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Monetary Policy Transmission to Small Business Loan Performance: Evidence from Loan-Level Data

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Abstract

This paper analyzes the dynamic and heterogeneous responses of loan performance to a monetary-policy shock using loan-level panel data for small-scale private firms in Canada. Our dataset contains detailed loan characteristics information that allows us to distinguish the effects of the aggregate-demand channel, which affects loan performance through general-equilibrium effects, and the cash-flow channel that directly impacts debt service of firms through variable rates. We find that the effects on loan performance through both channels materialize with a delay and are persistent over time. The peak effect of the cash-flow channel is as large as that of the aggregate-demand channel. Moreover, we investigate whether collateral can reduce the sensitivity of variable-rate loan performance to a policy-rate shock through an ex post disciplinary effect that incentivizes loan repayment by small firms. We find that collateral induces repayment incentives of borrowers relative to unsecured loans but only for ex ante safe loans that are used for investment rather than for other purposes such as working capital. This implies that collateral has a limited impact on reducing financial frictions of small firms.

Topics: Monetary policy transmission, Firm dynamics
JEL codes: C32, E17, E37, E52

Résumé

Nous analysons les réponses dynamiques et hétérogènes de la performance des prêts à un choc de politique monétaire à l'aide de données de panel au niveau des prêts octroyés aux petites entreprises privées au Canada. Notre ensemble de données contient des informations détaillées sur les caractéristiques des prêts nous permettant de séparer a) les effets du canal de la demande globale, qui influence la performance des prêts par le biais des effets d'équilibre général et b) les effets du canal des flux de trésorerie, qui a une incidence directe sur le service de la dette des entreprises par le biais des taux variables. Nous constatons que les effets des deux canaux sur la performance des prêts se matérialisent avec un retard et se prolongent dans le temps. À leur point culminant, les effets du canal des flux de trésorerie sont aussi importants que ceux du canal de la demande globale. De plus, nous cherchons à déterminer si les sûretés peuvent réduire la sensibilité de la performance des prêts à taux variable à un choc de politique monétaire en produisant un effet disciplinaire ex post qui inciterait les petites entreprises à rembourser leurs prêts. Nous constatons que les emprunteurs sont davantage incités à rembourser un prêt garanti qu'un prêt non garanti, mais uniquement dans le cas d'un prêt sûr ex ante utilisé à des fins d'investissement plutôt qu'à d'autres fins telles que le maintien d'un fonds de roulement. Ce constat implique que les sûretés ont une capacité limitée à réduire les frictions financières subies par les petites entreprises.

Sujets : Transmission de la politique monétaire; Dynamique des entreprises
Codes JEL : *C32, E17, E37, E52*

1 Introduction

Interest rates on bank loans play a crucial role in how monetary policy influences economic activity. This impact tends to be more significant for small enterprises than for larger publicly listed firms, as smaller businesses depend heavily on bank lending (Gertler and Gilchrist, 1994). Additionally, a substantial portion of loans to small firms carry variable interest rates that are higher than those available to larger companies (Galliot, 2023), making these firms more vulnerable to changes in interest rates. This vulnerability can hinder their ability to secure funding for new investments, exacerbated by issues like asymmetric information and a lack of collateralizable assets (Carpenter and Peterson, 2002). This is an important concern for policymakers, given the vital role small and medium-sized enterprises (SMEs) play in job creation and economic growth (OECD, 2017; ISED, 2023). Despite this, there is limited empirical evidence on how monetary policy affects the performance of small-business loans, especially compared to its impact on new investments (Bernanke et al., 1999), largely due to the scarcity of data on private business financial transactions.[1] Furthermore, the influence of monetary policy on firms' repayment behaviors has been less documented than that on lenders, such as banks' risk-taking activities (Jimènez et al., 2014; Ioannidou et al., 2015). To fill this gap, this paper aims to measure the impact of monetary policy on the performance of existing small-business loans, utilizing confidential, anonymized loan-level data from Canada.[2]

Two potentially important monetary-policy transmission channels impact small firms' loan performance. The first channel is the aggregate-demand channel that affects the demand for firm products. Due to price and wage stickiness, a policy-rate change can generate income and inter-temporal substitution effects on consumers. This, in turn, affects the demand for goods and services provided by firms and, thus, their ability to repay loans. The second channel is the cash-flow channel that works through the existing debt of small firms. A change in the policy rate can pass through to lending rates and directly affect their debt service. To the extent that small firms are financially constrained, this could

[1] For example, studies based on publicly listed firm data include Kashyap et al. (1994) and Ippolito et al. (2018); research based on data that cover SMEs include Ehrmann (2005) and Caglio et al. (2021).

[2] A loan is non-performing if it is in arrears, delinquent, or impaired or has write-off status.

impact their repayment decisions and, thus, the sensitivity of loan performance to monetary policy. In theory, these two mechanisms can change the loan performance of small firms independently or in tandem. To the best of our knowledge, there is no empirical evidence on how these channels impact small business loan performance. In this paper, we attempt to quantify the magnitude of effects through these two channels.

While monetary policy can alter repayment decisions of small firms through these channels, collateral can potentially help mitigate the sensitivities of small-business loan performance to interest-rate changes. In particular, due to the prevalence of unobserved risks, collateral effects on small firms can be different from those on larger publicly listed firms for which risks are more observable. Even if lenders can address some of these risks *ex-ante* through individual loan rates, moral hazard or limited enforceability of contracts (Boot and Thakor, 1994; Cooley et al., 2004) still remain as major concerns. Under such a circumstance, collateral, a scarce resource for small firms, could serve as an incentive device for repayment. This is in contrast with the case of publicly-listed firms, for which credit risk is more observable through financial reports. For them, collateral is often used to cover realized observed risk as documented by existing studies in the literature (Berger et al., 2011; Berger and Udell, 1990; Jimènez and Saurina, 2004), which generates a negative correlation between collateral and loan performance.[3] Unfortunately, there is a lack of empirical evidence on the *ex-post* disciplinary effect of collateral on small firm loan repayment because datasets used in the existing papers often do not include small private firms. This paper investigates whether such a theoretical feature of collateral exists in small business loans using a loan-level dataset.

In order to examine the monetary-policy transmission channels of interest, we first extract policy-induced exogenous variations in interest rates using a high-frequency identification following Kuttner (2001) and Nakamura and Steinsson (2018). Then, using Jordà (2005)'s local projection method adapted to a panel setting as in Cloyne et al. (2018), we estimate the impulse responses of the performance of *existing* loans to a one-standard-deviation increase in monetary-policy shock. In this setting, we identify *borrowers'* decisions to repay loans as follows. First, for a given monetary-policy shock, we focus on

[3]That is, collateralized loans are associated with worse performance than unsecured loans.

existing loans by excluding new loans that are added to the sample after the realization of the shock. Second, we exploit the fact that interest rates on existing variable-rate loans in our sample change mechanically with the fluctuations of the risk-free rate in the financial market. These features of our dataset make borrowers' repayment decisions independent of lenders' decisions, given loan interest rates at origination. Relying on this identification scheme, we start our analysis by quantifying to what extent small firms' loan performance reacts to monetary-policy shocks.

Then, to distinguish the effects of aggregate-demand and cash-flow channels, we compare the responses of variable-rate and fixed-rate loans. These two responses are obtained by adding an interaction term between a dummy variable for variable-rate loans and monetary-policy shocks in the regressions. Here, the idea is that both types of loans are impacted by the aggregate-demand channel, but only variable-rate loans are subject to the cash-flow channel. Thus, the difference between the two can be considered as the effect of the cash-flow channel. To examine the collateral disciplinary effect, we restrict the sample to variable-rate loans since the number of unsecured fixed-rate loans is few. Then, we add interaction terms between monetary-policy shocks and dummy variables for secured/unsecured loans, high/low interest rates and investment/non-investment loans. The dummy variables for interest-rate levels and investment loans are included to control for *ex-ante* credit risk of loans and the distribution of investment loans across secured and unsecured loans. In particular, comparing collateralized loans and unsecured loans in the same *ex-ante* risk category is important because safe borrowers could use collateral to signal their types to lenders to attract lower interest rates when loan contracts are made.[4]

The confidential loan-level dataset is offered by the Business Development Bank of Canada (BDC). As described in Section 2, BDC is a Canadian federal Crown corporation whose mission includes providing financial services to small and medium-sized enterprises (SMEs). BDC extends a large proportion of SME loans in Canada to complement financing from private financial institutions. This dataset contains granular information on monthly

[4]If the control group includes *ex-ante* risky unsecured loans, differences between secured and unsecured loans may reflect differences in *ex-ante* risk of loans rather than *ex-post* incentives that are generated by collateral.

loan interest rates, interest-rate types (i.e., variable or fixed) and collateral, among others, at the individual loan level for nearly 20 years since 2000. Such features of the dataset allow us to examine not only the average impact of exogenous shifts in monetary policy on loan performance, but also which types of loans are more sensitive to monetary-policy shocks than others. In particular, individual loan interest-rate information, which is not always available in other loan-level datasets, captures borrowers' *ex-ante* credit risk as perceived by the lender. Thus, we can use this valuable credit-risk information that may otherwise need to be proxied by various borrower characteristics such as age, size and leverage. This allows us to control for *ex-ante* credit risk of loans in a compact way.

The main findings of this paper are as follows. On average, a monetary-policy tightening leads to a deterioration of loan performance over time, which is consistent with our prior knowledge. The average response has a delayed effect, showing a trough after one year, and is persistent. This pattern is consistent with the aggregate-demand effect of monetary policy on aggregate variables. Quantitatively, in response to a 6 basis-point shock, the maximum deterioration in loan performance is about 21 basis points, which is quite large.

Second, we find that the cash-flow channel takes effect when the impact of the aggregate-demand channel is near the peak. This implies that changes in debt service do not have a strong impact on loan performance in the short run, but gain more traction when firms' sales start to change through the aggregate-demand effect. In terms of magnitude, with the cash-flow effect, the total response of loan performance increases to almost twice the size of the impact of the aggregate-demand effect near the trough.

Third, we find evidence of the *ex-post* disciplinary effect of collateral on loan repayment. Similar to the impact of cash-flow effect, the collateral effect shows meaningful improvement of loan performance, relative to unsecured loans, around the trough of the response of variable-rate loans. However, this effect is only observed for *ex-ante* safe loans that are in the low interest rate group. Moreover, the same effect cannot be observed for non-investment loans, most of which are working-capital loans. This result implies that collateral has a limited role in reducing financial constraints on small private firms through the disciplinary effect since it only improves the repayment incentives of safe borrowers of

a particular type of loan.[5]

The rest of the paper proceeds as follows. Section 2 describes the loan-level dataset that is used in this paper. Section 3 explains the empirical strategy to estimate monetary-policy shocks and the impulse response of loan performance to the shock. Section 4 discusses the empirical results. Finally, Section 5 concludes the analysis.

2 Data

The Business Development Bank of Canada (BDC) is a Canadian federal Crown corporation whose mandate is to provide financing and other specialized financial services to entrepreneurs. In this paper, we use BDC's confidential, anonymized dataset on small firm financing for the sample period of January 2000 to December 2018. BDC's main focus is on small business clients, and it is intended as a financing source that complements private financial institutions. BDC is an important player in the small business loan market. As of 2015, the outstanding balance of BDC loans under 5 million Canadian dollars is approximately 84 percent of the average of the outstanding balance of the same loans provided by the systemically-important banks (SIBs) in Canada. Similarly, it is approximately 12 percent of the sum of these loans provided by SIBs and BDC. This is a non-trivial share of the market. Most borrowers have a single loan from BDC, which implies that loans and borrowers can be interpreted almost interchangeably.

On the liability side, BDC relies mostly on short-term notes that are within three months of maturity. As most of the BDC's loans have variable rates, changes in the market funding rate, which is closely linked with the policy rate set by the Bank of Canada, has a large impact on interest rates charged to their clients. Indeed, there is a tight relationship between the market funding rate and the variable lending rates of BDC loans. This is an important characteristic of BDC loans that we exploit in this paper to estimate borrowers' reactions to monetary-policy shocks.[6]

The BDC dataset contains granular loan-level information on loans. Notably, it has

[5]Collateral could still have a signaling effect (Stiglitz and Weiss, 1981) that can reduce loan interest rate. This effect is controlled for through individual interest rates, but is not measured in our analysis.

[6]The majority of commercial loans provided by banks have variable rates.

information on interest rates applied to all variable- and fixed-rate loans. Moreover, the dataset provides the information on other loan-level characteristics, such as collateral, loan performance and loan purpose, as well as individual loan interest rate. These loan characteristics are valuable for controlling the credit risk of heterogeneous borrowers, in our estimation. Borrowers are heterogeneous in nature and differ in various dimensions such as age, size, leverage, assets and liquidity. Through loan negotiation, loan contracts map these borrower characteristics to specific loan terms such as interest-rate level, interest-rate type and collateral. Loan characteristics information, notably loan interest rate, is not always available. In such a case, a combination of borrower characteristics may be used for approximation. Instead, this paper exploits the loan interest-rate information of the BDC dataset, along with other important loan characteristics, to explain the credit risk of borrowers in a compact way.

Table 1 shows the summary statistics of BDC loans. The table classifies these loans in four groups identified by interest-rate levels (high versus low) and whether loans are secured by collateral. Sorting of loans by collateral is straightforward, and this is done by identifying whether loans are secured by collateral or not. Regarding interest-rate levels, loans with interest rates higher than the median value in each period are placed in the "high" bucket and the others in the "low" bucket. Then, we take the average across loans and over time for each group of loans.

As shown in the table, the majority of BDC loans have variable rates. The fraction of fixed-rate loans is relatively small and is higher for secured loans. A larger fraction of secured loans is used for financing investment than working capital. In terms of loan performance, on average, low-rate loans perform better than high-rate loans. Interestingly, secured loans with low rates show the highest loan performance, whereas secured loans with high rates exhibit the lowest loan performance.

The summary statistics are useful for understanding these correlations. However, to understand the dynamic response of loan performance to monetary-policy shocks and to disentangle the impact of these correlations on loan characteristics, we need to examine the response of loan performance to monetary-policy shocks and heterogeneities by loan

Table 1: Summary statistics of existing BDC loans

Group	1	2	3	4
Interest rate	High	Low	High	Low
Collateral	No	No	Yes	Yes
Fraction of loans (%)	30.7	10.1	20.9	38.3
Fixed-rate loans (%)	7.9	3.3	27.0	12.5
Investment loans (%)	15.8	46.4	63.7	72.8
Working-capital loans (%)	68.9	49.6	14.7	8.8
Performing loans (%)	92.0	95.9	88.8	95.8
Loan balance (CAD $)	138,340	97,358	421,622	992,547

Note: This table shows some summary statistics of the loans provided by the Business Development Bank of Canada between 2000 and 2018. High (Low) interest-rate groups are defined as loans with interest rates higher (lower) than the median of each year.

characteristics. This is the objective of the remaining sections.

3 Econometric methodology and specification

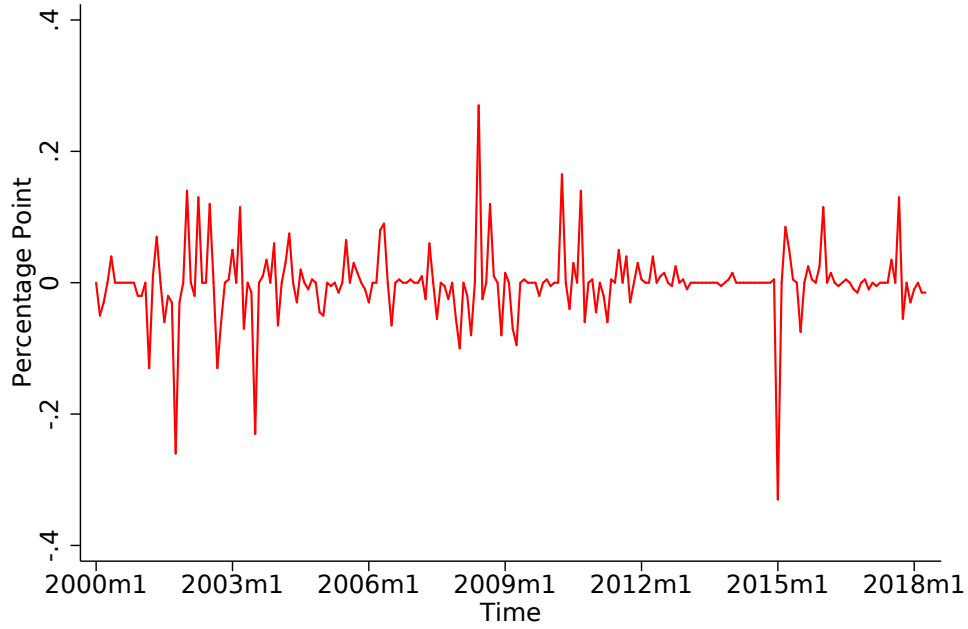
In this section, we explain how exogenous shifts in monetary policy are identified and how these shocks are used to estimate loan performance's reactions to interest-rate shocks.

3.1 Monetary-policy shocks

To examine how monetary policy changes the performance of BDC loans, we need to isolate exogenous movements in monetary policy from its systematic reactions to aggregate variables, such as GDP, employment and inflation. We identify interest-rate surprises using financial market instruments in a short time window around interest-rate decision announcements, as in Kuttner (2001), Faust et al. (2004), Nakamura and Steinsson (2018) and many others. More specifically, we measure the interest-rate surprises using changes in futures rates on three-month Canadian Bankers Acceptance (BAX) rates.[7] We take the

[7]BAX contracts are futures contracts based on the Canadian bankers acceptance rates. They are traded on the Montreal Exchange and are often recognized as the benchmark for Canadian short-term interest

Figure 1: Monetary-policy shocks



difference of BAX using a 30-minute window around interest-rate announcement periods from January 2008 to December 2018. Due to data availability, we use a daily BAX series from January 2000 to December 2007.[8] Figure 1 plots the monetary-policy shocks. One standard deviation of the monetary-policy shocks is about 6 basis points.

3.2 Panel local projection estimation

3.2.1 Baseline specification

To estimate the dynamic causal effect of monetary policy on loan performance, we use a fixed-effect local projection panel model as in Jordà et al. (2020). Specifically, we estimate

rates. See TMX Montreal Exchange (2013) for more details.

[8]The correlation of monetary-policy shock series created from the 30-minute frequency BAX and the one-day frequency BAX is 0.9 and discrepancies between the two series are small.

the following regression:

$$y_{t+h,i} - y_{t-1,i} = \beta_h \; x_t + \sum_{\ell=1}^{12} \beta_{h,\ell} \; x_{t-\ell} + \sum_{\ell=0}^{12} \gamma_{h,\ell}^{'} \; \mathbf{z}_{t-\ell} + \sum_{\ell=1}^{12} \delta_{h,\ell} \; y_{t-\ell} + \alpha_{h,i} + \lambda_h r_{i,t} + \sum_{j=1}^{11} \mu_{h,j} m_{j,t} + \varepsilon_{t+h,i}, \tag{1}$$

where i is an index of individual loans, t represents time and $h = 1, \ldots, 24$ is a time horizon for local projection. On the left-hand side of (1), $y_{t,i}$ takes the value of 1 if loan i is not in arrears, impaired, delinquent or written-off, and 0 otherwise. On the right-hand side, x_t is our measure of monetary-policy shocks, and $\mathbf{z}_t$ is a vector of macro controls including GDP growth, inflation rate and the growth of Bank of Canada Commodity Price Index. We use macro control variables instead of time-fixed effects since the latter could absorb all aggregate variations, including monetary-policy shocks. Although x_t is considered to be exogenous, we include both contemporaneous and lagged values of $\mathbf{z}_t$ to account for any systematic responses of monetary policy to fundamental movements in the economy. To control for unobserved permanent characteristics across different loans, we include loan-level fixed effects, denoted by $\alpha_{h,i}$. In addition, $r_{i,t}$ is an individual loan interest-rate spread from a reference rate to capture any revisions in loan-specific risk assessment by the lender. Month dummy variables, $m_{j,t}$, are included to capture seasonality across months. Finally, we include lagged dependent variables and lagged monetary-policy shocks to account for the persistent nature of non-performance and to isolate the impact of current monetary-policy shock from the past shocks, respectively.[9]

This linear probability model informs us of a cumulative change in loan performance h months ahead of a monetary-policy shock. The coefficient β_h traces the impact of an unexpected monetary-policy tightening on the fraction of performing loans over time. Since monetary tightening is expected to reduce aggregate demand and increase debt service on loans, economic theories predict β_h to be non-positive. Importantly, this coefficient can be interpreted as a demand-side reaction to a monetary-policy shock for two reasons. First, β_h

[9]The presence of lagged dependent variables also ensures that only loans that exist at the time of monetary-policy shock are included in estimation.

measures the response of loans that exist when a monetary-policy shock occurs. Hence, this does not include the impact on loans that enter the sample after a shock; the vulnerability of the new loans could be contaminated by a reaction of the lender to the shock. Second, once a loan is given, variable rates on *existing* BDC loans react to the policy rate in a mechanical way. Any revisions in individual credit risk assessments by the lender are controlled for by including individual loan interest-rate spreads from a reference rate, $r_{i,t}$ in the regression.

3.2.2 Specification to examine responses by loan characteristics

While (1) helps us understand the average reaction of loans to interest-rate shocks caused by monetary policy, the main questions of this paper require an analysis of differential reactions of loan performance by loan characteristics. The loan characteristics have implications for the *ex-post* performance of loans.[10] First, loan interest rates reflect the *ex-ante* risk of borrowers, as lenders demand higher risk premiums on borrowers with risky profiles. As shown in Table 1, borrowers paying high rates experience, on average, a higher chance of non-performance than those that pay low rates. This is because high debt services squeeze their cash flows closer to the point of delinquency when the interest rate rises. In addition, loan contracts have other features that allow both parties to share the risk of interest-rate fluctuations. For example, fixed-rate contracts may shield borrowers from rising interest rates while giving the lender the ability to gain when the market interest rate falls below the contractual rate. A non-interest instrument such as collateral can incentivize borrowers to repay (Lacker, 2001) and mitigate losses incurred by the lender should borrowers default.

We follow Cloyne et al. (2018) and estimate heterogeneous impulse responses by including in the regression interaction terms between monetary-policy shocks and dummy variables for loan characteristics of interest. For example, we consider dummy variables for interest-rate levels (high versus low), interest-rate types (variable versus fixed), collateral (secured versus unsecured) and loans types (investment versus non-investment), as necessary. Formally, the inclusion of interaction terms replaces the first term on the right-hand

[10] See also the discussions in Jimènez and Saurina (2002) and Jimènez et al. (2006).

side of (1) as

$$y_{t+h,i} - y_{t-1,i} = \sum_{j=1}^{J} \beta_{h,j} \mathbb{1}_j \; x_t + \sum_{\ell=1}^{12} \beta_{h,\ell} \; x_{t-\ell} + \sum_{\ell=0}^{12} \gamma_{h,\ell}^{'} \; \mathbf{z}_{t-\ell} + \sum_{\ell=1}^{12} \delta_{h,\ell} \; y_{t-\ell}$$
$$+ \alpha_{h,i} + \lambda_h r_{i,t} + \sum_{j=1}^{11} \mu_{h,j} m_{j,t} + \varepsilon_{t+h,i}, \tag{2}$$

where $J = 2^N$ is the total number of combinations of N loan characteristics, each of which is discretized into two groups. Moreover, the indicator function $\mathbb{1}_j$ takes the value of 1 for one particular combination of the dummy variables representing each of these loan characteristics. This approach is demanding data-wise since the coefficient $\beta_{h,j}$ is heterogeneous across each combination of loan characteristics. However, this method allows us to examine a differential impact of a certain loan characteristic, holding others constant. The remaining terms of equation 2 are the same as in equation 1. Namely, z_t is a vector of controls including GDP growth and CPI inflation, the Bank of Canada commodity price index, α_i, is a loan-level fixed effect, $r_{i,t}$ is an individual loan spread over the reference rate and $m_{j,t}$ are monthly dummies.

4 Empirical results

Using the empirical specifications in Section 3, we present estimation results in this section. First, we show the average response of loan performance. Then, we quantify how the effects of monetary policy materialize through the aggregate-demand channel and the cash-flow channel. Finally, we examine whether collateral has the *ex-post* disciplinary effect (Boot and Thakor, 1994; Cooley et al., 2004) to help mitigate the impact of monetary policy on small-business loan performance.

4.1 Average response of loan performance

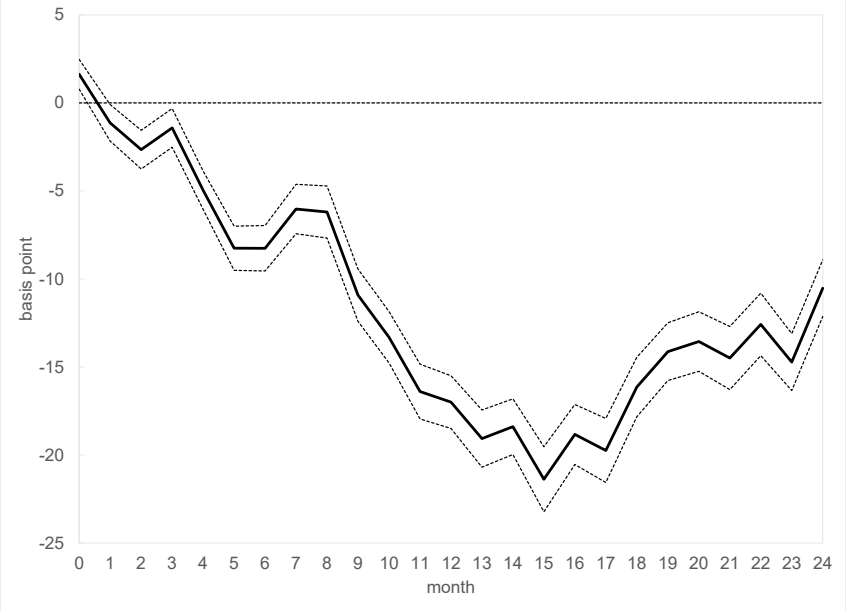
We start by examining the average response of loan performance to a monetary-policy shock by estimating (1). The coefficient β_h indicates the cumulative change of loan performance

across all types of loans up to h months. Figure 2 plots the estimates of β_h for $h = 0, 1, \ldots, 24$ months ahead. The black line is the average response and the dotted lines show 1 standard deviation confidence interval bands. The standard errors are clustered at the industry level.[11] The figure shows that, following a 1 standard deviation monetary tightening shock, the performance of existing loans deteriorates over time. Even though a vast majority of BDC loans have variable rates, the figure indicates a muted response on impact of the shock. Responses in the first few months are relatively slow, but the average loan performance keeps deteriorating up to 14–16 months ahead. After that, the average loan performance starts to improve relative to the trough, which is shown by the hump shape of the response.

The observed loan performance response mirrors general response patterns of aggregate variables, such as output and investment (Den Haan et al., 2009; Champagne and Sekkel, 2018). Therefore, the delayed reaction of loan performance is consistent with the conventional wisdom that the effects of monetary policy gradually permeate the economy as macroeconomic adjustments in prices and quantities take time to materialize through complex interactions (Christiano et al., 2005). The result also suggests that, even though the pass-through of a policy-rate change to loan interest rates is immediate in variable-rate loans, borrowers seem to absorb this direct impact of monetary policy for some time.

[11] We use the NAICS six-digit code to define industry classification.

Figure 2: Average loan performance response to contractionary monetary-policy shock



Note: This figure shows a response of loan performance to a 1 standard deviation (6 basis point) increase in the policy rate. The dashed lines represent 1 standard deviation confidence bands.

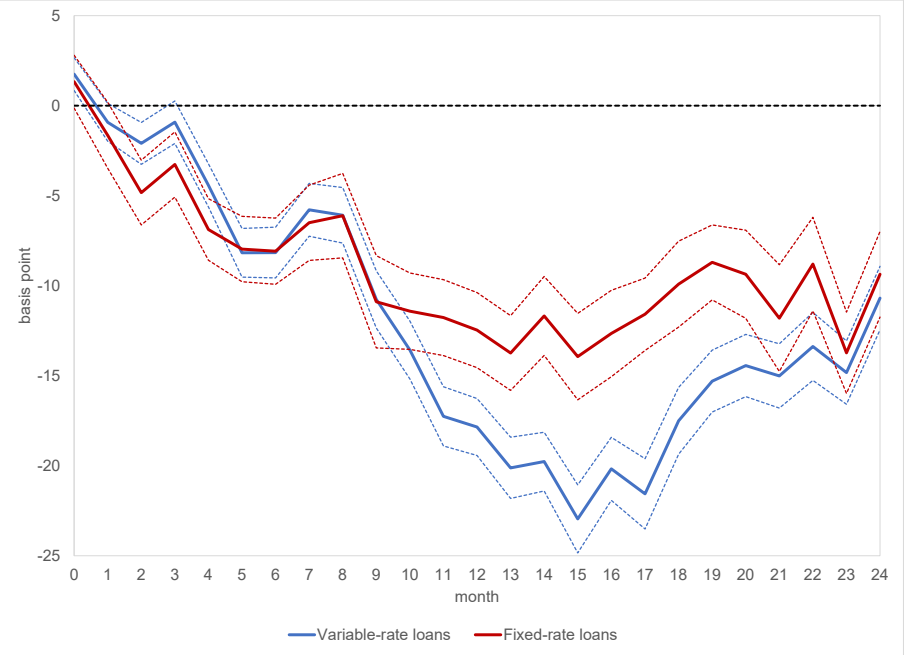
4.2 The aggregate-demand channel versus the cash-flow channel

In this section, we estimate the effect of monetary policy on loan performance through the aggregate-demand channel and the cash-flow channel by comparing the responses of fixed-rate loans and variable-rate loans. To do this, we construct the dummy variable that takes the value of 1 if a loan's interest rate is fixed and 0 otherwise. We interact the dummy variable with the measure of monetary-policy shocks as in (2). More specifically,

$$y_{t+h,i} - y_{t-1,i} = \beta_h x_t + \kappa_h \mathbb{1}_{[\text{fixed rate}]} x_t + \sum_{\ell=1}^{12} \beta_{h,\ell}\, x_{t-\ell} + \sum_{\ell=0}^{12} \gamma_{h,\ell}^{'}\, \mathbf{z}_{t-\ell} + \sum_{\ell=1}^{12} \delta_{h,\ell}\, y_{t-\ell} + \alpha_{h,i} + \lambda_h r_{i,t} + \sum_{j=1}^{11} \mu_{h,j} m_{j,t} + \varepsilon_{t+h,i}.$$

Whereas the aggregate-demand effect hits both types of loans, the cash-flow channel impacts only variable-rate loans. Note that we include loan-level fixed effects to control for permanent differences in loan characteristics. This allows us to interpret the fixed-rate response, $\beta_h + \kappa_h$, as representing the aggregate-demand effect of monetary policy and the variable-rate response, β_h, as showing the cash-flow effect. Figure 3 shows impulse responses of both types of loans. The blue line and the red line show responses of variable-rate loans and fixed-rate loans, respectively. The figure shows there is no statistically significant effect from the cash-flow channel for 10 months. Consistent with our interpretation of the average result in Figure 2, this implies that firms with variable-rate loans initially absorb the direct impact of monetary policy on debt service. However, the cash-flow effect emerges near the point where the effect of aggregate-demand channel on loan performance peaks in the second year. In terms of magnitude, the cash-flow effect generates an extra 11 basis points of loan performance deterioration to the maximum impact of the aggregate-demand effect of 12 basis points. Therefore, our view is that it is the aggregate-demand channel that triggers the cash-flow channel to take additional effect on the probability of loan performance. That is, the liquidity impact of monetary policy starts to matter for loan performance when the sales of firm products react sufficiently to monetary policy.

Figure 3: Variable- versus fixed-rate loan performance response to a contractionary monetary-policy shock



Note: This figure shows a response of variable (blue) and fixed-rate (red) loan performance to a 1 standard deviation (6 basis point) increase in the policy rate.The dashed lines represent 1 standard deviation confidence bands.

4.3 The disciplinary effect of collateral

Along with interest rate, collateral is an important element of loan contracts. Collateral compensates lenders for any realized losses and could potentially mitigate the impact of unobserved loan risks. We examine whether collateral helps mitigate the effect of monetary policy on the performance of existing loans. This *ex-post* disciplinary effect of collateral could be important for small private firms as much of their inherent risks are not observable, in contrast with publicly listed firms.[12] If this effect is large and prevalent, collateral could be a promising instrument to ameliorate the risk of non-repayment for lenders and improve negative impacts of financial frictions on loan contract terms for borrowers. To the best of our knowledge, the literature has not studied such a collateral effect in response to

[12]For publicly listed firms where unobserved risks tend to be smaller than observed risk, researchers find a negative correlation between collateral and loan performance. In other words, secured loans are riskier than unsecured loans.

monetary-policy shocks, in particular in the context of small-business loans.[13]

To test the *ex-post* disciplinary effect of collateral, it is crucial to compare secured and unsecured loans that are similar to one another. In doing so, we discard fixed-rate loans due to a limited number of observations of unsecured fixed-rate loans. We already mentioned that the loan-level fixed effects are included in the regressions to control for permanent differences in loan characteristics. Moreover, we distinguish loan characteristics in several dimensions and interact them with the monetary-policy shocks. First, we distinguish investment loans and non-investment loans to control for differences in the distribution of investment loans across secured and unsecured loans.

In addition, we separate low- versus high-rate loans. To do that, we create a dummy variable for the lower interest-rate group and put loans in that group if their individual interest rates are lower than the median of a given time period. This distinction aims at addressing possible selection effects associated with collateral when loans are originated. For example, *ex-ante* safe borrowers can pledge collateral to signal their types to attract lower interest rates. Such a signaling effect could sort inherently safe loans into the low-rate group. We want to compare them with *ex-ante* safe unsecured loans that repay lower interest rates to prevent a difference in *ex-ante* risk from contaminating the measurement of *ex-post* incentive for repayment. Similarly, for some loans, the lender may require collateral to cover their inherently high risk. These loans should be compared with high-rate unsecured loans to identify the disciplinary effect.

Given these considerations, we include in (2) three-dimensional dummy variables that consist of interest-rate levels (high versus low), collateral (secured versus unsecured) and

[13]Instead, the literature has studied *ex-ante* and *ex-post* effects of collateral by examining the correlation between collateralization and interest-rate premium or *ex-post* non-performance of loans. See Berger et al. (2011), Berger and Udell (1990), Jimènez and Saurina (2004).

loan purposes (investment versus non-investment). Specifically,

$$
\begin{aligned}
y_{t+h,i} - y_{t-1,i} = & \left(\beta_h^u + \theta_h^u \mathbb{1}_{[\text{low rate}]} + \omega_h^u \mathbb{1}_{[\text{invest}]} + \kappa_h^u \mathbb{1}_{[\text{low rate}]} \mathbb{1}_{[\text{invest}]}\right) x_t \\
& + \left(\beta_h^c + \theta_h^c \mathbb{1}_{[\text{low rate}]} + \omega_h^c \mathbb{1}_{[\text{invest}]} + \kappa_h^c \mathbb{1}_{[\text{low rate}]} \mathbb{1}_{[\text{invest}]}\right) \mathbb{1}_{[\text{collateral}]} x_t \\
& + \sum_{\ell=1}^{12} \beta_{h,\ell}\, x_{t-\ell} + \sum_{\ell=0}^{12} \gamma_{h,\ell}^{'}\, \mathbf{z}_{t-\ell} + \sum_{\ell=1}^{12} \delta_{h,\ell}\, y_{t-\ell} \\
& + \alpha_{h,i} + \lambda_h r_{i,t} + \sum_{j=1}^{11} \mu_{h,j} m_{j,t} + \varepsilon_{t+h,i}. \qquad (3)
\end{aligned}
$$

On the right-hand side of (3), the first line captures the total effects on unsecured loans, whereas the second line shows the marginal effects on collateralized loans, both conditional on *ex-ante* credit risk (safer or riskier) and loan type (investment or non-investment). If the *ex-post* collateral effect exists, an impulse response function of secured loans should lie above that of unsecured loans. If there is no statistically significant difference between the two, that implies that collateral does not significantly improve the performance of loan repayment by disciplining borrowers *ex-post*.[14]

Figure 4 presents results for investment loans. Green and orange lines show responses of collateralized loans and unsecured loans, respectively. Panel (a) compares responses of secured versus unsecured loans in the high-rate group. The panel shows a negligible difference between the two responses, indicating there is no evidence of *ex-post* disciplinary effect on *ex-ante* risky firms. In contrast, panel (b) reveals that secured loans in the low-rate group perform better than unsecured loans in the same group. Thus, panel (b) provides evidence of the *ex-post* collateral effect for relatively safe borrowers among small firms that use loans for future growth. Quantitatively, such a collateral effect is observed consistently during periods when the cash-flow effect of monetary policy affects the performance of small-business loans.

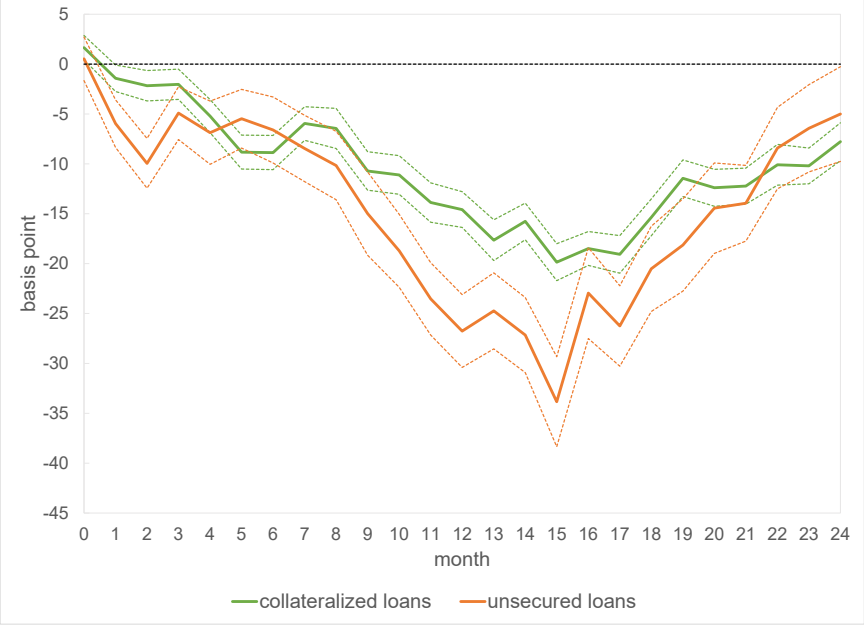
Figure 5 exhibits contrasting results for non-investment loans. Both panel (a) and (b) indicate there are negligible differences between secured and unsecured loan performances for each interest-rate level group. Given that the majority of non-investment loans are

[14]However, it is still possible that collateral has an *ex-ante* effect such as the signaling effect. It also has a loss-mitigating effect for the lender should a loan be written off.

used to finance working capital, this implies that the existence of *ex-post* incentive effect of collateral could depend on whether firms are borrowing for long-term investments or liquidity management. Firms that depend on working capital loans may have smaller financial buffers than those that borrow loans for investment. They are therefore susceptible to interest-rate changes, leaving little room for collateral to discipline these loans.

Figure 4: Secured versus unsecured investment loan performance response to a contractionary monetary-policy shock

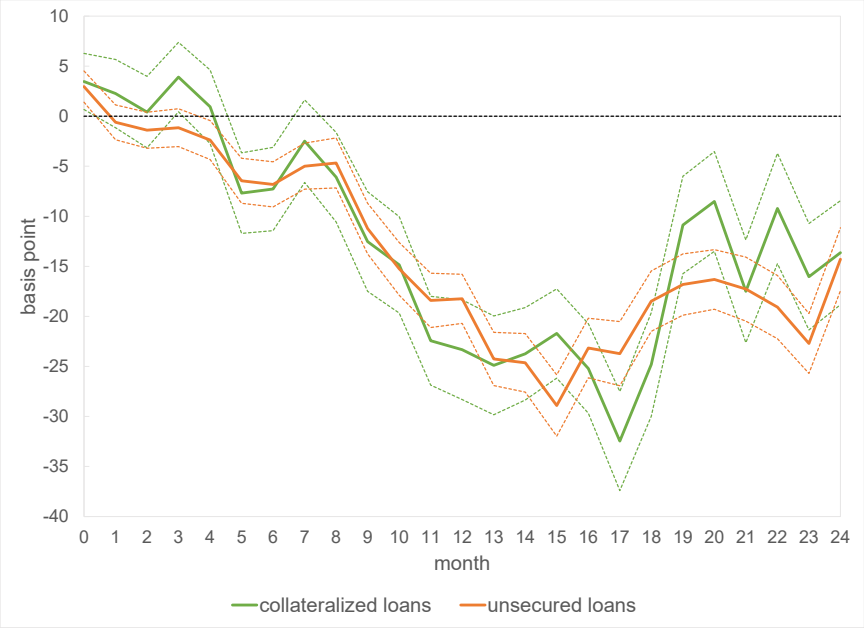
(a) High-rate loans



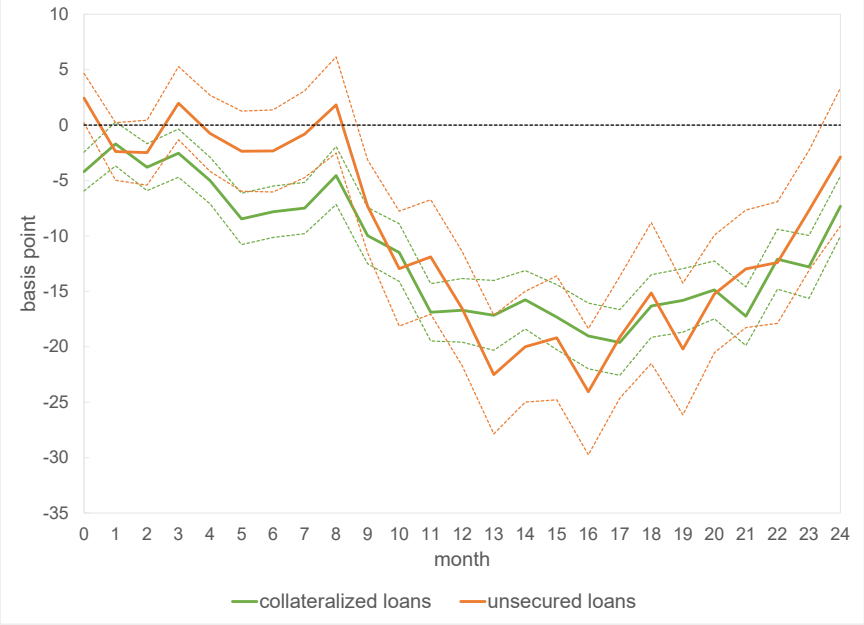
(b) Low-rate loans

Note: This figure shows a response of collateralized (green) and unsecured (red) investment loans amongst high loan-rate (upper panel) and low loan-rate groups (lower panel) to a 1 standard deviation (6 basis point) increase in the policy rate. The dashed lines represent 1 standard deviation confidence bands.

Figure 5: Secured versus unsecured non-investment loan performance response to a contractionary monetary-policy shock



(a) High-rate loans



(b) Low-rate loans

Note: This figure shows a response of collateralized (green) and unsecured (red) non-investment loans amongst high loan-rate (upper panel) and low loan-rate groups (lower panel) to a 1 standard deviation (6 basis point) increase in the policy rate. The dashed lines represent 1 standard deviation confidence bands.

5 Conclusion

Using BDC's confidential, anonymized loan-level dataset, this paper examines the implications of the aggregate-demand channel and the cash-flow channel of monetary-policy transmission for the performance of small business loans. We find that the cash-flow channel works in tandem with the aggregate-demand channel and impacts the loan performance of liquidity-constrained firms when the policy effect on the demand for products becomes large with a delay. Although we find that the sensitivity of loan performance to monetary policy through these channels can be mitigated by the disciplinary effect of collateral, such an effect is limited to relatively safe loans that may be less liquidity-constrained than other small private firms. In our data, such loans are 27 percent of variable-rate loans, which implies that firms holding the remaining fraction of loans show stronger sensitivity to monetary policy.

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