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Monetary policy, investment and firm heterogeneity

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ABSTRACT

This paper provides new evidence on the channels of monetary policy transmission combining 9 million observations on firm level investment and high-frequency identified monetary policy shocks. We show that the reaction of firms' investment to a monetary policy shock is heterogeneous along dimensions that correspond to the two main channels of monetary policy transmission. First, we show that young firms are more sensitive to monetary policy shocks and that high leverage amplifies the effects, supporting the existence of a credit channel of monetary policy. Second, we document large cross-sectional heterogeneity related to the industry the firm operates in. We find that firms producing durable goods react more than others, which is consistent with traditional interest rate channel effects of monetary policy. Furthermore, this sectoral effect is longer lived. In line with the demand effects of the interest rate channel, we also provide evidence that sales growth of durables producing firms reacts stronger to a monetary policy shock.

1. Introduction

Monetary policy affects the real economy through a number of mechanisms also known as transmission channels. Among all, the traditional interest rate and the credit channel of monetary policy are the most studied (Bernanke and Gertler, 1995). Whereas the first affects output through the direct effect of changes in interest rates on the interest-sensitive components of aggregate demand; the second operates through frictions in credit markets that amplify the effects of monetary policy on certain types of borrowers. The relative importance and strengths of these channels is however still uncertain. The aim of this paper is to empirically provide evidence on the existence of both channels while also uncovering their relative strength and importance. We develop this analysis by documenting the heterogeneity of firms' investment reactions to monetary policy shocks. We focus on investment since the traditional and the credit view of monetary policy imply the manifestation of different types of heterogeneity in the reaction of investment to shocks. Theory predicts that the strength of the traditional interest rate channel should depend on the interest-rate sensitivity of demand. Some components of spending, most prominently durable spending, are expected to be more interest-sensitive. Indeed, Ganley and Salmon (1996), Barth and Ramey (2002), Dedola and Lippi (2005) and Peersman and Smets (2005) provide empirical evidence that the *output* of durable industries reacts much stronger to a monetary policy shock. As a corollary, the input demand of the durable industries should also be expected to react more. We expect that one implication is that the *investment* of durable industries should react stronger to monetary policy shocks. Hence, the test of the traditional interest rate channel consists in checking whether firms' investment in durable industries reacts more to monetary policy shocks. The strength and importance of the credit channel depends on the sensitivity of external finance premia, which are unfortunately unobservable. The financial

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frictions literature stresses that some *observable* characteristics of firms such as size, age, leverage and liquidity are likely to affect the external finance premia. These individual firm characteristics through credit frictions lead to heterogeneous reactions to shocks. Hence, the test of the credit channel consists in checking whether firms expected to be more financially constrained react more to monetary policy shocks. Therefore, whereas the traditional interest rate channel of monetary policy implies differences in the effect of shocks across industries (i.e., the type of output), the credit channel implies differences across firms according to their characteristics (i.e., the type of firm). By uncovering the relative importance of these two types of heterogeneity – type of output versus type of firm – we provide novel empirical evidence on the relative role of both channels.

For this scope, we use micro firm-level data from the four largest economies in the euro area (Germany, France, Italy and Spain). We use a large and rich dataset of more than 1 million firms, which we observe over the period 2000–2016, providing us with roughly 9 million observations for investment at the firm level. We estimate the dynamic effect of monetary policy on firm investment using the monthly euro area monetary policy shock series from Jarociński and Karadi (2020). This series consists of high-frequency surprises in the EONIA swaps in a small window around policy announcements. The exogeneity of these surprises allows us to identify the effect of monetary policy on firms' investment in a local projection setting as in Jordá (2005) and following recent work by Cloyne et al. (2018), Jeenas (2019), Ottonello and Winberry (2020) and Crouzet and Mehrotra (2020). We estimate the reaction of investment for a period of up to 4 years after a shock. We find that firms reduce investment in a period between one and two years after the shock, in line with the macroeconomic literature.

To identify the two main transmission channels of monetary policy, we focus on differences across groups of firms. Since the dataset is very large we have enough statistical power to identify those differences. As proxies for financial constraints we use traditional measures such as size, liquidity and leverage and as employed by the recent literature (Cloyne et al., 2018), we also use age to identify more financially constrained firms. Young firms are generally more opaque, have shorter credit histories and should therefore be more exposed to financial frictions than older firms. They also tend to be small, highly leveraged and less liquid, all these characteristics are correlated with higher financial vulnerability. Age is arguably the only purely *exogenous* characteristic of firms that is related to financial frictions. Variables such as liquidity and leverage (and even size) are all endogenous and therefore potentially more problematic when serving on their own as indicators of financing constraints. We find that younger firms and firms with higher leverage react more to monetary policy shocks. We further look for evidence of the traditional interest rate channel of monetary policy by disaggregating the sample into different sectors such as manufacturing, construction and services and, even narrower, into 31 industries. In particular, we test whether firms in durable goods industries react more to monetary policy. We provide strong evidence that firms in the durable industries react more.

By crossing the two characteristics age and durability of output we are able to identify the relative strength of both channels. Both age and durability of output matter. However the "age" effect seems to be weaker than the "durability" effect and is also shorter lived. Age-related differences in investment reactions to monetary policy occur only one year after the shock but disappear thereafter. Durability of output however matters quite strongly: its effect is found to be stronger than the age effect and longer lived. Two years after the shock, durables producing firms still invest less. We provide further corroborating evidence and show that sales growth of especially the durables producing firms reacts stronger to a monetary policy shock, in line with the demand effects of the interest rate channel. In addition, we find that, even after controlling for age and durability, also more leveraged firms react stronger. We conclude therefore that both the traditional interest rate channel and the credit channel are alive and well. This results confirm the notion that the credit channel amplifies the traditional interest rate channel but does not replace it, in line with Bernanke and Gertler (1995). Finally, these findings should be helpful in developing better macroeconomic models of monetary policy transmission which should incorporate the relative strengths of both channels.

Contribution to the literature: This paper contributes to the literature that studies how the effect of monetary policy varies across firms. Earlier studies have stressed findings that are consistent with the existence of financial frictions which create heterogeneity across firms in the reaction to monetary policy. In a seminal article, Gertler and Gilchrist (1994) show that small firms' sales and inventories drop more than those of large firms after monetary policy tightening. Using firm level data from the US and the UK, Cloyne et al. (2018) show that the investment of younger firms that pay no dividends reacts more strongly to monetary policy shocks. Jeenas (2019) finds that monetary policy shocks create larger reactions in fixed capital formation, inventories and sales growth for firms with high leverage and low liquid assets. Our results complement the findings in Bahaj et al. (2022) that younger and more leveraged firms show larger employment responses to monetary policy. In a recent paper, Ottonello and Winberry (2020) show that firms with low default risk and low leverage are more responsive to monetary policy. The results by Ottonello and Winberry (2020) are only seemingly in contrast with the existing literature that finds stronger reaction of financial constrained firms to shocks. They interpret the difference between (Jeenas, 2019) and their results as a difference between *within-firm* effects and *across-firms* effects. Also in our paper, we are interested in across-firm heterogeneity. The findings in this literature are generally consistent with theories of financial frictions that predict stronger reactions of financially constrained firms to monetary policy (Bernanke and Gertler, 1989; Bernanke et al., 1999).

The main novel result that this paper brings to this literature is the large cross-sectional heterogeneity in the reaction of investment to monetary policy related to the industry the firm operates in. The large dataset allows us to provide disaggregated estimates for twenty-four manufacturing industries, six services industries and the construction sector. We find that firms producing durable goods have much stronger investment reactions than others. Thus far, the literature has emphasized balance sheet or other characteristics of firms related to financial frictions (such as size, age and leverage). We also find that young firms react stronger to monetary policy, similarly as in Cloyne et al. (2018) and that more leveraged firms react more, consistent with Jeenas (2019). However, the new result of this paper emphasizes the role of the type of good that firms produce. We find that this relatively underinvestigated feature of firm heterogeneity has substantial real effects. Our paper therefore complements the earlier findings

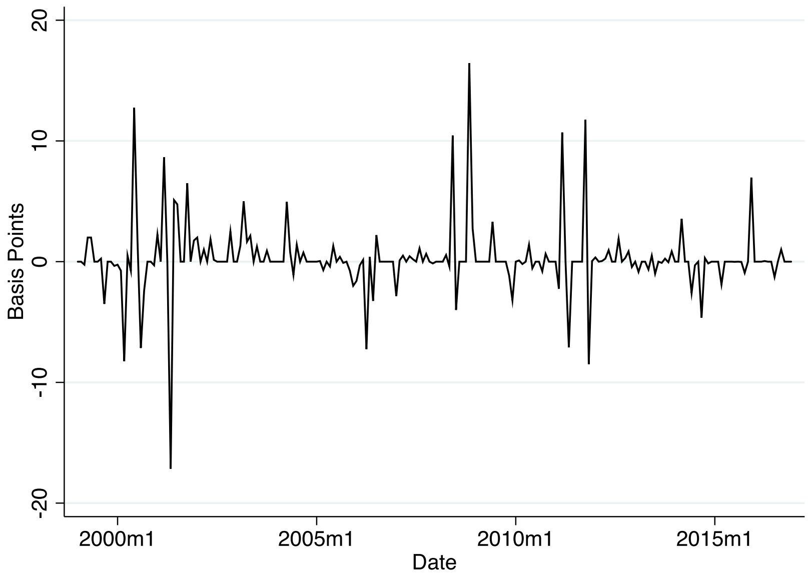


Fig. 1. The monetary policy shock. Note: The figure depicts the monetary policy shock series (poor man's proxy) of Jarociński and Karadi (2020).

related to financial frictions but does not contradict them. In addition, to the best of our knowledge, we believe our paper is the first to investigate the heterogeneous firm investment reactions to monetary policy in the euro area.

Roadmap: The rest of the paper is organized as follows. Section 2 describes the firm level dataset and the monetary policy shocks. Section 3 shows the impact of monetary policy on aggregate investment. Section 4 describes the baseline econometric framework and shows the average effect on firm investment of a monetary policy shock. Section 5 shows and discusses the heterogeneous effects of monetary policy. Section 6 provides robustness checks and Section 7 concludes.

2. Monetary policy shock and firm-level dataset

In this section, we present the two main data sources: the firm-level dataset and the monetary policy shock series. We also report summary statistics for the main variables of interest and we carefully explain the matching procedure we use to obtain the final dataset for the empirical analysis.

2.1. Monetary policy shock

Exogenous movements in the euro area policy rate are proxied by the high-frequency monetary policy shock series from Jarociński and Karadi (2020). The series is monthly and available from 1999 to 2016. The authors make use of a high-frequency identification strategy. In more detail, the series is constructed by measuring the reaction in the 3-month EONIA swaps[1] in a 30-minute window around press statements and a 90-minute window around press conferences.[2] More specifically, we use what Jarociński and Karadi (2020) call the poor man's sign restrictions series. The latter, takes the value of the changes in the 3-month EONIA swaps if the stock price surprises had the opposite sign to the high-frequency EONIA swaps changes, and zero otherwise. Fig. 1 depicts the monetary policy shock series as originally created by Jarociński and Karadi (2020) from January 1999 to December 2016. The series reaches a maximum of 16.4 basis points in November 2008 and a minimum of −17.1 basis points in May 2001. A more detailed discussion of these shocks can be found in Jarociński and Karadi (2020).

Since the frequency of the monetary policy shocks is monthly, whereas the firm-level data is annual, we need to match frequencies. We combine the firm-level data with the 12 month moving sum of the monetary policy shocks series using the variable that identifies the exact month in which a firm is filing its accounts.[3] We choose the 12 month moving sum because the annual value of investment of a certain firm is unlikely to be affected just by the monetary policy shock in the month when the account is reported.

[1] The EONIA is the average rate at which banks lend unsecured money to each other with a maturity of 1 day. The 3-month EONIA swap rate is the fixed rate at which a bank can swap the daily rate over a 3-month period. As the EONIA almost reacts one to one with movements in the ECB interest rate on the main refinancing operations (i.e. the policy rate) movements in the 3-month EONIA swap rates represent the markets' expectation of movements in the central bank policy rate in the next three months.

[2] Whenever there is a press conference after a press statements the surprise is the sum of the response in the two windows (see Jarociński and Karadi (2020) for more details).

[3] The specific variable is called "closing month" in the BvD Orbis dataset.

Table 1
Summary statistics.
Source: BvD Orbis.

	Germany	France	Italy	Spain	Pooled
Tangible net investment (percent)					
mean	8.50	11.21	8.54	7.61	9.31
std	46.35	76.45	63.28	54.23	66.21
min	−54.58	−59.92	−53.89	−47.62	−59.92
max	285.88	307.65	285.87	224.95	307.65
Total assets (log euro)					
mean	16.34	13.09	14.07	13.51	13.54
std	2.01	1.52	1.55	1.53	1.62
min	7.64	4.51	6.06	4.62	4.51
max	24.64	26.22	25.31	24.41	26.22
Age (years)					
mean	33	19	17	20	19
std	32	12	9	13	12
min	4	4	4	4	4
max	733	219	145	1005	1005
Obs	114,604	2,912,334	3,719,179	2,645,813	9,391,930
N. firms	23,313	402,639	533,439	404,948	1,364,339

Note: The descriptive statistics refer to the period 2000–2016 for firms with at least 5 consecutive years of observations.

We explain in more detail the merging procedure between the 12 month moving sum with the firm level dataset in the following section. Fig. A.1 in Appendix A depicts the 12 month moving sum series of the monetary policy shock.

2.2. Firm level dataset

Micro data at the firm level are the most appropriate source to document the heterogeneous transmission of monetary policy. We obtain granular firm-level annual information on companies' financial accounts for the four largest euro area countries (Germany, France, Italy and Spain) for the period between 2000 and 2016 from Orbis database provided by Bureau van Dijk (BvD). The database contains detailed information on all balance sheet and income statement components of each individual firm. Moreover, the database includes all industries (both services and manufacturing) and covers much of the corporate universe of the countries considered. One of the major advantages of such a rich database is the presence of both stock market listed and unlisted companies (including very small firms). This allows us to have enough statistical power to identify differences across various groups of firms in several dimensions (i.e., size, age, industry, etc.).

The empirical investigation revolves around non-financial corporations only, which means excluding banks and other firms in the financial sector. We drop a few sectors with atypical behavior such as agriculture and mining and sectors with high government ownership, such as administration. We keep the following sectors: Manufacturing (NACE Rev. 2 Section C), Construction (F), Wholesale and retail trade (G), Transportation and storage (H), Accommodation and food activities (I), information, communication and R&D (J and M) and other business activities (M and N). A detailed list of the included industries is in Appendix B.

We follow carefully the procedures in Kalemli-Ozcan et al. (2015) to obtain a nationally representative firm-level dataset. We first drop firms when they report negative total assets, negative employment, misreported employment (greater than 2 million employees), negative sales or negative tangible fixed assets. Moreover, we drop firm-year observations when: total assets takes the value zero; age is negative; fixed assets is missing, negative or zero; tangible fixed assets is missing or negative; or, intangible fixed assets is negative.[4] Thereafter, we eliminate firm-years that show clear mistakes in the balance sheet identities.[5] To reduce the impact of outliers, we winsorize all the ratios calculated from balance sheet variables. We follow the literature and winsorize each variable by country, year and sector at the percentage level needed so that the distribution of the variable has a kurtosis below 10. This is the same procedure as followed by Kalemli-Ozcan et al. (2018). Finally, as we focus on the dynamic effect of monetary policy shocks and use lags in the regressions, we keep only firms with at least 5 consecutive years of observations. The final sample contains 1,364,339 firms and more than 9 million observations. Table 1 reports basic summary statistics for our main variables of interest.

As the benchmark measure of firm level investment, we use the *tangible* net investment rate I_{it}, which is the net investment in tangible assets of firm i at year t, divided by the net capital stock, at end of year $t-1$.[6] Differently from recent empirical contributions

[4] In addition, we also eliminate firm-year observations when firms report negative values of non-current liabilities, long-term debt, current liabilities, loans, capital, creditors, debtors, other current liabilities, current assets, other fixed assets, stock and other current liabilities.

[5] See Kalemli-Ozcan et al. (2015) for more info about accounting identities.

[6] Note that in this case, the meaning of year t corresponds to the accounting year that coincides with the firms accounts' closing date. E.g., consider a firm which closes its accounts on 31st of May of year t. I_{it} for that firm is the tangible net investment over the period 1st of June of year $t-1$ until 31st of May of year t. Firms report the net book value of tangible assets at closing date of the accounts at year t, NTA_t. We define the tangible net investment rate at year t as $[NTA_t - NTA_{(t-1)}]/NTA_{(t-1)}$.

Table 2
The 12 month moving sum of the monetary policy shock.
Source: BvD Orbis and Jarociński and Karadi (2020).

	Germany	France	Italy	Spain	Pooled
mean	2.52	3.44	2.91	3.33	3.14
std	8.69	8.49	8.05	8.17	8.33

Note: Statistics are reported in basis points. The table shows the mean and standard deviation of the 12 month moving sum of the monetary policy shock when matched with the firm-level dataset.

Döttling and Ratnovski (2020) and Falato et al. (2020) we disregard the *intangible* component of investment. Firms with more intangible assets have limited collateral and can therefore borrow less. Recent research by Döttling and Ratnovski (2020) suggests that the credit channel of monetary policy could be weaker for more intangible intensive firms and in particular for financially constrained firms, as these types of firms typically rely less on external financing. Nevertheless, digging deeper into this mechanism is beyond the scope of this paper. On the contrary, the aim of this paper is to compare the relative importance and strength of both, interest rate and the credit channel and asset tangibility appears to be the most appropriate measure for this purpose.

The average net investment rate in the sample is 9.31 percent with a standard deviation of 66.21 percent. The average firm is 19 years old (with a standard deviation of 12). The minimum firms' age is 4 years old. This is simply due to the fact that we introduce lags in the model (i.e., the observations for firms when they are less than 4 years old are still used to construct the lags).[7] As is common with firm-level data, there is a wide variation reflecting a heterogeneous firm landscape. Average statistics on investment, size and age are relatively similar across countries with the sole exception of Germany where firms tend to be larger. It is quite well known that very small German firms in the BvD Orbis database are somewhat under-represented. Notwithstanding this small caveat, our sample is very large and contains practically the entire universe of firms for each country. This is rather an exception for the firm micro literature that mostly focuses on samples of large listed firms (such as in Compustat). Given that one of the goals of the paper is to understand the role of the credit channel in the monetary transmission, having a broad coverage of small and medium-sized enterprises (SMEs) is certainly important and advantageous.

A key feature of the dataset is that firms close their accounts at different months during the year. Hence, two firms that close their accounts in the same year but in different months will have experienced a different sequence of past shocks.[8] As stated in Section 2.1 we construct the 12 month moving sum of the monthly series obtained from Jarociński and Karadi (2020). We match the 12 month moving sum of the monetary policy shock with the variable "closing date" of each individual firm in each country in order to capture as much time variation as possible. More precisely, let $m_{i,t}$ be the month of closing of the accounts of firm i in year t. Then, the 12 month moving sum of the monetary policy shock for firm i at year t is defined as $\epsilon_{i,t} = \sum_{k=0}^{11} \epsilon_{m_{i,t}-k}$. A similar procedure is used in Cloyne et al. (2018).

The different distribution of the closing date across countries implies that the monetary policy shock hits the firms in each country differently. Table 2 shows the descriptive statistics of the monetary policy shock when matched with the firm-level data. In the dataset obtained by pooling together all the countries, the mean value of the shock is 3.14 basis points and the standard deviation is 8.33.

3. Aggregate investment response to monetary policy

Before discussing the main econometric specification, we study how the monetary policy shock series affect aggregate investment using time series data. Aggregate investment of country j in quarter q, $GFCF_{jq}$, is available from the national accounts.[9] We use subscript q to denote quarters.

To match frequencies, we first sum the monthly shock series over each quarter q and then merge it with the aggregate investment series. We estimate the impulse response of aggregate investment in reaction to the monetary policy shock using local projections following Jordá (2005). Formally, our model is written as follows:

$$log(GFCF)_{j,q+h} - log(GFCF)_{j,q-1} = \alpha_j^h + \beta^h * \epsilon_q + u_{j,q+h} \quad (1)$$

where j denotes the country and h the horizon. The coefficient β^h measures the effect of a 1 basis point change in the 3 month EONIA swaps on aggregate investment at horizon h.

$u_{j,q+h}$ is a mean zero error term capturing other shocks and α_j^h is a country fixed effect. Note that the quarterly monetary policy shock ϵ_q does not have the j subscript as it is identical across countries. We estimate Eq. (1) for each horizon $h \in (0,1...,12)$. The

[7] To construct an investment rate we need two years of balance sheets. Since we control for lagged investment in our regressions we cannot simply say anything meaningful on the investment dynamics of firms with 3 years of age or below.

[8] Most firms close their accounts at the 31st of December each year. The time variation is not very large for Italy, Spain and Germany while is more pronounced for France. However, the big volumes of our data reassure us to have enough time variation in our dataset.

[9] Unfortunately, an aggregate investment series restricted to non-financial firms does not exist for euro area countries. We use the available national accounts series for total investment which includes government investment and residential investment of households and in national accounts terminology is called Gross Fixed Capital Formation, chain linked volume.

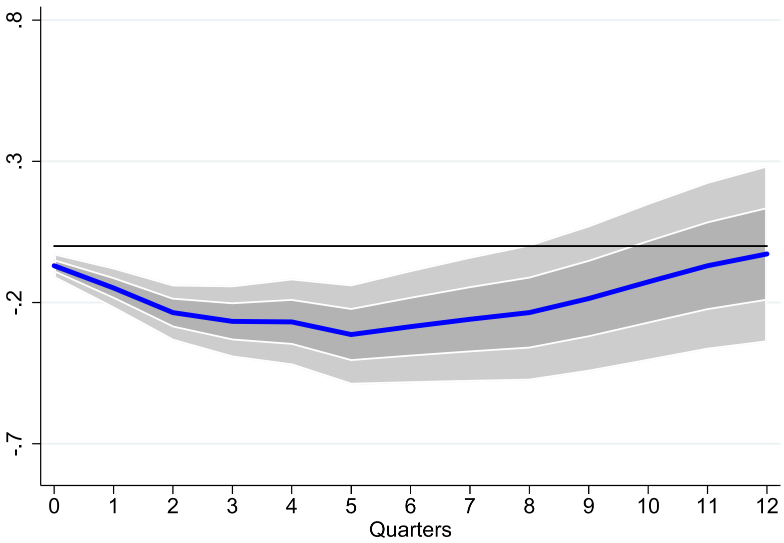


Fig. 2. Aggregate investment response to monetary policy shock. Note: shaded areas represent 90 and 95 percent confidence bands.

impulse response function is given by the sequence of estimates $\hat{\beta}^0, \hat{\beta}^1, \hat{\beta}^2, \ldots, \hat{\beta}^{12}$. Fig. 2 reports the aggregate investment response pooling all the four countries together. We can clearly observe that an upward surprise leads to a decrease in aggregate investment. In particular, a 1 basis point change in the 3 month EONIA swaps (i.e in the surprise) leads to a 0.31 percentage point drop in aggregate investment after 5 quarters. The effect remains large two years after the shock, i.e. in quarters 6, 7 and 8. At the end of the third year the effect disappears. These findings are consistent with the VAR based evidence for the US provided by Bernanke and Gertler (1995) in which the bulk of the response of business fixed investment after a monetary policy shock occurs between 6 and 24 months. Also Christiano et al. (2005) find a similar hump-shaped response of investment. Our estimated effect is however larger than this traditional VAR evidence. Christiano et al. (2005) estimate around a 100 basis points rise in aggregate investment after a temporary 60 basis points drop in the Federal Funds rate. However a direct comparison of effects of monetary policy from high-frequency shocks used here with the classic VAR literature is not straightforward. A potential explanation of the larger effects of the high-frequency shocks compared to the earlier empirical macro-literature is in the information embedded in the shocks. More recently, Gertler and Karadi (2015) combine traditional VARs with high-frequency shocks and show that small movements in short-term rates can lead to large movements in credit costs, i.e. due to the reaction of term premia and credit spreads. So it is possible that the high-frequency shocks not only affect policy rates but also work through the rise of (unobservable) credit spreads on bank loans of firms. This could potentially explain a larger effect on investment.

We find a similar u-shaped impulse response function as in Fig. 2 for each country individually (see Fig. C.1 in Appendix C). The effect peaks at around quarter 5 and is also estimated to be of roughly equal magnitude for all the countries. We can conclude that a contractionary monetary policy shock leads to a decrease in aggregate investment in all four economies considered. These results are reassuring us that the proxy we use for monetary policy affects – as expected – aggregate investment in all countries. It provides us with a good benchmark for our micro analysis.

4. Empirical framework

4.1. Baseline specification: panel OLS local projections

To estimate the dynamic reaction of firm investment to monetary policy shocks, we use the panel local projection approach (OLS-LP) proposed by Jordá (2005). We define our dependent variable $\Delta^*_h I_{i,t-1}$ as the h-year forward difference in the investment rate, i.e. $\Delta^*_h I_{i,t-1} = I_{i,t+h} - I_{i,t-1}$. We are interested in the effect of a monetary policy shock in year t (i.e., $\epsilon_{i,t}$) on the dependent variable at horizons $h \in (0,1,..4)$. Note that at time t, $I_{i,t-1}$ is predetermined so that we can interpret the effect as the response of the future investment rate (i.e., the dynamic causal effect of the monetary policy shock on investment). To test whether the investment rate of different groups of firms react less or more to the shock we define the dummy variable $D^g_{i,t-1}$ which selects the firms' group of interest. In particular, it takes the value 1 if at time $t-1$ the firm i belongs to the group g and 0 otherwise. We interact these dummies variables with our monetary policy shock $\epsilon_{i,t}$. Our baseline empirical specification follows Cloyne et al. (2018):

$$\Delta^*_h I_{i,t-1} = \alpha^h_i + \sum_{g=1}^{G} \beta^h_g * D^g_{i,t-1} * \epsilon_{i,t} + \sum_{g=1}^{G} \gamma^h_g * D^g_{i,t-1} + \Gamma^h \Delta X_{i,t-1} + u_{i,t+h} \tag{2}$$

Table 3
Average effect of monetary policy shock on investment.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
ϵ_{it}	0.14	−0.34***	−0.34**	−0.04	0.03
	(0.12)	(0.09)	(0.16)	(0.12)	(0.12)
ϵ_{it-1}	−0.33***	−0.37***	−0.13	−0.04	−0.07
	(0.08)	(0.10)	(0.18)	(0.16)	(0.15)
ϵ_{it-2}	−0.17**	−0.13	−0.08	0.02	0.01
	(0.07)	(0.11)	(0.16)	(0.17)	(0.10)
ΔI_{it-1}	−0.66***	−0.67***	−0.67***	−0.67***	−0.67***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ΔI_{it-2}	−0.33***	−0.33***	−0.34***	−0.33***	−0.32***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ΔCF_{it-1}	0.30***	0.13***	0.07***	0.05***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
ΔCF_{it-2}	0.20***	0.08***	0.05***	0.03**	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ΔSG_{it-1}	0.04***	0.03***	0.03***	0.03***	0.03***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
ΔSG_{it-2}	0.03***	0.03***	0.02***	0.03***	0.02**
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Note: clustered standard errors at firm and time level in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The firm fixed effect α_i^h, controls for heterogeneity in the investment rate across firms for each horizon h and $\Delta X_{i,t-1}$ is a vector of additional control variables. This flexible specification captures the heterogeneous effects of monetary policy across different groups. In particular, we are interested in the values of β_g^h which give us the impulse response for group g at the forecast horizon $h \in (0,1,..4)$. The coefficients γ_g^h control for different level effects of group membership (but when group membership does not change over time, these drop out of the regression as we include firm fixed effects in all regressions).

The control vector $\Delta X_{i,t-1}$ contains past shocks ($\epsilon_{i,t-1}, \epsilon_{i,t-2}$) and firm-specific controls: lagged investment differences ($\Delta I_{it-1}, \Delta I_{it-2}$), lagged sales growth differences ($\Delta SG_{i-1}, \Delta SG_{it-2}$), lagged cash flow differences ($\Delta CF_{it-1}, \Delta CF_{it-2}$). Variables definitions are provided in more detail in Table D.1 in Appendix D. Note that in principle the monetary policy shocks are exogenous and so control variables are only needed to improve efficiency of the estimates. We expect sales growth to positively affect investment as it captures demand factors and growth opportunities and similarly cash flow which represents internal sources of funding should have a positive effect. Note that in the regressions we measure shocks in basis points while our investment series are measured in percentages. Therefore, the coefficients β_g^h that we report in the regression tables are estimates of the percentage points reactions of investment to a 1 basis point shock. Finally, we cluster standard errors at firm and time level.[10]

4.2. The average effect

We first report the estimated average effect of the monetary policy shock in our full sample. This will be our benchmark. To estimate the average effect, we drop the group dummy $D_{i,t}^g$ from Eq. (2) and replace the group specific coefficient β_g^h with a single parameter β^h at horizon h. The average impulse response function is then given by the sequence of estimates $\hat{\beta}^0, \hat{\beta}^1, \dots, \hat{\beta}^4$. Table 3 shows the estimation results of the five regressions (h = 0, …4). We maximize the number of observations for each horizon and include all available years for all firms for the local projections. Therefore firms that enter the sample at the end of our dataset will not be in the regression at further horizons implying that the number of observations declines as the horizon increases. In the robustness section we show that various subsets of our dataset yield very similar results as these presented here. In line with our expectations, sales growth and cash flow are generally estimated to positively affect investment. Lags of investment differences have a negative effect on the h-year investment differences. This is likely due to the lumpy nature of investment where investment bursts are followed with lower investment.

Fig. 3 shows the average impulse response function for the full sample i.e. it shows at each horizon h (X-axis) the estimated effect in percentage points (Y-axis) on the net investment rate at the firm level of a 1 basis point upward surprise.

In the same year as the shock, i.e. at horizon $h = 0$, there is no statistically significant effect. This is expected since investment is generally planned in advance so that an instantaneous reaction is unlikely a priori. The shock has an economically and statistically significant negative effect in the first (at the 1 percent significance level) and second year (at the five percent significance level) after the shock. The point estimates imply that an upward surprise corresponding to a 1 basis point change in the 3 month EONIA

[10] Note that as firms close their account at any possible month during the year, clustering at the time level here means month-year level, not just year level.

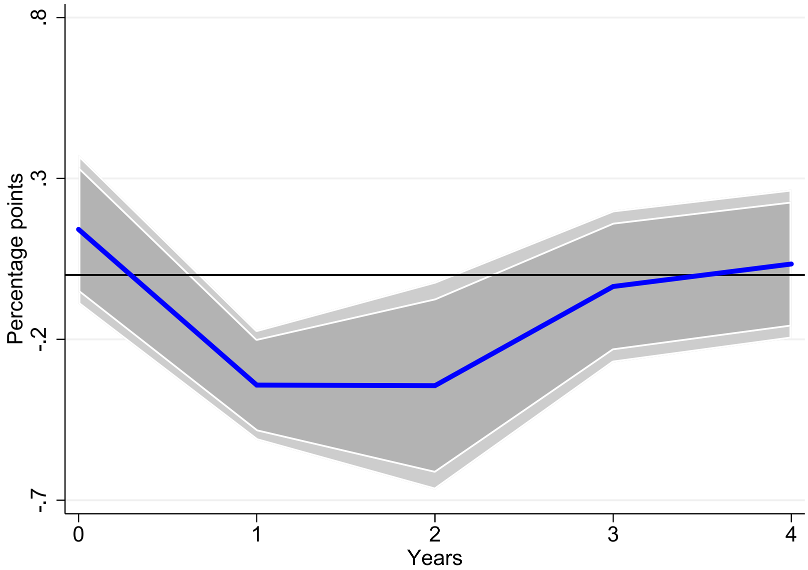


Fig. 3. Average firm level investment response to monetary policy shock. Note: effect of a 1 basis point upward surprise on the net investment rate. Shaded areas represent 90 and 95 percent confidence bands. Clustered standard errors at firm and time level.

swaps in year t, is followed by a drop in the investment rate in year t + 1 and t + 2 of 0.34 pp. Importantly in year t + 2, although the point estimate is identical as in year t + 1 the precision of the estimate halves (i.e the standard error of the estimate at 0.16 almost doubles compared to year t + 1, i.e. 0.09).

One possible interpretation of the higher standard error in year t + 2 is that effects of monetary shocks dissipate faster for some firms than for others. Even with the large dataset we used here we can be much more confident about the effect of the shock after one year than after two years. This is important, as we will see, inference on differences of monetary policy effects across different groups after one year will be easier than inference on differences of the effect after two years. In the third and fourth year after the shock, instead, there are no longer any significant effects. This u-shaped pattern with a peak in year one and two after the shock, is consistent with our aggregate quarterly analysis. Therefore, using aggregate time series and firm level micro data give us the same message: the negative effect on investment of a contractionary shock happens in year one and two after the shock and the rebound happens three years after. The consistency between firm level micro response and the aggregate data gives us a meaningful benchmark to study the heterogeneous effect across firms belonging to different groups.

Before testing heterogeneous effects across groups, we first test whether pooling all countries in our full sample might obscure country differences in the strength of reaction to monetary policy shocks. We interact the monetary policy shock $\epsilon_{i,t}$ with country dummies and re-estimate Eq. (2). Table C.1 in Appendix C reports the estimation results while Fig. C.2 reports the impulse response functions for each country. The pattern of the responses follows the u-shaped form for each of the countries. In all the four countries considered, the effect of an upward monetary policy surprise is largest in either year one or two. The point estimates for Spain and Italy are somewhat larger in absolute value, however are less precisely estimated. At the horizon of one and two years, F-tests at the 1 percent significance level for equality of the coefficients fail to reject equality. Only at a horizon of two years at the 5 percent level we can reject equality of the coefficient of Germany (−0.18) and Spain (−0.56) ($F_{1,155} = 5.49, p < .05$) and France (−0.11) and Spain (−0.56) ($F_{1,155} = 5.14, p < .05$). So Spanish firms seem to react stronger with some evidence of this in the effect two years after the shock. All in all, the evidence is not strongly in favor of notable country differences across countries. Dedola and Lippi (2005) also find that for output reactions to unanticipated monetary policy cross-industry differences are highly important but cross-country differences are not, so in the following we examine heterogeneity along different dimensions using the pooled full sample.

5. Heterogeneous investment response to monetary policy

5.1. Proxies for financial constraints

Financial frictions are an important potential source of heterogeneity in the transmission of monetary policy. They are a key determinant in the existence of the credit channel (Bernanke and Gertler, 1995). A large literature argues that financially constrained firms should have larger reactions to monetary policy shocks.[11] However, theories do not give any clear guidance on the exact identification of financial frictions.

[11] The mechanism goes as follows: capital market imperfections, such as e.g. imperfect information causes the access to finance (or terms of credit) of certain types of borrowers to be a function of their balance sheet. Say those borrowers have to pledge collateral. Monetary policy shocks move the value of that collateral and therefore the terms of credit.

Since financial frictions are not directly measurable, the literature has resorted to proxies or indicators. Various measures of information asymmetries (as these represent the main source of financial market imperfections) have been used as proxies for financial frictions. For instance, Gertler and Gilchrist (1994) use the firms' size postulating that "*the information frictions that add to the cost of finance apply mainly to younger firms, firms with a high degree of idiosyncratic risk, and firms that are not well collateralized. These are, on average, smaller firms.*"

Also other variables have been used to capture ways to cope with imperfect information, which hinders access to capital markets such as dividend policy, membership in a group or conglomerate, existence of bond rating, and concentration of ownership (see for instance Devereux and Schiantarelli (1990), Schiantarelli (1995) and Farre-Mensa and Ljungqvist (2016) for a more recent critical review of the most commonly used indicators of financing constraints).

According to Ferrando and Mulier (2015) firms that are more likely to be financially constrained[12] are also less liquid, more leveraged (expressed in terms of total debt to asset ratio), less profitable and smaller. Less liquid firms are more exposed to liquidity shocks which increases the probability that banks will be unwilling to supply external finance. The expected relation between leverage and financing constraints is twofold. On the one hand, a high leveraged firm might feel unconstrained as it holds a lot of debt on its balance sheet, but on the other hand, this might make it difficult or costly for the firm to find new debt. Finally, more profitable firms should have easier access to external finance as they generate more cash flow which increases the likelihood that they will be able to repay their loans. As profitability is directly related to cash flow and therefore investment we do not consider it as a proxy of financing constraints for our purpose, but we retain size, leverage and liquidity as traditional proxies.

For the purpose of this paper, the disadvantage of using only size, leverage and liquidity as proxies for financial constraints is that they endogenously respond to shocks or vary over the cycle. Accordingly, it is hard to interpret any ex-post heterogeneity as being driven exclusively by ex-ante differences in these specific firm characteristics.

In order to overcome this issue, we also use firms' age as an exogenous proxy for financial frictions. Gertler (1988) was one of the first to argue that firms' age is an important determinant of how much firms are financially constrained and that it is exogenous to any business cycle fluctuations or monetary policy shocks. Hadlock and Pierce (2010) reinforced the idea that age, together with size, is an important factor to determine whether firms are financially constrained. Moreover they found that below certain cut-off points there exists a quadratic relation between size and constraints, while the relation is linear between age and constraints. More recently, age has been used by others as a proxy for the presence of financial frictions also in empirical work studying the monetary policy effect on various firms' outcomes (Cloyne et al., 2018; Bahaj et al., 2022).

We check how age correlates with our other measures, size, leverage and liquidity. Fig. 4 shows that in our dataset younger firms are on average smaller, more leveraged and less liquid, indicating indeed a positive correlation with other proxies of constraints.[13] The fact that on average young firms are more highly leveraged is also found by Dinlersoz et al. (2018) for non-listed firms in the US.[14] They argue that this is consistent with financial frictions models, which predict that firms pay down (long-term) debt as they age.

5.2. Results based on age, size, liquidity and leverage

In this section we report on the heterogeneous response to monetary policy according to observable characteristics that proxy for financing constraints. We use age as exogenous measure and also report estimation results by grouping the sample of firms according to the balance sheet characteristics often used in the literature to characterize financial frictions; size, leverage and liquidity.[15] In order to study the heterogeneous response to monetary policy across firms with different age, we define three sub-groups: young, mature and old. We first define age as years since incorporation[16]: a firm is young when it is between 1 and 10 years old, mature from 11 up to 20 years and old from 21 onwards. In practice this implies that each group represents roughly one third of observations. Using those three age groups, we estimate Eq. (2) for each horizon $h \in (0,1...4)$. The group dummy variables D_{it}^{g} are D_{it}^{y}, D_{it}^{m} and D_{it}^{o} for respectively the young, mature and old firms. Note that we do not keep age fixed to define which sub-group a firm belongs to (e.g. when a firm turns 11 it switches from young to mature and similarly at age 21 from mature to old).

Since age is exogenous we multiply the shock at year t with the age dummy of year t (and not age dummy of year $t-1$). In Fig. 5 we report the impulse response functions for the groups of young, mature and old firms and also show the *difference* in the impulse response functions (and their error bands) of the young versus the old firms (panel d) and of the mature versus the old firms (panel e). Estimates of these differences and their error bands are obtained by the equivalent regression reformulated such that the old firms are the reference group. Our first observation is that none of the groups has a significant contemporaneous reaction of investment, in line with our earlier results. At the horizon of one year, young firms react strongest with a point estimate of −0.38,

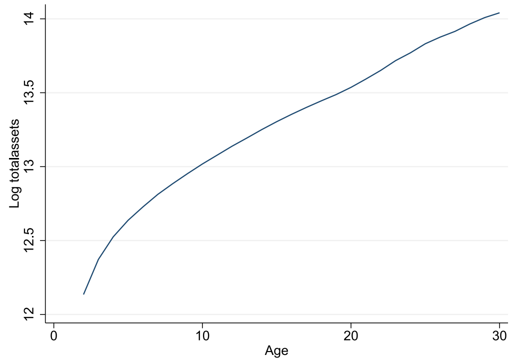
12 Ferrando and Mulier (2015) use a survey-based measure of financing constraints, based on rejections of loan applications and discouragement for fear of rejection to apply for bank products.

13 Size is measured as the natural logarithm of total assets, leverage as loans plus long term debt scaled by total assets, and liquidity as current assets minus stocks scaled by current liabilities. Exact definitions are provided in Table D.1 in Appendix D. To obtain the summary statistics in Fig. 4 we collapse our dataset in order to obtain the mean value of each firm characteristic by age.

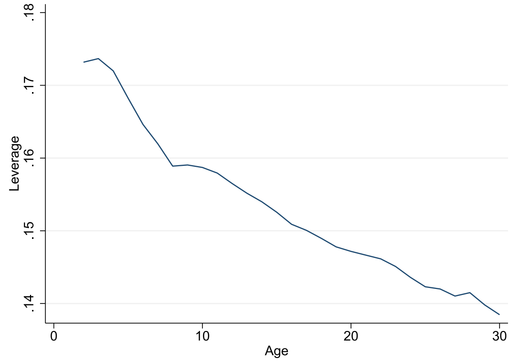
14 For listed firms, which on average are much older and much larger than non-listed firms, Dinlersoz et al. (2018) find the opposite.

15 For each of these characteristics we group firms according to the distribution of the variable, i.e lower quartile, middle two quartiles and upper quartile. We provide level effects regressions (Table E.1, Table E.3, Table E.5, Table E.7) and regressions with a reference group (Table E.2, Table E.4, Table E.6, Table E.8) as well as additional figures (Fig. E.1, Fig. E.2) in Appendix E. Compared to Table 3 the coefficients of the control variables barely move, to save space we do not report them. They are available upon request.

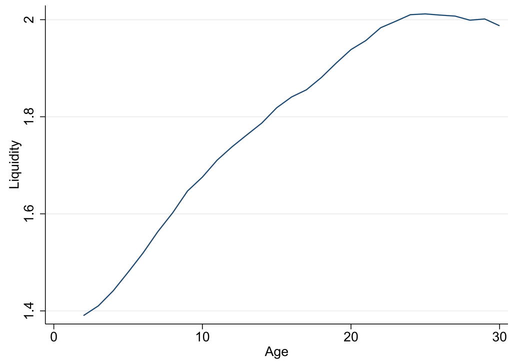
16 The variable name in the BvD Orbis database is 'years since incorporation'.



(a) Age vs Size



(b) Age vs Leverage



(c) Age vs Liquidity

Fig. 4. Correlation between age and firms' characteristics.
Source: BvD Orbis and own calculations.

compared to a point estimate of −0.34 for mature and −0.30 for old firms. Hence compared to an average firm, young firms have approximately a 10 percent stronger reaction whereas old firms have around 10 percent smaller reaction. The difference between young and old firms is significant at the 5 percent level. At the horizon of two years the reaction of young firms is essentially the same as the mature and the old firms. As before, three years after the shock the effect has vanished for all firms. Note that Fig. 5 (panel (d)) also shows that the young, besides at a horizon of 1 year, also react significantly stronger than the old at horizon 0 (and horizon 4). However as the total reaction at both these horizons is insignificantly different from zero (for both young and old) these statistical differences are economically immaterial. The relevant and important difference between young and old firms is at the horizon of 1 year. The key finding is that at that horizon compared to the old, the young have on average a 30 percent stronger

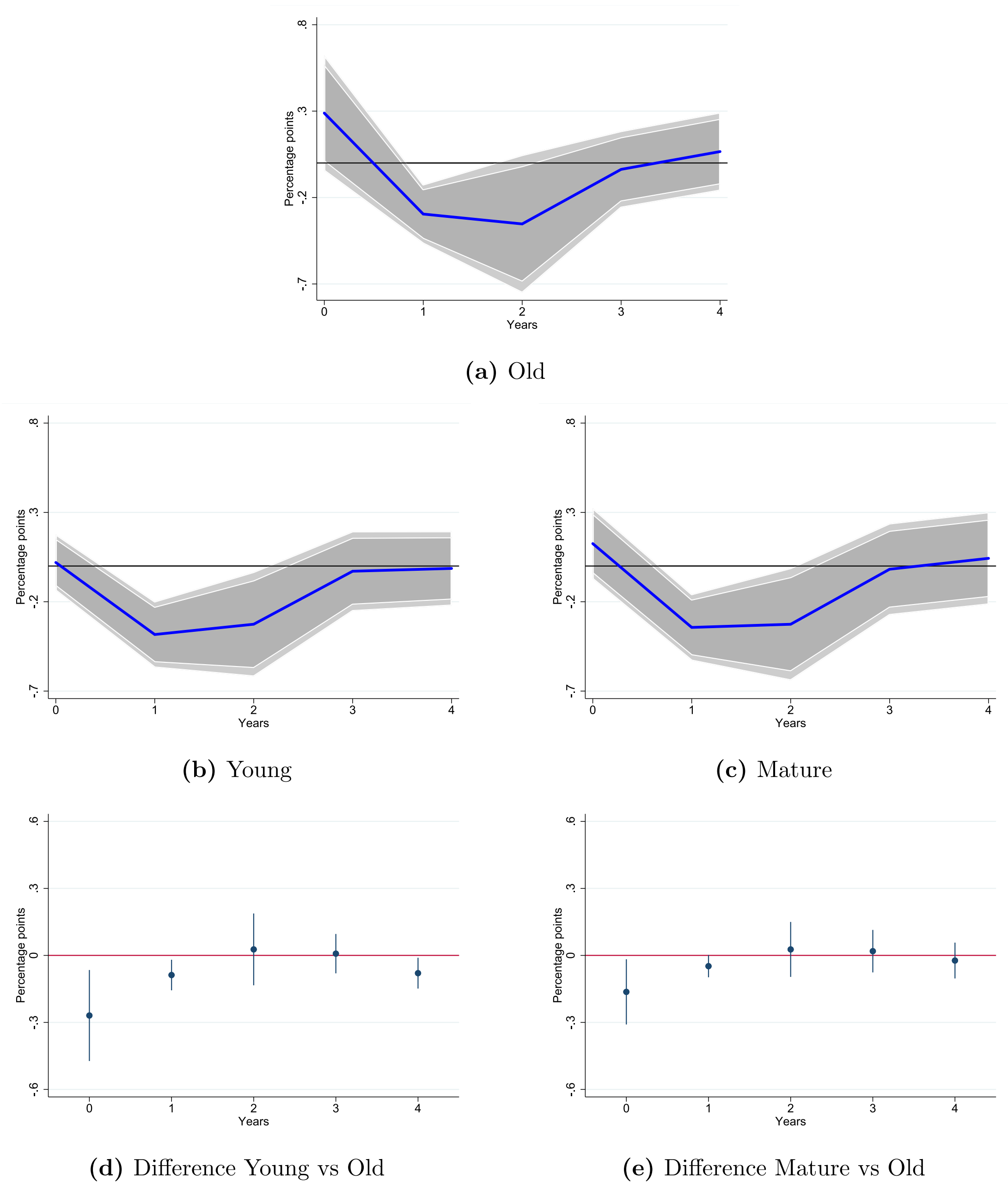


Fig. 5. Firm level investment response to monetary policy shock by age. Note: Shaded areas represent 90 and 95 percent confidence bands. Bars in (d) and (e) represent 95 percent confidence interval of the difference in the impulse responses. Clustered standard errors at firm and time level.

reaction. In a robustness check, we lower the threshold for the young firms to 9, 8 or 7 year respectively, the regression results (shown in Tables F.1–F.3 in Appendix F) are very similar.

The heterogeneous reactions with respect to age support the existence of a credit channel that predicts an amplification effect of monetary policy, i.e. a stronger reaction of financially constrained firms. These are in line with results in Cloyne et al. (2018). This suggests that financial frictions contribute to the heterogeneity of firms' investment responses to monetary policy. However the age-effect is not that strong. It is only present in the first year after the shock. Nevertheless it is likely that what we have estimated represents a lower bound on credit channel effects. Using observable characteristics it is clearly impossible to have a perfect separation of financially constrained versus unconstrained firms. Not all young firms will be financially constrained, and there are certainly firms that are mature or old that are financially constrained. Therefore the difference in the reaction of both groups is expected to be a lower bound of the credit channel effect.

In contrast to our results with respect to age, we find that size of the firm is not very informative to predict the reaction to monetary policy. At the horizon of 1 year large firms react the strongest with a point estimate of −0.39, small firms react the weakest with −0.26, however the difference is not statistically significant. Similarly, at the horizon of two years large firms react the strongest with a point estimate of −0.44, while small firms react the weakest with a point estimate of −0.19, however the difference is only significant at the 10 percent level. Although these results are somewhat surprising, given the role of size as a traditional proxy for financing constraints, the results for size are nevertheless consistent with the recent findings of Crouzet and Mehrotra (2020) who similarly find no differences in reaction to monetary policy shocks for firms with different sizes.

In our regressions using the liquidity grouping we do not find statistically significant differences either. This might reflect the ambiguous nature of liquidity. It is not a priori clear how liquidity of the firm relates to financing constraints. On the one hand, low liquidity firms could be more exposed to shocks and be more constrained when a shock hits, on the other hand a firm could choose to hold more liquidity because it expects to be borrowing constrained (Kim et al., 1998). At the horizon of 1 year the least liquid firms react the least with a point estimate of −0.30, firms in the middle two quartiles of liquidity react the strongest with −0.36, however the difference is not statistically significant. At the horizon of two years the most liquid firms react the least with a point estimate of −0.30, while firms in the middle two quartiles of liquidity react the strongest with a point estimate of −0.37, however the difference is not statistically significant.

In Fig. 6 we report the impulse response functions for the groups of low, medium and high leverage firms and also show the *difference* in the impulse response functions. For leverage we find results in line with Bahaj et al. (2022) and Jeenas (2019) that higher leveraged firms react stronger. This is most visible at the horizon of two years, where the highest leveraged firms react the strongest with a point estimate of −0.48, the lowest leverage firms react the least with a point estimate of −0.24, the difference being statistically significant at the 5 percent level. If high leverage is interpreted as an indication of a higher external finance premium, this result is consistent with the interpretation that firms that are more likely to be financially constrained react more to monetary policy.

5.3. Results based on sectors and industries

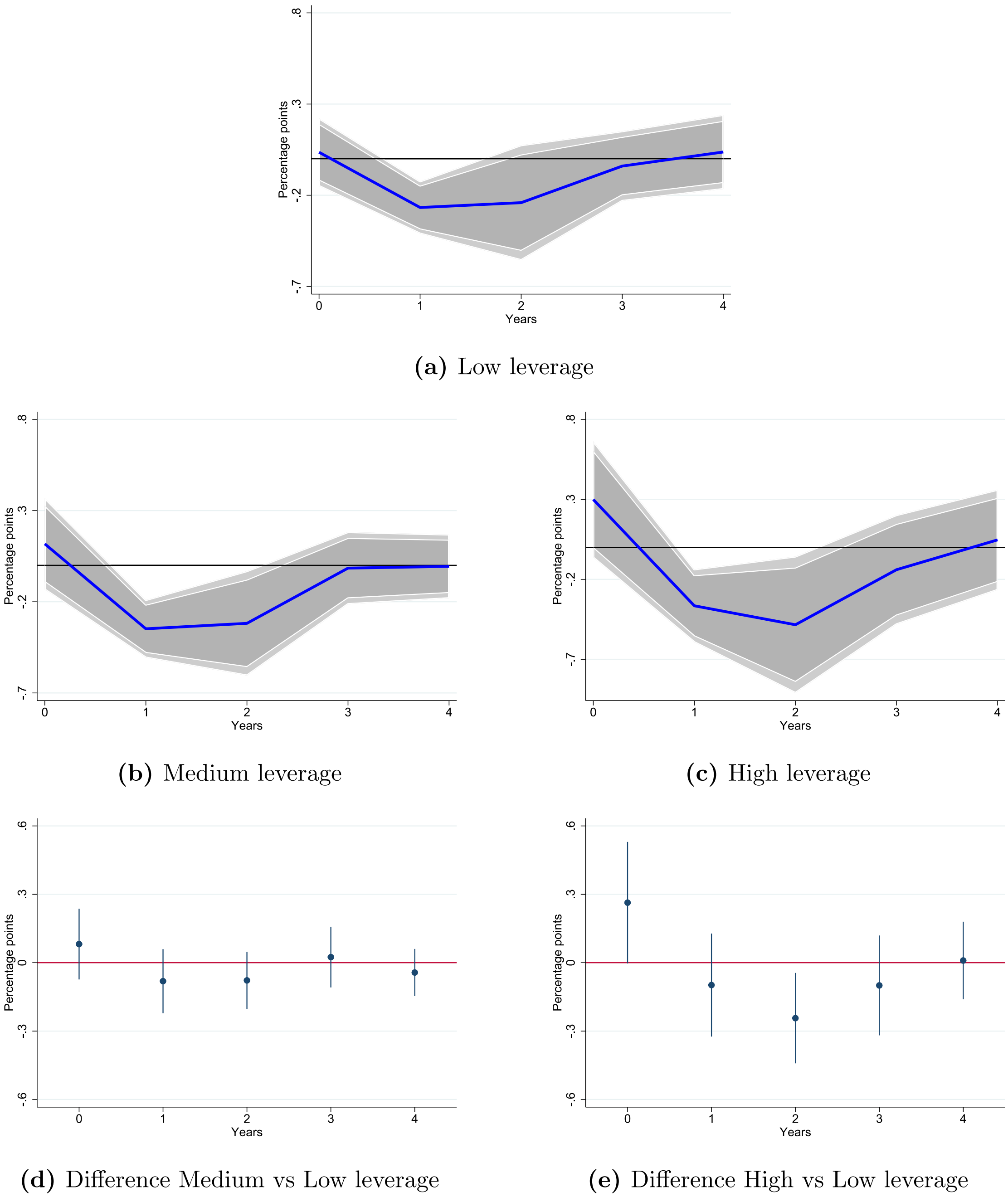
In this section, we analyze differences in the impulse response functions of investment across different sectors and industries. We start by considering three broad sectors: manufacturing (NACE rev.2 C), construction (NACE rev.2 F) and services. The latter is obtained by pooling together the following NACE rev.2 sections: wholesale and retail trade (G), transport and storage (H), accommodation and food activities (I), information, communication and R&D (J) and other business activities (M and N). Then, we analyze several industries corresponding to the NACE rev. 2 two-digit Divisions within the three broad sectors. The idea is that by documenting differences in the responses at sectoral or industry level we can learn something about the transmission mechanism of monetary policy.

We estimate Eq. (2) for each horizon $h \in (0,1...4)$ by assigning each firm to one of the three main sectors such that the group dummy variables D_i^g are D_i^{man}, D_i^{con} and D_i^{ser} for respectively the manufacturing, construction and services firms. Table G.1 in Appendix G reports the estimation results while Fig. 7 shows the impulse response functions of manufacturing, services and construction separately. Again, we also show the differences in the impulse response functions of manufacturing and construction firms with services firms.

One year after the shock, a 1 basis point upward surprise produces a decrease in the investment rate of 0.40 pp for construction sector firms and 0.38 pp for firms in the manufacturing sector. For firms operating in services, a 1 basis point surprise leads to a drop in the investment rate of 0.31 pp. Two years after the shock, the effect remains stronger for construction (−0.36) and manufacturing (−0.47) relative to services (−0.28). The temporary change in the investment rate after a contractionary shock is therefore the strongest for construction and manufacturing firms. We conclude that after a monetary policy surprise, construction and manufacturing firms react roughly one quarter stronger than firms in services.

Given the impulse response functions shown in Fig. 7 one may wonder what is behind the stronger reaction of manufacturing firms. One of the most consistent findings in the literature on heterogeneity of *output* effects of monetary policy shocks is that within the manufacturing sector durable goods industries react more strongly than industries producing non-durables (See Dedola and Lippi (2005) and Peersman and Smets (2005)) which is consistent with a demand driven interest-channel story. Also, Ganley and Salmon (1996) and Barth and Ramey (2002) provide further evidence on industry differences in output reactions to monetary policy.

In order to investigate whether similar industry differences, as were found for output in these earlier studies, are at work when we consider investment spending we proceed as follows. Given the theoretical reasoning that durable goods demand should react stronger to interest rates (due to user cost effects) paired with the consistent finding in the earlier literature discussed above that



(a) Low leverage

(b) Medium leverage

(c) High leverage

(d) Difference Medium vs Low leverage

(e) Difference High vs Low leverage

Fig. 6. Firm level investment response to monetary policy shock by leverage. Note: shaded areas represent 90 and 95 percent confidence bands. Bars in (d) and (e) represent 95 percent confidence interval of the difference in the impulse response functions. Clustered standard errors at firm and time level.

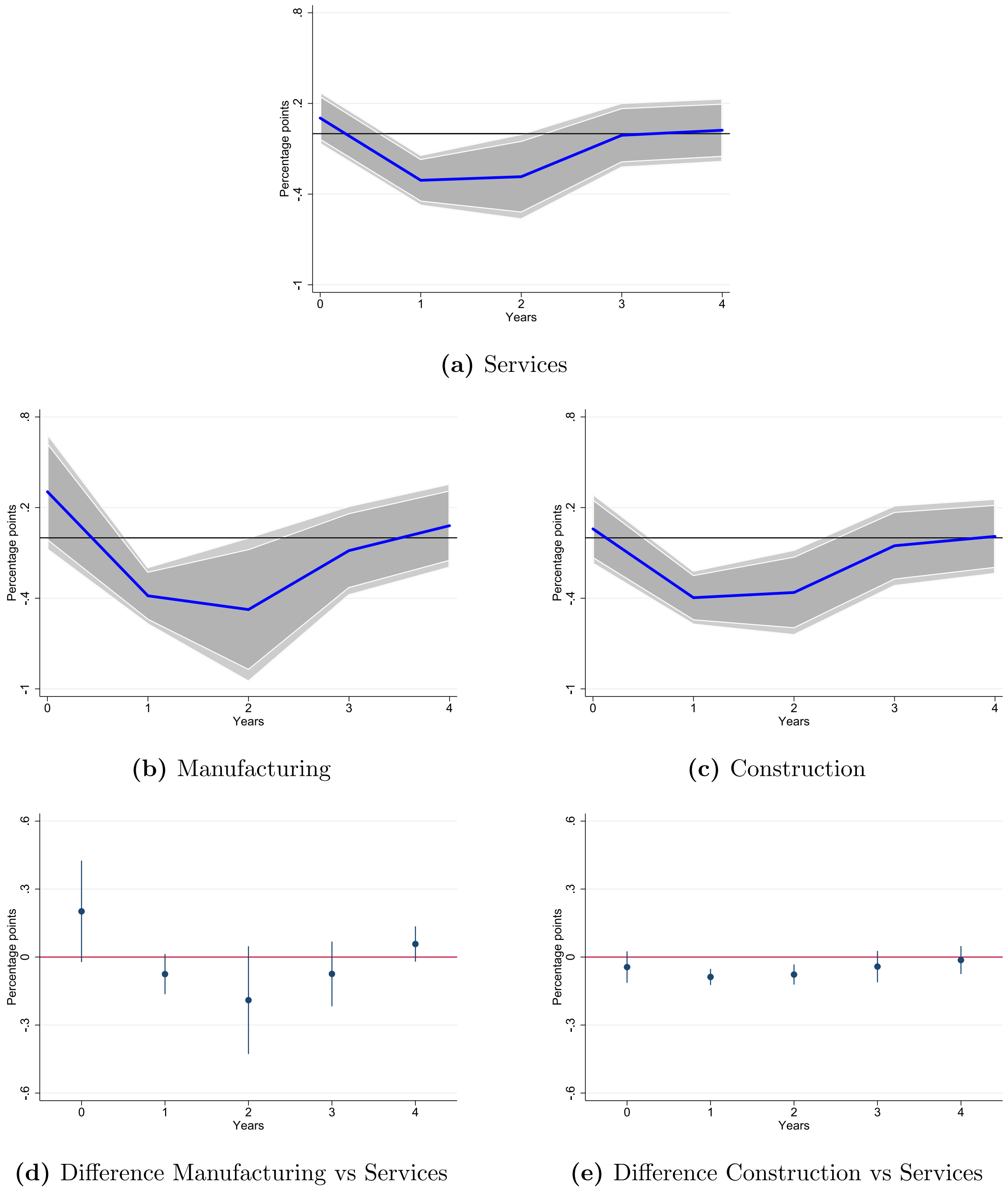
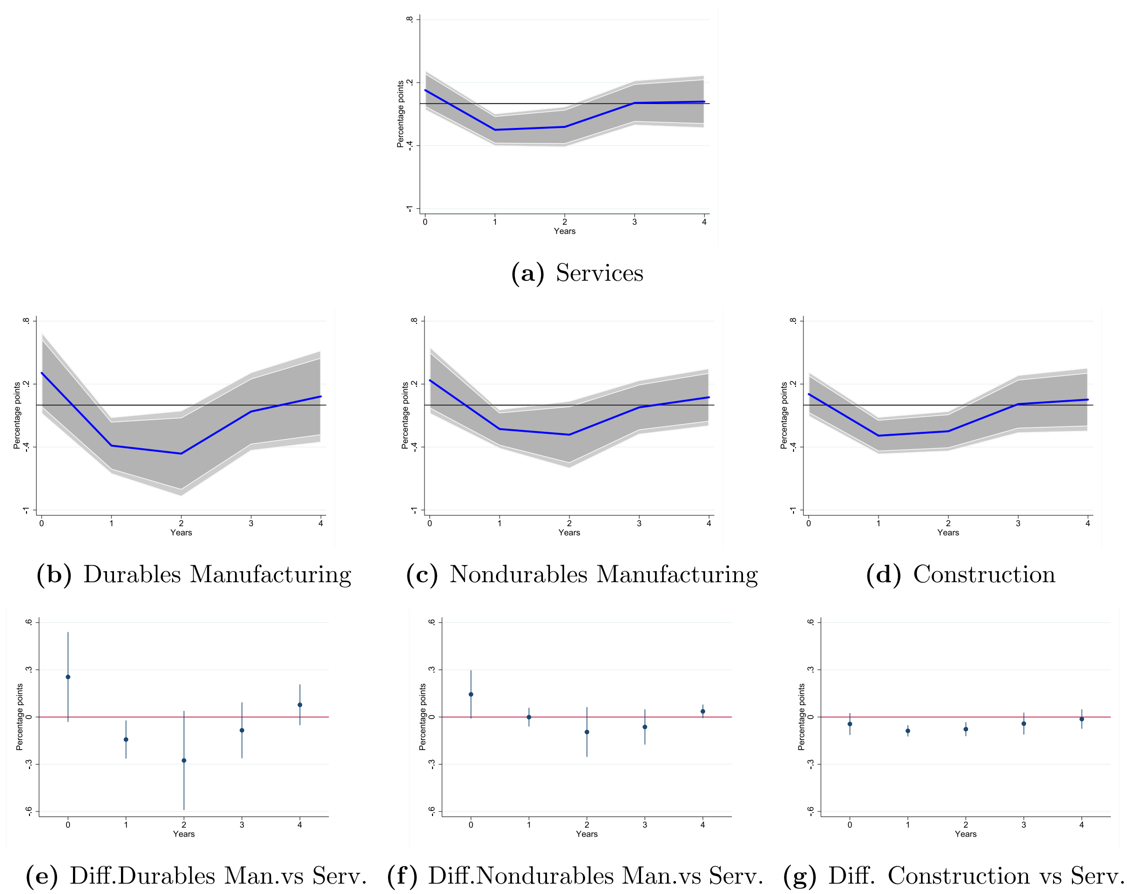


Fig. 7. Sectoral response to monetary policy shock. Note: shaded areas represent 90 and 95 percent confidence bands. Bars in (d), and (e) represent 95 percent confidence interval of difference in impulse responses. Clustered standard errors at firm and time level.



(a) Services

(b) Durables Manufacturing (c) Nondurables Manufacturing (d) Construction

(e) Diff.Durables Man.vs Serv. (f) Diff.Nondurables Man.vs Serv. (g) Diff. Construction vs Serv.

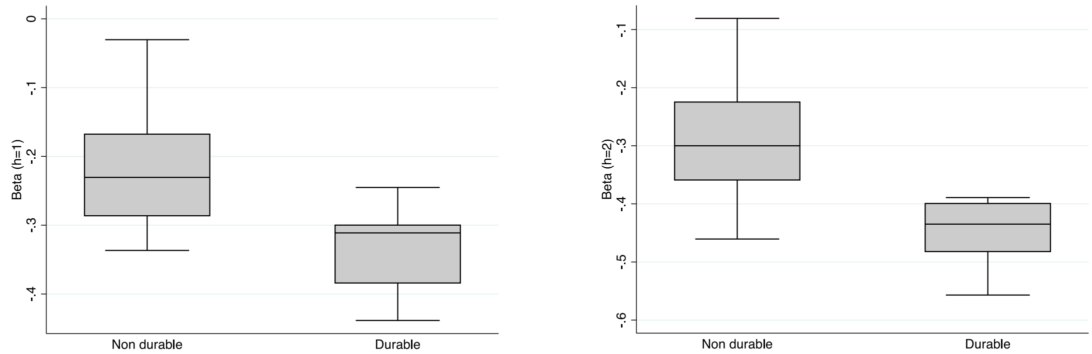
Fig. 8. Firm level investment response to monetary policy shock: durables Manufacturing, nondurables manufacturing, construction, services. Note: shaded areas represent 90 and 95 percent confidence bands. Bars in (e), (f) and (g) represent 95 percent confidence interval of the difference in impulse responses. Clustered standard errors at firm and time level.

output of durable goods producing industries react stronger to monetary policy shocks we first analyze whether the *investment* of manufacturing firms that produce durables also reacts stronger after a monetary policy shock.

First, we define the new group dummy variables durables, D_i^{dman} and nondurables, D_i^{ndman} (i.e. each manufacturing firm belongs to one of these groups) and re-estimate Eq. (2) using the now four groups (durables manufacturing, nondurables manufacturing, construction, services).[17] As we want to test differences, we take the services firms as baseline. Estimation results are presented in Table G.2 in Appendix G. Fig. 8 shows the impulse response functions for firms operating in the durable and non-durable manufacturing industries, construction and services separately. We also show the differences in the impulse response functions of the durable and non-durable manufacturing industries and construction with the services firms.

The stronger reaction of investment of firms in the durable-manufacturing industries is immediately visible, especially when compared with non-durable manufacturing industries and services firms. We thus find that indeed, the stronger reaction of manufacturing firms we found earlier is due to the durables producing firms. At a horizon of one year, a 1 basis point upward surprise produces an extra decrease in the investment rate of 0.14 pp for durable producing firms relative to services, that is a total effect of 0.45 pp, so almost a 50 percent stronger reaction than services. For non-durable producing firms, there is no difference with services at a horizon of one year, i.e. the investment rate drop is 0.31 pp, identical to that of services firms. After two years the durables manufacturing show a difference of 0.28 pp with services (significant at the 10 percent level), that is a 100 percent stronger total reaction, i.e. 0.56 pp versus 0.28 pp for services. Construction is also reacting significantly more than services in both years.

[17] The durable industries are: manufacture of basic metal, manufacture of computer and electronic products, manufacture of electronic equipment, manufacture of fabricated metal products, manufacture of other non metallic minerals, manufacture of wood and products of wood and cork, manufacture of furniture, manufacture of machinery and equipment, manufacture of motor vehicles and trailers, manufacture of transport equipment. All the others are the nondurables industries.



(a) h = 1 (b) h = 2

Fig. 9. Firm level investment response to monetary policy shock for 31 industries grouped into durable and non-durable producing. Note: The figure plots the distribution of the estimated coefficients β^1 and β^2 from Eq. (2) using estimates for the pooled sample shown in Table G.3.

The granularity of our firm level dataset allows us to further disaggregate the manufacturing sector into 24 two-digit NACE code industries and the services sector into 6 two-digit NACE code industries.[18] Table G.3 in Appendix G shows the values of estimated coefficients β^h from Eq. (2) at one year and two years horizon for the 31 industries in each country. Since the previous results show that the average effect of monetary policy at the firm level is concentrated around year one and two after the shock, we discuss these detailed results only referring to those two years.

Looking across the 248 estimated coefficients, we can observe that the effect of an upward surprise leads almost everywhere to a decrease in the investment rate, since the coefficient values have almost all a statistically significant negative sign. However, there are clear differences across industries in the strength of the effect. For instance, in Germany at the horizon of one year, the most sensitive industry is the manufacture of basic metal (−0.74) whereas some low (statistically significant) sensitive industries are other non-durable goods (−0.15), accommodation and food services (−0.19) and retail trade (−0.19). Similar large differences can be observed across industries within the other countries. This finding suggests that, while country-specific differences seem to be not so relevant, marked differences appear across industries. This result is also in line with industry level findings on *output* by Dedola and Lippi (2005). To the best of our knowledge, our findings on *investment* are new.

Not surprisingly, the durability of the output is associated to the strength of the reaction of investment to monetary policy. Fig. 9 plots the distribution of the estimated 31 coefficients from Eq. (2) at horizon one (Panel a) and two years (Panel b) using the pooled sample. We group separately firms operating in durables industries and the ones that do not (i.e the nondurables manufacturing, construction and services industries). Fig. 9 shows that for both horizons, the distribution of the estimated coefficients for the group of durables producers are significantly more concentrated around larger negative values.[19]

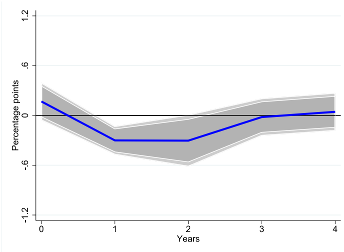
5.4. Results combining durability and age

In the previous sections, we found that age and leverage of the firm and whether it produces durables affect the strength of the effect of monetary policy shocks on investment. This suggests that both the credit channel and the interest-rate channel are operative. To identify which channel is likely to be the strongest, we first interact our exogenous proxy for financing constraints, the age grouping, with the durability grouping. In the next section we will then analyze age, leverage and durability combined. To simplify the discussion, we create 4 groups so that a firm belongs to one (and only one) group. We do this as follows. We first combine the mature and old firms and call these the 'Not-Young' firms. A firm is therefore Young or Not-Young. Similarly, we combine the nondurables manufacturing, construction and services firms and call these the 'Nondurables' firms. A firm is therefore a 'Durables' firm or a 'Nondurables' firm. Crossing these two characteristics, every firm belongs to one of four groups.[20] We choose as the reference group the largest group, i.e. the Nondurables-Not-Young firms. Their investment represents a share of 58 percent of aggregate investment. The Nondurables-Young firms group is the second largest with a share of 25 percent. Third is the Durables-Not-Young firms with a share of 14 percent. The Durables-Young firms have a share of 3 percent in aggregate investment.

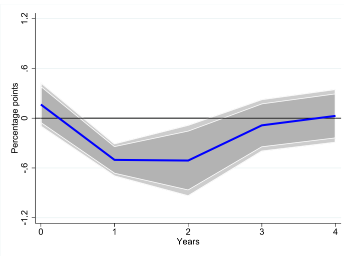
[18] We end up with a total of 31 industries: 24 two-digit NACE code industries for the manufacturing sector, 6 two-digit NACE code industries for the service sector and the construction sector.

[19] In Fig. H.1 in Appendix H we show the box plots for each country. These confirm that also *within* each country Durable Goods Manufacturing Industries react more.

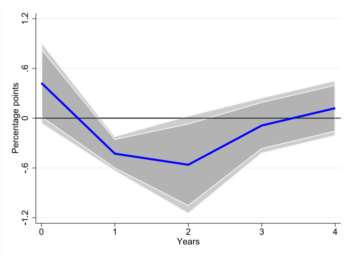
[20] These four groups are: Durables-Young firms (dummy variable D_{it}^{dy}), Durables-Not-Young firms (dummy variable D_{it}^{dny}), Nondurables-Young firms (dummy variable D_{it}^{ndy}) and the Nondurables-Not-Young firms (dummy variable D_{it}^{ndny}). In Table I.1 and Fig. I.1 in Appendix I we provide the results of a more detailed grouping where we interact the age grouping (young, mature, old) with the sectoral grouping (durables manufacturing, nondurables manufacturing, construction, services) to obtain twelve distinct groups of firms. The results are qualitatively similar. We thank a referee for the suggestion to simplify the analysis into 4 groups.



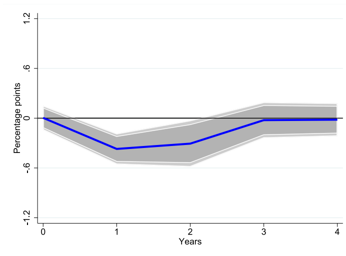
(a) Nondurables-Not-Young



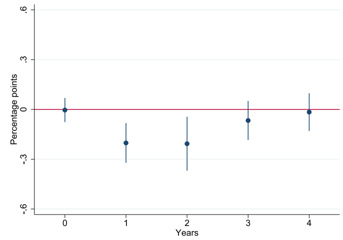
(b) Durables-Young



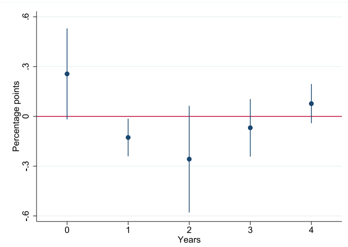
(c) Durables-Not-Young



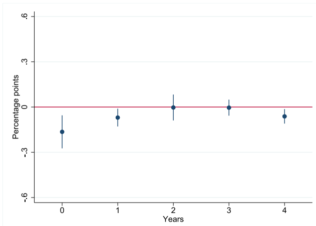
(d) Nondurables-Young



(e) Difference (b)-(a)
Joint effect of durability and young age



(f) Difference (c)-(a)
The effect of durability



(g) Difference (d)-(a)
The effect of young age

Fig. 10. Firm level investment response to monetary policy shock: effect of durability and age. Note: (a), (b), (c), (d) are impulse response functions. Shaded areas represent 90 and 95 percent confidence bands. Bars in (e), (f) and (g) represent 95 percent confidence interval of the difference in the impulse response functions. Clustered standard errors at firm and time level.

We again estimate Eq. (2) and use the group of firms that reacts the least to monetary policy, i.e. the Nondurables-Not-Young firms, as the reference group. Results are presented in Table J.2 in Appendix J.[21] Fig. 10 shows the impulse responses of the four groups and the differences with respect to the Nondurables-Not-Young reference group.

In the first year after the shock, the reference group of Nondurables-Not-Young firms has a reaction of −0.30 pp. The same is true for the second year. This is very similar to the reaction of services firms we saw earlier, which is unsurprising as they form by far the largest share within that group. Durables-Young firms have around a 66 percent stronger reaction than this base group in both years (i.e. an additional 0.20 pp in the first year and 0.21 pp in the second year). Both are statistically significant (at 1 pct level for the first year and 5 pct level for the second year). So the joint effect of durability and being young is strong. Also the effect of durability on the Not-Young firms is strong. This can be seen by comparing the Durables-Not-Young firms with our reference group. For the Durables-Not-Young firms we find that they have around a 40 percent stronger reaction in the first year and an (albeit imprecisely) estimated 90 percent stronger reaction in the second year (i.e. an additional 0.13 pp in the first year and 0.26 pp in the second year). So durability of output affects the reaction to monetary policy a lot, independent if firms are young or not. The effect of age is less strong for the Nondurables firms and basically present only in the first year after the shock. This can be seen by comparing the Nondurables-Young firms with the reference group. For these firms, we find an around 20 percent stronger reaction in the first year and no different reaction in the second year (i.e. an additional 0.07 pp in the first year and no difference in the second year). The picture that emerges is that both durability and age matter, where the effect of durability seems quite stronger and longer lived than that of age.

[21] Estimates of the total effect for each of these groups are reported in Table J.1 in Appendix J.

Using the shares in total investment of the four different groups we do two different back-of-the-envelope calculations. First, we calculate the contribution of each group to the average reaction in the investment rate. This gives an idea how important age and durability are in affecting the average reaction of investment. Second, we calculate the *difference* between the average reaction of firms and a counterfactual average reaction when all firms react as little as the group that reacts the least to monetary policy (i.e. the Nondurables-Not-Young firms) and we evaluate how much durability and age explain this difference. This second exercise can be interpreted as a back-of-the-envelope calculation of the relative importance of the interest rate channel versus the credit channel in determining the average reaction.[22]

We first multiply the estimated coefficient of each group (taken from Table J.1) by the investment share of the group. Summing those we get the average effect (which is very close to the estimated average effect in Table 3):

$$\beta^h_{avg} = \alpha_{ndny}\beta^h_{ndny} + \alpha_{ndy}\beta^h_{ndy} + \alpha_{dny}\beta^h_{dny} + \alpha_{dy}\beta^h_{dy} \tag{3}$$

where α_g is the investment share of group g (with $\sum \alpha_g = 1$), and β_g is the estimated investment response of group g at horizon h.[23]

Each groups' share in the total effect of a monetary policy shock is then the ratio of the estimated coefficient multiplied by the investment share divided by the average effect.

The results of these calculations imply the following. Although the total investment of durable firms has a share of 17 percent of total aggregate investment, it accounts for 21 percent in the reaction of investment one year after the shock and 26 percent (4 percent for the young and 22 percent for the not young) two years after the shock. Similarly, although the total investment of young firms has a share of 28 percent of total investment, it accounts for 32 percent of the reaction of investment one year after the shock and 27 percent two years after the shock. So indeed the effect of age is only present in the first year after the shock. The share of Durables-Young firms in total investment is around 3 percent. Accounting for their stronger reaction to monetary policy shocks, their weight in the reaction of total investment one year after the shock is 1/3 larger at around 4 percent. The Durables-Not-Young firms have a share of around 14 percent of total investment and their weight in the reaction to monetary shocks one year after the shock is around 17 percent (which is around 1/5 larger than their investment share). Although the Nondurables-Not-Young firms have the lion share of total investment, at around 58 percent, their more mute reaction to shocks implies that their weight in the total reaction to a shock after one year is only 51 percent.

For the second back-of-the-envelope exercise we do the following counterfactual thought experiment. If one were to impose that all firms had the investment responsiveness of the least responsive (Nondurables-Not-Young) group, then the implied average responsiveness would be:

$$\beta^h_{low} = \alpha_{ndny}\beta^h_{ndny} + \alpha_{ndy}\beta^h_{ndny} + \alpha_{dny}\beta^h_{ndny} + \alpha_{dy}\beta^h_{ndny} = \beta^h_{ndny} \tag{4}$$

One could think of this as the average investment response in a counterfactual world where all firms are financially unconstrained (Not-Young) and respond with the sensitivity of Nondurables producers.

We now attempt to answer which channel explains the gap between β^h_{avg} and β^h_{low}. This gap can be decomposed as follows in three terms:

$$\beta^h_{avg} - \beta^h_{low} = \underbrace{\alpha_{ndy}(\beta_{ndy} - \beta^h_{ndny})}_{\text{I}} + \underbrace{\alpha_{dny}(\beta_{dny} - \beta^h_{ndny})}_{\text{II}} + \underbrace{\alpha_{dy}(\beta_{dy} - \beta^h_{ndny})}_{\text{III}} \tag{5}$$

The economic intuition of term I is that the gap exists because some firms are actually Young. The intuition of term II is that the gap exists because some firms are actually Durables producers. We use a comparison of the relative share of the terms I and II to provide an assessment of whether the average responsiveness β_{avg} is explained by the credit channel or the traditional interest rate channel, respectively. (Note that term III denotes the joint effect of both being Young and being a Durables producer. This term can be distributed over the two channels.)

We find that the difference between β^h_{avg} and β^h_{low} at the horizon of 1 year (−0.04) is for 43 percent explained by term I and for 42.5 percent by term II (and for 14.5 percent by term III). Therefore the gap can be explained about half by the interest rate channel and half by the credit channel. At a horizon of two years the importance of term I drops to 6 percent, while 80 percent can be explained by term II and 14 percent by term III. Therefore the traditional interest rate channel seems to explain most of the effect after two years. Note that this exercise cannot explain why the firms that respond the least, i.e Nondurables-Not-Young firms respond the way they do. We can assume that they react mostly due to the traditional interest rate channel.

5.5. Results combining durability, age and leverage

Is the effect of age possibly a proxy for the effect of leverage? We know that young firms are on average more highly levered, so it is possible that young age might proxy for high leverage. We also found that leverage matters at a horizon of two years. To understand better the interplay between durability, age and leverage, we split each of the four cross groups of durability and age into two subgroups, i.e. a subgroup with low leverage (below the 75 pctile) and a subgroup with a high leverage (above the 75th percentile). We can therefore check whether leverage matters *within* each cross group. If it matters within groups it would imply that age is not simply a proxy for leverage, but that leverage matters independently from age.

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[22] We thank an anonymous referee for developing and suggesting this second back-of-the-envelope exercise.

[23] The four groups are: Nondurables-Not-Young, Nondurables-Young, Durables-Not-Young and Durables-Young.

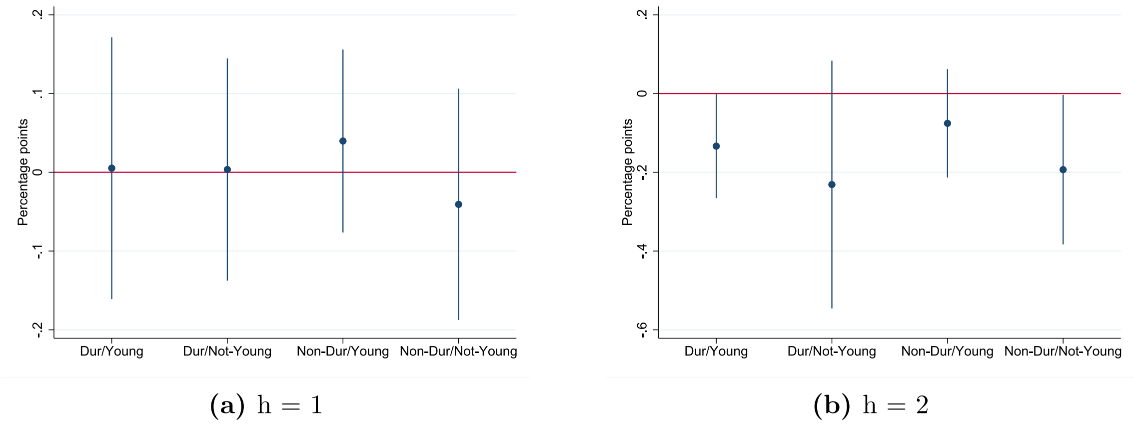


Fig. 11. Effect of leverage for age and durability groups: difference between high and low leverage. Note: The figure plots the difference (dot) and 95 percent confidence interval (line) in the estimated coefficients β^1 and β^2 between high and low leverage subgroups within the four age-durability cross groups.

Fig. 11 shows the difference in the point estimates between the high and low leverage subgroups *within* each of the four durability-age cross groups.[24] Panel (a) in Fig. 11 indicates that for each of the four durability-age cross groups leverage at a horizon of 1 year does not matter. There is no statistically significant difference between subgroups with low and high leverage. The point estimate of the difference is always very small. This is consistent with our earlier results that leverage has no effect at a horizon of 1 year.

However, in the second year the difference in the point estimates between lowly leveraged and highly leveraged firms for all four group is much more sizeable. The differences are statistically significant at the 5 pct level for two groups. A significant difference exists between the Durable-Young-highly-leveraged firms (estimate −0.60) and the Durable-Young-lowly-leveraged firms (estimate −0.46). Basically for the young firms in the durable industry high leverage matters and make those firms react even stronger to monetary policy. A second group for which leverage matters significantly is the large group of Non-durable Not-Young firms. There the lowly-leveraged firms (point estimate −0.26) react much less than the highly-leveraged firms (point estimate −0.45). All in all, this confirms our earlier results. High leverage firms react stronger to monetary policy after two years, and this is an independent effect from age.

5.6. Age, leverage, durability and other balance sheet characteristics of firms

Are age, durability and leverage the only characteristics that matter for the reaction of investment to monetary policy? An earlier literature that has analyzed different *output* reactions to monetary policy has found that heterogeneous responses across industries are related to a number of characteristics that are either linked to the traditional interest rate channel or the credit channel. Dedola and Lippi (2005) found that the magnitude of the output response to monetary policy shocks is systematically related to industry characteristics such as output durability, financing requirements, borrowing capacity and average firm size in the industry. They show that *output* reactions to monetary policy differ as a function of different industry characteristics. Our large dataset allows us to go more granular and measure characteristics not just at the industry level but at the firm level. This allows us to test if balance sheet characteristics at the firm level are important to explain differences in the reaction of investment to monetary policy.

We follow Dedola and Lippi (2005) in the choice of the balance sheet characteristics. First, we define variables that measure liquidity and financing requirements. In particular, we use short-term debt, leverage (now as a continuous variable) and interest coverage. We add log total assets as a measure of size. A significant relationship of the reaction of investment to monetary policy with these variables would suggest the operation of the credit channel that goes beyond the effect of age and leverage. Second, we include working capital among our variables.[25] If firms with higher working capital requirements react more to monetary policy this would suggest the existence of the cost channel (Barth and Ramey, 2002). To allow for easy interpretation we first standardize the balance sheet variables. We then add to our earlier regression of the 4 cross groups of age and durability both the one-year lagged standardized variables and their interaction with the monetary policy shock. We use one-year lagged balance sheet characteristics to avoid endogeneity.

We first include one balance sheet variable at a time to the regression. We also include country-time fixed effects as we want to allow for country and time variation in the balance sheet variables unrelated to monetary policy. This causes the reference group to drop out of the regression. The interactions of the dummy variables D_{it}^{dy}, D_{it}^{dny} and D_{it}^{ndy} have to be interpreted carefully now as they still represent the difference of the Durables-Young, Durables-Not-Young and Not-Durables-Young firms with respect to the reference group, however now conditional on the firms having the same balance sheet characteristic. The results of these regressions

[24] Table K.1 in Appendix K shows the total effect of each of the subgroups.

[25] A precise definition of our balance sheet variables is provided in Appendix D.

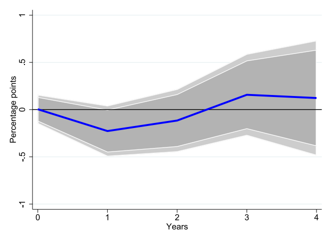
Table 4
Effect of balance sheet characteristics in reaction to monetary policy.

	(1)	(2)	(3)	(4)	(5)	(6)
Horizon 1 year						
$\epsilon_{it} D^{dy}_{it}$	−0.21***	−0.22***	−0.21***	−0.22***	−0.22***	−0.19***
	(0.05)	(0.05)	(0.07)	(0.05)	(0.05)	(0.06)
$\epsilon_{it} D^{dny}_{it}$	−0.11***	−0.12***	−0.06	−0.12***	−0.11***	−0.07**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
$\epsilon_{it} D^{ndy}_{it}$	−0.09***	−0.09***	−0.13**	−0.09***	−0.11***	−0.14**
	(0.03)	(0.04)	(0.05)	(0.04)	(0.04)	(0.05)
$\epsilon_{it} * wcap_{it-1}$	−0.04**					−0.03*
	(0.02)					(0.02)
$\epsilon_{it} * shdebt_{it-1}$		−0.01				−0.01
		(0.01)				(0.02)
$\epsilon_{it} * size_{it-1}$			−0.05*			−0.02
			(0.03)			(0.02)
$\epsilon_{it} * lev_{it-1}$				0.01		0.01
				(0.02)		(0.03)
$\epsilon_{it} * icov_{it-1}$					0.00	0.01
					(0.01)	(0.02)
Observations	7 726 036	7 784 894	7 795 733	7 516 155	6 497 301	6 205 644
Horizon 2 year						
$\epsilon_{it} D^{dy}_{it}$	−0.17**	−0.18***	−0.18***	−0.22***	−0.22***	−0.15
	(0.07)	(0.07)	(0.09)	(0.05)	(0.05)	(0.10)
$\epsilon_{it} D^{dny}_{it}$	−0.18**	−0.18**	−0.14	−0.12***	−0.11***	−0.14
	(0.09)	(0.10)	(0.10)	(0.04)	(0.04)	(0.09)
$\epsilon_{it} D^{ndy}_{it}$	−0.07	−0.08	−0.11	−0.09***	−0.11***	−0.11
	(0.06)	(0.06)	(0.08)	(0.04)	(0.04)	(0.09)
$\epsilon_{it} * wcap_{it-1}$	−0.04					−0.03
	(0.03)					(0.03)
$\epsilon_{it} * shdebt_{it-1}$		−0.03**				−0.01
		(0.01)				(0.02)
$\epsilon_{it} * size_{it-1}$			−0.04			−0.02
			(0.02)			(0.02)
$\epsilon_{it} * lev_{it-1}$				−0.04*		−0.03
				(0.02)		(0.02)
$\epsilon_{it} * icov_{it-1}$					0.05**	0.02
					(0.02)	(0.01)
Observations	6 368 255	6 423 899	6 435 184	6 187 111	5 407 513	5 142 175

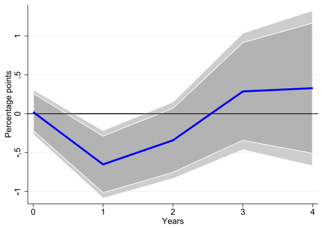
Note: $wcap_{it}$, $shdebt_{it}$, $size_{it}$, lev_{it} and $icov_{it}$ are standardized. Definitions are in Appendix D. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

are presented in Table 4. To save space, we only report coefficient estimates of the interactions of the dummy variables with the monetary policy shock and of the balance sheet variables interacted with the monetary policy shock. These coefficients can be directly interpreted as measuring the percentage point effect of a one standard deviation increase in the balance sheet variable to a one basis point monetary policy shock. We show results for the horizon of one year and two years as these are the horizons where monetary policy has a significant effect.

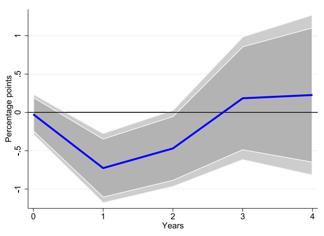
We find that some balance sheet characteristics indeed predict an increase in the reaction to monetary policy shocks. First, we find that firms with higher working capital requirements react more to policy (at a horizon of 1 year) which suggests the existence of the cost channel (Barth and Ramey, 2002). At the horizon of two years the borrowing capacity becomes more important as firms are reacting stronger when they are higher leveraged and have more short-term liabilities. At the same time, at the horizon of two years, firms with a higher interest coverage ratio are reacting less to monetary policy shocks as an additional sign of their operational health. Finally, as it can be seen in the last column, when all these financial characteristics are put together, they become statistically insignificant at a time horizon of two years pointing to an interplay among them to dilute the detrimental impact of negative monetary policy shocks on investment. In line with our earlier results, size does not seem to matter much. Importantly however, the coefficients on the interaction variables with balance sheet characteristics are relatively small compared to those that measure the impact of age and durability. As we have standardized our balance sheet characteristics we can easily interpret this. To take an example, a firm would need to have a 5 standard deviation larger leverage than the average firm to have the same negative effect on investment after a monetary policy shock as a firm that is young and produces durables.



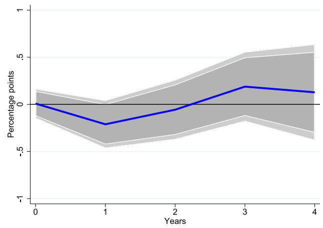
(a) Nondurables-Not-Young



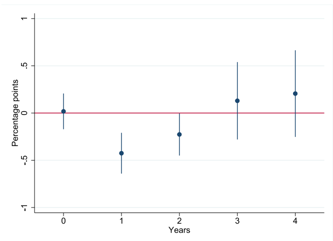
(b) Durables-Young



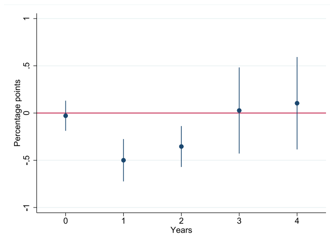
(c) Durables-Not-Young



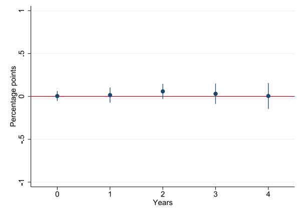
(d) Nondurables-Young



(e) Difference (b) - (a)



(f) Difference (c) - (a)



(g) Difference (d) - (a)

Fig. 12. Firm level sales growth response to monetary policy shock: by durability and age. Note: (a),(b),(c),(d) are impulse response functions. Shaded areas represent 90 and 95 percent confidence bands. Bars in (e), (f) and (g) represent 95 percent confidence interval of the difference in the impulse response functions. Clustered standard errors at firm and time level.

5.7. Sales and financing after a monetary policy shock

We have interpreted the stronger effect of monetary policy shocks on durables firms as stemming from demand effects. The interest-rate sensitivity of durable goods demand is well established. To corroborate our interpretation, we investigate the reaction of sales growth, leverage, short-term debt and working capital after a monetary policy shock. To save on space we only show the impulse response functions. Tables with regression coefficients can be found in Tables L.1–L.4 in Appendix L.

We first investigate the reaction of sales growth after a monetary policy shock. We want to see if sales growth of different groups of firms behaves differently after a monetary policy shock. If the interest-rate channel is operating through a reduction in demand for durables firms, we should observe a reduced sales growth for these firms. Similarly, if the reduced investment of young firms is due to the credit channel we would not necessarily observe reduced sales (although that should not be excluded either as both channels could operate). Once again, we estimate the impulse response function of sales growth after a monetary policy shock. Fig. 12 shows the impulse-response function of the four groups. We indeed find that sales growth drops more for the Durables-Young firms, and the Durables-Not-Young firms, relative to our reference group of Nondurables-Not-Young firms. This confirms our interest-channel demand story for durables firms. In addition, the Nondurables-Young firms do not have a different sales growth reaction relative to our reference group. This indicates that the reaction of these young firms to monetary policy shocks is likely more caused by financing constraints than demand effects.

We also analyze how working capital reacts to monetary policy shocks. Barth and Ramey (2002) provide an interesting reasoning how monetary policy shocks that initially work through demand effects might propagate through the supply side by their effect on working capital. Basically, as demand falls, firms might be faced with involuntary rises in working capital (e.g. through accumulating accounts receivable as other constrained firms start to delay payment). We find that working capital drops in the first year and then rises two years after the shock (see Fig. 13). However the rise in the second year is imprecisely estimated and not statistically significant. We find statistically significant differences for the Young firms (Durables-Young and Nondurables-Young) where the rise

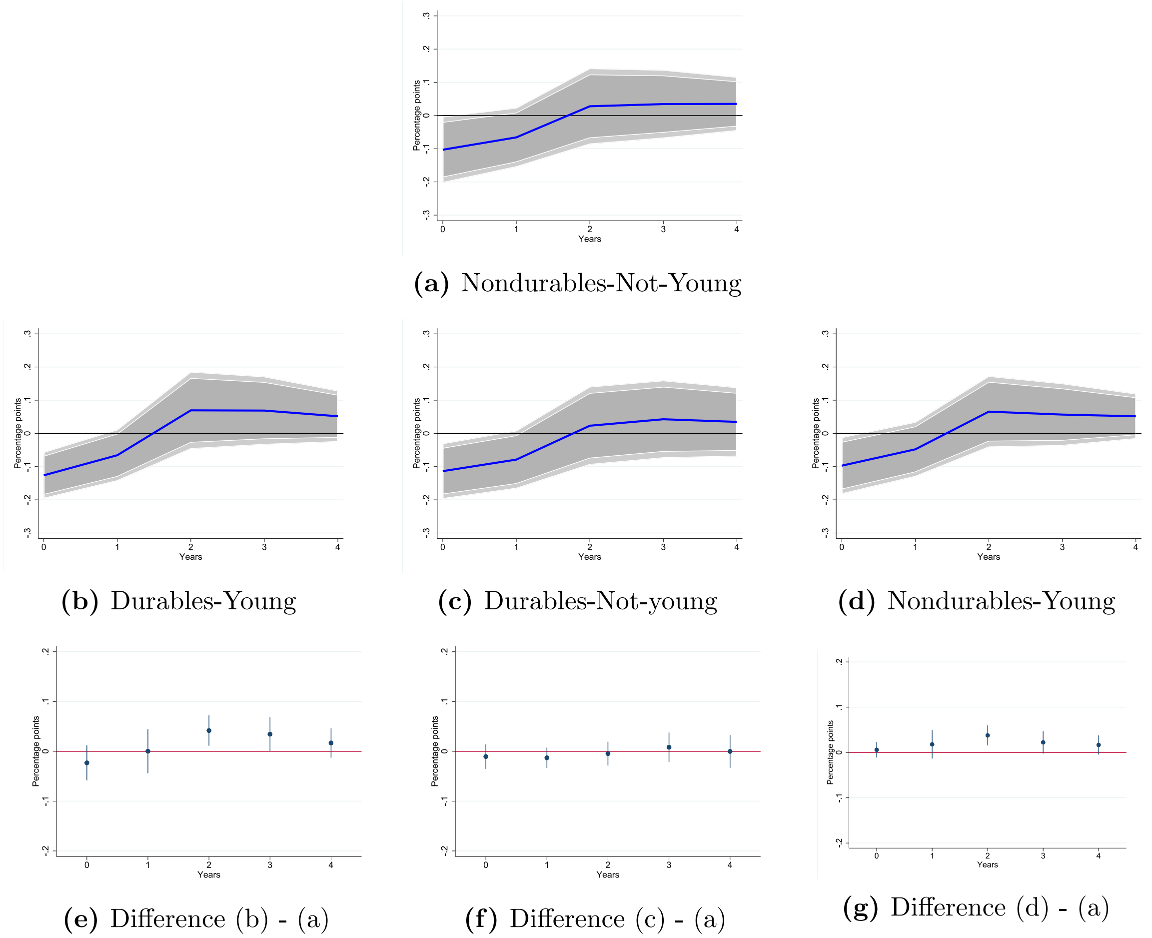


Fig. 13. Firm level working capital response to monetary policy shock: by durability and age. Note: shaded areas represent 90 and 95 percent confidence bands. Bars in (e), (f) and (g) represent 95 percent confidence interval of the difference in the impulse response functions. Clustered standard errors at firm and time level.

in the second year (although itself not significant) is significantly larger than the reference group. Potentially, this points towards some degree of involuntary rise among Young firms as suggested by Barth and Ramey (2002).[26]

We furthermore investigate what happens to leverage. A priori it is not necessarily clear how leverage should react to a monetary policy shock. Faced with higher interest rates, firms would want to reduce leverage. On the other hand, financing needs might increase (due to e.g. involuntary higher working capital). Results are presented in Fig. 14. Compared to our reference group the Nondurables-Not-Young firms, it is the Young firms (both the durables and nondurables producing) which reduce their leverage, especially two years after the shock. This coincides with the negative effect of leverage on investment after two years for these firms. The same holds for short-term debt, which gets especially reduced for the Durables-Young firms. Results are shown in Fig. 15. Together these results indicate that Young firms are either attempting or are being forced to reduce their leverage which again is consistent with the interpretation of financing constraints for these young firms and why by reducing fixed investment they might reduce financing needs. This is consistent with some recent findings by Dinlersoz et al. (2018) for US firms, where firms with high leverage before the financial crisis had to cut down employment and revenue more during the crisis in order to delever.

All in all, the joint reaction of sales, working capital, short-term debt and leverage after a monetary policy shock is consistent with the combination of the interest rate channel and the traditional financial accelerator story as in Bernanke and Gertler (1995). These two channels complement each other. Monetary policy shocks initially reduce demand through the interest rate channel, especially for durables. This is further amplified through leverage (and potentially working capital channels). The fact that leverage matters only two years after the shock and not immediately after the shock strengthens the amplification idea. Reduced sales weaken the balance sheet, and perhaps some involuntary buildup of working capital (especially among the young firms) increases financing

[26] See also recent theoretical and empirical analysis by Manea (2020) who develops a heterogeneous New Keynesian model with constrained and unconstrained firms. In Manea's model the working capital of constrained firms first falls after a monetary shock and then rises again.

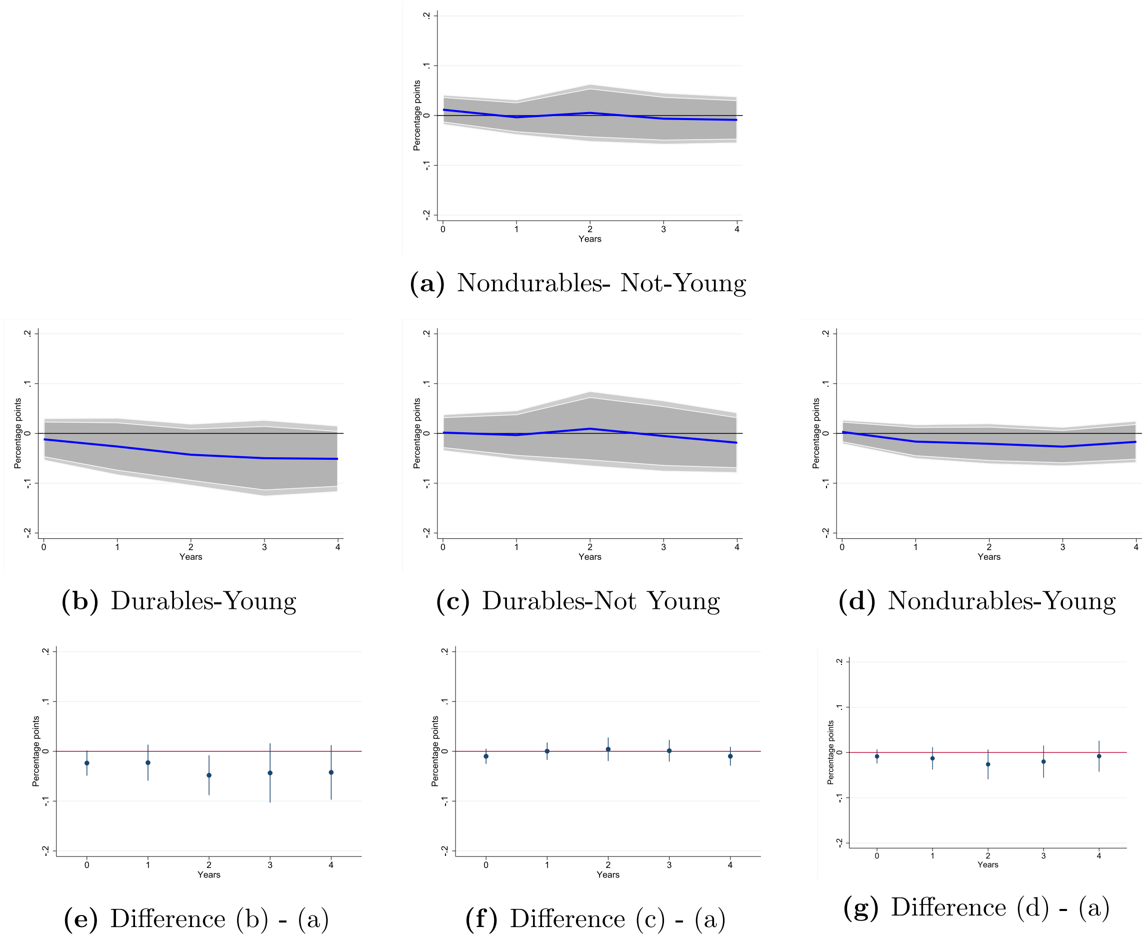


Fig. 14. Firm level leverage response to monetary policy shock: by durability and age. Note: shaded areas represent 90 and 95 percent confidence bands. Bars in (e), (f) and (g) represent 95 percent confidence interval of the difference in the impulse response functions. Clustered standard errors at firm and time level.

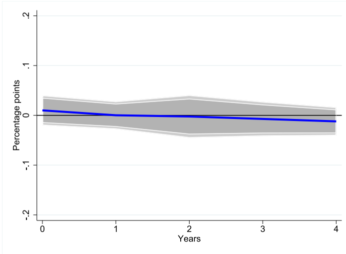
needs further. Firms react by reducing fixed investment. This confirms our earlier interpretation of the mechanism of the interest-rate demand channel for durable firms and financing constraints which are more important for young firms. Firms that are both young and are producing durables are most affected by the joint effect of the interest-rate channel and the credit-channel.

6. Robustness checks

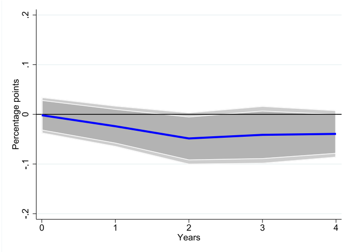
In this section we add seven robustness checks to our findings that might alleviate some potential concerns. The results are presented in Table 5. First, one concern might be that our sample is short. Adding two years of lagged control variables has even reduced our sample further. In principle lagged control variables are not needed as the monetary policy shocks are purely exogenous. To increase our sample to a maximum size in the time dimension we drop all the control variables and estimate our main regression over the entire sample period. The results, presented in column (1), change relatively little.

Second, the time period for which the regressor variables are available is sometimes small as not all firms are alive from 2000 to 2016. Especially for these firms, this might raise concerns about the precision in the estimation of the firm fixed effect. A bias could potentially exist in the estimation of this fixed effect. A firm fixed effect could also raise concerns of a standard Nickell bias (Nickell, 1981). In a second robustness check we therefore check our results by omitting the fixed effect. Results are presented in column (2). There is very little effect on the estimation when the fixed effects are removed.

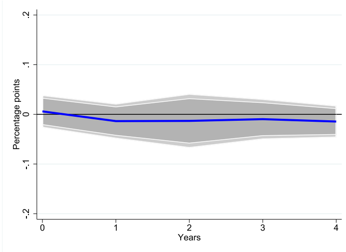
Third, aggregate macroeconomic shocks that differ across countries and that are contemporaneous with the monetary policy shocks could potentially affect our results. In a third robustness check we include a complete set of country-time fixed effects. Since the balance sheet dates cover all months of the year, this implies twelve time dummies each year for each country. Results are presented in column (3). They are relatively unchanged. In a fourth robustness check, presented in column (4), instead we control for aggregate macroeconomic shocks by adding country specific lagged annual GDP growth and inflation (measured by the HICP) and the country specific 10 year government bond yield. Results are relatively unchanged.



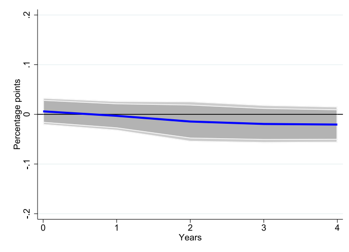
(a) Nondurables-Not-Young



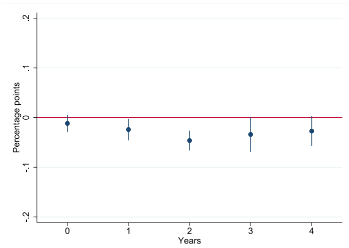
(b) Durables-Young



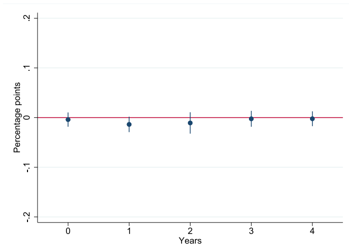
(c) Durables-Not-Young



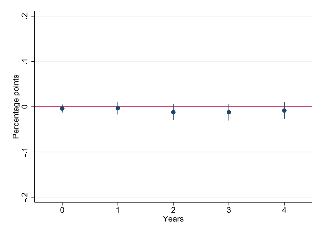
(d) Nondurables-Young



(e) Difference (b) - (a)



(f) Difference (c) - (a)



(g) Difference (d) - (a)

Fig. 15. Firm level short-term debt response to monetary policy shock: by durability and age. Note: shaded areas represent 90 and 95 percent confidence bands. Bars in (e), (f) and (g) represent 95 percent confidence interval of the difference in the impulse response functions. Clustered standard errors at firm and time level.

In a fifth robustness exercise we check what happens when we only include firms that were alive over the entire period 2000–2016. We do not necessarily expect the results to remain unchanged as it excludes by definition young firms that enter in the sample at any time after 2000.[27] It also excludes firms that leave the sample (either through mergers or failure or ending business). Basically this is a select sample of successful firms, only around 25 percent of our original sample remains. For this specific group of firms we find that the estimates of the coefficients become much more imprecisely estimated, although their size is relative similar as our other results. This implies that indeed a full non-selected sample (including new young firms and disappearing firms) is needed to investigate the full extent of monetary policy effects.

Of potential interest is the effect of the financial crisis on our results, which is in the middle of our sample. In a sixth robustness check we exclude the large shocks that occurred before and during the financial crisis. That is, we remove the shocks of 2008 and 2009 (and we also remove the lagged variables to obtain a large enough sample in the time dimension). We find that our results are robust to removing these shocks. They are not driving our results.

In a seventh and final robustness check we remove the entire period of the financial crisis and the sovereign debt crisis. That is we estimate the impulse responses on a very short sample from 2000–2007. This reduces the time span of our regressions and the sample size by half. The point estimates are still not much affected, but their significance (not surprisingly) is. This confirms that one needs a long enough sample to find precisely estimated impulse responses of monetary policy.

[27] By definition, only a select group of young firms are in this sample, those born in the ten years before the year 2000.

Table 5
Robustness checks for difference in effect of monetary policy: reference group Non-durable-Not Young.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Horizon 1 year							
ϵ_{it}	−0.22***	−0.30***	–	−0.26***	−0.25**	−0.21**	−0.09
	(0.08)	(0.09)		(0.09)	(0.11)	(0.09)	(0.07)
$\epsilon_{it} D_{it}^{dy}$	−0.24***	−0.17***	−0.22***	−0.21***	−0.16	−0.25*	−0.28
	(0.06)	(0.03)	(0.05)	(0.06)	(0.25)	(0.14)	(0.17)
$\epsilon_{it} D_{it}^{dny}$	−0.12*	−0.06*	−0.12***	−0.13**	−0.10	−0.13	−0.18
	(0.07)	(0.04)	(0.04)	(0.06)	(0.08)	(0.09)	(0.11)
$\epsilon_{it} D_{it}^{ndy}$	−0.07	−0.03	−0.09***	−0.07***	0.12	−0.04	−0.08
	(0.05)	(0.04)	(0.03)	(0.03)	(0.18)	(0.09)	(0.12)
Observations	13 262 107	7 995 699	7 795 733	7 795 739	2 392 510	11 028 206	4 723 373
Horizon 2 year							
ϵ_{it}	−0.22*	−0.31*	–	−0.40**	−0.31*	−0.44***	−0.35*
	(0.12)	(0.16)		(0.17)	(0.16)	(0.16)	(0.21)
$\epsilon_{it} D_{it}^{dy}$	−0.24***	−0.17***	−0.18***	−0.19**	−0.30	−0.29*	−0.37
	(0.07)	(0.06)	(0.07)	(0.08)	(0.30)	(0.15)	(0.23)
$\epsilon_{it} D_{it}^{dny}$	−0.23*	−0.17	−0.19*	−0.25	−0.20	−0.38**	−0.46**
	(0.12)	(0.15)	(0.10)	(0.17)	(0.21)	(0.19)	(0.20)
$\epsilon_{it} D_{it}^{ndy}$	0.00	0.03	−0.07	0.00	0.20	0.05	0.01
	(0.07)	(0.6)	(0.06)	(0.05)	(0.21)	(0.11)	(0.13)
Observations	11 022 496	6 607 820	6 435 184	6 435 191	2 202 781	8 980 866	4 342 573

(1) control variables are omitted
(2) Fixed effects are omitted
(3) Including country-time fixed effects
(4) Including lagged interest rate, gdp growth and inflation
(5) Restricting sample to only firms which existed in entire period 2000–2016
(6) Restricting sample by removing the shocks of 2008 and 2009 and exclude control variables
(7) Restricting sample by removing the period 2008–2014 and exclude control variables
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7. Conclusion

Our analysis has uncovered substantial heterogeneous effects of monetary policy on business investment. This way we shed new light on the relative importance of two different transmission channels through which monetary policy affects investment, i.e. the credit channel and the traditional interest rate channel.

First, we find that young firms react more to monetary policy shocks. If age is considered a reasonable exogenous proxy for financing constraints (as in Cloyne et al. (2018)), our finding supports the existence of the credit channel. Second, we explored whether other traditional proxies for financing constraints might affect firms' reaction to monetary policy shocks. We show that leverage explains firms' reactions, providing evidence for an amplifying effect of the credit channel. Third, by exploring the heterogeneity of firms' reactions across various sectors and industries, we find that durable goods producers react more to monetary policy shocks compared to firms operating in other industries. Fourth, whereas the recent literature has mainly investigated the importance of the credit channel of monetary policy to business investment (Cloyne et al., 2018; Jeenas, 2019; Ottonello and Winberry, 2020), our analysis provides evidence of an equally strong role for the interest rate channel of monetary policy suggested by the large role played by *durability* in across-firm differences. Overall, we find that the age effect is shorter lived than the durability effect.

The substantial heterogeneity in the reaction to monetary policy shocks that we found can potentially be replicated in a macroeconomic model. Such a model should allow for multiple sectors with different interest rate sensitivities related to output characteristics such as durability combined with financial accelerator effects. Developing such a model which matches our evidence seems a fruitful future research agenda.

Acknowledgments

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Appendix A. The 12-month moving sum of the monetary policy shock

See Fig. A.1.

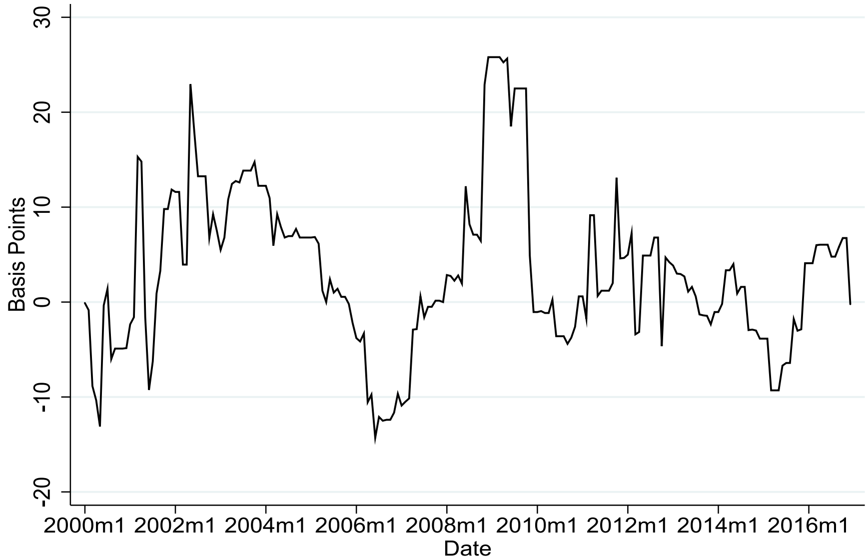


Fig. A.1. 12 month moving sum of monetary policy shock series from Jarociński and Karadi (2020).

Appendix B. List of NACE rev.2 sectors and industries used in the paper

Sector: Manufacturing (C)
- Durable industries:
  - Manufacture of basic metal
  - manufacture of computer and electronic products
  - manufacture of electronic equipment
  - manufacture of fabricated metal products
  - manufacture of other non-metallic minerals
  - manufacture of wood and products of wood and cork
  - manufacture of furniture
  - manufacture of machinery and equipment
  - manufacture of motor vehicles and trailers
  - manufacture of transport equipment
- Non durable industries:
  - Manufacture of food products
  - manufacture of beverage
  - manufacture of tobacco products
  - manufacture of textile
  - manufacture of wearing apparel
  - manufacture of leather
  - manufacture of paper and paper products
  - printing of reproduction
  - manufacture of coke and petroleum products
  - manufacture of chemical and chemical products
  - manufacture of basic pharmaceutical products
  - manufacture of rubber and plastic
  - repair and installation,
- Sector: Construction (F)
- Sector Services (G, H, I, J, M and N):
  - Accommodation and food services (I),
  - information, communication and R&D (J and M)
  - manufacture of other business activities (N)
  - retail trade, transport and storage (H)
  - wholesale trade (G)

Appendix C. Country level table and figures

See Figs. C.1, C.2 and Table C.1.

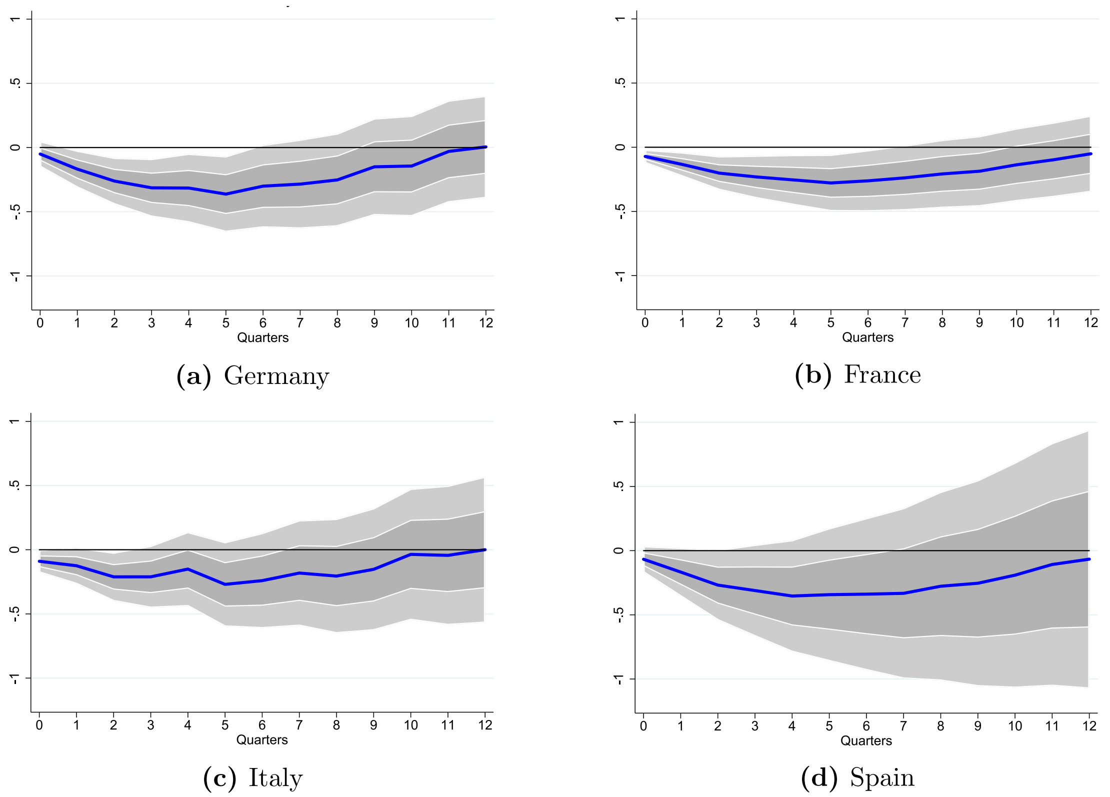


Fig. C.1. Aggregate investment response to monetary policy shock. Country level analysis. Note: shaded areas represent 90 and 95 percent confidence bands.

Table C.1
Average effect of monetary policy shock on investment: country level grouping.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^{DE}_{it}$	0.02	−0.28***	−0.18	0.05	0.02
	(0.05)	(0.07)	(0.13)	(0.08)	(0.07)
$\epsilon_{it} D^{ES}_{it}$	0.35**	−0.47***	−0.56**	−0.11	0.15
	(0.16)	(0.16)	(0.23)	(0.26)	(0.28)
$\epsilon_{it} D^{FR}_{it}$	−0.15***	−0.24***	−0.11	0.04	−0.05
	(0.04)	(0.07)	(0.08)	(0.07)	(0.05)
$\epsilon_{it} D^{IT}_{it}$	0.38**	−0.35***	−0.46	−0.09	0.04
	(0.17)	(0.10)	(0.33)	(0.15)	(0.16)
Controls	YES	YES	YES	YES	YES
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Standard errors in parentheses
* $p < 0.10$,** $p < 0.05$,*** $p < 0.01$.
Controls: ϵ_{it-1}, ϵ_{it-2}, ΔI_{it-1} ΔI_{it-2} , ΔCF_{it-1}, ΔCF_{it-2}, ΔSG_{it-1}, ΔSG_{it-2}

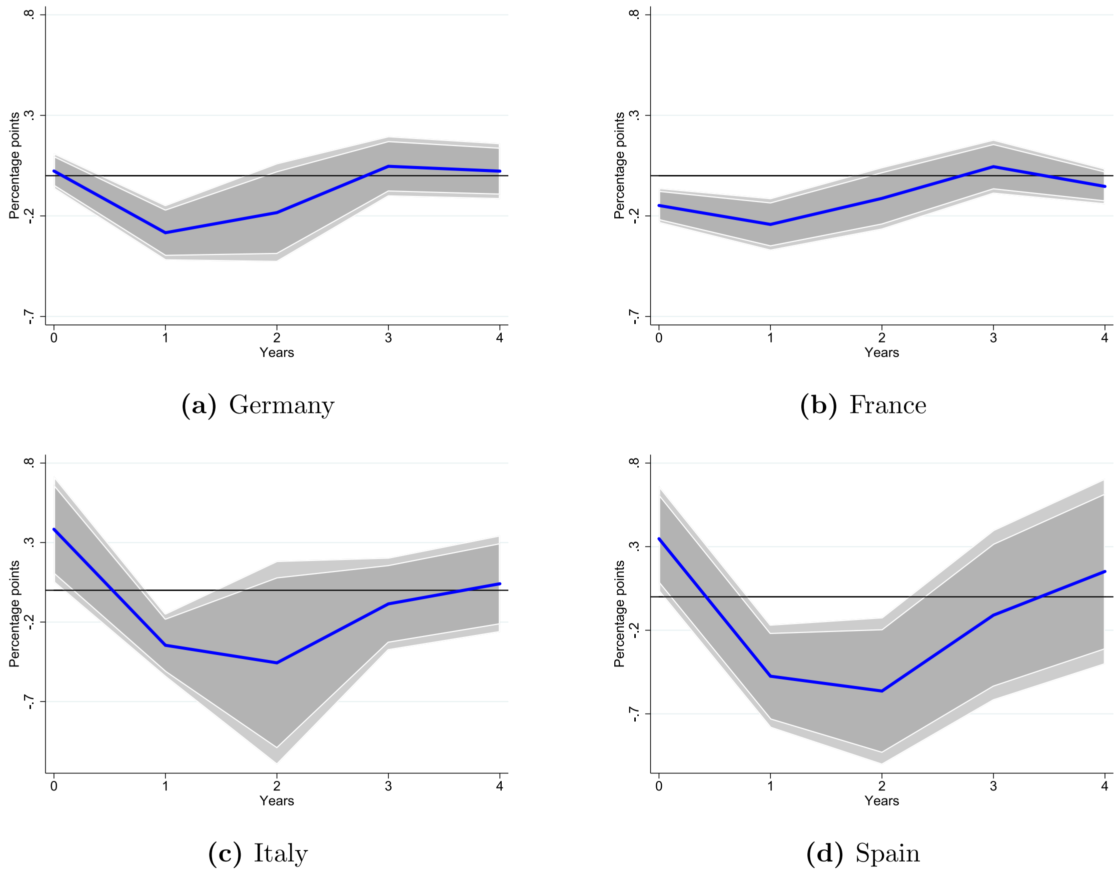


Fig. C.2. Average firm level investment response to monetary policy shock. Country level analysis. Note: shaded areas represent 90 and 95 percent confidence bands. Clustered standard errors at firm and time level.

Appendix D. Data appendix

See Table D.1.

Table D.1
Detailed description and definition of the variables used in the empirical analysis.
Source: BvD Orbis.

Variables	Description
$I_{i,t}$	$(\textbf{Tangible fixed assets}_t - \textbf{Tangible fixed assets}_{t-1})/\textbf{Tangible fixed assets}_{t-1}$
$\epsilon_{i,t}$	12-month moving sum of the monetary policy shock
Age	Years since incorporation
SG_{it}	$\ln \textbf{Sales}_t - \ln \textbf{Sales}_{t-1}$
CF_{it}	$\textbf{Cash Flow}_t/\textbf{Total Assets}_t$
$size_t$	$\ln \textbf{Total Assets}_t$
lev_t	$(\textbf{Loans}_t + \textbf{Long term debt}_t)/\textbf{Total Assets}_t$
$Liquidity_t$	$(\textbf{Current Assets}_t - \textbf{Stocks}_t)/\textbf{Current Liabilities}_t$
$icov_t$	$(\textbf{Earnings before interest and taxes (EBIT)}_t)/\textbf{Interest expenses}_t$
$wcap_t$	$(\textbf{Current assets}_t - \textbf{Current liabilities}_t)/\textbf{Total assets}_t$
$shdebt_t$	$\textbf{Loans}_t/\textbf{Total Assets}_t$

Note: BvD Orbis specific variables are highlighted in bold.

Appendix E. Response to monetary policy by age, size, liquidity and leverage: Tables and figures

See Tables E.1–E.8 and Figs. E.1 and E.2.

Table E.1
Effect of monetary policy shock on investment according to age.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^y_{it}$	0.02	−0.38***	−0.33**	−0.03	−0.01
	(0.08)	(0.09)	(0.15)	(0.11)	(0.11)
$\epsilon_{it} D^m_{it}$	0.13	−0.34***	−0.33**	−0.02	0.04
	(0.10)	(0.09)	(0.16)	(0.13)	(0.13)
$\epsilon_{it} D^o_{it}$	0.29*	−0.30***	−0.35*	−0.04	0.07
	(0.17)	(0.09)	(0.20)	(0.11)	(0.12)
D^y_{it}	−2.35	−1.32	−2.82	−4.60	−3.02
	(1.75)	(2.48)	(3.54)	(4.50)	(4.84)
D^m_{it}	0.04	0.80	0.05	−0.80	0.14
	(0.90)	(1.23)	(1.88)	(2.34)	(2.57)
Controls	YES	YES	YES	YES	YES
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Note: standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E.2
Difference in effect of monetary policy shock on investment according to age old firms are reference group.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
ϵ_{it}	0.29*	−0.30***	−0.35*	−0.04	0.07
	(0.17)	(0.09)	(0.20)	(0.11)	(0.12)
$\epsilon_{it} D^m_{it}$	−0.16**	−0.05*	0.03	0.02	−0.02
	(0.07)	(0.03)	(0.06)	(0.05)	(0.04)
$\epsilon_{it} D^y_{it}$	−0.27**	−0.09**	0.03	0.01	−0.08**
	(0.10)	(0.03)	(0.08)	(0.04)	(0.04)
D^y_{it}	−2.35	−1.32	−2.82	−4.60	−3.02
	(1.75)	(2.48)	(3.54)	(4.50)	(4.84)
D^m_{it}	0.04	0.80	0.05	−0.80	0.14
	(0.90)	(1.23)	(1.88)	(2.34)	(2.57)
Controls	YES	YES	YES	YES	YES
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E.3
Average effect of monetary policy shock on investment: size grouping.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^{sm}_{it}$	−0.05	−0.26***	−0.19*	0.03	0.02
	(0.06)	(0.07)	(0.11)	(0.08)	(0.07)
$\epsilon_{it} D^{me}_{it}$	0.08	−0.36***	−0.34**	−0.04	0.00
	(0.11)	(0.08)	(0.15)	(0.12)	(0.10)
$\epsilon_{it} D^{la}_{it}$	0.28*	−0.39***	−0.44**	−0.07	0.08
	(0.17)	(0.10)	(0.21)	(0.16)	(0.15)
D^{sm}_{it}	50.05***	52.50***	46.94***	40.32***	36.14***
	(2.40)	(2.17)	(2.16)	(2.05)	(2.55)
D^{me}_{it}	20.92***	21.74***	20.05***	17.43***	16.60***
	(1.58)	(1.47)	(1.55)	(1.39)	(1.88)
Controls	YES	YES	YES	YES	YES
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls: ϵ_{it-1}, ϵ_{it-2}, ΔI_{it-1} ΔI_{it-2} , ΔCF_{it-1}, ΔCF_{it-2}, ΔSG_{it-1}, ΔSG_{it-2}.

Table E.4
Difference in effect of monetary policy shock on investment: size grouping large firms are reference group.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
ϵ_{it}	0.28*	−0.39***	−0.44**	−0.07	0.08
	(0.17)	(0.10)	(0.21)	(0.16)	(0.15)
$\epsilon_{it} D^{sm}_{it-1}$	−0.33**	0.12	0.25*	0.10	−0.05
	(0.14)	(0.08)	(0.14)	(0.11)	(0.09)
$\epsilon_{it} D^{me}_{it-1}$	−0.21***	0.02	0.11	0.04	−0.08
	(0.07)	(0.04)	(0.08)	(0.06)	(0.05)
D^{sm}_{it-1}	50.05***	52.50***	46.94***	40.32***	36.14***
	(2.40)	(2.17)	(2.16)	(2.05)	(2.55)
D^{me}_{it-1}	20.92***	21.74***	20.05***	17.43***	16.60***
	(1.58)	(1.47)	(1.55)	(1.39)	(1.88)
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547
Controls	YES	YES	YES	YES	YES

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E.5
Average effect of monetary policy shock on investment: leverage grouping.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^{ll}_{it-1}$	0.04	−0.27***	−0.24	−0.04	0.04
	(0.09)	(0.07)	(0.16)	(0.10)	(0.10)
$\epsilon_{it} D^{ml}_{it-1}$	0.12	−0.35***	−0.32**	−0.02	−0.01
	(0.13)	(0.08)	(0.15)	(0.10)	(0.09)
$\epsilon_{it} D^{hl}_{it-1}$	0.30	−0.37***	−0.48**	−0.14	0.05
	(0.19)	(0.12)	(0.22)	(0.17)	(0.16)
D^{ll}_{it-1}	37.29***	28.82***	22.62***	19.66***	17.22***
	(1.91)	(1.54)	(1.16)	(1.01)	(1.15)
D^{ml}_{it-1}	17.80***	14.24***	10.96***	8.49***	8.25***
	(0.92)	(0.81)	(0.57)	(0.81)	(0.56)
Controls	YES	YES	YES	YES	YES
Observations	8 769 834	7 201 395	5 898 975	4 890 179	4 053 730

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls: ϵ_{it-1}, ϵ_{it-2}, ΔI_{it-1} ΔI_{it-2} , ΔCF_{it-1}, ΔCF_{it-2}, ΔSG_{it-1}, ΔSG_{it-2}.

Table E.6
Difference in effect of monetary policy shock on investment: leverage grouping low leverage firms is reference group.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
ϵ_{it}	0.04	−0.27***	−0.24	−0.04	0.04
	(0.09)	(0.07)	(0.16)	(0.10)	(0.10)
$\epsilon_{it} D^{ml}_{it-1}$	0.08	−0.08	−0.08	0.02	−0.04
	(0.08)	(0.07)	(0.06)	(0.07)	(0.05)
$\epsilon_{it} D^{hl}_{it-1}$	0.26*	−0.10	−0.24**	−0.10	0.01
	(0.14)	(0.12)	(0.10)	(0.11)	(0.09)
D^{ml}_{it-1}	−19.48***	−14.58***	−11.67***	−11.17***	−8.97***
	(1.13)	(0.93)	(0.87)	(0.96)	(0.95)
D^{hl}_{it-1}	−37.29***	−28.82***	−22.62***	−19.66***	−17.22***
	(1.91)	(1.54)	(1.16)	(1.01)	(1.15)
Controls	YES	YES	YES	YES	YES
Observations	8 769 834	7 201 395	5 898 975	4 890 179	4 053 730

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E.7
Average effect of monetary policy shock on investment: liquidity grouping.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^{lliq}_{it-1}$	0.15	−0.30***	−0.32**	−0.02	0.05
	(0.10)	(0.09)	(0.14)	(0.13)	(0.12)
$\epsilon_{it} D^{mliq}_{it-1}$	0.17	−0.36***	−0.37**	−0.05	0.03
	(0.13)	(0.09)	(0.18)	(0.12)	(0.12)
$\epsilon_{it} D^{hliq}_{it-1}$	0.07	−0.33***	−0.30**	−0.03	0.03
	(0.10)	(0.08)	(0.15)	(0.11)	(0.11)
D^{lliq}_{it-1}	−27.77***	−19.93***	−16.15***	−13.99***	−12.22***
	(0.98)	(0.76)	(0.72)	(0.54)	(0.58)
D^{mliq}_{it-1}	−16.09***	−12.05***	−10.19***	−9.37***	−8.23***
	(0.52)	(0.39)	(0.39)	(0.28)	(0.34)
Controls	YES	YES	YES	YES	YES
Observations	9 297 320	7 703 287	6 357 323	5 313 562	4 449 717

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E.8
Difference in effect of monetary policy shock on investment: liquidity grouping high liquidity firms is the reference group.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
ϵ_{it}	0.07	−0.33***	−0.30**	−0.03	0.03
	(0.10)	(0.08)	(0.15)	(0.11)	(0.11)
$\epsilon_{it} D^{lliq}_{it-1}$	0.07**	0.03	−0.02	0.01	0.01
	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)
$\epsilon_{it} D^{mliq}_{it-1}$	0.10**	−0.04	−0.07	−0.02	−0.01
	(0.04)	(0.03)	(0.04)	(0.03)	(0.02)
D^{lliq}_{it-1}	−27.77***	−19.93***	−16.15***	−13.99***	−12.22***
	(0.98)	(0.76)	(0.72)	(0.54)	(0.58)
D^{mliq}_{it-1}	−16.09***	−12.05***	−10.19***	−9.37***	−8.23***
	(0.52)	(0.39)	(0.39)	(0.28)	(0.34)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	9 297 320	7 703 287	6 357 323	5 313 562	4 449 717

Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

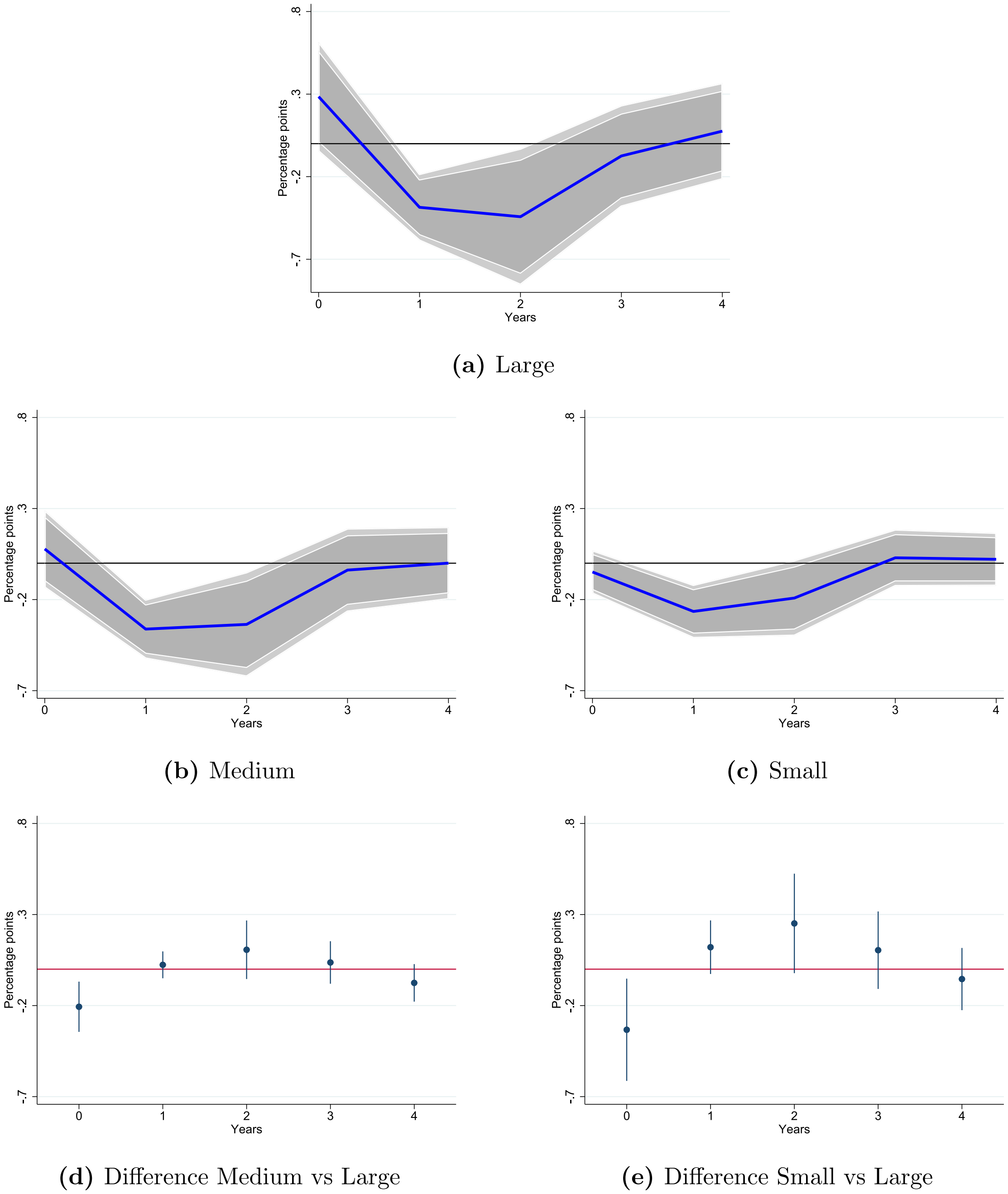
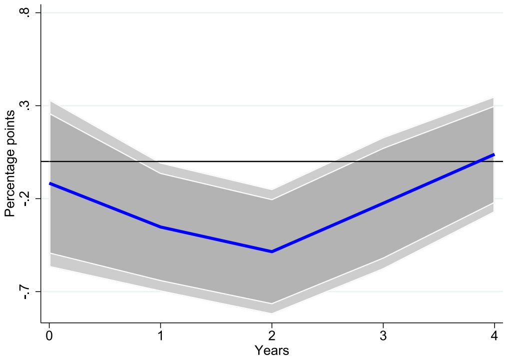
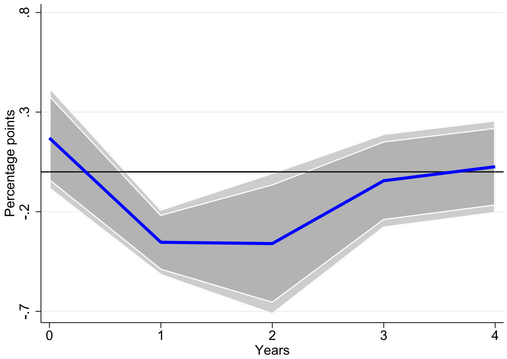


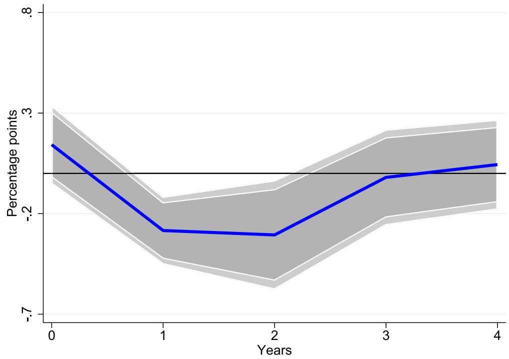
Fig. E.1. Firm level investment response to monetary policy shock by size. Note: shaded areas represent 90 and 95 percent confidence bands. Bars in (d)and (e) represent 95 percent confidence interval of the difference in the impulse response functions. Clustered standard errors at firm and time level.



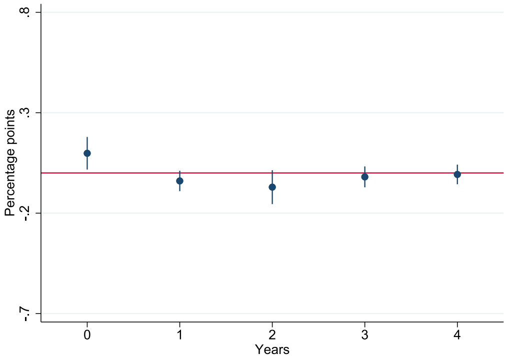
(a) High liquidity



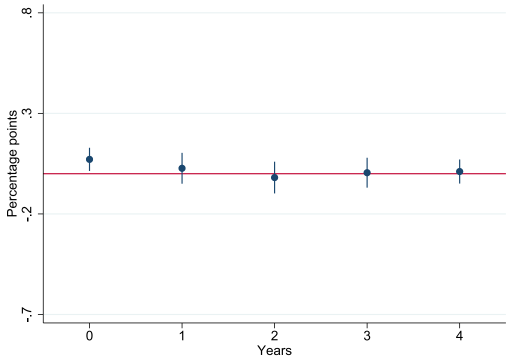
(b) Medium liquidity



(c) Low liquidity



(d) Difference Medium vs High liquidity



(e) Difference Low vs High liquidity

Fig. E.2. Firm level investment response to monetary policy shock by liquidity. Note: shaded areas represent 90 and 95 percent confidence bands. Bars in (d) and (e) represent 95 percent confidence interval of the difference in the impulse response functions. Clustered standard errors at firm and time level.

Appendix F. Robustness check age threshold

See Tables F.1–F.3.

Table F.1
Effect of monetary policy shock on investment according to age (threshold young: 9 year).

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^y_{it}$	0.02	−0.39***	−0.31**	−0.02	−0.01
	(0.08)	(0.10)	(0.15)	(0.11)	(0.11)
$\epsilon_{it} D^m_{it}$	0.12	−0.34***	−0.33**	−0.02	0.04
	(0.10)	(0.09)	(0.16)	(0.13)	(0.13)
$\epsilon_{it} D^o_{it}$	0.29*	−0.30***	−0.35*	−0.04	0.07
	(0.17)	(0.09)	(0.20)	(0.11)	(0.12)
D^y_{it}	−2.93*	−1.97	−3.96	−5.81	−4.40
	(1.74)	(2.46)	(3.52)	(4.43)	(4.75)
D^m_{it}	0.02	0.77	0.02	−0.82	0.16
	(0.92)	(1.24)	(1.89)	(2.36)	(2.57)
Controls	Yes	Yes	YES	Yes	Yes
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Controls: ϵ_{it-1}, ϵ_{it-2}, ΔI_{it-1} ΔI_{it-2} , ΔCF_{it-1}, ΔCF_{it-2}, ΔSG_{it-1}, ΔSG_{it-2}.

Table F.2
Effect of monetary policy shock on investment according to age (threshold young: 8 year).

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^y_{it}$	0.01	−0.39***	−0.31**	−0.03	−0.02
	(0.08)	(0.10)	(0.15)	(0.10)	(0.10)
$\epsilon_{it} D^m_{it}$	0.11	−0.34***	−0.32**	−0.02	0.04
	(0.10)	(0.09)	(0.16)	(0.13)	(0.13)
$\epsilon_{it} D^o_{it}$	0.29*	−0.29***	−0.35*	−0.04	0.07
	(0.17)	(0.09)	(0.20)	(0.11)	(0.12)
D^y_{it}	−3.97**	−2.97	−5.09	−7.36*	−5.97
	(1.73)	(2.46)	(3.44)	(4.33)	(4.62)
D^m_{it}	0.00	0.74	−0.01	−0.85	0.17
	(0.93)	(1.26)	(1.90)	(2.36)	(2.57)
Controls	Yes	Yes	YES	Yes	Yes
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Controls: ϵ_{it-1}, ϵ_{it-2}, ΔI_{it-1} ΔI_{it-2} , ΔCF_{it-1}, ΔCF_{it-2}, ΔSG_{it-1}, ΔSG_{it-2}.

Table F.3
Effect of monetary policy shock on investment according to age (threshold young: 7 year).

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^y_{it}$	0.00	-0.40^{***}	-0.31^{**}	−0.04	−0.03
	(0.07)	(0.10)	(0.15)	(0.10)	(0.10)
$\epsilon_{it} D^m_{it}$	0.10	-0.34^{***}	-0.32^{**}	−0.02	0.03
	(0.10)	(0.09)	(0.16)	(0.13)	(0.12)
$\epsilon_{it} D^o_{it}$	0.29^{*}	-0.29^{***}	-0.35^{*}	−0.04	0.07
	(0.17)	(0.09)	(0.20)	(0.11)	(0.12)
D^y_{it}	-5.44^{***}	-4.75^{*}	-6.65^{*}	-8.88^{**}	-7.92^{*}
	(1.73)	(2.46)	(3.39)	(4.15)	(4.38)
D^m_{it}	0.01	0.72	−0.03	−0.85	0.19
	(0.94)	(1.27)	(1.89)	(2.36)	(2.58)
Controls	Yes	Yes	YES	Yes	Yes
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls: ϵ_{it-1}, ϵ_{it-2}, ΔI_{it-1} ΔI_{it-2} , ΔCF_{it-1}, ΔCF_{it-2}, ΔSG_{it-1}, ΔSG_{it-2}.

Appendix G. Results based on sectors and industries: Tables

See Tables G.1–G.3.

Table G.1
Effect of monetary policy shock on investment: manufacturing, construction and services.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^{man}_i$	0.31	-0.38^{***}	-0.47^{*}	−0.08	0.08
	(0.20)	(0.10)	(0.24)	(0.15)	(0.14)
$\epsilon_{it} D^{con}_i$	0.06	-0.40^{***}	-0.36^{**}	−0.05	0.01
	(0.12)	(0.09)	(0.14)	(0.14)	(0.13)
$\epsilon_{it} D^{ser}_i$	0.10	-0.31^{***}	-0.28^{*}	−0.01	0.02
	(0.09)	(0.09)	(0.14)	(0.11)	(0.11)
Controls	Yes	Yes	YES	Yes	Yes
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Note: standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table G.2
Difference in effect of monetary policy shock on investment across sectors: services is reference group.

	ΔI^{*}_{it0}	ΔI^{*}_{it1}	ΔI^{*}_{it2}	ΔI^{*}_{it3}	ΔI^{*}_{it4}
ϵ_{it}	0.10	−0.31***	−0.28*	−0.01	0.02
	(0.09)	(0.09)	(0.14)	(0.11)	(0.11)
$\epsilon_{it} D^{dman}_{it}$	0.25*	−0.14**	−0.28*	−0.08	0.08
	(0.15)	(0.06)	(0.16)	(0.09)	(0.07)
$\epsilon_{it} D^{ndman}_{it}$	0.14*	−0.00	−0.10	−0.06	0.04
	(0.08)	(0.03)	(0.08)	(0.06)	(0.02)
$\epsilon_{it} D^{con}_{it}$	−0.04	−0.09***	−0.08***	−0.04	−0.01
	(0.04)	(0.02)	(0.02)	(0.04)	(0.03)
ϵ_{it-1}	−0.33***	−0.37***	−0.13	−0.04	−0.07
	(0.08)	(0.10)	(0.18)	(0.16)	(0.15)
ϵ_{it-2}	−0.17**	−0.13	−0.08	0.02	0.01
	(0.07)	(0.11)	(0.16)	(0.17)	(0.10)
ΔI_{it-1}	−0.66***	−0.67***	−0.67***	−0.67***	−0.67***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

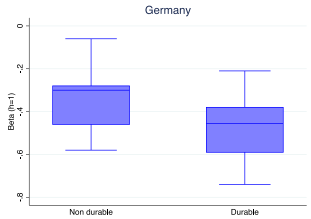
Table G.3
Reaction to monetary policy at horizon 1 and 2 year for 31 industries at country level.

	Germany		France		Italy		Spain	
	h = 1	h = 2	h = 1	h = 2	h = 1	h = 2	h = 1	h = 2
	β^1	β^2	β^1	β^2	β^1	β^2	β^1	β^2
Manufacturing								
Durable goods								
Basic metal	−0.74***	−0.42 ***	−0.21	−0.27 *	−0.37 ***	−0.62 ***	−0.36 ***	−0.48 ***
Computer and electronic products	−0.48***	−0.36 ***	−0.31 ***	−0.27 **	−0.23 ***	−0.45 ***	−0.53 ***	−0.54 ***
Electronic equipment	−0.43***	−0.20 **	−0.20 *	−0.02	−0.39 ***	−0.59 ***	−0.55 ***	−0.64 ***
Fabricated metal products	−0.59***	−0.45 ***	−0.45 ***	−0.26 ***	−0.40 ***	−0.64 ***	−0.40 ***	−0.62 ***
Other non metallic minerals	−0.21***	−0.21 ***	−0.18 *	−0.24 ***	−0.15 ***	−0.57 ***	−0.43 ***	−0.52 ***
Wood and products of wood and cork	−0.32***	−0.16 *	−0.29 ***	−0.26 ***	−0.26 ***	−0.47 ***	−0.33 ***	−0.42 ***
Furniture	−0.43***	−0.26 **	−0.36 ***	−0.27 ***	−0.24 ***	−0.61 ***	−0.24 ***	−0.38 ***
Machinery and equipment	−0.53***	−0.43 ***	−0.35 ***	−0.12	−0.43 ***	−0.63 ***	−0.41 ***	−0.53 ***
Motor vehicles and trailers	−0.68***	−0.41 ***	−0.20 *	−0.18	−0.28 ***	−0.47 ***	−0.23 ***	−0.35 ***
Transport equipment	−0.38*	−0.08	−0.16	−0.18	−0.43 ***	−0.60 ***	−0.22	−0.33 **
Non durable goods								
Basic pharmaceutical products	0.02	−0.07	−0.23	−0.14	−0.06	−0.21	−0.09	−0.25
Beverage	−0.16	−0.30 ***	−0.11	−0.11	0.03	−0.34 ***	−0.30 ***	−0.30 ***
Chemical and chemical products	−0.30***	−0.19 **	−0.17 *	0.07	−0.23 ***	−0.55 ***	−0.31 ***	−0.31 ***
Coke and petroleum products	−0.58	−0.13	0.14	1.13 *	−0.14	−0.50 ***	0.96 *	0.38
Food products	−0.06	0.05	0.01	0.02	0.02	−0.25 ***	−0.23 ***	−0.25 ***
Leather	−0.29	0.05	−0.37 **	−0.16	−0.47 ***	−0.58 ***	−0.33 ***	−0.30 ***
Paper and paper products	−0.39***	0.14	−0.28 **	−0.13	−0.27 ***	−0.45 ***	−0.25 ***	−0.37 ***
Rubber and plastic	−0.41***	−0.19 ***	−0.32 ***	−0.19 **	−0.25 ***	−0.42 ***	−0.36 ***	−0.47 ***
Textile	−0.46***	−0.22 *	−0.26 **	−0.14	−0.23 ***	−0.54 ***	−0.34 ***	−0.47 ***
Tobacco products	−1.13	−1.31 *	−1.34	−0.45	0.49	0.22	−0.36	−0.26
Wearing apparel	−0.28	−0.16	−0.36 ***	−0.08	−0.36 ***	−0.54 ***	−0.28 ***	−0.32 ***
Other business activities	−0.28***	−0.14 ***	−0.28 ***	−0.09 ***	−0.22 ***	−0.37 ***	−0.39 ***	−0.44 ***
Other	−0.15**	−0.07	−0.01	0.09	−0.17 ***	−0.32 ***	−0.11	−0.15 *
Services								
Printing or reproduction	−0.19**	−0.17 *	−0.23 ***	−0.16 **	−0.33 ***	−0.43 ***	−0.37 ***	−0.64 ***
Accommodation and food services	−0.19***	−0.08	−0.12 ***	−0.01	−0.12 ***	−0.32 ***	−0.24 ***	−0.24 ***
Information, communication and R&D	−0.39***	−0.15 ***	−0.31 ***	−0.06	−0.16 ***	−0.25 ***	−0.43 ***	−0.49 ***
Repair and installation	−0.42***	−0.49 ***	−0.29 ***	−0.28 ***	−0.49 ***	−0.63 ***	−0.33 ***	−0.53 ***
Retail trade	−0.19***	−0.04	−0.10 ***	−0.04 *	−0.19 ***	−0.30 ***	−0.27	−0.29 ***
Transport, storage	−0.55***	−0.16 ***	−0.37 ***	−0.14 ***	−0.30 ***	−0.41 ***	−0.48 ***	−0.81 ***
Wholesale trade	−0.40***	−0.19 ***	−0.13 ***	−0.03 ***	−0.25 ***	−0.41 ***	−0.31 ***	−0.37 ***
Construction								
	−0.27***	−0.13 ***	−0.25 ***	−0.09 ***	−0.22 ***	−0.39 ***	−0.39 ***	−0.42 ***

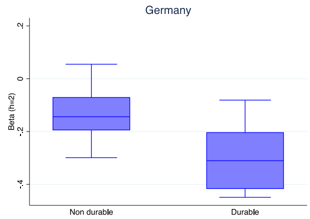
Note: robust standard errors in parentheses.
**** p<0.01, ** p<0.05, * p<0.1.

Appendix H. 31 Industries grouped into durable and non-durable

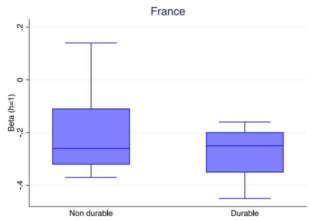
See Fig. H.1.



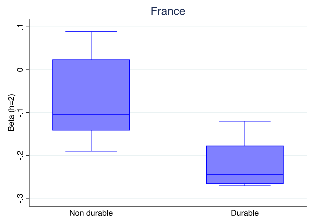
(a) h = 1



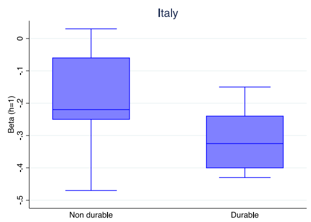
(b) h = 2



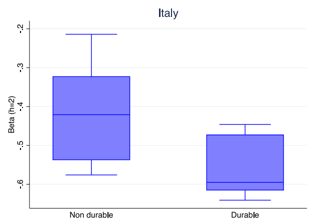
(c) h = 1



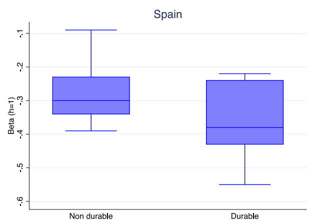
(d) h = 2



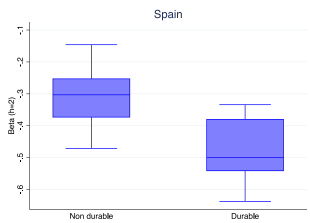
(e) h = 1



(f) h = 2



(g) h = 1



(h) h = 2

Fig. H.1. Firm level investment response to monetary policy shock for 31 industries grouped by country into durable and non-durable producing. Note: The figure plots the distribution of the estimated coefficients β^1 and β^2 from Eq. (2) using the pooled sample. The numbers are taken from Table G.3.

Appendix I. Detailed analysis age and sectors: 12 groups

A detailed analysis of age within sectors shows that in the first year after the shock, the investment of young firms always drops the most. The difference in the point estimate between the young and the old firms is respectively −0.08 for the durables manufacturing sector, −0.06 for the non-durables manufacturing sector, −0.12 for the construction sector and −0.11 for the services sector. An F-test rejects equality of the effect of the shock between young (−0.44) and old (−0.32) for construction ($F_{1,167} = 8.58, p < .01$) and between young (−0.38) and old (−0.27) for the services sector ($F_{1,167} = 12.46, p < .01$). Within these two sectors the effect for the young is more than one third larger than for the old. The differences between the young (−0.50) and old (−0.42) in the durables and likewise between young (−0.33) and old (−0.27) in the non-durables manufacturing sector are small and both are not statistically significant. (The respective F-test results are $F_{1,167} = 2.26, p > .1$ and $F_{1,167} = 1.56, p > .1$.) Two years after the shock, age does not matter anymore. Indeed the difference in the point estimate between young and old firms becomes smaller and F-tests never reject equality of the effect of the shock (see Fig. I.1 and Table I.1).

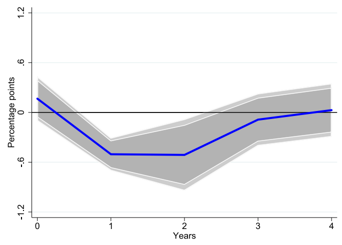
Table I.1
Effect of monetary policy shock on investment: age and sectors.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^{dmany}_{it}$	0.17	−0.50***	−0.51**	−0.09	0.03
	(0.14)	(0.10)	(0.22)	(0.16)	(0.16)
$\epsilon_{it} D^{dmanm}_{it}$	0.26	−0.44***	−0.54**	−0.08	0.10
	(0.18)	(0.11)	(0.25)	(0.17)	(0.17)
$\epsilon_{it} D^{dmano}_{it}$	0.55*	−0.42***	−0.58*	−0.10	0.13
	(0.31)	(0.12)	(0.35)	(0.18)	(0.17)
$\epsilon_{it} D^{ndmany}_{it}$	0.07	−0.33***	−0.34**	−0.07	0.00
	(0.09)	(0.10)	(0.14)	(0.11)	(0.11)
$\epsilon_{it} D^{ndmanm}_{it}$	0.15	−0.33***	−0.34*	−0.07	0.03
	(0.12)	(0.09)	(0.19)	(0.13)	(0.11)
$\epsilon_{it} D^{ndmano}_{it}$	0.44*	−0.27***	−0.41	−0.06	0.11
	(0.23)	(0.10)	(0.27)	(0.14)	(0.12)
$\epsilon_{it} D^{cony}_{it}$	−0.01	−0.44***	−0.36**	−0.02	−0.01
	(0.10)	(0.10)	(0.15)	(0.13)	(0.11)
$\epsilon_{it} D^{conm}_{it}$	0.09	−0.41***	−0.37**	−0.03	0.04
	(0.12)	(0.11)	(0.15)	(0.16)	(0.16)
$\epsilon_{it} D^{cono}_{it}$	0.13	−0.32***	−0.32**	−0.08	−0.00
	(0.15)	(0.07)	(0.15)	(0.11)	(0.11)
$\epsilon_{it} D^{sery}_{it}$	−0.04	−0.38***	−0.32**	−0.07	−0.06
	(0.07)	(0.09)	(0.13)	(0.12)	(0.11)
$\epsilon_{it} D^{serm}_{it}$	0.12	−0.29***	−0.26*	0.02	0.05
	(0.08)	(0.09)	(0.14)	(0.12)	(0.12)
$\epsilon_{it} D^{sero}_{it}$	0.22*	−0.27***	−0.28*	0.00	0.05
	(0.12)	(0.09)	(0.17)	(0.10)	(0.10)
Controls	YES	YES	YES	YES	YES
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

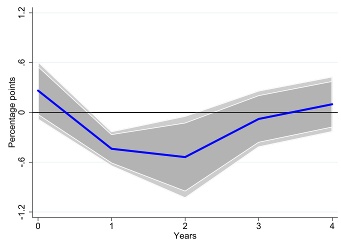
Standard errors in parentheses
$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
Controls: ϵ_{it-1}, ϵ_{it-2}, ΔI_{it-1} ΔI_{it-2} , ΔCF_{it-1}, ΔCF_{it-2}, ΔSG_{it-1}, ΔSG_{it-2}
Coefficients of dummy group variables not reported.

In contrast, within each age category, there are large differences across sectors. Firms in the durables manufacturing sector always react the most. For young firms the differences in the point estimates between the durables manufacturing sector and the non-durables manufacturing, construction and services sector are respectively −0.17, −0.06, −0.12. Furthermore, for mature firms these differences are −0.11, −0.03, −0.15 and for the old firms these differences are −0.15, −0.10, −0.15. F-tests show that most of these differences are statistically significant. Differences between young companies from durables manufacturing (−0.50) and construction sectors (−0.44) are not statistically significant ($F_{1,167} = 1.39, p > .1$), confirming once again a similar reaction of firms in these two sectors. Two years after the shock, the differences in the point estimates between the durables manufacturing sector and the other sectors remain large and in most of the cases statistically significant.

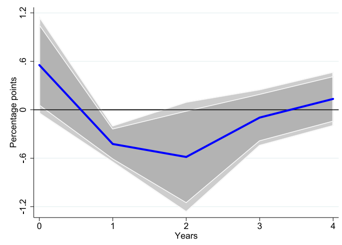
The following picture emerges. First, age matters. Young firms react the strongest and this is indicative of the presence of credit channel effects. However, the age effect is short lived as it affects investment only one year after the shock. Second, age matters more for the construction and services sectors, less so within manufacturing. Third, durability of output matters. Within each age category durables producing firms react the most. The durability effect on investment looks stronger than the age effect and it is definitely longer lived.



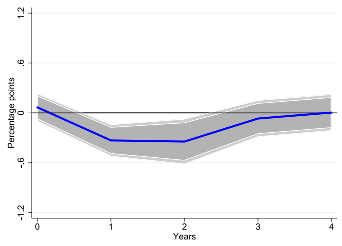
(a) Young - Durable manuf.



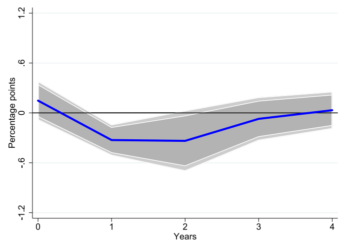
(b) Mature - Durable manuf.



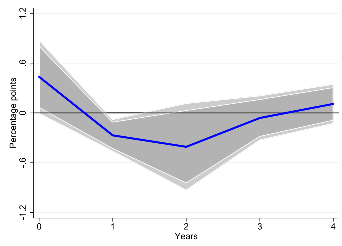
(c) Old - Durable manuf.



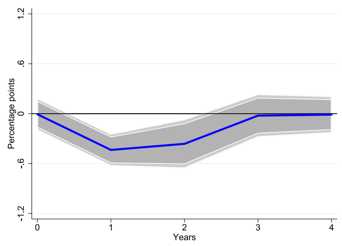
(d) Young - Non-durable manuf.



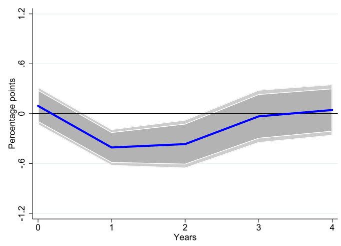
(e) Mature - Non-durable manuf.



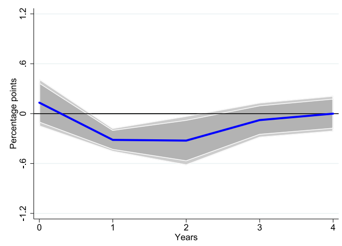
(f) Old - Non-durable manuf.



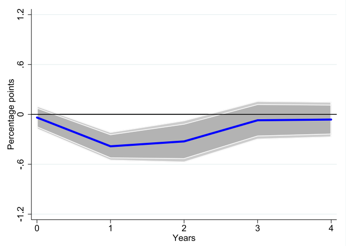
(g) Young - Construction



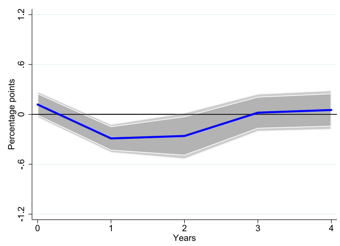
(h) Mature - Construction



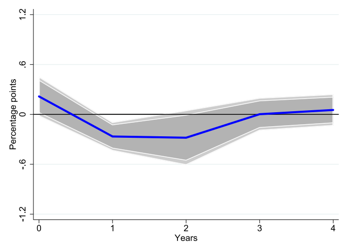
(i) Old - Construction



(j) Young - Services



(k) Mature - Services



(l) Old - Services

Fig. I.1. Joint effect of age and sector. Note: shaded areas represent 90 and 95 percent confidence bands. Clustered standard errors at firm and time level.

Appendix J. Results combining durability and age: Tables

See Tables J.1 and J.2.

Table J.1
Effect of monetary policy crossing durability and age.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^{dy}_{it}$	0.16	−0.50***	−0.51**	−0.09	0.03
	(0.14)	(0.10)	(0.22)	(0.16)	(0.16)
$\epsilon_{it} D^{dny}_{it}$	0.42*	−0.43***	−0.56*	−0.09	0.12
	(0.25)	(0.11)	(0.30)	(0.17)	(0.17)
$\epsilon_{it} D^{ndy}_{it}$	0.00	−0.37***	−0.31**	−0.02	−0.02
	(0.07)	(0.09)	(0.14)	(0.11)	(0.10)
$\epsilon_{it} D^{ndny}_{it}$	0.17	−0.30***	−0.30*	−0.02	0.04
	(0.12)	(0.09)	(0.16)	(0.11)	(0.12)
D^{dy}_{it}	−4.01***	−3.03*	−3.63	−4.36	−2.75
	(1.31)	(1.79)	(2.20)	(3.05)	(3.49)
D^{ndy}_{it}	−2.07**	−1.93	−2.78*	−3.76*	−3.18
	(0.93)	(1.25)	(1.65)	(2.13)	(2.21)
Controls	YES	YES	YES	YES	YES
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Standard errors in parentheses
$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
D^{dy}_{it} is dummy variable indicating Durables-Young firm
D^{dny}_{it} is dummy variable indicating Durables-Not-Young firm
D^{ndy}_{it} is dummy variable indicating Nondurables-Young firm
D^{ndny}_{it} is dummy variable indicating Nondurables-Not-Young firm.

Table J.2
Difference in effect of monetary policy crossing durability and age. The reference group is Nondurables-Not-Young firms.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
ϵ_{it}	0.17	−0.30***	−0.30*	−0.02	0.04
	(0.12)	(0.09)	(0.16)	(0.11)	(0.12)
$\epsilon_{it} D^{dy}_{it}$	−0.00	−0.20***	−0.21**	−0.07	−0.02
	(0.04)	(0.06)	(0.08)	(0.06)	(0.06)
$\epsilon_{it} D^{dny}_{it}$	0.26*	−0.13**	−0.26	−0.07	0.08
	(0.14)	(0.06)	(0.16)	(0.09)	(0.06)
$\epsilon_{it} D^{ndy}_{it}$	−0.16***	−0.07**	−0.00	−0.00	−0.06**
	(0.06)	(0.03)	(0.04)	(0.03)	(0.02)
D^{dy}_{it}	−4.01***	−3.03*	−3.63	−4.36	−2.75
	(1.31)	(1.79)	(2.20)	(3.05)	(3.49)
D^{ndy}_{it}	−2.07**	−1.93	−2.78*	−3.76*	−3.18
	(0.93)	(1.25)	(1.65)	(2.13)	(2.21)
Controls	YES	YES	YES	YES	YES
Observations	9 391 930	7 795 739	6 435 191	5 376 790	4 501 547

Note: standard errors in parentheses
$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
D^{dy}_{it} is dummy variable indicating Durables-Young firm
D^{dny}_{it} is dummy variable indicating Durables-Not-Young firm
D^{ndy}_{it} is dummy variable indicating Nondurables-Young firm.

Appendix K. Results combining durability, age and leverage: Table

See Table K.1.

Table K.1
Effect of monetary policy crossing durability, age and leverage.

	ΔI^*_{it0}	ΔI^*_{it1}	ΔI^*_{it2}	ΔI^*_{it3}	ΔI^*_{it4}
$\epsilon_{it} D^{dylowl}_{it}$	0.12	−0.50***	−0.46**	−0.08	−0.01
	(0.12)	(0.09)	(0.19)	(0.14)	(0.15)
$\epsilon_{it} D^{dyhighl}_{it}$	0.25*	−0.49***	−0.60**	−0.10	0.05
	(0.15)	(0.14)	(0.24)	(0.21)	(0.21)
$\epsilon_{it} D^{dnylowl}_{it}$	0.36	−0.43***	−0.52*	−0.07	0.10
	(0.24)	(0.09)	(0.28)	(0.16)	(0.15)
$\epsilon_{it} D^{dnyhighl}_{it}$	0.71**	−0.43***	−0.75*	−0.23	0.12
	(0.33)	(0.16)	(0.43)	(0.24)	(0.23)
$\epsilon_{it} D^{ndylowl}_{it}$	−0.06	−0.37***	−0.27**	−0.02	−0.06
	(0.07)	(0.09)	(0.13)	(0.09)	(0.08)
$\epsilon_{it} D^{ndyhighl}_{it}$	0.11	−0.33***	−0.34**	−0.09	−0.00
	(0.09)	(0.10)	(0.15)	(0.15)	(0.13)
$\epsilon_{it} D^{ndnylowl}_{it}$	0.11	−0.29***	−0.26*	−0.01	0.01
	(0.10)	(0.07)	(0.14)	(0.09)	(0.09)
$\epsilon_{it} D^{ndnyhighl}_{it}$	0.36**	−0.33**	−0.45**	−0.12	0.07
	(0.18)	(0.13)	(0.22)	(0.17)	(0.17)
Controls	YES	YES	YES	YES	YES
Observations	8 769 834	7 201 395	5 898 975	4 890 179	4 053 730

Note: standard errors in parentheses
$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
D^{dylowl}_{it} is dummy variable indicating Durable-Young firm with low leverage
$D^{dyhighl}_{it}$ is dummy variable indicating Durable-Young firm with high leverage
$D^{dnylowl}_{it}$ is dummy variable indicating Durable-Not-Young firm with low leverage
$D^{dnyhighl}_{it}$ is dummy variable indicating Durable-Not-Young firm with high leverage
$D^{ndylowl}_{it}$ is dummy variable indicating Not-durable-Young firm with low leverage
$D^{ndyhighl}_{it}$ is dummy variable indicating Not-durable-Young firm with high leverage
$D^{ndnylowl}_{it}$ is dummy variable indicating Not-durable-Not-Young firm with low leverage
$D^{ndnyhighl}_{it}$ is dummy variable indicating Not-durable-Not-Young firm with high leverage.

Appendix L. Effect of monetary policy shocks on sales growth, working capital, leverage and short-term debt: Tables

See Tables L.1–L.4.

Table L.1
Difference in effect of monetary policy on sales growth: reference group Nondurables-Not-Young firms.

	ΔSG_{it0}	ΔSG_{it1}	ΔSG_{it2}	ΔSG_{it3}	ΔSG_{it4}
ϵ_{it}	0.00	−0.23	−0.12	0.16	0.12
	(0.08)	(0.14)	(0.17)	(0.22)	(0.31)
$\epsilon_{it} D_{it}^{dy}$	0.02	−0.43***	−0.23**	0.13	0.21
	(0.10)	(0.11)	(0.11)	(0.21)	(0.23)
$\epsilon_{it} D_{it}^{dny}$	−0.03	−0.50***	−0.35***	0.03	0.10
	(0.08)	(0.11)	(0.11)	(0.23)	(0.25)
$\epsilon_{it} D_{it}^{ndy}$	0.00	0.02	0.06	0.03	0.01
	(0.03)	(0.05)	(0.05)	(0.06)	(0.08)
D_{it}^{dy}	9.15***	16.11***	19.97***	23.78***	27.82***
	(1.52)	(2.32)	(3.24)	(4.40)	(5.81)
D_{it}^{ndy}	9.45***	15.43***	19.57***	24.00***	27.94***
	(0.96)	(1.57)	(1.98)	(2.31)	(3.09)
ϵ_{it-1}	−0.34***	−0.22	0.09	0.11	0.03
	(0.11)	(0.15)	(0.24)	(0.31)	(0.33)
ϵ_{it-2}	0.01	0.15	0.21	0.23	0.18
	(0.08)	(0.16)	(0.26)	(0.32)	(0.32)
ΔSG_{it-1}	−0.25***	−0.33***	−0.38***	−0.42***	−0.46***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
ΔSG_{it-2}	−0.10***	−0.13***	−0.16***	−0.19***	−0.21***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Constant	−2.14**	−4.04***	−7.59***	−10.65***	−11.43***
	(0.85)	(1.36)	(1.66)	(1.30)	(1.61)
Observations	11 109 482	9 123 477	7 647 190	6 469 298	5 433 819

Standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table L.2
Difference in effect of monetary policy on working capital: reference group Nondurables-Not-Young firms.

	$\Delta wcap_{it0}$	$\Delta wcap_{it1}$	$\Delta wcap_{it2}$	$\Delta wcap_{it3}$	$\Delta wcap_{it4}$
ϵ_{it}	−0.10**	−0.07	0.03	0.03	0.03
	(0.05)	(0.05)	(0.06)	(0.05)	(0.04)
$\epsilon_{it} D_{it}^{dy}$	−0.02	0.00	0.04***	0.03**	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
$\epsilon_{it} D_{it}^{dny}$	−0.01	−0.01	−0.00	0.01	−0.00
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
$\epsilon_{it} D_{it}^{ndy}$	0.01	0.02	0.04***	0.02*	0.02
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
D_{it}^{dy}	1.33***	1.26**	0.83	0.45	0.71
	(0.26)	(0.54)	(0.67)	(0.60)	(0.63)
D_{it}^{ndy}	0.65***	0.23	−0.45	−1.08*	−0.94
	(0.17)	(0.47)	(0.59)	(0.55)	(0.62)
ϵ_{it-1}	−0.03	0.05	0.08*	0.06***	0.04***
	(0.02)	(0.05)	(0.04)	(0.02)	(0.01)
ϵ_{it-2}	0.02	0.06*	0.09***	0.05*	0.04
	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)
$\Delta wcap_{it-1}$	−0.42***	−0.51***	−0.56***	−0.59***	−0.62***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
$\Delta wcap_{it-2}$	−0.20***	−0.27***	−0.31***	−0.33***	−0.35***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)
Constant	−0.02	−0.62	−1.36**	−1.40***	−1.57***
	(0.19)	(0.49)	(0.53)	(0.50)	(0.47)
Observations	12 131 962	9 984 492	8 335 187	6 966 606	5 759 602

Standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table L.3
Difference in effect of monetary policy on leverage: reference group Nondurables-Not-Young firms.

	Δlev_{it0}	Δlev_{it1}	Δlev_{it2}	Δlev_{it3}	Δlev_{it4}
ϵ_{it}	0.01	−0.00	0.01	−0.01	−0.01
	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
$\epsilon_{it} D_{it}^{dy}$	−0.02*	−0.02	−0.05**	−0.04	−0.04
	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)
$\epsilon_{it} D_{it}^{dny}$	−0.01	0.00	0.00	0.00	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\epsilon_{it} D_{it}^{ndy}$	−0.01	−0.01	−0.03	−0.02	−0.01
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
D_{it}^{dy}	1.26***	2.11***	3.05***	3.88***	4.40***
	(0.42)	(0.48)	(0.57)	(0.59)	(0.68)
D_{it}^{ndy}	0.59***	1.19***	1.82***	2.44***	2.79***
	(0.20)	(0.25)	(0.28)	(0.30)	(0.36)
ϵ_{it-1}	−0.01	−0.01	−0.01	−0.00	−0.00
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
ϵ_{it-2}	0.00	0.01	0.03	0.02	0.01
	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)
Δlev_{it-1}	−0.33***	−0.44***	−0.50***	−0.55***	−0.58***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Δlev_{it-2}	−0.17***	−0.25***	−0.30***	−0.33***	−0.35***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	−0.33**	−0.50*	−0.71*	−0.59	−0.43
	(0.16)	(0.28)	(0.42)	(0.45)	(0.47)
Observations	10 918 163	8 944 445	7 456 855	6 235 235	5 164 048

Standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table L.4
Difference in effect of monetary policy on short-term debt: reference group Nondurables-Not-Young firms.

	$\Delta shdebt_{it0}$	$\Delta shdebt_{it1}$	$\Delta shdebt_{it2}$	$\Delta shdebt_{it3}$	$\Delta shdebt_{it4}$
ϵ_{it}	0.01	0.00	−0.00	−0.01	−0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)
$\epsilon_{it} D_{it}^{dy}$	−0.01	−0.02**	−0.05***	−0.03*	−0.03*
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
$\epsilon_{it} D_{it}^{dny}$	−0.00	−0.01*	−0.01	−0.00	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\epsilon_{it} D_{it}^{ndy}$	−0.00	−0.00	−0.01	−0.01	−0.01
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
D_{it}^{dy}	0.88***	1.35***	1.84***	2.13***	2.41***
	(0.30)	(0.35)	(0.42)	(0.46)	(0.51)
D_{it}^{ndy}	0.41***	0.65***	0.90***	1.12***	1.29***
	(0.12)	(0.20)	(0.24)	(0.29)	(0.35)
ϵ_{it-1}	−0.01	−0.01	−0.01	−0.01	−0.01
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
ϵ_{it-2}	−0.00	−0.00	0.00	0.00	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
$\Delta shdebt_{it-1}$	−0.41***	−0.51***	−0.57***	−0.60***	−0.62***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
$\Delta shdebt_{it-2}$	−0.20***	−0.28***	−0.32***	−0.35***	−0.35***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Constant	−0.02	0.05	0.09	0.19	0.28
	(0.11)	(0.23)	(0.32)	(0.32)	(0.33)
Observations	11 661 334	9 626 287	8 071 635	6 792 274	5 673 374

Standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Appendix M. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.euroecorev.2022.104251.

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