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Foreign Debt Flows and the Credit Market: A Principal Agent Approach☆

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ABSTRACT

As has been documented in different studies, there is a close relationship between capital flows and domestic credit. This relationship emerges from different channels, which are usually not directly identified. In this paper, a principal-agent approach is proposed in order to disentangle the distinct channels through which shocks on capital debt flows can affect credit-related variables. The model predicts that a foreign credit crunch will not only adversely affect aggregate credit, but will reduce the proportion of firms with access to intermediated funds. Using a comprehensive micro data set for the period comprised between 1999Q1-2012Q1 on foreign debt flows and the relevant credit-related variables, a VEC model is estimated to empirically validate the predictions from the theoretical framework. Results confirm that, in the short-run, a negative shock to foreign funds effectively reduces the proportion of firms with access to intermediated finance (both local and foreign), whilst at the same time induces a substitution of funding by firms from foreign to local sources, thus effectively having a positive effect on domestic credit growth. Nonetheless, the estimated long-run relationship indicates that capital debt flows and domestic credit growth are positively related. These results have important policy implications, related with the potential impact on credit (and access) generated by the use of certain macro prudential measures.

Los flujos de la deuda externa y el mercado de crédito: un enfoque agente principal

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RESUMEN

Como se ha documentado en diversos estudios, existe una estrecha relación entre los flujos de capital y crédito doméstico. Esta relación surge de diferentes canales, que por lo general no se identifican directamente. En este trabajo, se propone un enfoque desde el punto de vista del agente-principal con el fin de separar los distintos canales a través de los cuales los choques en los flujos de deuda de capital pueden afectar las variables relacionadas con el crédito. El modelo predice que una contracción del crédito externo no sólo afectará adversamente el crédito agregado, sino que reducirá la proporción de empresas con acceso a los fondos de intermediación. Usando un conjunto de microdatos, para el período comprendido entre 1999Q1 - 2012Q1, de flujos de deuda externa y de variables pertinentes relacionadas con el crédito, se estima un modelo VEC para validar empíricamente las predicciones desde el marco teórico. Los resultados confirman que, a corto plazo, un choque negativo a fondos extranjeros reduce la proporción de empresas con acceso a la financiación intermediada (local y extranjera), mientras que al mismo tiempo induce un cambio de la financiación de las empresas desde el extranjero a las fuentes locales, por lo que tiene efectivamente un efecto positivo en el crecimiento del crédito interno. No obstante, la relación de largo plazo estimada indica que los flujos de deuda de capital y el crecimiento del crédito interno se relacionan positivamente. Estos resultados tienen importantes consecuencias políticas, relacionadas con el impacto potencial en el crédito (y el acceso) generadas por el uso de ciertas medidas macro-prudenciales.

1. Introduction

Understanding the relationship between capital flows and domestic credit dynamics has gained special attention in the last few decades, in no small part due to the correlation between credit growth and capital flows turning highly significant, especially after

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1975 (Jorda et al., 2011). Since then, the academic literature has widely documented how scenarios of credit booms (credit crunches) have been closely associated with episodes of capital inflows (outflows) (Reinhart and Calvo, 2000; Kohli, 2003; Calomiris, 2009; Bruno and Shin, 2012; Lane and McQuade, 2012). Colombia is not an exception in exhibiting this kind of behavior, a result that has been well referenced in the empirical literature (Carrasquilla et al., 2000; Tenjo and López, 2002; Villar et al., 2005).

The literature focusing on the effect of capital flows on credit markets can be broadly divided in two: a macroeconomic and a microeconomic approach. Regarding the former, several studies are centered on the indirect effects that capital flows have on credit via their impact on asset prices. According to the financial accelerator literature (Bernanke and Gertler, 1995), which introduces a collateral restriction à la Kiyotaki and Moore (1997), the financial strength (or resilience) of borrowers depends on asset prices, due to the effect of the latter on the risk premium. This premium surges from the difference between obtaining funding internally and externally, thus contradicting the principles of the Modigliani-Miller (1958) theorem. Capital flows, through their effect on asset prices, negatively affect the external financing premium, augmenting the borrowing capacity of firms. A similar conclusion can be drawn from the theoretical model proposed by Aoki et al. (2009), in which asset prices and credit limits are shown to have a strong interaction that works as a propagation mechanism; the effects of higher capital inflows towards the real sector are amplified by the increase in asset prices, which further loosens borrowing constraints.

The relationship between asset prices and capital flows has also been documented in the empirical literature. Aizenman and Jinjarak (2009) study the association between the current account and real estate valuation across a sample of countries. The authors find a robust and strong positive association between current account deficits and the appreciation of real estate prices. A similar conclusion is drawn from the work by Adam et al. (2011), where the authors calibrate a small open economy asset pricing model to replicate the empirical evidence linking current account deficits and house price dynamics in the G7 countries. In addition, using quarterly data and a panel of 40 countries from 1990 to 2010, Olaberría (2012) finds that emerging countries are more likely to experience booms in asset prices during periods of large capital inflows.

Another strand of the macroeconomic literature has centered on studying the effect of foreign flows in the economy through the use of dynamic stochastic general equilibrium models (DSGE) calibrated so as to match observed business cycles. In particular, Ghironi and Melitz (2005) develop a two country DSGE model of trade and macro dynamics with international borrowing and lending, and show that less regulated countries face higher appreciation and run higher foreign debt deficits than their more regulated counterparts. Mendoza (2005), on the other hand, uses a DSGE model to replicate the observed dynamics during episodes of sudden stops, and concludes that a Fisherian debt deflation mechanism, triggered by a binding credit constraint, seems to be at the heart of sudden stop episodes. In a more recent paper, Kollman (2013) estimates, using Bayesian methods, a two country DSGE model with a global bank, in an attempt to provide empirical assessment of the role of banks as a source of shocks and as a transmission mechanism. The author finds evidence that real activity in the US and the Euro Area depends on banking shocks, as these account for a significant part of its variance.

Another important contribution stemming from the macroeconomic approach relates to the study of the role of capital flows as a direct external funding source for credit institutions (Chinn and Dooley, 1997; Edwards and Vegh, 1997). In addition, in an economy with firms borrowing directly from abroad, capital inflows can liberalize resources in the financial sector, which may be channeled to firms without prior access to credit markets (Villar and Salamanca, 2005); thus, capital flows could change the composition of firms' liabilities. This intuition is also present in Gertler and Gilchrist (1994), where small firms are more likely to be credit-constrained when credit becomes more costly.

On the other hand, the microeconomic literature pertaining to capital flows is somewhat more recent, and seems to be particularly interested in the effect of shocks on capital flows on both bank and firms' decisions. Using microdata on the Japanese market, Amiti and Weinstein (2013) analyze how financial shocks affect lending and investment, and effectively find that bank shocks account for 40% of the variation in both variables. Interestingly, the authors show that only loan dependent firms are affected negatively by bank shocks, implying that such firms cannot easily substitute sources of funding after a shock. Moreover, Ongena et al. (2013) show that banks relying on international funding reduce their lending more than locally funded domestic banks, and consequently, firms borrowing from these banks suffer more financial and real effects than those borrowing from locally-funded institutions. A similar result is found by Bofondi et al. (2013), who show that Italian banks tightened credit supply less than foreign banks after the outbreak of the sovereign debt crisis. This same intuition can be found in Schnabl (2012) and Correa et al. (2012), as international banks are found to transmit liquidity shocks across countries and such adverse shocks effectively reduce lending in the affected countries.

Having these focuses in mind, this paper's interest lies in understanding how the aggregate debt structure of Colombian firms changes when faced with the possibility of financing locally or abroad, and how such liability structure can be affected by changes in the fundamentals of the external lenders; i.e. the link between a firm's foreign debt flows and its domestic credit. Therefore, a revisit of the question posited above calls for a joint approach: a macroeconomic exercise with a micro foundation. Thus, in this paper an alternative version of the Holmström and Tirole (1997) model is proposed, in order to introduce a new investor as a potential financier of the project. Including a new investor allows one to study the impact of different sources of financing (local, foreign and capital markets) on the debt structure of firms and on particular credit-related variables.

In effect, a principal-agent can suggest insightful explanations to the problem at hand. First, in a model with imperfect information, the Modigliani-Miller (1958) paradigm breaks-up and financial structure matters. Under this alternative setting, credit rationing is generated endogenously through an optimal decision by the external investors (principal), and lending not only becomes relevant, but can coexist with capital markets. In their seminal work on financial intermediation theory, Holmström and Tirole (1997) explain the role of financial intermediaries and their relationship with firms and capital markets. The authors also analyze the effect of shocks on the debt structure of firms, identifying, for instance, the repercussions of a credit crunch caused by a drop in bank capital or from a capital squeeze potentially originated by a decrease in the value of the firm's assets.

Under certain (reasonable) assumptions, the extended model presented here predicts that a foreign credit crunch (i.e. a fall in the amount of funds available for lending from foreign investors) will not only adversely affect aggregate external credit, but will reduce the portion of firms with access to intermediated funds (both from foreign investors and local banks). Thus, poorly-capitalized firms will lose their access to credit markets and funds will be concentrated in higher value firms. Importantly, some firms which initially were exclusively financed through foreign and capital markets will now have to additionally borrow funds from local banks.

Using quarterly data for the period comprised between 1999Q1-2012Q1 on foreign debt flows and domestic credit to the corporate sector, as well as on the cost of such funding, the proportion of firms with access to intermediated funds and asset prices, a VECX model is estimated to empirically validate the propositions from the theoretical framework. In a nutshell, one

finds that a negative shock to foreign funds effectively reduces both credit growth and the proportion of firms with access to intermediated finance in the long-run. Interestingly, no significant statistical relationship is found between debt flows and domestic credit in the short-run, which may be a result of the particularities of the local market, which restricts lending in local currency using foreign funds, thus rendering the credit-channel stemming from foreign debt flows virtually non-existent.

The policy implications of the main findings in this paper are also noteworthy and provide valuable elements to enrich discussions concerning the effectiveness and potential effects of distinct measures, such as the imposition of capital controls. In particular, the evidence presented shows that, though not contemporaneous, a reduction in capital flows does have negative effects on the local credit market. This type of effects should not be overlooked when discussing measures of this nature.

The paper is organized as follows. This section presented a brief introduction, while Section 2 describes the theoretical model. Comparative statics exercises from the theoretical framework are performed in Section 3, where the main predictions from the model are outlined. Section 4 presents the empirical application as well as some stylized facts of the relevant variables in the model. Finally, Section 5 concludes.

2. The Model

In this section, a modified version of the Holmström and Tirole (1997) model is presented, allowing for the possibility of financing the investment project through different funding sources[1]. In particular, this modification proposes the inclusion of an additional set of risk neutral (monitoring) agents in the model; foreign investors. In essence, this allows one to extend the simple model to an "open-economy" setting, expanding on the comparative statics exercises regarding the economic impact of exogenous shocks.

As in the standard version of the model, the presence of asymmetric information, due to a moral hazard problem, validates the financial intermediation activity. The model considers three periods *(t=0,1,2)* and four agents: entrepreneurs *(e),* banks *(b),* foreign investors *(f)* and uninformed investors *(i).* In what follows, each of these agents and their actions are described, assuming that the interest rate demanded by uninformed investors is exogenous[2].

2.1. Entrepreneurs

A continuum of risk neutral entrepreneurs is considered, which are the executors of the investment project. These agents are heterogeneous, since they differ in their level of capital, which is represented by *A*. They are willing to invest this capital in a project of size *I*, where $I > A$. Therefore, the total amount of resources that they need to borrow from financiers is represented by $I - A$.

The accumulated distribution of capital is represented by *G(A),* which is assumed to be normalized to have a mass of 1. A change in the general level of capital is assumed to be represented by a parameter θ, such that $G(A|\theta)$.

There are three ways to finance the project externally, which will be discussed in detail in Sections 2.6, 2.7 and 2.8 below. Entrepreneurs decide to behave or misbehave at time t=1, depending on the level of effort they put on the project. When they behave, the project has a higher probability of success (p_H); when they misbehave, the probability is p_L (with $p_H > p_L$) and managers obtain a private benefit of either *b* or *B*, which is conditional on the presence of monitoring. Δp is defined as $p_H - p_L$.

2.2. Uninformed Investors

There is a mass of uninformed investors which are risk neutral and individually small and therefore, unable to monitor the project directly. They claim a rate of return of γ (their opportunity cost) on the amount invested in the project (I_i).

2.3. Banks

In this economy there are several small banks which are also risk neutral. They participate in the project either as monitors/financiers or they can mimic uninformed investors. In the first case, they incur in a cost denoted by *c* at *t=1*. This activity allows to reduce the private benefit of entrepreneurs from *B* to *b*. As monitors, they hold a level of capital denoted by K_b and demand a rate of return of χ on their investment, I_b. If they participate as uninformed investors, then they incur no cost and claim a rate of return of γ on their investment.

2.4. Foreign Investors

In this economy there is a mass of foreign investors that, analogous to the other agents in the model, are also risk neutral. They participate in the project either as monitors/financiers or they can mimic uninformed investors, but they cannot act as local banks[3]. In their role as monitors, they incur in a cost denoted by c^* at *t=1*. This activity allows to reduce the private benefit of entrepreneurs from *B* to *b*. As monitors, they hold a level of capital denoted by K_f and demand a rate of return of χ^* on their investment, I_f. If they participate as uninformed investors, then they incur no cost and claim a rate of return of γ on their investment. Finally, we assume that these agents can finance themselves at a lower cost in foreign markets; in other words, that there exists an interest rate $\gamma^* < \gamma$.

2.5 The Project

The project requires an initial investment of *I* at *t=0*. The only two possible outcomes of this project are *R* if the project is successful, and *0* otherwise. The output of the project is shared among the four agents of the economy, that in case of success, is given by:

$$R = R_i + R_e + R_b + R_f \tag{1}$$

where the subscripts represent the uninformed investors *(i),* entrepreneurs *(e),* foreign investors *(f)* and banks *(b).*

The difference between the project's size and the entrepreneur's capital needs to be financed externally, either solely by uninformed investors (direct finance), or by additionally employing foreign investors and eventually local banks as well (intermediated finance).

The project generates a positive net present value (NPV) if and only if the entrepreneur behaves. This is represented by the following condition:

$$p_H R - \gamma I > 0 > |p_H R - \gamma I| + B \tag{2}$$

Equation (2) implies that only the good project is socially desirable.

1. A standard version of Holmström and Tirole (1997) is presented in Appendix A.
2. As in the model of Holmström and Tirole (1997), this is equivalent to assuming that uninformed investors have access to a "storage facility" yielding a return of γ units of good for each unit of investment. Their saving are thus completely elastic at interest rate $\gamma - 1$.
3. This assumption is somewhat similar to the one made in Holmström and Tirole (1997), where uninformed investors are assumed to be unable to monitor. Moreover, it is justified by the fact that Colombian regulation, for instance, does not allow foreign banks to operate as branches in the domestic market, but rather as subsidiaries, thus increasing the costs of extending loans to local firms.

To complete the basic setting of the model, one has that foreign investors demand a rate of return χ^*, for which it should naturally hold that $\gamma^* < \gamma < \chi^* < \chi$. The inequality ($\gamma < \chi^*$) results from the fact that monitoring is costly and foreign investors could pose as uninformed investors (and earn γ) if not given the incentive to exert this effort. The inequality ($\chi^* < \chi$) stems from the assumption that these agents have access to a lower funding cost ($\gamma^* < \gamma$), which allows them to demand a lower rate of return for their funds; it follows naturally that managers will prefer to be financed by foreign investors than by banks[4], as long as their level of assets provides access to such funding[5]. Uninformed investors are, of course, still preferred to both banks and foreign investors[6]. In addition, one has that both external and domestic monitor's capital, K_f and K_b, are exogenous.

2.6. Direct Finance

First, the case where the entrepreneur is (potentially) financed by uninformed investors exclusively is presented. Here, the existence of indirect financiers is abstracted.

The sharing rule is thus divided between investors and entrepreneurs, which implies that:

$$R = R_i + R_e \tag{3}$$

The next condition guarantees the good behavior of entrepreneurs. It states that the expected outcome for the firm if managers exert high effort should be higher than the one with low effort:

$$p_H R_e \geq p_L R_e + B$$

$$R_e \geq \frac{B}{\Delta p} \tag{4}$$

From the uninformed investors' perspective, the project will be financed if the expected outcome (of investing in the project) is higher than their opportunity cost:

$$p_H R_i \geq \gamma (I - A)$$

$$I_i \geq \frac{p_H R_i}{\gamma} \tag{5}$$

The firm can only obtain direct financing if it has enough capital (i.e $A + I_i \geq I$). From the combination of equations (3), (4) and (5), it is possible to obtain the minimum level of capital ($\bar{A}$) required by uninformed investors in order to finance the project, which is given by:

$$A \geq \bar{A}(\gamma) \equiv \mathrm{I} - \frac{p_H}{\gamma}\left[R - \frac{B}{\Delta p}\right] \tag{6}$$

2.7. Intermediated Finance — Foreign Investors

If firms do not have enough assets to finance the project through direct lending only, they can try to borrow I_e from foreign investors (in return for R_e). The total amount to be financed ($I - A$) will be contributed by foreign (I_f) and uninformed investors (I_i):

$$I - A = I_i + I_f \tag{7}$$

The sharing rule is divided between these three agents:

$$R = R_i + R_f + R_e \tag{8}$$

Given the definition of the rate of return demanded by the foreign monitor, the following accounting identity must prevail:

$$p_H R_f = \chi^* I_f$$

$$\chi^* = \frac{p_H R_f}{I_f} \tag{9}$$

Similarly, for the uninformed investor it must also be the case that the expected outcome from the project is equal to the required rate of return on the initial investment:

$$p_H R_i = \gamma I_i$$

$$\gamma = \frac{p_H R_i}{I_i} \tag{10}$$

Moreover, the following incentive compatibility condition must hold in order for foreign investors to act as monitors/financiers and not mimic uninformed investors:

$$\chi^* I_f - c^* \geq \gamma I_f$$

$$\chi^* - \gamma \geq \frac{c^*}{I_f} \tag{11}$$

There are two conditions that must be satisfied in order to (socially) justify the monitoring activity:

$$p_H R_e < p_L R_e + B \tag{12}$$

$$p_H R_e \geq p_L R_e + b \tag{13}$$

Equation (13) implies:

$$R_f + R_i \leq R - \frac{b}{\Delta p} \tag{14}$$

or equivalently:

$$R_e \geq \frac{b}{\Delta p} \tag{15}$$

The incentive compatibility constraint of foreign investors to effectively monitor and not shirk is:

$$p_H R_f - c^* \geq p_L R_f$$

$$R_f \geq \frac{c^*}{\Delta p} \tag{16}$$

Since intermediated finance is more costly than direct funds, the entrepreneur will try to minimize the investment from foreign investors (and hence the return that must be given to them). From equations (9) and (16) the minimum stake from foreign investors in the project is given by:

$$I_f = I_f(\chi^*) \equiv \frac{p_H R_f}{\chi^*}$$

$$= \frac{p_H c^*}{\chi^* \Delta p} \tag{17}$$

The rest of the financing is obtained from uninformed investors, which will invest in the project provided the net present income that can be pledged by the entrepreneur exceeds their initial investment:

$$\frac{p_H}{\gamma}\left[\mathrm{R} - \frac{b + c^*}{\Delta p}\right] \geq I - A - I_f(\chi^*) \tag{18}$$

From equation (18), one can obtain the firm's minimum capital level in order to receive funding for the investment project as:

$$A \geq \underline{A}(\gamma, \chi^*) \equiv I - I_f(\chi^*) - \left[\frac{p_H (R - (b + c^*)/\Delta p)}{\gamma}\right] \tag{19}$$

4. See Appendix B for a formal proof of this claim.
5. This assumption seems reasonable in the case of Colombia, where not only are external funds typically less costly than local funds, but where big firms (in asset size) are generally the only capable of tapping foreign liquidity markets.
6. This claim is proved later, and follows from the fact that $\chi > \chi^* > \gamma$.

Note that $\underline{A}$ is increasing in b, c, γ and χ^* and decreasing in Δp, p_H and R. The existence of foreign investors is justified if $\underline{A} < \overline{A}$. This is satisfied when $\chi^* > \gamma$ and the condition that the monitoring cost c^* is small enough is met.

2.8. Intermediated Financing — Banks

Now, consider the possibility that certain firms' level of capital is not sufficient to obtain intermediated financing from foreign investors (i.e $\underline{A} < \overline{A}$). Entrepreneurs would like to invest in the project, but in the absence of an additional source of funding, their asset base would be insufficient. Thus, the simultaneous presence of banks and foreign investors will, intuitively, increase the number of firms that will be able to invest in the model. Those firms whose asset size allows for access to foreign (cheaper) liquidity markets will do so, and smaller firms will fund their investment activities tapping additional (more expensive) funds from local banks.

Hence, one now has that firms that do not have enough assets to finance the project through direct lending and indirect funding from foreign investors, can try to borrow I_b from banks (in return for R_b). The total amount to be financed ($I - A$) will be contributed by banks (I_b), and both foreign (I_f) and uninformed investors (I_i):

$$I - A = I_i + I_f + I_b \tag{20}$$

The sharing rule is now divided between these four agents:

$$R = R_i + R_f + R_b + R_e \tag{21}$$

Given the definition of the rate of return demanded by the monitors, the following accounting identities must prevail:

$$\chi^* = \frac{p_H R_f}{I_f} \tag{22}$$

$$\chi = \frac{p_H R_b}{I_b} \tag{23}$$

Additionally, it must again be the case that the uninformed investors' expected outcome from the project equals their required rate of return on the initial investment:

$$\gamma = \frac{p_H R_i}{I_i} \tag{24}$$

The following incentive compatibility conditions must hold in order for both foreign investors and banks to act as monitors/financiers and not mimic uninformed investors:

$$\chi^* I_f - c^* \geq \gamma I_f$$

$$\chi^* - \gamma \geq \frac{c^*}{I_f} \tag{25}$$

$$\chi I_b - c \geq \gamma I_b$$

$$\chi - \gamma \geq \frac{c}{I_b} \tag{26}$$

In addition, the following must also hold in order for banks to have the incentive to behave and not mimic foreign investors:

$$\chi I_b - c \geq \chi^* I_b - c \tag{27}$$

$$\chi - \chi^* \geq 0 \tag{28}$$

In this model, it is assumed that the moral hazard issue that arises from foreign investors' incentive to mimic banks (and earn a higher rate of return at lower monitoring costs) is eliminated de facto by regulation, which prohibits foreign investors from acting as local banks.

As in the Holmström and Tirole (1997) model, the incentive compatibility constraint of the entrepreneur implies that, when monitored, he is induced to behave:

$$p_H R_e < p_L R_e + B \tag{29}$$

$$p_H R_e \geq p_L R_e + b \tag{30}$$

The incentive compatibility constraint of banks to carry out monitoring is:

$$p_H R_b - c \geq p_L R_b$$

$$R_b \geq \frac{c}{\Delta p} \tag{31}$$

Since intermediated finance is more costly than direct funds, the entrepreneur will try to minimize the investment from both banks and foreign investors (and hence the return that must be given to them). The minimum stake that must be invested by foreign investors is given in equation (17), while that of banks can be obtained from equations (23) and (31) as:

$$I_b = I_b(\chi) \equiv \frac{p_H R_b}{\chi}$$

$$= \frac{p_H c}{\chi \Delta p} \tag{32}$$

The rest of the financing is obtained from uninformed investors, whose break-even condition is given by:

$$\frac{p_H}{\gamma}\left[R - \frac{b^* + c + c^*}{\Delta p}\right] \geq I - A - I_b(\chi) - I_f(\chi^*) \tag{33}$$

From equation (33), the minimum level of capital required by the firm to obtain funding for the investment project is given by:

$$A \geq \underline{\underline{A}}(\gamma, \chi^*, \chi) \equiv I - I_b(\chi) - I_f(\chi^*) - \left[\frac{p_H (R - (b^* + c + c^*)/\Delta p)}{\gamma}\right] \tag{34}$$

Note that $\underline{\underline{A}}$ is increasing in b, c, γ, χ and χ^* and decreasing in Δp, p_H and R. The existence of banks is justified if $\underline{\underline{A}} < \underline{A}$.This is satisfied if $\chi > \chi^*$ and both monitoring costs c and c^* are small enough.

Given these elements, four different financing regions can be defined:

- The region where $A \geq \overline{A}$: the project is financed directly by uninformed investors.
- The region where $A \in [\underline{A}, \overline{A})$: the project is additionally financed by foreign investors.
- The region where $A \in [\underline{\underline{A}}, \underline{A})$: the project is additionally financed by local banks.
- The region where $A < \underline{\underline{A}}$: the project is not financed externally; the firm cannot invest.

Importantly, the area between $\overline{A}$ and $\underline{\underline{A}}$ corresponds to the proportion of firms that need to obtain intermediated finance in order to invest; i.e., the proportion of firms with credit in the economy. The general setup of the model is depicted in Figure 1.

It must also be the case that entrepreneurs will undertake the project even if they have to be monitored, rather than invest their resources at the opportunity cost in the market. This condition is equivalent to the following expression:

$$p_H R - \frac{(\chi - \gamma) p_H c}{\Delta p \chi} - \frac{(\chi^* - \gamma) p_H c^*}{\Delta p \chi^*} \geq I\gamma \tag{35}$$

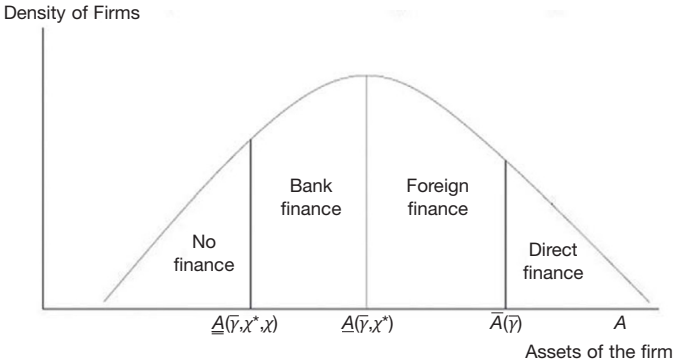

Figure 1 Repartition between the three types of finance among firms.

Banks and foreign investors will finance the project using their own (exogenous) capital according to:

$$K_f \geq \left[G(\bar{A}(\gamma)) - G\left(\underline{\underline{A}}(\gamma,\chi^*,\chi)\right)\right] I_f(\chi^*) \tag{36}$$

$$K_b \geq \left[G\left(\underline{A}(\gamma,\chi^*)\right) - G\left(\underline{\underline{A}}(\gamma,\chi^*,\chi)\right)\right] I_b(\chi) \tag{37}$$

When the interest rate on uninformed investor funds is endogenous, the supply of savings, which depends on the interest rate, must finance total investment according to the following expression:

$$\begin{aligned} S(\gamma) = &\int_{\bar{A}(\gamma)}^{\infty} (I-A)dG(A) + \int_{\underline{A}(\gamma,\chi^*)}^{\bar{A}(\gamma)} (I - I_f(\chi^*) - A)dG(A) \\ &+ \int_{\underline{\underline{A}}(\gamma,\chi^*,\chi)}^{\underline{A}(\gamma,\chi^*)} (I - I_f(\chi^*) - I_b(\chi) - A)dG(A) - \int_0^{\underline{\underline{A}}(\gamma,\chi^*,\chi)} A\,dG(A) \end{aligned} \tag{38}$$

Which guarantees the savings market clears.

3. Comparative Statics

The importance of comparative statics exercises is that they provide testable hypothesis from a particular theoretical framework that can be empirically assessed. In this particular case, one is interested in evaluating the predictions from the theoretical model that changes in capital flows have on the relevant credit-related variables. In this sense, the comparative statics exercises provide the economic backdrop against which the quantitative results must be contrasted.

Furthermore, in this particular case they play a potentially more significant role. The empirical application proposed in this paper consists of a VEC model, where proxies of K_f, K_b, A, $\chi - \chi^*$ and $G(\bar{A}) - G(\underline{\underline{A}})$ are included as endogenous variables. The objective is to estimate the response of the aforementioned variables given a shock to K_f, allowing for both direct and indirect channels to operate in tandem. Thus, it is clear that, empirically, it will be difficult to isolate the precise effect of an individual channel. However, theoretically one can analyze the separate impact of each, allowing for a dissection of the overall expected effect should all channels operate in the market.

In what follows, aggregate credit in the economy is defined as the sum of intermediated finance (foreign and bank funds), whilst access to credit can be evaluated by assessing the portion of firms with access to intermediated funds. Note that, by definition, any kind of capital squeeze in this model will directly imply that the equilibrium amount of credit falls, since both banks and foreign investors lend out all their capital to firms.

3.1. Direct Effect

First, consider the direct impact that a fall in K_f has on the relevant credit-related variables.

Proposition 1. *Assuming that γ is exogenous (so $\bar{A}(\gamma)$ is fixed), a foreign credit crunch will adversely affect aggregate investment and will increase the thresholds $\underline{A}(\gamma, \chi^*)$ and $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ over which firms can raise money, thus reducing the proportion of firms with access to intermediated finance.*

Proof of Proposition 1. By contradiction. Consider the case in which a capital squeeze makes $\underline{A}(\gamma, \chi^*)$ and $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ fall. The former implies that a strictly larger set of firms is financing investment through intermediated funds with foreign investors. Each firm will thus receive less capital (if decreases according to equation (37)), and so χ^* must rise. As intermediated foreign capital becomes more expensive, fewer firms will be able to rely on foreign investors as their sole provider of intermediated funds; $\underline{A}(\gamma, \chi^*)$ goes up as seen on equation (20). If $\underline{A}(\gamma, \chi^*)$ increases and $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ decreases, intermediated bank funds will span a strictly larger set of firms. From equation (35), this implies that each firm will receive a lower amount of funds (i.e. $I_b(\chi)$ falls), which implies an increase in the cost of intermediated bank funds, χ. If both types of intermediated capital have become more expensive (χ and χ^* increase), it cannot be that $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ decreases (from equation (35)), contradicting the initial statement.

The above Proposition has some interesting implications. Firstly, it implies that, not only will aggregate investment in the economy fall (i.e. less credit), but so will the portion of firms with access to intermediated funds. Moreover, it implies that during a foreign credit crunch the interest rate on foreign funds, χ^*, must increase, which directly implies that the portion of firms whose access to intermediated funds is met exclusively by foreign investors will invariable decrease (i.e. $G(\bar{A}) - G(\underline{A})$ falls). Finally, the result for local rates is ambiguous, and will depend on the shape of the function $G(\cdot)$. Proposition 1 simply states that $\underline{A}(\gamma, \chi^*)$ and $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ must increase, but one cannot rule out the possibility that as this happens, the proportion of firms with access to intermediated bank funds actually increases (decreases), so that $I_b(\chi)$ must fall (increase) to guarantee equilibrium, implying an increment (decrease) in χ. A visual representation of Proposition 1 is presented in Figure 2A.

In order to reduce some of the ambiguity in the results, consider the following (very broad) restriction on the distribution of $G(\cdot)$ and its implications on the comparative statics of the extended model:

Proposition 2. *If the distribution for $G(\cdot)$ is unimodal, and $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ is either the mode or to the right of it, then a foreign credit crunch will imply a reduction in the proportion of firms that receive intermediated local bank funding.*

Proof of Proposition 2. By contradiction. Assume that a foreign credit crunch increases the set of firms that have access to bank finance (i.e. $[G(A)-G(\underline{\underline{A}})]$ increases). The latter implies that $I_b(\chi)$ must fall, and so χ is pushed up. However, if χ increases, then $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ increases more than proportionally compared to $\underline{A}(\gamma, \chi^*)$ (since both χ and χ^* increase)[7], and given the shape of G(•) and the placing of $\underline{\underline{A}}(\gamma, \chi^*, \chi)$, it must always be true that $[G(A)-G(\underline{\underline{A}})]$ falls (since one is moving towards a lower probability mass area in the distribution), which contradicts the initial hypothesis.

7. When χ^* increases by a small amount, both $\underline{A}(\gamma, \chi^*)$ and $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ move in the same proportion. Formally, a small change in χ^* shifts both $\underline{\underline{A}}(\gamma,\chi^*)$ and $\underline{\underline{A}}(\gamma,\chi^*,\chi)$ by $\partial\underline{A}(\gamma,\chi^*)/\partial\chi^* = \partial\underline{\underline{A}}(\gamma,\chi^*,\chi)/\partial\chi^* = \frac{pHc^*}{(\chi^*)^2\Delta p}$. Thus, an additional increase in χ will unquestionably imply that $\underline{\underline{A}}(\gamma,\chi^*,\chi)$ moves more than proportionally, since $\partial\underline{\underline{A}}(\gamma,\chi^*,\chi)/\partial\chi > 0$.

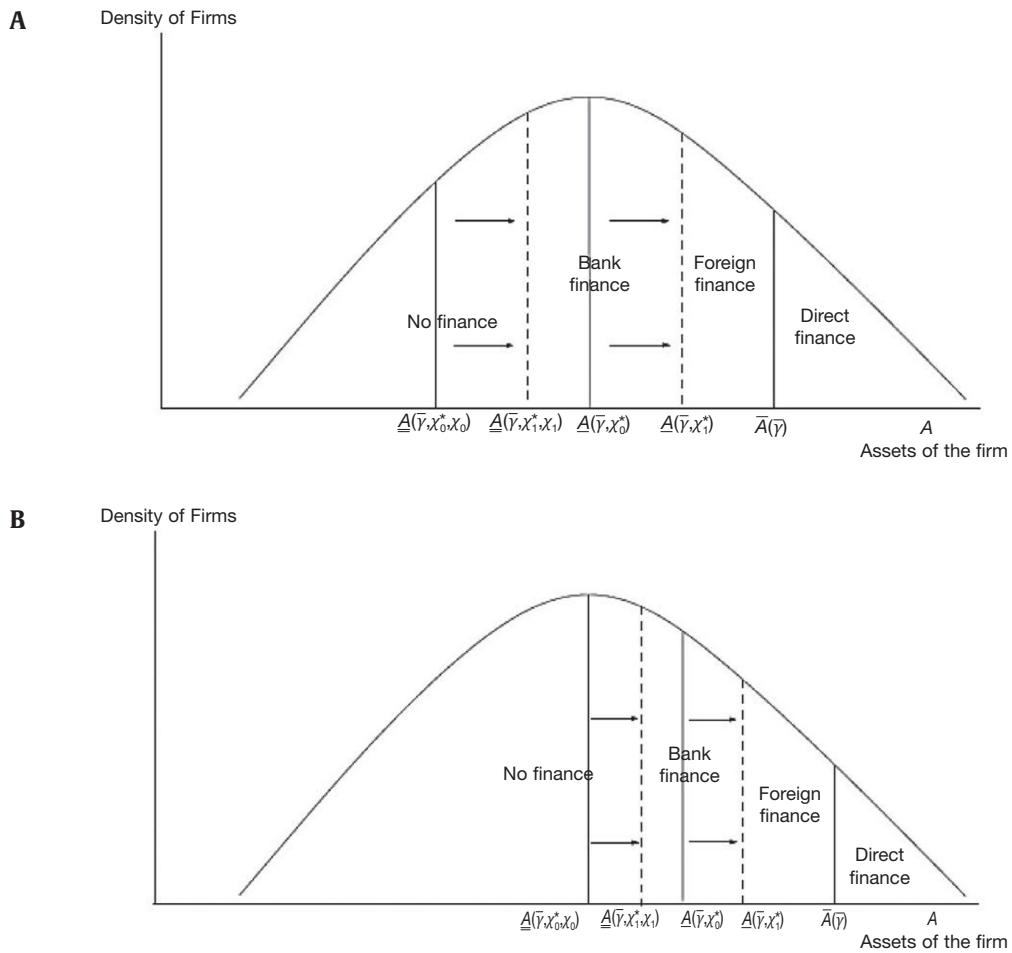

Figure 2 Effect of credit crunch on the three types of finance among firms. A) No distributional assumption. B) Distribution of G(·) is unimodal and $\underline{\underline{A}}(\gamma,\chi^*,\chi)$ is at the mode. Source: authors' calculations.

An interesting corollary of Proposition 2 is that the interest rate for domestic intermediated funds will always be pushed down. The latter is a result of local banks concentrating their loans on a smaller proportion of (higher value) firms. Intuitively, as a result of the uncertainty in the market caused by the foreign credit crunch, local banks will seek to "cherry-pick" the best firms in the bunch, and smaller highly leveraged firms will be the first to go. Targeting their portfolio on a smaller set of larger, less leveraged firms allows for rates in the local credit market to fall.

Hence, under the conditions in the distribution of $G(\cdot)$ implied by Proposition 2, the effects of the foreign capital shock are that poorly-capitalized firms will lose their financing, aggregate investment will fall, the spread between local and foreign rates will be reduced and access to intermediated funds will be concentrated in higher value firms. Importantly, some firms which initially were exclusively financed through foreign and uninformed capital will now have to additionally borrow funds from local banks. In other words, there will be a crowding-out effect in the local market for intermediated capital. This situation is depicted in Figure 2B.

The effects of a negative shock to K_f on the relevant credit-related variables can be summarized as:

- The rate on intermediated foreign funds increases $-\ \chi^* \uparrow$.
- The rate on intermediated local bank funds falls $-\ \chi \downarrow$.
- The proportion of firms with access to intermediated funds falls $-\ G(\bar{A}) - G(\underline{A}) \downarrow$.

On a final note, observe that in practical terms, Proposition 2 requires the distribution of firm asset value to be unimodal and for the portion of firms with access to external funds to be lower than the percentage of firms to the right of the mode of the empirical asset distribution (i.e. $\underline{A}$ is to the right of the mode). This condition is reasonably met using data for Colombia; indeed, while the percentage of firms with access to credit was close to 50% as of December 2011[8], the portion of firms to the right of the mode ranged between 76% and 92%, depending on the bin width used in constructing the histogram[9]. Moreover, a simple inspection of Figure 3 unequivocally reveals the unimodal shape of the firms' asset value distribution.

In what follows, the restriction on the $G(\cdot)$ function described in Proposition 2 is assumed to hold.

3.2. Indirect Effect — Bank-Lending Channel

The lending channel assumes that if banks suffer an adverse shock to the supply of loanable funds available to them (i.e. a bank's

8. In calculating this proportion, the number of firms with at least one of the following types of financing were considered: local bank credit, loans from a foreign bank, loans from a foreign bank intermediated by a local bank, supplier loans and bond issuances.

9. In calculating the portion equivalent to 76% of the data, a band width of COP$500 million was used (around US$257,400), whilst the 92% was calculated assuming a band width of only COP$5 million (close to US$2,600).

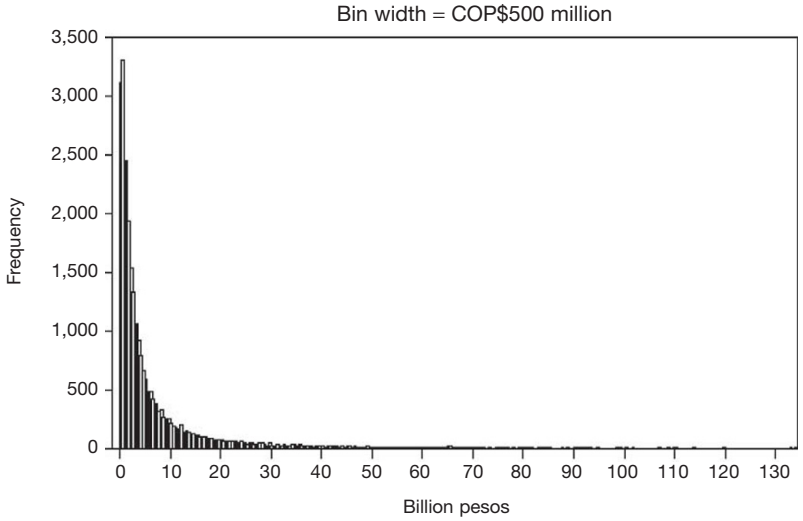

Figure 3 Empirical distribution of firm asset value.
Source: Superintendencia de Sociedades; authors' calculations.

liabilities), and cannot easily substitute such funds, then the total amount of loans they can make will also be affected. In this simple model, such a shock is parameterized by a fall in K_b.

Proposition 3. *Assuming that γ is exogenous (so $\overline{A}(\gamma)$ is fixed), a domestic capital squeeze will adversely affect aggregate investment and will increase the threshold over which firms can raise local bank funds ($\underline{\underline{A}}(\gamma, \chi^*, \chi)$), thus reducing the proportion of firms with access to intermediated finance.*

Proof of Proposition 3. By contradiction. Assume that a domestic capital squeeze lowers the threshold over which firms can access bank finance ($\underline{\underline{A}}$). Since $\overline{A}$ is fixed, the latter implies that the proportion of firms with access to intermediated funding has increased. From equation (37), it is clear that foreign investors will thus have to lend a smaller amount I_f per firm, which implies that χ^*, the rate on foreign funds, must rise. As intermediated foreign capital becomes more expensive, $\underline{\underline{A}}$ shifts to the right, and given that $\underline{\underline{A}}$ is assumed to fall, the portion of firms with access to local bank funds must invariably increase. The latter implies that each firm will receive a lower amount of funds (i.e. I_b falls), which implies an increase in the cost of intermediated bank funds, χ. If both types of intermediated capital have become more expensive (χ and χ^* increase), it cannot be that $\underline{\underline{A}}(\gamma, \chi^*, \chi)$ decreases (from equation (35)), contradicting the initial statement.

Proposition 3 has important implications. Whenever there is a domestic capital squeeze, aggregate investment will unequivocally contract, the portion of firms with access to intermediated funds will fall, and local funding rates will increase. Interestingly, note that since the fall in the proportion of firms with access to intermediated funds is not met with a reduction in foreign capital, equilibrium requires each firm to obtain a larger amount of foreign funds, which is only possible provided the rate on the latter falls. This implies that under a domestic capital squeeze $\underline{\underline{A}}$ increases but $\underline{A}$ actually decreases, implying that there is now a larger portion of firms which obtain all the intermediated funds they need exclusively from foreign investors.

Intuitively, as local bank capital falls and loans become more expensive, fewer firms are able to access domestic funding, and poorly-capitalized firms are the first to be withdrawn from banks' credit lines. However, this also implies that the overall portion of firms with access to intermediated finance is lower, and concentrated in higher value firms, so that foreign investors can effectively increase the amount granted per firm and lower their funding costs. Moreover, the reduction in the cost of foreign funds implies that certain firms, which needed local banks to undertake the project, will now be able to meet their investment requirement by solely tapping foreign liquidity markets in need of intermediated funds.

Therefore, the effects of a fall in K_b on the relevant variables can be summarized as:

- The rate on intermediated foreign funds falls $-\ \chi^* \downarrow$.
- The rate on intermediated local bank funds increases $-\ \chi \uparrow$.
- The proportion of firms with access to intermediated funds falls $-\ G(\overline{A}) - G(\underline{\underline{A}}) \downarrow$.

3.3. Indirect Effect - Balance-Sheet Channel

In a nutshell, the balance-sheet channel states that the greater the net worth of the borrower, the higher the collateral to put up against the funds they need to borrow. Hence, when the value of the collateral decreases, the firm's ability to raise intermediated capital falls, dampening credit and overall investment. This is the so-called financial accelerator effect.

In practical terms, the balance-sheet channel works by shifting the distribution of firms' assets ($G(A|\theta)$, with $\partial G(\cdot)/\partial\theta < 0$, towards lesser values of A. A deterioration of firms' collateral corresponds to a decrease in θ, that is, to a worsening of the distribution in the sense of first-order stochastic dominance.

Proposition 4. *Assuming that γ is exogenous (so $\overline{A}(\gamma)$ is fixed), a collateral squeeze will adversely affect aggregate investment and will "increase" the thresholds ($\underline{A}(\gamma, \chi^*)$ and $\underline{\underline{A}}(\gamma, \chi^*, \chi)$) over which firms can raise money, thus reducing the proportion of firms with access to intermediated finance.*

Proof of Proposition 4. First-order stochastic dominance implies that X dominates Y if $F_X(\chi) \leq F_Y(\chi)$ for all x, with strict inequality at some x. Hence, a worsening of the distribution when θ decreases implies that $G(A|\theta_0) \leq G(A|\theta_1)$ for all A, with $\theta_1 < \theta_0$. The latter implies that the proportion of firms which can access money (via capital markets or intermediated finance) falls, and so does aggregate investment. This effect is equivalent to that of increasing the thresholds $\underline{A}(\gamma, \chi^*)$ and $\underline{\underline{A}}(\gamma, \chi^*, \chi)$

In other words, in this simple setup, a collateral squeeze has the same effects on aggregate investment and the portion of firms with access to funding as a foreign credit crunch, analogous to the original model proposed by Holmström and Tirole (1997)[10]. Intuitively, the effect of a collateral squeeze is straightforward. If an industrial recession hits the economy and all firms suddenly find themselves with a lower value of their assets, *ceteris paribus*, then access to funding (both direct and intermediated) will be restricted to a smaller number of firms, and aggregate investment will invariably fall.

Nonetheless, the effects of a collateral squeeze on interest rates are distinct from those observed under the capital contraction scenarios examined above. In particular, note that the proportion of firms with access to both types of intermediated funds (i.e, local and foreign) falls, but this reduction is not met with a detriment in capital, so that to guarantee equilibrium in the market, both banks and foreign investors will be forced to lower their rates in order to disburse a larger amount of credit per firm.

Thus, the effects of a collateral squeeze on the credit-related variables of interest can be summed up as:

- The rate on intermediated foreign funds falls $-\chi^* \downarrow$.
- The rate on intermediated local bank funds falls $-\chi \downarrow$.
- The proportion of firms with access to intermediated funds falls $-G(\bar{A}) - G(\underline{\underline{A}}) \downarrow$.

Note that, if the collateral shock is induced by a decrease in foreign capital, then the adverse effect on the access to intermediated financing will be more pronounced. The reader can deduce that if, in addition, the foreign credit crunch is accompanied by a reduction in bank capital then the effect on the proportion of firms with funding will be more stringent, as access to bank capital is likely to be further reduced to a smaller range of firms.

The importance of the comparative statics exercises carried out in this section, is that they provide testable hypothesis. In this particular case, one sees that a reduction in foreign capital flows should reduce the overall level of aggregate investment, but most importantly, it will adversely affect the access of firms to intermediated credit markets. This overall effect is the result of less firms having access to intermediated foreign investor funds (direct effect), and could further be reinforced if it is met with a local capital squeeze (bank-lending channel) or through lower value of collateral as asset prices fall (balance-sheet channel). Moreover, it is worth mentioning that the model also predicts that any kind of shock will result in a crowding-out of small firms in favor of larger firms (i.e. with higher asset value) in the local market for intermediated capital. The overall effect on interest rates is less clear, and dependant on the nature and magnitude of the shock(s), implying that the overall effect on the interest margin ($\chi - \chi*$) is ambiguous.

4. Empirical Application

The objective of this section is to empirically assess the relationships between the key variables of the theoretical model found in the comparative statics exercises performed in Section 3. In particular, this paper's interest lies on the effects that shocks on foreign debt flows have on credit-related variables. In the theoretical model, these shocks where shown to have an impact on firms' access to intermediated finance, which could be further reinforced (or mitigated) through alterations on collateral values (balance-sheet channel) or on banking resources (bank-lending channel).

10. Recall that the foreign investors in this setup are equivalent to the bank/monitors of the original model.

Table 1
Key model variables

Variable	Model	Empirical Application
Foreign funds	K_f	Foreign capital debt flows to the corporate sector (financial loans from foreign banks, commercial credit from foreign suppliers and loans in foreign currency through a domestic intermediary)
Bank credit	K_b	Annual growth of commercial loans to the corporate sector (in local currency)
Firms' asset value	A	Colombian Stock Market Index (IGBC)
Interest margin†	$\chi - \chi^*$	Spread between the interest rate on local bank credit and the rate on foreign funds
Proportion of firms with access to intermediated funds	$G(\bar{A}) - G(\underline{\underline{A}})$	Percentage of firms with financing in foreign currency and/or with loans in domestic currency, as a percentage of total firms in the sample

†The rates are both weighted averages using each of the loan portfolios, and the rate on foreign funds includes the implicit expected depreciation from forward contracts.
Source: Banco de la República, Superintendencia Financiera de Colombia, Superintendencia de Sociedades; authors' calculations.

4.1. The Data

The empirical model was estimated using quarterly data for the period comprised between 1999Q1-2012Q1. Table 1 summarizes the variables used in the exercise.

The following caveats must be kept in mind. First, when referring to the corporate sector in this paper, what is meant is the universe of firms being supervised by Superintendencia de Sociedades (Colombia's Corporate Sector Superintendence), for which balance-sheet data is readily available[11]. This sample is the best proxy of the corporate sector in Colombia, not only due to the quality of the information, but also because the loan portfolio of these firms accounts for 45% of total credit to the corporate sector, and so their representativeness is undeniable. In addition, disbursements of domestic loans are not available prior to 2002, and so in this paper they are approximated using the annual growth rate of the loans portfolio, in local currency, extended to the corporate sector. Lastly, it is worth noting that debt capital flows are annualized and that all the variables in the exercise are in real terms (December 2011 prices).

Moreover, as mentioned in the introduction, one of the main contributions of this paper, when compared to those evaluating the relationship between foreign capital flows and credit, is the extensive work done using micro data to approximate the composition of firms along the distinct forms of financing. On the one hand, information relating to loans from the domestic financial system is obtained from a database constructed by the Superintendencia Financiera (Colombia's Financial Superintendence), which contains information from every debtor in the commercial loans portfolio. On the other, debt capital flow information is also available at the firm-level at Banco de la República. Both data sets are then cross-referenced with the balance-sheet data from Supersociedades, from where bond issuances are additionally obtained. Importantly, since balance-sheet data is annual, whilst the other data sets are quarterly, it is assumed that the balance-sheet items remain unchanged during the following year[12]. With this information it is then possible to determine the proportion of firms with the relevant forms of financing.

11. The size of the corporate sector, per year, can be assessed in Table C1, Appendix C. The sample has 16,575 firms on average per year.
12. The data sets are cross-referenced on December of every year, and during the following three quarters the balance-sheet data is constant.

Finally, the rationale behind including only debt capital flows to approximate the foreign funds variable is that the theoretical model is built upon liabilities, which finance local investment decisions, and not funds that involve participation in ownership. Therefore, FDI or other types of equity capital are not included in the series.

4.2. The Econometric Model

In order to quantify the effect of a negative shock on capital debt flows on the relevant credit-related variables, a Vector Error Correction Model with exogenous variables (VECX) is estimated, using the proxies of the variables from the theoretical framework described in Table 1. In particular, the choice to include an exogenous variable is to control for external shocks that might affect the local supply of credit, and hence, one expects that by capturing changes in investors' degree of risk aversion such objective is met. Therefore, the VIX index is included as an exogenous variable in the empirical model[13].

Appendix D contains the stationarity and endogeneity tests performed on the variables employed in the system, along with normality and autocorrelation tests on the error terms. The lag length of the VECX model was chosen so as to guarantee the "proper" behavior of the residuals in the model[14]. The particular ordering of the variables in the VECX for the impulse response analysis was based on the exogenous/endogenous nature of the variables in the theoretical model[15].

The existence of long-run relationships between the variables in the system is verified using the approach proposed by Johansen (1988). The aforementioned Appendix includes the result of the trace test, which suggests that there exists at most one cointegrated vector for the system (Table D2, Appendix D). The estimated VECX model, which includes an intercept in the short-run dynamics and deterministic variables, is summarized in Table 2, which additionally reports the calculated cointegration vector.

Table 2
Estimated VECX model

endogenous variables:	K_f	K_b	IGBC	Spread	Prop	
exogenous variables:	VIX					
deterministic variables‡:	CONST.	S1	S2	S3	D1	D2
lags:	4					
sample range:	[2000 Q1 -	2012 Q1]		T = 49		
Cointegration Vector						
	K_f	K_b	IGBC	Spread	Prop	VIX
Coefficient:	1.00	–92.854	0.045	–509.650	28.09	1.441

‡S1, S2 and S3 are centered seasonal dummy variables. D1 and D2 are dummy variables that take a value of 1 in March, 2002 and June, 2006, respectively.
Source: authors' calculations.

4.3. Results

The comparative statics exercises carried out in Section 3 are based on the premise that changes in debt capital flows might have both direct and indirect effects. In order to determine the validity of the theoretical statements, the behavior of capital flows and their effect on key credit-related variables is analyzed via the impulse response functions of the VECX model. Figure 4 presents the reaction of the variables in the model following a negative shock on annualized debt flows[16].

First, when analyzing the relationship between capital debt flows and loans to the corporate sector in local currency, the impulse response shows that there is no significant short-run relationship and a positive long-run relationship between the former and the growth rate of credit (Figure 4A). In the comparative statics exercises it was argued that the negative direct effects of a foreign credit crunch on the relevant credit-related variables could be reinforced or mitigated through other indirect channels, such as the bank-lending channel. In this particular case, despite the shock on foreign funds affecting market liquidity, the lending channel does not seem to be very strong, at least in the short-run, thus rendering the lending capacity of local banks unaffected. The latter could be related to the particularities of Colombian regulation, which prohibits banks from borrowing in foreign currency to lend in local currency[17]. In this sense, a foreign credit-crunch induced bank- lending channel need not occur in the short-term, but rather subsequently to the extent that the reduction in aggregate market liquidity drains funds from banks' balance sheets, diminishing their lending capacity.

Consistent with this intuition, one finds that in the long-run, the relation between foreign debt flows and domestic credit becomes positive, as evidenced in the estimated cointegration vector: a decline in foreign liquidity is bound to have a negative effect on domestic economic conditions and local credit, both through the adverse effect on firms' investment decisions (local funding is typically more expensive) as well as through a lower supply of bank credit as a result of overall lower market liquidity. As can be seen in Figure 5, both types of financing seem to have a positive relationship, nevertheless, this appears to be not contemporaneous, but instead, the behavior of capital flows leads the subsequent path of domestic loans to the corporate sector.

By contrast, the response of firms' asset value to capital flows is positive and significant (Figure 4B). When there is a negative shock on debt flows, the stock market's response is also negative, which is in line with what is usually observed in the Colombia securities market (Figure 6); it is difficult to state that foreign resources go directly towards financing investments in the stock market, but again, a negative global environment with less available funds could be part of the explanation. One important thing to keep in mind is that the strong correlation between these two variables may imply that the adverse effect of a foreign credit crunch is reinforced by the so-called balance-sheet channel, in the sense that a decrease in asset value, caused by falling debt flows, threatens the ability firms have of raising funds further, due to the deterioration of their collateral. This is particularly interesting when analyzing the response of the proportion of firms with access to funding following a negative shock on foreign debt flows, which is analyzed next.

According to the theoretical model, another effect of a foreign credit crunch is to increase the asset value thresholds, which leaves a smaller portion of firms with access to intermediated funding (both domestic and foreign). This claim has been found to also hold empirically, since a negative shock on capital flows leads to a lower percentage of firms with access to financing (Figure 4C). One can intuit that, firms borrowing abroad lose their access to these markets, causing the proportion to decrease. If such firms were

13. Technically, it is not assumed a priori that VIX is an exogenous variable. In fact, the existence of the cointegration vector is determined using all variables, and consequently exogeneity tests are performed, which allow concluding that treating such variable as exogenous is appropriate. These tests are found in Table D1, Appendix D.
14. To ensure that these assumptions were satisfied, it was necessary to include two dummy variables to correct for some abnormal observations.
15. The most exogenous of the endogenous variables is foreign debt capital flows, followed by domestic credit, the value of assets, the spread and the proportion of firms with access to intermediated financing.
16. The shock is defined using the Choleski decomposition and the ordering of the endogenous variables presented in Table 2.
17. According to the local regulation, intermediaries are allowed to use external resources to either lend in foreign currency with a shorter maturity compared to that of the funds, hedge derivatives or for currency exchange operations (Board of Governors of the Central Bank, Resolution No. 8 of 2000).

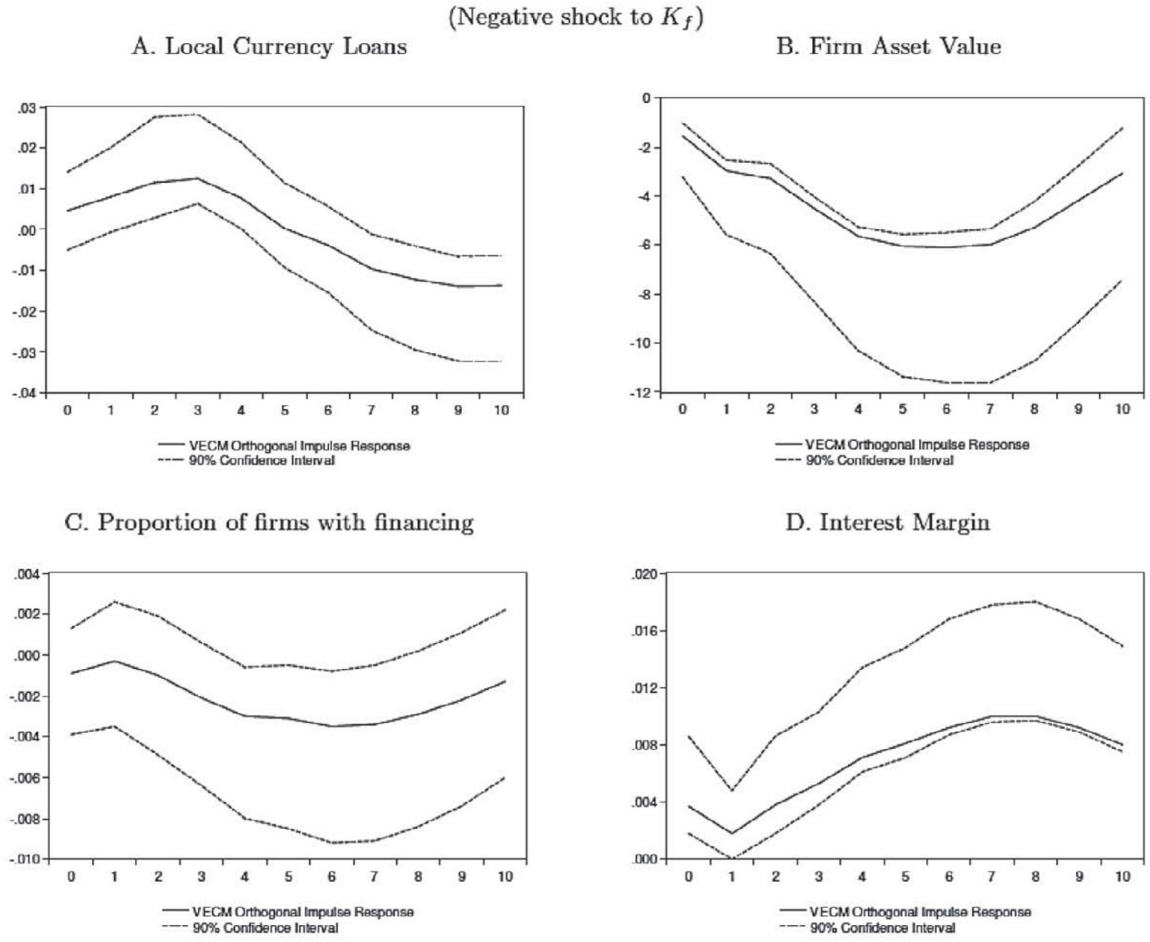

Figure 4 Response to Cholesky One S.D. Innovations.
Source: Banco de la República, Superintendencia Financiera de Colombia, Superintendencia de Sociedades; authors' calculations.

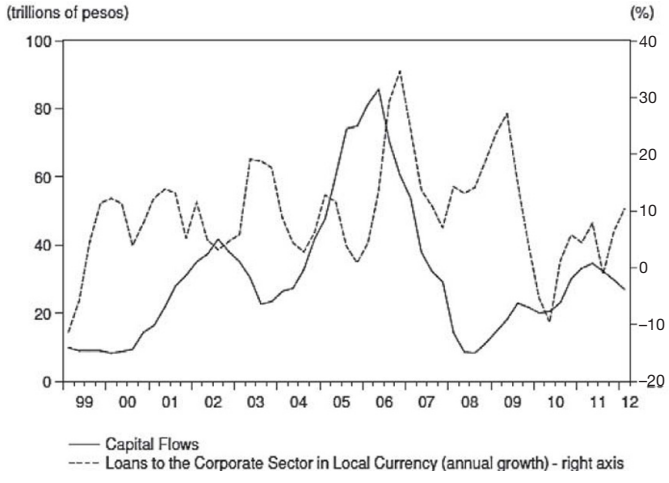

Figure 5 Capital flows and loans to the corporate sector.
Source: Banco de la República, Superintendencia Financiera de Colombia, Superintendencia de Sociedades; authors' calculations.

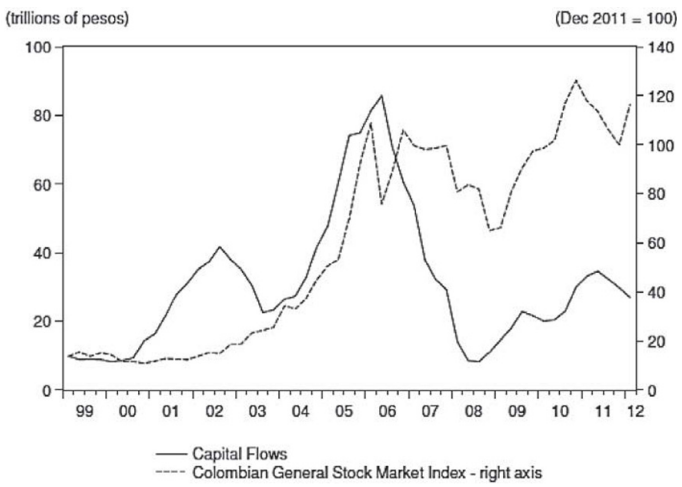

Figure 6 Capital flows and firm asset value.
Source: Banco de la República, Bolsa de Valores de Colombia, Superintendencia Financiera de Colombia, Superintendencia de Sociedades; authors' calculations.

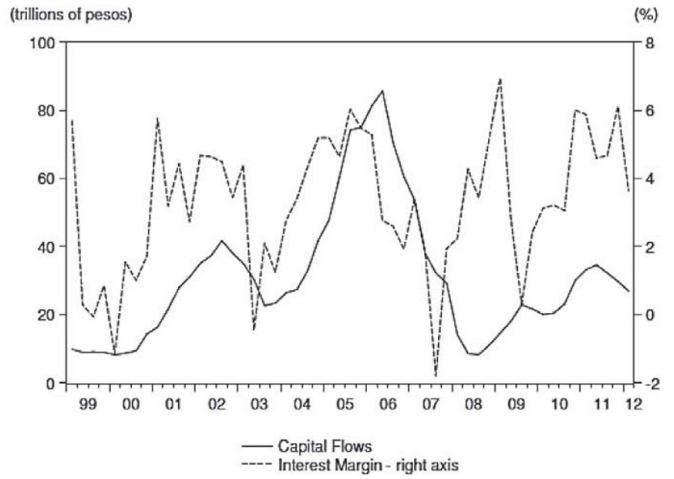

Figure 7 Capital flows and interest margin.
Source: Banco de la República, Superintendencia Financiera de Colombia, Superintendencia de Sociedades; authors' calculations.

able to substitute their foreign funding for domestic credit, then the overall proportion of firms with intermediated funds should be unchanged; however, this is not the case, so it must be that the foreign shock causes some firms to lose their access to credit markets altogether.

Finally, going back to the impulse response results, one has that the relationship between capital flows and the interest margin is not statistically significant in the short-run and negative in the medium and long-term. When there is a cut in debt flows, the theoretical model predicts an increase in the external rate, as fewer funds are available to lend. If domestic bank credit does not change, the local rate will decrease (since the same amount is lent to less firms), reinforcing the effect on the spread. However, it has been shown that, empirically, this result does not hold. The latter might be due to at least two factors. On one hand, the proportion of firms is unchanged in the short-term, and on the other, local rates might be increasing in the local market as a result of exogenous policy actions aimed at controlling the effect of the capital flows shock.

The effect in the long-run, however, seems to be consistent with the long-term relationship found between domestic credit and foreign funds: in the medium-term, the internal rate should rise in response to the reduction in loanable funds following the fall in overall market liquidity, thus increasing the interest margin. The increment in the relative cost of domestic funds should, some periods later, have a negative impact on the amount that firms borrow locally. The two variables, capital flows and the interest margin, are shown graphically in Figure 7.

5. Concluding Remarks

The main goal of this paper was to measure the impact of a foreign capital flows shock on the debt structure of firms and other credit-related variables. An augmented version of the Holmström and Tirole (1997) model was developed with the purpose of including a new investor to account for the relevance of foreign creditors (together with domestic ones) in the financing of local projects. The theoretical model allows one to individually explore the different channels through which shocks on capital flows may affect the economic variables related with domestic credit. The main theoretical prediction of the model is that a foreign credit crunch will affect both aggregate external credit and the portion of firms with access to intermediated funds. This implies that poorly-capitalized firms will lose their access to credit markets and funds will be concentrated in higher value firms, and thus, some firms financing exclusively from foreign and capital markets will turn to borrow funds from local intermediaries as well.

Testing the predictions of the theoretical model for the Colombian economy is of particular interest because the potential effects that foreign capital flows have on domestic credit have been the subject of debate by policy makers during the last decades, in no small part due to the observed relationship between the two variables along the economic cycle. In this paper, a VECX model is estimated to empirically validate the proposed relations between the relevant variables. When a negative shock to foreign funds occurs, consistent with the predictions from the theoretical framework, the proportion of firms with access to intermediated finance decreases. Interestingly, the estimated long-run relationship between the model variables indicates that capital flows and domestic credit growth are positively related, as is usually found in the empirical literature.

The result on firms' asset value is also interesting, since it seems to reinforce the existence of a balance-sheet channel related with foreign debt flows. The positive relationship found between capital flows and asset prices underlines the strong correlation that is usually observed between these variables. Even though it seems difficult to state that foreign resources go directly towards financing investments in the stock market, a negative global environment accompanied with lower liquidity does appear to adversely affect prices in this market.

The contributions of this paper are related to different issues. First, an extended version of a seminal paper on financial intermediation is presented trying to consider a principal-agent setting in an open economy. This version allows identifying the potential channels through which capital debt flows affect credit-related variables, thus providing a micro foundation to the empirical macro exercise. Second, an extensive set of micro data was constructed and used in order to evaluate how shocks on foreign capital flows change the aggregate debt structure of firms in the Colombian corporate sector and in particular, how the proportion of firms with access to intermediated finance changes through time. Third, the empirical application of the theoretical model using Colombian data, which allows one to explore and confirm the relations between the relevant variables, along with the respective channel that, may explain such relationships.

The policy implications of the findings are also diverse. Discussions about the effectiveness and potential effects of measures, such as the imposition of capital controls by regulatory authorities, are always at the center of debate. The message here is that measures that affect foreign debt flows to the economy can potentially affect domestic credit market variables, even if not contemporaneously. Results indicate that controls that prohibit domestic banks from intermediating foreign funds in order to extend loans in local currency appear to be effective in the short-run, as the lack of a lending channel related to foreign debt flows indicates. The latter is positive considering this was one of the main purposes of these regulations when they were created. However, as shown, the long-run relationship between capital flows and credit holds, in the sense that lower debt capital flows eventually have negative effects on the economy, possibly demeaning the welfare of the economy as a whole.

On a final note, a natural extension to the approach developed in this paper would be to further exploit the microeconomic data available, through panel data techniques, to evaluate what type of shocks affect the supply of credit of local banks and how in turn the former affects domestic firms' financing and investment decisions. This would constitute an ideal complement to the macroeconomic exercise explored in this paper.

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Appendix A The Benchmark Model

In this appendix a standard version of Holmström and Tirole (1997) is presented. This is a moral hazard model with financial intermediation where there are three periods ($t = 0, 1, 2$) and three agents: entrepreneurs, banks (monitors) and (uniformed) investors. In what follows, each of these agents and their actions are described, assuming that the interest rate is exogenous.

1. Entrepreneurs

A continuum of risk neutral entrepreneurs is considered, which are the executors of the investment project. These agents are heterogeneous, since they differ in their level of capital, which is represented by A. They are willing to invest this capital in a project of size I, where $I > A$. Therefore, the total amount of resources that they need to borrow from external investors is represented by $I - A$.

The accumulated distribution of capital is represented by $G(A)$, which is assumed to be normalized to have a mass of 1. A change in the general level of capital is assumed to be represented by a parameter θ, such that $G(A|\theta)$.

There are two ways to finance the project externally, which will be discussed in further detail below. Entrepreneurs decide to behave or misbehave at time $t = 1$, depending on the level of effort they put on the project. When they behave, the project is said to be good, and has a higher probability of success (pH); when they misbehave, the probability is pL (with $pH > pL$) and managers obtain a private benefit of either b or B, which is conditional on the presence of monitoring; this is the bad version of the project. Δp is defined as $pH - pL$.

2. Investors

Uninformed investors are risk neutral and individually small and therefore, unable to monitor the project directly. They claim a rate of return of γ (their opportunity cost) on the amount invested in the project (I_i).

3. Banks

In this economy there are several small banks which are also risk neutral. They participate in the project either as monitors/financiers or they can mimic uninformed investors. In the first case, they incur in a cost denoted by c at $t=1$. This activity allows to reduce the private benefit of entrepreneurs from B to b. As monitors, they hold a level of capital denoted by K_b and demand a rate of return of on χ their investment, I_b. If they participate as uninformed investors, then they incur no cost and claim a rate of return of γ on their investment.

4. The Project

The project requires an initial investment of I at $t=0$. The only two possible outcomes of this project are R if the project is successful and 0 otherwise. The output of the project is shared among the three agents of the economy, that in case of success is given by:

$$R = R_i + R_e + R_b \tag{A1}$$

where the subscripts represent the uninformed investors (i), entrepreneurs (e) and banks (b).

The difference between the project's size and the entrepreneur's capital needs to be financed externally by banks (intermediated finance) and/or uninformed investors (direct finance).

The project only generates a positive net present value (NPV) when it is externally financed if entrepreneurs behave. This is represented by the following condition:

$$p_H R - \gamma I > 0 > |p_H R - \gamma I| + B \tag{A2}$$

Equation (2) states that the expected return of the project is greater than its opportunity when the entrepreneur behaves, and thus, only the good project is socially desirable.

4.1. Direct Finance

First, the case where the entrepreneur is (potentially) financed by investors exclusively is presented. Here, the existence of banks is abstracted.

The sharing rule is thus divided between investors and entrepreneurs, which implies that:

$$R = R_i + R_e \tag{A3}$$

The next condition guarantees the good behavior of entrepreneurs. It states that the expected outcome for the firm if managers exert high effort should be higher than the one with low effort:

$$p_H R_e \geq p_L R_e + B$$

$$R_e \geq \frac{B}{\Delta p} \tag{A4}$$

From the uninformed investors' perspective, the project will be financed if the expected outcome (of investing in the project) is higher than their opportunity cost:

$$p_H R_i \geq \gamma (I - A)$$

$$I_i \geq \frac{p_H R_i}{\gamma} \tag{A5}$$

The firm can only obtain direct financing if it has enough capital (i.e. $A + I_i \geq I$. From the combination of equations (A3), (A4) and (A5), it is possible to obtain the minimum level of capital ($\bar{A}$) required by uninformed investors in order to finance the project, which is given by:

$$A \geq \bar{A}(\gamma) \equiv I - \frac{p_H}{\gamma}\left[R - \frac{B}{\Delta p}\right] \tag{A6}$$

4.2. Intermediated Finance

Alternatively, the case where other agents (i.e. banks) finance the project is also considered. The total amount to be financed, $I - A$, will be jointly contributed by banks (I_b) and uninformed investors I_i):

$$I - A = I_i + I_b \tag{A7}$$

The sharing rule is now divided between the three agents:

$$R = R_i + R_b + R_e \tag{A8}$$

The rate of return demanded by banks and uninformed investors is given by the project's expected outcome as a percentage of the initial investment:

$$\chi = \frac{p_H R_b}{I_b} \tag{A9}$$

$$\gamma = \frac{p_H R_i}{I_i} \tag{A10}$$

As monitors incur in a higher cost than uninformed investors, due to the presence of monitoring activity, it is natural to expect that $\chi > \gamma$. Moreover, since banks could choose to operate as investors (and earn a rate of return of γ), without incurring in a monitoring cost, the remuneration for banks should be larger. As a consequence, the following condition must be satisfied:

$$\chi I_b - c \geq \gamma I_b$$

$$\chi - \gamma \geq \frac{c}{I_b} \tag{A11}$$

When introducing the banks as monitors, two conditions must be satisfied, in order to justify the monitoring activity:

$$p_H R_e < p_L R_e + B \tag{A12}$$

$$p_H R_e \geq p_L R_e + b \tag{A13}$$

Note that equation (A13) implies that:

$$p_H(R - R_i - R_b) \geq p_L(R - R_i - R_b) + b$$

$$R_i + R_b \leq R - \frac{c}{\Delta p}$$

or equivalently:

$$R_e \geq \frac{b}{\Delta p} \tag{A14}$$

The bank's incentive compatibility constraint is given by the following equation, which compares the expected outcome with monitoring to the one obtained without such activity:

$$p_H R_b - c \geq p_L R_b$$

$$R_b \geq \frac{c}{\Delta p} \tag{A15}$$

Using (A9) and (A15), the minimum amount that banks will invest in the project (I_b) is obtained[18]:

$$I_b = I_b(\chi) \equiv \frac{p_H R_b}{\chi} \tag{A16}$$

The rest of the financing is obtained from uninformed investors. From equation (A10), the fact that (A15) is binding and equation (A14) one has that:

$$I_i \leq \frac{p_H}{\gamma}\left[R - \frac{b+c}{\Delta p}\right] \tag{A17}$$

Equation (A17) effectively implies that the net present value of the project for the uninformed investor is higher than their initial investment. In other words, that the financing condition is met. One can rewrite the latter as:

$$\frac{p_H}{\gamma}\left[R - \frac{b+c}{\Delta p}\right] \geq I - A - I_b(\chi) \tag{A18}$$

From (A18), the firms' minimum level of capital, $\underline{A}$, required by banks to finance the project, is:

$$A \geq \underline{A}(\gamma,\chi) \equiv I - I_b(\chi) - [(p_H(R - (b+c)/\Delta p)/\gamma] \tag{A19}$$

Note that $\underline{A}$ is increasing in b, c, γ and χ and decreasing in Δp, p_H and R. The existence of intermediated funding is justified if $\underline{A} < \overline{A}$. It follows that if $\chi > \gamma$ and the monitoring cost c is small enough, this condition is satisfied.

Given these elements, three different regions, depending on the source of financing, have been defined:

- The region where $A \geq \overline{A}$: the project is financed directly by uninformed investors.
- The region where $A \in [\underline{A}, \overline{A})$: the project is additionally financed by banks.
- The region where $A < \underline{A}$: the project is not financed externally; the firm cannot invest.

From the view of entrepreneurs, they will prefer to finance the project externally rather than invest in other alternatives in the market. This condition is equivalent to the following expression:

$$\frac{p_H R - \frac{(\chi - \gamma)\, p_H c}{\Delta p \chi}}{\gamma} \geq I \tag{A20}$$

Banks will finance the project using their own capital according to:

$$K_m \geq [G(\overline{A}(\gamma)) - G(\underline{A}(\gamma,\chi)]I_b(\chi) \tag{A21}$$

When the interest rate is endogenous, the supply of savings, which depends on the interest rate, must finance total investment according to the following expression:

$$S(\gamma) = \int_{\overline{A}(\gamma)}^{\infty}(I - A)dG(A) + \int_{\underline{A}(\gamma,\chi)}^{\overline{A}(\gamma)}(I - I_m(\chi) - A)dG(A) - \int_0^{\underline{A}(\gamma,\chi)} A\, dG(A) \tag{A22}$$

18. One is interested in the minimum since entrepreneurs will use the least amount possible of bank funds to finance their project. The reason is simple: these funds are more expensive than those obtained from uninformed investors.

Appendix B Pecking Order of Debt Structure in the Model

Define the utility of the entrepreneur as the NPV of the investment project for the firm (i.e. the expected return discounted at the opportunity market rate minus the cost of the project for the firm), such that:

$$\begin{aligned} U_e &\equiv \frac{p_H R_e}{\gamma} - A \\ &\equiv \frac{p_H (R - R_i)}{\gamma} - A \\ &\equiv \frac{p_H R}{\gamma} - \frac{p_H R_i}{\gamma} - A \\ &\equiv \frac{p_H R}{\gamma} - I \end{aligned}$$

The latter implies that the utility of the entrepreneur depends on the NPV of the investment project. If the NPV is positive, then the entrepreneur will always prefer investing in the project rather than in other firms in the market (in exchange for γ).

From this definition of utility, it is clear to see that one can obtain a similar condition for the case when the firm employs a foreign monitor and/or the case of a local monitor. In the former, the utility of the firm can be expressed as:

$$\begin{aligned} U_e^f &\equiv \frac{p_H (R - R_i - R_f)}{\gamma} - A \\ &\equiv \frac{p_H R - \gamma I_i - \chi^* I_f(\chi^*)}{\gamma} - A \\ &\equiv \frac{p_H R - (\chi^* - \gamma) I_f(\chi^*)}{\gamma} - I \\ &\equiv \frac{p_H R - (\chi^* - \gamma) p_H c^* / \Delta p \chi^*}{\gamma} - I \end{aligned}$$

In this case, a positive NPV implies that the firm will prefer to enlist a foreign monitor and receive funding rather than invest in other firms.

In the case when a local monitor (i.e. a bank) is also employed, the condition is given by:

$$\begin{aligned} U_e^{f,b} &\equiv \frac{p_H (R - R_i - R_f - R_b)}{\gamma} - A \\ &\equiv \frac{p_H R - \gamma I_i - \chi^* I_f(\chi^*) - \chi I_b(\chi)}{\gamma} - A \\ &\equiv \frac{p_H R - (\chi^* - \gamma) I_f(\chi^*) - (\chi - \gamma) I_b(\chi)}{\gamma} - I \\ &\equiv \frac{p_H R - (\chi^* - \gamma) p_H c^* / \Delta p \chi^* - (\chi - \gamma) p_H c / \Delta p \chi}{\gamma} - I \end{aligned}$$

In this case, a positive NPV implies that the firm will prefer to enlist both a foreign and internal monitor and receive funding rather than invest in other firms in the market.

Moreover, one can easily verify that if $\chi > \chi^* > \gamma$, then it is always true that:

$$U_e > U_e^f > U_e^{f,b}$$

which implies that firms will always prefer direct to intermediated lending.

In addition, in this model there is a pecking order for intermediated funds. Entrepreneurs would, as shown above, ideally: *a)* finance the project themselves; *b)* acquire funds from uninformed investors; *c)* involve additional funds from a foreign investor, and *d)* additionally borrow from local banks. This ordering has an implicit assumption, namely, that when faced with the decision of borrowing from a monitoring agent, entrepreneurs will prefer foreign investors to local banks. This statement follows from the fact that, if required to borrow an amount M from the market for intermediated funds, the upcoming would hold:

$$\begin{aligned} & U_e^f > U_e^b \\ & \frac{p_H R - (\chi^* - \gamma) M}{\gamma} - I > \frac{p_H R - (\chi - \gamma) M}{\gamma} - I \\ & (\chi - \gamma) > (chi^* - \gamma) \end{aligned}$$

The latter condition is equivalent to:

$$\chi > \chi^*$$

which is assumed to always be true.

Appendix C Firm Statistics

Table C1
Number of firms per year

Year	# of firms
1999	9,205
2000	10,157
2001	9,576
2002	8,927
2003	8,931
2004	10,537
2005	19,027
2006	22,787
2007	20,929
2008	21,544
2009	23,893
2010	23,860
2011	26,101

Source: Superintendencia Financiera de Colombia, Superintendencia de Sociedades; authors' calculations.

Appendix D Statistical Tests of the Empirical Model

In this appendix the statistical tests of the VECX model are presented.

Table D1 reports the weak exogeneity, exclusion and stationarity tests performed on the series in the system. The first test's objective is to verify if each variable can be treated as an endogenous variable in the system. The second one has the purpose of verifying whether each variable in fact belongs to the cointegration vector. Both these tests are constructed using a likelihood ratio which follows a χ^2 distribution with r degrees of freedom, where r corresponds to the number of cointegrated vectors in the system.

In the first case, the endogeneity test suggests that K_b, K_f and IGBC are endogenous variables in the system, whereas Spread, Prop and VIX can be potentially treated as exogenous variables. Nonetheless, in this paper one is interested in empirically assessing both the effect of debt flows on asset prices, as well as the effect on credit-related variables when the indirect channels are at work; for this reason, all the variables in the system, with the exception of VIX, are treated as endogenous. In particular, Prop must be considered an endogenous variable since the main predictions of the theoretical model are concerning the effects on the private sector's access to credit in response to reductions in capital and/or asset value. Moreover, the exclusion test suggests that all the variables belong to the estimated cointegrated relationship.

Lastly, the stationarity test suggests that all variables are $I(1)$ in the system. This test is also constructed based on the ratio of likelihood functions which follow a χ^2 distribution with $p - r$ degrees of freedom, where p corresponds to the number of endogenous variables in the system.

The Johansen trace test, with the adjustment for small sample proposed by Cheung and Lai (1993), is applied in order to identify the number of cointegration vectors that are found under different model specifications. The results presented in Table D2 suggest that, for a model with four endogenous lags, deterministic variables and an intercept in the short-run dynamics, there is at most one cointegrated vector considering a 95% confidence level.

Regarding the behavior of the residuals, multivariate normal test is verified using the NM statistic proposed by Doornick and Hansen (1994). The test suggests that it is not possible to reject the null hypothesis that disturbances are normally distributed (Table D3). With respect to the potential presence of autocorrelation, multivariate Lagrange Multiplier (LM) tests are presented in Table D4. These tests suggest that it is not possible to reject the null hypothesis of no serial correlation of order h (for h=1 and h=4).

Table D1
Statistical tests of the time series properties of the individual series

Variables	Weak-Exogeneity	Exclusion	Stationarity
	Distribution: $\chi^2(1)$ Critical value: 2.71 α = 10%	Distribution: $\chi^2(1)$ Critical value: 2.71 α = 10%	Distribution: $\chi^2(5)$ Critical value: 9.24 α = 10%
K_f	42.32	68.51	88.21
K_b	17.68	46.24	90.17
IGBC	7.80	3.35	118.32
Spread	0.01	27.71	103.58
Prop	0.71	2.88	112.86
VIX	1.70	56.42	106.24

Source: authors' calculations.

Table D2
Johansen Trace test

Adjusted for small sample and number of lags using the methodology proposed by Cheung & Lai (1993) (Test critical values at the 5% level)			
Endogenous variables:	K_f, K_b, IGBC, Spread, Prop, VIX		
Deterministic variables:	CONST., S1, S2, S3, D1, D2		
Sample range:	2000:Q1-2012:Q1, T = 49		
Included lags (levels):	4		
# of vectors	d.f.	Test statistic	Crit. value
None	6.00	131.18	124.61
At most 1	5.00	65.23	95.38
At most 2	4.00	35.11	70.22

Source: authors' calculations.

Table D3
Test for nonnormality

Doornick & Hansen (1994)	
Joint test statistic:	13.84
p-value:	0.18
Degrees of freedom:	10

H0: residuals are normally distributed.
Source: authors' calculations.

Table D4
LM-type test for autocorrelation with 1 and 4 lags

LM test with 1 lag	
LM statistic - $\chi^2(25)$	17.78
p-value	0.85
LM test with 2 lags	
LM statistic - $\chi^2(25)$	26.18
p-value	0.40

H0: h-th order residual autocorrelations equal to 0.
Source: authors' calculations.