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Working Paper

Heterogeneous responses to monetary policy: The role of floating rate loans

Bank of Finland Research Discussion Papers, No. 7/2025

Provided in Cooperation with:

Bank of Finland, Helsinki

Suggested Citation: Kerola, Eeva; Laine, Olli-Matti; Paavola, Aleksi (2025) : Heterogeneous responses to monetary policy: The role of floating rate loans, Bank of Finland Research Discussion Papers, No. 7/2025, Bank of Finland, Helsinki,
<https://nbn-resolving.de/urn:nbn:fi-fe2025082784710>

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Bank of Finland Research Discussion Papers
7 • 2025

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Bank of Finland
Research

Bank of Finland Research Discussion Papers
Editor-in-Chief Esa Jokivuolle

Bank of Finland Research Discussion Papers 7/2025
26 August 2025

Eeva Kerola – Olli-Matti Laine – Aleksi Paavola
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ISSN 1456-6184, online

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Heterogeneous responses to monetary policy: the role of floating rate loans

Eeva Kerola[#] Olli-Matti Laine^{*} Aleksi Paavola⁺

This version: August 2025

Abstract

This study examines the *floating rate channel*—a mechanism through which monetary policy affects firms’ investment and credit demand based on their exposure to variable rate loans. Using a granular loan-level dataset from the euro area, we find that firms with variable rate loans significantly reduce their investment-related borrowing after monetary tightening, compared to firms with fixed rate loans. This effect is most pronounced among the smallest firms, consistent with the theoretical view that the floating rate channel is explained by financial constraints. Our results highlight the heterogeneity in firms’ reactions to interest rate changes and underscore the importance of accounting for firm size and financial constraints in monetary policy analysis.

JEL codes: G21, G30, E52

Keywords: monetary policy, floating rate channel, euro area

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We are grateful to Esa Jokivuolle and Markku Lehmus for their useful comments. We are also grateful for the insights from the participants at the Bank of Finland LaUNCH seminar and Microdata Workshop. This paper represents the views of the authors and not necessarily those of the Bank of Finland. Any remaining errors are our own.

1. Introduction

The firm balance sheet channel is a well-established mechanism through which monetary policy influences firms' investment and output by affecting their balance sheet strength and ability to fund new investments (Bernanke & Gertler, 1995; Mishkin, 1995; Aysun & Hepp, 2013). Subsequently, Ippolito, Ozdagli and Perez-Orive (2018) highlighted that bank lending plays an important role in this transmission mechanism through the *floating rate channel*. They posit that changes in monetary policy affect firms' demand for investment and credit differently depending on the share of floating rate credit (as opposed to fixed rate credit) in their balance sheets¹. Most importantly, the floating rate channel differs from earlier transmission channels of monetary policy as it works through existing debt rather than new loan supply. Ippolito et al. (2018) theoretically show that investments and stock returns of financially constrained firms with unhedged floating rate debt are more sensitive to policy rate changes compared to firms that do not suffer from financial constraints, hedge their floating rate debt, or do not have floating-rate debt.

This sensitivity may have important macroeconomic consequences. During periods of monetary tightening, firms with a relatively higher proportion of floating rate debt are subject to more pronounced increases in debt servicing costs and may reduce their investment more sharply than firms with fixed rate debt, leading to a more pronounced contraction in economic activity. Conversely, during monetary easing, these firms may increase their investment more significantly, amplifying the expansionary effects of the policy. Moreover, as the prevalence of floating rate loans is heterogeneous, this can lead to uneven economic outcomes across different sectors and regions.

Despite its theoretical relevance, existing empirical evidence on the floating rate channel's impact on firm-level investment decisions remains limited. There is some evidence that stock prices of firms with floating rate leverage respond more strongly to monetary policy shocks than other firms (Gürkaynak, Karasoy-Can and Lee, 2022; Ippolito et al., 2018), and that investments of financially constrained firms with unhedged bank loans are more sensitive to interest rate changes in the United States (Ippolito et al., 2018). Core, De Marco, Eisert and Schepens (2024) also find that the impact of monetary tightening on inflation is smaller in markets dominated by floating-rate loans, as firms with floating-rate loans keep prices elevated to offset higher borrowing costs.

Our paper aims to fill this gap in the literature by empirically investigating whether firms with relatively more variable rate loans² cut back their borrowing for investment purposes following a policy rate hike compared to firms with more fixed rate loans. We also explore whether firm size, a common proxy for financial constraints, matters, thereby providing a novel contribution to the macrofinance literature.

¹ A related mechanism should apply to housing loans and other credit: households' disposable income and consumption decisions are affected by changes in borrowing costs (Calza et al., 2013; Di Maggio et al., 2017).

² In this paper, the terms 'floating rate loans' and 'variable rate loans' are used interchangeably.

Using comprehensive corporate credit registry data covering the entire euro area, we directly observe the amount of floating and fixed rate loans each firm has acquired, as well as the stated purpose of each loan. We also observe firm size and can thus investigate whether the floating rate channel is more pronounced for firms with financial constraints. Smaller firms typically face greater financial constraints due to limited collateral, higher perceived risk and inability to acquire market funding (Beck et al., 2005; Petersen and Rajan, 1994; Beck and Demirguc-kunt, 2006; Kumar et al., 1999). Thus, firm size is commonly used as a measurement of financial constraints in the existing literature (Ahamed et al., 2022). Moreover, our analysis leverages the latest interest rate hike cycle, which began in 2022. This cycle was unprecedentedly rapid and strong, and largely unexpected from the outset.

Our findings suggest that the floating rate channel does exist in the euro area, and its impact on borrower behavior is sizable. First, using a difference-in-differences setup, we find that companies with a high level of floating rate debt reduce their investment borrowing by about 4.5% following the ECB's rate hikes compared to firms with less floating rate debt. This result is not explained by country-, industry-, or bank-specific factors, nor by size-related trends. Further, using triple difference-in-differences to tackle potential endogeneity issues, we show that the effect is stronger for relatively small firms. These results align with theoretical findings of Ippolito et al. (2018), which suggest that the floating rate channel is stronger for more financially constrained firms (which are on average smaller) than for financially less constrained firms. Moreover, the effects build up gradually over time, consistent with the notion that monetary policy transmits to the real economy with a lag. By 2024, reductions in investment borrowing among smaller firms with a high share of variable rate loans reach up to 11%.

To our knowledge, this paper is the first empirical investigation on the floating rate channel in the euro area, using granular, firm-level data that directly captures the structure of firms' debt composition. We thus contribute to the macrofinance literature by providing new insights into how monetary policy affects firm-level investment decisions through increasing the interest rate expenses of existing debt.

The structure of the article is as follows. Section 2 provides institutional context to firms' debt structure and the interest rate hikes of 2022 in the euro area. Section 3 introduces our data and summarizes some key patterns observed in the data. Section 4 outlines the methodology. Section 5 presents the results, while Section 6 provides additional estimations and robustness checks. Section 7 concludes.

2. Policy rate hikes and the composition of interest rate fixation in the euro area

Before the ECB began to hike its policy rates in July 2022, interest rates had been close to zero for about a decade, following the financial crisis of 2008 and the subsequent euro area sovereign debt crisis. Additionally, both market participants and the general public anticipated that policy rates would remain

low for an extended period because long-term inflation expectations were below the central bank's 2% target, and the ECB had communicated that rates would remain low. These expectations were reinforced by the ECB's strategy change: in the new strategy launched in 2021, the ECB communicated that "When the economy is operating close to the lower bound on nominal interest rates, it requires especially forceful or persistent monetary policy action to prevent negative deviations from the inflation target from becoming entrenched".

Against this backdrop, the hiking cycle of 2022 came as a surprise to banks and firms. At the outset, many were probably indifferent between choosing a fixed or variable rate loan contract, as it was broadly assumed that rates would remain low for multiple years. When we compare the realized policy rate hikes to the interest rate option implied (risk-neutral) probability distribution prior to the inflation surge and rate hikes in 2022, we can see that the realized rate hikes do not fit within the 95% interval (Figure 1, left panel).

Overall, the ECB's deposit facility rate was raised from -0.5% to 4%, with the first hike taking place in July 2022. Long-term market rates began to rise gradually during the last quarter of 2021, whereas short-term rates exhibited a marked increase only from the third quarter of 2022 onward (Figure 1, right panel). The final hike occurred in September 2023, and a rate cutting cycle began in June 2024.

The share of variable and fixed rate corporate loans varies greatly across countries (Figure 2, left panel). On average, half of the corporate loan stock in the euro area consists of variable rate loans. Compared with the euro area average, the proportion of variable rate corporate loans is significantly lower in countries such as France and Germany (25-30%). In contrast, in Lithuania, Latvia, and Finland, variable rate loans account for more than 90% of the corporate loan stock. While floating rate loans predominate especially in smaller euro area countries, there is considerable cross-country variation in loan reference rates, ranging from overnight to 12-month maturities (Vilerts et al., 2025). Variable rate loans are also more common in some industries, like manufacturing or construction, than in others, like services (Kerola et al., 2024). This variation is much smaller across firms of different sizes (Figure 2, right panel). Although variable rate loans have become little more common following the rise in interest rates, their country-specific or firm size-specific shares of the loan stock have remained remarkably stable in recent years. This observation supports the idea that the economic reasoning of firms and banks does not fully explain the selection of variable rate loans over fixed rate loans. Instead, the underlying reasons are also related to slow-moving preferences and habits based on long-term differences between countries (Campbell, 2012; Albertazzi et al., 2024).

The difference in the increase in financing costs between corporates holding variable or fixed rate loans is significant (Figure 3). The average interest rate on the stock of fixed rate corporate loans has risen from approximately 2% in January 2022 to around 2.5% at the end of 2023, a rise of less than one percentage point. By contrast, for variable rate corporate loans, the average interest rate increased by

more than 3 percentage points to over 5% by the end of 2023. Given that both fixed and variable rate corporate loan stocks in the euro area amounted to approximately €2,500 billion at the end of 2023, a differential of roughly 3 percentage points implies an additional €75 billion in interest expenditures for borrowers holding variable rate loans.

Figure 1. Risk neutral interest rate expectations based on option prices and the realized policy rate path (left panel) and change in market rates (OIS; right panel).

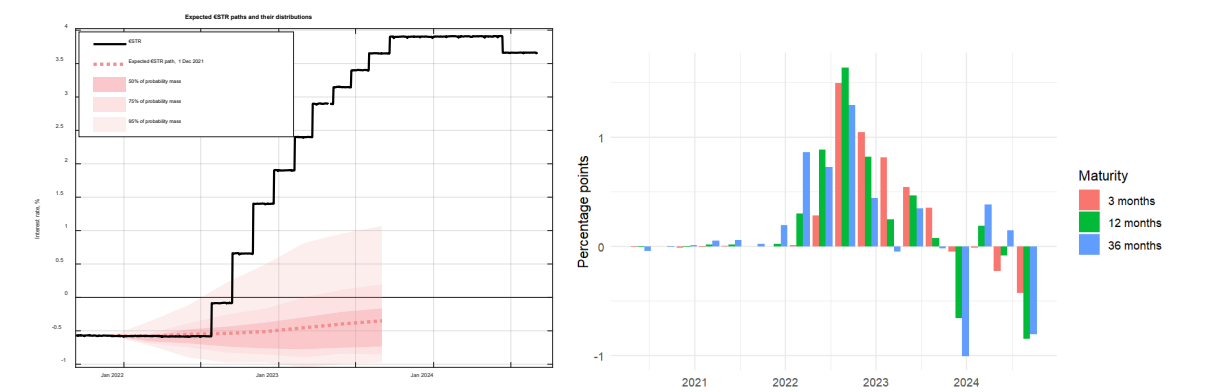


Figure 2. Composition of interest rate fixation in the euro area (left panel) and across firm sizes (right panel).

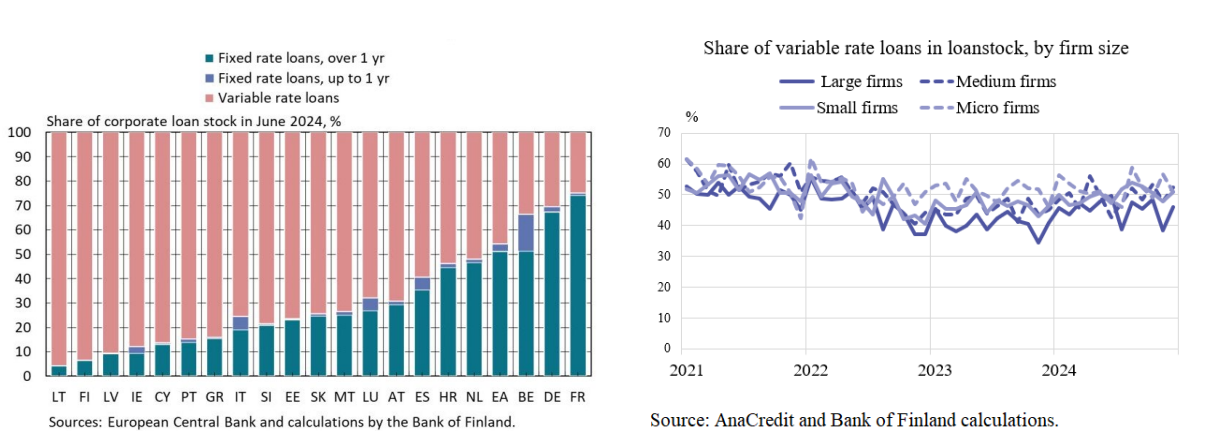
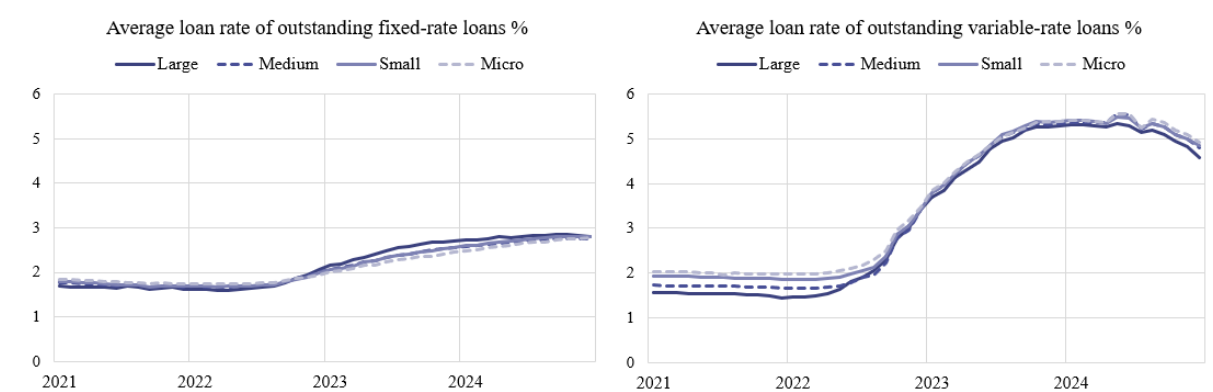


Figure 3. Average loan rate of outstanding fixed-rate (left panel) and variable-rate (right panel) loans.



Source: AnaCredit and Bank of Finland calculations.

The period beginning in late 2021 offers a near-ideal setting for assessing the differential impact of unexpected interest rate shocks on firms with varying exposure to interest rate risk. The ECB’s policy tightening was largely unanticipated, and the distribution of floating versus fixed rate debt across firms was shaped more by long-standing institutional habits than by recent firm-level decisions.

3. Data

Our analysis is based on *Analytical Credit Datasets* (AnaCredit), a granular credit registry compiled by the European Central Bank. AnaCredit provides comprehensive and harmonized information on individual bank loans exceeding €25,000 across euro area countries. The dataset encompasses a wide range of credit-related information, including loan amounts, interest rates, maturities, and borrower characteristics.

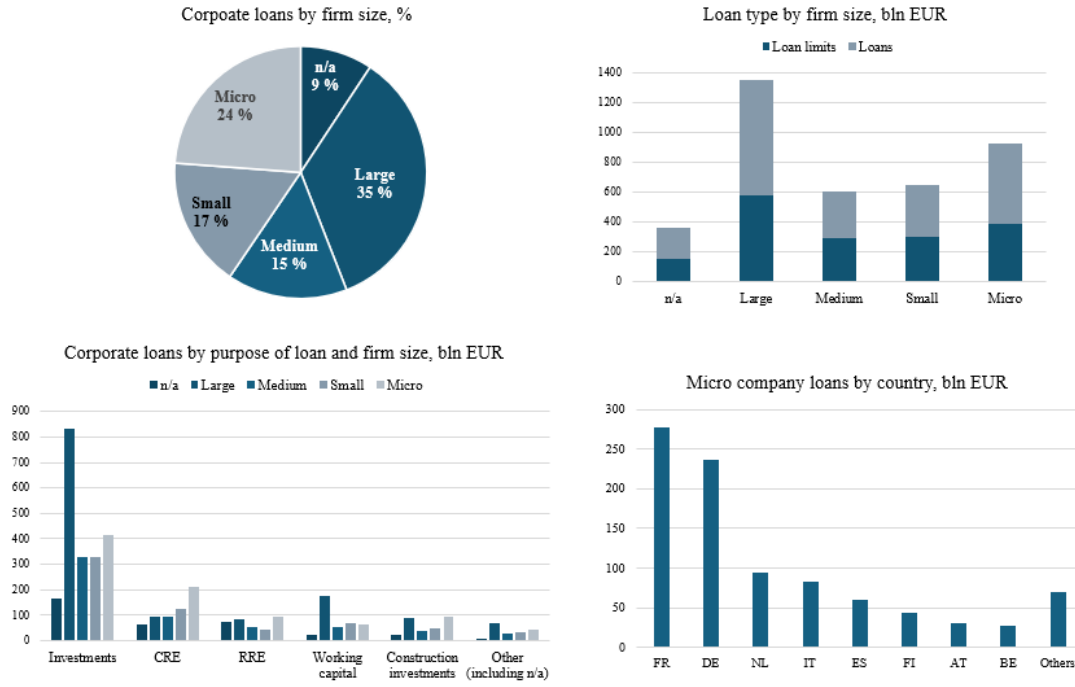
Although data collection commenced in September 2018, we focus on the period from June 2020 to September 2024, during which data quality and coverage are substantially improved. In this way, we also intentionally exclude from the sample the observations that reflect the immediate reaction of firms to the pandemic shock. We aggregate the data into quarterly frequency by including only the last month of each quarter in our sample. For example, we define each firm’s loan stock in March 2021 as its loan stock for the first quarter of 2021.

Our primary explanatory variable is the firm-level share of variable rate loans, which captures firms’ exposure to interest rate fluctuations. We define a variable rate loan as any loan that is *not* defined as “fixed rate”. To ensure our data quality, we include all loans³ denominated in euro with an annual agreed interest rate between 0% and 50%, where the creditor bank is from euro area countries and from the sector *other monetary financial institutions* (S122) and the debtor sector is *non-financial corporations* (S11).⁴ Banks also report the purpose of the loan, which falls into 10 categories: margin lending, debt financing, imports, exports, construction investments, working capital, residential real estate, commercial real estate, and other purposes. This last category, “other purposes” includes loans taken in for any investments other than construction investments. We relabel this category as investment loans. These loans are representative of typical investment loans taken by firms, making them a reliable proxy for measuring firm investment.

³ Specifically, we consider loans with 1) instrument type “1004” that corresponds to loans *other* than overdrafts, credit card debt, trade receivables, finance leases, deposits or reverse repos, revolving credit, or credit lines. Our results are qualitatively unaffected if we include also loans with instrument type 1002 (credit line other than revolving credit).

⁴ Our sample includes all non-financial corporations irrespective of their domestic jurisdiction. If we would exclude firms domiciled outside the euro area, we lose around 0.2% of observations in our baseline regressions and the results remain qualitatively unchanged.

Figure 4. Composition of outstanding corporate lending in September 2024 with respect to firm size, loan type, purpose of loan, and country coverage.



Source: AnaCredit and Bank of Finland calculations. Outstanding loans in September 2024.

We utilize the firm size classification provided directly by AnaCredit, which categorizes firms into four groups. *Microenterprises* are firms that employ fewer than 10 people and have an annual turnover and/or annual balance sheet total not exceeding €2 million. *Small* enterprises employ fewer than 50 people and have an annual turnover and/or annual balance sheet total not exceeding €10 million. *Medium-sized* enterprises employ fewer than 250 people and have an annual turnover not exceeding €50 million or an annual balance sheet total not exceeding €43 million. *Large* enterprises are those that do not meet the criteria for micro, small, or medium-sized firms. Figure 4 presents the composition of outstanding corporate lending in September 2024 with respect to firm size, loan type, purpose of loan and country coverage.

We also utilize information on firms' country of origin and industry (at NACE 2-digits) when we include fixed effects in our regressions.

4. Methodology

We study the floating rate channel utilizing two complementary strategies. First, following Core et al. (2024), we estimate a difference-in-differences (DiD) equation of the form:

$$\log(\text{investment debt})_{fbt} = \beta_1 \text{High variable rate share}_f \times \text{Post 2021}_t + FE + e_{fbt} \quad (1)$$

where $\log(\text{investment debt})_{fbt}$ is the log of investment loans from bank b to firm f at time t .⁵ Investment loans are defined as explained in Section 3. The treatment variable, *High variable rate share* _{f} , is a firm-level dummy equal to 1 if more than 50 per cent of the firm’s bank loans in 2021 had variable interest rates. We interact this dummy variable with *Post 2021* _{t} , a dummy variable equal to 1 from the first quarter of 2022 onward, when short-term market interest rates began to rise rapidly.

To study the dynamics of the effect on investment debt, we replace *Post 2021* _{t} with quarterly dummies in the interaction term. We control macroeconomic trends using time fixed effects, firm-specific time-invariant characteristics using firm fixed effects, country-specific shocks using country-time fixed effects, and sectoral trends using industry-time fixed effects. We also include bank-time fixed effects to control for banks’ loan supply in the spirit of Khwaja and Mian (2008) and Amiti and Weinstein (2018). Size-specific trends are controlled by firm size-time fixed effects. The standard errors are clustered at the firm level⁶.

The key assumption in difference-in-differences estimation is the assumption of common trend: in the absence of treatment, treated and control firms would have experienced similar investment borrowing trends. Although the ECB’s rate hikes in 2022 were largely unanticipated, and the cross-sectional variation in interest rate exposure appears quasi-random, we cannot fully rule out selection bias. While the allocation of loan types may not be random, the substantial cross-country variation in variable rate use — largely unexplained by economic fundamentals — helps mitigate this concern. Still, despite extensive fixed effects, we cannot fully rule out bias in our differences-in-differences estimates.

To address this, we additionally estimate a difference-in-difference-in-differences or a triple difference (TD) specification (see Olden and Møen, 2022). The TD approach allows for causal inference under weaker assumptions than DiD. Specifically, we do not require parallel trends across all firms—only that any bias in the DiD estimates is similar across firm size groups. If this holds, differences in treatment effects between smaller (more constrained) and larger (less constrained) firms can be interpreted causally.

The relevance of firm size as a proxy for financial constraints is supported by Ippolito et al. (2018), who argue that the floating rate channel should operate most strongly among financially constrained firms. Since financial constraints cannot be directly observed, we follow Ahamed et al. (2022) and use firm size as a proxy, drawing on the size classifications reported in AnaCredit.

⁵ In some specifications, we focus on firm-period (as opposed to firm-bank-period) level data and therefore use aggregated firm-level debt as the dependent variable.

⁶ The results are robust to different clustering of standard errors (for example at the firm, bank, and time level).

We divide firms into two groups—micro/small and medium/large—and estimate the TD specification of the form:

$$\log(\text{investment debt})_{fbt} = \beta_1 \text{High variable rate share}_f \times \text{Post 2021}_t + \beta_2 \text{Micro/Small}_f \times \text{High variable rate share}_f \times \text{Post 2021}_t + \beta_3 \text{Micro/Small}_f \times \text{High variable rate share}_f + FE + e_{fbt} \quad (2)$$

The triple interaction coefficient β_2 captures the additional effect of the treatment for smaller (more financially constrained) firms. This coefficient is unbiased as long as the bias of β_1 is similar across firm sizes (see Olden and Møen, 2022). This assumption is weaker than the assumption of common trends between high-variable-rate-share-firms and low-variable-rate-share-firms. The sum of coefficients β_1 and β_2 is then the treatment effect for small firms with high variable rate exposure. As for equation (1), we can replace Post 2021_t with time fixed effects to study the dynamics of the effect.

If a floating rate channel is present, we expect β_1 to be negative (in both specifications): firms with high variable rate exposure reduce investment borrowing after rate hikes. Similarly, we expect β_2 to be negative: the effect is stronger (more negative) for smaller, financially constrained firms.

5. Main results

Table 1 presents our baseline results for both DiD (columns 1-2) and TD (columns 3-4) specifications. The first column of each specification (columns 1 and 3) includes firm, time, and firm country-time fixed effects. The second column (columns 2 and 4) adds firm size-time fixed effects and bank-time fixed effects.

In the DiD specification, the difference-in-difference estimate β_1 captures the effect of high variable rate exposure on investment borrowing following interest rate hikes. The coefficient is negative and statistically significant ($p < 0.01$), indicating the presence of the floating rate channel. Specifically, when interest rates increased in 2022, firms with a higher initial share of variable rate loans reduced their investment borrowing by approximately 4.5% more than firms with lower exposure to variable rates. This result remains robust even after controlling for industry-time or bank-time fixed effects.

In the TD specification, the triple interaction estimate, β_2 , captures the effect of high variable rate exposure on investment borrowing after interest rate hikes, now specifically for smaller firms. The coefficient is negative and statistically significant ($p < 0.01$) in columns 3 and 4. However, the interaction between High variable rate share and Post_2021 dummy is no longer statistically significant, suggesting that the floating rate channel is particularly relevant for smaller firms. When interest rates increased in 2022, small firms with a higher initial share of variable rate loans reduced their investment borrowing by approximately 3 to 4% more than larger firms with similar exposure to variable rates. This result is

consistent with the theoretical model of Ippolito et al. (2018), that the investments of financially constraint firms are more sensitive to interest rate changes. The total effect of policy rate hikes for these relatively small and highly exposed firms ($\beta_1 + \beta_2$) is approximately 4–5%.

In Table 2, we replace the *Post_2021* dummy with annual dummies. As before, columns 1-2 present the results for the DiD specification, and columns 3-4 for the TD specification. The first column of each specification includes firm, time, and firm country-time fixed effects. The second column adds firm size-time fixed effects, and the last column further includes bank-time fixed effects.

In the DiD specification, we observe that the difference-in-difference estimate, β_1 , is statistically insignificant for the interaction between the high variable rate share dummy and the dummy for the year 2020. This supports the common trend assumption prior to the rate hikes. The interactions between the high variable rate share and the annual dummies for 2022-2024 are statistically significant ($p < 0.01$), and the magnitude of the coefficients increases over time. This pattern is consistent with the theory that monetary policy transmits to the real economy with a lag (e.g. Havránek and Rusnák, 2012). Firms with a higher initial share of variable rate loans reduced their investment borrowing by approximately 4% in 2022, 5% in 2023 and 6% in 2024 more than firms with lower exposure to variable rates. These results remain robust after controlling for industry- and bank-specific trends.

In the TD specification, the difference-in-difference estimate β_1 is negative and statistically significant during the first year of rate hikes after the inclusion of industry-time fixed effects and bank-time fixed effects (column 4, $p < 0.1$). For that same year, 2022, the triple interaction estimate β_2 is not statistically significant, indicating that the floating rate channel could have been present across firms of all sizes at the onset of the rate hikes. In contrast, for 2023 and 2024, the floating rate channel appears to be relevant only for smaller firms. The triple interaction estimate is statistically significant for 2023 ($p < 0.1$) and 2024 ($p < 0.01$ in column 3 and $p < 0.05$ in column 4). In 2023, micro and small firms with a high share of variable rate loans reduced their investment borrowing by 4–5% more than similarly exposed medium-sized and large firms. By 2024, this difference increased to 6–9%, depending on the fixed effects included in the estimations. The total effect of policy rate hikes for these relatively small and highly exposed firms ($\beta_1 + \beta_2$) is approximately 6% in 2023 and between 7.5 and 11% in 2024.

Table 1. Baseline estimations with post_2021 period dummies

Dependent variable: log(investment debt)	(1)	(2)	(3)	(4)
High variable rate share x Post_2021	-0.0437*** (0.009)	-0.0477*** (0.009)	-0.0086 (0.019)	-0.0227 (0.016)
Micro/Small x High variable rate share			-0.0089 (0.0109)	-0.0107 (0.0080)
High variable rate share x Micro/Small x Post_2021			-0.0430** (0.020)	-0.0309** (0.016)
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Firm Country-Time FE	YES	YES	YES	YES
Firm size-Time FE	YES	YES	YES	YES
Industry-Time FE	NO	YES	NO	YES
Bank-Time FE	NO	YES	NO	YES
Standard errors clustered	by firm&bank	by firm&bank	by firm&bank	by firm&bank
# Observations	33,427,473	33,427,473	33,427,473	33,427,473
R2	0.78488	0.80687	0.78488	0.80678
Within R2	0.00010	0.00012	0.00013	0.00014

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Estimation of equation (1) for columns 1-2 and of equation (2) for columns 3-4. Estimation period June 2021 - September 2024. Dependent variable log of investment loans from bank b to firm f at time t . High variable rate share is a firm-level dummy equal to 1 if more than 50% of firm's bank loans in 2021 had variable interest rates. Post_2021 is a dummy equal to 1 from January 2022 onwards. Micro/Small is a dummy equal 1 for micro and small firms. Standard errors clustered at the firm and bank level.

Table 2. Estimations with annual dummy interactions

Dependent variable: log(investment debt)	(1)	(2)	(3)	(4)
High variable rate share x 2020_dummy	0.0007 (0.008)	-0.0021 (0.008)	0.0087 (0.0131)	0.0013 (0.0081)
High variable rate share x 2022_dummy	-0.0367*** (0.008)	-0.0382*** (0.007)	-0.0223 (0.016)	-0.0277* (0.014)
High variable rate share x 2023_dummy	-0.0450*** (0.010)	-0.0521*** (0.010)	-0.0029 (0.020)	-0.0195 (0.020)
High variable rate share x 2024_dummy	-0.0536*** (0.012)	-0.0620*** (0.010)	0.0207 (0.021)	-0.0170 (0.021)
Micro/Small x High variable rate share			-0.0023 (0.011)	-0.0073 (0.009)
High variable rate share x Micro/Small x 2020_dummy			-0.0092 (0.015)	-0.0038 (0.011)
High variable rate share x Micro/Small x 2022_dummy			-0.0177 (0.021)	-0.0131 (0.011)
High variable rate share x Micro/Small x 2023_dummy			-0.0515* (0.020)	-0.0402* (0.017)
High variable rate share x Micro/Small x 2024_dummy			-0.091*** (0.011)	-0.0559** (0.009)
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Firm Country-Time FE	YES	YES	YES	YES
Firm size-Time FE	YES	YES	YES	YES
Industry-Time FE	NO	YES	NO	YES
Bank-Time FE	NO	YES	NO	YES
Standard errors clustered	by firm&bank	by firm&bank	by firm&bank	by firm&bank
# Observations	33,427,473	33,427,473	33,427,473	33,427,473
R2	0.78488	0.80678	0.78489	0.80678
Within R2	0.00011	0.00014	0.00016	0.00016
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Estimation of equation (1) for columns 1-2 and of equation (2) for columns 3-4 but Post_2021 dummy replaced by annual dummies. Estimation period June 2021 - September 2024. Dependent variable log of investment loans from bank b to firm f at time t . High variable rate share is a firm-level dummy equal to 1 if more than 50% of firm's bank loans in 2021 had variable interest rates. Micro/Small is a dummy equal 1 for micro and small firms. Standard errors clustered at the firm and bank level.

To better understand the dynamics of the effects and to assess the validity of the common trend assumption, we estimate the DiD and TD specifications using quarterly dummies instead of annual ones. These specifications include fixed effects for firm, time, firm country-time, firm size-time, industry-time, and bank-time. These results are reported in Figure 5. The upper panel reports the double interaction estimates (β_1) from the DiD specification, while the lower panel presents both the double and triple interaction estimates (β_1 and β_2) from the TD specification.

Consistent with Table 2, where the double interaction estimate for the full year 2020 was statistically insignificant – supporting the common trend assumption prior to the rate hikes – we observe that the last three quarters of 2020 in the DiD figure are also statistically not different from zero. However, for the first three quarters of 2021, the coefficients are statistically different from zero, suggesting that the common trend assumption may no longer hold and that the DiD estimates could be biased.

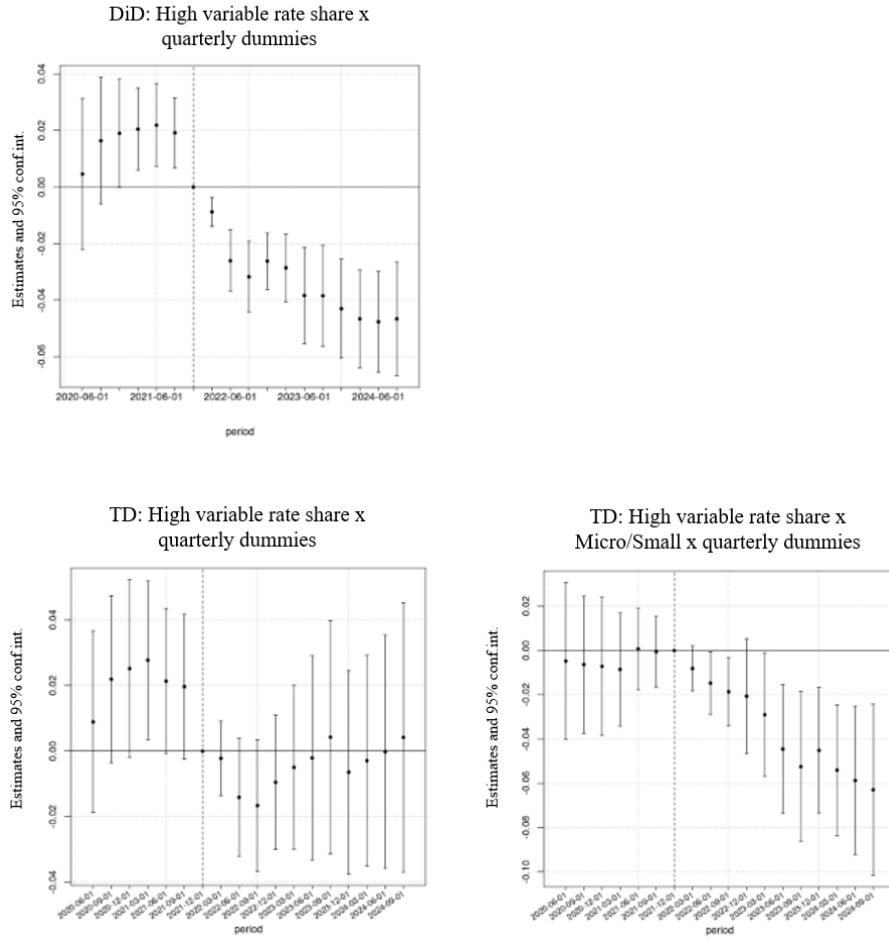
It is worth noting that if the reference quarter were shifted from 2021Q4 to 2021Q3, the estimates would generally be lower, and the common trend would appear to hold again. The third quarter of 2021 could plausibly be considered an alternative point at which the treatment began to take effect, given that market rates started rising gradually before and after the December 2021 monetary policy meeting. Therefore, the apparent violation of the common trend assumption in the upper panel of Figure 5 may be less problematic. The actual beginning of the treatment may have been during Q4 of 2021 rather than after it.

The negative effect of exposure to variable rates builds up gradually. In the second quarter of 2022, firms with a higher initial share of variable rate loans reduced their investment borrowing by approximately 1% compared to firms with lower exposure. This impact increases to around 3% by the end of 2022 and further to 5% by 2024.

For the TD specification, the lower-left chart displays the double interaction estimate, while the lower-right chart presents the triple interaction estimate. The common trend assumption for the triple interaction estimate appears to hold prior to the rate hikes. The effect of higher interest rates on smaller firms with greater exposure to variable rates materializes gradually. By September 2022, these smaller firms had reduced their investment borrowing by approximately 2% compared to similarly exposed larger firms. This impact increases to around 5% by September 2023 and exceeds 6% by September 2024.

Even if the common trend assumption is violated in the DiD specification, this does not imply that the floating rate channel is relevant only for the smallest firms. Rather, the estimate of the average effect across firm sizes may be biased. Although the direction of this bias is uncertain, it is plausible that the DiD results underestimate the true effect. Firms that endogenously choose variable rate loans over fixed rate loans are likely to be those better positioned to bear the risk of rising interest rates – e.g., firms with stronger balance sheets, more resilient business models, and less binding financing constraints (Goldberg and Heuson, 1999; Vickery, 2008). The positive and upward sloping pre-treatment trend in investment borrowing among firms with a higher share of variable rate loans suggests that these firms were, on average, investing more than others prior to the rate hikes. Therefore, it is possible that the true economic effect of the floating rate channel is larger than what our DiD estimates suggest.

Figure 5. Estimations with quarterly dummy interactions



Note: The charts correspond to the models in columns (2) and (4) of Tables 1 and 2, respectively, but with quarterly period dummy interactions. The upper panel of the figure presents the DiD specification and the lower panel presents the TD specification.

6. Additional estimations and robustness checks

We conduct several additional estimations to assess the robustness of our results. First, we re-estimate the DiD and TD specifications using aggregate firm-level loan data instead of bank-firm level data. This allows us to capture the effect of rising interest rates on the total investment borrowing of each exposed firm. Second, we test an alternative definition of exposure to variable rate loans: using the share of variable rate loans as a continuous variable. Third, we re-estimate our main specifications using a balanced panel, including only firms that continue borrowing throughout the sample period.

6.1. Firm level estimations

In this section, we re-estimate the DiD and TD specifications with the $Post\ 2021_t$ dummy using a dataset where individual loans are aggregated at the firm level instead of firm-bank level (Table 3). This

exercise helps us investigate whether the aggregate behavior of individual firms differs from our baseline analysis.

In the baseline, we control for banks' loan supply using bank-time fixed effects. That is, if several firms sharing the same bank reduce their investment borrowing, this is interpreted as a tightening of the bank's lending policy. However, these fixed effects may unintentionally capture some demand effects as well. Additionally, there may be spillovers between firm-bank relationships: for instance, a firm might reduce borrowing from one bank and compensate by borrowing from another. Therefore, we assess whether the results change when bank-time effects fixed effects are excluded and data are aggregated at the firm level.

The results suggest that loan supply plays a limited role in determining loan amounts (see Table 3). In fact, the effects are slightly stronger than those reported in the baseline. In the TD specification, the DiD coefficient is now statistically significant, providing some evidence that medium-sized and large firms may also have reduced their investment borrowing. The dynamics of the effect closely resemble those in the baseline (Figure 6).

Table 3. Firm-level estimations with Post_2021 period dummies

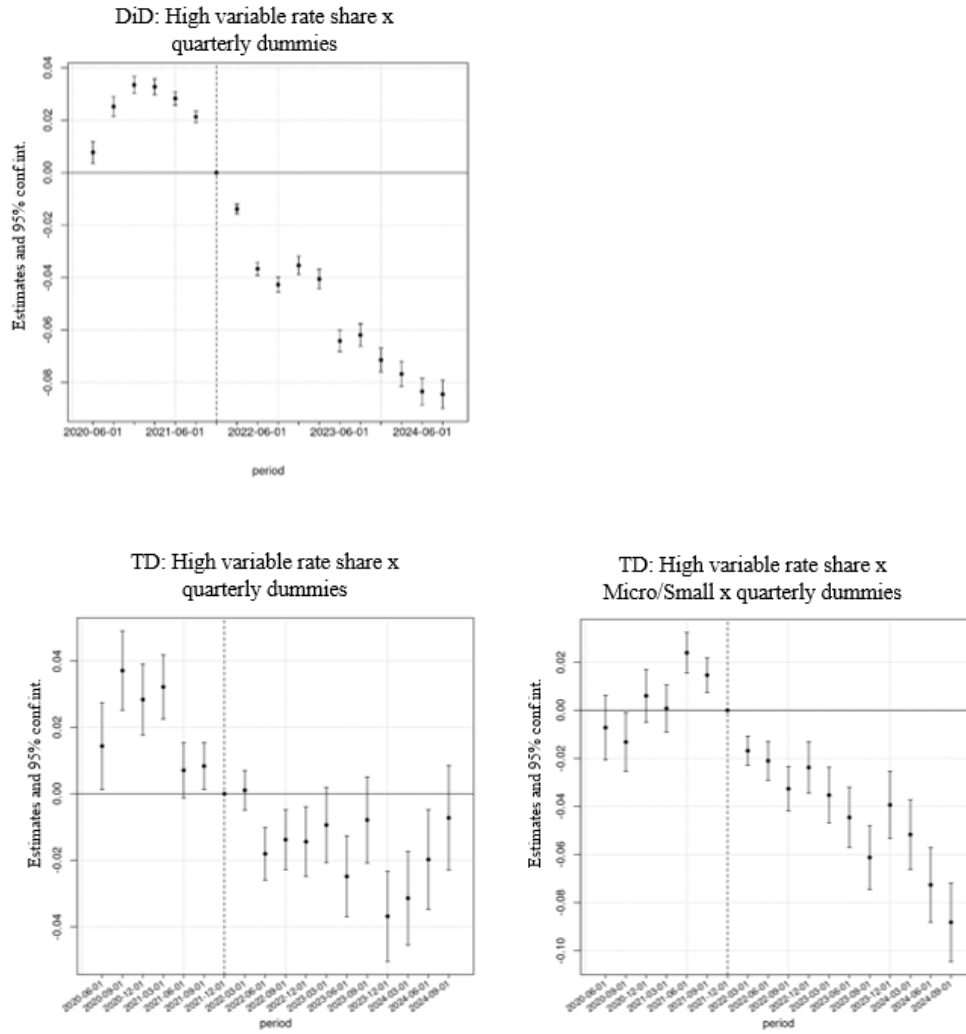
Dependent variable: log(investment debt)	(1)	(2)	(4)	(5)
High variable rate share x Post_2021	-0.0700*** (0.0091)	-0.0732*** (0.0090)	-0.0326*** (0.0086)	-0.0338*** (0.0083)
High variable rate share x Micro/Small x Post_2021			-0.0424*** (0.0090)	-0.0447*** (0.0090)
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Firm Country-Time FE	YES	YES	YES	YES
Firm size-Time FE	YES	YES	YES	YES
Industry-Time FE	NO	YES	NO	YES
Standard errors clustered	by firm	by firm	by firm	by firm
# Observations	19,901,804	19,901,804	19,901,804	19,901,804
R2	0.89478	0.89504	0.89478	0.89504
Within R2	0.00058	0.00062	0.00061	0.00066

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Firm level estimations of equation (1) for columns 1-2 and of equation (2) for columns 3-4. Estimation period June 2021 - September 2024. Dependent variable log of investment loans of firm f at time t . High variable rate share is a firm-level dummy equal to 1 if more than 50% of firm's bank loans in 2021 had variable interest rates. Post_2021 is a dummy equal to 1 from January 2022 onwards. Micro/Small is a dummy equal 1 for micro and small firms. Standard errors clustered at the firm level.

Figure 6. Firm-level estimations with quarterly dummy interactions



Note: The charts correspond to the models in columns (2) and (4) of Tables 1 and 2, respectively, but with quarterly period dummy interactions. The upper panel of the figure presents the DiD specification and the lower panel presents the TD specification.

6.2. Continuous treatment

In our main estimations, *High variable rate share* is defined as a dummy equal to 1 for firms whose variable rate loans accounted for more than 50% of their total borrowing in 2021. We re-estimate the DiD and TD specifications using the continuous share of variable rate loans instead of the binary indicator. This specification helps us assess whether firms with greater exposure to variable rate loans were more affected than those with lower exposure.

Table 4 presents the baseline results when the treatment dummy is replaced by a continuous treatment variable (the share of variable rate loans). The results in column 2 indicate that, for example, a firm with a variable rate share of 60% reduced its investment borrowing by approximately 4.1% (0.0687×0.6). These findings suggest that the share of variable rate loans have an impact also on the intensive margin.

Table 4. Continuous treatment

Dependent variable: log(investment debt)	(1)	(2)	(3)	(4)
Variable rate share x Post_2021	-0.0596*** (0.0122)	-0.0687*** (0.0120)	-0.0026 (0.0267)	-0.0316 (0.0219)
Micro/Small x Variable rate share			0.0069 (0.0155)	-0.0121 (0.0113)
Variable rate share x Micro/Small x Post_2021			-0.0666** (0.0278)	-0.0438** (0.0200)
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Firm Country-Time FE	YES	YES	YES	YES
Firm size-Time FE	YES	YES	YES	YES
Industry-Time FE	NO	YES	NO	YES
Bank-Time FE	NO	YES	NO	YES
Standard errors clustered	by firm&bank	by firm&bank	by firm&bank	by firm&bank
# Observations	33,427,473	33,427,473	33,427,473	33,427,473
R2	0.78488	0.80678	0.78489	0.80678
Within R2	0.00012	0.00016	0.00015	0.00017

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Estimation of equation (1) for columns 1-2 and of equation (2) for columns 3-4. The average share of variable rate loans in 2021 is used as a measure of treatment intensity instead of binary treatment variable. Estimation period June 2021 - September 2024. Dependent variable log of investment loans from bank b to firm f at time t . High variable rate share is a firm-level dummy equal to 1 if more than 50% of firm's bank loans in 2021 had variable interest rates. Post_2021 is a dummy equal to 1 from January 2022 onwards. Micro/Small is a dummy equal 1 for micro and small firms. Standard errors clustered at the firm and bank level.

6.3. Balanced panel

Lastly, we re-estimate our main DiD and TD specifications using a balanced panel instead of the full sample. In other words, we include only firms that continue borrowing every period throughout the sample window. This restriction results in a substantial reduction in the number of observations. The results are presented in Table 5.

The DiD specification yields results that are highly consistent with the baseline. Firms with greater exposure to variable rate loans reduce their investment borrowing by approximately 5% compared to firms with lower exposure. In the TD specification, the difference-in-difference estimate is negative and statistically significant ($p<0.1$). However, the triple interaction loses statistical significance, suggesting that the floating rate channel may not be more relevant for smaller firms.

Table 5. Balanced panel

Dependent variable: log(investment debt)	(1)	(2)	(3)	(4)
High variable rate share x Post_2021	-0.0561*** (0.0137)	-0.0541*** (0.0144)	-0.0364* (0.0221)	-0.0364* (0.0221)
Micro/Small x High variable rate share			0.0022 (0.0286)	0.0022 (0.0286)
High variable rate share x Micro/Small x Post_2021			-0.0291 (0.0217)	-0.0291 (0.0217)
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Firm Country-Time FE	YES	YES	YES	YES
Firm size-Time FE	YES	YES	YES	YES
Industry-Time FE	NO	YES	NO	YES
Bank-Time FE	NO	YES	NO	YES
Standard errors clustered	by firm&bank	by firm&bank	by firm&bank	by firm&bank
# Observations	2,959,626	2,959,626	2,959,626	2,959,626
R2	0.71964	0.75925	0.71964	0.71964
Within R2	0.00013	0.00013	0.00014	0.00014

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Estimation of equation (1) for columns 1-2 and of equation (2) for columns 3-4. The sample is restricted to firms with no missing observations (balanced panel). The firms whose average variable rate share in 2021 was either 0 or 1 are excluded from the sample. Estimation period June 2021 - September 2024. Dependent variable log of investment loans from bank b to firm f at time t . High variable rate share is a firm-level dummy equal to 1 if more than 50% of firm's bank loans in 2021 had variable interest rates. Post_2021 is a dummy equal to 1 from January 2022 onwards. Micro/Small is a dummy equal 1 for micro and small firms. Standard errors clustered at the firm and bank level.

It is important to note that using a balanced panel may bias the results toward zero and understate the floating rate effect. This approach can underrepresent the most interest rate sensitive firms, thereby attenuating the estimated response to rate hikes. By including only firms that continue borrowing after the rate hikes, we exclude those that reduce borrowing to zero (i.e., drop out), and those that are no longer able to access credit. These firms are likely to be the most financially constrained and the most responsive to rising rates and debt servicing costs.

7. Conclusions

This paper provides a first empirical investigation of the floating rate channel in the euro area, examining how shifts in the monetary policy rate affect firm-level investment and credit demand. Utilizing a unique loan-level dataset and employing difference-in difference and triple difference specifications, we find robust empirical evidence that firms with a higher initial share of variable rate loans significantly

reduced their investment borrowing following the interest rate hikes of 2022–2024. These effects are not driven by country-, industry-, or bank-specific factors, nor by trends related to firm size. The impact is particularly pronounced for smaller firms, with total reductions in investment borrowing reaching up to 11% by 2024. The effects build up gradually over time, consistent with the notion that monetary policy transmits to the real economy with a lag. Our findings suggest that financial constraints amplify the transmission of monetary policy through the floating rate channel, especially for smaller firms.

Our findings underscore the importance of considering firm size and financial constraints when analyzing the effects of monetary policy. The heterogeneity in firms' responses to interest rate changes may require, for example, tailored policy measures to address the varying impacts across different regions. In addition, the floating rate channel has implications for financial stability. Firms with high exposure to variable rate loans may face increased financial stress during periods of rising interest rates, potentially leading to higher default rates and financial instability.

In the future research, one could merge information about bank loans with firms' financial statements to more carefully assess the effect on investments. Moreover, further research is needed to better understand the mechanisms that explain the floating rate channel. For example, one could examine the role of financial constraints in greater detail. Additionally, future literature should analyze the relevance of the floating rate channel at the macroeconomic level. For instance, are there economically significant differences in the overall transmission of monetary policy between economies dominated by floating rate loans and those dominated by fixed rate loans?

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