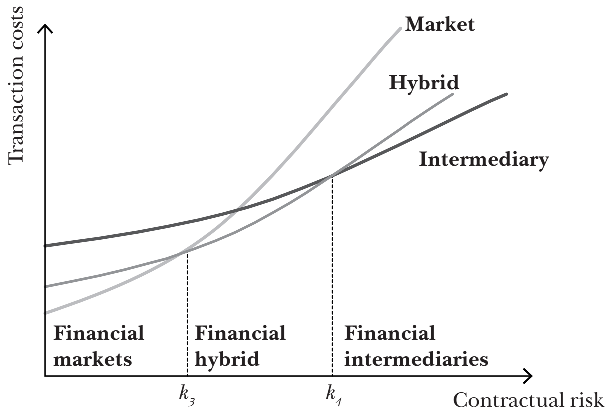
In practice, incumbent financial intermediaries have been incorporating new digital products, new channels to commercialize traditional ones, using data intensive techniques in order to tailor offers to customers, provide a better experience to them, and attract new ones. Otherwise stated, we are also seeing this scenario in the real world, which implies that competition between intermediaries and fintechs becomes stronger for intermediate levels of transaction risk.

The effect of fintech on the reduction of transaction costs seems particularly relevant on those that are associated with ex ante asymmetries of information, that is, adverse selection. The transactions costs that are implied by ex post asymmetry of information problems–costly state verification–could be (at least partially) reduced by technologies like the blockchain. In this case, the reduction of auditing costs, for example, may imply similar effects to the ones discussed in Figure 7. However, for interim asymmetry of information problems–like moral hazard–it is still not clear whether current technological developments could reduce the costs of, for instance, monitoring borrowers (but possibly through the development of internet of things). If this is the case, financial intermediaries would continue being the transaction costs minimizing option for transactions that embody large contractual risk due to moral hazard threats.

Williamson (1996) also describes a hybrid model, which is located between market and intermediaries with respect to incentives, adaptability, and bureaucratic costs: $M(0) < H(0) < I(0)$ and $M'(0) > H'(0) > I'(0)$. As compared with the market, the hybrid sacrifices incentives in favor of superior coordination among the parts. As compared with the intermediary, the hybrid sacrifices cooperativeness in favor of greater incentive intensity. The provision of credit by market, intermediary, and hybrid–where fintech startups developed under the same holding company of an incumbent bank is an example of the last one–illustrates the argument. Transactions for which the requisite adaptations to disturbances are neither predominantly autonomous nor bilateral, but require a mixture of each, are candidates to be organized under the hybrid mode, which has its parallels with the vertical integration of fintech by incumbent financial intermediaries described in Section 4. Over some intermediate range of contractual risk (between k_3 to k_4 in Figure 9), the mixed adaptation that hybrids afford could well be superior to the autonomous-favoring or cooperative-favoring adaptations supported by markets and intermediaries, respectively.

Figure 9

HYBRID FINTECH-INTERMEDIARY



In this scenario, which is the most likely to occur in the long-run, low contractual risk transactions previously organized through financial markets will continue to be conducted through them, but in new digital, fintech, forms. High contractual risk transactions will continue being conducted through financial intermediaries which may perform these activities by using financial innovations. Finally, new activities and products (like for example bundles of banking, insurance and other financial services) will emerge for intermediate levels of contractual risk through the association of traditional intermediaries with new forms of fintech institutions in hybrid models.

6. RISKS, REGULATION AND SUPERVISION: CHALLENGES AND OPPORTUNITIES

Fintechs pose several challenges to regulation and control of financial systems. But it may also represent opportunities for gaining efficiency on these activities. Fintech can improve both financial stability and access to services, but this requires significant changes in the focus of regulation (see Philippon, 2017, and the references therein).

One of the main reasons why regulation and supervision in this new framework is particularly challenging is because of the high speed at which fintech developments occur. Regulatory frameworks, including the legal support for these activities, generally take time to be built and adapted to changing circumstances. Indeed, even in the nonobvious case when the rationale for regulating is clear, to delegate authority to some agency generally involves a somewhat long process. For example, several of the new regulations introduced after the global financial crisis of 2007-2008–as Basel III–, are still under debate in the process to be implemented.

A second challenge comes from the experimental nature of fintech innovation. It may also represent a risk for financial systems to which financial supervisors need to be particularly attentive. Like the internet in the 1980s, now fintech developments embody innovation and give rise to more of it. They are experiments in themselves of, for instance, how to maintain a public database (the *blockchain*) without anybody in particular, a bank, say, being in charge. This may seem like a dangerous way to generate innovation in financial markets. A crash in some part of the experiment could spread from one asset to others, creating wobbles in the financial system.

However, the associated systemic risk will keep under control as long as the innovation does not spread too much, nor too rapidly, and market participants understand the risk they are taking; as opposed to what happened with securitization, structured products and special conduits before the 2007-2008 financial crisis. This seems to be the case with cryptocurrencies nowadays. It is hard to argue that those buying cryptocurrencies are unaware of the risks. Moreover, authorities in several jurisdictions have been recently issuing alerts about the riskiness of buying and selling cryptocurrencies in an attempt to protect consumers and keep risks under control. In addition to that, since this business is still a fairly self-contained system, contagion is unlikely. But if the analogies of fintech with the internet are right, financial authorities should remember the dotcom boom and bust it created in the late 1990s. In the case that fintechs expand rapidly and imposing huge competitive pressure on traditional intermediaries (as we discuss in Section 4), then financial authorities should be ready to act in order to control systemic risk. Nevertheless, financial authorities should think twice before coming down hard. Being too spiky would not just prick a bubble, but also prevent a lot of the useful innovation that is likely to come about at the same time.

A significantly large share of fintech activity in the financial system could present a mix of financial stability benefits and risks in the future. Among potential benefits are effects associated with financial inclusion, access to alternative funding sources in the economy, lower concentration of credit in the traditional banking system, more diversity in credit provision and efficiency pressures on incumbents (see Section 4). Among the risks are a disorderly impact on traditional intermediaries, a potential deterioration in lending standards and increased procyclicality of credit provision.

Fintech credit poses challenges to the regulatory perimeter and authorities' monitoring of credit activity. From a microprudential perspective, the financial performance of fintech activities could be substantially buffeted by swings in investor confidence, given their agency lending models. Moreover, financial risk in platforms may be higher than that at banks due to greater credit risk appetite, untested risk processes and relatively greater exposure to cyberattacks. And some factors that contribute to increased financial inclusion associated with fintech credit could also lower lending standards in countries where credit markets are already deep. Conceptually, we have shown in Figure 7 (see Section 5) that fintechs may process transactions with higher contractual risk than the maximum accepted by nonfintech financial markets.

Nevertheless, by the moment, the small size of fintech credit relative to credit extended by traditional intermediaries limits the direct impact on financial stability across major jurisdictions. However, fintech credit provision could be relatively procyclical and there is the potential for a pullback in credit to certain parts of the economy because of a loss of investor confidence during times of stress. Incumbent banks might take on more credit risk in response to increased lending competition (something we have discussed in Section 4), while an abrupt erosion of their profitability could generate broader difficulties for the financial system, given banks' provision of a range of systemically important services.

Fintech regulation should adopt different forms in order to balance the potential trade-offs between innovation, efficiency gains, and financial inclusion in the one hand and, on the other hand, the market failures, externalities, and systemic risk that justifies prudential regulation and supervision (see Sections 3, 4 and 5). Licensing and conduct regulation are generally applied to financial services providers to promote the fairness and efficiency of financial markets. In many jurisdictions, these rules can differ across financial markets depending on the potential for, and impact of, market failure. For example, markets interacting with consumers and retail investors may be subject to a specific set of rules aimed at protecting against the establishment of inappropriate financial contracts. More intense prudential regulation, as in the banks' case, aims to ensure that small and nonsophisticated investors are protected, or that certain financial functions are delivered with a much greater degree of safety. This reflects the concern for the negative externalities that the failure of a critical financial service could impose to the economy. In general, a convenient regulatory principle is to apply the same regulation to the same kind of risks regardless of whether they are intermediated by traditional banks or new fintech developments. However, the challenge to regulators is to promptly identify risks when traditionally regulated activities (financial intermediation, for instance) are done through new fintech channels as well as when new business models appear.

Fintech and other forms of nontraditional intermediation in financial markets should also be considered seriously when designing regulation for traditional intermediaries. For instance, requirements for traditional intermediaries have become higher recently, and those more stringent regulation has been identified as one of the factors favoring shadow banking activities and fintech developments. In a setting where traditional/regulated financial intermediaries coexist with unregulated competitors, Martínez-Miera and Schliephak (2017) show that optimal capital regulation will depend on the degree of current bank competition. If bank competition is low and part of the market is uncovered, then capital requirements should be higher and unregulated lending would provide loans to uncovered market participants (a situation we have exemplify in Figure 2). This will be welfare improving. But, if banks are already covering most of the market, then rent seeking of banks would push borrowers to unregulated lending, which in turn reduces social welfare. In this case, capital requirements should be lower.

As we argue in the previous section, fintech may foster competition or not on financial markets. Following Sutton (1991), industries where innovation and quality production imply important investments and sunk costs, like it is the case in fintechs, tend to concentration with few and big participants. Hence, competition policy should be a matter of particular concern of financial authorities. Absent of an increase in market power, the reduction in transaction costs due to financial innovation should translate into a more efficient financial system and the inclusion of currently excluded financial customers. In doing this competition policy work, it is particularly important to consider the potential changes to the structure of financial markets. Network economies, infrastructures and two-sided market platforms would become particularly relevant in the nearby future of financial markets. In these market structures, the traditional tools to determine the relevant market, the abuse of market power and the corrective measures might be different from those in traditional market structures. Moreover, incumbent financial intermediaries may like to prevent entry of fintech participants in order to abuse of their dominant position. Again, competition policy ensuring the access of startups to basic financial infrastructures, and even to certain information, which is managed by traditional intermediaries may be deemed necessarily.

Fintech may also imply changes on financial risks, risk management, and hence on regulation and supervision. For instance, the network nature of financial innovation combined with automated transactions might increase correlation among financial assets. In turn, financial cycles might be amplified and systemic risk mounted. In addition to that, a disruption in some parts of the financial network would imply immediate contagion to other parts of the financial system. Financial regulators and supervisors would have an important task on anticipating and controlling systemic risk creation and its propagation in financial markets. They would also care about facilitating the reduction of operational risk and mounting contingent plans for business continuity by market participants.

Trust is crucial for the well-functioning of financial markets and especially of those that are based on networks. Trust in financial networks is an asset that should be preserved by all market participants. Supervisor would play an important role, for example, by keeping the experiments under control on the innovation stage, but also when fintech matures. For instance, blockchain would serve as a device to provide trust on financial transactions. The growth of transaction with cryptocurrencies, which are based on this digital technology, in recent years, may be considered as indicator for that. To be sure, regulators should watch out that cryptocurrencies do not become even more of a conduit for criminal activity, such as drug dealing, money laundry, or financing of terrorist activities. Consumer protection policies, information privacy, and transparency are particularly relevant areas for supervisors' action. For example, authorities in several jurisdictions have been issuing alerts to customers about the high risk of crypto-currency transactions.

Cybersecurity is another important field to which to contribute. Unfair lending practices related to unmonitored use and analysis of big data and increased systemic vulnerabilities due to threats to cybersecurity should be on between the main concerns of financial supervisors.

A clear legal and regulatory framework for the sustainable development of fintech may be deemed necessarily. Authorities in several jurisdictions are devoting efforts on this although there is not an emerging consensus on the recommendations yet. In some jurisdictions the current legal framework seems to be enough in order to provide a fair field for fintech innovation and risk control. Other jurisdictions, like for example Mexico, are issuing new and specific legislation for fintechs.

Digital technologies themselves could facilitate regulatory compliance and increase efficiency in financial regulation and supervision. They may also enhance financial control to avoid money laundry and other illegal activities. The automation of manual processes (for example, by using artificial intelligence), new capacities to aggregate, share and store data (for example, through cloud-computing), enhancements in security (like using blockchain), and in identifying suspicious transactions (by incorporating biometrics and using big data analysis, for instance) could facilitate the interaction of financial intermediaries with their supervisors, as well as improve the efficiency of the latter to perform their mandates.

7. FINAL REMARKS

In this paper we analyzed the potential impact of the fintech on banking, financial markets, and regulation based on conceptual fundamentals about the rationale for the existence of financial intermediaries, the reasons behind their coexistence with financial markets, and the justification of financial regulation and oversight. On those grounds, the microeconomics of banking literature, traditional industrial organization models and the transaction cost economics framework shed relevant light. Issues such as asymmetric information and contractual risks, as well as the ability of adaptation by incumbent financial intermediaries, become crucial in the analysis.

At this stage, one can stress that we are assisting to some kind of revolution in technological developments that may be applied to finance; mostly due to the speed of technical advance and communication that are common to a more general digital revolution. No doubt financial systems would need to evolve more or less quickly in response to the challenges imposed by technical advance, as well as to profit from the opportunities for it generated. But, at the current stage, it is not obvious that some of the fundamental rationales behind the existence of financial intermediaries will be disrupted by the kind of fintech developments we are seeing.

The financial market landscape is in a state of flux. The final outcome in terms of the financial market structure and competition is certainly difficult to anticipate. However, as long as market power does not rise considerably, the reduction in transaction costs should translate into a more efficient financial system which, in turn, would provide financial services to a large number of customers. All in all, financial inclusion and transaction costs reduction due to fintech innovation would add efficiency and welfare to a larger number of customers.

Considering the effects on reducing information asymmetries in some cases and informational costs and entry barriers in others, we identify declining opportunities for profitability in traditional financial intermediation activities and the increasing role of innovative financial arrangements closer to markets rather than financial intermediaries. Nevertheless, that does not necessarily imply that banks and other intermediaries will reduce their participation in the financial arena, given their systematic ability to adapt to changing circumstances, particularly when driven by technological change. Moreover, the impacts are not homogeneous among all kinds of financial transactions due to different needs for solving asymmetric information problems; for example: monitoring different types of projects according to their remaining contractual risks.

Fintech poses several challenges to the regulation and supervision of financial systems. But it may also represent opportunities for gaining efficiency on these activities. A significantly large share of fintech activity in the financial system could present a mix of financial stability benefits and risks in the future. Hence, fintech regulation should adopt different forms in order to balance the potential trade-offs between innovation, efficiency gains and financial inclusion in the one hand and, in the other hand, the market failures, externalities and systemic risk that justifies prudential regulation and supervision. The emergence of fintech challenges the scope and ability of regulatory frameworks, and each new development has to be assessed from a regulatory standpoint–understanding the object to protect–, whether it constitute financial intermediation or not, and if it potentially affect the systemic risk.

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Variance Decomposition of Prices in an Emerging Economy

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Joaquín Saldain

Abstract

We use a one million good-level dataset of prices in Uruguay which comprises grocery stores in the capital city of Montevideo to decompose the variance of prices to identify the sources of such variability. We estimate the specific contribution of the product, chain, and individual store to the variability of prices. Estimates are carried out with the data in different periods, with time trend inflation and excluding nonhomogeneous goods to estimate robust results. We use the three-error model to decompose the price variation to find that chain specific shocks account for half of it. The importance of shocks to individual products and product categories common to all stores is the other half. Our results indicate that the importance of chains in price variation in Uruguay is halfway between that of the United States and Chile. Therefore, in an emerging

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economy, the price strategies of retailers are not so much different from those in the United States to compare to what previously thought.

Keywords: prices, variance decomposition, firm strategy, Uruguay.

JEL classification: E31, E52, L10.

1. INTRODUCTION

Understanding the process of price formation is key to both macroeconomics–the design of monetary policy–, and microeconomics–the competitive process in the retailing sector–, especially in a small open economy like Uruguay. This analysis allows a better understanding of the behavior, dispersion, and volatility of prices. In a seminal study, Klenow and Malin (2010) provided an up-to-date and concise overview of the empirical evidence based on microdata. Also, Nakamura and Steinsson (2008), and Bils and Klenow (2004) studied price setting in the United States.

In this paper we analyze one million prices in Montevideo, the capital city of Uruguay, to study the behavior of prices and to decompose its variability in shocks common to stores within a particular retail (chain effect), shocks common across stores selling an identical product and shocks idiosyncratic to the store and product. This analysis allows us to estimate the contribution of retailer and manufacturer shocks to explain price variability. Hence, it is of particular relevance given the regulation in the capital city of Montevideo that restricts the entry of supermarkets.

In a related paper, Nakamura (2008) finds for the case of the United States (USA) that 65% of the price variation is common to stores within a particular retail, 16% of the variation in prices is common across stores selling an identical product and 17% idiosyncratic to the store and product. Therefore, she finds that the shocks to chains are the most important to explain price variability.

For an emerging economy, the only study is Chaumont et al., (2011) that analyze the case of Santiago in Chile. Contrary to Nakamura (2008), they find that shocks to individual goods and product categories are the most important factors to explain the behavior of prices. In the case of Chile, the manufacturers' shocks are more important than chain shocks to analyze price variation.

We use the three-error model to decompose price variation and include a time trend at the product category level to capture inflation. We find that variance can explain half of the variation in prices at the chain level. Therefore, the results for Uruguay are between those found for the United States and Chile. This suggests that retail prices do not vary mainly as a result of supply and demand changes. If for example, following a positive cost shock the price of one particular soft drink bottle goes up, the more likely it is that the price of substitute drinks change, so the pricing strategies are the most relevant and not the shocks of supply or demand that affect all the beverages category such as increased costs for wages, new technologies or changes in consumer tastes. This fact allows us to understand better the effect of competition on market prices and the effect of monetary policy on prices.

We perform robustness tests to correct for outliers, for product mix, period, and sales. In all of them, the estimation of the chain effect remains the same.

2. THE SUPERMARKET INDUSTRY AND INFLATION IN URUGUAY[1]

Uruguay is a middle-upper income country, with a population of 3.37 million people, in 2011. Approximately half of the population or 1.7 million people live in Montevideo, the capital city, and its metropolitan area. According to the Ministry of Economics and Finance, 60% of the supermarkets are concentrated in Montevideo. The main supermarket chains in Montevideo are Grupo Disco del Uruguay (which manages

[1] This section is based on Borraz et al. (2014).

brand names Disco, Géant, and Devoto), Tienda Inglesa, Ta-Ta (who bought Multiahorro in 2012), and Macro Mercado. Of these, Disco and Tienda Inglesa target consumers with higher incomes. Concentration, transformation, and entry in the supermarket industry characterized the late 1990s, but that trend was slowed by the 2001-2002 financial and economic crises in Uruguay. In the 2000s, supermarkets accounted for a roughly stable 35% of total sales of the food retailing sector in Montevideo.[2]

Both multinational entry and consolidation prompted lobbying by small retailers in Uruguay to restrict entry and to promote the sector's interest more generally. This lobbying resulted in a new set of regulations that covered the installation of large retailers in Uruguay. In 1999, a law was passed to regulate the entry of large retailers. In the early years, the only cases that were submitted to the antitrust agency were alleged predatory pricing practices from large supermarkets, mainly Géant.

The law required entrants in the food retailing sector, which plan to operate stores of $300m^2$ of sales area or more, to obtain special approval from the municipal authority. The Law No. 17.188, "Standards for Large Area Commercial Establishments for the Sale of Food and Household Items" creates and empowers municipal commissions to make recommendations to the municipal authority to approve or disapprove the installation of large-scale commercial establishments.

The administrative requirement applied also to the case of expansions of establishments that would exceed the $300m^2$ threshold, as well as to the opening of new establishments (that would exceed $300m^2$) by incumbents. In 2003 the law was amended, and the threshold was decreased to $200m^2$ of sales

[2] This data is from IdRetail. The reasons for the increased supermarket participation in total sales may have varied and has not been studied in depth and are beyond the scope of this study.

area (see Law No. 17.657, "Large Commercial Area Establishments for the Sale of Food and Household Items").

Each time a new approval request is submitted, a commission assesses the effect of entry on: *1)* global supply and demand in the area defined by the local government (mainly whether there is excess demand by consumers or not, which is not being satisfied by incumbent firms); *2)* small retailer's exit; and *3)* net employment (which was introduced in 2003). The commission is required to make a decision based on these three criteria.

The Uruguayan law regulating entry in the food retailing sector mirrors European legislation in some respects.[3] However, the Uruguayan law has some distinguishing features: first, the threshold of square meters above which a store is considered a supermarket is much lower than in Europe. Second, the Commission has no veto power on a supermarket's entry, given that the ultimate decision lies in the hands of the local government. Finally, one member of each Commission is a representative of the central government, who casts the deciding vote in the case of a tie.

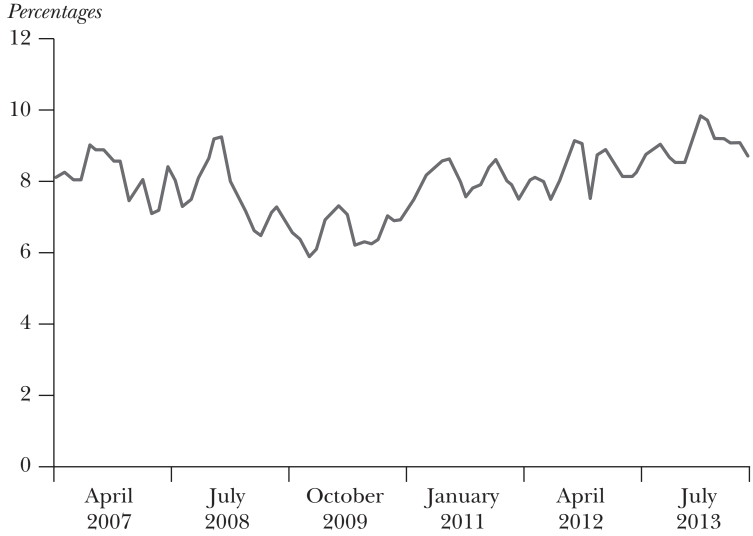
In summary, these laws restricted entry of supermarkets in Montevideo and therefore make it interesting and relevant to analyze the impact of the existing chains on price variability.

Figure 1 shows the 12-month inflation rate in Uruguay between 2007 and 2014. The yearly average rate is 7.4%, and we observe an increase from 6% at the end of 2009 to 8% in middle 2014. Our methodology will consider the fact that inflation in Uruguay is high in an international comparison. Also, we estimate the model for a subperiod with low inflation because of the shocks hitting the economy (September 2009 to May 2010).

[3] See Bertrand and Kramarz (2002) for entry regulation in France; Griffith and Harmgart (2008), and Haskel and Sadun (2009) for the United Kingdom.

Figure 1

URUGUAY: 12-MONTH INFLATION



Source: National Statistics Institute.

3. DATA

We use a good-level dataset of daily prices compiled by the General Directorate of Commerce (DGC) which comprises grocery stores all over the country. The DGC is the authority responsible for the enforcement of the Consumer Protection Law at the Ministry of Economy and Finance. This same dataset is used in Borraz et al. (2016), and Borraz and Zipitría (2012).

In 2006 a new tax law was passed by the Uruguayan legislature which changed the tax base and rates of the value-added tax. The Ministry of Economy and Finance was concerned about incomplete pass-through from tax reductions to consumer prices and hence decided to collect and publish a dataset of prices in different grocery stores and supermarkets across the country. The DGC issued the Resolution No. 061/006 which mandates grocery stores and supermarkets to report its daily prices for a list of products if they meet the following two conditions: *1)* they sell more than 70% of the products listed, and *2)* either have more than four grocery stores under the same name, or have more than three cashiers in a store. The information sent by each retailer is a sworn statement, and they are subject to penalties in case of misreporting. The objective of the DGC is to ensure that posted prices reflect real posted prices by stores. In this regard, stores are free to set the prices they optimally choose, but they face a penalty only if they try to misreport them.

Map 1 shows the cities covered in the dataset. These cities represent more than 80% of the total population of Uruguay. Montevideo, the country's capital, with 45% of the population, accounts for 57% of the supermarkets in the sample. Because we have many cities with few supermarkets and the competitive conditions are different, we restrict our analysis to retailers located in the capital city of Montevideo.[4] Map 2 shows the distribution of supermarkets across Montevideo.

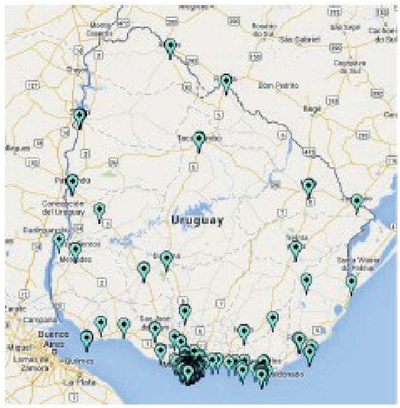
The data includes monthly prices in 137 supermarkets from April of 2007 to August of 2014 for 150 items corresponding to 50 product categories, where each item is defined by its universal product code (UPC).[5] The total number of observations is 984,485. The three highest-selling brands are reported for each product category. Most items had to be homogenized in order to be comparable, and each supermarket must always report the same item. Whenever prices are 50% greater (or less) than the average price, the retailer is contacted to confirm whether the submitted price is correct. The data is then used in a public web site that allows consumers to check prices

[4] We include two big supermarkets (Géant and Macro Mercado) that are located in the outskirt of Montevideo.

[5] The only exceptions are meat, eggs, ham, some types of cheese, and a type of bread. However, as we later show, the exclusion of these goods which could potentially be affected by an imperfect matching, does not modify the results.

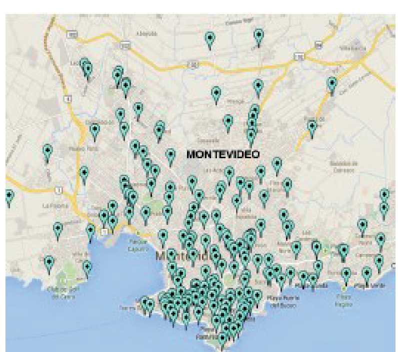
Map 1

CITIES WITH SUPERMARKETS IN URUGUAY



Map 2

SUPERMARKETS IN MONTEVIDEO



in different stores or cities and to compute the cost of different baskets of goods across locations.[6] Therefore, the products in our dataset are identical across supermarkets.

Table 1 provides the summary statistics of the data and Table A.1 in the Annex provides a detailed list of the products, its share in the CPI and the total number of observations for each item. Moreover, the goods in the sample represent 40% of the food, beverages and personal item categories in the consumer price index (CPI) and 14% of the CPI.

One concern is the possibility of error in the data report. We consider two datasets separately to account for outliers that may have a greater impact on the variance decomposition. A baseline case with the complete sample, and a second case in which we exclude those prices higher than three times (or less than a third) of the median daily price. However, deleted prices only account for a small 0.013% of the whole database.

Table 1

PRODUCT, TIME AND REGIONAL COVERAGE IN THE DATA

	All stores
Retailers	11
Stores	137
Products	150
Categories	50
Country	Uruguay
Cities	Montevideo
Departments	Montevideo
Period	April 2007 to August 2014
Months	89
Observations	984,485

Note: Summary statistics of the data compiled by the General Directorate of Commerce.

6 See <www.precios.uy/servicios/ciudadanos.html>.

Another concern is the definition of chain. Because in the data there are some small supermarkets with few branches we define a chain if there are five or more branches under the same name. Table 2 shows the numbers of branches per chain in our final sample.

Table 2

BRANCHES BY CHAIN IN THE SAMPLE

Chain	*Number of branches*
Multi Ahorro	38
Grupo Casino Disco-Géant	22
Grupo Casino - Devoto	17
Ta-Ta	12
Red Market	10
El Clon	8
Frigo	7
Tienda Inglesa	7
La Colonial	6
Micro Macro	5
Macromercado Mayorista	5
Total	*137*

4. EMPIRICAL METHODOLOGY

In order to decompose price variability in retailer and manufacturer shocks, we use the three-error correction model (Baltagi, 2005). Following Nakamura (2008), this model decomposes price variation in two classes: *1)* variation common to all UPCs within a product category; and *2)* variation that is idiosyncratic to a particular UPC. Within each of these classes, we decompose price variation in *1)* variation in prices common across stores selling an identical product, *2)* price variation common to stores within a particular retail chain, and *3)* price variation idiosyncratic to the store and product.

Formally, the equation to be estimated, for each product category separately, is:

$$Ln(P_{isct}) - Ln(\bar{P}_{isc}) = \mu + \delta t + \eta_t + \alpha_{it} + \beta_{ct} + \gamma_{ict} + \phi_{cst} + \varepsilon_{i}$$

where i is UPC, s is supermarket, c is chain, and t is time. $\propto$ and δt are mean and time trend fixed effects, while the other terms are random effects: η_t is a product category effect, α_{it} is an individual UPC effect, β_{ct} is a chain effect, γ_{ict} is a chain-UPC effect, ϕ_{cst} is a supermarket-product category effect and ε_{ist} is an idiosyncratic UPC and supermarket shock. Each random effect is assumed to be identically and independently normally distributed.

The multilevel model is estimated using maximum likelihood (ML) and restricted or residual maximum likelihood (REML). The REML estimator is a twostep estimator. The first step is to remove the fixed effect and the second step estimates the variance decomposition of the residual. Contrary to ANOVA, the ML and the REML estimators provide non-negative estimates (Marchenko, 2006).

One concern in the estimation of the previous equation is the high inflation in the period April 2007 to August 2014 (74% or 7.4% the yearly average) that can drive our results. Because of that, we include a time trend in prices for each product category, and we estimate the equation separately every two years. Also, as a robustness check, we estimate the equation: excluding meat and bread; without outliers; aggregating product categories; for the nine months period with the lowest inflation in our sample; excluding sales; and to different composition of chains (accounting for mergers between chains).

5. RESULTS AND ROBUSTNESS CHECKS

Table 3 shows the results of the variance decomposition by time. We report the average weighted by the product's importance in CPI. The chain effect is approximately 50%. This result highlights the importance of chains in the price formation process. The other 50% of the variation is common across all stores, and the rest is idiosyncratic to the store-product. The effect of shocks to all stores is below 40%, and the effect of idiosyncratic shocks is of an order of magnitude lower (15%). These results are similar across periods and estimation method (ML or REML).

Table 3

VARIANCE DECOMPOSITION OF PRICES BY PERIOD

Maximum likelihood (ML)
and restricted maximum likelihood estimation (REML)

	All stores		***Chain***		***Individual store***	
	ML	*REML*	*ML*	*REML*	*ML*	*REML*
April 2007-2008	40.3	39.5	48.5	50.4	11.2	10.0
2009-2010	39.1	50.0	46.5	37.1	14.4	12.8
2011-2012	35.6	36.3	48.8	48.3	15.7	15.5
2013-August 2014	31.4	32.0	51.6	51.2	17.0	16.8
2007-2014 averages	36.5	39.5	48.4	46.6	15.0	13.8

Note: Number of observations, 984,485. The estimation includes product categories and time trend to allow trend inflation. The table shows the arithmetic average, weighted by the product's importance on CPI.

These findings indicate that retail prices do not mainly vary because of supply and demand changes. If for example, following a positive cost shock the price of one particular soft drink goes up, the more likely it is that the price of substitute drinks change, so the pricing strategies are the most relevant and not the shocks of supply or demand that affect all the beverages category such as increased costs for wages, new technologies or changes in consumer tastes. This fact allows us to understand better the effect of competition on market prices and the effect of monetary policy on prices.

Table 4 shows the estimation results by product category. We report the mean, median and weighted average by the product's importance in CPI. We observe significant variability across product categories. The results show that the chain estimation ranges from 15.6% for the brown eggs category to 86.7% for the ham category. As expected, the importance of variation common across stores is the highest for highly concentrated industries (beer and cola for example). Also, the importance of the individual store is below 33% for all products. This result highlights the preponderance of shock common to all product and chain shocks.

Table 4

VARIANCE DECOMPOSITION BY PRODUCT CATEGORY

	All stores	*Chain*	*Individual store*
Beans	11.4	71.6	17.0
Beef (aguja)	15.6	66.7	17.7
Beef (nalga)	4.7	74.9	20.4
Beef (paleta)	29.6	52.1	18.2
Beer	56.9	28.4	14.7
Bleach	28.3	59.2	12.5
Bread	39.8	43.5	16.7
Brown eggs	78.8	15.6	5.7
Butter	44.8	42.8	12.4
Cacao	7.7	76.3	15.9
Chicken	57.2	35.3	7.5
Coffee	48.7	36.8	14.5
Cola	72.7	20.5	6.7

Table 4 (cont.)

	All stores	*Chain*	*Individual store*
Corn oil	12.2	67.4	20.3
Crackers	57.5	31.0	11.5
Deodorant	11.3	74.8	14.0
Dishwashing detergent	18.4	68.0	13.6
Dulce de leche	34.1	41.9	24.0
Frankfurters	42.5	45.4	12.1
Grated cheese	26.6	60.9	12.4
Ground beef	16.9	53.6	29.6
Ham	1.5	86.7	11.8
Ham (leonesa)	26.0	56.4	17.6
Hamburger	24.8	47.6	27.6
Ice cream	27.5	64.1	8.4
Laundry soap	18.5	66.0	15.5
Laundry soap, in bar	27.4	53.3	19.3
Maize flour	58.6	25.9	15.5
Margarine	29.7	57.3	13.0
Mayonnaise	16.0	67.4	16.6
Noodles	18.0	63.6	18.4
Peach jam	43.7	41.9	14.4
Rice	44.4	48.8	6.8
Salt	24.4	63.6	12.1
Sausage	17.6	67.6	14.7
Semolina noodles	20.0	66.4	13.6
Shampoo	25.7	46.0	28.3
Soap	39.2	52.4	8.4
Soybean oil	34.1	54.9	11.0
Sparkling water	24.8	59.9	15.3
Sugar	36.0	45.4	18.6
Sunflower oil	46.9	37.1	15.9
Tea	22.0	45.4	32.6
Toilet paper	32.1	55.0	12.9
Tomato paste	50.0	41.5	8.6

Table 4 (cont.)

	All stores	*Chain*	*Individual store*
Tooth paste	21.0	58.8	20.3
Wheat flour	42.6	48.3	9.0
Wine	53.9	33.1	13.0
Yerba	46.3	29.9	23.8
Yogurt	41.9	45.2	12.9
Median	29.0	52.9	14.6
Average	32.6	51.9	15.5
Weighted average	36.5	48.4	15.0

Notes: Maximum likelihood estimation. Number of observations, 984,485. The estimation includes product categories and time trend to allow trend inflation.

We test the robustness of our estimates to changes in the subsample of product mix, excluding outliers, with a more aggregate definition of categories, in a low inflation period, excluding sales and to different periods and to different composition of chains (accounting for mergers between chains). In all cases we find that the results are quantitatively similar.

First, we eliminate products in which the matching across stores is not perfect. In particular, we exclude meat and bread. Table 5, Panel A, shows that the results are similar with respect to the whole sample.

Second, we use all products but eliminate the outliers, defined here as those whose price is above three times (or a third below) the median price. This approach is more conservative than the one typically used in the literature. For example, Gopinath and Rigobón (2008) and Klenow and Kryvtsov (2008) eliminate prices that are more than 10 times higher or less than a tenth of the median price. Still, our rule only excludes less than 0.013% of the observations. Once again, the patterns are almost identical to the ones obtained using the complete number of observations (see Table 5, Panel B).

Third, we also perform the variance decomposition with a more aggregate definition of the product categories. Instead of using 50 categories we define 26 more aggregate categories (see Table A.2 for a full description of them). Table 5, Panel C, shows that our estimation results are qualitatively similar.

Fourth, one concern in the estimation is the possibility that inflation in the period under analysis could bias our results. In order to alleviate the impact of inflation, we estimate the regression separately for the nine months period of lowest inflation in our sample between September 2009 and May 2010.[7] Table 5, Panel D, shows that the chain effect in this period explains a little more than 50% of the price variation.

Fifth, a part of the price variation can be explained by short-term movements of prices like sales. Therefore, in Table 5, Panel E, we decompose the variance of regular prices excluding sales. We define a sale as a price that decreases, and in a 30-days windows, the price returns to the initial level. The variance decomposition of regular prices is very similar to that of posted prices (Table 5, Panel E).

Finally, we estimate the equation without the time trend and considering the different composition of chains (to account for mergers between chains). In these scenarios, the results are similar.[8]

Table 6 compares our results with those of previous studies. Nakamura (2008) finds that the chain effect is 65% in USA and Chaumont et al. (2011) estimates it in 32% in Chile. We estimate that chain effect is 50%. Our results show that the importance of chains in price variation in Uruguay is halfway between that of USA and Chile. Therefore, in an emerging economy the importance of price strategies of retailers to explain price variation is not so much different from that in USA as previously thought (Chaumont et al., 2011).

[7] In this period the inflation rate was 3.6 percent.

[8] Results available upon request.

Table 5

VARIANCE DECOMPOSITION OF PRICES: ROBUSTNESS CHECKS

	All stores	*Chain*	*Individual store*
Panel A. Product quality			
All goods	36.5	48.4	15.0
Excluding meat and bread	40.4	45.5	14.1
Panel B. Excluding outliers			
All goods	36.4	49.4	14.2
Excluding meat and bread	40.1	46.6	13.2
Panel C. Aggregate product categories			
All goods	45.8	42.2	12.1
Excluding meat and bread	48.2	40.2	11.6
Panel D. Low inflation period (Sept. 2009 to May 2010)			
All goods	28.8	55.4	15.8
Excluding meat and bread	31.5	54.6	13.9
Panel E. Regular prices (excluding sales)			
All goods	36.5	48.4	15.0
Without sales	33.9	53.0	13.1

Notes: Maximum likelihood estimation. Number of observations, 984,485. The estimations include product categories and time trend to allow trend inflation. The table shows the arithmetic average, weighted by the product's importance on CPI.

Table 6

VARIANCE DECOMPOSITION OF PRICES FOR URUGUAY, CHILE AND UNITED STATES

	All stores	*Chain*	*Individual store*
Uruguay 2007 - 2014 averages	36.5	48.4	15.0
Chile	59.0	32.1	11.2
United States	16.5	64.8	18.7

Note: The results for Chile are from Chaumont et al. (2011), and for the United States are from Nakamura (2008).

6. CONCLUDING REMARKS

We estimate the three-error model with one million prices of Uruguayan supermarkets to find that chain shocks explain half of the total price variation. The remaining variability is explained by common shocks to all stores and idiosyncratic store-product shocks. This result highlights the relevance of chain's price strategies in the analysis of price dynamics. The price variation of prices can be explained by supply and demand shocks but mainly by chain shocks. Therefore, in an emerging economy like Uruguay, the importance of retailer' price strategies is not much different from that in the United States to explain price setting.

ANNEX

Table A.1

DETAILED PRODUCT LIST AND SHARE IN CPI

Category	*Brand*	*Specification*	*Share in CPI (%)*	*Number of observations*
Beans	Campero	0.3 kg	0.0864	304
Beans	Cololó	0.3 kg	0.0864	3,292
Beans	Nidemar	0.38 kg	0.0864	1,239
Beef (aguja)	Boneless, no brand	1 kg	0.2319	5,861
Beef (aguja)	With bone, no brand	2 kg	0.2319	7,250
Beef (nalga)	With bone, no brand	1 kg	0.3154	4,764
Beef (nalga)	Boneless, no brand	1 kg	0.3154	7,119
Beef (paleta)	With bone, no brand	1 kg	0.1962	6,526
Beef (paleta)	Boneless, no brand	1 kg	0.1962	5,343
Beer	Patricia	0.961	0.3774	10,873
Beer	Pilsen	0.961	0.3774	10,804

Table A.1 (cont.)

Category	*Brand*	*Specification*	*Share in CPI (%)*	*Number of observations*
Beer	Zillertal	1 l	0.3774	5,590
Bleach	Agua Jane	1 l	0.1623	10,815
Bleach	Sello Rojo	1 l	0.1623	9,553
Bleach	Solución Cristal	1 l	0.1623	4,793
Bread	Los Sorchantes	0.33 kg	0.0583	5,509
Bread	Bimbo	0.33 kg	0.0583	5,270
Bread	Pan Catalán	0.33 kg	0.0583	3,205
Bread	No brand	Aprox. 0.125 kg - 1 unit	0.0583	8,478
Brown eggs	El Jefe	1/2 dozen	0.4555	2,207
Brown eggs	Prodhin	1/2 dozen	0.4555	7,154
Brown eggs	Super Huevo	1/2 dozen	0.4555	3,186
Butter	Calcar	0.2 kg	0.2322	8,080
Butter	Conraprole	0.2 kg	0.2322	10,562
Butter	Kasdorf	0.2 kg	0.2322	4,537
Cacao	Copacabana	0.5 kg	0.0837	10,294
Cacao	Vascolet	0.5 kg	0.0837	10,409
Chicken	Tenent	1 kg	0.8266	6,837
Chicken	Avícola del Oeste	1 kg	0.8266	4,936
Chicken	Tres Arroyos	1 kg	0.8266	1,328
Coffee	Chaná	0.25 kg	0.0878	10,835
Coffee	Saint	0.25 kg	0.0878	1,231
Coffee	Águila	0.25 kg	0.0878	10,000
Cola	Coca Cola	1.5 l	1.2313	10,822
Cola	Coca Cola	2.25 l	1.2313	5,782
Cola	Nix	1.5 l	1.2313	1,393
Cola	Pepsi	1.5 l	1.2313	5,398
Cola	Pepsi	2 l	1.2313	10,453
Corn oil	Delicia	0.9 l	NI	5,797
Corn oil	Río de la Plata	0.9 l	NI	5,316
Corn oil	Salad	0.9 l	NI	906
Crackers	Famosa	0.14 kg	0.2783	8,881
Crackers	Maestro Cubano	0.12 kg	0.2783	5,790

Table A.1 (cont.)

Category	*Brand*	*Specification*	*Share in CPI (%)*	*Number of observations*
Deodorant	Axe	0.105 l	0.3410	5,854
Deodorant	Dove	0.113 l	0.3410	5,855
Deodorant	Rexona	0.1 l	0.3410	5,854
Dishwashing detergent	Deterjane limón	1.25 l	0.1335	7,511
Dishwashing detergent	Hurra Nevex limón	1.25 l	0.1335	10,892
Dishwashing detergent	Protergente limón	1.25 l	0.1335	4,021
Dulce de leche	Conaprole	1 kg	0.1372	10,390
Dulce de leche	Los Nietitos	1 kg	0.1372	10,250
Dulce de leche	Manjar	1 kg	0.1372	10,153
Frankfurters	Schneck	8 units	0.2328	8,342
Frankfurters	Centenario	8 units	0.2328	3,208
Frankfurters	Ottonello	8 units	0.2328	8,853
Grated cheese	Artesano	0.08 kg	0.1628	628
Grated cheese	Conaprole	0.08 kg	0.1628	10,106
Grated cheese	Milky	0.08 kg	0.1628	5,493
Ground beef	Up to 5 percent fat, no brand	1 kg	0.9826	7,251
Ground beef	Up to 20 percent fat, no brand	1 kg	0.9826	7,308
Ham	Cativelli	1 kg	0.4375	2,150
Ham	Ottonello	1 kg	0.4375	5,204
Ham (leonesa)	La Constancia	1 kg	0.1576	3,604
Ham (leonesa)	Ottonello	1 kg	0.1576	346
Ham (leonesa)	Schneck	1 kg	0.1576	9,934
Hamburger	Burgy	2 units	0.1735	2,973
Hamburger	Paty	2 units	0.1735	4,654
Hamburger	Schneck	3 units	0.1735	4,875

Table A.1 (cont.)

Category	*Brand*	*Specification*	*Share in CPI (%)*	*Number of observations*
Ice cream	Conraprole	1 l	0.2153	5,629
Ice cream	Crufi	1 l	0.2153	5,275
Ice cream	Gebetto	1 l	0.2153	2,057
Laundry soap	Skip	0.8 kg	0.4529	8,407
Laundry soap	Drive	0.8 kg	0.4529	10,172
Laundry soap	Nevex	0.8 kg	0.4529	10,752
Laundry soap, in bar	Bull Dog	0.3 kg - 1 unit	NI	10,878
Laundry soap, in bar	Nevex	0.2 kg - 1 unit	NI	10,758
Laundry soap, in bar	Primor	0.3 kg	NI	2,422
Maize flour	Gourmet	0.45 kg	NI	2,282
Maize flour	Presto Pronta Arcor	0.5 kg	NI	5,375
Maize flour	Puritas	0.45 kg	NI	5,794
Margarine	Doriana	0.25 kg	NI	10,651
Margarine	Flor	0.25 kg	NI	825
Margarine	Primor	0.25 kg	NI	6,453
Mayonnaise	Fanacoa	0.5 kg	0.2147	9,411
Mayonnaise	Hellmans	0.5 kg	0.2147	10,748
Mayonnaise	Uruguay	0.5 kg	0.2147	1,579
Noodles	Adria	0.5 kg	0.4328	9,661
Noodles	Cololó	0.5 kg	0.4328	5,415
Noodles	Las Acacias	0.5 kg	0.4328	9,109
Peach jam	Dulciora	0.5 kg	NI	7,692
Peach jam	El Hogar	0.5 kg	NI	4,964
Peach jam	Los Nietitos	0.5 kg	NI	10,303
Rice	Aruba	1 kg	0.3836	8,184
Rice	Blue Patna	1 kg	0.3836	8,710
Rice	Green Chef	1 kg	0.3836	8,523
Rice	Pony	1 kg	0.3836	6,405
Rice	Saman Blanco	1 kg	0.3836	5,798
Rice	Vidarroz	1 kg	0.3836	5,869

Table A.1 (cont.)

Category	*Brand*	*Specification*	*Share in CPI (%)*	*Number of observations*
Salt	Sek	0.5 kg	0.0947	6,665
Salt	Torrevieja	0.5 kg	0.0947	3,367
Salt	Urusal	0.5 kg	0.0947	6,004
Sausage	Cattivelli	1 kg	0.3698	5,108
Sausage	Centenario	1 kg	0.3698	2,903
Sausage	La Familia	1 kg	0.3698	4,644
Semolina noodles	Adria	0.5 kg	0.4328	7,791
Semolina noodles	Las Acacias	0.5 kg	0.4328	8,927
Semolina noodles	Puritas	0.5 kg	0.4328	2,156
Shampoo	Fructis	0.35 l	0.3620	8,555
Shampoo	Sedal	0.35 l	0.3620	9,356
Shampoo	Suave	0.35 l	0.3620	9,104
Soap	Astral	0.125 kg	0.1552	5,773
Soap	Palmolive	0.125 kg	0.1552	9,862
Soap	Rexona	0.125 kg	0.1552	2,029
Soybean oil	Condesa	0.9 l	0.1078	8,216
Soybean oil	Río de la Plata	0.9 l	0.1078	4,969
Soybean oil	Salad	0.9 l	0.1078	1,176
Sparkling water	Salus	2 l	0.8163	10,745
Sparkling water	Matutina	2.25 l	0.8163	10,089
Sparkling water	Nativa	2 l	0.8163	7,990
Sugar	Azucarlito	1 kg	0.3512	10,699
Sugar	Bella Unión	1 kg	0.3512	10,821
Sunflower oil	Río de la Plata	0.9 l	0.3659	3,100
Sunflower oil	Uruguay	0.9 l	0.3659	3,000
Sunflower oil	Óptimo	0.9 l	0.3659	10,841

Table A.1 (cont.)

Category	*Brand*	*Specification*	*Share in CPI (%)*	*Number of observations*
Tea	Hornimans	Box 10 units	0.0748	10,889
Tea	La Virginia	Box 10 units	0.0748	9,960
Tea	President	Box 10 units	0.0748	4,890
Toilet paper	Elite	4 units	0.2377	5,337
Toilet paper	Higienol Export	5 units	0.2377	10,234
Toilet paper	Sin Fin	6 units	0.2377	10,176
Tomate paste	Conaprole	1 l	0.1624	10,569
Tomate paste	Gourmet	1 l	0.1624	4,066
Tomate paste	De Ley	1 l	0.1624	6,830
Tooth paste	Colgate Herbal Blanqueador	0.09 kg	0.1895	5,854
Tooth paste	Kolynos Triple Acción	0.09 kg	0.1895	5,581
Tooth paste	Pico Jenner Plus	0.09 kg	0.1895	4,509
Wheat flour	Cañuelas 000	1 kg	0.2070	4,085
Wheat flour	Cololó 000	1 kg	0.2070	460
Wheat flour	Cañuelas 0000	1 kg	0.2070	9,760
Wheat flour	Cololó 0000	1 kg	0.2070	5,404
Wheat flour	Primor 0000	1 kg	0.2070	1,732
Wine	Faisán	1 l	0.7917	4,852
Wine	Santa Teresa Clásico	1 l	0.7917	10,769
Wine	Tango	1 l	0.7917	9,166
Yerba	Baldo	1 kg	0.6356	5,589
Yerba	Canarias	1 kg	0.6356	10,735
Yerba	Del Cebador	1 kg	0.6356	10,372
Yogurt	Conaprole Bio Top	1 l	0.1294	5,473
Yogurt	Calcar (skim)	1 l	0.1397	3,449
Yogurt	Parmalat Bio Yogur (skim)	1 l	0.1397	5,322

Note: NI stands for not included in the CPI, kg for kilograms, and l for liters. Number of observations, 984,485.
Source: own elaboration from data of the General Directorate of Commerce.

Table A.2

DEFINITION OF THE AGGREGATE CATEGORIES

Category	*Aggregate category*
Beer	Alcoholic beverages
Wine	Alcoholic beverages
Beans	Beans
Beef (aguja)	Beef
Beef (nalga)	Beef
Beef (paleta)	Beef
Bread	Bread
Brown eggs	Brown eggs
Cacao	Cacao
Chicken	Chicken
Coffee	Coffee
Cola	Cola
Frankfurters	Cold cuts and sausages
Ground beef	Cold cuts and sausages
Ham	Cold cuts and sausages
Ham (leonesa)	Cold cuts and sausages
Hamburger	Cold cuts and sausages
Sausage	Cold cuts and sausages
Crackers	Crackers
Butter	Dairy products
Grated cheese	Dairy products
Ice cream	Dairy products
Margarine	Dairy products
Yogurt	Dairy products
Maize flour	Flour

Table A.2 (cont.)

Category	*Aggregate category*
Wheat flour	Flour
Bleach	Cleaning supplies
Dishwashing detergent	Cleaning supplies
Laundry soap	Cleaning supplies
Laundry soap, in bar	Cleaning supplies
Mayonnaise	Mayonnaise
Noodles	Noodles
Semolina noodles	Noodles
Corn oil	Oil
Soybean oil	Oil
Sunflower oil	Oil
Deodorant	Personal care
Shampoo	Personal care
Soap	Personal care
Toilet paper	Personal care
Tooth paste	Personal care
Rice	Rice
Salt	Salt
Sparkling water	Sparkling water
Sugar	Sugar
Dulce de leche	Sweet spreads and jam
Peach jam	Sweet spreads and jam
Tea	Tea
Tomato paste	Tomato paste
Yerba	Yerba

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Patterns and Drivers of Corporate Bonds in Latin America

Adrian Robles
Bennett Sutton
Svetlana Vtyurina

Abstract

This paper overviews patterns in bond issuance in local and external markets by firms in six large Latin American countries. Also, using an unbalanced panel of firm and market-level indicators for years 1995-2015, we control for variables representing several theories of capital structure to gauge the firm's decision on the choice of issuance jurisdiction.

Keywords: capital structure, firm-level, Latin America, LA6, corporate bond markets.

JEL classification: G100, F300.

1. MOTIVATION

Heeding lessons from crises in the 1990s, many emerging market governments have sought to create deeper and more liquid local bond markets to reduce the risk of the double mismatch of currencies and maturities, and to channel local savings into long-term domestic investment (Laeven, 2014; IMF, 2014).

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In Latin America, expanding the array of investment vehicles was seen necessary to expand the investor base domestically and abroad, to improve lending terms for corporate and sovereign borrowers, and to promote financial stability (Goldstein and Turner, 2004; Borensztein et al. 2008; and Rodrigues-Bastos et al., 2015). Policymakers have also eyed the accumulation of domestic savings to fund the region's large infrastructure investments needed to raise potential growth (Cerra et al., 2017). Long-term ambitions envisioned easier access to capital through the development of regional financial centers featuring best practices in financial infrastructure, and in regulatory and tax regimes. Increasing the absorptive capacity of local markets could also improve domestic monetary policy transmission.[1]

Efforts to attract investment, coupled with the Latin America's rapid economic growth in the past decades, have brought a fresh wave of companies and investors into capital markets (Rodrigues, 2014). Against this backdrop, this paper provides a granular look at the trends in corporate bond financing over the past two decades, especially after the global financial crisis (GFC), in six of the most financially integrated economies in Latin America: Argentina, Brazil, Chile, Colombia, Mexico, and Peru (LA6, hereafter). In the context of the increased access to both local and external markets, and to contribute

[1] IMF (2004) states that money and bond markets provide instruments needed for the implementation of monetary policy and improve the transmission mechanism of the monetary policy. More than a decade later, this has become challenging, as Obstfeld (2015) puts it, "financial globalization has worsened the trade-offs monetary policy faces in navigating between multiple domestic objectives." Within the placed limitations, greater issuance in local markets (in local currency) could still help reduce the pressure to maintain stable exchange rates and give more prominence to the domestic interest rate policy. Liquid long-term local bond markets provide valuable information for the conduct of the monetary policy, including expectations and reactions to monetary policy changes (Laeven, 2014).

and expand on relevant research, this paper also examines the firm and market level factors influencing the choice of jurisdiction for bond placements. Guided by the outcomes, we offer some policy considerations on further development of local bond markets.

The rest of this paper is structured as follows. Section 2 overviews recent reforms, patterns in bond issuance and market structure in the LA6. Section 3 presents a literature review, description of the selected empirical methodology, data and results. Section 4 concludes with some policy considerations.

2. RECENT REFORMS AND THE STATE OF LATIN AMERICAN BOND MARKETS

2.1 Reform Overview

Borensztein et al. (2008) document that, in the early 1990s, Latin America had essentially no corporate bond markets (apart from Chile). The economic reforms of the 1990s, including privatizations and the introduction of private pension systems accelerated the demand for long-term debt instruments and deepening of the local markets (Jeanneau and Tovar, 2006; de la Torre et al., 2012; Tendulkar, 2015).[2] Adoption of international best practices, like International Financial Reporting Standards and Basel bank supervisory regimes, signaled a strengthening of corporate governance and regulatory capacity, which, in turn, generated externalities such as more favorable credit risk assessments.

Governments also spurred the evolution of debt markets by easing restrictions on foreign investment, simplifying investment regulations, allowing pension funds to invest in a wider array of assets, and developing derivatives and repurchase markets. Concurrently, modern asset management strategies

[2] For an account of reforms and regulatory developments in several countries prior to 2008, see Borensztein et al. (2008).

utilized by fund managers have increased demand for a more diverse universe of financial vehicles.

Governments also worked to make government debt instruments more attractive through greater financing of fiscal deficits on local markets, increased transparency with respect to the size, timing, and participation in issuances, including by setting up the market makers groups, and the establishment of liquid local benchmarks.

2.2 Stylized Facts

These efforts supported the growth and development of local bond markets, though the prominence of sovereign paper may have been an unexpected outcome. Government bonds constitute almost 60% of total stock, compared to 40% in Asia. Conversely, the role of corporate bonds is much smaller in Latin America. As a share of GDP, corporate bonds outstanding are about half the size of bonds in other emerging regions and advanced economies, and the flow of new issuances significantly lags other emerging regions (Figures 1 and 2).[3] Among the LA6 countries, Brazilian firms have the most debt outstanding, with their liabilities accounting for nearly 60% of the regional corporate bond stock. Until 2016, quasi-sovereign firms (largely Brazilian and Mexican) represented about a third of corporate funds raised, with most of it occurring externally (Figures 2 and 3).[4]

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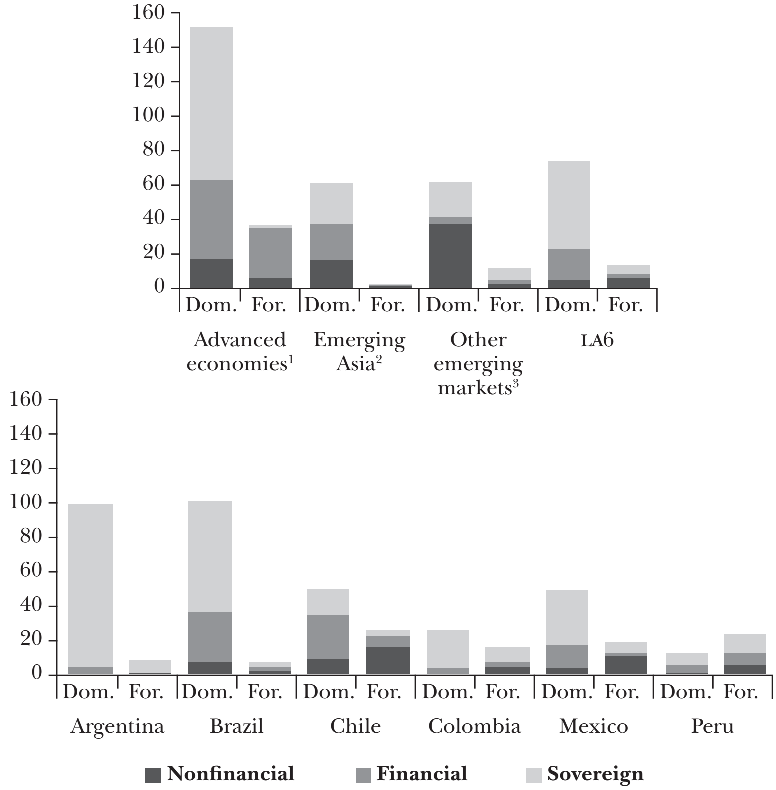
[3] It is important to highlight that emerging Asia does not include Hong Kong SAR, Singapore, and Korea as we use the IMF's World Economic Outlook definition, which considers the three as advanced economies.

[4] Since 2009, quasi-sovereigns have played an important role in foreign bond issuance, and most foreign issuance associated with Brazilian firms has taken place through subsidiaries located outside the country. So, calculating total issuance based on a residency criterion misses a significant amount of bond issuance that can be linked back to Brazil on a nationality basis

Figure 1

VALUE OF BONDS OUTSTANDING IN LOCAL AND EXTERNAL MARKETS, 2015

As percent of GDP



Notes: Dom. stands for *domestic*, and For. for *foreign*. [1] Includes: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and United States. [2] Includes China, India, Indonesia, Malaysia, Philippines, and Thailand. [3] Includes Croatia, Czech Republic, Hungary, Lebanon, Pakistan, Poland, Russia, Saudi Arabia, South Africa, and Turkey.

Sources: Bank for International Settlements, Securities Statistics; Dealogic; Ibero-American Federation of Exchanges; and IMF staff calculations.

Efforts to develop local markets, coupled with macroeconomic stability, spurred domestic issuance (Table 1). However, more dramatic was the speed and degree to which corporate debt finance has moved offshore. In the early 2000s, close to 60% of corporate bonds were issued locally, but by 2013-2015, the share had fallen to below 40%. Total issuance more than doubled in both value and number of issuances as external issuance exploded from USD 38 billion to over USD 200 billion.[5] In addition to larger issuance amounts, Latin American firms were also attracted by longer maturities and lower interest rates in advanced economy markets where post-GFC quantitative easing programs exacerbated favorable financing terms. The trade-off has been a substantial increase in foreign currency liabilities, in contrast to the objective of reducing currency mismatches.[6] Through much of the boom in foreign issuance (2009-2013), the currency risks appeared to be contained by financial and natural hedges as well as by domestic currencies that began appreciating soon after the crisis ended. Just before the GFC, there was a spike in demand for local currency denominated debt issued abroad, however, the demand has since returned to precrisis levels (Figure 2).

Within local markets, the major change has been the curtailed access for noninvestment grade firms, while their external issuance doubled (Table 1). However, the result is highly influenced by Brazil, where a contraction took place in both local and external issuances for noninvestment grade firms

(Rodrigues-Bastos et al., 2015). Easier access of quasi-sovereign to external markets may be underpinned by the explicit or implicit government guaranties.

5 External issuance is defined as bonds placed in a jurisdiction other than the country of residence; whereas local is defined as issuance in the country of residence.

6 Using firm-level data for five large Latin American economies, Rodrigues-Bastos et al. (2015) provide evidence of a significant change in companies' external funding strategies and liability structures since 2010, as well as in the balance sheet risks that firms face.

Table 1

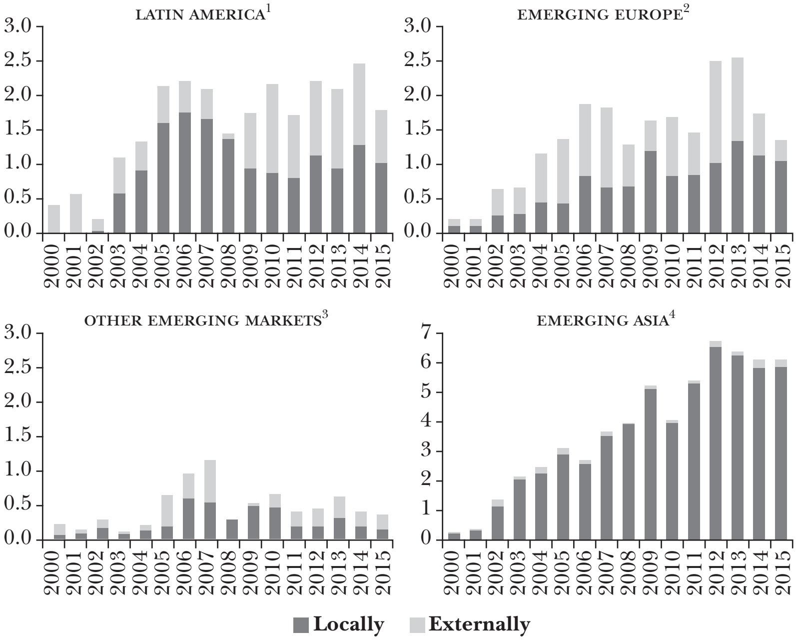
LA6: SUMMARY OF CORPORATE BOND ISSUANCE

	2003-2005		*2013-2015*	
	Local	*External*	*Local*	*External*
Investment: Grade				
Number of issuances	418	60	1,171	266
Total amount issued (USD millions)	34,648	20,624	121,996	163,831
Average amount issued (USD millions)	82.9	343.7	104.2	615.9
Average term[1] (months)	106.0	127.5	92.8	158.8
Average yield to maturity at issuance[1] (%)	6.1	6.5	6.3	4.8
Investment: Other				
Number of issuances	153	107	12	99
Total amount issued (USD millions)	19,638	18,004	882	37,257
Average amount issued (USD millions)	128.3	168.3	73.5	376.3
Average term[1] (months)	114.1	96.3	88.6	93.8
Average yield to maturity at issuance[1] (%)	7.6	8.4	10.2	7.4
Investment: Total				
Number of issuances	571	167	1,183	365
Total amount issued (USD millions)	54,285	38,628	122,878	201,087
Average amount issued (USD millions)	95.1	231.3	103.9	550.9
Average term[1] (months)	108.9	113.8	92.8	146.7
Average yield to maturity at issuance[1] (%)	6.2	7.4	6.4	5.3

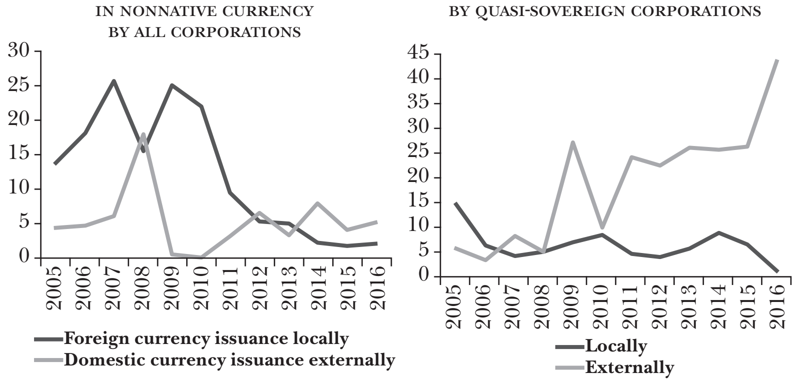
[1]Average weighted by amount issued.
Sources: Dealogic; and IMF staff calculations.

Figure 2

LA6: CORPORATE BOND ISSUANCE
As percentage of GDP



Notes: [1] Includes: Argentina, Brazil, Chile, Colombia, Mexico, and Peru. [2] Includes Hungary, Poland, Romania, Russia, and Turkey. [3] Includes China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand, and Vietnam. [4] Includes Algeria, Bahrain, Jordan, Lebanon, Nigeria, Pakistan, Saudi Arabia, and South Africa.
Sources: Dealogic and IMF staff calculations.



Source: Dealogic.

as economic conditions deteriorated (Table A.1). Investment grade firms fared better despite the sovereign's downgrade.[7] However, in most countries, except Argentina, overall issuance declined after the 2013 Taper Tantrum episode, with non-financial companies suffering more than financials (Figure 3).

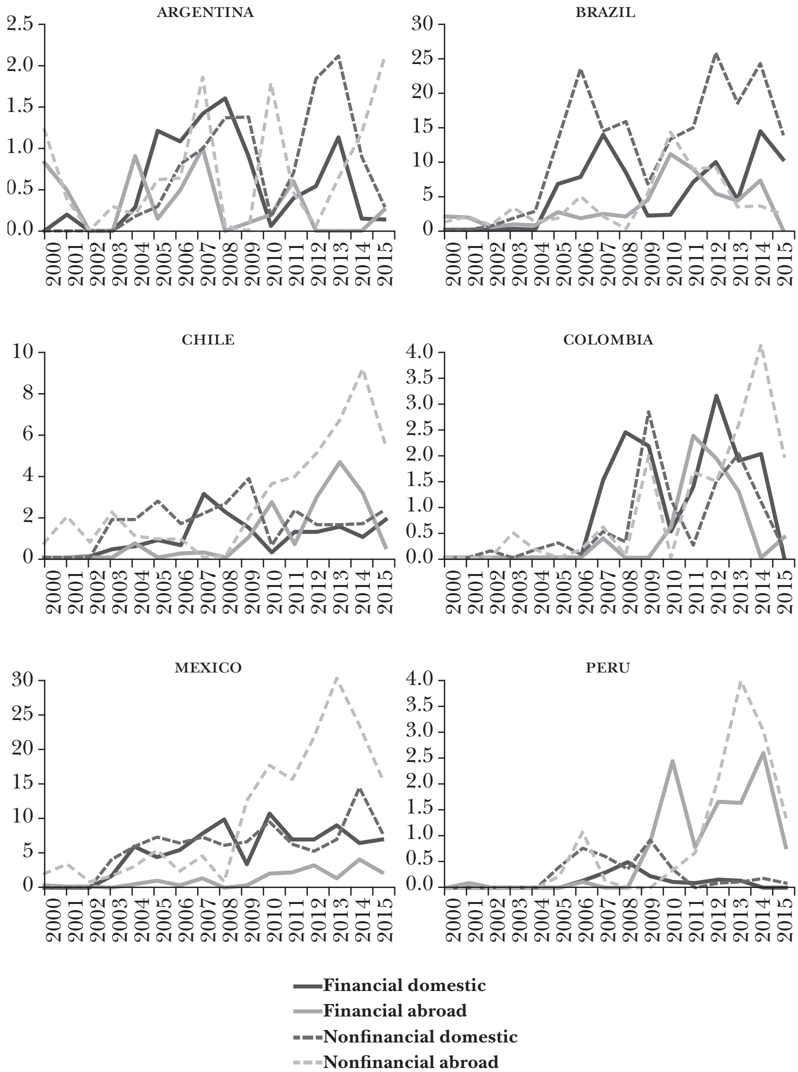
Relative liquidity conditions between local and external markets are also important indicators of market development. The level of market liquidity has many dimensions and cannot be captured by any single measure (IMF, 2015). Figures 4-6 provide some insights into general liquidity conditions in the LA6 economies. Aside from in Chile (data for Mexico is not available), markets are characterized by low trading volumes. While data limitations hinder a more in-depth analysis of corporate versus sovereign trading conditions, the World Federation of Exchanges data on the value of bonds traded on exchanges point to stronger investor interest in sovereign paper than corporate, except in Brazil and Peru.[8] Low trading volumes most likely encourage firms to cultivate demand from long-term institutional buyers and/or offer higher interest rates to compensate buyers for holding less liquid assets. These rigidities could push corporates to issue abroad where markets are more liquid.

[7] The Brazilian Development Bank (BNDES) provided substantial funding to Brazilian companies through loans and equity injections after the global crisis. This is likely to have contributed to lower bond issuance amongst Brazilians firms than it would otherwise have been the case (Rodrigues-Bastos et al., 2015).

[8] The value of bonds traded may be affected by different lot sizes or face values of different instruments. The volume (or number) of trades is also helpful in assessing market liquidity for different instruments, however, such data to measure corporate and sovereign trading was not available.

Figure 3

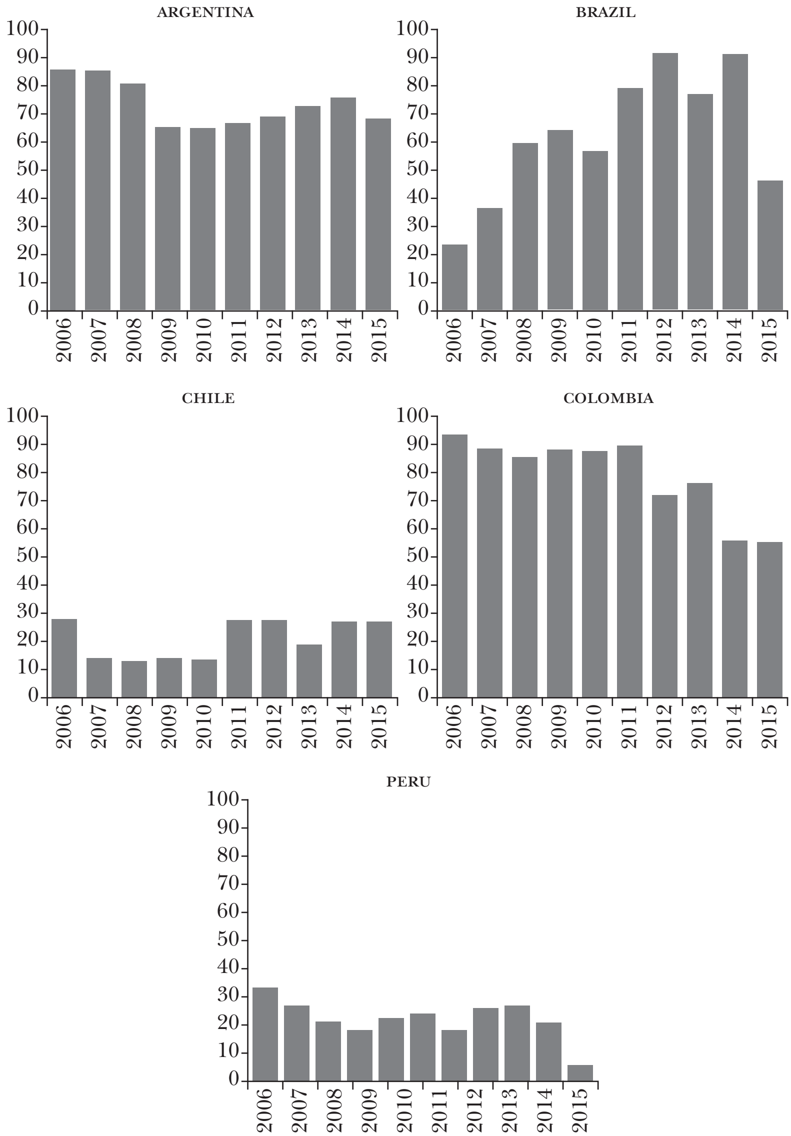
LA6: CORPORATE ISSUANCE BY COUNTRY[1]
Billions of USD



[1] Currencies converted to USD at prevailling exchange rate on the day issuance.
Sources: Dealogic and IMF staff calculations.

Figure 4

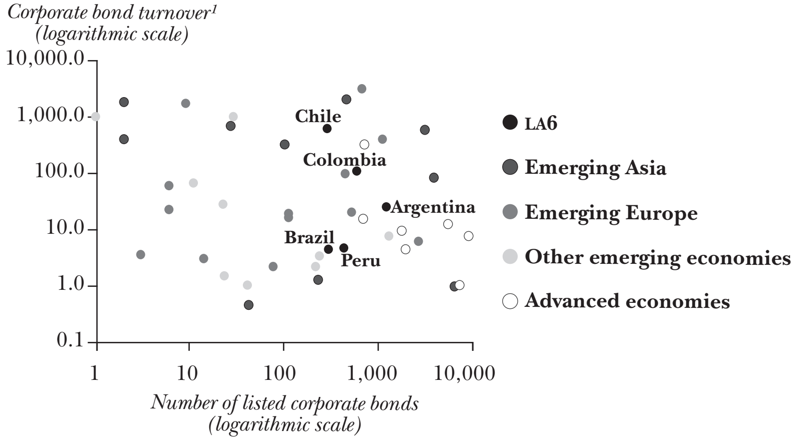
SHARE OF TRADING OF THE 10 LARGEST FIXED INCOME INSTRUMENTS, 2006-2015[1]
Percentages



[1] Includes both sovereign and private instruments.
Source: Ibero-American Federation of Exchanges.

Figure 5

CORPORATE BOND MARKET TURNOVER, 2016

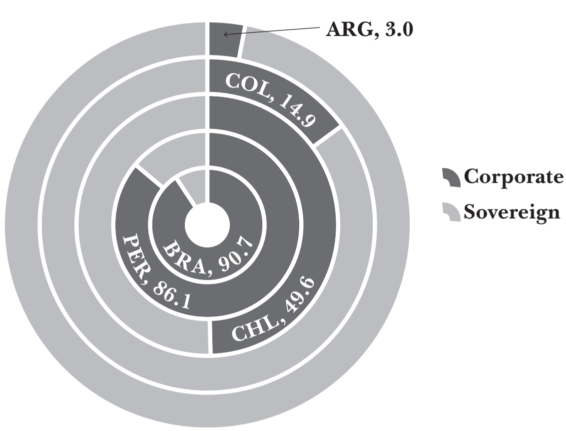


[1] Ratio of the number of transactions to the number of bonds listed.
Sources: World Federation of Exchanges; Bolsa de Santiago; and IMF staff calculations.

Figure 6

CORPORATE SHARE OF LOCAL BOND TRADING, 2016

Percentage of value traded



Source: World Federation of Exchanges.

2.3 Characteristics of Local Bond Markets

The largest markets are Chile, Brazil, and Mexico. Chile has a well-developed local market that generally meets the needs of local firms as it provides size, tenor (average at 13 years), and the funding tailored to the local needs.[9] The market's buyside, however, is dominated by large pension funds, which only hold top-rated paper, subjecting the lower-rated firms to fund through banks. Brazil's market is the largest (in nominal terms and by the number of issuances), and absorbs most local needs.[10] However, it struggles to support long-term instruments as few tenors exceed five years, and, like Chile, its slate of corporate issuers is heavily dominated by investment-grade companies. Mexico boasts many issuers, but the buyside is concentrated. Pension funds and the insurance sector buy the longer dated corporate paper (7 to 10 years), while mutual funds tend to buy the shorter floating rate notes with tenors of between three and

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9 The local regulator has encouraged the entrance of international investors to the local corporate market by removing the withholding tax for corporate bonds bought by international investors if they access the Chilean markets via what are known as *Huaso* bonds but to date there have been limited transactions.

10 In 2009, the Brazilian Securities Commission launched regulation 476 which was designed to speed up debt issuance in the local markets. Deals are to be marketed to a select number of investors and sold to a subset of them. Also, as opposed to the formal offering regulation (400), there is no need for prior notification or a deal prospectus given to the Stock Market Supervisor, although *400* deals can be marketed and sold to an unlimited number of qualified investors (those with more than BRL1 million in liquid assets). Also, with *476* deals, the bank can distribute to an unlimited number of investors through secondary distribution after 90 days. Most bonds remain similar to loan arrangements where banks fully underwrite the deals and therefore should take risk on their books if there is a lack of appetite from investors (*Euromoney*, 2015).

five years.[11] When buying local paper, pension funds are also limited to issuers rated AA– and above to guard against a forced sell-off if the debtor falls below investment grade.

Colombia's local debt market is also dominated by high-grade issuers, which reflects conservative risk management among institutional investors that largely buy and hold. Tenors go up to 20 years, although the average is about 10 years. Peru's local market is small, with most issuance dominated by financial institutions and a few large energy companies. As in other countries, the main players are very large pension funds, which are limited by prudential limits on lower rated firms. However, the largest obstacle preventing market growth is the limited number of corporate issuers and the small issuance amounts. Argentina's market tends to feature shorter term issuances with tenors averaging 15-25 months given the country's persistently high inflation, although volumes are large.[12] Secondary trading is light, not least because investors tend to hold to maturity given short tenors.

In summary, patterns of issuance in local bond markets are not homogeneous in Latin America (Table A.1), but there are common features including the outsized role of pension funds and a strong preference for investment grade issuers.

[11] Several large Mexican firms have considered issuing a series of transactions rather than just single placement to increase liquidity in peso securities. Also, *grossing-up* the Mexican withholding tax to compensate for the tax that international investors pay when they buy local debt (about 4.9%) is seen to improve foreign interest (*Euromoney*, 2015).

[12] Fernández et al. (2007) found that the small size of firms in Argentina could help explain why the bond market was a lot less developed, given the minimum size required for bond issues to be an attractive source of financing. The fact that many corporations in Argentina were reluctant to go public, and remain as closely held family businesses, might help explain this pattern of size distributions, as well as other features of capital markets.

3. DATA, METHODOLOGY, AND RESULTS

3.1 Literature Review

While the determinants of local market development are not explored in this article, the topic underlies many of our priors and results. Studies by Burger and Warnock (2004), Eichengreen and Luengnaruemitchai (2004), Braun and Briones (2006), and Bae (2012), among others, examine the role of scale, institutional development, and macroeconomic policy in spurring growth of local bond markets across the globe. Chinn and Ito (2006) identify capital market openness, legal, institutional, and accounting improvements when explaining the level of financial development.

We focus on the firm's capital structure and motivation theories that could explain the firm's decision regarding the jurisdiction of issuance. A comprehensive overview of those is found in Black and Munro (2010) and Mizen et al. (2012). Studies by Rajan and Zingales (1995), Booth et al. (2001), and Gozzi et al. (2012) find the size and strength of the firm's balance sheet being the determining factors in financing choice decisions (local or external), across both developed and developing countries. Whereas, Myers and Majluf (1984) concluded that before issuing abroad the largest and strongest firms might first tap local savings akin to the pecking order theory.[13] Lower-rated/smaller firms may attempt to go abroad where risk taking is more prevalent and the pool of investors is more diverse (Black and Munro, 2010).[14]

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[13] In corporate finance, pecking order theory postulates that the cost of financing increases with asymmetric information. Companies prioritize their sources of financing, first preferring internal financing, and then debt, lastly raising equity as a *last resort.*

[14] The cost of issuance has been perceived as one of the impediments for smaller firms to enter the market (Gozzi et al., 2012). The cost includes but is not limited to disclosure costs and accounting changes (when becoming a first-time issuer) and

Some firms might also seek external markets for its completeness/depth, which relates to the capacity to absorb larger issuances and innovatively structured or tailored products available in a larger and more diversified investor pool. Firms may also try to maintain market presence to ensure market continued access (Faulkender, 2005; Siegfried et al., 2007). Based on a sample of Asian economies, Mizen et al. (2012) reaffirm that the depth of the markets, their size and liquidity, can affect corporate financing decisions, and highlight the importance of a large nonresident investment base and the exemption from withholding taxes.

Issuance decisions can also be driven by risk management considerations where firms look for natural hedges, in which the exposure to a foreign currency debt service risk is offset by foreign currency revenues. Issuers in less developed markets may tap external markets to realize lower costs and other considerations, such as lengthening the tenor or locking in a rate (timing the market for yield). In more sophisticated and active markets, price arbitrage/static trade off considerations may drive decisions where deviations in cost incentives are actively arbitraged through variations in interest rates in different currencies and proceeds are frequently swapped back into local currency (Black and Munro, 2010).

The agency theory stipulates that while costs of disclosure and issuance fees rise when issuing aboard, this could be mitigated through collateral and the positive effects from greater transparency. Weak local indicators (namely, adverse macroeconomic conditions, inadequacy of local savings, tax regimes, underdeveloped local market infrastructure, information asymmetries, and barriers to nonresident investment) may also encourage firms in less developed local markets to issue externally (Burger and Warnock, 2006; Chan et al., 2012).

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underwriting fees (related to each specific issuance). However, for firms in Brazil, Chile, and Mexico, based on survey results, Zervos (2004) concludes that cost is not a factor behind a choice to issue externally.

Though these topics have been well covered in the literature, the strand of research looking together at the firm and market level factors influencing a choice of jurisdiction is not particularly large, with just a few studies examining the larger and more mature Asian markets. We contribute to the studies by examining these factors in the case of the LA6 firms.

3.2 Data

We compile a dataset on issuances in local and global markets by LA6 firms between 1995 and 2015, collecting both financial statements and issuance characteristics. The choice of variables for this analysis is guided by the findings in the previous literature but largely follows the approach of Mizen et al. (2012), and adapted for data availability in our countries of interest. The data were sourced from Bloomberg for 2,985 companies and includes a total of 9,060 separate issuances (Table A.2, panels A and B).[15] Compared to the analyses of Asian markets, which include advanced economies, the sample size is relatively small (Black and Mizen used between 35,000-45,000 observations). The pool of companies in the dataset is further restricted by the availability of financial statement information for each of the firm level explanatory variables for at least three years (Table 2). We then segment firms into financial versus nonfinancial and seasoned versus nonseasoned issuers to look for patterns in the structure and placement.[16]

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15 As in other studies, we do not consider the breakdown between parent and daughter companies or affiliates/subsidiaries, with the presumption that every entity borrows independently (even if not for its own purpose).

16 Nonseasoned firms are defined as entering the market for the first time.

3.3 Empirical Methodology

We use a discrete choice (probit model), which is a natural empirical method to evaluate the probability of a firm to issue abroad, once a decision to seek financing has been made.

$$Pr\left(EXTB_{ijt}=1\right)=\Phi(\alpha_i+X_{ijt}\beta_i+Z_{jt}\gamma+\epsilon_{ijt}).$$

The variable EXTB_{ijt} takes the value one if the bond is issued externally, and zero if issued locally. We also include firm-specific regressors, X_{ijt} for firm size, years present on stock market, liquid assets, term of the bond, and collateral.[17] These variables have been evaluated with and without a lag to check for robustness and to mitigate potential endogeneity concerns. Finally, the model includes a global financial crisis dummy, a rating agency dummy, and a time trend to account for debt markets becoming increasingly international over time. In Table 2, we present the regressors and the expected signs of the estimated coefficients.

3.4 Data Overview

In this section, we discuss summary statistics, including means and standard deviations for the individual factors in the choice of financing with respect to the jurisdiction. These are reported for all sample firms, then broken down into financial and nonfinancial, those that issue locally or externally, and for each country. Table A.3 shows that issuers in local markets are smaller and have lower capital expenditure needs, which suggests that their financing needs could be met in local markets. The results are similar to Mizen et al. (2012) findings for the Asian economies.

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[17] ijt and jt indicate firm and market level indicators, respectively. α_i represents the constant, X_{ijt} represents firm level coefficients, and Z_{jt} represents the coefficients for market level indicators.

Table 2

VARIABLES AND EXPECTED OUTCOMES

Variable	*Definition*	*Expected* Outcome / Expected Sign (for increasing the probability of external issuance)
	Firm Level Indicators	
SIZE	Logarithm of the firm's total assets	Larger firms (+)
AGE	Years listed on the stock exchange	Older firms (+)
LIQ	Current assets over total liabilities	Highly liquid firms (+)
COL	Tangible assets over total assets	Highly collateralized firms (+)
Rating	Dummy	Rated firms (+)
TERM	Term of the bond	Foreign markets at longer terms (+)
	Market Level Indicators	
TDSEC	Total bonds to GDP	Small total market (−)
ONSRT	Local issuance over total issuance	Small local market (−)
INTD	Difference between short-term local and external rates (3-12-month maturity, in percentage points)	Higher local rates (−)
EXGD	External government debt over GDP	Lower public external presence (+)
FDI	Foreign direct investment over GDP	Lower FDI (−)
FC	Global financial crisis dummy (2008-209)	High liquidity abroad (−)

At the same time, local firms are less leveraged (which could be interpreted as a sign of vulnerability), more liquid (which could mean that they need less funding), and possess less collateral (which could deter borrowing terms). The fact that larger firms issue in external markets could be an indication of the lack of local market's depth. Financial firms are smaller in size, which is also in line with findings by Mizen et al. (2012). Also, their assets are more liquid, which could be associated with the region's substantial dependency on deposit funding or in the case of Peru, high levels of dollarization. Financial firms also maintain larger collateral. Seasoned firms are less leveraged than the nonseasoned ones, but nonseasoned entities are slightly larger in size.[18] The rating dummy indicates that a large share of our estimation sample is composed of entities that have received a rating by at least one main rating agency.[19]

Table A.4 shows differences by country at the firm level. Issuance in local and external markets depict quite sizable variations by country. Unsurprisingly, Brazil has an outsized impact on the aggregate averages for most indicators. Brazil's weight in the estimation sample increases after applying the selection criteria. Companies in Brazil, Colombia, and Mexico are most indebted, but are also among the most profitable. Aside from Argentine and Peruvian firms, the sizes of total assets are comparable, with Brazil having the bigger companies on average. The ratio of rating is similar among countries apart from Chile, perhaps highlighting the depth of the local market.

Table A.5 shows the market level indicators. The averages display significant variation between each of the LA6, with Brazil's, Chile's, and Mexico's markets having the biggest impact on regional averages. These have the deepest markets (TDSEC), while Peru's and Argentina's markets are small. Mexican and Brazilian firms dominate large issuances abroad (FCY) and

[18] The difference in the firms' characteristics by issuance type (local or external) is small but statistically significant.

[19] Rating agencies include Standard & Poor's, Fitch, or Moody's.

in local markets (LCY) where the sizes of issuances are larger than their external placements, also indicated by size of the local market (ONSRT). Foreign direct investment (FDI) is similar across countries, with Chile having a higher level than average, indicating favorable domestic conditions for foreign investment.

3.5 Empirical Results

As discussed, we aim to identify the factors behind the decision to issue in foreign jurisdictions. The decision is partly determined by firm characteristics (size and years on the market, among others) and partly dependent on the level of development of the market (depth and liquidity, among others). Our dependent variable is *EXTB*, which takes a value of one if the bond is issued externally.

3.5.1 Firm Level Indicators

At the firm level, the results show that the balance sheet of a firm (SIZE) is statistically significant in all specifications (Table 3). This likely reflects that smaller firms are more inclined to issue in domestic markets where the investor base is more familiar with the issuer. Furthermore, international underwriters may be empowered to exercise a strong preference for large recognizable names and thus deprioritize issuance by smaller firms. Transaction costs of issuing externally could be higher and larger firms might have more capacity to absorb these costs. It is also possible that the funding needs of larger firms could stress liquidity conditions in local markets leading to higher borrowing costs. While highly liquid (LIQ) firms may need less borrowing and tend to issue externally, this factor may not have a sizeable impact on the issuance decision (positive sign with 10% statistical significance on a couple specifications), perhaps owing to a need to maintain access to more liquid markets. At the same time, and in line with expectations, firms with higher collateral (COL) seem to issue less in local markets, as they most likely get better terms abroad as foreign lenders may require greater pledges of tangible assets to assuage concerns of agency risk and the potential for high costs of recovery (statistical significance in all three specifications). The impact by the terms of the bond (TERM) is also in line with expectations; companies generally seek foreign markets to borrow at longer terms (positive and statistically significant in all specifications). Finally, the years of presence in the market (AGE) seem to have an impact in the decision of issuance as established companies might benefit from industry and international presence. Also, there are benefits of validation associated with having been rated by a major agency, as this variable (RATING) shows high statistical significance in all specifications. This suggest that bond markets take a favorable view of even *young* and *small* firms if they are rated.

3.5.2 Market Level Indicators

With respect to market characteristics, the relative size of a local market (ONSRT) seems to have an impact on issuance (highly statistically significant), factors such as competition and low/high domestic liquidity could be driving forces in altering the lure of local issuance. The overall size of the market (TDSEC) influences (negative coefficient) the jurisdiction choice, indicating support for the pecking order theory as firms will access a market if there is sufficient scale and depth. The incentive to issue abroad spurred by the interest rate differential (INTD), did not prove statistically significant, it plays some role in the decision on issuing externally in both specifications (lower local rates reduce the probability of going abroad). Unlike our expectations, a larger presence of sovereign external debt (EXGD) increases the probability of financing externally. Also, higher net FDI inflows may be associated with supportive foreign conditions reducing the need of borrowing locally. In sum, the results of the market indicators are consistent with the market depth theory.

Table 3

CHOICE OF MARKET: FIRM LEVEL DATA, WITH TIME TREND

	1	*2*	*3*
$SIZE_{ijt}$	0.0683[c] (3.26)	0.0906[c] (4.09)	0.0943[c] (4.23)
$LEVER_{ijt}$	0.264[a] (1.80)	0.249[a] (1.68)	0.194 (1.31)
AGE_{ijt}	0.0236[c] (5.14)	0.0264[c] (5.55)	0.0234[c] (4.87)
LIQ_{ijt}	0.127[a] (1.66)	0.154[b] (1.99)	0.129 (1.64)
COL_{ijt}	0.474[c] (3.23)	0.522[c] (3.42)	0.582[c] (3.77)
$RATING_{ijt}$	0.818[c] (12.37)	0.890[c] (12.74)	0.852[c] (12.09)
$TERM_{ijt}$	0.0183[c] (6.20)	0.0198[c] (6.53)	0.0204[c] (6.60)
FC_dummy	0.206[a] (1.95)	0.252[b] (2.38)	0.195[a] (1.82)
$EXGD_{jt}$	0.00945[c] (3.10)	0.004 (1.05)	0.0257[c] (4.97)
$TDSEC_{jt}$	−1.103[c] (−10.20)	0.031 (0.11)	−0.100 (−0.364)
$ONSRT_{jt}$		−1.610[c] (−4.299)	−1.532[c] (−4.049)
$INTD_{jt}$		−0.007 (−0.781)	−0.001 (−0.065)
FD_{ijt}			−0.147[c] (−6.347)
Constant	−2.553[c] (−8.314)	−1.776[c] (−4.459)	−1.312[c] (−3.191)
Pseudo R^2	0.152	0.165	0.176
BIC	3,347.695	3,133.818	3,100.485

Note: Z-statistic in parenthesis; [a] p<0.05, [b] p<0.01, [c] p<0.001.

3.5.3 Sectoral Characteristics

When controlling for firm-specific characteristics, we find that factors affecting the choice of the jurisdiction vary depending on the firms' business segment (financial or nonfinancial) and the presence on the market (seasoned or unseasoned). In Table A.6, which shows the detailed breakdown for the choice of a market, nonfinancial entities display more significant variables primarily due to the small sample size of financials. The absolute size of the market (TDSEC) has a positive influence on the jurisdiction choice suggesting that the overall market depth is more important for all nonfinancial firms, specifically for the unseasoned (statistical significance), while financial firms may be indifferent given several funding options at their disposal, including through deposits. The result for the relative size of the local market (ONSRT) for both groups of nonfinancial entities in the sample do not show statistical significance, while financial firms' result may be once again explained by specificities of their funding structures. Interest rate differential (INTD) is most significant for nonfinancial seasoned firms. Finally, nonseasoned and seasoned, nonfinancial firms may be more likely to issue locally when there are strong FDI inflows.

In Table A.7, we provide full results, including both firm and market level indicators with seasoned dummy interactions, for all observations and nonfinancial firms. The financial corporations are not represented due to observation limitations in the sample. Most of the indicators behave as expected and consistent with previously reported model specifications, but we can clearly see the difference between seasoned and nonseasoned firms in both firm and market level variables.

We provide detailed results on goodness-of-fit tests, both intercept and full model, for all the specifications used in this exercise in Table A.8. We also provide the marginal effects for our Table 3 specifications in Table A.9, which calculates the marginal effects at the means of the independent variables by using the default prediction option associated with the previous estimation command, in this case a probit model. Before moving on to robustness checks on our models, we note that the marginal effects share consistent coefficient signs and statistical significance for our indicators in Table 3.

3.5.4 Robustness

The indicators used in our model specifications were carefully selected to reduce the number of bias and other statistical problems that might arise during our analysis. For robustness checks, we include a variety of additional indicators to our established specifications. These indicators include:

- VIX: Indicates macroenvironment (from Bloomberg);
- EMBI: Indicative of the shocks as market reprices the risk (from Bloomberg);
- Oil prices: Captures the shock caused by the change in prices (from US Energy Information Administration).

We report these new specifications in tables A.10-A.12 in the Annex. In Table A.10 we use introduce VIX to our initial specification in Table 3. The results show very little changes in the behavior of the chosen indicators. Firm-level indicators: *Size, Age, Collateral, Ratings,* and *Term*, behave similarly to the specification shown in Table 3. These components have the same statistical significance level and coefficient responses as in the base specification.

To further test the robustness, we introduce the EMBI index. The EMBI index is a general emerging markets sovereign debt benchmark. Similar to the introduction of VIX, we add this component to our base specification of Table 3 and see very little change in the significance and behavior of the components.

While we include various firm and market level indicators to capture the overall dynamic of local or foreign issuance, we do not include a component capturing the shocks of oil price that affects the global economy and might have greater importance in oil producing countries such as Colombia and Mexico. As part of our robustness check and to avoid any issues we might encounter with including excessively correlated variables in the specification, we introduce market-level indicator WTI oil prices. Since we utilize standard WTI prices, this indicator does not vary across countries. The results suggest that this modification in the specification does not alter the coefficient response, and there is very little change in statistical significance with the most noticeable change being in the *Financial-crisis* dummy variable, which slightly increases significance but remains with a consistent and comparable coefficient value. Most importantly, WTI oil price seems to be significant with two of the specifications, with a very small but negative coefficient, meaning that when the price of oil increases, the probability of foreign issuance goes down. This is particularly important for oil producing countries in our sample, higher prices contribute to higher economic growth and incentivize investment in the economy through borrowing internationally.

4. CONCLUSIONS AND POLICY CONSIDERATIONS

The volume and the relative size of corporate bond issuances in both external and local markets increased significantly in the LA6 over the past two decades. This was facilitated by greater macroeconomic stability and regulatory reforms. However, local markets remain relatively small compared to peers, not very liquid and dominated by government paper.

With the greater availability of funding in both foreign and domestic markets, we searched for evidence in support of several capital structure theories by examining the firm-level and market factors influencing the firm's choice where to issue. Our results support the market completeness theory, where the choice of the jurisdiction depends on the markets' scale and depth and their ability to accommodate the borrower's needs. The size of the overall market was a statistically significant factor in selecting the jurisdiction of issuance. At the firm level: size, age, collateral, and term of the bond were indicators of higher probability of external issuance, most likely driven by large financial and liquidity needs not being accommodated by the local market. This supports firm structure/scale and agency cost theories.

The analysis confirms that local bonds markets in several countries studied here will need to continue growing and developing to attract more issuers and provide a wider array of investment opportunities. However, this could be construed as a chicken and egg dilemma, as firms look for larger markets for funding, but markets will not become larger unless more firms enter. This is where the recommendations from other studies on the prerequisites for local market development become relevant.

Strong macroeconomic policies play an important role in spurring growth of local bond markets (Burger and Warnock, 2006). For example, in our country sample, recent macroeconomic imbalances resulting in high inflationary environments, like in Argentina, led to bond maturities of a very short nature, which are not attractive for long-term investors. Consistent with crowding out theory, a high level of government debt, as in Brazil, may have reduced the share of corporate bonds in the total stock.

Governments should continue to support local markets by establishing highly traded benchmark instruments against which private bond spreads can be valued. Domestic bond spreads provide traders and policy makers with market perceptions of credit risk, which can inform and improve the conduct of monetary policy. Also, the expansion of hedging instruments would help reduce currency risks and external funding dependence (Saxena and Villar, 2008). These are more available and diversified in the countries with larger capital markets (Mexico and Brazil) but are still scarce in countries like Peru. Ensuring continued participation of the country in emerging-market benchmarks and global portfolios is also an important factor for attracting global interest to the country.

Regulatory restrictions and reforms have also been found important in hindering or promoting local bond financing

(Borensztein et al., 2008).[20] For example, while Peru has achieved and maintained impressive macroeconomic stability, its local markets remain small, not least due to regulatory hurdles and institutional weaknesses. Overall, to foster greater issuer participation and investor confidence, it is necessary to further strengthen the corporate governance frameworks, streamline issuance processes and procedures, not least by reducing cumbersome registration requirements (IMF, 2005). Improving data collection and dissemination, and enhancing competitiveness of the market infrastructure (safer, more efficient payment and settlement systems) will also help achieve greater market efficiency and transparency (IOSCO, 2007).

Finally, as both firm and market size continue to be important obstacles to the development of local markets, consideration should be given to policies that widen the attractiveness of pooling vehicles that generate subsequent trades like mutual funds, money market accounts and index funds. (Borensztein et al., 2008). There is also room to consider greater cross-border integration to address the problem of small market size and liquidity, perhaps through the Latin America Integrated Market (MILA) initiative that aims to foster equity and bond market integration among Chile, Colombia, Mexico, and Peru. Expanding pension and mutual funds not only creates demand for fixed income securities but also contributes to the increase in financial innovation, improved corporate governance, and enhances competition in the bond market (Silva, 2008).[21]

[20] While we did not test for the effect of the withholding tax on the decision of foreigners entering the local market and providing greater funding, as all countries have this tax, albeit with various provisions, exemptions, and rate structure (The International Bureau of Fiscal Documentation' s Tax Research Platform, IBFD.org), not surprisingly, this was a negative factor for the development of the local markets in the study of the Asian economies.

[21] IMF (2017) recommends a small exemption to the limits on foreign asset holdings by pension funds, specifically that up to

Building on the latter point, further research could consider the demand side factors, like the capacity of the domestic institutional investors to absorb the additional domestic bond issuance, although, as mentioned, the issue lies in part in the regulation and limits on investments guided by firms' ratings, but also in the expansion employee participation in pension schemes. Another angle could be looking in more detail into the pecking order theory to gauge what types of firms first issue domestically or abroad (for example, better rated firms and more liquid firms). Similarly, it could be explored how reliance/availability of bank financing factors into the decision on the firms' financing choice.

5% of assets under management can be regional instruments and would not count towards statutory foreign asset limits. Regulators could agree on a bilateral or multilateral basis as to which countries would qualify for the exemption. Prudential regulations applicable to domestic assets such as credit quality criteria should also apply to regional assets held under the 5% exemption.

Annex

Table A.1

SUMMARY OF LA6 CORPORATE BOND ISSUANCE BY COUNTRY

		2003-2005		*2013-2015*	
		Local	*External*	*Local*	*External*
Argentina					
Investment Grade	Number of issuances	71	–	161	1
	Total amount issued (USD millions)	729	–	4,789	375
	Average amount issued (USD millions)	10.3	–	29.7	375.0
	Average term[1] (months)	52.8	–	35.9	120.0
	Average yield to maturity at issuance[1] (%)	5.7	–	10.9	6.5
Other	Number of issuances	3	13	2	10
	Total amount issued (USD millions)	68	1,950	21	4,208
	Average amount issued (USD millions)	22.5	150.0	10.5	420.8
	Average term[1] (months)	27.2	105.7	13.6	100.7
	Average yield to maturity at issuance[1] (%)	–	–	–	–
Brazil					
Investment Grade	Number of issuances	12	34	586	65
	Total amount issued (USD millions)	899	4,948	55,824	54,763
	Average amount issued (USD millions)	75.0	145.5	95.3	842.5
	Average term[1] (months)	52.0	100.7	70.5	102.7
	Average yield to maturity at issuance[1] (%)	–	7.1	19.0	5.0

Other	Number of issuances	108	85	7	21
	Total amount issued (USD millions)	17,491	14,060	708	6,456
	Average amount issued (USD millions)	162.0	165.4	101.2	307.4
	Average term[1] (months)	117.4	91.0	73.0	92.4
	Average yield to maturity at issuance[1] (%)	10.1	8.7	7.5	8.2
Chile					
Investment	Number of issuances	178	3	99	70
Grade	Total amount issued (USD millions)	7,495	950	9,799	27,289
	Average amount issued (USD millions)	42.1	316.7	99.0	389.8
	Average term[1] (months)	200.0	120.0	178.9	139.3
	Average yield to maturity at issuance[1] (%)	5.4	5.0	3.7	4.2
Other	Number of issuances	8	3	–	7
	Total amount issued (USD millions)	645	850	–	3,600
	Average amount issued (USD millions)	80.6	283.3	–	514.3
	Average term[1] (months)	135.3	116.6	–	101.0
	Average yield to maturity at issuance[1] (%)	4.8	7.6	–	7.3
Colombia					
Investment	Number of issuances	–	–	98	14
Grade	Total amount issued (USD millions)	–	–	7,231	10,242
	Average amount issued (USD millions)	–	–	73.8	731.5
	Average term[1] (months)	–	–	114.2	184.3
	Average yield to maturity at issuance[1] (%)	–	–	4.9	5.5

Table A.1 (cont.)

SUMMARY OF LA6 CORPORATE BOND ISSUANCE BY COUNTRY

		2003-2005		*2013-2015*	
		Local	*External*	*Local*	*External*
Other	Number of issuances	4	–	–	8
	Total amount issued (USD millions)	450	–	–	4,700
	Average amount issued (USD millions)	112.6	–	–	587.5
	Average term[1] (months)	104.6	–	–	91.5
	Average yield to maturity at issuance[1] (%)	–	–	–	6.0
Mexico					
Investment	Number of issuances	169	21	213	93
Grade	Total amount issued (USD millions)	26,852	14,446	45,188	62,887
	Average amount issued (USD millions)	158.9	687.9	212.2	676.2
	Average term[1] (months)	81.4	139.6	104.3	203.7
	Average yield to maturity at issuance[1] (%)	7.2	6.3	6.3	4.8
Other	Number of issuances	21	5	1	37
	Total amount issued (USD millions)	766	920	44	14,803
	Average amount issued (USD millions)	36.5	184.0	44.1	400.1
	Average term[1] (months)	51.2	112.3	24.0	91.7
	Average yield to maturity at issuance[1] (%)	8.8	10.2	–	6.9

Peru

Investment	Number of issuances	3	2	18	23
Grade	Total amount issued (USD millions)	150	280	416	8,275
	Average amount issued (USD millions)	50.0	140.0	23.1	359.8
	Average term[1] (months)	140.0	76.6	125.9	172.1
	Average yield to maturity at issuance[1] (%)	7.2	–	6.5	5.2
Other	Number of issuances	9	1	2	16
	Total amount issued (USD millions)	217	225	108	3,490
	Average amount issued (USD millions)	24.1	225.0	54.0	218.1
	Average term[1] (months)	54.6	126.0	232.0	92.3
	Average yield to maturity at issuance[1] (%)	6.0	8.0	8.1	8.0

[1] Average weighted by amount issued.
Sources: Dealogic; and IMF staff calculations.

Table A.2

A. CORPORATE BOND ISSUERS IN ESTIMATION SAMPLE

	Pre-estimation (1)			*Post-estimation (2)*		
	No. of issuers	*No. of external*	*External as % of total*	*No. of issuers*	*No. of external*	*External as % of total*
All						
1995-2005	4,580	1,571	34.30	1,940	1,005	51.80
2006-2015	903	269	29.79	224	84	37.50
Peru						
1995-2005	433	98	22.63	125	63	50.40
2006-2015	174	54	31.03	38	28	73.68
Mexico						
1995-2005	919	499	54.30	523	352	67.30
2006-2015	137	57	41.61	35	20	57.14
Chile						
1995-2005	544	166	30.51	214	90	42.06
2006-2015	74	9	12.16	22	0	0.00
Argentina						
1995-2005	514	174	33.85	120	54	45.00
2006-2015	55	19	34.55	20	7	35.00
Colombia						
1995-2005	377	95	25.20	46	23	50.00
2006-2015	114	33	28.95	17	1	5.88
Brazil						
1995-2005	1,793	539	30.06	912	423	46.38
2006-2015	349	97	27.79	91	28	30.77

Table A.2

B. CORPORATE BOND ISSUANCES IN ESTIMATION SAMPLE

	No. of issuances	*No. of external issuances*	*External issuances as % of total*
All			
1995-2005	2,612	975	37.33
2006-2015	6,448	1,810	28.07
Peru			
1995-2005	185	65	35.14
2006-2015	610	124	20.33
Mexico			
1995-2005	742	417	56.20
2006-2015	1,180	402	34.07
Chile			
1995-2005	220	87	39.55
2006-2015	832	291	34.98
Argentina			
1995-2005	123	65	52.85
2006-2015	848	267	31.49
Colombia			
1995-2005	120	9	7.50
2006-2015	498	114	22.89
Brazil			
1995-2005	1,222	332	27.17
2006-2015	2,480	612	24.68

Table A.3

SUMMARY STATISTICS FOR FIRM-SPECIFIC VARIABLES

	All	*Local*	*External*	*Diff.*	*Financial*	*Nonfinancial*	*Diff.*	*Seasoned*	*Nonseasoned*	*Diff.*
SIZE*ijt*	8.581	7.886	8.559	0.000	8.210	8.586	0.003	8.140	8.811	0.000
	(1.85)	(1.43)	(1.54)		(1.61)	(1.85)		(1.37)	(2.02)	
LEVER*ijt*	0.319	0.358	0.371	0.065	0.417	0.317	0.000	0.291	0.333	0.000
	(0.17)	(0.16)	(0.21)		(0.20)	(0.17)		(0.16)	(0.18)	
AGE*ijt*	19.831	17.108	19.406	0.000	16.547	19.880	0.000	19.087	20.221	0.000
	(5.92)	(6.02)	(5.82)		(6.07)	(5.91)		(6.20)	(5.74)	
LIQ*ijt*	0.631	0.554	0.522	0.033	1.166	0.623	0.000	0.623	0.636	0.144
	(0.51)	(0.42)	(0.30)		(1.36)	(0.48)		(0.53)	(0.50)	
COL*ijt*	0.878	0.827	0.872	0.000	0.892	0.877	0.232	0.863	0.885	0.000
	(0.18)	(0.22)	(0.16)		(0.21)	(0.18)		(0.20)	(0.16)	
RATING*ijt*	0.648	0.532	0.847	0.000	0.708	0.647	0.066	0.534	0.707	0.000
	(0.48)	(0.50)	(0.36)		(0.46)	(0.48)		(0.50)	(0.46)	
TERM*ijt*	8.211	7.725	9.207	0.000	6.341	8.890	0.051	8.162	9.292	0.001
	(7.96)	(7.72)	(8.35)		(6.11)	(8.62)		(6.50)	(9.67)	

Notes: The table reports sample means with standard deviations in parenthesis. SIZE*ijt* : Logarithm of total assets. INV*ijt* : Investments over total assets. AGE*ijt* : Numbers of years listed on the stock exchange. LEVER*ijt* : Total debt to total assets. LIQ*ijt* : Current assets over total liabilities. COL*ijt* : Tangible assets to total assets. RATING*ijt* : Rating provided by at least one rating agency. YRS_MAT*ijt* : Yield to maturity at issuance. Equality of mean *p*-value is reported under *Diff.* with H_0: diff =0 and H_a: diff ≠0.

Table A.4

SUMMARY STATISTICS FOR FIRM-SPECIFIC VARIABLES, COUNTRY LEVEL

	All	*Peru*	*Mexico*	*Chile*	*Argentina*	*Colombia*	*Brazil*
SIZE*ijt*	8.581	7.503	8.289	8.031	7.301	8.552	9.055
	(1.85)	(1.06)	(1.54)	(1.42)	(1.61)	(0.96)	(2.04)
LEVER*ijt*	0.319	0.267	0.339	0.263	0.293	0.340	0.325
	(0.17)	(0.11)	(0.19)	(0.15)	(0.11)	(0.28)	(0.17)
AGE*ijt*	19.831	16.823	20.041	22.015	17.377	17.320	19.926
	(5.92)	(5.04)	(5.40)	(6.13)	(5.63)	(4.76)	(6.08)
LIQ*ijt*	0.631	0.654	0.635	0.955	0.551	0.380	0.584
	(0.51)	(0.34)	(0.54)	(0.71)	(0.36)	(0.17)	(0.46)
COL*ijt*	0.878	0.913	0.832	0.930	0.933	0.909	0.881
	(0.18)	(0.14)	(0.21)	(0.11)	(0.14)	(0.12)	(0.17)
RATING*ijt*	0.648	0.672	0.759	0.288	0.475	0.680	0.671
	(0.48)	(0.47)	(0.43)	(0.45)	(0.50)	(0.47)	(0.47)
TERM*ijt*	8.211	9.149	10.014	11.433	4.124	9.841	7.057
	(7.96)	(6.86)	(8.56)	(10.14)	(4.22)	(5.52)	(7.71)

Notes: The table reports sample means with standard deviations in parenthesis. SIZE*ijt* : Logarithm of total assets. INV*ijt* : Investments over total assets. AGE*ijt* : Numbers of years listed on the stock exchange. LEVER*ijt* : Total debt to total assets. LIQ*ijt* : Current assets over total liabilities. COL*ijt* : Tangible assets to total assets. RATING*ijt* : Rating provided by at least one rating agency. YRS_MAT*ijt* : Yield to maturity at issuance. Equality of mean *p*-value is reported under *Diff.* with H_0: diff =0 and H_a: diff ≠0.

Table A.5

MARKET SUMMARY STATISTICS

	All	*Peru*	*Mexico*	*Chile*	*Argentina*	*Colombia*	*Brazil*
FCY*jt*	107.339 (53.74)	27.872 (13.03)	137.864 (57.06)	36.139 (18.53)	51.323 (1.56)	34.150 (8.43)	123.182 (29.48)
LCY*jt* [1]	1,018.927 (782.74)	23.465 (6.14)	472.146 (125.34)	119.960 (16.66)	20.865 (5.29)	81.568 (13.34)	1,689.536 (445.79)
TDSEC*jt*	0.695 (0.25)	0.300 (0.04)	0.530 (0.12)	0.655 (0.08)	0.127 (0.02)	0.346 (0.02)	0.892 (0.08)
ONSRT*jt*	0.818 (0.16)	0.491 (0.12)	0.778 (0.04)	0.749 (0.07)	0.286 (0.06)	0.707 (0.05)	0.930 (0.02)
INTD*jt*	6.846 (4.11)	3.490 (1.84)	3.635 (1.18)	1.238 (1.44)	12.275 (0.53)	4.133 (0.67)	10.158 (2.44)
EXGD*jt*	28.70 (10.18)	31.08 (7.73)	27.70 (6.54)	49.33 (10.55)	27.55 (3.65)	26.97 (6.18)	24.92 (6.79)
FDI*jt*	3.65 (1.81)	4.68 (1.01)	2.57 (0.59)	8.01 (1.46)	1.79 (0.60)	3.97 (0.71)	3.32 (0.79)

Notes: The table reports sample means with standard deviations in parenthesis. FCY*jt* : Firm's external liabilities in millions of USD. LCY*jt* : Firm's local liabilities in millions of USD. TDSEC*jt* : Total bonds to GDP. ONSRT*jt* : Local bonds to total bonds. INTD*jt* : Short-interest differential between local and US nominal rates. EXGD*jt* : External government debt. FDI*jt* : Foreign direct investment as percentage of GDP. [1]Local firm's liabilities are calculated using only nonfinancial firm data for Colombia and calculated using only financial firm data for Argentina.

Table A.6

DETAILED BREAKDOWN OF CHOICE OF MARKET, WITH TIME TREND

	4	*5*	*6*	*7*
	Financial	*Financial*	*Nonfinancial*	*Nonfinancial*
EXGD*jt**SEAS	0.000 (.)	0.000 (.)	0.010[a] (2.28)	0.032[c] (4.95)
EXGD*jt**(1−SEAS)	3.632 (0.03)	−0.283 (−0.00)	0.017[c] (4.64)	0.047[c] (8.27)
TDSEC*jt**SEAS	0.000 (.)	0.000 (.)	−0.291 (−0.83)	−0.349 (−0.96)
TDSEC*jt**(1−SEAS)	107.510 (0.04)	−178.469 (−0.02)	−1.017[b] (−3.10)	−1.020[b] (−3.08)
ONSRT*jt**SEAS	0.000 (.)	0.000 (.)	−0.467 (−1.16)	−0.380 (−0.92)
ONSRT*jt**(1−SEAS)	662.744 (0.06)	432.29 (.)	−0.151 (−0.38)	−0.384 (−0.95)
INTD*jt**SEAS	0.000 (.)	0.00 (.)	−0.059[c] (−3.89)	−0.062[c] (−4.05)
INTD*jt**(1−SEAS)	−26.712 (−0.12)	−6.392 (−0.02)	0.011 (0.93)	0.027[a] (2.14)
FC_dummy	0.000 (.)	0.000 (.)	0.262[b] (2.58)	0.196 (1.92)
FDI*jt* *SEAS		0.000 (.)		−0.140[c] (−3.82)
FDI*jt**(1−SEAS)		5.13 (0.02)		−0.202[c] (−7.27)
Constant	−518.694 (−0.05)	−470.467 (−0.08)	−0.131 (−0.39)	0.567 (1.59)
Pseudo R^2		0.060	0.079	
BIC	33.1	36.5	3,467.6	3,414.9

Note: *Z*-statistic in parenthesis. [a]$p < 0.05$, [b]$p < 0.01$, [c]$p < 0.001$.

Table A.7

CHOICE OF MARKET: FULL RESULTS, WITH SEASONED COMPONENT

	8	9	10	11
	All	*All*	*Nonfinancial*	*Nonfinancial*
SIZE*ijt* *SEAS	0.045 (1.03)	0.069 (1.58)	0.042 (0.97)	0.068 (1.55)
SIZE*ijt* *(1−SEAS)	0.109[c] (4.28)	0.107[c] (4.14)	0.114[c] (4.42)	0.113[c] (4.33)
LEVER*ijt* *SEAS	−1.044[b] (−2.60)	−0.885[a] (−2.20)	−1.020[a] (−2.55)	−0.856[a] (−2.13)
LEVER*ijt* *(1−SEAS)	0.164 (0.96)	0.119 (0.70)	0.229 (1.32)	0.191 (1.10)
AGE*ijt* *SEAS	0.011 (1.22)	0.012 (1.32)	0.009 (0.99)	0.010 (1.11)
AGE*ijt* *(1−SEAS)	0.021[c] (3.41)	0.018[b] (2.94)	0.020[c] (3.35)	0.018[b] (2.88)
LIQ*ijt* *SEAS	0.542[a] (2.32)	0.548[a] (2.34)	0.541[a] (2.32)	0.549[a] (2.34)
LIQ*ijt* *(1−SEAS)	−0.118 (−1.10)	−0.116 (−1.09)	−0.050 (−0.49)	−0.043 (−0.42)
COL*ijt* *SEAS	−0.126 (−0.56)	−0.104 (−0.46)	−0.088 (−0.39)	−0.065 (−0.28)
COL*ijt* *(1−SEAS)	0.819[c] (3.67)	0.864[c] (3.85)	0.770[c] (3.37)	0.836[c] (3.64)
RATING*ijt* *SEAS	1.380[c] (10.48)	1.345[c] (10.20)	1.372[c] (10.44)	1.336[c] (10.15)
RATING*ijt* *(1−SEAS)	0.682[c] (7.55)	0.666[c] (7.28)	0.703[c] (7.75)	0.685[c] (7.47)
TERM*ijt* *SEAS	0.020[b] (2.63)	0.020[b] (2.61)	0.021[b] (2.65)	0.021[b] (2.64)
TERM*ijt* *(1−SEAS)	0.019[c] (5.65)	0.020[c] (5.75)	0.019[c] (5.51)	0.019[c] (5.61)

	8	9	10	11
	All	*All*	*Nonfinancial*	*Nonfinancial*
EXGD*jt* *SEAS	0.011 (1.94)	0.030[c] (3.85)	0.012[a] (2.01)	0.030[c] (3.87)
EXGD*jt* *(1−SEAS)	−0.002 (−0.38)	0.021[b] (3.16)	−0.002 (−0.56)	0.020[b] (3.06)
TDSEC*jt* *SEAS	0.159 (0.37)	0.113 (0.25)	0.168 (0.39)	0.121 (0.27)
TDSEC*jt* *(1−SEAS)	−0.281 (−0.78)	−0.347 (−0.96)	−0.306 (−0.84)	−0.367 (−1.01)
ONSRT*jt* *SEAS	−1.720[b] (−3.13)	−1.745[b] (−3.12)	−1.669[b] (−3.04)	−1.692[b] (−3.03)
ONSRT*jt* *(1−SEAS)	−2.445[c] (−4.75)	−2.382[c] (−4.57)	−2.415[c] (−4.67)	−2.368[c] (−4.52)
INTD*jt* *SEAS	−0.063[c] (−3.74)	−0.067[c] (−3.84)	−0.063[c] (−3.75)	−0.066[c] (−3.84)
INTD*jt* *(1−SEAS)	0.029[a] (2.31)	0.040[b] (3.02)	0.029[a] (2.25)	0.039[b] (2.94)
FC_Dummy	0.315[b] (2.91)	0.254[a] (2.33)	0.322[b] (2.97)	0.263[a] (2.40)
FDI*jt* *SEAS		−0.133[c] (−3.31)		−0.131[b] (−3.26)
FDI*jt* *(1−SEAS)		−0.138[c] (−4.59)		−0.140[c] (−4.64)
Constant	−0.916[a] (−2.04)	−0.512 (−1.10)	−0.991[a] (−2.19)	−0.611 (−1.30)
Pseudo R^2	0.1947	0.2034	0.1965	0.2053
BIC	3,113.0	3,097.5	3,069.5	3,053.8

Note: *Z*-statistic in parenthesis. [a]$p < 0.05$, [b]$p < 0.01$, [c]$p < 0.001$.

Table A.8

POST-ESTIMATION MEASURES OF FIT

Intercept only	*Table 7*			*Table 8*				*Table 9*			
Model:	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Log-Lik intercept only	−1,916.82	−1,809.67	−1,809.67	−15.01	−15.01	−1,798.27	−1,798.27	−1,809.67	−1,809.67	−1,786.80	−1,786.80
McFadden's R^2	0.152	0.165	0.176	0.465	0.465	0.060	0.079	0.195	0.203	0.196	0.205
Maximum likelihood R^2	0.180	0.193	0.205	0.372	0.372	0.075	0.098	0.223	0.232	0.226	0.235
McKelvey and Zavoina's R^2	0.293	0.317	0.335	1.000	0.998	0.128	0.163	0.397	0.408	0.397	0.409
Variance of y^*	1.413	1.465	1.503	2,310.176	404.465	1.146	1.194	1.657	1.690	1.658	1.692
Count R^2	0.696	0.709	0.712	0.867	0.867	0.641	0.671	0.728	0.733	0.724	0.733
AIC	1.120	1.095	1.081	1.268	1.535	1.234	1.212	1.064	1.054	1.065	1.055
BIC	−20,005.86	−18,974.68	−19,008.01	−48.57	−34.97	−18,373.09	−18,409.93	−18,995.46	−19,011.01	−18,646.33	−18,662.04

Full model	*Table 7*			*Table 8*				*Table 9*			
Model:	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Log-Lik full model	−1,625.96	−1,511.38	−1,490.75	−8.02	−8.02	−1,690.22	−1,655.96	−1,457.36	−1,441.65	−1,435.78	−1,420.01
McFadden's adj. R^2	0.145	0.157	0.168	−0.267	−0.534	0.054	0.071	0.181	0.188	0.182	0.190
Cragg & Uhler's R^2	0.247	0.265	0.281	0.589	0.589	0.103	0.135	0.307	0.319	0.310	0.322
Efron's R^2	0.180	0.193	0.207	0.423	0.423	0.073	0.099	0.224	0.234	0.227	0.237
Variance of error	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Adj count R^2	0.163	0.176	0.183	0.333	0.333	−0.004	0.080	0.229	0.243	0.227	0.251
AIC*n	3,275.92	3,050.76	3,011.49	38.05	46.05	3,402.45	3,341.92	2,964.71	2,937.30	2,921.56	2,894.01
BIC	−493.92	−493.45	−526.79	−0.37	3.03	−136.88	−189.57	−514.24	−529.79	−512.04	−527.75

Table A.9

MARGINAL EFFECTS FOR TABLE 3 SPECIFICATIONS

	1	*2*	*3*
SIZE*ijt*	0.025[b] (− 3.25)	0.032[c] (− 4.09)	0.034[c] (− 4.23)
LEVER*ijt*	0.096 (− 1.80)	0.089 (− 1.68)	0.069 (− 1.31)
AGE*ijt*	0.009[c] (− 5.15)	0.009[c] (− 5.56)	0.008[c] (− 4.88)
LIQ*ijt*	0.046 (− 1.66)	0.055[a] (− 1.99)	0.046 (− 1.64)
COL*ijt*	0.172[b] (− 3.23)	0.186[c] (− 3.42)	0.207[c] (− 3.78)
RATING*ijt*	0.275[c] (− 13.92)	0.289[c] (− 14.71)	0.277[c] (− 13.85)
TERM*ijt*	0.007[c] (− 6.20)	0.007[c] (− 6.52)	0.007[c] (− 6.60)
FC_dummy	0.077 (− 1.90)	0.094[a] (− 2.30)	0.072 (− 1.77)
EXGD*jt*	0.003[b] (− 3.10)	0.001 (− 1.05)	0.009[c] (− 4.96)
TDSEC*jt*	−0.401[c] (−10.27)	0.011 (−0.110)	−0.036 (−0.36)
ONSRT*jt*		−0.574[c] (−4.31)	−0.545[c] (−4.05)
INTD*jt*		−0.003 (−0.78)	0.000 (−0.07)
FDI*jt*			−0.052[c] (−6.34)

Note: *Z*-statistic in parenthesis. [a] $p < 0.05$, [b] $p < 0.01$, [c] $p < 0.001$.

Table A.10

VIX SPECIFICATION

	1	*2*	*3*
SIZE*ijt*	0.0665[c]	0.0897[c]	0.0932[c]
	(0.02)	(0.02)	(0.02)
LEVER*ijt*	0.253[a]	0.233	0.164
	(0.15)	(0.15)	(0.15)
AGE*ijt*	0.0236[c]	0.0264[c]	0.0229[c]
	(0.00)	(0.00)	(0.00)
LIQ*ijt*	0.119	0.142[a]	0.106
	(0.08)	(0.08)	(0.08)
COL*ijt*	0.514[c]	0.572[c]	0.663[c]
	(0.15)	(0.15)	(0.16)
RATING*ijt*	0.826[c]	0.896[c]	0.858[c]
	(0.07)	(0.07)	(0.07)
TERM*ijt*	0.0183[c]	0.0197[c]	0.0203[c]
	(0.00)	(0.00)	(0.00)
FC_dummy	−0.101	−0.090	−0.342[a]
	−0.168	−0.170	−0.177
VIX*jt*	0.0226[b]	0.0251[b]	0.0385[c]
	−0.010	−0.010	−0.010
EXGD*jt*	0.00976[c]	0.004	0.0286[c]
	(0.00)	(0.00)	(0.01)
TDSEC*jt*	−1.120[c]	0.018	−0.119
	(0.11)	(0.27)	(0.28)
ONSRT*jt*		−1.553[c]	−1.460[c]
		(0.38)	(0.38)
INTD*jt*		−0.010	−0.004
		(0.01)	(0.01)
FDI*jt*			−0.164[c]
			(0.02)
Constant	−3.098[c]	−2.420[c]	−2.200[c]
	(0.39)	(0.47)	(0.48)
Pseudo R^2	0.153	0.167	0.180
BIC	3,350.137	3,135.226	3,093.944

Note: *Z*-statistic in parenthesis. [a]$p < 0.05$, [b]$p < 0.01$, [c]$p < 0.001$.

Table A.11

EMBI SPECIFICATION

	1	*2*	*3*
SIZE*ijt*	0.0713[c]	0.0857[c]	0.0905[c]
	(0.02)	(0.02)	(0.02)
LEVER*ijt*	0.270[a]	0.202	0.188
	(0.15)	(0.15)	(0.15)
AGE*ijt*	0.0246[c]	0.0249[c]	0.0236[c]
	(0.00)	(0.00)	(0.00)
LIQ*ijt*	0.138[a]	0.140[a]	0.130[a]
	(0.08)	(0.08)	(0.08)
COL*ijt*	0.461[c]	0.551[c]	0.578[c]
	(0.15)	(0.15)	(0.16)
RATING*ijt*	0.835[c]	0.856[c]	0.847[c]
	(0.07)	(0.07)	(0.07)
TERM*ijt*	0.0199[c]	0.0199[c]	0.0202[c]
	(0.00)	(0.00)	(0.00)
FC_dummy	0.148	−0.144	0.003
	−0.107	−0.128	−0.136
EMBI*jt*	0.000725[c]	0.00443[c]	0.00238[b]
	0.000	−0.001	−0.001
EXGD*jt*	0.0104[c]	−0.0107[b]	0.010
	(0.00)	(0.00)	(0.01)
TDSEC*jt*	−1.014[c]	0.211	0.049
	(0.11)	(0.28)	(0.28)
ONSRT*jt*		−0.652	−1.047[b]
		(0.42)	(0.44)
INTD*jt*		−0.109[c]	−0.0580[b]
		(0.02)	(0.03)
FDI*jt*			−0.0949[c]
			(0.03)
Constant	−2.702[c] (0.31)	−2.658[c] (0.43)	−1.954[c] (0.49)
Pseudo R^2	0.155	0.175	0.178
BIC	3,340.048	3,103.304	3,101.747

Note: *Z*-statistic in parenthesis. [a]$p < 0.05$, [b]$p < 0.01$, [c]$p < 0.001$.

Table A.12

OIL PRICES SPECIFICATION

	1	*2*	*3*
SIZE*ijt*	0.0541[b] (0.02)	0.0794[c] (0.02)	0.0888[c] (0.02)
LEVER*ijt*	0.204 (0.15)	0.174 (0.15)	0.170 (0.15)
AGE*ijt*	0.0224[c] (0.00)	0.0249[c] (0.00)	0.0232[c] (0.00)
LIQ*ijt*	0.120 (0.08)	0.133[a] (0.08)	0.124 (0.08)
COL*ijt*	0.480[c] (0.15)	0.555[c] (0.15)	0.588[c] (0.16)
RATING*ijt*	0.822[c] (0.07)	0.876[c] (0.07)	0.852[c] (0.07)
TERM*ijt*	0.0193[c] (0.00)	0.0200[c] (0.00)	0.0204[c] (0.00)
FC_dummy	0.146 −0.106	0.193[a] −0.107	0.177[a] −0.107
WTI*jt*	−0.00729[c] −0.001	−0.00716[c] −0.002	−0.00316[a] −0.002
EXGD*jt*	0.004 (0.00)	−0.003 (0.00)	0.0196[c] (0.01)
TDSEC*jt*	−1.177[c] (0.11)	−0.237 (0.28)	−0.199 (0.28)
ONSRT*jt*		−1.198[c] (0.38)	−1.358[c] (0.39)
INTD*jt*		−0.0159[a] (0.01)	−0.006 (0.01)
FDI*jt*			−0.124[c]
			(0.03)
Constant	−1.414[c] (0.38)	−0.991[b] (0.43)	−1.039[b] (0.44)
Pseudo R^2	0.159	0.171	0.177
BIC	3,328.256	3,120.404	3,105.23

Note: Z-statistic in parenthesis; [a] $p < 0.05$, [b] $p < 0.01$, [c] $p < 0.001$.

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