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Firm-Level Evidence of the Link between Credit, Firm Size and Competitiveness in Colombia

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Abstract[1]

Credit has been found to be a catalyst for economic growth, as it spurs investment, enhances productivity, allows costs to be spread out over time, improves resource allocation, and enables investors to cope better with macroeconomic volatility. Most studies focus on the relationship between financial development and growth at the country level, while few analyze the relationship at the firm level. Using a panel-shaped firm-level dataset of Colombian firms and employing the methodology developed by Love and Zicchino (2006), this paper examines whether the response of firms to financial and real shocks varies according to firm size and across different levels of firm productivity. The study finds that financial shocks have a significant positive impact on firm growth, which is larger for larger firms and more productive firms that export. The results indicate that something is preventing smaller firms from taking full advantage of access to external financing.

JEL classifications: G32, O54
Keywords: Firm size, credit, external financing, productivity

[1] The views in this paper are those of the authors and do not represent those of the IDB or its Board of Directors.

1. Introduction

There is abundant evidence that credit is important for economic growth. Credit enables borrowers to carry out investment projects that are the basis of capital accumulation, and it enhances productivity in a number of ways. For instance, it enables firms to sustain long gestation periods to develop new technologies or processes by allowing them to spread costs over time. So productivity improvements through upgrading depends largely on access to long-term financing. Also, credit markets improve resource allocation across firms. Bagehot (1873) and later Schumpeter (1912) argue that credit enhances productivity by facilitating efficient capital reallocation. Credit markets not only allow more talented entrepreneurs, who would not be able to do it based on their wealth, to step into the production arena, but are also efficient in filtering the best projects and entrepreneurs.[2] Larger financial markets play an important role in allocating and reallocating funds toward the more productive firms and sectors, allowing them to grow, while the less productive shrink or go out of business, which has a positive impact on aggregate productivity. Finally, access to credit allows firms to cope better with macroeconomic volatility.

Most studies showing strong links between financial development and growth are based on cross-sectional growth regressions and others are based on pooled time series cross-sectional country-level data.[3] Evidence based on firm-level data is scarcer. Estimating the relationship between financial variables and measures of firm performance is challenging because of potential biases due to unobserved variables that may simultaneously determine access to external financing and firm performance. It is also challenging because of the difficulty of finding appropriate measures for the financial factors that enter into the performance equations that will not be correlated to the firm's future performance. Love and Zicchino (2006) use a panel vector autoregression approach (P-VAR) to overcome this problem and isolate the response of investment to financial and fundamental factors. They focus on the orthogonalized impulse-response functions showing the response of one variable of interest to an orthogonal shock in another. They use this methodological approach on a firm-level dataset from 36

[2] See Arizala et al. (2012) for cross-country evidence on the impact of credit on productivity growth at the sector level.

[3] For empirical evidence based on cross-sectional regressions, see, for example, King and Levine (1993a and 1993b), Levine (1997), Levine and Zervos (1998). For evidence based on cross-country time-series regressions, see Beck, Levine, and Loayza (2000).

countries to explore whether the dynamics of investment vary across countries with different levels of financial development, arguing that the level of financial development of a country can be used as an indicator of the financing constraints faced by firms. By using vector autoregressions on panel data, they are able to study the complex relationship between investment opportunities and financial conditions without having to make strong modeling assumptions or controlling for unobserved firm-specific heterogeneity.

In this paper, we use Love and Zicchino's methodological approach to identify financial shocks and investigate whether the response of firm performance to financial and real shocks varies across firm sizes. We use a rich panel-shaped firm-level dataset of Colombian firms containing both information about firm activity in domestic and foreign markets and information about the use of external financing. We also investigate whether this response varies across different levels of firm productivity measured by their capacity to compete as exporters in global markets.[4]

We find that financial shocks have a significant positive impact on firm growth, measured by both sales and assets. This impact is, however, stronger for larger firms and for the more productive firms that export. These findings are not surprising. We interpret our results as indicative that something is missing that prevents smaller firms from taking full advantage of access to external financing. The possible explanations range from the differential conditions under which credit is granted across firm sizes, to factors lacking in small firms that are complementary to financing and just as necessary for firm growth.

The paper is organized as follows. Section 2 introduces our data and presents some descriptive statistics about performance and credit use by firm size. Section 3 presents our empirical approach. Section 4 discusses our estimation results, and Section 5 concludes.

2. Credit and Firm Size

We were able to combine two firm-level data sources using firm identifiers: detailed financial statements available from the Superintendencia de Sociedades (Supersociedades) and international trade information obtained directly from official customs records.[5] Both datasets

[4] For evidence on the causal link between productivity and exports, see Clerides et al. (1998).
[5] Both datasets are public. Supersociedades data are available at www.supersociedades.gov.co, and official customs records are available for sale from the Ministry of Finance of Colombia on a monthly basis.

cover the period 2000-2010. The resulting dataset is an unbalanced panel that includes the universe of firms with annual income or reported assets at or above 30,000 minimum monthly wages (MMW), and a large sample of firms in smaller size categories. Table 1 shows firms in the dataset by size category.[6]

Table 1. Firms in Dataset, by Size of Assets

Year	All firms	By size of assets			
		[500, 5,000)	[5,000, 20,000)	[20,000, 30,000)	[30,000, .)
2000	10,490	2,500	4,151	1,025	2,814
2001	9,851	2,245	3,840	993	2,773
2002	9,208	2,137	3,536	960	2,575
2003	9,162	2,097	3,523	916	2,626
2004	9,815	2,863	3,537	884	2,531
2005	18,329	9,461	4,923	1,064	2,881
2006	22,211	10,867	6,905	1,203	3,236
2007	20,487	9,459	6,422	1,208	3,398
2008	20,868	9,500	6,437	1,276	3,655
2009	24,019	10,756	8,040	1,429	3,794
2010	23,371	10,036	7,975	1,451	3,909

Source: Supersociedades and authors' calculations.

All firms incorporated as companies fall under the supervision of Supersociedades, but not all of them are required to report their annual financial statements to this authority. Only larger firms and those falling in particular categories (for example, small firms in terms of assets that are partially owned by companies subject to the supervision of any authority) are required to do so. Obligations to report were partially modified in 2006 to, among other things, release firms with assets valued at or above 20,000 MMW and below 30,000 MMW from this obligation (unless they fell among firms required to report for any other reason).[7] As a result, after 2007 it is uncertain whether the database contains the full universe of firms in this size category. The evolution of the number of firms in this category suggests, however, that the reporting habit was strong and not significantly affected by the rule change (see column 6 in Table 1). Additionally, and perhaps more importantly, irrespective of the legal reporting obligations in place, since 2005 Supersociedades set out to collect information from all companies registered in its database. This

[6] According to the standard size categories used to classify firms by size in Colombia, firms with annual income or assets below 500 MMW are micro firms; firms with annual income or assets equal to 500 MMW or higher but below 5,000 MMW are small; firms with annual income or assets equal to 5,000 MMW or higher but below 50,000 MMW are medium; and firms with annual income or assets above 50,000 MMW are large.

[7] Until 2006, reporting obligations were given by Decree 3100 of 1997. Decree 4350 of 2006 contains the obligations that have applied since 2007.

explains the increase in the number of firms in the dataset starting in that year (notice the increasing number of firms in the lower size ranges).

In summary, we have a panel-shaped dataset of *formal firms incorporated as companies* that contains the universe of large firms (with income or assets at or above 50,000 MMW) and larger medium firms (with income or assets at or above 30,000 MMW and below 50,000), a representative sample of the smaller medium sized-firms (with income or assets at or above 5,000 MMW and below 30,000), and a representative sample of small firms (with income or assets at or above 500 MMW and below 5,000).[8] The dataset is not representative of micro firms; firms falling in this category by the size of their income or assets were eliminated from this study. The data contain information about each firm's sales, assets, exports, sector of activity and, most importantly, financial debt.

Table 2 shows average firm sizes over time. A number of things are noteworthy. First, firm growth is far from spectacular over the period. When size is measured by average sales, small firms are the ones that look better, growing at an average annual rate of 3.6 percent over the ten-year period; the largest firms follow, with an average annual growth of 3.4 percent, and firms in the medium-range sizes have the poorest performance. When measuring size by assets, the story is different. In this case, growth is poor for firms in all size categories, and directly related to size: small firms shrink over the period, the smaller medium firms do not grow at all, the larger medium firms grow at an average annual rate of 1.4 percent, and the largest firms grow at an average annual rate of 1.8 percent. Firm growth by exports is in the mid-range of growth by the two previous measures and highest on average for the largest firms. Medium-size firms perform the worst by this measure.

[8] Firms in the size categories not required to report represent 47.6 percent of all formal firms with income or assets below 30,000 MMW.

Table 2. Average Sizes by Sales, Assets and Exports (in thousands of US$)

	Year	By size of assets in MMW			
		[500, 5,000)	[5,000, 20,000)	[20,000, 30,000)	[30,000, .)
Sales	2000	717	2,546	5,415	32,137
	2001	782	2,874	5,993	33,847
	2002	716	2,880	5,942	37,096
	2003	752	3,214	6,403	39,318
	2004	868	3,326	7,225	49,337
	2005	813	3,451	7,547	42,821
	2006	889	3,560	7,379	44,835
	2007	934	3,662	7,749	45,924
	2008	863	3,515	7,363	45,156
	2009	1,002	3,351	6,989	43,275
	2010	1,017	3,360	6,651	45,077
Fixed assets	2000	640	2,493	5,676	60,299
	2001	648	2,583	5,769	61,206
	2002	642	2,594	5,857	62,569
	2003	638	2,631	5,928	61,913
	2004	598	2,659	5,986	55,990
	2005	502	2,578	6,129	68,670
	2006	534	2,598	6,232	67,227
	2007	552	2,666	6,286	66,703
	2008	550	2,636	6,178	64,623
	2009	614	2,740	6,534	67,697
	2010	632	2,762	6,536	72,369
Exports	2000	25	201	427	4,682
	2001	40	216	428	5,160
	2002	32	247	501	5,365
	2003	40	319	396	6,354
	2004	30	237	555	6,664
	2005	33	326	721	7,507
	2006	33	324	537	7,600
	2007	37	295	531	7,076
	2008	28	269	483	7,062
	2009	29	199	520	6,420
	2010	31	234	348	6,197

Source: Supersociedades, Customs records and authors' calculations. Money values are in 2010 pesos converted to US dollars using the December 2010 USD/Peso exchange rate.

Table 3 shows the number of firms that export in our database. The percentage of exporters increases dramatically with firm size, in line with the empirical evidence available about both the correlation of size and productivity [9] and the causal relationship between productivity and exports. [10] Only 7 percent of small firms reported exports in 2010. The corresponding percentage for firms in the largest size category that year was 32 percent. This variance in export participation both between and within firm size categories will be used in the next section to investigate the impact of credit on firm growth, controlling for productivity/competitiveness. A striking finding from this table is that participation in exporting

[9] See IDB (2010), among others.
[10] See Clerides et al. (1998).

activities peaked during 2003-2005 for all firm sizes and has deteriorated ever since. For example, 42 percent of the largest firms were exporters in 2003.

Table 3. Firms that Export by Size

	Year	All firms	By size of assets in MMW							
			[500, 5,000)		[5,000, 20,000)		[20,000, 30,000)		[30,000, .)	
			Number	%	Number	%	Number	%	Number	%
Firms that export	2000	2046	170	7	677	16	221	22	978	35
	2001	2143	167	7	727	19	248	25	1,001	36
	2002	2045	156	7	663	19	241	25	985	38
	2003	2176	159	8	696	20	226	25	1,095	42
	2004	2216	229	8	699	20	247	28	1,041	41
	2005	3257	824	9	993	20	302	28	1,138	40
	2006	3772	880	8	1,376	20	318	26	1,198	37
	2007	3552	758	8	1,280	20	298	25	1,216	36
	2008	3455	691	7	1,172	18	318	25	1,274	35
	2009	3704	857	8	1,278	16	302	21	1,267	33
	2010	3479	726	7	1,192	15	297	20	1,264	32

Source: Supersociedades, Customs records, and authors' calculations.

A majority of the firms in our dataset report debt on their financial statements (68 percent in 2010 and 72 percent in 2010). This should not come as a surprise, since we are looking at the set of Colombian small, medium and large *formal* firms. In terms of numbers, these are a minority of firms,[11] so these percentages should not be interpreted as a finding that credit flows unrestrictedly to the productive sector. For the purpose of our study, however, the set of firms analyzed is most interesting since it concentrates not only credit, but also output, exports, and investment.[12] Moreover, even for this particular set of firms, credit is not always equally available. The following figures and tables present some evidence to support this statement.

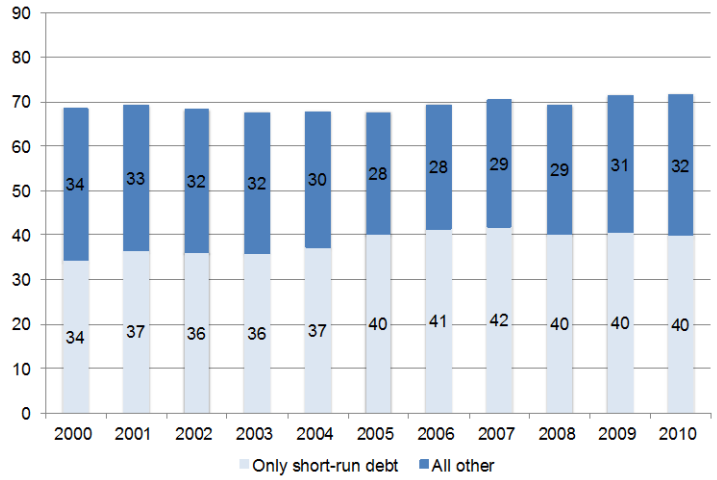
Figure 1 shows, for example, that among firms with debt on their balance sheets, a majority has only short-term debt. Figure 2 shows that this finding is more pronounced for the smaller firms in the sample, and is the reverse for the largest firms. In terms of value, short-term debt represents half or more of total debt for firms in all size categories. This is shown in Table 4.

Table 4 also shows that the Colombian productive sector does not seem to be highly indebted, based on the relatively low average ratios of debt to total assets in all firm size

[11] According to census data from 2005, 96.06 percent of firms are micro firms; 3.38 percent are small firms; 0.68 percent are medium firms and 0.04 percent are large, and this is unlikely to have changed much over time.
[12] It also represented 50 percent of employment in 2005, according to the census.

categories. This is consistent with previous findings that Colombian firms finance their activity mostly with retained profits (see Arbeláez et al., 2010).

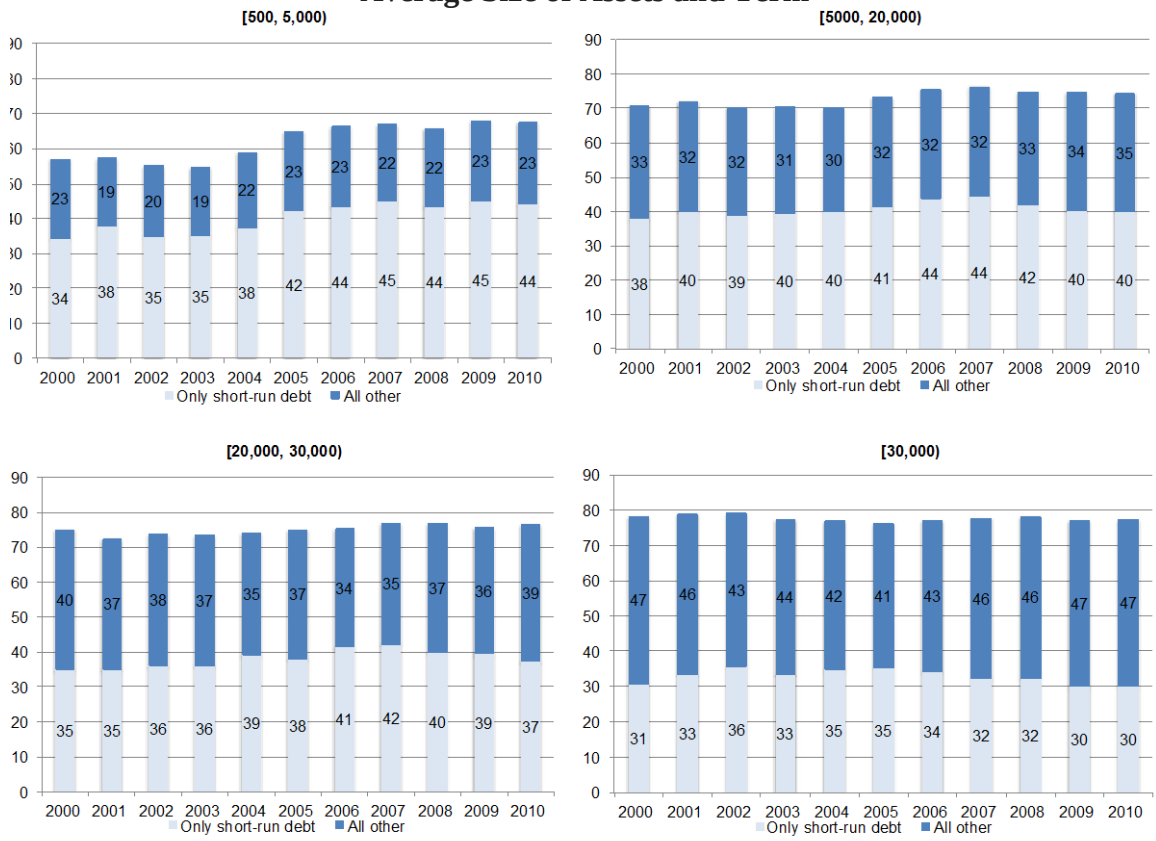
Figure 1. Percentage of Firms with Financial Debt



Source: Supersociedades and authors' calculations.

Finally, Figure 3 suggests that access to credit helped the larger firms to cope better during the economic crisis of 2008-2009. Growth dynamics measured by both sales and assets between 2007 and 2009 were better on average for medium and large firms that had financial debt on their balance sheets than for those that did not. The difference is particularly dramatic in the case of large firms. In contrast, sales performance of firms in the small size category seems to have been unaffected by credit.

Figure 2. Percentage of Firms with Financial Debt, by Average Size of Assets and Term



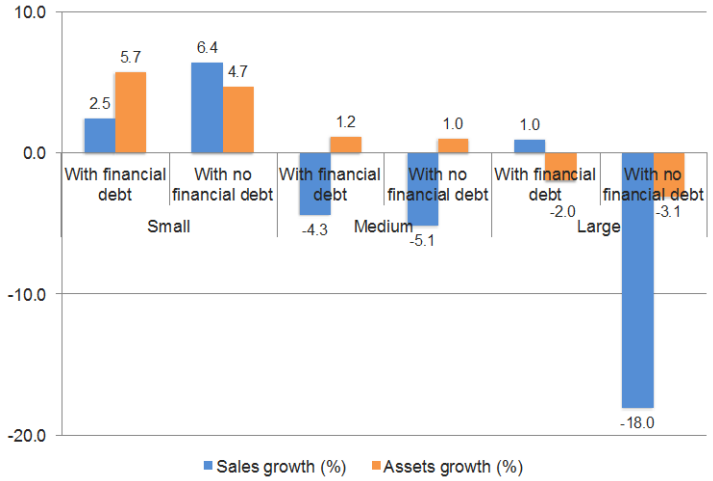
Source: Supersociedades and authors' calculations.

Table 4. Debt as a Share of Assets*
and Short-term Debt as a Share of Total Debt

	Year	By size of assets in MMW			
		[500, 5,000)	[5,000, 20,000)	[20,000, 30,000)	[30,000, .)
Financial debt/ Total Assets	2000	14	12	13	17
	2001	16	12	13	17
	2002	14	12	13	16
	2003	10	12	13	15
	2004	10	12	13	15
	2005	12	13	15	15
	2006	12	14	15	16
	2007	12	14	15	17
	2008	12	14	16	17
	2009	12	14	15	16
	2010	12	14	15	17
Short-term financial debt as % of total dept	2000	24	49	57	37
	2001	20	59	58	37
	2002	27	51	57	44
	2003	58	57	61	49
	2004	58	55	65	60
	2005	57	61	65	60
	2006	72	62	65	59
	2007	57	64	65	55
	2008	59	62	63	56
	2009	57	61	58	49
	2010	50	62	57	46

Source: Supersociedades and authors' calculations. *Calculated over all firms.

Figure 3. Average Annual Growth between 2007 and 2009
by Firm Size and Use of Bank Credit



Source: Supersociedades and authors' calculations. Medium firms are firms with assets between 5,000 and 30,000 MMW.

3. Empirical Approach

The estimation of the relationship between firm growth and financing is challenging because of the obvious endogeneity problem that arises. Firms that are more productive and show the best growth dynamics over time tend to receive more external financing, since performance is usually a dimension analyzed by creditors before granting credit. On the other hand, when credit is properly used, it may lead to an improvement in firm productivity and growth. Due to this two-way causality, identifying the impact of increased external financing on firm performance requires a technique that allows for the simultaneous modeling of both relationships and the identification of the precise response of the variables of interest to exogenous shocks.

In this paper we use a panel vector autoregression (P-VAR) methodology, which is a combination of the traditional VAR approach that treats all variables in the system as endogenous and the panel-data approach, which allows for unobserved individual heterogeneity. This approach allows us to address the endogeneity problem and isolate the response of firm performance to a financial shock. Specifically, we analyze the orthogonalized impulse-response functions that describe the reaction of different measures of firm performance to innovations in another variable in the system, while holding all other shocks equal to zero.

Formally, we estimate the following first order P-VAR model:

$$x_{ijt} = \Gamma_0 + \Gamma_1 x_{ijt-1} + \alpha_i + d_{jt} + \varepsilon_t \qquad (1)$$

where x_{it} is a two-variable vector containing a measure of change in firm performance and a measure of change in external financing; i denotes the individual firm; j denotes the 4-digit ISIC sector of activity to which the firm belongs; t denotes time, α_i is a firm-specific effect, d_{jt} are sector-time dummies that control for any changing variables in a year that affect all firms in a sector; and ε_t are the model's residuals.

We use two alternative measures of performance in our exercise: the growth rate of a firm's sales in real values, and the growth rate of its assets, also in real values. The use of external financing is measured as the firm's financial liabilities to assets ratio. All variables are taken from firms' balance sheets as described in the previous section.

To isolate shocks to one of the variables in the system it is necessary to decompose the residuals in a way that they become orthogonal. In order to do this we have to adopt a particular

ordering and allocate any correlation between the residuals to the variable that comes first in the ordering. This procedure, known as the *Choleski decomposition* of the variance-covariance matrix of residuals, is equivalent to transforming the system in a recursive P-VAR for identification. The identifying assumption is that the variable that comes first in the ordering (the financial shock) affects firm performance and the firm's ratio of debt to assets contemporaneously, while the other one (the real shock) affects performance contemporaneously and the debt to assets ratio with a lag.[13] This assumption determines the ordering of the variables in the P-VAR model.[14]

In order to capture differences in firm responses according to specific characteristics, we provide two breakdowns in our data. First, we separate the firms according to their size. Firms are categorized in three size ranges according the value of their assets measured in MMW, as described above. For simplicity we are pulling together in a middle category all firms falling in the intermediate size categories used to present our descriptive statistics. As a result, small firms are those with assets at or above 500 MMW and below 5,000 MMW; medium firms are those with assets at or above 5,000 MMW and below 30,000 MMW; and large firms are those with exceeding 30,000 MMW. This separation allows us to test the effect of financial shocks on firms of different sizes. Presumably, larger firms are more able to generate internal resources or tap capital markets by, for example, issuing stock, which may complement external financing and lead to a greater increase in their scale of operation when faced with a financial shock. In other words, larger firms are more able to leverage funds than smaller ones. If this were true, larger firms would grow more than smaller ones when hit by a positive financial shock. Second, we also divided the firms into exporters and non-exporters. Presumably, exporting firms are ex ante more productive and may use external financing to expand their more productive technologies and hence achieve better outcomes.

In the P-VAR model described in (1), we are allowing for individual heterogeneity in the levels of the variables by introducing the fixed effect η_i. As in dynamic panel data models, in this case the fixed effect will also be correlated with the regressors due to the inclusion of the lags of the dependent variable, and the mean differentiating procedure commonly used to

[13] See Hamilton (1994) for a discussion of impulse-response functions.

[14] As we will show, our main results are robust to a change in this assumption to allow the real shock to affect contemporaneously both variables in the system, the financial shock to affect firm performance with a lag, and the ratio of debt to assets contemporaneously.

eliminate the fixed effects leads to a bias in the estimated coefficients. To overcome this problem, we use forward mean-differencing, a procedure that removes only the forward mean, or the mean of all future observations available for each firm in each year. This is known as the *Helmert procedure*, and allows the preservation of the orthogonality between the transformed variables and the lagged regressors, so that the latter can be used as instruments and the coefficients estimated using a system GMM, unbiased, estimator.

Finally, as our main objective is analyzing the impulse-response functions that track the evolution of firm performance to an exogenous financial shock, we calculate standard errors and generate confidence intervals using Monte Carlo simulations.

4. Estimation Results

Table 5 reports our baseline results for the P-VAR models using real sales growth and real asset growth. What is interesting to note from these result is the significance of the lagged value of the ratio of debt to assets in the real sales growth equation in model 1 and in the real asset growth equation in model 2. Figures 4 and 5 report the associated impulse response functions for these models respectively. Financial shocks in these figures, as well as in all of the figures that follow, have been normalized to 10 percent for comparability purposes. The shaded areas are confidence intervals of the impulse-response functions resulting from the 5th and 95th percentiles of the distribution, generated using 500 Monte Carlo repetitions. All figures present time periods on the horizontal axis and percentages of shock or response on the vertical axis.

Table 5. Baseline Results of P-VAR Models

	Model 1		Model 2	
	Real Sales Growth	Debt/Assets	Real Assets Growth	Debt/Assets
Real Sales Growth(t-1)	-0.032	0.002		
	(0.005)***	(0.001)**		
Real Assets Growth(t-1)			0.005	0.004
			(0.004)	(0.001)***
Debt/Asset(t-1)	0.228	0.467	0.021	0.471
	(0.030)***	(0.007)***	(0.010)**	(0.007)***
Number of Observations	72452		79139	
Number of Firms	4733		4733	

Notes: Standard errors in parenthesis. ** Significant at 5%. *** Significant at 1%.

Figure 4. Impulse Response Functions of P-VAR Model with Sales Growth and Debt to Assets Ratio

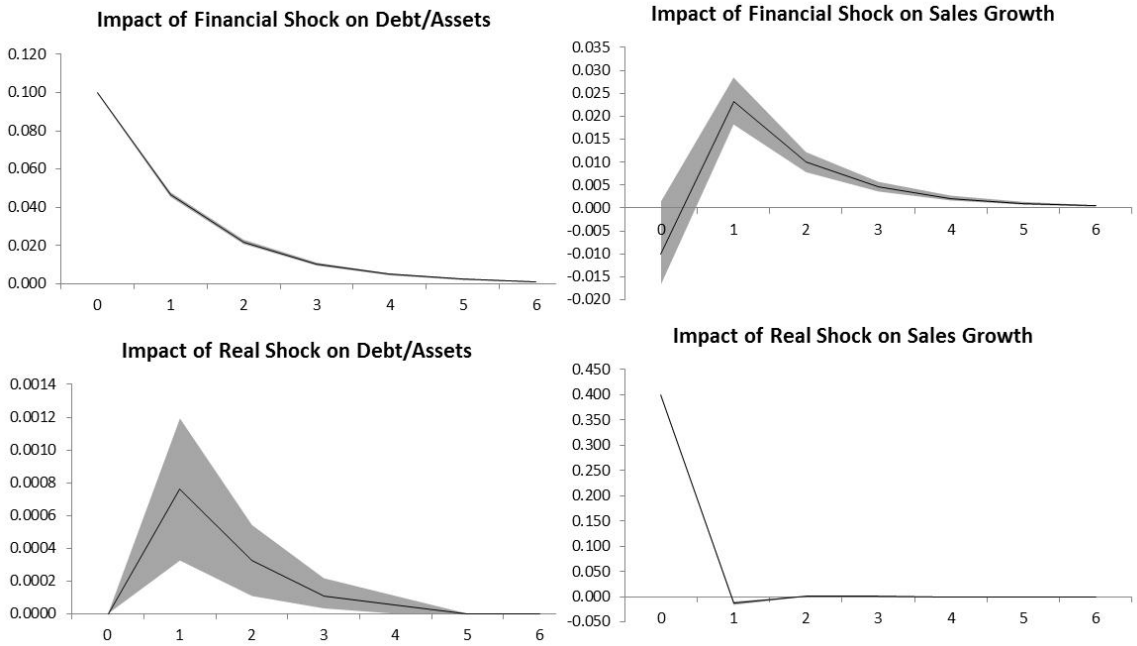
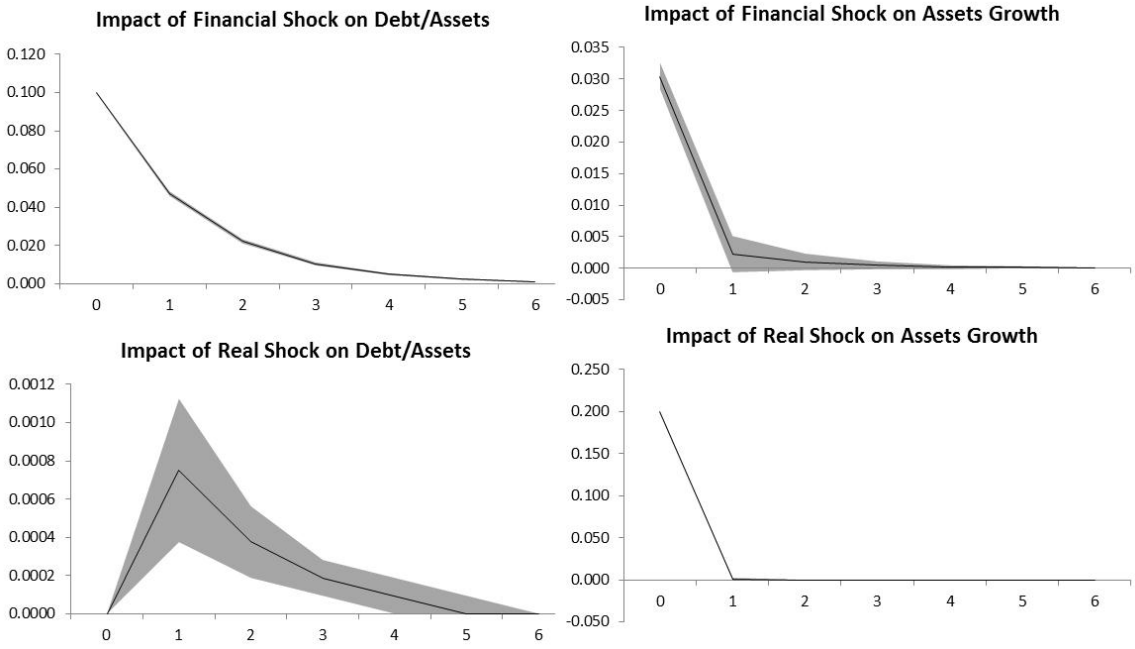


Figure 5. Impulse Response Functions of P-VAR Model with Asset Growth and Debt to Assets Ratio



Our baseline results are intuitive. In any of the models, a 10 percent shock to the debt to assets ratio leads to a significant response in both of our measures of firm performance. This is shown in the second panel of the first row in each of the figures. In the sample in Figure 4, such a shock leads to an increase in the real growth rate of sales of 2.3 percentage points in the year following the shock. The impact of the shock fades away by the sixth year, after which the impact has added up to 3.1 percentage points. In Figure 5, a shock of the same magnitude leads to an instantaneous increase of nearly 3.0 percentage points in the first year and vanishes the year immediately after the shock. It is also interesting to note how the ratio of debt to assets responds significantly to a real shock in either the sales growth or the asset growth model. This can be interpreted as evidence that overall external creditors monitor the performance of firms when granting credit. Firms that perform better are more likely to have external sources of funding.

In summary, our baseline results suggest that financial shocks have significant impacts on sales growth and asset growth.[15] In this sense, credit is conducive to firm growth.

Next, we explore whether the effect of financial shocks on firm performance depends on firm size. In order to save space we are not reporting the regression results, which are available upon request, but only plot the relevant impulse response functions. Figure 6 plots the impulse response functions of the model, including sales growth for small, medium, and large firms. Figure 7 does the same for the model of asset growth.

Figures 6 and 7 report similar patterns for each set of firms to those reported by their counterparts in Figures 4 and 5; however, the results are stronger for larger firms. The first panel in Figure 6 suggests that there is a very small response of firm growth to a financial shock in the case of small firms. The result is somewhat larger for medium-sized firms and almost double for larger ones. The shock is also longer lived in larger firms. After six years, the impact of a 10 percent financial shock represents increases of 0.3, 2.5 and 8.9 percentage points for small, medium, and large firms, respectively.

Regarding asset growth, the pattern of response is similar, with small firms having a smaller response than medium firms, and large firms having the largest response to a 10 percent financial shock. In this case, however, the main difference comes from the response of large firms, which is not only significantly higher than that of the rest of the sample, but also has a

[15] These results hold when using investment defined as growth in productive assets rather than growth in total assets as reported in the text.

much longer duration. While the impact fades away for small and medium sized firms within a year, in the case of large firms, the response remains significant until the sixth year following the shock. This can be interpreted as evidence that larger firms may have more long-term investment plans than smaller firms, and that they are more able to leverage other types of resources as they expand. A 10 percent financial shock leads to long-term increases in asset growth of 2.4 percentage points for small firms, 3.0 for medium-sized ones, and 6.7 for large ones.

To ensure that our results are not affected by the ordering of the variables in estimation or by our assumptions about their relative degrees of endogeneity, Figures 8 and 9 report the responses of firm growth by firm size when the ordering of the variables is reversed. That is, Figures 8 and 9 report the impulse-response functions obtained when assuming that the real shock affects external financing both contemporaneously and with a lag, while the financial shock affects firm performance only with a lag. These figures report the responses of sales growth and asset growth, respectively. The pattern and magnitude of the results are relatively similar for the sales growth model. The long-term effects of a 10 percent financial shocks on sales growth are of 2.1, 3.5, and 8.7 percentage points for small, medium, and large firms, respectively. The results regarding asset growth are slightly different than those in the sales growth model when changing the order of the variables. In this case, we only find a significant response in large firms, while we find no response for medium and small firms. While this could raise questions about the robustness of the results, we interpret these results as evidence of misspecification of this model. Although they are not significant, the fact that the impulse response functions for small and medium-sized firms suggest a negative impact is inconsistent with economic modeling. A sign restriction approach to the identification of the financial shock would dismiss this second specification as a valid one and would support the original ordering used in this paper for the VAR.[16]

[16] See Canova (2007) for a discussion of identification of VARs using sign restrictions.

Figure 6. Impulse Response Functions of P-VAR Model with Sales Growth and Debt to Assets Ratio, by Firm Size

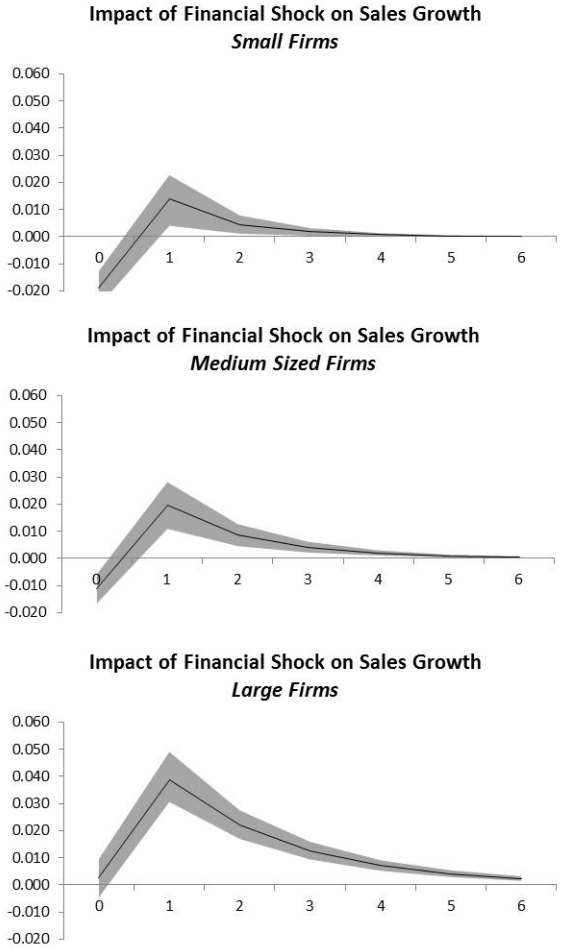


Figure 7. Impulse Response Functions of P-VAR Model with Asset Growth and Debt to Assets Ratio, by Firm Size

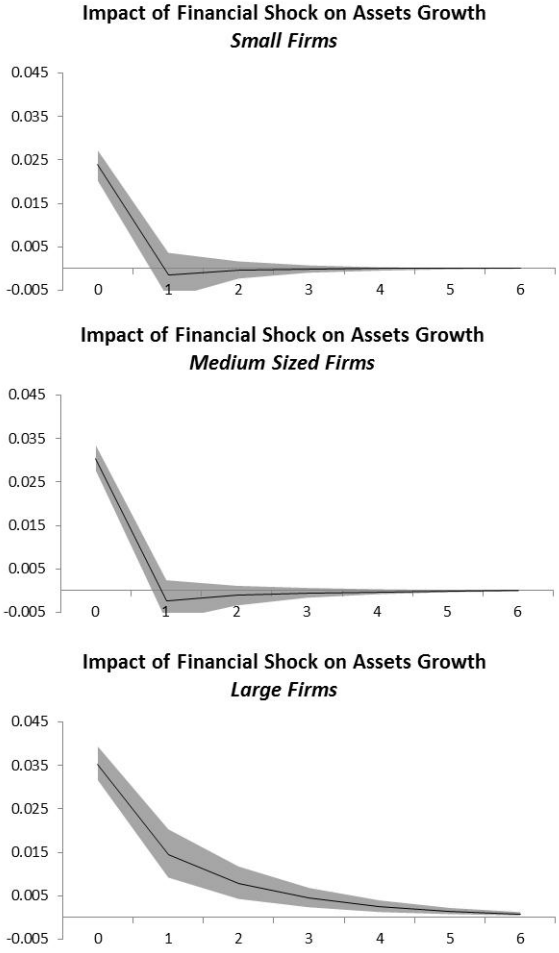


Figure 8. Impulse Response Functions of P-VAR Model with Sales Growth and Debt to Assets Ratio, by Firm Size, Alternate Variable Ordering

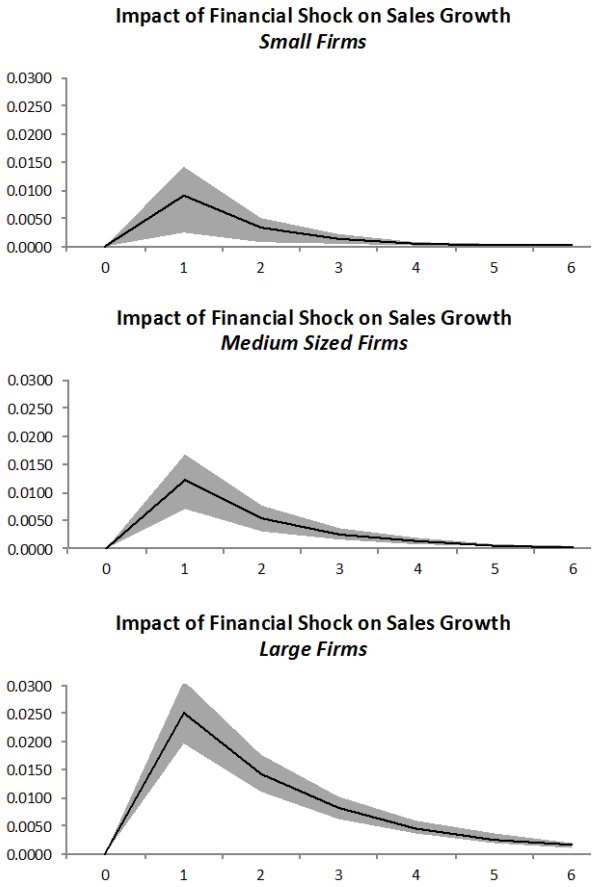
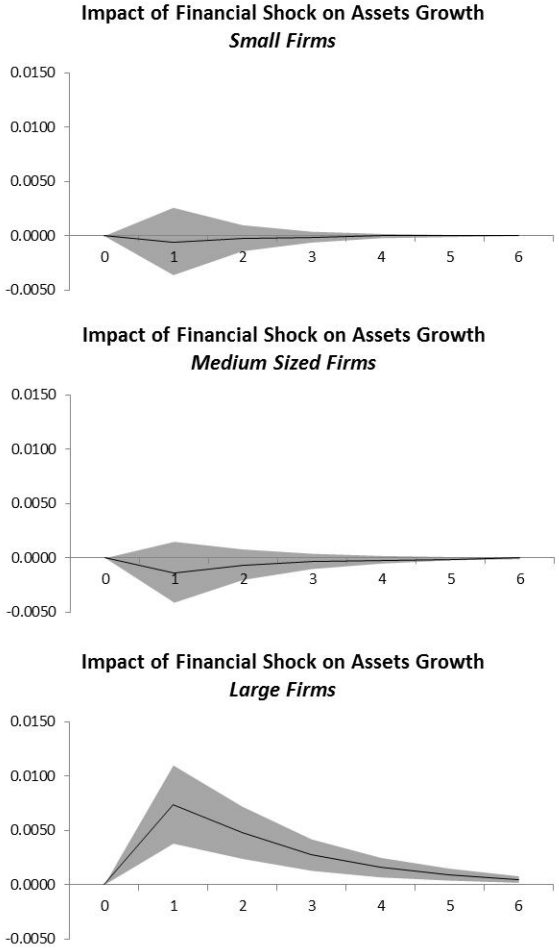


Figure 9. Impulse Response Functions of P-VAR Model with Asset Growth and Debt to Assets Ratio, by Firm Size, Alternate Variable Ordering

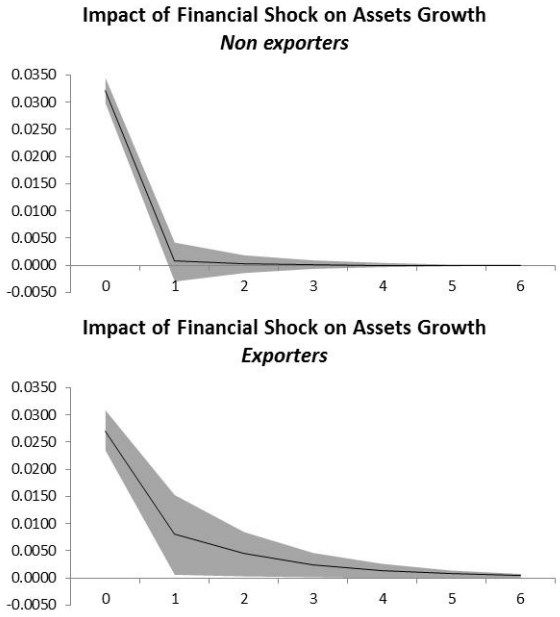


Next, we split the sample according to the export orientation of firms in order to test if in firms with presumably higher productivity (exporters) and more external financing have a different impact. This is reported in Figure 10 for the model with sales growth and in Figure 11 for the model with asset growth.

The results of splitting firms between exporters and non-exporters suggest that the former respond more to financial shocks. In the model with sales growth, a financial shock of similar size leads to a long-term increase in sales growth of exporting firms that is almost double that of non-exporters. In the case of exporters, a 10 percent financial shock increases sales growth by 5.4 percentage points over a six-year horizon, while it only increases by 2.9 percentage points for non-exporters. In the case of asset growth, the same shock represents a 3.2 percentage point increase for non-exporters and a 4.5 percentage point increase for exporters.

Figure 10. Impulse Response Functions of P-VAR Model with Sales Growth and Debt to Assets Ratio, by Export Orientation

Figure 11. Impulse Response Functions of P-VAR Model with Asset Growth and Debt to Assets Ratio, by Export Orientation



If the export orientation of a firm is indeed an adequate proxy for productivity, our results suggest that more productive firms tend to take better advantage of external financing than others. More productive firms may use credit to scale up their better technology and hence lead to differential effects with respect to less productive firms. Regarding the duration of the impact, it is likely that more productive firms also have access to "better" forms of finance, such as long-term credit or bond issuance, and hence have the opportunity to reap the benefits over a much longer period of time.

We also ran the models splitting the sample by export orientation and firm size. Due to space limitations we do not report the whole set of results here, but they follow the same pattern as the two sets of breakdowns shown above. To summarize, we report results for small non-exporting firms and for large exporting ones, the two polar cases. Smaller non-exporting firms have very small, short-lived impacts on either one of the performance variable when affected by the external financing shock, as shown in the upper panels of Figures 12 (sales growth model) and 13 (asset growth model). The impacts increase in both size and duration as firms grow and become export-oriented. The lower panels of Figures 12 and 13 show the impact response functions for large exporting firms.

The results show strong differences between these two groups. The rest of the results lie within that spectrum. In the case of small non-exporting firms, a 10 percent financial shock leads to an accumulated increase of 0.5 percentage points of sales growth, while for large exporting firms the same shock leads to an 8.3 percentage point increase.

Figure 12. Impulse Response Functions of P-VAR Model with Sales Growth and Debt to Assets Ratio, by Export Orientation and Size

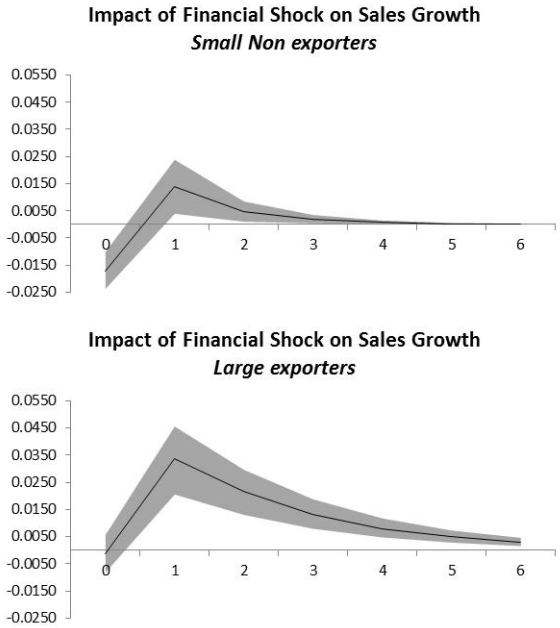
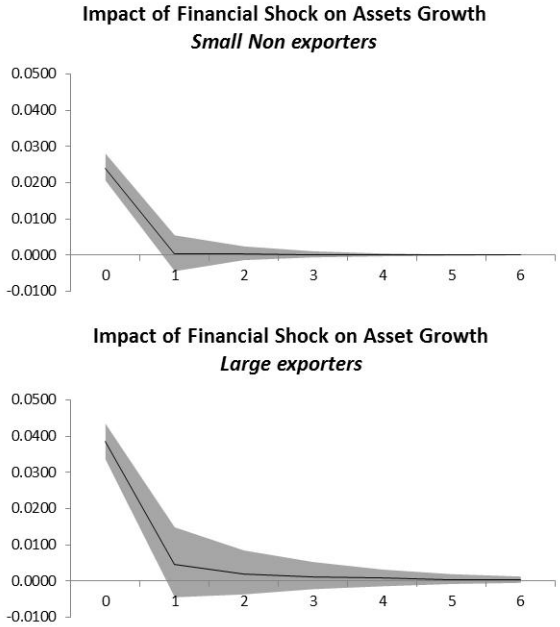


Figure 13. Impulse Response Functions of P-VAR Model with Asset Growth and Debt to Assets Ratio, by Export Orientation and Size



Financial shocks can come from either the supply or the demand side, and shocks from either side may result in firm growth. Credit supply shocks will have a positive effect on firm growth when firms are credit constrained, while credit demand shocks will have a positive effect on firm growth when firms are not credit constrained. Identifying which of these mechanisms is at work is beyond the scope of this study. We are, however, able to explore whether the response to a financial shock of relatively more credit-constrained firms in Colombia is in any way different from that of less credit-constrained firms.

In order to do this, we use the correlation of firm investment and firm cash flow, with operational utility over assets as a proxy for cash flow, to rank firms according to their relative levels of credit constraint.[17] Conceptually, this approach is based on the idea that the more credit-constrained firms depend on their internal cash flow for investment, while this is not the case for firms that can secure external financing for their investment projects.[18] Consequently, firms with a higher correlation between investment and cash flow can be considered to be more credit constrained. We split the sample in three parts of equal size based on this correlation's ranking and call firms falling in the upper category "credit constrained" and firms falling in the lower category "unconstrained." Figures 14 and 15 report the impulse-response functions of these two groups of firms when considered separately. The response of constrained and unconstrained firms to financial shocks is very similar, almost indistinguishable, in terms of both magnitude and duration, for both sales and asset growth. The long-term effect of a 10 percent financial shock on sales growth for credit-constrained firms reaches 3.3 percentage points and 2.7 for unconstrained ones. The results for asset growth are 3.3 and 2.9 percentage points, respectively.

[17] This approach for identifying relative levels of credit constraints is extensively used in the literature. See, for example, Calomiris and Hubbard (1995) or Hsie and Parker (2007).

[18] While there may be firms that can secure external financing but prefer to rely on their internal resources for investment, this is rather uncommon in Colombia. Notice that the percentage of firms with debt on their balance sheets increases with size (Figure 2). The case would need to be made that the smaller firms have less need for external financing than large firms do.

Figure 14. Impulse Response Functions of P-VAR Model with Sales Growth and Debt to Assets Ratio, by Relative Credit Constraints

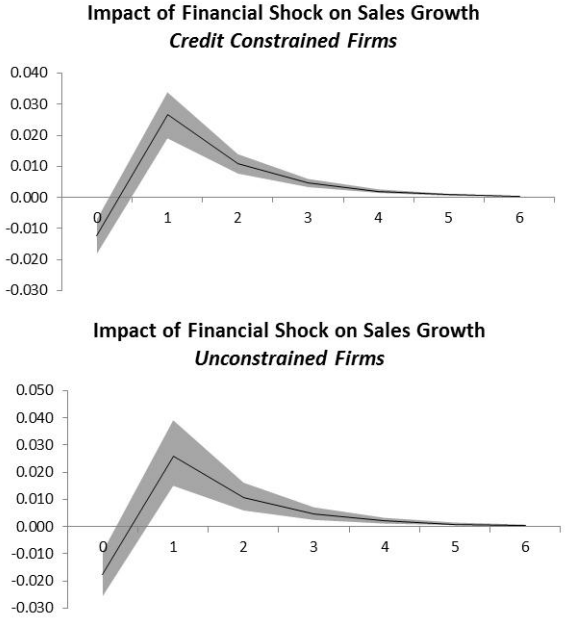
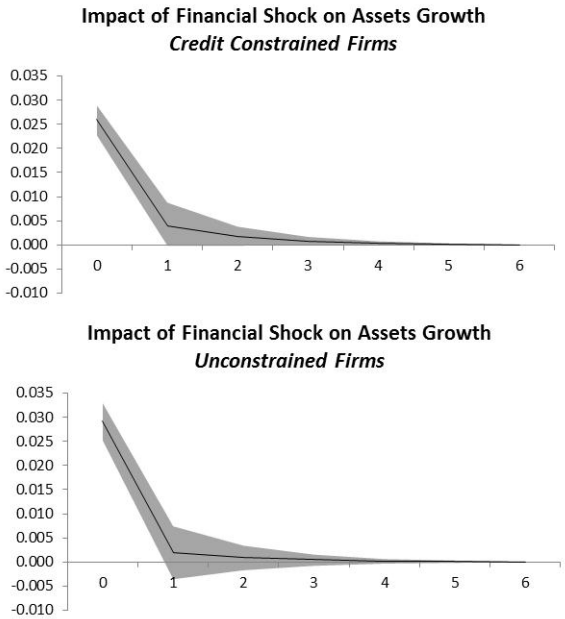


Figure 15: Impulse Response Functions of P-VAR Model with Asset Growth and Debt to Assets Ratio, by Relative Credit Constraints



This finding of no difference between the responses of firms facing different degrees of credit constraints may be explained by the fact that formal Colombian firms that are incorporated are probably all more or less similarly credit constrained. If this is the case, as Colombia's relatively low level of financial development would suggest, consistent with the results of Love and Zicchino (2006), the study may be capturing the response of firm growth to supply-side financial shocks. Another explanation of this result, assuming that the credit-constraint variable captures different levels of credit constraints, is that demand and supply financial shocks have similar effects on firm performance. Alternatively, this finding could be the result of the correlation of investment and cash flow not being fully able to capture credit constraints in every possible dimension. This would be consistent with the fact that we do capture differences in responses across firm sizes, which can be treated as an alternative proxy of credit constraints.

Table 6 presents a summary of our results, in the form of the accumulated impulse responses described above, in order to facilitate comparisons. It shows the accumulated impact of a 10 percent financial shock over a six-year period, by firm type, on both sales and assets.

Table 6. Summary of Results, Accumulated Responses to a 10 Percent Financial Shock

		Accumulated impact in percentage points(*)
Baseline: All firms		
Sales		3.10
Assets		3.00
Exercise 1: By firm size		
Sales	Small	0.30
	Medium	2.50
	Large	8.90
Assets	Small	2.40
	Medium	3.00
	Large	6.70
Exercise 2: By firm size (alternative ordering)		
Sales	Small	2.07
	Medium	3.53
	Large	8.67
Assets	Small	0.00
	Medium	0.00
	Large	2.00
Exercise 3: By export orientation		
Sales	Non exporter	2.90
	Exporter	5.36
Assets	Non exporter	3.21
	Exporter	4.46
Exercise 4: By export orientation and Size		
Sales	Small non exporter	0.50
	Large exporter	8.30
Assets	Small non exporter	2.40
	Large exporter	3.85
Exercise 5: By credit constraints		
Sales	Credit constrained	3.30
	Non credit constrained	2.70
Assets	Credit constrained	3.30
	Non credit constrained	2.90

* Refers to the accumulated impact up to the period in which the impulse response remains significant.

5. Conclusions

Using a firm-level dataset of Colombian formal firms and a panel vector autoregression (P-VAR) estimation methodology that addresses endogeneity problems, isolating the response of firm performance to financial shocks, we find that these shocks have a significant positive impact on firm growth, measured both by sales and assets. This impact is stronger for larger firms. There is a very small response of firm growth measured by sales to a shock in debt in the case of small firms. The result is significantly larger for medium-sized firms and more than double for larger

ones. Regarding asset growth, the story is similar. In this case, the main difference is the longer duration of the response in large firms.

When we split firms into exporters and non-exporters, we find that the former are more sensitive to financial shocks than the latter. In the model with sales growth, an identical financial shock leads to an increase in sales growth in exporting firms about twice as large as that of non-exporting firms. With respect to asset growth, there is also a larger response to financial shock in the case of exporters and the effect wears out in six years, while in non-exporting firms it lasts only a year. If a firm's export orientation is indeed a proxy for productivity, our results suggest that more productive firms tend to take better advantage of external financing than others.

Our results are not surprising. Larger, more productive firms may have longer-term investment plans than smaller firms, may use credit to scale up their better technology, leading to differential effects with respect to less productive firms, and are better able to leverage other types of resources as they expand. All of this adds up to more opportunity to reap the benefits of credit over a much longer period of time.

We interpret our results as indicating not that credit should only flow toward larger, more productive firms, but rather that something is preventing smaller firms from taking full advantage of access to external financing. The possible explanations range from the different conditions under which credit is granted depending on firm size (access to financing is not homogeneous across firms with different characteristics, and this probably holds even when firms have been able to secure financing from the banking sector) to certain missing elements that are complementary to financing and may be just as necessary for firm growth. We are cautious not to draw nave policy conclusions from our analysis that could be lead to the design of schemes aimed at reducing credit flows to small firms, since it may be that if there are restrictions on credit to small firms, the right policy would not be to "starve" them of credit but rather to design adequate tools to remove such barriers (e.g., education or formalization) to allow them to better exploit the advantages of credit.

Finally, because the sample of firms used in the study does not include informal firms, micro-firms or firms not constituted as companies, we are capturing the responses of the best-established businesses, large or small. These are firms that, despite possibly being credit constrained in the sense that they are unable to obtain all the external financing they want or can only obtain it under suboptimal conditions, are nevertheless able to secure external financing. If

size is indeed a good proxy of credit constraints, as has been shown in the literature, we expect that the response of all firms smaller than those in our sample to financial shocks will be even smaller—if indeed they are able to secure external financing at all.

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