Sudden Stops Under the Microscope*

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Abstract

This paper studies the micro-level dynamics of firms' borrowing during sudden stops. Using data on the universe of loans in the Uruguayan economy, we provide evidence on three channels of transmission driving these episodes: a lender channel, which links borrowing adjustments to the balance sheets of financial intermediaries; a collateral channel, which links these dynamics to changes in collateral values; and a risk channel, which connects them to changes in external risky-borrowing costs. We show that the lender channel significantly strengthens during sudden stops, suggesting that the distinctiveness of these episodes, relative to regular business cycles, may lie in acceleration mechanisms tied to financial intermediaries' balance sheets. Finally, we document that the lender channel is more pronounced for riskier firms and those in the nontradable sector, while the collateral channel operates more uniformly across firms.

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1. Introduction

Emerging markets experience recurrent episodes of abrupt reversals of capital flows, or "sudden stops." At the aggregate level, these episodes tend to be characterized by significant contractions in economic activity, consumption, aggregate investment, and currency depreciation (see, for example, Calvo *et al.*, 2006). Our goal in this paper is to study the micro-level patterns of adjustment during sudden stops and to inform theories explaining these episodes and their macroeconomic adjustments. We focus on the case of Uruguay, an emerging-market economy that experienced two sudden stops in its recent history (in 2002 and 2009) and has rich loan-level data that can be used to characterize the micro-level adjustment of firms during these episodes.

Using these data, our paper studies three questions. First, what are the channels of transmission of sudden stops. We provide evidence on three channels that have been studied at the macro level. First, a "lender channel," which links the dynamics of sudden stops to the balance sheet of financial intermediaries (see, for example, Calvo, 2004; Morelli *et al.*, 2022). The central idea of these theories is that sudden stops are caused by negative shocks affecting intermediaries' net worth, which contracts the supply of credit for domestic agents. Second, a "collateral channel," which links the dynamics of sudden stops to changes in collateral values (see Korinek and Mendoza, 2014, for a survey). The main idea of these theories is that negative shocks (e.g., to aggregate productivity) lead to contractions in collateral values, which induce firms and households to decrease their borrowing. Agents' deleveraging, in turn, induces further contractions in collateral values, leading to a downward spiral characterized by deleveraging and contraction in economic activity. Third, a "risk channel," which links the dynamics of sudden stops to changes in external risky borrowing costs (see, for example, Neumeyer and Perri, 2005; Uribe and Yue, 2006; Hegarty *et al.*, 2022). The main idea of these theories is that increases in the global price of risk lead to an increase in borrowing costs for risky agents, leading to declines in their borrowing.

For each of these channels, we exploit firm- and loan-level variation and estimate local projections (à la Jorda, 2005) in a panel setting. For the lender channel, we examine how a firm's borrowing is linked to the average return on assets of its lenders and how, within a firm, the borrowing from a particular bank is linked to the returns on assets from that bank (exploiting firm-time fixed effects, as in Khwaja and Mian, 2008). For the collateral channel, we study how a firm's borrowing is linked to the average change in its collateral values and how, within a firm, the borrowing using a particular type of collateral is linked to changes in the values of that type of collateral. For the risk channel, we study how firms with different shares of unsecured debt are differentially affected by changes in the global price of risk, and how, within a firm, the borrowing using unsecured and secured debt is differentially affected by changes in the global price of risk. For all three channels, we find economically large and persistent effects, linking firms' borrowing to the balance sheet of lenders, collateral values, and changes in the global price of risk.

The second question in our empirical analysis is whether sudden stops are different from regular business cycles, a topic long argued in the literature based on the macro-level patterns of these episodes (e.g., Calvo and Mendoza, 1996). We address this question by analyzing whether the strength of the three studied channels varies during periods of sudden stops. We find that the effect of the lender channel more than doubles during episodes of sudden stops, suggesting that bank performance becomes particularly relevant for the dynamics of firm credit in crisis periods, when banks face greater constraints in their ability to obtain external finance. We do not find a strengthening of the collateral and risk channels during episodes of sudden stops, suggesting that the main reason why sudden stops are different may lie in acceleration mechanisms linked to financial intermediaries' balance sheets (e.g., Caballero and Krishnamurthy, 2001; Gertler and Kiyotaki, 2010; He and Krishnamurthy, 2012; Brunnermeier and Sannikov, 2014).

Finally, our paper asks whether the effects of sudden stops are heterogeneous across different firms. We document that the lender channel has heterogeneous effects on different firms, with riskier firms and firms in the nontradable sector experiencing greater credit contractions following the same negative shock to banks' performance. We also find lower degrees of heterogeneous effects for the risk channel and a generalized, homogeneous effect for the collateral channel.

In addition to the literature on sudden stops, our paper is related to the literature that studies the domestic transmission of the global financial cycle and imperfections in global capital markets (see, for example, Rey, 2015; Maggiori, 2021, and references therein). One strand of this literature studies how shocks in global capital markets affect the macroeconomics of open economies (see, for example, Di Giovanni *et al.*, 2022; Hassan *et al.*, 2021; Hegarty *et al.*, 2024). Our work is closely related to Di Giovanni *et al.* (2022), who study the domestic transmission of capital inflows using granular loan-level data from Turkey. Our paper shares their methodology and focuses on periods of sudden stops with financial crises. We contribute to this literature by documenting how international shocks that affect domestic financial intermediaries transmit to firms' credit during these periods.

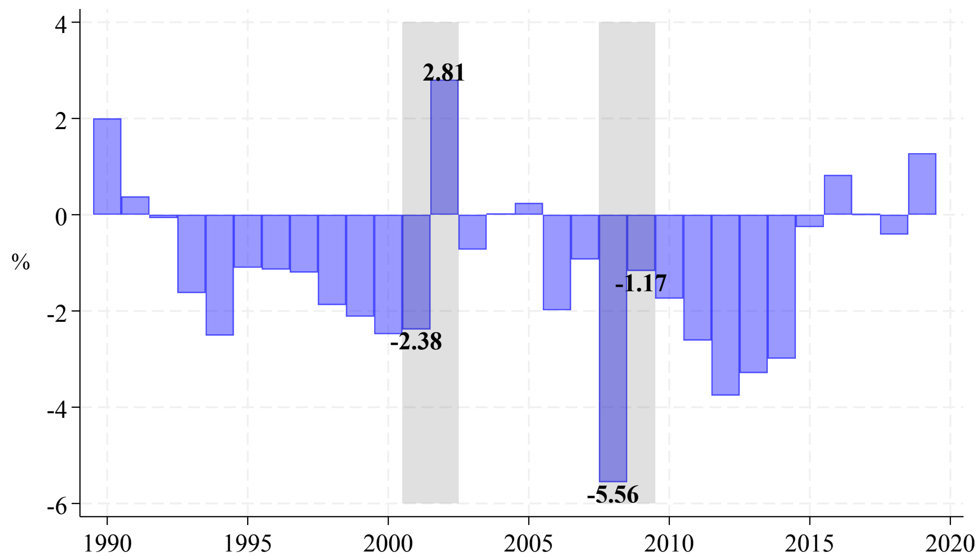
2. The Macroeconomic Dynamics During Sudden Stops

We begin by providing a summary of the key macroeconomic patterns observed during the sudden stop episodes experienced in the Uruguayan economy over the last three decades, serving as background for the empirical analysis.

Figure 1 reports the current account as a share of GDP. Since 1990, the Uruguayan economy has experienced two sudden stop episodes, marked with shaded gray areas. The first episode occurred in 2002, in the context of the Argentine crisis, and featured a 5 p.p. of GDP current account adjustment. The second episode occurred in 2009, in the context of the global financial crisis, and was associated with a 4 p.p. of GDP current account adjustment. In what follows, we provide a summary of the macroeconomic dynamics observed in each of these episodes.

The 2002 episode. This episode occurred as part of one of the largest economic crises in Uruguay's recent macroeconomic history. Appendix Table A.1 provides a timeline of key events marking this episode (see Antía, 2003; De Brun and Licandro, 2006; Fernández *et al.*, 2003; Polgar, 2004; Vallcorba, 2003, for detailed descriptions of this episode). The origin of this episode can be traced to Russia's default in August 1998, which was followed by a

Figure 1: Sudden Stop Episodes: Uruguayan Current Account Dynamics (% GDP)



Notes: This figure reports Uruguay's current account as a share of GDP. Data source: WDI. Shaded gray areas denote sudden stop episodes, with bold values indicating the current-account-to-GDP levels observed during these periods.

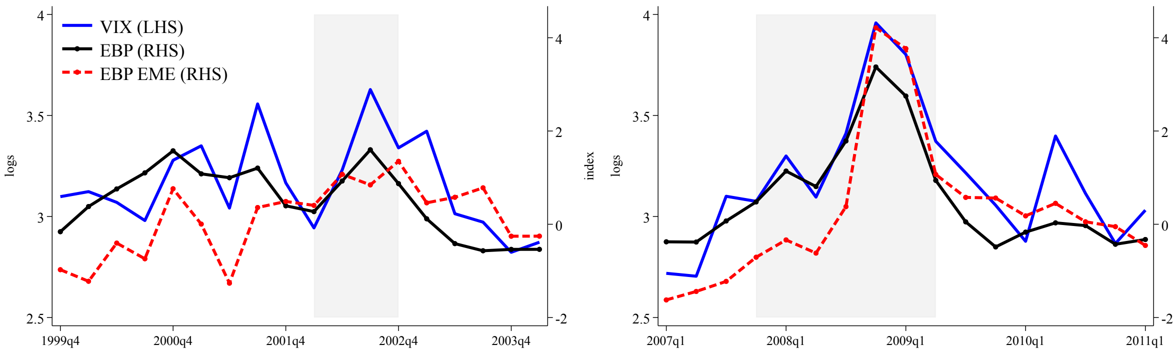
widespread recession in Latin America. The economic contraction was particularly severe in Argentina, which had a currency peg against the U.S. dollar, a substantial amount of liabilities denominated in that currency, and increasing levels of sovereign risk, as illustrated in Panel (b) of Figure 2 (for a detailed analysis of this episode, see Calvo *et al.*, 2003; Kehoe, 2007, and references therein). The nadir of this crisis occurred in December 2001 and January 2002, marked by a deposit freeze (the "corralito"), sovereign default, abandonment of the fixed exchange rate, economic collapse, and social and political unrest.

In the decade before the crisis, Uruguay had developed strong economic ties with Argentina, one of which was a large share of deposits from Argentine residents (during 2001, 41% of private deposits were from non-residents, and 80% of those belonged to Argentinians). As illustrated in Figure 3, these deposits experienced a collapse during 2002, which triggered a severe banking crisis involving the bankruptcy of five major banks and a major contraction in domestic deposits and credit. As illustrated in Figure 4, the real side of the economy was characterized by an economic depression, involving significant contractions in

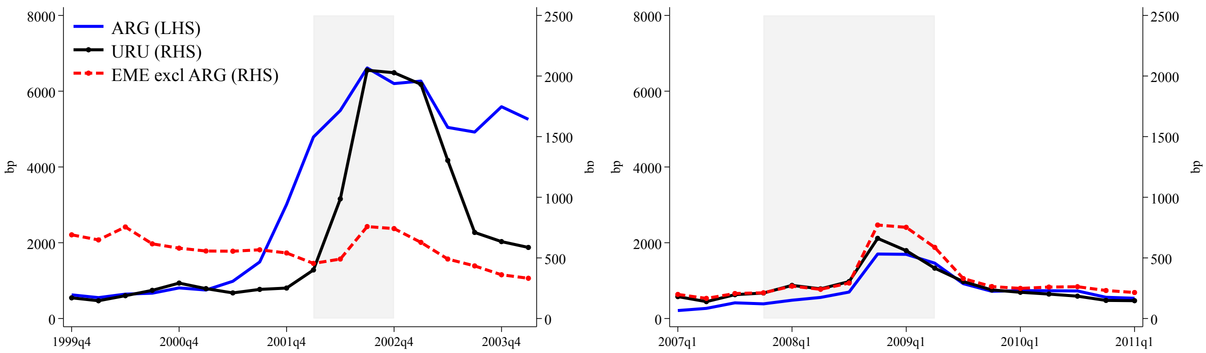
Figure 2: Global and Regional Context during Sudden Stop Episodes

2002 episode 2009 episode

a) VIX and EBP



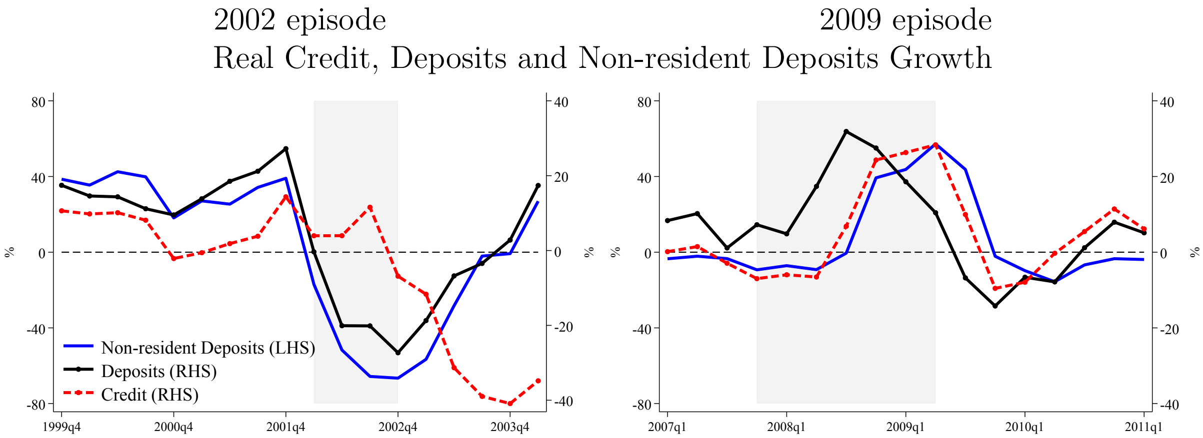
b) EMBI and Uruguay Bond Index (UBI) Spreads



Notes: Panel (a) displays the VIX, the EBP from Gilchrist and Zakrajšek (2012), and the EME EBP from Hegarty *et al.* (2024). Panel (b) shows Uruguay's country risk index, the "Uruguay Bond Index" from República AFAP, which measures the average spreads of Uruguayan bonds over U.S. Treasury bill rates. Panel (b) also reports the EMBI spreads of Argentina and an EME average comprising the following countries: Brazil, Chile, Colombia, Ecuador, Korea, Malaysia, Mexico, Peru, the Philippines, South Africa, Thailand, Turkey, and Uruguay. Shaded gray areas denote periods of GDP growth decline associated with each sudden stop episode. *Sources*: Hegarty *et al.* (2024), FRED, Gilchrist and Zakrajšek (2012), World Bank, and República AFAP.

economic activity, consumption, investment, and a large increase in unemployment. Figures 2 and A.1 show that the government was not insulated from this contraction, experiencing an increase in sovereign spreads, a large contraction in spending and foreign reserves, and the abandonment of the crawling peg, which resulted in a substantial nominal and real currency depreciation (see Panel (c) of Figure 4).

Figure 3: Banking Sector Dynamics during Sudden Stop Episodes



Notes: This figure reports the real growth rates of credit, deposits, and non-resident deposits within the financial system (including private banks, public banks, cooperatives, and non-bank financial institutions). All growth rates are year-over-year and expressed as percentages. Shaded gray areas denote periods of GDP growth decline associated with each sudden stop episode. *Source*: Central Bank of Uruguay.

The 2009 episode. This episode occurred in the context of the global financial crisis, triggered by the bankruptcy of Lehman Brothers in September 2008 (for a detailed description of this episode, see Chodorow-Reich, 2014; Gertler and Gilchrist, 2018, and references therein). As illustrated in Panel (a) of Figure 2, this episode was marked by a substantial increase in the global price of risk, measured by the excess bond premium and the VIX.

As illustrated in Figures 2-4, the economic effects of this global financial crisis were not particularly severe in Uruguay, at least compared with those of the 2002 episode. In particular, this episode was characterized only by a deceleration in economic activity, minor increases in unemployment, and no bank failures or distress in the public sector. Yet, investment contracted by 15%, accounting for the bulk of the current account contraction.

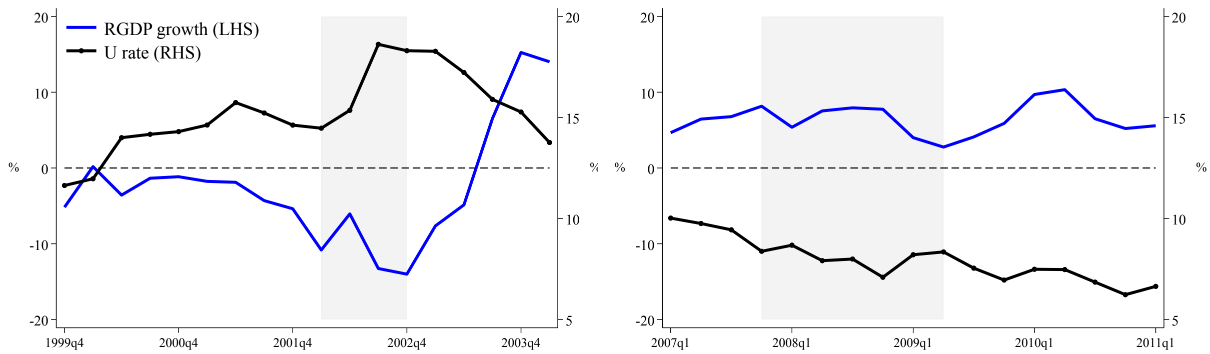
3. Microlevel Data and Descriptive Statistics

Data. Our empirical analysis uses two datasets managed by the Central Bank of Uruguay, containing monthly data from 1999 to 2019. The first dataset is the "Credit Register" (*Central de Riesgos Crediticios*), which covers the universe of loans issued within the Uruguayan

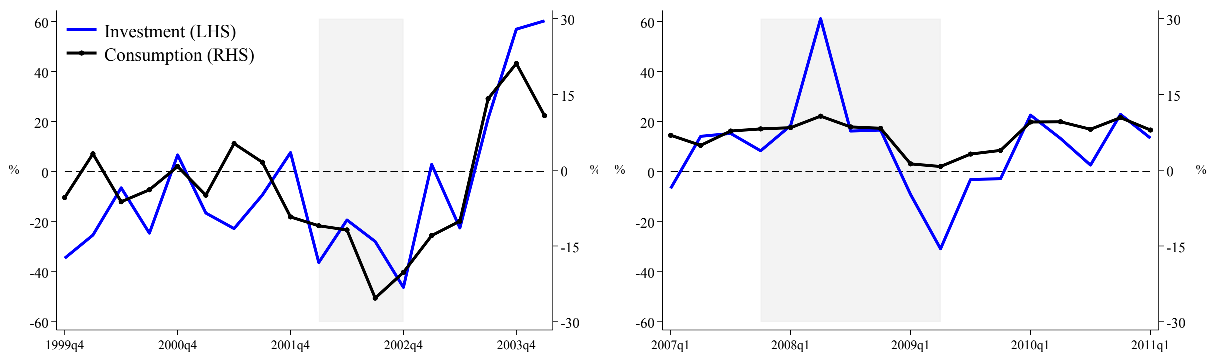
Figure 4: Economic Activity during Sudden Stop Episodes

2002 episode | 2009 episode

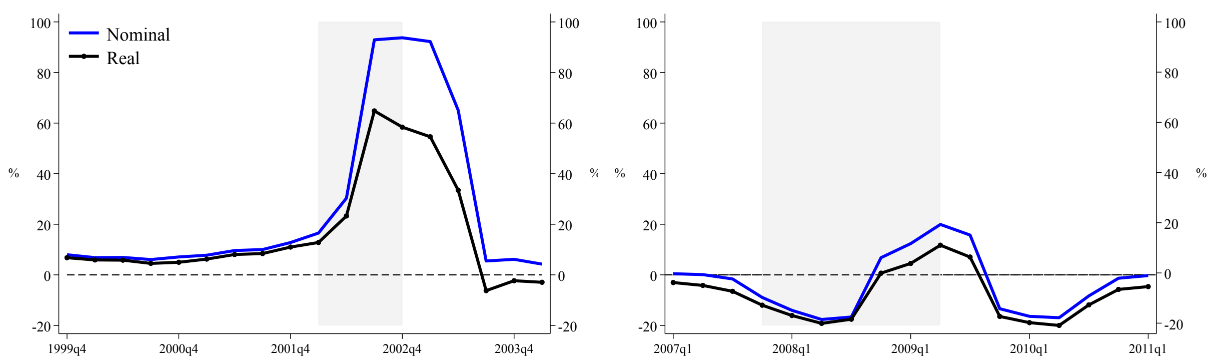
a) Real GDP Growth and Unemployment rate



b) Investment and Consumption Growth



c) Nominal and Real Depreciation



Notes: Panel (a) shows real GDP growth and the unemployment rate. Panel (b) displays real investment and consumption growth. All growth rates are year-over-year, expressed in percentages, and based on seasonally adjusted raw series. Panel (c) reports real and nominal depreciation rates, with the real exchange rate calculated as $NER\frac{P^*}{P}$, where NER stands for nominal exchange rate. All series are in percent. Shaded gray areas denote periods of GDP growth decline associated with each sudden stop episode. *Sources*: Central Bank of Uruguay and IMF-IFS.

financial system. For each loan, it contains rich contractual information, such as the loan amount, currency, maturity, and collateral. Importantly for our identification, it also includes an identifier for the borrower and lender involved in the contract, as well as information about the borrower's country of residency, sector, and credit risk category assigned each month by its lender (according to Uruguayan regulation). For part of our analysis, we also use a second dataset, which contains the balance sheet and income statement of all financial institutions operating in Uruguay and is publicly available through the Central Bank of Uruguay.

Combining these data sources, we build a loan-level dataset containing information on both firms' borrowing and banks' balance sheets for the universe of loans in the banking system.[1] The dataset covers a total of 109,419 firms, 23 banks, and 170,924 different bank-firm pairs over the period considered.[2]

Descriptive statistics. Table 1 presents a set of descriptive statistics for key variables in our empirical analysis. We conduct this analysis at a quarterly frequency, pooling all periods and winsorizing the variables involved in the analysis at the top and bottom 1% of the distribution to mitigate the influence of outliers.

The first column of Table 1 shows that the data exhibits considerable variation in the log change in debt, as measured by its standard deviation. The top panels of Figure 5 indicate that firms in our sample experience a sharp contraction in borrowing following sudden stop episodes, with a lag relative to the changes in economic activity documented in the previous section. Appendix Figure A.2 shows that this adjustment is observed in both local and foreign currency debt and is not driven by debt revaluation.

As further explained below, our empirical analysis exploits the fact that a subset of firms in our sample have multiple bank relationships, multiple loans that vary in the type of pledged collateral, and loans that differ in their credit risk. The second and third columns of Table 1 present descriptive statistics for the firms with loans from multiple banks. On

[1]We exclude from the analysis non-banking institutions, as well as the state-owned bank whose unique line of business is mortgages (i.e., the *Banco Hipotecario*).

[2]Following the 2002 banking crisis, the Uruguayan banking system underwent a process of bank failures, mergers, and acquisitions, which reduced the number of banks from 23 in 1999 to 10 in 2019.

average, these firms have 2.4 bank relationships, exhibit higher loan growth than the average set of firms, and a lower standard deviation. Despite these differences, Figure A.2 indicates that these firms experience similar average borrowing dynamics during sudden stops as the rest of the firms in the economy. Finally, the middle panels of Figure 5 show a collapse in banks' return on assets during sudden stop episodes, which was particularly pronounced in the 2002 episode.

The fourth and fifth columns of Table 1 present descriptive statistics for firms with loans secured by different types of collateral. On average, these firms have 2 collateral types and exhibit similar descriptive statistics to those of all firms in the sample. In the dataset, firms pledge 13 different types of collateral (commonly used examples include real estate, machinery, vehicles, land, cattle, and government debt). Appendix B lists all types of collateral. The aggregate value of collateral in our dataset contracts in the year following sudden stop episodes (see the bottom panels of Figure 5, and Appendix Figures A.3 and A.4).

Finally, the last two columns of Table 1 focus on firms with loans of varying credit risk. We identify variation in credit risk of different loans from the same borrowing firm based on whether or not the loans are collateralized. The rationale is that collateralized loans have better recovery values and, therefore, lower credit risk. The average share of unsecured debt for firms with both types of loans is 27%, with significant variation in the share of unsecured debt.

Table 1: Descriptive Statistics on Firms' Debt and Banks' Assets

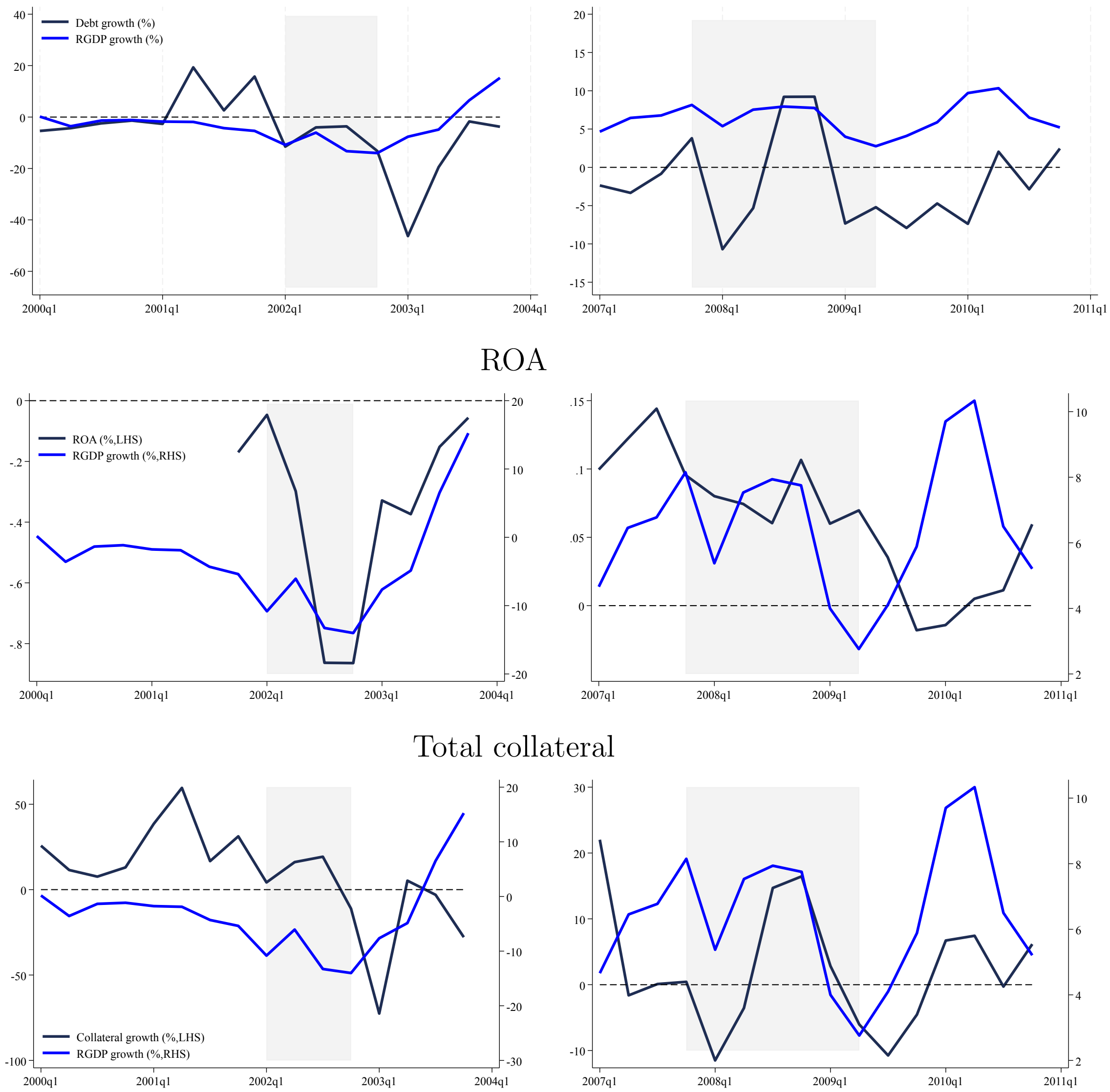
	All firms	Firms w multiple banks		Firms w multiple collateral		Firms w multiple credit risk	
	$\Delta \log b_{jt}$	$\Delta \log b_{jt}$	# banks relationships	$\Delta \log b_{jt}$	# collateral types	$\Delta \log b_{jt}$	Unsecured loans (%)
Mean	-3.5	7.0	2.4	-3.6	2.0	-1.9	26.8
Median	-5.4	-1.7	2.0	-4.5	2.0	-3.6	1.6
SD	99.2	80.8	0.8	80.2	0.2	60.5	38.1
Bottom 5%	-152.9	-96.5	2.0	-124.8	2.0	-97.8	0.0
Top 95%	161.7	139.7	4.0	122.2	2.0	99.1	100.0
Number of units	109,409	2,123	2,123	7,765	7,765	24,144	24,144
Observations	1,919,998	345,327	345,327	51,474	51,474	345,327	345,327

Notes: This table reports summary statistics of firm- and bank-level variables, using quarterly data for the period 1999 to 2009. b_{jt} denotes the debt of firm j in period t, expressed as a percentage.

Figure 5: Firms' Borrowing Dynamics during Sudden Stops

2002 episode | 2009 episode

Firms' debt



Notes: This figure reports, in the first row, the average change in firms' debt, $\Delta \log b_{j,t}$, for the firms in our sample; in the second row, the average ROA, weighted by banks' total assets; and the total collateral. The blue line denotes real GDP growth. Shaded gray areas indicate periods of GDP growth decline associated with each sudden stop episode.

4. The Micro Dynamics during Sudden Stops

In this section, we study the transmission of sudden stops through their microlevel patterns. Section 4.1 examines the economic relevance of three key channels of transmission studied in the sudden stop literature. Section 4.2 explores whether sudden stops differ from regular business cycle fluctuations across these three channels. Finally, Section 4.3 investigates whether different firms are heterogeneously exposed to these channels.

4.1. Channels of Transmission

We study three channels of transmission of sudden stops, as described in the introduction: the lender channel, the collateral channel, and the risk channel.

The lender channel. The lender channel, also referred to as the bank lending channel, relates to theories that link variations in firms' borrowing to the balance sheets of financial intermediaries. We begin by exploiting firm-level exposure to this channel and estimate the following local projections (à la Jorda, 2005):

$$\log b_{jt+h} - \log b_{jt-1} = \alpha_{jh} + \alpha_{th} + \beta_h Z_{jt} + \boldsymbol{\Gamma}'_h \boldsymbol{X}_{jt-1} + \varepsilon_{jt+h}, \tag{1}$$

where b_{jt} denotes the debt of firm j in period t. Z_{jt} measures the firm-level exposure to the lender channel, defined as the average return on assets of banks linked to firm j, i.e., $Z_{jt} = \sum_i \omega_{ijt} R_{it}$, where R_{it} is the return on assets of bank i in period t and ω_{ijt} is the ratio of loans from bank i to firm j over total loans from all banks to firm j. α_{jh} and α_{th} denote firm and time fixed effects. $\boldsymbol{X}_{jt-1}$ is a vector of firm-level controls, which includes the variables $\Delta \log b_{jt-1}$ and Z_{jt-1}, along with a set of firm-level time-varying characteristics available in the dataset: the firm's risk category (measured by its riskiest loan), the ratio of nonperforming loans to total debt, the share of liquid assets in collateral, and the number of months since the first loan observed in the dataset (as a proxy for the firm's age). Appendix B details the construction of each of these variables, as well as all other variables used in the following regression analyses. Our coefficients of interest are β_h, which measure the semi-elasticity of a firm's borrowing to its banks' average return on assets at different horizons.

Panel (a) of Figure 6 reports the results from estimating (1) for different horizons. The estimates for β_h indicate that a 1% contraction in the return on assets of the banks linked with a given firm is associated with a peak contraction in the firm's credit of 0.7% and an average contraction of 0.28% during the following two years. These results are consistent with the predictions of intermediary-based theories of sudden stops. In particular, in these theories, sudden stops are periods in which intermediaries face shocks leading to a higher marginal cost of external finance (see, for example, Morelli *et al.*, 2022). Therefore, if bank relationships are sticky (e.g., Chodorow-Reich, 2014), it can be costlier for firms that experience a contraction in the supply of credit from a bank to substitute that shock with credit from another bank.

A challenge in interpreting the estimates from (1) is that the association between firms' borrowing and banks' assets can be driven by either credit supply or demand factors. The latter may arise if, for example, there is assortative matching between firms and banks, and negative shocks to a set of firms reflect poorer performance with their linked banks. To study how firms' borrowing is linked to changes in credit supply, i.e., the lender channel, we exploit the loan-level variation in the data and estimate the empirical model:

$$\log b_{ijt+h} - \log b_{ijt-1} = \alpha_{ih} + \alpha_{jth} + \beta_h R_{it} + \mathbf{\Gamma}'_h \boldsymbol{X}_{ijt-1} + \varepsilon_{ijt+h}, \tag{2}$$

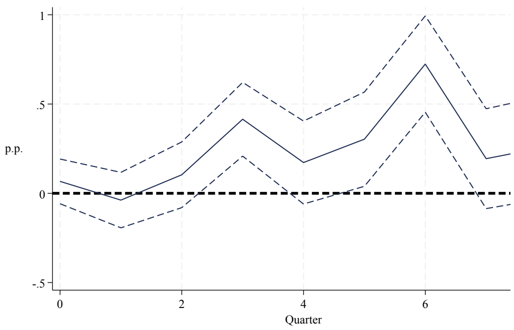
where b_{ijt} denotes the debt of firm j from bank i in period t; and α_{ih} and α_{jth} denote bank and firm-by-time fixed effects. Following the literature exploiting loan-level variation, the firm-by-time fixed effect absorbs all firm-specific credit demand shocks (see, for example, Khwaja and Mian, 2008). We include a similar set of controls in the vector $\boldsymbol{X}_{ijt-1}$ as when estimating equation (1), but with loan-level information: the loan's risk category, the share of the loan that is nonperforming, the share of liquid assets in the loan's collateral, and the variables $\Delta \log b_{ijt-1}$ and ΔR_{it-1}.

Panel (b) of Figure 6 reports the results from estimating (2) for different horizons. The estimates for β_h are large and persistent. In particular, they indicate that a 1% contraction

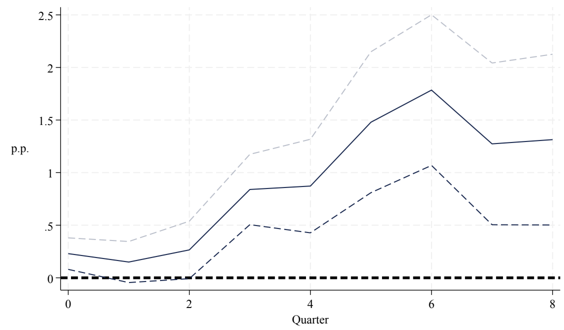
Figure 6: Channels of Transmission

Lender channel

(a) Firm-level estimates

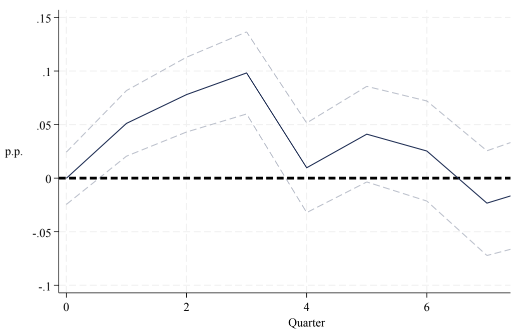


(b) Loan-level estimates

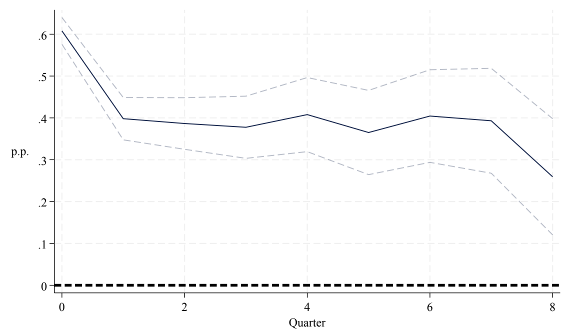


Collateral channel

(c) Firm-level estimates

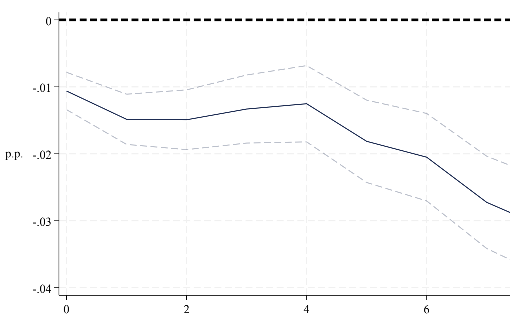


(d) Loan-level estimates

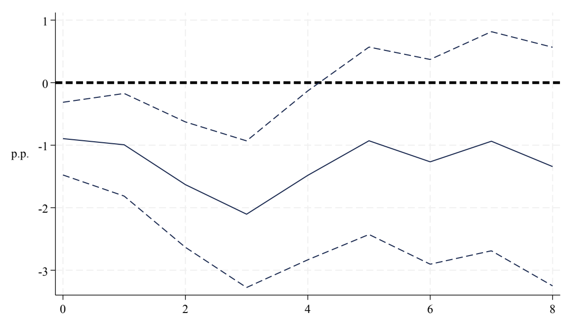


Risk channel

(e) Firm-level estimates



(f) Loan-level estimates



Notes: This figure reports the estimates of β_h from the different empirical models by setting $\gamma = 0$. The left column shows results for firm-level specifications, while the right column shows results for loan-level specifications. Confidence intervals at the 90% confidence level are shown with dashed lines, using Newey-West adjusted standard errors.

in the return on assets of a bank is followed by a peak contraction of almost 2% in firms' borrowing from that bank. This suggests that firms' borrowing from a given bank is largely supply-determined and tightly linked to changes in that bank's performance. Finally, panel (a) of Appendix Table 3 shows the robustness of the results to excluding loan-level controls and replacing firm-by-time fixed effects with separate time and firm fixed effects.

The collateral channel. Second, we study theories that link variation in firms' borrowing to changes in the value of their collateral. As in the previous channel, we start by exploiting firm-level variation. In particular, we estimate a version of (1) in which we define Z_{jt} as the average change in the value of collateral associated with all loans to firm j. Specifically, $Z_{jt} = \sum_k \omega_{jkt} \Delta q_{kt}$, where q_{kt} is a measure of the log value of collateral of type k in period t, and ω_{jkt} is the ratio of loans using collateral type k over total loans from firm j. We measure q_{kt} by aggregating the value of individual collaterals of type k across all firms. Appendix Figures A.3 and A.4 show the time series for the measures of q_{kt} for all different types of collateral.[3]

Panel (c) of Figure 6 reports the estimates of β_h for the collateral regressions at the firm level for different horizons. These estimates indicate that a decrease of 1% in the measured value of a firm's collateral is associated with a peak contraction in the firm's credit of 0.1% and an average contraction of 0.04% during the first year after the shock. These results identify an empirical relationship between firms' borrowing and collateral value, a key ingredient in theories of collateral-driven sudden stops.

A challenge to this analysis is that these estimates are also consistent with negative sectoral shocks that induce firms to deleverage and reduce their investment in different types of capital. This could link deleveraging at the firm level with reductions in the value of their collateral even in the absence of a collateral channel. To further identify the collateral channel, we exploit variation in loans with different pledged collateral within a given firm by

[3]Note that our measure potentially captures both variation in the value and in the aggregate quantity of available collateral. To further validate that our measure captures price variation, Figure A.5 shows that our measure positively correlates with time series of prices of collateral for those types where price data is available.

estimating the following empirical model:

$$\log b_{kjt+h} - \log b_{kjt-1} = \alpha_{kh} + \alpha_{jth} + \beta_h q_{kt} + \mathbf{\Gamma}'_h \boldsymbol{X}_{kjt-1} + \varepsilon_{kjt+h}, \tag{3}$$

where b_{kjt} denotes the debt of firm j with pledged collateral type k in period t, and α_{kh} and α_{jth} denote collateral type and firm-by-time fixed effects. In this case, the control vector $\boldsymbol{X}_{kjt-1}$ includes (at the loan-collateral-category level): the loan's risk category, the share of the loan that is nonperforming, the share of liquid assets in the loan's collateral, and the variables $\Delta \log b_{kjt-1}$ and Δq_{kt-1}.

Panel (d) of Figure 6 reports the estimates of the elasticity of firm borrowing to the value of collateral, β_h, with a peak impact effect of 0.6, which remains positive during the two years following the shock. Finally, panel (b) of Appendix Table 3 shows that the results are robust to excluding loan-level controls and replacing firm-by-time fixed effects with separate time and firm fixed effects. Overall, these results are consistent with theories that emphasize the role of collateral constraints and Fisherian debt-deflation dynamics during sudden stops (see, for example, Mendoza, 2002, 2010; Bianchi, 2011).

The risk channel. Finally, we investigate the relevance of theories that link economic contractions during sudden stops to spikes in the market price of risk (see, for example, Neumeyer and Perri, 2005; Hegarty *et al.*, 2022). This channel predicts that contractions in firms' credit should be larger when loans are riskier. We start by estimating a version of (1) in which we define Z_{jt} as the interaction between a measure of the risk of firm j and an aggregate measure of the market price of risk. Specifically, $Z_{jt} = \text{Risk}_{jt-1}\text{EBP}_t$, where Risk_{jt} is a measure of firm j's risk in period t, and EBP_t is a measure of the market price of risk. For the firm risk measure, we use the share of unsecured debt to total debt of firm j, exploiting the fact that unsecured debt has lower expected recovery in a default event, and hence, more risk. The baseline measure of the market price of risk is the emerging market excess bond premium measure from Hegarty *et al.* (2022). Our results are robust to considering the VIX as an alternative measure of the global price of risk. Panel (e) of Figure

6 reports the estimates of β_h for the risk regressions at the firm level for different horizons, measuring the differential effect on riskier firms following an increase in the market price of risk. These estimates indicate that a firm with a one-standard deviation larger share of unsecured debt experiences an additional contraction in credit of 0.03% following an increase of 100 basis points in the excess bond premium.

As in the previous cases, these estimates may reflect the effects of other shocks that are potentially correlated with risk at the firm level. To address this, we also estimate the same regression at the loan level and include firm-time fixed effects. In this case, we replace the measure of firm risk with an indicator of loan risk, given by a dummy variable that is one if the loan is uncollateralized. Panel (f) of Figure 6 reports the estimates of β_h, using loan-level variation, which indicate that uncollateralized credit contracts by 2% more than collateralized debt following an increase of 100 basis points in the excess bond premium.[4]

These results are robust to excluding loan-level controls and replacing firm-time fixed effects with separate time and firm fixed effects (see panel (c) of Appendix Table 3). Our results are also robust to alternative measures of the market price of risk. Appendix Figure 6 shows similar results when using the VIX instead of the excess bond premium. Overall, these results suggest the presence of a risk channel through which riskier firms are more exposed to sudden stops induced by surges in the price of risk.

4.2. Are sudden stops different?

In this section, we ask whether the strength of these channels varies during periods of sudden stops. To investigate this, we estimate the same regressions as in the previous sections, with an additional independent variable given by the interaction of the variable Z_{jt} with an indicator variable for sudden stop periods. Specifically, for the firm-level regressions, we estimate:

$$\log b_{jt+h} - \log b_{jt-1} = \alpha_{jh} + \alpha_{th} + \beta_h Z_{jt} + \gamma_h Z_{jt} S_t + \mathbf{\Gamma}'_h \boldsymbol{X}_{jt-1} + \varepsilon_{jt+h}, \tag{4}$$

[4]The difference in magnitudes in the point estimates in the regressions at the firm and loan levels may be due to significant substitution of uncollateralized for collateralized debt within firms during surges in the market price of risk.

where S_t is a dummy variable that takes the value of 1 in the years 2002, 2003, 2009, and 2010, and zero otherwise. We also perform a similar analysis in the regressions with firm-time fixed effects. Figure 7 reports the estimates of γ_h for the different regressions estimating the effects of the three channels. For the lender channel, we find that the semi-elasticity of bank returns on assets to firm credit more than doubles during episodes of sudden stops (see panels (a) and (b)). These results suggest that bank performance becomes particularly relevant for the dynamics of firm credit in crisis periods, when banks face greater constraints in their ability to obtain external finance.

Panels (c)-(f) of Figure 7 report the estimates of γ_h for the regressions of the collateral and risk channels. In these cases, the estimates are not statistically different from zero, suggesting that the relationships between collateral value and credit, and risk and credit do not change significantly in periods of sudden stops relative to normal times.

Finally, Appendix Table 4 shows that these findings are robust to considering shorter windows of the two sudden stop episodes and analyzing the differential effects for each of the two episodes separately. For the lender channel, we find that the additional effect of bank returns on firm credit is present in both the 2002 and 2009 episodes, with a larger increase observed in the latter episode.

4.3. Heterogeneous effects

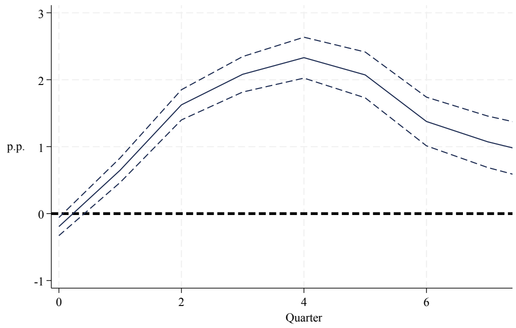
In this section, we study whether the channels of transmission of sudden stops affect firms heterogeneously. For each of the studied channels, we estimate the same regressions as in Section 4.1 across different samples of firms that vary along multiple cross-sectional dimensions.

Table 2 reports the heterogeneous effects of the lender channel, showing the estimates of β_h when we split samples based on the firm's risk and sector, the loan's type of collateral, currency of denomination, and the type of bank providing the loan. We estimate the lending channel to be most heterogeneous across different types of firms. High-risk firms experience an average credit contraction approximately three times larger than that of low-risk firms following the same decrease in banks' return on assets. This finding is consistent with

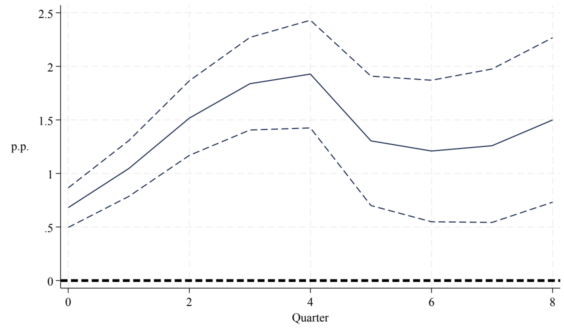
Figure 7: Channels of Transmission: Differential Effects During Sudden Stops

Lender channel

(a) Firm-level estimates

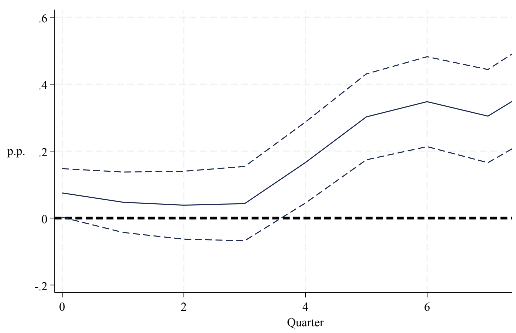


(b) Loan-level estimates

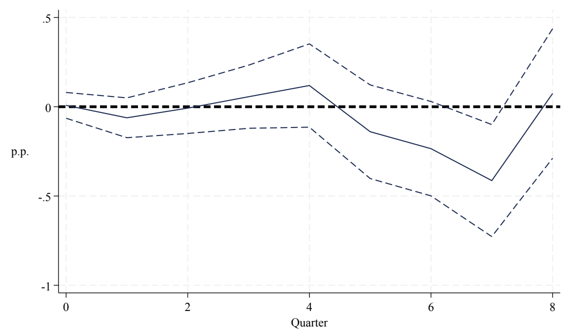


Collateral channel

(c) Firm-level estimates

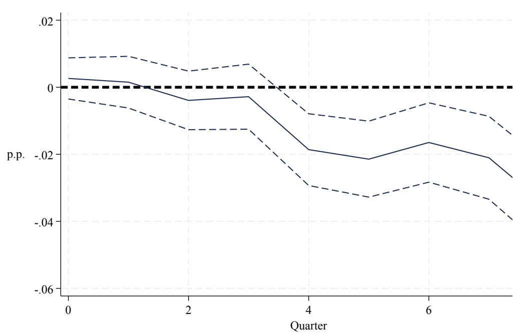


(d) Loan-level estimates

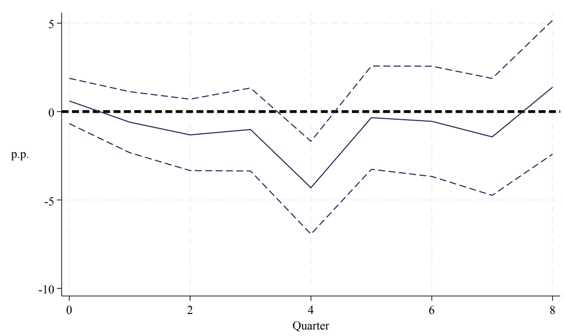


Risk channel

(e) Firm-level estimates



(f) Loan-level estimates



Notes: This figure reports the estimates of γ_h from the different empirical models. The left column shows results for firm-level specifications, while the right column shows results for loan-level specifications. Confidence intervals at the 90% confidence level are indicated with dashed lines, using Newey-West adjusted standard errors.

Table 2: The Lender Channel: Heterogeneous Effects

			Impact	Peak	Average	Obs
A	By type of collateral	Uncollateralized	.23	3.8	1.6	76,211
			(.423)	(1.61)		
		Collateralized	.25	1.9	.93	311,100
			(.135)	(.773)		
B	By firm's risk	Low risk	-.17	1.1	.4	218,505
			(.16)	(.957)		
		High risk	.9	2.6	1.5	169,909
			(.259)	(1.08)		
C	By firm's sector	Tradable	.11	.88	.23	123,235
			(.227)	(.964)		
		Non-tradable	.3	2.4	1.2	435,626
			(.137)	(.668)		
D	By currency denomination	Local currency	-.82	3.3	1.5	209,533
			(.33)	(1.23)		
		Foreign currency	.42	1.3	.61	382,719
			(.115)	(.638)		
E	By type of bank	Local banks	.47	6	2.7	63,041
			(.143)	(1.42)		
		Foreign banks	.12	2.2	1.5	245,086
			(.439)	(.944)		
		Private banks	-.063	1.4	.64	338,420
			(.133)	(.693)		
		Excluding failed banks	.56	1.8	1.2	539,072
			(.235)	(.559)		

asymmetric effects operating through risk premia, as predicted by intermediary-based asset pricing theories (e.g., He and Krishnamurthy, 2013). Moreover, the average response among non-tradable firms is five times larger than in tradable firms. We also estimate heterogeneous effects across loan and bank characteristics, though the differences are much more muted.

Table 3 reports the heterogeneous effects of the collateral channel. We study the effects of the collateral channel on firms with different risk levels and in different sectors, loans with different currencies of denomination, and for different types of banks. In this case, we find effects that are consistently similar across these different dimensions, suggesting that the collateral channel operates in a generalized way.

Table 3: The Collateral Channel: Heterogeneous Effects

			Impact	Peak	Average	Obs
A	By firm's risk	Low risk	.62	.62	.37	5,558
			(.043)	(.043)		
		High risk	.6	.6	.41	12,468
			(.031)	(.031)		
B	By firm's sector	Tradable	.66	.66	.34	3,552
			(.046)	(.046)		
		Non-tradable	.58	.58	.43	14,474
			(.031)	(.031)		
C	By currency denomination	Local currency	.61	.61	.4	4,638
			(.047)	(.047)		
		Foreign currency	.61	.61	.38	13,422
			(.028)	(.028)		
D	By type of bank	Local banks	.83	.96	.407	2,573
			(.079)	(.31)		
		Foreign banks	.68	.68	.47	6,076
			(.045)	(.045)		
		Private banks	.63	.63	.42	8,637
			(.033)	(.033)		
		Excluding failed banks	.61	.61	.39	16,860
			(.027)	(.027)		

Finally, Table 4 reports the heterogeneous effects of the risk channel. We find the effect of the risk channel to be most heterogeneous across firms in different sectors. In this case, the contraction in credit for tradable firms is more than twice as large as that for nontradable firms following an increase in the market price of risk. Additionally, we find that the risk channel is present among local currency debt but not foreign currency debt.

Table 4: The Risk Channel: Heterogeneous Effects

			Impact	Peak	Average	Obs
A	By firm's sector	Tradable	-.011	-.06	-.026	123,235
			(.01)	(.02)		
		Non-tradable	-.0086	-.0119	-.0091	435,626
			(.0051)	(.017)		
B	By currency denomination	Local currency	-.015	-.035	-.013	209,533
			(.012)	(.021)		
		Foreign currency	-.0009	-.0035	.0049	382,719
			(.005)	(.0088)		
C	By type of bank	Local banks	-.023	-.025	-.014	63,041
			(.012)	(.029)		
		Foreign banks	-.0079	-.0256	-.0142	245,086
			(.0083)	(.0163)		
		Private	-.009	-.0293	-.0132	338,420
			(.0063)	(.0127)		
		Excluding failed banks	-.01	-.025	-.016	539,072
			(.0046)	(.0093)		

5. Conclusion

This paper provides evidence that key channels of transmission for sudden stops, traditionally studied at the macro level—financial intermediaries' balance sheets, collateral values, and external borrowing costs—are also observed in micro-level data. Our findings highlight two central factors in these episodes: the role of intermediaries' balance sheets, which appear to be a distinguishing feature setting sudden stops apart from regular business cycles, and firms' default risk, which amplifies these effects.

These results suggest that policies focusing on the stability of financial intermediaries, firms' indebtedness, and bankruptcy resolution can be central to mitigating the effects of sudden stops. When studying these policies, the empirical estimates provided in our framework can be used to inform quantitative models of sudden stops. We leave this for future research.

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A. Additional Tables and Figures

Table A.1: 2002 Sudden Stop Chronology

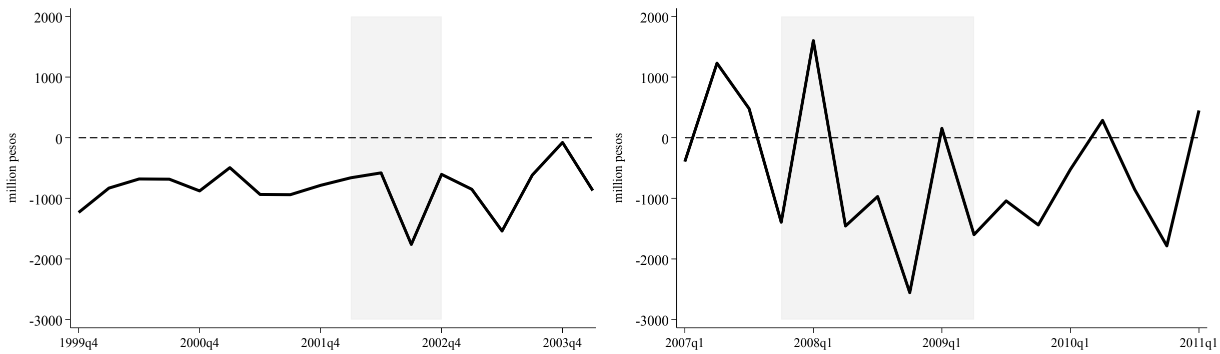
8/1998	Russia's devaluation
1/1999	Brazil's devaluation
6/2001	Uruguay extends crawling exchange rate band
12/2001	Argentina establishes the "Corralito"
	Argentinean president quits
	IMF suspends loan disbursements to Argentina
	Argentina defaults
1/2002	Argentina's devaluation
	Uruguay re-extends crawling exchange rate band
2/2002	Argentina establishes the "Corralón"
	BCU intervenes to re-capitalize Banco Comercial, the main private bank
	BCU suspends Banco Galicia Uruguay and bank run starts
	Uruguay loses investment grade status
	Uruguay's Congress approves fiscal adjustment package
3/2002	Agreement between IMF and Uruguay was achieved for $743 million
4/2002	Foot-and-mouth disease ("Aftosa") breaks in Uruguay
5/2002	Uruguay's Congress approves 2nd fiscal adjustment package
6/2002	BCU intervenes in Banco Montevideo and La Caja Obrera
	Uruguay abandons crawling peg exchange rate regime
7/2002	Uruguay's Minister of Economy quits followed by the president of the BCU
	Uruguay declares bank holiday
8/2002	Bank holiday lifted after $3 billion bailout package provided by the US and mulilaterals

Notes: BCU stands for Central Bank of Uruguay. During the "Corralito," the government of Argentina imposed capital controls and deposit freezes on Argentine nationals, while during the "Corralón," these deposit freezes were tightened.
Sources: Díaz (2018), De la Plaza and Sirtaine (2005).

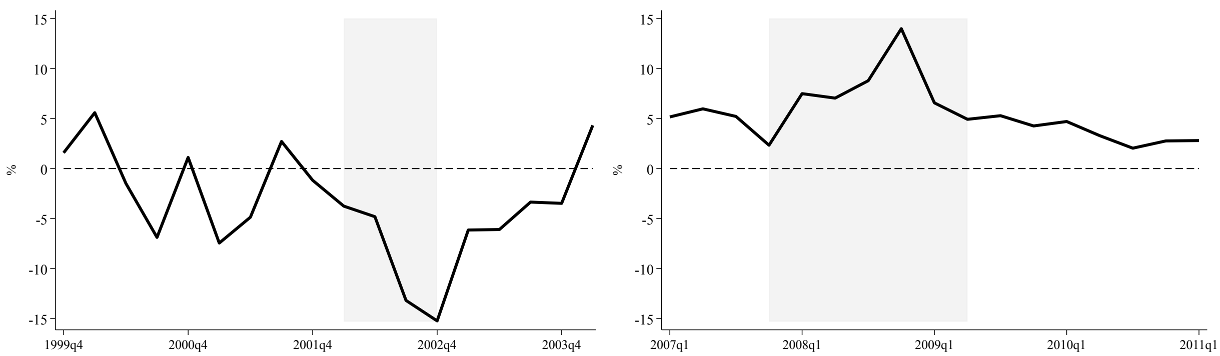
Figure A.1: Fiscal and Reserve Dynamics during Sudden Stop Episodes

2002 episode 2009 episode

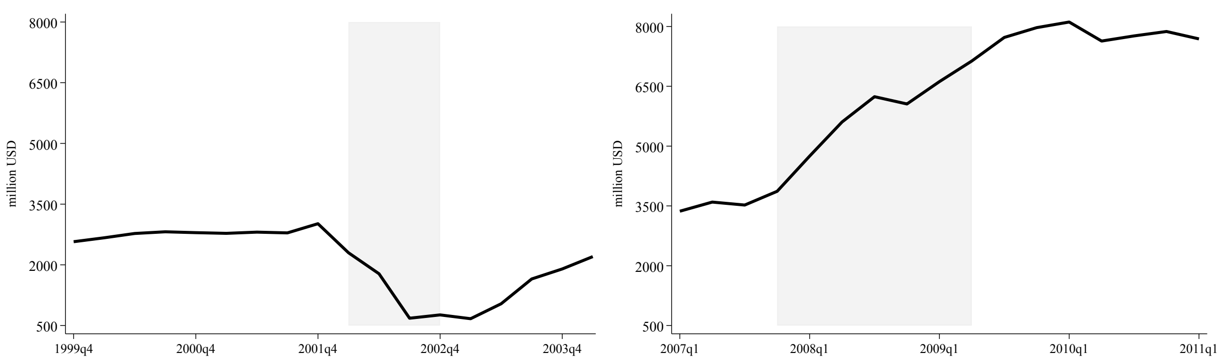
a) Consolidated Fiscal Balance



a) Real Government Spending Growth



b) Official Reserve Assets



Notes: Panel (a) reports the consolidated fiscal balance. Panel (b) shows the year-over-year growth of real government spending, expressed as a percentage. The raw series are seasonally adjusted. Panel (c) reports official reserve assets in millions of USD. Shaded gray areas denote periods of GDP growth decline associated with each sudden stop episode. *Sources*: Central Bank of Uruguay and IMF-IFS.

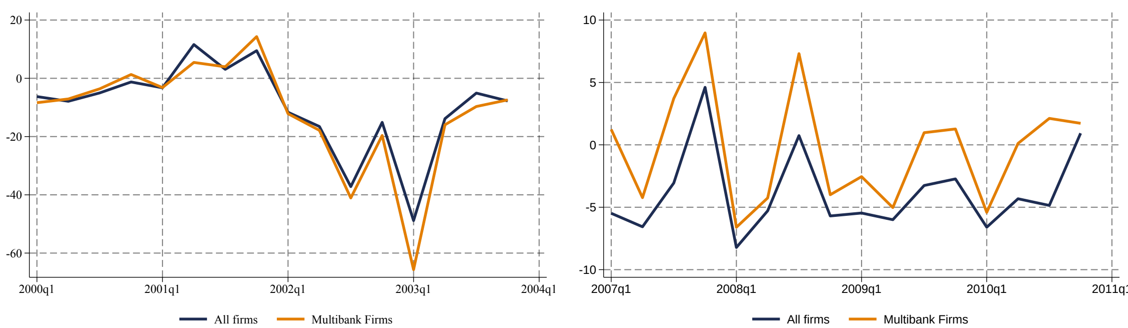
Figure A.2: Firms' Borrowing during Sudden Stops

2002 episode 2009 episode

(a) Firms' borrowing

(b) Local currency debt

(c) Foreign currency debt

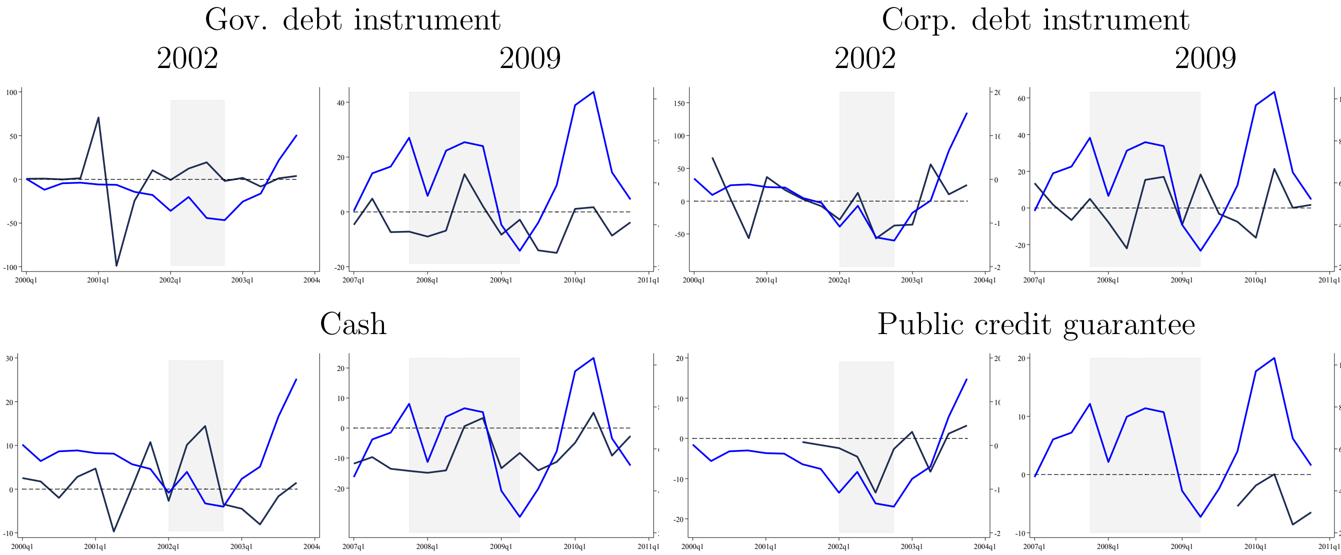


Notes: This figure reports the average $\Delta \log b_{jt}$ for firms in our sample during sudden stop episodes, expressed as a percentage, where b_{jt} denotes the debt of firm j in quarter t. "Multibank firms" refers to firms in our sample with two or more bank lending relationships within a quarter. Panel (a) shows total debt, Panel (b) shows debt denominated in local currency, and Panel (c) shows debt denominated in foreign currency.

B. Data description

In this section, we describe the data sources, sample selection criteria, and variable definitions used in our empirical analysis in Section 4.

Figure A.3: Average dynamics of firms' collateral (liquid assets)



Notes: This figure reports the average change in collateral values for liquid types of collateral. The dark blue line denotes the growth rate of collateral values (left axis), while the blue line represents the growth rate of real GDP (right axis). For each series, we include only loans associated with a single type of collateral and then compute the total collateral value for each type at the firm level. Shaded gray areas denote periods of GDP growth decline associated with each sudden stop episode.

- *Debt:* Firm-level outstanding debt to the financial sector, expressed in local currency at 2005 prices. The data are from the Credit Register, a comprehensive database containing all loans issued within the Uruguayan financial system. The sample covers the period 2000 to 2010.

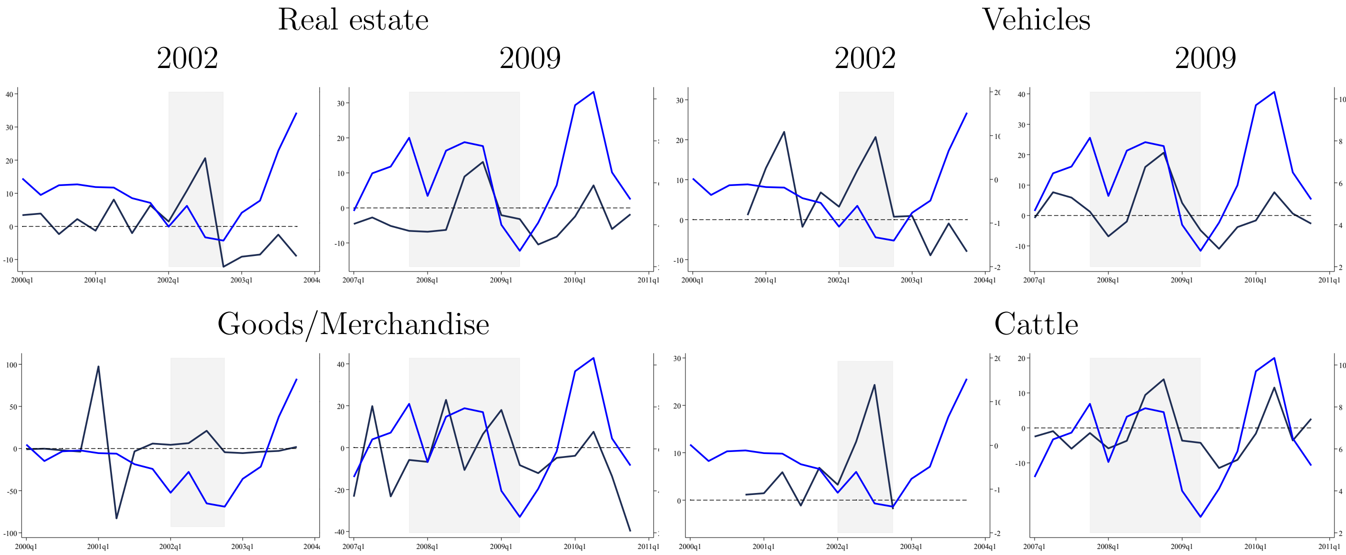
- *Banks' return on assets:* Bank-level return on assets (annualized rate in Uruguayan pesos), calculated as the ratio of a bank's after-tax net income to its average total assets over a year. The information is from banks' balance sheets available through the Central Bank of Uruguay.

- *Risk category:* According to Uruguayan regulations, borrowers are classified using a rating scale that reflects their payment capacity. The rating scale is as follows:[5]

  - Rating 1A: Back-to-back loans, loans fully covered by very liquid collateral.
  - Rating 1C: Borrowers with strong payment capacity (i.e., less than 10 days past due).
  - Rating 2A: Borrowers with adequate payment capacity (i.e., less than 30 days past due).
  - Rating 2B: Borrowers with potential problems in their payment capacity (i.e., less than 60 days past due).
  - Rating 3: Borrowers with compromised payment capacity (i.e., less than 120 days past due).

[5]For more details, see: Comunicación N^o 2019/001, Superintendencia de Servicios Financieros, BCU.

Figure A.4: Average dynamics of firms' collateral (illiquid assets)



Notes: This figure reports the average change in collateral values for non-liquid types of collateral. The dark blue line denotes the growth rate of collateral values (left axis), while the blue line represents the growth rate of real GDP (right axis). For each series, we include only loans associated with a single type of collateral and then compute the total collateral value for each type at the firm level.

- Rating 4: Borrowers with very compromised payment capacity (i.e., less than 180 days past due).
- Rating 5: Unrecoverable borrowers (more than 180 days past due).

- *Ratio of nonperforming loans to total debt:* The ratio of past-due gross loans to total gross loans, computed at the bank level and reported in Annex 4 of the balance sheet and income statements that banks report monthly to the Central Bank of Uruguay. This variable was also computed at the firm-bank level based on the Credit Register data.

- *Share of liquid assets in collateral:* The value of liquid assets (government debt instruments, corporate debt instruments, cash deposits, and public credit guarantees) pledged by firms to banks as collateral for loans, relative to total debt. For firms without collateral, the value is 0.

- *Type of collateral:* According to regulations, banks must report a detailed description of assets pledged by firms as collateral for loans.[6] We classify collateral assets into 13 categories: government debt instruments, corporate debt instruments, cash deposits, real estate, trust funds, public credit guarantees, vehicles, machinery, goods/merchandise, insurance, cattle, land, and third-party guarantees.

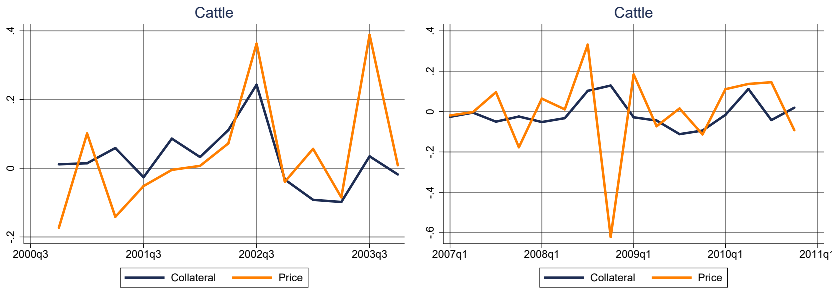
- *Price of land:* The price per hectare of land, originally expressed in USD but converted to 2005 prices in local currency using the CPI and monthly average exchange rate. The data are

[6] See: Accounting standards for financial statement preparation.

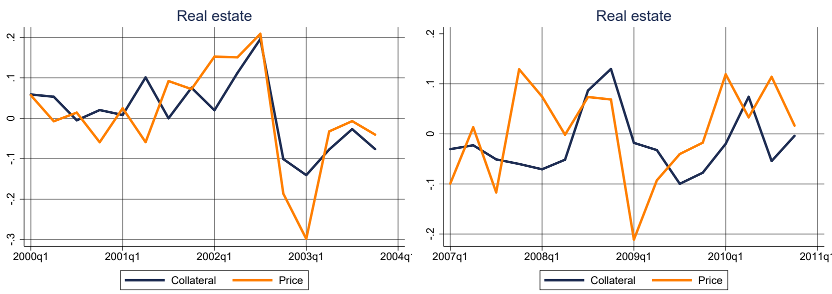
Figure A.5: Change in asset prices and change in collateral value

2002 episode 2009 episode

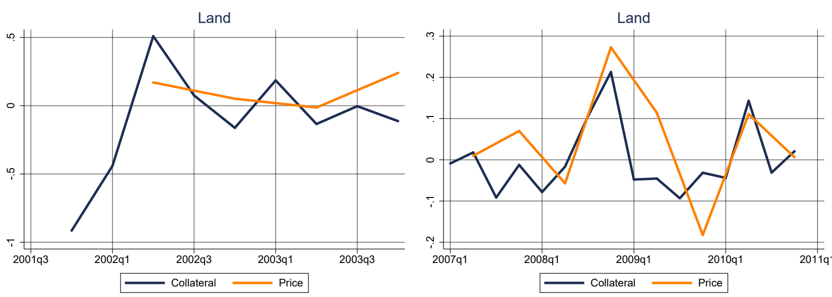
(a) Cattle



(b) Real Estate



(b) Land



Notes: This figure reports the average change in the log of the value of each type of collateral, along with the change in the corresponding asset price. Panel (a) shows the change in collateral value and price of cattle, Panel (b) shows the change in collateral value and price of real estate, and Panel (c) shows the change in collateral value and price of land.

from the *Ministerio de Ganadería, Agricultura y Pesca* (Ministry of Livestock, Agriculture and Fisheries).

- *Price of real estate:* The price per square meter of sold properties, expressed in constant prices. Properties in Uruguay are usually sold in USD, so we used the CPI and monthly average exchange rate to convert prices to constant local currency. The data are from Ponce (2015).

Table A.2: Robustness: β

			Impact	Peak	Average	Obs
A	Baseline		-.056	.047	-.002	313,752
			(.03)	(.06)		
B	Robustness	No firm-level controls	-.059	.061	.01	313,752
			(.03)	(.07)		
		Separate firm and time FE	-.081	.043	-.01	313,752
			(.03)	(.05)		
		Shorter sudden stop window	-.048	.069	.02	313,752
			(.03)	(.05)		
C	By sudden stop episode	2002 episode	-.048	.065	.01	284,861
			(.03)	(.07)		
		2009 episode	-.048	.065	.01	284,861
			(.03)	(.07)		
D	By firm's credit risk	Low risk	-.091	.068	-.02	108,834
			(.05)	(.08)		
		High risk	-.063	.011	-.04	114,687
			(.05)	(.1)		
E	By loan currency	Local currency	-.062	.041	-.01	291,541
			(.03)	(.07)		
		Foreign	-.019	.14	.04	241,186
			(.03)	(.06)		
F	By type of bank	Only foreign bank	.012	.088	.04	136,706
			(.05)	(.07)		
		Only local banks	-.083	.15	-.01	38,752
			(.07)	(.12)		
		Excluding failed banks	-.051	.05	-.005	301,545
			(.03)	(.06)		

Notes: This table summarizes the estimates of β_h from regression (2) across different specifications, as detailed in Section 4. *Impact* corresponds to the estimated elasticity for $h = 0$. *Peak* refers to the largest estimated elasticity across all horizons within two years. *Average* reports the average elasticity across all horizons within two years. Robust standard errors are in parentheses.

- *Price of cattle:* The price per kilogram of live cattle, originally expressed in USD and converted to 2005 constant prices in local currency using the monthly average exchange rate and CPI. The data are from the Instituto Nacional de Carnes.

Table 3: Channels of Transmission: Robustness Analysis

			Impact	Peak	Average	Obs
Panel A: Lender Channel						
A	Baseline		.23	1.8	.91	558,861
			(.117)	(.559)		
B	Robustness	No loan-level controls	.25	1.8	.96	558,861
			(.117)	(.561)		
		Separate firm and time FE	.32	1.5	.77	558,861
			(.098)	(.441)		
Panel B: Collateral Channel						
A	Baseline		.61	.61	.4	18,164
			(.025)	(.025)		
B	Robustness	No loan-level controls	.61	.61	.4	18,164
			(.025)	(.025)		
		Separate firm and time FE	.64	.64	.34	18,164
			(.02)	(.02)		
Panel C: Risk Channel						
A	Baseline		-.9	-2.1	-1.3	558,861
			(.454)	(.915)		
B	Robustness	No loan-level controls	-1	-2.3	-1.6	558,861
			(.454)	(.917)		
		Separate firm and time FE	-.4	-1.3	-.32	558,861
			(.348)	(1.09)		

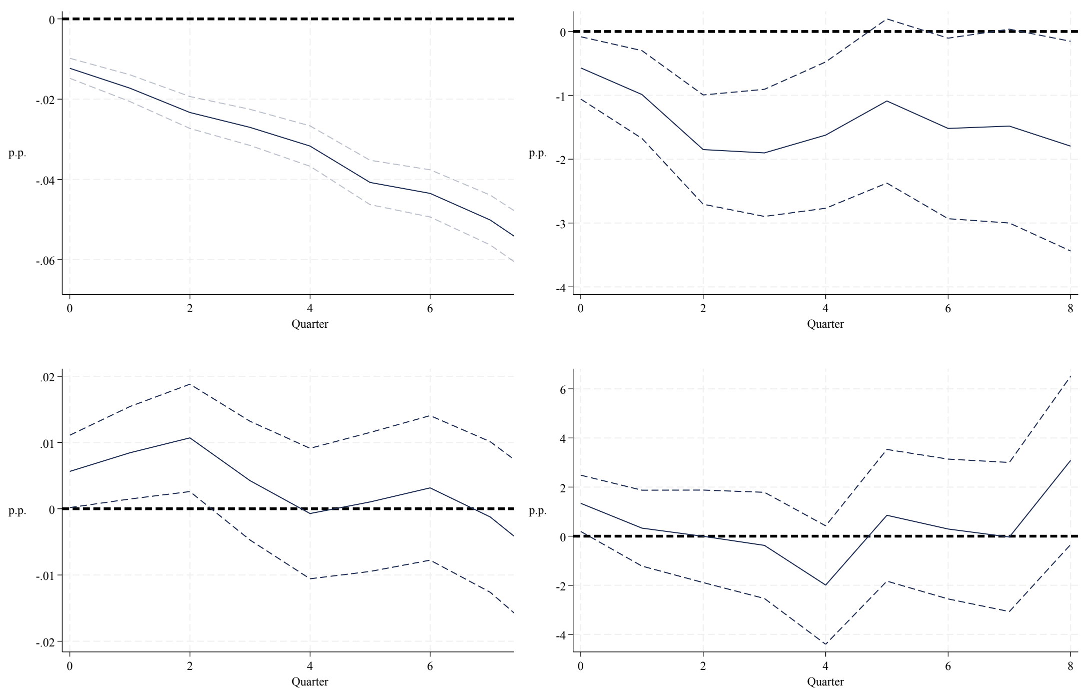
Notes: This table summarizes the estimates of β_h for different specifications. *Impact* corresponds to the estimated elasticity for $h = 0$. *Peak* refers to the largest estimated elasticity across all horizons within two years. *Average* reports the average elasticity across all horizons within two years. Robust standard errors are in parentheses.

Table 4: Differential Effects of Channels of Transmission: Robustness Analysis

			Impact	Peak	Average	Obs
Panel A: Lender Channel						
A	Baseline		.68	1.9	1.4	558,861
			(.144)	(.392)		
B	Robustness	Shorter sudden stop window	.29	3.1	1.9	558,861
			(.148)	(.508)		
C	By Sudden stop episode	2002 episode	.38	.63	.27	558,861
			(.17)	(1.25)		
		2009 episode	.99	2.2	1.7	558,861
			(.175)	(.411)		
Panel B: Collateral Channel						
A	Baseline		.018	.14	-.048	18,164
			(.056)	(.183)		
B	Robustness	Shorter sudden stop window	.048	.16	.00097	18,164
			(.065)	(.249)		
C	By sudden stop episode	2002 episode	.009	.29	.0092	18,164
			(.065)	(.262)		
		2009 episode	.037	.097	-.105	18,164
			(.092)	(.342)		
Panel C: Risk Channel						
A	Baseline		.6	-4.3	-.84	558,861
			(.999)	(2.05)		
B	Robustness	Shorter sudden stop window	.29	-4.7	-.76	558,861
			(1)	(2.05)		
C	By sudden stop episode	2002 episode	4.3	-2.3	8.8	558,861
			(2.2)	(18)		
		2009 episode	-.047	-4.8	-1.4	558,861
			(1.1)	(2.1)		

Figure 6: The Risk Channel of Firms' Borrowing During Sudden Stops: VIX

(a) Firm-level estimates (b) Loan-level estimates



Notes: This figure replicates the risk channel plots from Figure 6, using the VIX as a global risk premium measure and reporting the estimates of β_h. The left column shows results for firm-level specifications, while the right column shows results for loan-level specifications. Dashed lines indicate confidence intervals at the 90% confidence level, using Newey-West adjusted standard errors.