5.3. Do bank credit shocks matter for firms' investment decisions?

João Amador, Arne Nagengast

1. Motivation

Assessing the impact of bank shocks on firms' investment is an important aspect when it comes to discussing economic growth. In particular, persistently weak investment against a backdrop of low bank lending might be an impediment to growth. Although the rate of return on investments carried out by firms and their indebtedness levels are very relevant concerns, the ability to support firms' investment efforts is a basic task for any banking system. These considerations naturally apply to the Portuguese economy, especially in view of weak investment and low levels of capital per worker. Nevertheless, identifying the origin of variations in credit is hard, since the total loan volume in an economy is a function of both credit demand and credit supply.

This Section, based on Amador and Nagengast (2016), adopts the methodology suggested by Amiti and Weinstein (2018) and shows that credit supply shocks have a sizeable impact on firm-level as well as on aggregate investment in Portugal. Adverse bank shocks are found to impair firm-level investment as a function of the capital structure and size of firms. For the economy as a whole, granular shocks in the banking system account for a sizeable share of aggregate investment dynamics.

2. The analytical framework

While initial contributions to identifying credit supply shocks were based on aggregate data, more recent studies have made use of the increasing availability of matched bank-firm loan datasets, exploiting the across-bank variation of an exogenous event affecting bank lending, as well as the fact that firms obtain their loans from different credit institutions (e.g. Amiti and Weinstein, 2011; Chava and Purnanandam, 2011; Jimenez *et al.*, 2012; Schnabl, 2012; Chodorow-Reich,

2014; Iyer *et al.*, 2014; Miyakawa *et al.*, 2015; Dwenger *et al.*, 2015; Kaoru *et al.*, 2015; Paravisini *et al.*, 2015). The main obstacle in applying the previous approaches to other countries is the difficulty of finding suitable instruments to identify credit supply shocks. Even if these instruments are available, the analysis is usually limited to studying one particular episode. Another shortcoming is that, while these studies convincingly address the identification problem at the firm level, they remain silent on the aggregate effect of credit supply shocks.

In Amador and Nagengast (2016) bank shocks are identified by applying the decomposition framework proposed by Amiti and Weinstein (2018) to a rich dataset of matched bank-firm loans. The methodology decomposes the growth rate of individual credit relationships along bank, firm, industry and common shocks, adding up to the growth rate of bank credit in the economy as a whole. Figure 38 plots a stylised set of bank-firm relationships and aims at providing the basic intuition underlying the identification strategy. The argument builds on the fact that each bank serves a subsample of firms and each firm works with a subset of banks. Therefore, if a shock is observed in a bank-firm relationship, the source can be attributed to the firm if the bank is behaving normally with all its other clients, whereas if the firm is obtaining credit from other banks under normal circumstances, this means that the shock should be attributed to the bank. Overall, the methodology exploits the variation of firm borrowing across different banks.

In comparison to a simple fixed-effects approach, the introduction of an adding-up constraint in this methodology has the advantage of being much more efficient and providing macro-level estimates of bank shocks that are consistent with the micro-level shock decomposition.

The methodology used to disentangle loan supply shocks from loan demand shocks requires a dataset mainly consisting of firms with multiple bank relationships, i.e. the availability of matched bank-firm loan information. In addition, in order to assess the effect of bank shocks on firms' investment decisions, while controlling for their characteristics, balance sheet and income statement information is required. Therefore, another data requirement is linking the lender-borrower information with other characteristics of the firm. The Portuguese credit registry and balance sheet databases together with the existence of a common firm identifier allow us to construct a very rich micro-level dataset for Portugal for the period 2005-2013.

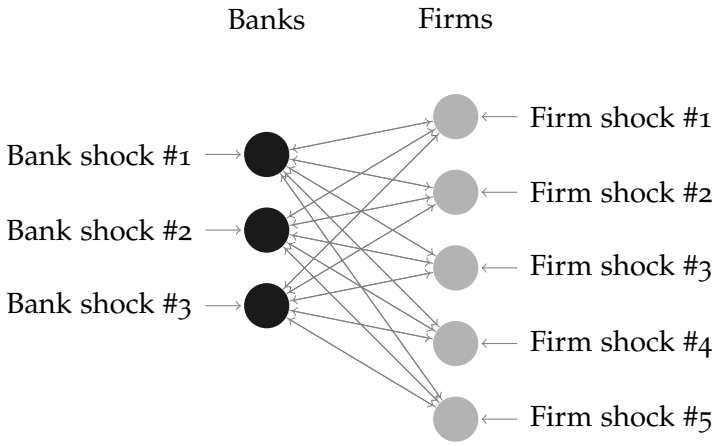

Figure 38: Stylised credit relationships between banks and firms

Notes: This diagram presents a stylised set of credit relationships between banks and firms. Each bank serves a subset of firms and each firm works with a subset of banks. This variation (along with adding-up constraints) allows for the identification of bank and firm shocks. If a shock is observed in one edge (a single bank-firm relationship), the source is attributed to the firm if the bank is behaving normally with other clients, whereas if the firm is obtaining credit under normal circumstances from other institutions, the shock is attributed to the bank.

3. Results

3.1. *Bank shocks and firm-level investment*

In order to quantify the effect of bank shocks on firm investment, we use a standard investment regression framework with cash flow and lagged sales growth, which is a commonly used proxy for Tobin's Q of unlisted firms (Whited, 2006; Bloom *et al.*, 2007; Kaoru *et al.*, 2015). In addition, we always include firm and year fixed effects to control for unobserved firm-level characteristics as well as common time-varying factors affecting investment in all firms. Table 9 presents our baseline results along with a number of robustness tests and alternative specifications. In line with the literature, we find a positive association between a firm's investment and its cash flow and investment opportunities. In Column 2 we add the bank shock, firm shock and industry shock from the decomposition of firm borrowing.[32]

Since not all firms borrow from banks to the same extent, the effect that bank shocks have on investment is likely to differ as a function of firms' dependence on bank loans. For example, a given bank shock will affect firms that borrow very little from banks relative to their size

32 We cannot include the common shock separately since it does not vary across firms and therefore is already absorbed in the year fixed effect.

Dependent Variable: $\text{Investment}_{f,t}$ / $\text{Capital}_{f,t-1}$	(1) Full Sample	(2) Full Sample	(3) Largest firms
$\text{Cash Flow}_{f,t}$ / $\text{Capital}_{f,t-1}$	0.0260***	0.0257***	0.00385***
	(0.000403)	(0.000404)	(0.00102)
$\text{Sales Growth}_{f,t-1}$	0.0388***	0.0295***	0.00104
	(0.00190)	(0.00186)	(0.00487)
$\text{Bank Shock}_{f,t}$		0.146***	0.0396
		(0.00835)	(0.0628)
$(\text{Bank Shock}_{f,t})\times$ $\times(\text{Mean Bank-Loan-to-Asset Ratio}_f)$		0.147***	0.301**
		(0.0259)	(0.143)
$\text{Firm Shock}_{f,t}$		0.133***	0.137***
		(0.00277)	(0.0156)
$(\text{Firm Shock}_{f,t})\times$ $\times(\text{Mean Bank-Loan-to-Asset Ratio}_f)$		0.142***	0.0451
		(0.0142)	(0.0419)
$\text{Industry shock}_{f,t}$		0.498***	0.141***
		(0.0293)	(0.0545)
Fixed Effects			
Year	Yes	Yes	Yes
Firm	Yes	Yes	Yes
Observations	656246	656246	21415
R^2	0.356	0.388	0.418

Table 9: Determinants of firm-level investment

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05 *p<0.1. We drop the top and bottom two and a half percentiles of each variable. The mean bank-loan-to-asset ratio is defined for each firm as its average ratio of bank loans to assets over the sample period. Largest firms correspond to the top three percentile of loan volume in each year.

much less than firms that depend almost entirely on bank financing. In order to account for these differences in bank dependence, we include interaction terms with the mean ratio of bank loans to total assets.[33]

Column 2 of Table 9 shows that the coefficient on bank shocks interacted with the mean loan-to-asset ratio is positive, indicating that a stronger exposure to bank loans is associated with a more pronounced effect of bank shocks. We also find a positive coefficient on bank shocks entering alone, which means that even firms with

33 Since the mean bank-loan-to-asset ratio is time invariant, we cannot include it separately in the regression since it is already absorbed in the firm fixed effect.

few bank loans would have financed more investment projects in the absence of negative shocks to their banks' credit supply. As expected, both the firm borrowing shock and its interaction with the mean bank-loan-to-asset ratio show a positive coefficient. This implies that the firm-borrowing channel, for example capturing changes in the marginal product of capital or changes in the credit worthiness of the firm, has a strong impact on investment which is more pronounced for firms that are highly dependent on the supply of bank credit. Similarly, we find a positive coefficient for the industry shock, suggesting that investment opportunities often arise at the level of particular industries. For example, these might be related to the price of industry-specific investment goods, or demand and productivity shocks that are shared by all firms within the same industry.

We repeat the decomposition exercise including only the largest firms in our dataset, and in Column 3 we present the results for this additional analysis. In this case, we find that the coefficient on bank shocks is statistically indistinguishable from zero. Very large firms may be more likely to benefit relative to other firms when credit conditions tighten, while small firms lack alternative financing sources and may generally struggle in the presence of adverse financing conditions even if their exposure to bank loans is relatively low. The coefficients of the remaining variables do not change sign. Bank shocks interacted with the mean bank-loan-to-asset ratio become more important, while firm shocks become less important. Similarly, the coefficient on industry shocks is lower, indicating that industry dynamics seem to be slightly less important than for smaller firms.

The broad coverage of firms in the micro-dataset supports the findings by Amiti and Weinstein (2018) and makes it possible to consider how the effect of credit supply shocks varies across firms with different characteristics. Small firms are found to be much more vulnerable to the adverse impact of bank shocks on investment mainly for two reasons. First, their bank lending contracts much more than for large firms since they are less able to substitute their borrowing from other banks. Moreover, they have a larger share of short-term maturities and they may be considered more risky by their banks than larger firms. Second, while we find that alternative financing sources mitigate the adverse impact of bank shocks on investment, small firms are almost entirely bank-dependent and hence feel the full brunt of disruptions to their banks' credit supply.

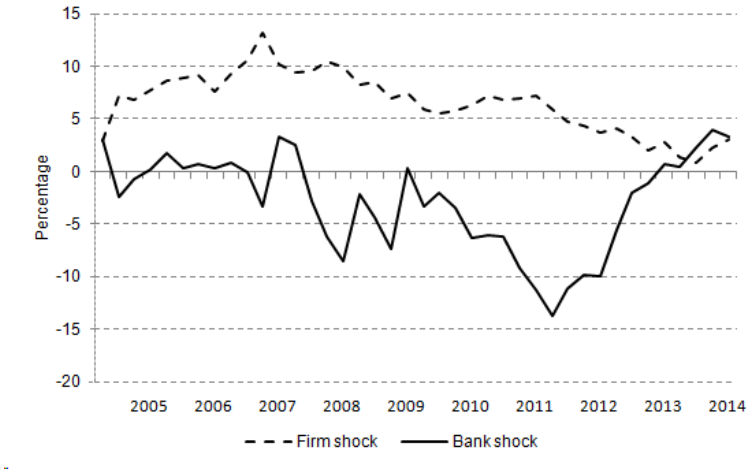

Figure 39: Aggregate Bank and Firm Shock

3.2. *Bank shocks and aggregate investment dynamics*

One important feature of the methodology proposed by Amiti and Weinstein (2018) is that it also provides a complete decomposition of loan growth rates into bank, firm, industry and common shocks at the aggregate level. Figure 39 presents the aggregate decomposition results for a quarterly dataset between 2005 and 2014. The aggregate bank shock series is characterised by two pronounced contractions with values falling below zero, thus indicating that larger banks in Portugal were particularly hard hit by idiosyncratic shocks in the last decade.

In order to assess the relative importance of the shocks, we correlate them with the growth rate of investment excluding housing. The aggregate bank shock accounts for 37 to 38 percent of investment dynamics, while the common shock and the aggregate firm shock are much less important (accounting for about 1 to 3 and 10 to 12 percent, respectively). Therefore, on the whole, our analysis provides strong evidence for the importance of granular bank shocks in explaining aggregate investment fluctuations.

4. Final remarks

Overall, bank supply shocks have a strong and robust negative effect on firm-level investment for the average firm in Portugal. In addition, small firms are found to be much more vulnerable to the adverse impact of bank shocks on investment. Moreover, the banking system in Portugal – as in most other countries – is very concentrated. The

ten largest banks account for more than three-quarters of the total loan volume in our dataset. This implies that idiosyncratic shocks to these institutions do not average out in the aggregate, but can have a considerable effect on total lending and hence investment.

The ongoing efforts to reduce the level of non-performing loans in the Portuguese economy and the recapitalisation of banks are likely to reduce the prevalence of bank shocks, thus having a positive impact on investment. Moreover, the diversification of firms' funding sources, with a larger role to be played by capital markets, is likely to be beneficial to them as a shield from adverse bank shocks.

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