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Granular shocks to corporate leverage and the macroeconomic transmission of monetary policy

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Abstract

We study how shocks to corporate leverage alter the macroeconomic transmission of monetary policy. We identify leverage shocks as idiosyncratic firm-level disturbances that are aggregated up to a size-weighted country-level average to generate a *Granular Instrumental Variable* (Gabaix and Koijen, forthcoming). Interacting this instrumental variable with high-frequency identified monetary policy shocks, we find that transmission to the price level strengthens in the presence of leverage shocks, while the real effects of monetary policy are unaffected. We show that this disconnect can be rationalized with an internal devaluation channel. Economies experiencing an increase in leverage exhibit a stronger monetary policy-induced contraction in domestic demand. This, however, is counteracted by a weaker contraction in exports, facilitated by their improved price competitiveness.

Keywords: Monetary policy transmission, Corporate leverage, Granular Instrumental Variable, Micro-to-macro analysis

JEL Classification: C36, E22, E52

Non-technical summary

This paper studies the interaction between monetary policy and aggregate corporate leverage. This issue has acquired renewed relevance over recent years, as monetary policy around the globe has swiftly pivoted from loose to restrictive, while corporate leverage in many economies remains elevated by historical standards.

We find that monetary policy transmission to the price level strengthens in the presence of exogenous increases in corporate leverage, whereas the transmission to real GDP is unaffected. This contrast is striking since the main channel through which monetary policy typically feeds through to the price level is by first dampening economic activity – a regularity we also observe for our estimates in the absence of leverage shocks.

Subdividing GDP into key components, we explain this disconnect with an internal devaluation channel. Economies experiencing an increase in leverage exhibit a stronger monetary policy-induced contraction in domestic demand than those experiencing a decline. However, in the former case, this is counteracted by a milder drop in exports, facilitated by the competitiveness gains resulting from their stronger price-level response. In view of the pronounced variation in corporate leverage, these findings point to another relevant source of heterogeneity in monetary policy transmission across euro area countries and over time.

1 Introduction

The interaction between monetary policy and private sector indebtedness is a key determinant of macroeconomic outcomes, as has been recognized at least since Fisher (1933). It has also become a centerpiece of a large and influential literature on financial accelerator effects, initiated by Bernanke et al. (1996), with a particular focus on firm balance sheets as a potential amplifier of adverse shocks. In recent years, the interaction between monetary policy and firm balance sheets has acquired renewed relevance. Monetary policy around the globe has swiftly pivoted from loose to restrictive, while corporate leverage in many economies remains elevated by historical standards (Beck et al., 2023). At the same time, existing empirical literature on this issue has mostly focused on the micro level and evidence on its broader macroeconomic implications is scarce.

The current paper seeks to narrow this gap. We deploy a novel identification strategy, developed by Gabaix and Koijen (forthcoming), to obtain aggregate corporate leverage shocks. This Granular Instrumental Variables (GIV) method first extracts idiosyncratic disturbances arising at the micro level and then aggregates them up to the macro level. The aggregation is based on a weighting scheme that accounts for the potential of large cross-sectional units to significantly affect aggregate outcomes. It also supports the exogeneity of the instrument as dependencies on common factors are netted out. In our application, the first step is implemented by regressing leverage on a range of firm-specific and macroeconomic variables for a comprehensive panel of euro area companies. In the second step, we aggregate the remaining, unexplained firm-level variation to a weighted country-level average, using as weights the share of each firm in total corporate debt. The inclusion of a broad set of covariates in the first step supports the instrument-exogeneity assumption. The weighting scheme adopted in the second step further strengthens exogeneity and ensures instrument relevance at the aggregate level.

We then estimate the dynamic responses of key macroeconomic variables to monetary policy shocks conditional on exogenous variation in leverage. The aggregate estimation is based on a euro area country panel and the impulse response functions (IRFs) are estimated via local projections (Jordà, 2005). We use high-frequency surprises in interest rates on meeting days of the European Central Bank's (ECB) Governing Council to identify exogenous changes in monetary policy. By including an interaction of the GIV-based leverage shocks and the monetary policy surprises in our panel estimation, we can gauge whether changes in corporate leverage alter the macroeconomic transmission of monetary policy.

We find that monetary policy transmission to the price level strengthens in the presence of exogenous increases in corporate leverage, whereas its transmission to real GDP is unaffected. This contrast is striking since the main channel by which monetary policy typically feeds through to the price level is by first dampening economic activity – a regularity we also observe for our estimates in the absence of leverage shocks. Subdividing GDP into key components, we explain this disconnect with an internal devaluation channel. Economies experiencing an increase in leverage exhibit a stronger monetary policy-induced contraction in domestic demand than those experiencing a decline. However, in the former case, this is counteracted by a milder drop in exports, facilitated by the competitiveness gains resulting from their stronger price-level response. In view of the large variation in corporate leverage, these findings point to another relevant source of heterogeneity in monetary policy transmission across euro area countries and over time.

We subject our findings to a series of robustness checks. First, we control for asymmetries in monetary policy across business cycle phases, as the latter may differ in their susceptibility to leverage shocks. Second, we modify the GIV construction by winsorizing the shock and weight distributions and by extracting common variation across the firm-level residuals through a principal component. Last, we use alternative maturities of the high-frequency monetary policy shocks and a time-weighted aggregation that takes into account the specific dates of the policy events. All these robustness checks leave our main findings intact.

Related literature. Our paper contributes to an extensive literature on the role of corporate leverage in shaping firm-level and macroeconomic performance.[1] On the micro-level, Dinlersoz et al. (2019) demonstrate that a reduction in corporate leverage, in particular for private firms, was associated with lower revenues and employment during the Great Recession. Kalemli-Özcan et al. (2022) show that firms with higher leverage at the onset of the European sovereign debt crisis were more likely to reduce investment after the crisis. At the aggregate level, however, recent contributions by Schularick (2021) and Jordà et al. (2022) suggest that high aggregate debt levels have limited consequences for economic growth during episodes of economic recovery.

A second strand of related research studies how the level and structure of corporate debt shapes monetary policy transmission, including the role of debt maturity (Jungherr et al., 2022), floating vs. fixed-rate debt (Ippolito et al., 2018), as well as the split of corporate debt between bank loans and bonds (Crouzet, 2021, Holm-Hadulla and Thürwächter, 2021). On the role of leverage, the micro-level results are mixed. Jeenas (2019) finds that investments of firms with higher leverage are more responsive to monetary policy but this effect vanishes when controlling for balance sheet liquidity. Ottonello and Winberry (2020) instead conclude that investments are less responsive to monetary policy for more indebted firms. Using cross-industry variation, Auer et al. (2021) document a non-linear relationship between leverage and the sensitivity of industrial production to monetary policy: starting from low levels, increases in leverage are associated with a higher sensitivity of output; as the initial levels increase, however, the relationship changes sign and higher leverage is associated with a lower responsiveness to monetary policy. Our work contributes to this literature by: *(i)* studying the interaction of corporate leverage and monetary policy transmission at the macroeconomic level; and *(ii)* using a novel strategy for identifying exogenous changes in corporate leverage at the aggregate level.

Last, we also contribute to a growing number of papers that rely on the GIV method for causal inference. The initial work by Gabaix and Koijen (2021) looks at price formation in equity markets. Other applications of the GIV method include Chodorow-Reich et al. (2020), Galaasen et al. (2020), Adrian et al. (2022), who study the pass-through of asset values to valuations of insurance companies, the propagation of credit shocks from borrowers to the aggregate economy, and the effect of financial conditions on future GDP growth, respectively. To our knowledge, this paper is the first to use this method in the context of monetary policy transmission.

[1] A related strand of work has documented that high debt levels of households can exert downward pressure on economic growth and delay the recovery after recessions (see, e.g., Dynan (2012), Jordà et al. (2013), Mian et al. (2013, 2017)).

Outline. Section 2 describes the firm-level and aggregate data used in the analysis. Section 3 lays out the methodology for identifying exogenous changes in corporate leverage and monetary policy, as well as the local projections framework to examine their macroeconomic propagation. Section 4 presents the results and Section 5 reports a series of robustness checks, before Section 6 concludes.

2 Data

We use firm-level and aggregate data from ten euro area countries ranging from 2002 to 2018.[2] In the following subsections, we present the main features of these data, whereas additional details, including transformations and sources, can be found in Table A.1 in Appendix A.

2.1 Firm-level data

The firm-level data are from the Orbis historical database, which has particularly good coverage for European firms. Orbis provides panel data for a large number of firms, including their financial reports, as well as other firm characteristics like the industry, number of employees, and the date of incorporation. For the preparation and cleaning of the data, we follow the detailed guidance by Kalemli-Özcan et al. (2019) and the additional steps suggested by Durante et al. (2022), as well as conducting further manual checks for potential outliers. The firm-level data have an annual frequency. We assign firms with an account closing month between January and June to the previous accounting year, and firms with an account closing month between July and December are assigned to the current accounting year. The sample is restricted to firms from non-financial sectors.[3] All financial variables are deflated using the annual GDP deflator of the respective country and are winsorized at the 1% and 99% level.

The baseline sample has a high coverage and good representativeness of the aggregate economies. When summing the sales of all firms in the sample and comparing them to the respective country aggregates, we cover between 47% and 85%. In terms of representativeness, we compare the share of firms in our sample that are of a certain size, measured by the number of employees, with the shares in country-level data. The two distributions match each other pretty well, with a slightly higher share of large firms in the Orbis sample.[4]

Table 1 shows summary statistics from all firm-year observations in the estimation sample, which is a subset of the full data due to missing values in some variables. The sample consists of more than 3.4 million firms and 24 million firm-year observations. There is large variation in terms of size, measured through assets, sales, or employees. Similarly, there is a lot of dispersion

[2] The countries are Austria, Belgium, Germany, Spain, Finland, France, Greece, Italy, the Netherlands and Portugal, which combined account for more than 95% of total euro area GDP. We follow the recommendation by Altavilla et al. (2019) and exclude data from the early periods of the euro area due to sparse intraday quotes for OIS rates.

[3] We exclude the following NACE groups: Agriculture, Forestry, Fishing (A), Financial and insurance activities (K), Real estate activities (L), Public administration and defence, and Compulsory social security (O), Education (P), Activities of households as employees (T), Activities of extraterritorial organizations and bodies (U). In addition, we also exclude firms with activity status "Inactive", "Uknown" and "Active (dormant)", as well as firms with missing information for the date of incorporation.

[4] For further details on the comparison we refer the reader to the Appendix in Thürwächter (2023) and the related analysis by Kalemli-Özcan et al. (2019).

among firms with respect to their leverage, measured as total debt over total assets, the share of tangible assets, as well as their profitability. The vast majority of firms in our data are rather small, with a median value for total assets and sales of around five hundred thousand euros and five employees. This reflects the fact that most firms in the Orbis data are privately held, in line with the distribution of firms in the overall economy.[5]

2.2 Aggregate data

The aggregate data are at monthly frequency. As the main activity variable we use GDP and, for the price level, we use the GDP deflator. We further include the following GDP components: business investment, domestic demand, exports and imports. Business investment is measured through the Gross Fixed Capital Formation of non-financial firms. Domestic demand is the difference between GDP and net exports (exports minus imports). We interpolate all quarterly series to monthly frequency along corresponding monthly series, using the Chow and Lin (1971) method.[6] For the interpolation of GDP we use the monthly index of industrial production excluding construction; for the deflator the monthly HICP index; for business investment the monthly index of industrial production in the construction sector;[7] and for exports and imports we use the monthly series of merchandise trade. GDP and its components are all expressed in real terms.

For aggregate balance sheet data of the corporate sector, we use time series from the financial accounts. As for the firm-level data, we define aggregate leverage as the ratio of total debt to total assets, where total debt is the sum of outstanding debt securities of and loans to non-financial corporations. The two series are interpolated from quarterly to monthly frequency along corresponding variables from the ECB's SEC and BSI database respectively, again using the Chow and Lin (1971) method. Total assets are interpolated linearly. All balance sheet items are measured as notional stocks, which correct for variation arising due to valuation changes. We compute a measure of debt costs as the weighted average of costs for loans to NFCs and corporate bond costs, for which we use the iBoxx index. For Greece, there is no iBoxx index available, which reflects the scarce amount of corporate bonds, so we use only the costs for loans here. Last, we use the 3-month OIS rate as a policy indicator for which we average daily observations over each month.

[5] In this regard, our firm-level data are in stark contrast to the Compustat data used by many of the related papers, which consists only of publicly listed firms.

[6] For the choice of variables along which to interpolate investments, GDP and the deflator, we follow Stock and Watson (2010).

[7] For Greece this variable is not available and we interpolate linearly instead.

Table 1: Summary statistics.

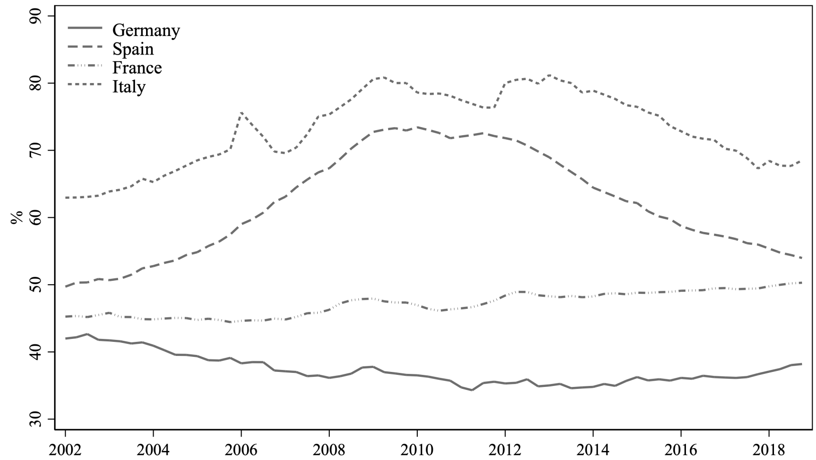
	N	Mean	Std.dev.	Min	Median	Max
Firm-level						
Total assets	24,628,415	7.88	352.23	0.00	0.43	201,399.38
Sales	24,628,415	6.08	176.85	0.00	0.47	110,317.35
Nr. of employees	15,483,516	27.78	484.18	0	5	288,820
Firm age	24,628,415	14.18	12.62	1	11	893
Leverage	24,628,415	19.35	25.61	0.00	8.88	145.60
Fixed asset share	24,628,415	21.08	24.32	0.00	11.01	96.40
Profitability	24,628,415	1.00	21.05	-169.43	1.77	58.57
Aggregate-level						
Leverage	2,040	63.12	19.18	34.31	59.50	128.33
Debt cost	1,800	3.32	1.56	1.11	3.15	8.58
GDP	2,040	80,758.45	74,736.02	14,424.62	42,836.94	269,423.66
GDP Deflator	2,040	93.76	7.19	77.82	95.16	106.40
Investment	2,040	9,101.37	8,503.94	565.10	5,057.30	32,717.69
Domestic demand	2,040	78,756.12	71,775.27	14,053.96	41,535.39	255,246.52
Exports	2,040	30,282.12	27,896.16	3,168.27	24,759.51	132,453.33
Imports	2,040	28,279.79	23,985.97	4,027.42	25,044.66	115,815.21
Leverage (EA)	2,040	52.83	1.54	50.35	52.69	56.07
GDP (EA)	2,040	847,239.76	42,946.90	767,343.25	850,150.00	938,594.19
GDP Deflator (EA)	2,040	93.58	6.37	81.18	94.18	103.80
3-month OIS	2,040	1.28	1.51	-0.36	0.67	4.33
Monetary policy shocks						
1-year OIS	2,040	0.23	3.38	-16.10	0.00	20.30
Leverage shocks						
Firm-level	24,628,415	0.04	11.92	-163.05	-0.39	166.31
Granular IV	2,040	0.69	2.62	-12.75	0.64	10.48

Note: All financial variables, as well as GDP, investment, domestic demand, exports and imports are in real terms. Total assets, sales, GDP, investment, domestic demand, exports and imports are in million EUR. The GDP deflator is indexed to 100 in 2015. Firm age is the number of years between the date of incorporation and the reporting date. Leverage is defined as the ratio of total debt to total assets of non-financial firms multiplied by 100. Profitability is measured as the ratio of net income to total assets multiplied by 100. The firm-level variables have been winsorized at the 1% and 99% level and we only report observations that are used for aggregation to the Granular Instrumental Variable (IV). Debt costs and the 3-month OIS rate are in percent and the monetary policy shock is in basis points. Data for debt costs are only available from 2004. The firm-level leverage shocks are the fitted residual from regression (1). For the Granular IV they are aggregated up to the country-year frequency using firm-level debt shares as weights in line with equation (2). All values are rounded to the nearest two decimals.

2.3 Evolution of aggregate corporate leverage

Figure 1 plots the evolution of corporate leverage across the four biggest euro area countries over the sample period (for the full set of countries see Figure A.1 in Appendix A). It shows that corporate leverage occasionally undergoes major shifts and is very heterogeneous across economies. In Spain, it increased by more than twenty percentage points during the first ten years of the euro, before returning closer to its initial level by the end of the sample period. For Italy, a similar build-up and subsequent reversal is visible. By contrast, corporate leverage in Germany and France varied much less, and in Germany, it even declined, over this period. Moreover, these fluctuations arise at vastly different levels. For example, considering the last sample observation, the difference between Germany and Italy amounts to more than thirty percentage points. These pronounced differences over time and across countries participating in the same currency union further motivate the subsequent analysis of how variation in corporate leverage interacts with the transmission of a common monetary policy.

Figure 1. Evolution of corporate leverage.



Note: The figure shows the time series of corporate leverage for the biggest four euro area countries. Leverage is calculated as the ratio of total debt to total assets of the non-financial sector multiplied by 100.

3 Econometric methodology

To study monetary policy transmission conditional on identified shocks in aggregate leverage, we proceed in three steps. First, we estimate regressions on a large panel of firms to isolate unexplained idiosyncratic variation in leverage (subsection 3.1). We then aggregate up this unexplained firm-level variation to a weighted country-level average (subsection 3.2). As weights we use each firm's share in total corporate debt in each country and year. This choice is motivated by the assumption that disturbances affecting large cross-sectional units may also alter aggregate leverage. These two steps implement the GIV method proposed by Gabaix and Koijen (forthcoming). Under the assumptions spelled out below, they ensure the exogeneity and relevance of our instrument for corporate leverage. The last step is to combine the GIV series with identified monetary policy shocks (subsection 3.3) and estimate their joint impact on key macroeconomic variables (subsection 3.4).

3.1 Estimates of firm-level leverage shocks

To obtain firm-level leverage shocks, we estimate the following equation country-by-country:[8]

$$Leverage_{i,t} = \alpha_i + \mu_{s,t} + \Gamma_1' X_{i,t} + \Gamma_2' X_{i,t-1} + \Gamma_3' \bar{X}_t + \Gamma_4' \bar{X}_{t-1} + \epsilon_{i,t} \tag{1}$$

The outcome variable, leverage, is defined as the ratio of total debt – the sum of short-term debt and long-term debt – to total assets of firm i in year t multiplied by 100. α_i is a firm fixed effect

[8] The results are unaffected if we estimate the firm-level shocks from a pooled sample and subsequently apply country-level weights for the aggregation.

that controls for firm-specific factors that are constant over time and $\mu_{s,t}$ is an industry-year fixed effect that absorbs unobserved variation across industries for any given year.[9] As firm-level controls, $X_{i,t}$, we include total fixed assets over total assets in percent, which is a proxy for the share of assets a firm can post as collateral. We also control for profitability, measured as the ratio of net income to total assets multiplied by 100; firm size measured by the log of sales; and firm age, measured by the number of years between the date of incorporation and the respective financial report. In addition, the lagged firm-level controls $X_{i,t-1}$ also include the leverage ratio.

The aggregate controls $\bar{X}_t$ and $\bar{X}_{t-1}$ include the year-on-year growth of the interpolated GDP and deflator series, as well as the twelve-month moving average of the 3-month OIS rate. The dating of the aggregate variables takes into account the closing month of the firm-level reports, i.e., if a firm is reporting in March, the growth rate of GDP and the deflator is the year-on-year change between the current observation and March of the previous year. Likewise, the OIS rate is the moving average up until the month of reporting.[10]

The key object of interest from the firm-level regression is $\epsilon_{i,t}$, the unexpected change in firm leverage. We refer to the fitted residuals, $\hat{\epsilon}_{i,t}$, as the estimated leverage shock of firm i in year t. They are a central input to the aggregate series of leverage shocks, which are described in more detail in the following subsection.

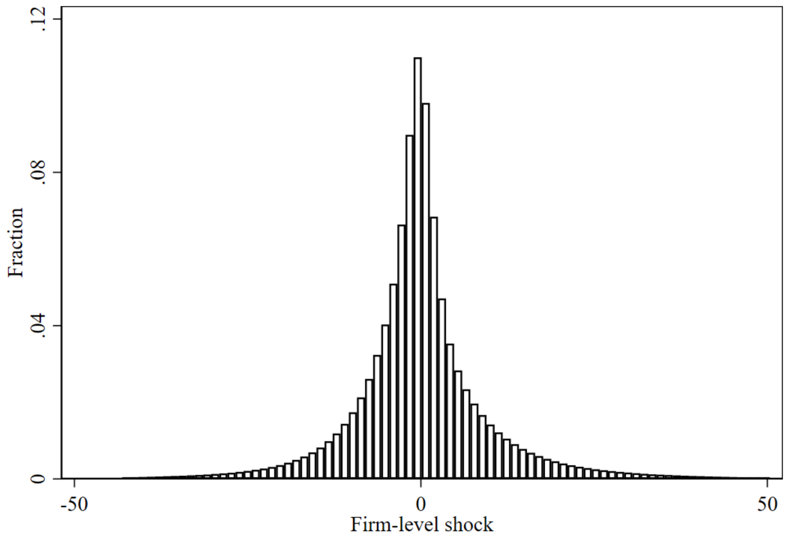
Inspection of firm-level shocks. We start with an inspection of the firm-level leverage shocks $\hat{\epsilon}_{i,t}$, which suggests a high degree of idiosyncrasy. Figure 2 shows the distribution of estimated leverage shocks $\hat{\epsilon}_{i,t}$ pooled across all countries.[11] The shocks are centered around zero with ca. 80% of mass in the range between -10.24 and 11.03. A value of ten here corresponds to a realization of corporate leverage at the firm-level that is ten percentage points larger than what would be predicted by the firm-level and aggregate control variables.

[9] The industries are grouped at the two-digit level according to the NACE industry classification.

[10] Through the dating of the aggregate control variables, we ensure the best possible mapping between the period covered by the firm's financial account and the contemporaneous developments at the macro-level. Since the GDP series is only available from 1999, which allows us to compute growth rates only from 2000 onward, we use the year-on-year change in the monthly index of industrial production for 1999.

[11] We exclude estimated residuals that are equal to zero, which are obtained for firms with a small number of observations. Table C.1 in Appendix C.1 shows summary statistics of the estimated shocks by country and pooled across all countries.

Figure 2. Histogram of estimated firm-level shocks ($\hat{\epsilon}_{i,t}$).



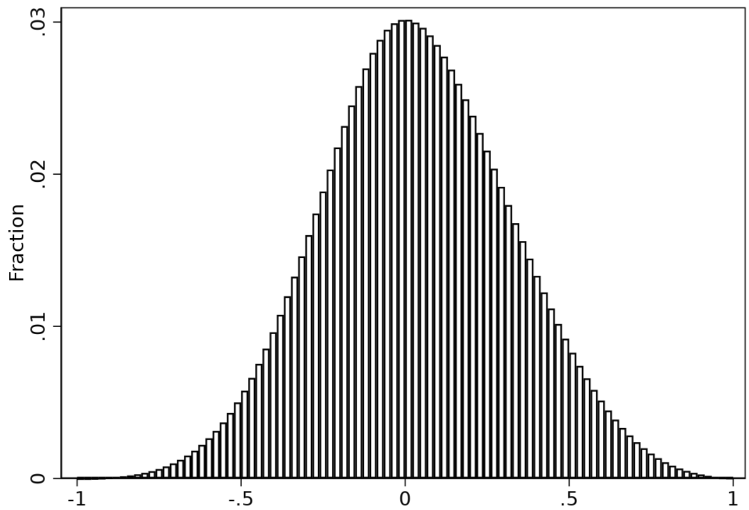
Note: The figure shows the distribution of estimated firm-level shocks to leverage extracted from equation (1) pooled across countries. The distribution is cut at the top and bottom 0.5% and we only show observations that are used for aggregation to the GIV.

The firm-level residuals are in part reflective of idiosyncratic firm-level components and in part of unobserved aggregate fluctuations that potentially affect many firms at once. At this stage, we test to what extent the estimated firm-level residuals appear to be purely idiosyncratic. We do this by *(i)* examining the degree of cross-sectional correlation of residuals across firms; and *(ii)* testing for autocorrelation in the residuals within firms over time. A high degree of cross-firm dependence or structural time dependence of the estimated residuals could indicate that the residuals may not only reflect idiosyncratic factors.

For *(i)* we compute pairwise correlations between firms within a given country for firms with a sufficiently large number of observations.[12] Figure 3 plots the distribution of the correlations and Table C.2 in Appendix C.1 shows related summary statistics. The pairwise correlations between the estimated firm-level shocks show no systematic dependence between firms within a given country. The correlations appear close to normally distributed and have a median value of 0.03 across the sample. Austria is an exception, with a relatively large mean and median indicating a positive correlation across firms but these values get smaller if we consider a subsample of firms with more observations. To test for autocorrelation in the estimated residuals, as per *(ii)*, we estimate a panel regression of the firm-level shocks on their lags. The coefficient from this estimation is small, standing at -0.04, which indicates that there is no meaningful autocorrelation in the firm-level leverage shocks.

[12] The cut-off for the number of observations depends on the overall number of observations available. For Spain, France and Italy, we keep firms with at least nineteen observations; for Belgium, Germany, Finland, Greece and Portugal, the cut-off is set at thirteen observations; for Austria, we require at least five observations and for the Netherlands no restrictions are applied.

Figure 3. Histogram of firm-by-firm correlations of estimated firm-level shocks.



Note: The figure shows the distribution of pairwise correlations of the estimated firm-level shocks. Correlations have been calculated between firms within a given country. To calculate a correlation, the sample of estimated shocks has been restricted to firms with a certain number of observations. The cutoffs are set at 5/12/19 observations for firms in Austria / Belgium, Germany, Finland, Greece, Portugal / Spain, France and Italy respectively, depending on the overall amount of observations for the estimated shocks.

3.2 Granular changes to corporate leverage

Equipped with the estimated firm-level leverage shocks, we proceed with the construction of an aggregate instrument for corporate leverage. Formally, we can describe the micro level residual estimated in the previous step as $\epsilon_{i,t} = \lambda_{i,t}\eta_t + u_{i,t}$, composed of firm-$i$'s exposure to unobserved aggregate shocks ($\lambda_{i,t}\eta_t$) and an idiosyncratic component ($u_{i,t}$). These firm-level shocks can be aggregated for each country and year to form the granular instrumental variable, denoted $\text{GIV}_{j,t}$, where j is the country in which a firm is incorporated. In case all firms have the same time-invariant dependence on unobserved aggregate shocks such that $\lambda_{i,t} = \lambda \; \forall \, i, t$, the $\text{GIV}_{j,t}$ is the difference between the size-weighted and the equal-weighted average of the residuals:

$$\text{GIV}_{j,t} = \sum_i s_{j,i,t-1}\hat{\epsilon}_{j,i,t} - \sum_i \frac{1}{N_{j,t-1}}\hat{\epsilon}_{j,i,t} = \sum_i s_{j,i,t-1}\hat{u}_{j,i,t} - \sum_i \frac{1}{N_{j,t-1}}\hat{u}_{j,i,t} \tag{2}$$

Here, $\hat{\epsilon}_{j,i,t}$ is the estimated firm-level residual obtained from equation (1) with an additional country index j. The weights are denoted by $s_{j,i,t}$. In our application, we use the share of firm-i's debt in the total corporate debt of year t and country j as the size-weight, such that the shares sum to one for each country-year cell ($\sum_i s_{j,i,t} = 1$).[13] To avoid that the shares are affected by the contemporaneous shocks, we lag them by one year. For the equal-weighted average, $N_{j,t}$ denotes the total number of firms in country j and year t. We also lag the fraction of firms $\frac{1}{N_{j,t}}$ by one year to match the timing of the debt shares. For both the size-weighted and the equal-weighted residuals, the terms multiplied by the unobserved aggregate component

[13] Gabaix and Koijen (forthcoming) provide a formal definition of optimal weights for the GIV but they also demonstrate that the aggregation is robust to misspecified weights.

η_t sum to one. When subtracting them from each other, this term thus cancels out.[14] As a consequence, the $\text{GIV}_{j,t}$ consists only of the idiosyncratic component, $\hat{u}_{j,i,t}$, which assures that the variation in leverage at the aggregate level is exogenous. Figure C.1 in Appendix C shows a time series plot for the GIV of each country.

Instrument validity. Like any other instrumental variable, the GIV has to fulfill two central conditions to be valid: exogeneity and relevance. Formally, these can be stated as:

$$\text{Exogeneity:} \quad \sum_i \mathbb{E}\left[s_{j,i,t} u_{j,i,t} e_{j,t}\right] = 0 \tag{3}$$

where $e_{j,t}$ is any unobserved error in the aggregate estimation equation; and:

$$\text{Relevance:} \quad \sum_i \mathbb{E}\left[s_{j,i,t} u_{j,i,t} \text{lev}_{j,t}\right] \neq 0 \tag{4}$$

where $\text{lev}_{j,t}$ denotes corporate leverage at the country-level, whiche instrument with the aggregated idiosyncratic shocks.

While the exogeneity assumption is not testable, several steps in our identification strategy help us guard against remaining confounding factors. When extracting the firm-level residual, we add GDP, the deflator and the 3-month OIS rate as contemporaneous and lagged controls, which capture prevailing macroeconomic conditions; and we include detailed industry-year fixed effects to control for other, unobserved influences specific to each industry in a given year. In addition, we confirm that the estimated firm-level leverage shocks are uncorrelated across firms in any given country and do not show dependence over time, as documented in the previous subsection. Last, we confirm that the lagged debt shares and the estimated leverage shocks are uncorrelated.[15]

For the relevance condition to hold, there need to be large "granular" firms in the sample that account for a sizable share of the aggregate economy such that their idiosyncratic shocks have the potential to affect macroeconomic outcomes. The distribution of debt shares in our sample appears to fulfill this criterion in that a limited number of firms account for a meaningful share of aggregate debt (see Table C.3 in Appendix C.1). In sum, these steps support our country-level series of identified leverage shocks as a valid instrument.

Generalized GIV. The GIV definition in equation (2) is based on the assumption that all firms have constant and homogeneous loadings on the aggregate disturbances η_t such that

[14] Dropping time and country subscripts, we can write:

$$\text{GIV} = \sum_i s_i \epsilon_i - \sum_i \frac{1}{N}\epsilon_i = \sum_i s_i(\lambda\eta + u_i) - \sum_i \frac{1}{N}(\lambda\eta + u_i) = \sum_i s_i \lambda\eta + \sum_i s_i u_i - \left(\sum_i \frac{1}{N}\lambda\eta + \sum_i \frac{1}{N}u_i\right)$$

Since $\sum_i s_i = 1$ and $\sum_i \frac{1}{N} = 1$ this simplifies to:

$$\text{GIV} = \lambda\eta + \sum_i s_i u_i - \lambda\eta - \sum_i \frac{1}{N}u_i = \sum_i s_i u_i - \sum_i \frac{1}{N}u_i$$

[15] In the pooled sample the correlation is 0.0006. On the country-level the correlation ranges between −0.0008 and 0.0050.

$\lambda_{i,t} = \lambda \, \forall i, t$. It is possible to relax this assumption and allow for heterogeneous loadings across firms and over time. For this generalized version of the GIV, we run a principal component analysis across all firm residuals for a given country, which extracts common factors that vary on the year and country level.[16] Subsequently, we regress the estimated firm-level residuals on the first principal component and obtain a new set of fitted residuals that controls for these common latent factors. We then aggregate this series to the country-level as in equation (2). We examine the robustness of our baseline results with this generalized form of the GIV and confirm the main findings, as detailed in Section 5.

3.3 Identification of monetary policy shocks

For the identification of monetary policy shocks, we rely on high-frequency surprises in interest rates around meetings of the ECB's Governing Council. This method, pioneered by Kuttner (2001), has found widespread use in the monetary economics literature (see, e.g., prominent examples by Gertler and Karadi (2015) and Nakamura and Steinsson (2018) and, for the euro area, by Altavilla et al. (2019) and Jarocinski and Karadi (2020); Ramey (2016) provides an in-depth review of this identification approach). The identification assumption is that changes in the interest rate, which are calculated over a narrow time window around central bank decisions, reflect purely unanticipated shocks to the interest rate and are not endogenous to other aggregate developments. The specific surprise we use is the change in interest rates from before the press release to the end of the subsequent press conference on meeting days of the ECB's Governing Council. Following Jarocinski and Karadi (2020), we define monetary policy shocks as those surprises for which the change of the interest rate and the stock market index are of opposite signs.

We obtain data for interest rate changes at all Governing Council meetings of the ECB from the Euro Area Monetary Policy Event-Study Database (EA-MPD) by Altavilla et al. (2019).[17] To find a good mapping between the policy indicator and the identified monetary policy shocks among the range of interest rates available in the EA-MPD, we choose the surprises from the maturity with the best statistical fit. Specifically, we regress the 3-month OIS rate on a range of candidate surprises and evaluate the impact response to a 100 basis point (bps) change in the surprise (while also controlling for all other variables in the system).[18] Based on this exercise, we choose the surprise in the 1-year OIS rate for constructing the monetary policy shocks, as it results in the tightest confidence intervals and the point estimate suggests an almost one-to-one mapping to the policy indicator (see Figure B.1 in Appendix B). The event-level surprises are mapped into monthly frequency by summing them up in case there is more than one policy

[16] We estimate the principal component on a balanced subsample of firms. We choose the subsample such that we keep a large amount of firms for each country with the longest possible time series. For Austria / Germany / Belgium, Finland, France, Greece, Italy, Portugal and Spain, these subsamples consist of firms with at least nine / fifteen / eighteen consecutive observations. For feasibility we further draw a random subset of 10% of firms for Spain, France and Italy and 20% of firms for Greece. The shorter time series in the balanced panel for Austria and Germany leads to missing values in the principal component. We replace these with values from France. For the Netherlands, there are not enough firms in the balanced subsample to extract a principal component, so we instead use values for Belgium.

[17] The database is updated regularly and can be accessed through the following link: `https://www.ecb.europa.eu/pub/pdf/annex/Dataset_EA-MPD.xlsx`.

[18] The regression specification is equivalent to the baseline detailed in equation (5) evaluated at GIV=0.

meeting during the month and setting them to zero for months without policy meetings. The time series of the monetary policy shock series is shown in Figure B.2 of Appendix B. As part of our robustness analysis in Section 5, we confirm our results for the use of alternative maturities of the high-frequency surprises and a different approach for aggregating these surprises over time.

3.4 Aggregate transmission

We estimate the transmission of monetary policy conditional on changes to aggregate corporate leverage in a country panel, using Jordà (2005)'s local projection method. We estimate the following equation separately for each projection horizon h:

$$Y_{j,t+h} = \alpha_{j,h} + (\beta_{0,h} + \beta_h \text{GIV}_{j,t-12})\, MP_t + \gamma_h \sum_{p=1}^{2} X_{j,t-p} + \theta_h \sum_{p=1}^{2} \bar{X}_{t-p} + e_{j,t+h} \qquad (5)$$

The projection horizon h denotes the number of months after the monetary policy shock, j is the country index, and t is the month in which the shock arises. As dependent variables, $Y_{j,t+h}$, we consider the aggregate level of corporate leverage, firms' debt costs, GDP, the GDP deflator, and the short-term policy rate. $\alpha_{j,h}$ is a country fixed effect. The coefficient $\beta_{0,h}$ estimates the effect of the monetary policy shock MP_t on the outcome variables in the absence of changes to aggregate leverage, i.e., when the GIV is zero. The coefficient on the interaction between the monetary policy shock and the GIV, β_h, gives the dependence of monetary policy transmission on exogenous changes in leverage. We lag the GIV by twelve months in order to obtain a good mapping between the period covered in the annual firm-level financial reports and the outcome variables.

The vector $X_{j,t-p}$ includes country-level controls, consisting of lags of leverage, GDP, the deflator, lags of the GIV variable and interactions of the GIV and the monetary policy shock. The common controls X_{t-p} comprise lags of euro area-wide leverage, euro area GDP and deflator, as well as the policy rate and the monetary policy shock. The series of GDP and the deflator enter the regressions in 100 times their log-levels and leverage as the ratio of total debt over total assets in the corporate sector, also multiplied by 100. Debt costs and the policy rate enter in percent per annum. We use two lags in the estimation ($p = 2$) and $e_{j,t+h}$ are Driscoll and Kraay (1998) standard errors that account for cross-sectional correlation across countries and auto-correlation over the projection horizons.

4 Results

We start with the impulse responses to a monetary policy shock in the absence of changes in leverage (subsection 4.1), which also allows us to benchmark our estimates against the related literature. We then inspect how transmission changes when it coincides with exogenous changes in aggregate corporate leverage (subsection 4.2). Last we present impulse responses for individual components of GDP, which shed light on potential channels underlying our main results (subsection 4.3).

4.1 Transmission in the absence of leverage shocks

In the absence of leverage shocks, the IRFs exhibit the typical patterns of monetary policy transmission across outcome variables (see Figure 4).[19] In the initial period after the monetary policy shock, the short-term interest rate increases and reaches a peak after three months. It then displays a slight undershooting after roughly one and a half years, before returning to its initial level towards the end of the horizon. The debt costs move in tandem with the short-term rate and increase on impact, albeit with a smaller magnitude. The peak is obtained after four months and is around one percentage point smaller than the peak for the short-term rate. After a small undershooting also the debt costs return to their initial levels.

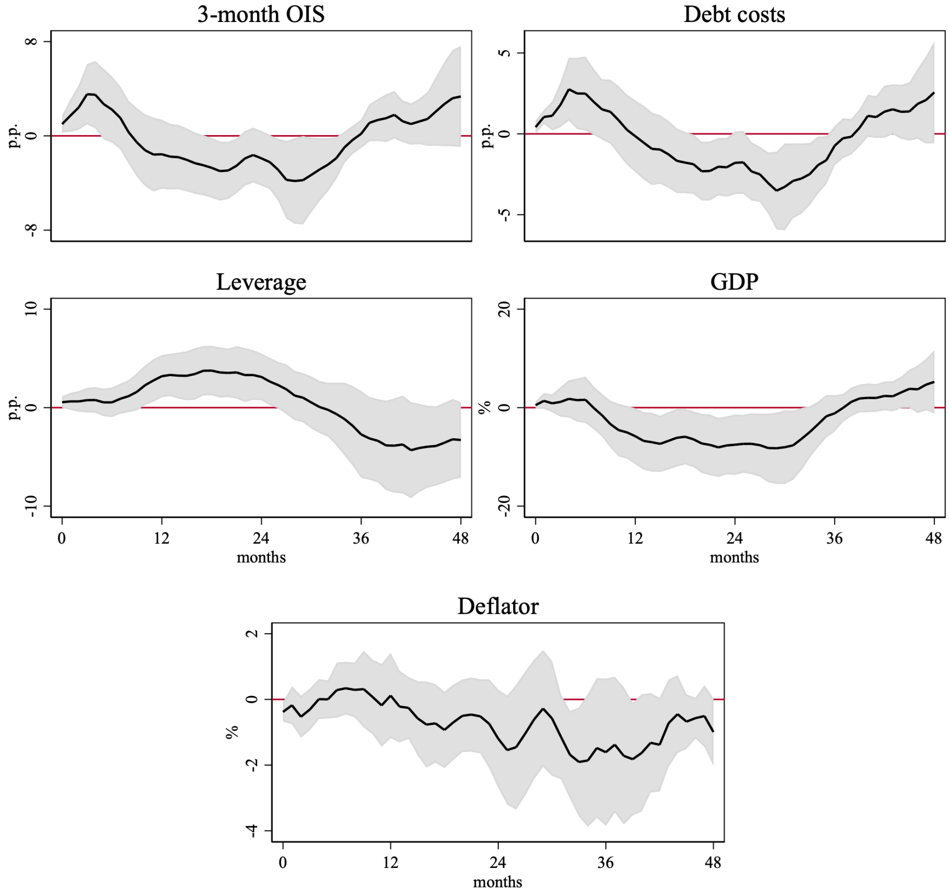
Aggregate leverage increases around one year after the shock and stays elevated until a year later. The decomposition of leverage into its parts reveals that both total debt and total assets decline in response to the monetary policy shock (see Figure D.3 in Appendix D).

Economic activity declines in response to the interest rate increase. The GDP contraction materializes between the first and the third year after the shock and the trough is obtained after two and a half years. The aggregate price level, measured by the GDP deflator, also declines in response to the monetary policy tightening. The trough in the response is reached at the end of the third transmission year, indicating a relatively short lag relative to the trough in economic activity, followed by a higher persistence in the price level adjustment.

The size of the estimates falls within the range reported in the related literature. For this comparison, we scale the trough response of GDP and the deflator by the peak response of the short-term interest rate. By this metric, the peak-to-trough transmission for GDP and the deflator are -2.6% and -0.8% respectively, which is in line with previous estimates (see Ramey (2016) for a comprehensive overview).

[19] We use the full sample for all variables except when estimating the IRFs for the cost of debt, which are based on a shorter sample starting in 2004 due to constraints in data availability. We confirm the baseline IRF patterns for all other variables in the shorter sample, too (see Figure D.2 in Appendix D).

Figure 4. Impulse responses in absence of leverage shocks (GIV=0).



Note: The IRFs are estimated from equation (5). The plots show the IRFs for $\beta_{0,h}$, which are normalized to a 100 bps impact response in the 3-month OIS rate. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data. The grey area is the 90% confidence interval using Driscoll and Kraay (1998) standard errors.

4.2 Transmission in the presence of leverage shocks

To test for heterogeneity in the transmission of monetary policy conditional on changes in corporate leverage, we inspect the regression coefficient from the interaction of the GIV and the monetary policy shock (see equation (5)). Table 2 lists estimates from the monetary policy shocks ($\beta_{0,h}$) and the interaction term (β_h) at selected IRF horizons. The regression coefficients on the full set of controls, as well as a plot of the IRF for the interaction term, can be found in Appendix D in Tables D.1 to D.5 and Figure D.1, respectively.

For the short-term rate, the interaction coefficient is not statistically different from zero. The interaction terms for debt costs and leverage show a statistically significant increase for some horizons, whereas for GDP none of the point estimates for the interaction term is significant. By contrast, the interaction coefficient for the deflator is negative and statistically significant at the 5%-level for several impulse response horizons. For example, the coefficient at the two-year horizon implies that the deflator declines by an additional 2.1% for each standard deviation increase in leverage, on top of a point estimate of around -1% in the absence of leverage shocks.

Table 2: Baseline estimates for coefficients on monetary policy shock and interaction with GIV.

$Y_{j,t}$		$h = 0$	$h = 3$	$h = 12$	$h = 18$	$h = 24$	$h = 36$
3-month OIS	$\beta_{0,h}$	0.869**	3.070**	-1.353	-2.351*	-1.658	0.152
		(0.382)	(1.344)	(1.540)	(1.337)	(1.217)	(0.634)
	β_h	-0.011	-0.076	-0.001	-0.026	-0.130	-0.121
		(0.022)	(0.085)	(0.125)	(0.127)	(0.167)	(0.120)
Debt costs	$\beta_{0,h}$	0.363*	1.563**	-0.125	-1.545	-1.555	-0.639
		(0.204)	(0.729)	(1.162)	(0.992)	(1.017)	(0.636)
	β_h	0.008	0.003	0.243	0.273**	0.186	0.095
		(0.035)	(0.166)	(0.163)	(0.137)	(0.144)	(0.124)
Leverage	$\beta_{0,h}$	0.483	0.658	2.771**	3.269**	2.709**	-2.363
		(0.305)	(0.655)	(1.121)	(1.318)	(1.247)	(2.315)
	β_h	0.093	0.347*	0.579	0.258	0.254	-0.248
		(0.068)	(0.191)	(0.362)	(0.297)	(0.302)	(0.453)
GDP	$\beta_{0,h}$	0.439	1.013	-5.032*	-5.123*	-6.541**	-1.008
		(0.393)	(1.582)	(2.979)	(2.960)	(3.216)	(1.938)
	β_h	-0.051	-0.021	-0.026	-0.057	-0.192	-0.257
		(0.076)	(0.134)	(0.272)	(0.355)	(0.262)	(0.281)
Deflator	$\beta_{0,h}$	-0.331**	-0.265	0.102	-0.808	-1.037	-1.397
		(0.154)	(0.333)	(0.682)	(0.611)	(0.784)	(1.179)
	β_h	0.004	-0.149	-0.380	-0.659**	-0.819**	-0.602
		(0.038)	(0.119)	(0.249)	(0.307)	(0.403)	(0.401)
N		1,900	1,870	1,780	1,720	1,660	1,540
N (debt costs)		1,780	1,750	1,660	1,600	1,540	1,420

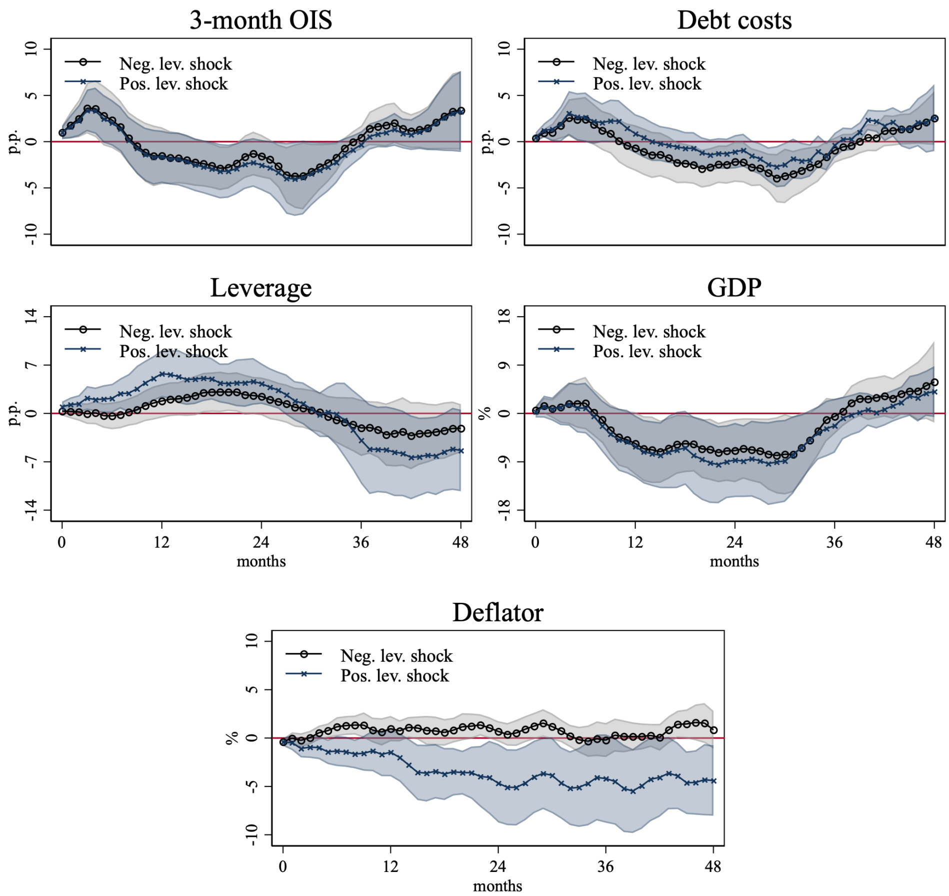
Note: The table shows estimates from the regression equation (5). Column $Y_{j,t}$ lists the dependent variables and h refers to the horizon of the IRF. $\beta_{0,h}$ corresponds to the coefficient on the monetary policy shock in the absence of changes in corporate leverage (GIV=0) and β_h is the coefficient on the interaction of the monetary policy shock with the GIV. Coefficients for debt costs are estimated from a shorter sample starting in 2004 due to missing data. Coefficients for control variables are not shown. The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

In Figure 5, we further examine the economic relevance of leverage shocks for transmission. For this purpose, we evaluate the IRFs at the $10th$ and $90th$ percentile of the GIV distribution. At the $10th$ percentile, the GIV is negative, which implies a decline in aggregate leverage, whereas at the $90th$ percentile, it is positive, thus corresponding to an increase in leverage.

The results show distinct differences across variables as to how exogenous changes in leverage impact the transmission of monetary policy. For the short-term rate, the IRFs are very similar during times of negative and positive leverage shocks. The transmission to debt costs and leverage exhibits slight differences during leverage expansions and contractions. Both variables remain elevated for longer when the monetary policy shock coincides with a leverage expansion.

The responses of GDP and the deflator point to an interesting disconnect. GDP adjusts to a monetary policy shock in essentially the same way, independent of the realization of the leverage shock. By contrast, the deflator remains unaffected by monetary policy in times of negative leverage shocks, whereas its transmission during increases in leverage leads to a pronounced fall in the price level. This contrast is striking since the main channel by which monetary policy typically affects the price level is by first dampening economic activity (see our estimates in the absence of leverage shocks in Figure 4). To investigate this disconnect between the real and nominal transmission of monetary policy conditional on leverage, we next turn to the responses of individual subcomponents of GDP.

Figure 5. Impulse responses at 10th and 90th percentile of the GIV.



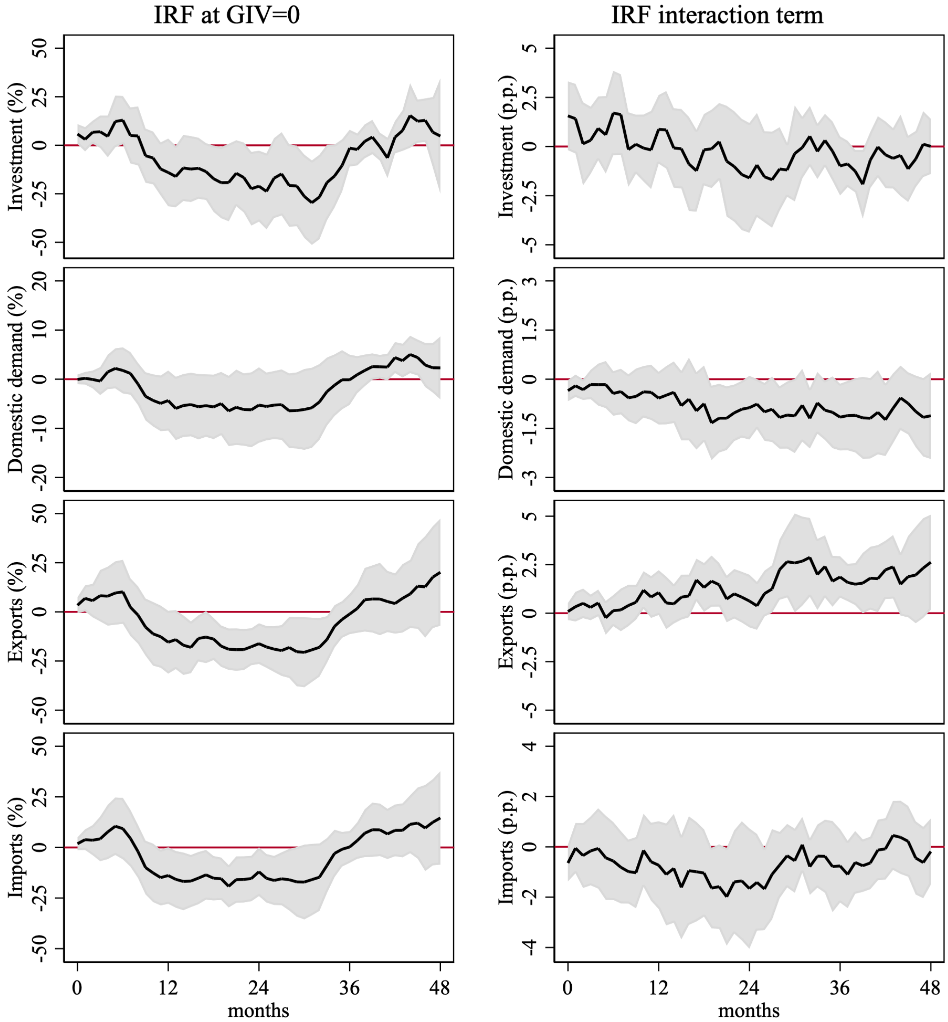
Note: The IRFs are estimated from equation (5) and evaluated at the 10th percentile (negative leverage shock) and 90th percentile (positive leverage shock) of the GIV. The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the 10th (90th) percentile of the GIV. The gray (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay (1998) standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

4.3 Channels

As subcomponents of GDP, we consider investment by the corporate sector and on the other hand a GDP breakdown into domestic demand, exports and imports. The former presents the most direct measure by which the corporate sector can adjust to leverage shocks. The latter yields insights into the adjustments in the broader economy taking place in the presence of leverage shocks.

Figure 6 shows the IRFs for the four variables in the absence of leverage shocks and for the interaction between monetary policy and the GIV (see Tables E.1 to E.4 in Appendix E for the corresponding regression tables). Investments, exports and imports exhibit strong declines in response to a monetary policy tightening. Domestic demand also tends to drop, but its coefficient is imprecisely estimated and insignificant at the 10% level. The IRFs for the interaction term reveal that leverage shocks lead to statistically significant changes in transmission to domestic demand and exports between one and four years after the monetary policy shock, whereas for investment and imports no clear pattern emerges.

Figure 6. Impulse responses in absence of leverage shocks and interaction term (GDP components).

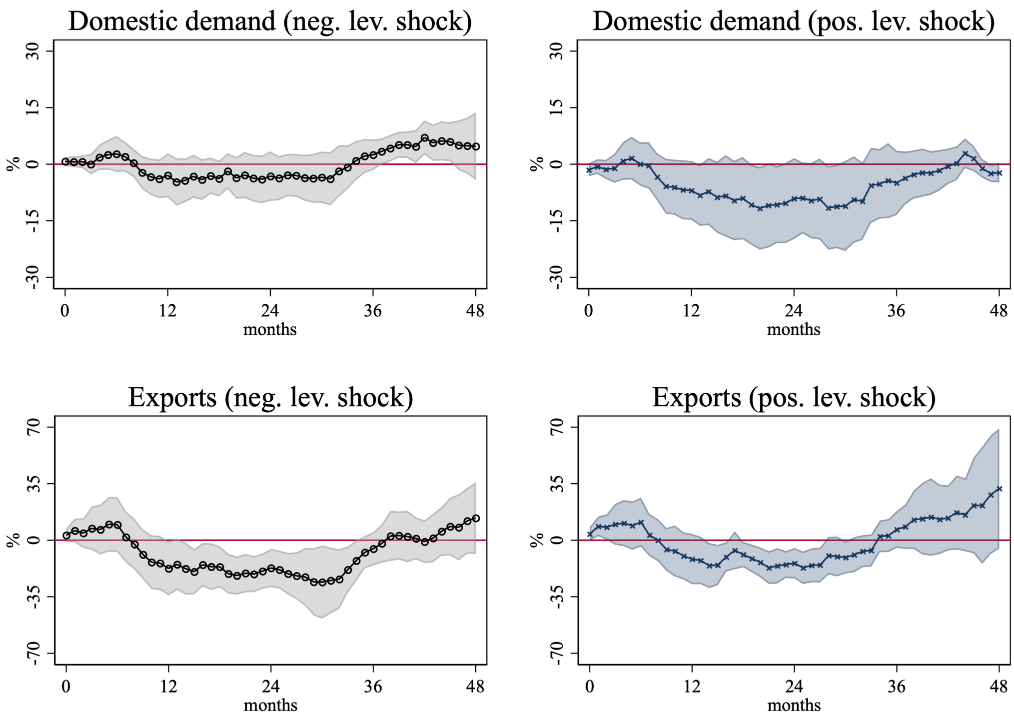


Note: The IRFs are estimated from equation (5). The left column shows the IRFs for $\beta_{0,h}$, which are normalized to a 100 bps impact response in the 3-month OIS rate. The right column shows the IRFs for the interaction term β_h. The grey area is the 90% confidence interval using Driscoll and Kraay (1998) standard errors.

To gauge the economic significance stemming from the differential effect of leverage shocks, Figure 7 shows the IRFs of domestic demand and exports, again evaluated at the 10*th* and 90*th* percentile of the GIV distribution. While, in case of a decrease in leverage, domestic demand does not respond, increasing leverage leads domestic demand to contract around two years after the monetary policy shock. Exports in turn fall by more in case of negative leverage shocks and the reduction is muted during positive leverage shocks.

The differential transmission of monetary policy to domestic demand and exports, in the presence of corporate leverage shocks, points to an *internal devaluation channel* that may also rationalize the disconnect in the effects on GDP and the price level. The stronger fall in prices supports international competitiveness, which results in a more muted export reduction when monetary policy tightens and leverage rises simultaneously. The improved export performance, relative to the case with declining leverage, counteracts the stronger decline in domestic absorption that arises in response to the combined monetary policy tightening and upward leverage shock. In contrast, when leverage falls there is no adjustment in the price level, which leads to a stronger fall in exports. Together with broadly unchanged domestic demand, the export decline results in a GDP reduction of similar magnitude as in times of leverage increases.

Figure 7. Impulse responses of domestic demand and exports at 10*th* and 90*th* percentile of the GIV.



Note: The IRFs are estimated from equation (5) and evaluated at the 10*th* percentile (negative leverage shock) and 90*th* percentile (positive leverage shock) of the GIV (upper and lower row respectively). The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The grey and blue areas are the 90% confidence intervals using Driscoll and Kraay (1998) standard errors.

5 Robustness

Our main findings are confirmed by a series of robustness checks, which we report in the current section; the corresponding charts are available in Figures F.1 to F.7 in Appendix F.

Business cycle asymmetries. The occurrence of leverage shocks may be systematically related to the state of the business cycle. For instance, if there was a tendency for them to arise at the onset of or during recessions, our interaction term may capture not only the genuine conditioning effect of corporate leverage but also asymmetries of monetary policy over the cycle. We thus test whether our results are affected when accounting for this potential confounding factor. For this purpose, we define an indicator variable that is equal to one during recessions and zero otherwise. We measure recessions as two subsequent quarters of negative growth in GDP of the respective country. We then interact the recession indicator with the monetary policy shock series and add the interaction, together with the indicator variable, to the baseline regression from equation (5). The extended regression confirms our main findings (see Figure F.1 in Appendix F).

Alternative GIV specifications. A second set of robustness exercises tests the stability of our findings to alternative GIV measures. We exchange our baseline measure with a version that winsorizes the estimated firm-level shocks and the debt shares at the 1% and 99% level of the respective within-country distribution. A second modification uses the generalized version of the GIV, which relaxes the assumption of constant and homogeneous loadings of the firm-level surprises on unobserved aggregate factors (see subsection 3.2 for details). These alternative specifications of the GIV lead to similar patterns as the baseline (see Figures F.2 to F.4 in Appendix F).

Alternative monetary policy surprises. Last, we check the robustness of our findings with regard to the monetary policy shock definition. We change the monetary policy shock in three ways: first, we use the surprises from the 3-month OIS rate, thus matching the maturity of the policy rate; second, we use a summary measure of surprises along various maturities, ranging from 1-week to 2-years, following the example by Nakamura and Steinsson (2018); third, we weight the surprises according to the number of days in a calendar month since the last Governing Council meeting (see, e.g., Gertler and Karadi (2015) for this aggregation of the event-level series). In all three versions of the monetary policy shock, our main findings remain intact (see Figures F.5 to F.7 in Appendix F).

6 Conclusion

We study the interaction between corporate leverage and the macroeconomic transmission of monetary policy. We identify exogenous variation in leverage with the Granular Instrumental Variable method, drawing on an extensive firm-level dataset for the euro area. To construct our instrument, we first back out idiosyncratic firm-level disturbances and then aggregate them up to the country level. In this process, we ensure the exogeneity of the instrument by purging the observed variation in leverage from a host of firm-specific and macroeconomic factors; and, in the aggregation step, we ensure instrument relevance by attaching a higher weight to large firms with the potential to significantly affect leverage dynamics also at the country level.

We find that monetary policy transmission to the price level strengthens in the presence of exogenous increases of corporate leverage, whereas its transmission to real GDP is unaffected. Subdividing GDP into key components, we explain this disconnect with an internal devaluation channel. Economies hit by an upward shock to leverage respond with a stronger monetary policy-induced contraction in domestic demand and, supported by their improved price competitiveness, exhibit a countervailing milder drop in exports than economies experiencing an exogenous decline in leverage. In view of the pronounced variation in corporate leverage, these findings point to another relevant source of heterogeneity in monetary policy transmission across euro area countries and over time.

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Appendices

A Data details

A.1 Variables and transformation

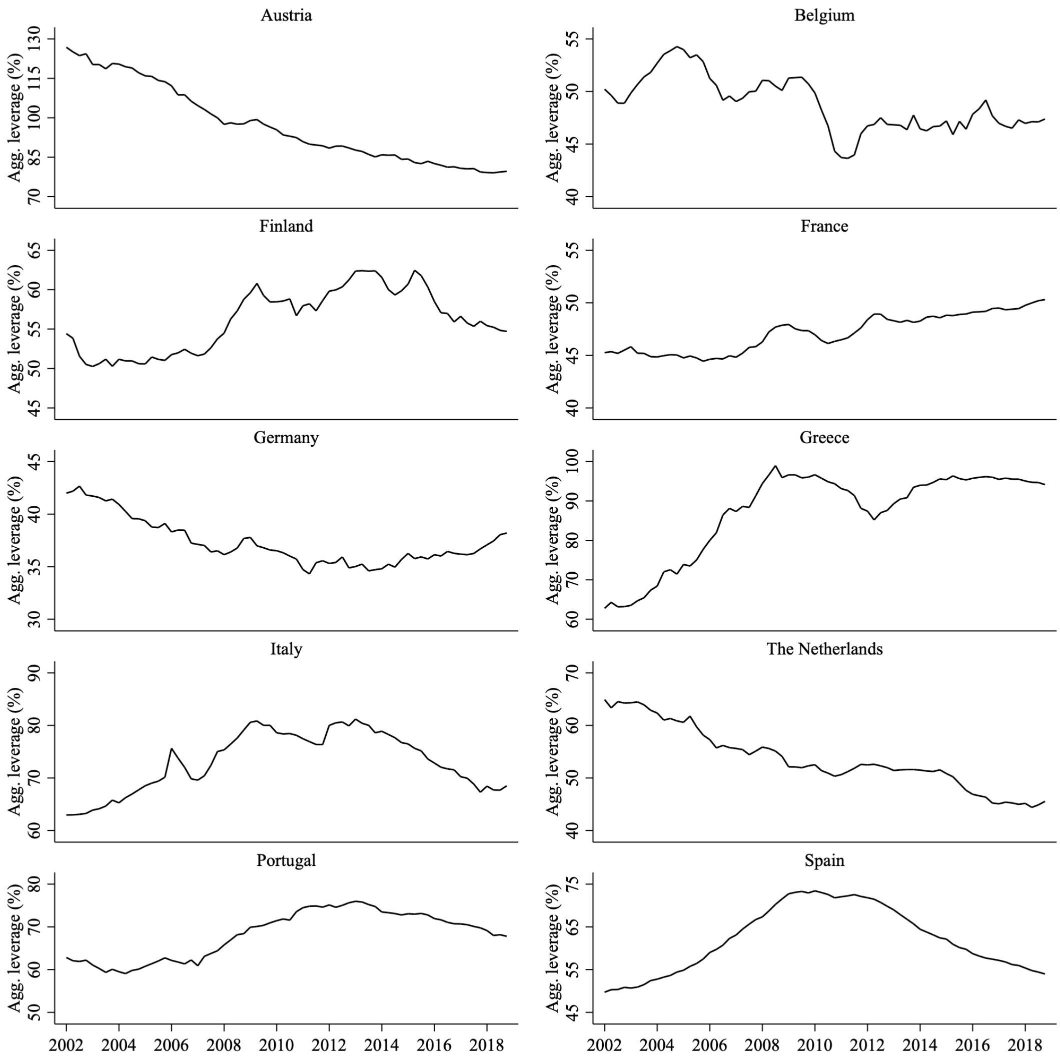
Table A.1: Detailed data overview.

Variable	Description and transformation	Source
Firm-level variables		
Leverage	Ratio of total debt (sum of short-term debt and long-term debt) to total assets; multiplied by 100	Orbis
Size	Log of sales	Orbis
Age	Nr. of years between date of incorporation and report	Orbis
Fixed asset share	Share of total fixed assets to total assets in percent	Orbis
Profitability	Ratio of net income to total assets; multiplied by 100	Orbis
Aggregate variables		
Leverage	Ratio of total debt to total assets of non-financial corporations (NFCs)	SDW
Total debt	Sum of debt securities and loans of NFCs reported in financial accounts; interpolation based on monthly counterparts from the BSI and SEC databases using Chow and Lin (1971) method; notional stocks; seasonally adjusted; enter in log-levels	SDW
Total assets	Total assets of NFCs reported in financial accounts; linearly interpolated to monthly frequency; notional stocks; seasonally adjusted; enters in log-levels	SDW
Debt costs	Weighted average of costs for loans to NFCs on new business loans and corporate bond costs; costs for corporate bonds are the yield of the iBoxx index; weights are based on the notional stocks of loans and bonds	SDW, Reuters
Real GDP	Interpolated based on monthly industrial production (ex. construction) using Chow and Lin (1971) method; seasonally adjusted; enters in log-levels	SDW (GDP), Eurostat (IP)
GDP deflator	Interpolated based on monthly HICP index using Chow and Lin (1971) method; seasonally adjusted; enters in log-levels	SDW (HICP), Eurostat (deflator)
Investment	Real Gross Fixed Capital Formation of NFC sector; interpolated based on monthly index of construction activity using Chow and Lin (1971) method; seasonally adjusted; enters in log-levels	SDW (Gross Fixed Capital Formation), Eurostat (construction index)
Domestic demand	Difference between interpolated GDP and interpolated exports net of interpolated imports; enters in log-levels	Authors' calculation
Exports	National accounts; interpolated based on monthly series of merchandise trade by the OECD using Chow and Lin (1971) method; seasonally adjusted; enters in log-levels	SDW, OECD
Imports	National accounts; interpolated based on monthly series of merchandise trade by the OECD using Chow and Lin (1971) method; seasonally adjusted; enters in log-levels	SDW, OECD
Policy rate	3-month OIS rate; average of daily observations over the month	Reuters
Leverage (EA)	See leverage	See leverage
Real GDP (EA)	See GDP	See GDP
GDP deflator (EA)	See deflator	See deflator
Monetary policy shock		
Baseline shock	High-frequency surprises of 1-year OIS rate; identified through negative cross-asset correlation of surprise of rate and Eurostoxx index; daily surprises summed over the month	EA-MPD Altavilla et al. (2019)
Estimated shocks		
Firm-level	Estimated residual from equation (1)	Authors' calculation based on Orbis data
Granular IV	Firm-level shocks aggregated to country-level as per equation (2) using debt shares as weights	Authors' calculation based on Orbis data

Note: All financial firm-level variables are deflated using the annual GDP deflator of the respective country and winsorized at the 1% and 99% level. SDW refers to the ECB Statistical Data Warehouse. BSI is the Balance Sheet Items database and SEC the Securities Issues Statistics database by the ECB, which can be accessed through the SDW.

A.2 Aggregate corporate leverage

Figure A.1. Time series of corporate leverage by country.

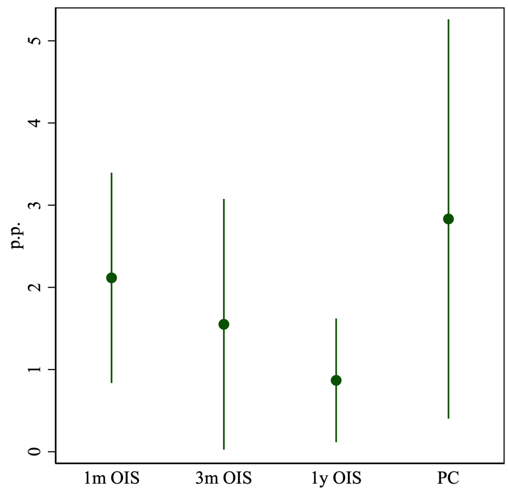


Note: The figure shows the country-by-country time series of corporate leverage calculated as the ratio of total debt to total assets of the non-financial sector multiplied by 100.

B Identification of monetary policy shocks

B.1 Impact response of policy rate

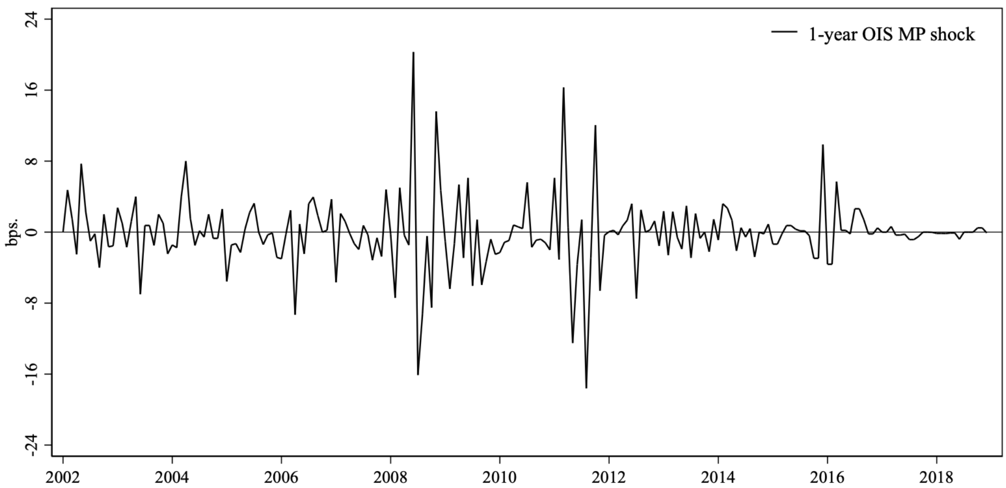
Figure B.1. Impact response of 3-month OIS rate.



Note: The estimates are obtained from the regression specification in equation (5) varying the right-hand side variable MP_t in the absence of leverage shocks (GIV=0). The response is scaled to a 100 bps tightening shock in the respective high-frequency surprise. PC refers to the first principal component of the 1-week to 2-year OIS rates. The range shows the 95% confidence interval.

B.2 Time series of monetary policy shocks

Figure B.2. Time series of monetary policy shocks.



Note: The figure shows the time series of the identified monetary policy shock. The event-level surprises have been aggregated to the monthly frequency. The monetary policy shocks have been identified from negative cross-asset correlation in the interest rate and stock prices around ECB Governing Council meetings as detailed in subsection 3.3.

C Identification details GIV

C.1 Firm-level shocks

Table C.1: Summary statistics of firm-level shocks (country-by-country).

	N	Mean	Std.dev.	Min	p10	Median	p90	Max
AT	23,851	0.05	13.95	-129.11	-13.66	0.13	14.04	137.61
BE	431,161	0.01	10.19	-129.49	-8.57	-0.15	8.78	136.71
DE	263,488	-0.02	10.80	-142.78	-9.54	-0.19	9.52	132.29
ES	4,656,648	0.04	11.53	-146.85	-10.69	-0.53	11.64	150.18
FI	613,115	0.00	13.30	-152.94	-12.24	-0.30	13.04	153.30
FR	9,068,060	0.04	11.71	-163.05	-9.63	-0.42	10.07	166.31
GR	251,967	0.04	9.14	-123.38	-7.54	-0.22	8.16	141.46
IT	8,048,640	0.05	12.06	-144.57	-10.47	-0.35	11.27	147.86
NL	4,700	0.08	9.82	-99.04	-8.91	-0.04	9.41	80.28
PT	1,266,785	0.01	14.19	-154.27	-12.73	-0.19	13.42	148.52
Total	24,628,415	0.04	11.92	-163.05	-10.29	-0.39	10.98	166.31

Note: The table shows the distribution of estimated firm-level leverage shocks estimated from equation (1). Each line contains summary statistics for a country in the sample and the last line pools the estimated shocks across all countries. All values are rounded to the nearest two decimals.

Table C.2: Summary statistics of firm-by-firm correlations of estimated firm-level shocks (country-by-country).

	N	Mean	Std.dev.	Min	p10	Median	p90	Max
AT	1,465,242	0.14	0.58	-1.00	-0.71	0.18	0.91	1.00
BE	37,892,865	0.01	0.32	-1.00	-0.41	0.00	0.42	1.00
DE	5,182,590	0.02	0.38	-1.00	-0.48	0.02	0.53	1.00
ES	344,871,525	0.01	0.27	-0.98	-0.34	0.00	0.37	1.00
FI	66,464,685	0.00	0.33	-1.00	-0.43	-0.00	0.44	1.00
FR	484,585,146	0.03	0.27	-0.99	-0.32	0.02	0.38	1.00
GR	53,981,245	0.01	0.29	-1.00	-0.37	0.00	0.39	1.00
IT	621,157,881	0.07	0.29	-0.98	-0.30	0.06	0.45	1.00
NL	123,042	0.02	0.66	-1.00	-0.91	0.03	0.93	1.00
PT	117,312,903	0.02	0.35	-1.00	-0.44	0.02	0.48	1.00
Total	1,733,037,124	0.04	0.29	-1.00	-0.33	0.03	0.42	1.00

Note: The table shows the distribution of pairwise correlations of the estimated firm-level shocks. Each line contains summary statistics for a country in the sample and the last line pools the estimated shocks across all countries. Correlations have been calculated between firms within a given country. To calculate a correlation, the sample of estimated shocks has been restricted to firms with a certain number of observations. The cutoffs are set at 5/12/19 observations for firms in Austria / Belgium, Germany, Finland, Greece, Portugal / Spain, France and Italy respectively, depending on the overall amount of observations for the estimated shocks. All values are rounded to the nearest two decimals.

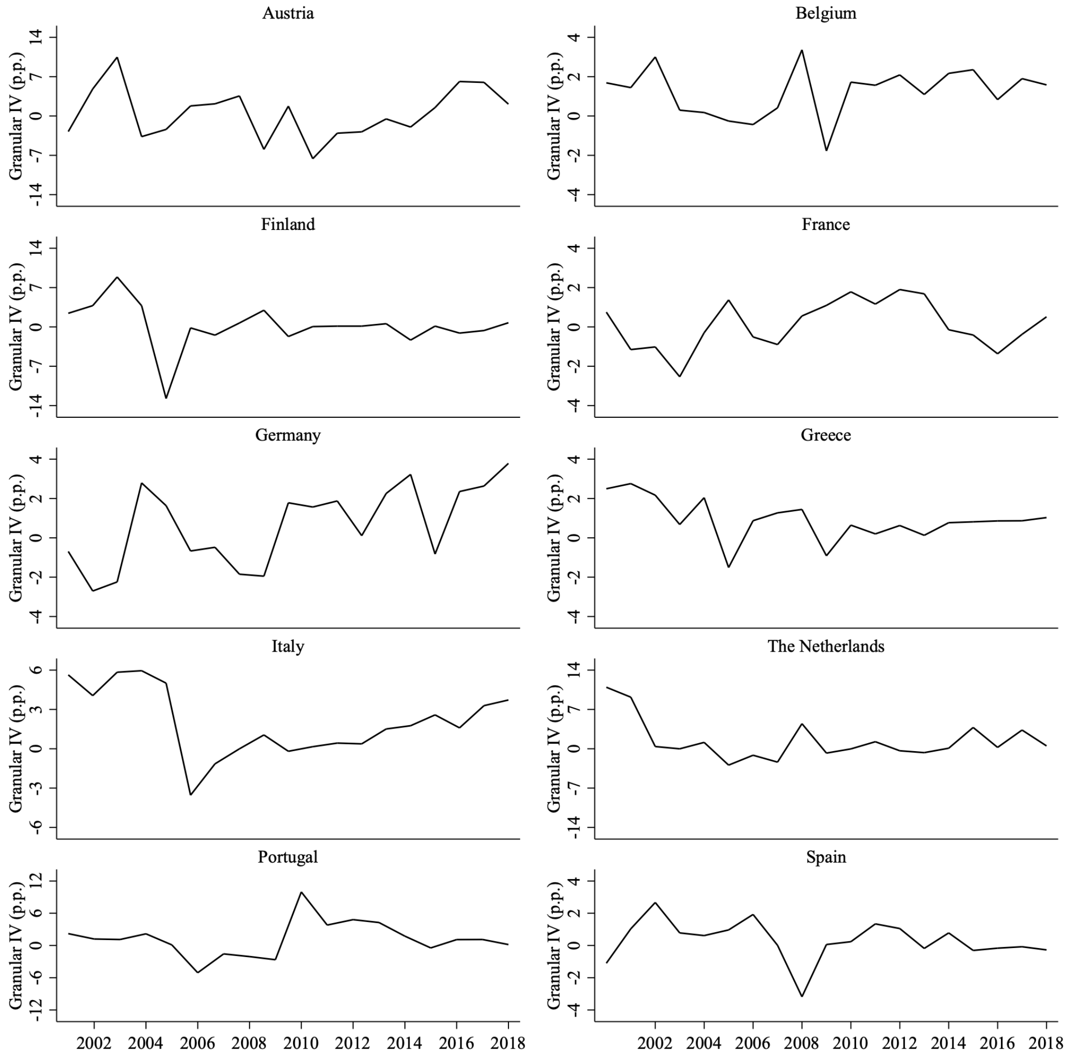
Table C.3: Summary statistics of debt share (country-by-country).

	N	Mean	Median	p90	p99	Max
AT	23,851	0.00	0.00	0.00	0.01	0.34
BE	431,161	0.00	0.00	0.00	0.00	0.20
DE	263,488	0.00	0.00	0.00	0.00	0.32
ES	4,656,648	0.00	0.00	0.00	0.00	0.10
FI	613,115	0.00	0.00	0.00	0.00	0.09
FR	9,068,060	0.00	0.00	0.00	0.00	0.17
GR	251,967	0.00	0.00	0.00	0.00	0.14
IT	8,048,640	0.00	0.00	0.00	0.00	0.07
NL	4,700	0.00	0.00	0.00	0.07	0.60
PT	1,266,785	0.00	0.00	0.00	0.00	0.10
Total	24,628,415	0.00	0.00	0.00	0.00	0.60

Note: The table shows the distribution of firm-level debt shares. Each line contains summary statistics for a country in the sample and the last line pools all countries. The debt shares are lagged one period relative to the firm shocks. All values are rounded to the nearest two decimals.

C.2 Granular IV

Figure C.1. Time series of Granular IV by country.



Note: The figure shows the country-by-country time series of the Granular IV at annual frequency, which has been constructed as detailed in subsection 3.2.

D Additional results baseline

Table D.1: Baseline estimates (3-month OIS).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	0.869**	-1.353	-1.658	0.152
	(0.382)	(1.540)	(1.217)	(0.634)
MP*L12.GIV	-0.011	-0.001	-0.130	-0.121
	(0.022)	(0.125)	(0.167)	(0.120)
L.MP	0.234	-2.968	-2.288	1.442
	(0.268)	(2.003)	(1.703)	(1.026)
L2.MP	0.102	-2.999*	-1.903	1.806*
	(0.149)	(1.758)	(1.732)	(1.040)
L.MP*L13.GIV	-0.038*	0.041	-0.127	-0.172
	(0.021)	(0.123)	(0.158)	(0.147)
L2.MP*L14.GIV	0.007	0.060	-0.087	-0.143
	(0.012)	(0.122)	(0.132)	(0.129)
L12.GIV	0.000	-0.019**	-0.024***	-0.011
	(0.001)	(0.008)	(0.009)	(0.012)
L13.GIV	-0.001	-0.001	-0.004	-0.002
	(0.001)	(0.005)	(0.005)	(0.004)
L14.GIV	-0.001	-0.024***	-0.027**	0.004
	(0.001)	(0.008)	(0.011)	(0.009)
L.3-month OIS	1.725***	1.827*	0.216	-0.845
	(0.093)	(0.996)	(0.756)	(0.714)
L2.3-month OIS	-0.753***	-1.515*	-0.557	0.637
	(0.100)	(0.822)	(0.938)	(0.583)
L.Leverage	0.000	-0.104**	0.008	0.126***
	(0.004)	(0.045)	(0.032)	(0.033)
L2.Leverage	0.000	0.107**	0.001	-0.122***
	(0.004)	(0.044)	(0.032)	(0.032)
L.GDP	0.005	0.083**	-0.032	-0.090**
	(0.007)	(0.036)	(0.030)	(0.040)
L2.GDP	-0.005	-0.075**	0.044	0.094**
	(0.007)	(0.035)	(0.030)	(0.041)
L.Deflator	0.002	-0.014	0.026	0.013
	(0.007)	(0.062)	(0.047)	(0.021)
L2.Deflator	-0.002	0.013	-0.046	-0.031
	(0.007)	(0.062)	(0.044)	(0.021)
L.Leverage (EA)	0.021	-0.910*	0.232	0.012
	(0.055)	(0.496)	(0.349)	(0.414)
L2.Leverage (EA)	-0.021	0.866*	-0.332	-0.280
	(0.056)	(0.473)	(0.379)	(0.370)
L.GDP (EA)	0.024	0.256***	0.001	-0.157
	(0.021)	(0.087)	(0.160)	(0.121)
L2.GDP (EA)	-0.020	-0.175**	0.122	0.166***
	(0.021)	(0.089)	(0.094)	(0.056)
L.Deflator (EA)	0.050	0.413	-0.616**	-0.886**
	(0.055)	(0.388)	(0.302)	(0.420)
L2.Deflator (EA)	-0.058	-0.613	0.279	0.639*
	(0.056)	(0.418)	(0.336)	(0.377)
N	1,900	1,780	1,660	1,540

Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

Table D.2: Baseline estimates (debt costs).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	0.363*	-0.125	-1.555	-0.639
	(0.204)	(1.162)	(1.017)	(0.636)
MP*L12.GIV	0.008	0.243	0.186	0.095
	(0.035)	(0.163)	(0.144)	(0.124)
L.MP	-0.042	-2.155	-2.119*	0.915
	(0.190)	(1.424)	(1.152)	(0.570)
L2.MP	-0.478*	-2.707**	-1.959*	1.069*
	(0.271)	(1.338)	(1.014)	(0.573)
L.MP*L13.GIV	0.025	0.256	0.272*	0.158
	(0.047)	(0.178)	(0.154)	(0.127)
L2.MP*L14.GIV	0.046	0.243	0.236*	0.070
	(0.069)	(0.159)	(0.142)	(0.128)
L12.GIV	0.003	0.018	-0.009	-0.007
	(0.003)	(0.027)	(0.017)	(0.015)
L13.GIV	0.001	-0.000	0.006	0.007
	(0.005)	(0.010)	(0.007)	(0.009)
L14.GIV	-0.001	-0.041*	-0.031**	-0.035**
	(0.004)	(0.022)	(0.013)	(0.015)
L.Debt costs	0.773***	0.656***	0.362**	0.234
	(0.050)	(0.180)	(0.142)	(0.143)
L2.Debt costs	0.199***	0.006	-0.170	-0.457***
	(0.048)	(0.189)	(0.120)	(0.174)
L.Leverage	0.001	-0.050	-0.069	0.087***
	(0.009)	(0.057)	(0.087)	(0.030)
L2.Leverage	-0.000	0.056	0.088	-0.062**
	(0.009)	(0.054)	(0.084)	(0.025)
L.GDP	-0.016	-0.041	-0.160***	-0.170***
	(0.011)	(0.034)	(0.052)	(0.062)
L2.GDP	0.016	0.039	0.154***	0.150**
	(0.011)	(0.035)	(0.053)	(0.058)
L.Deflator	-0.005	-0.116	-0.273**	-0.215*
	(0.024)	(0.074)	(0.113)	(0.112)
L2.Deflator	0.009	0.159**	0.334***	0.299**
	(0.024)	(0.076)	(0.117)	(0.117)
L.3-month OIS	0.685***	1.811***	0.093	-1.360**
	(0.090)	(0.684)	(0.601)	(0.566)
L2.3-month OIS	-0.656***	-2.188***	-0.748	1.347***
	(0.083)	(0.521)	(0.623)	(0.452)
L.Leverage (EA)	-0.027	-1.194***	0.121	0.162
	(0.061)	(0.453)	(0.281)	(0.478)
L2.Leverage (EA)	0.037	1.314***	0.027	-0.117
	(0.061)	(0.439)	(0.266)	(0.444)
L.GDP (EA)	0.068***	0.463***	0.246***	-0.128
	(0.021)	(0.116)	(0.089)	(0.128)
L2.GDP (EA)	-0.059***	-0.270**	-0.018	0.148
	(0.019)	(0.115)	(0.086)	(0.102)
L.Deflator (EA)	-0.005	0.664*	-0.265	-0.562**
	(0.051)	(0.383)	(0.281)	(0.223)
L2.Deflator (EA)	-0.005	-0.978**	-0.240	0.209
	(0.052)	(0.407)	(0.265)	(0.222)
N	1,780	1,660	1,540	1,420

Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

Table D.3: Baseline estimates (leverage).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	0.483	2.771**	2.709**	-2.363
	(0.305)	(1.121)	(1.247)	(2.315)
MP*L12.GIV	0.093	0.579	0.254	-0.248
	(0.068)	(0.362)	(0.302)	(0.453)
L.MP	0.328	2.346*	-0.277	-5.601*
	(0.257)	(1.372)	(1.225)	(3.035)
L2.MP	0.184	1.618	-1.497	-5.420**
	(0.241)	(1.246)	(1.199)	(2.690)
L.MP*L13.GIV	0.009	0.360	0.125	-0.607
	(0.053)	(0.332)	(0.431)	(0.616)
L2.MP*L14.GIV	0.007	0.362	0.286	-0.464
	(0.062)	(0.317)	(0.355)	(0.563)
L12.GIV	-0.007	0.045	0.016	0.077**
	(0.008)	(0.035)	(0.038)	(0.032)
L13.GIV	0.007	0.017	0.009	0.000
	(0.009)	(0.026)	(0.028)	(0.020)
L14.GIV	0.004	0.016	0.072	-0.005
	(0.006)	(0.040)	(0.053)	(0.051)
L.Leverage	1.307***	1.893***	1.978***	1.717***
	(0.040)	(0.202)	(0.287)	(0.356)
L2.Leverage	-0.314***	-1.044***	-1.331***	-1.300***
	(0.040)	(0.203)	(0.280)	(0.331)
L.GDP	-0.015	0.343	0.664	0.338
	(0.029)	(0.278)	(0.434)	(0.253)
L2.GDP	0.020	-0.286	-0.621	-0.331
	(0.028)	(0.268)	(0.460)	(0.293)
L.Deflator	0.050	0.018	0.518	0.426
	(0.048)	(0.330)	(0.432)	(0.595)
L2.Deflator	-0.052	-0.037	-0.520	-0.471
	(0.047)	(0.337)	(0.467)	(0.648)
L.3-month OIS	-0.011	0.800	2.946***	1.804
	(0.077)	(0.519)	(1.071)	(1.192)
L2.3-month OIS	0.053	-0.159	-2.784***	-2.731**
	(0.077)	(0.588)	(0.684)	(1.079)
L.Leverage (EA)	-0.086	-0.356	-1.499**	-1.102**
	(0.099)	(0.629)	(0.692)	(0.552)
L2.Leverage (EA)	0.085	0.401	1.871***	1.789***
	(0.100)	(0.594)	(0.558)	(0.534)
L.GDP (EA)	-0.031	-0.205	0.217	0.535***
	(0.033)	(0.224)	(0.330)	(0.138)
L2.GDP (EA)	0.027	0.191	0.161	0.311
	(0.034)	(0.218)	(0.367)	(0.206)
L.Deflator (EA)	-0.075	0.672	0.818	-0.148
	(0.096)	(0.503)	(0.810)	(0.611)
L2.Deflator (EA)	0.080	-0.637	-1.197	-0.718
	(0.096)	(0.530)	(0.907)	(0.725)
N	1,900	1,780	1,660	1,540

Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

Table D.4: Baseline estimates (GDP).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	0.439	-5.032*	-6.541**	-1.008
	(0.393)	(2.979)	(3.216)	(1.938)
MP*L12.GIV	-0.051	-0.026	-0.192	-0.257
	(0.076)	(0.272)	(0.262)	(0.281)
L.MP	-0.045	-6.393	-5.362	2.466
	(0.493)	(4.025)	(4.501)	(1.660)
L2.MP	-1.141**	-6.077*	-3.569	3.194*
	(0.496)	(3.492)	(4.273)	(1.667)
L.MP*L13.GIV	0.003	0.038	-0.309	-0.271
	(0.073)	(0.283)	(0.306)	(0.384)
L2.MP*L14.GIV	0.048	-0.033	-0.250	-0.387
	(0.064)	(0.303)	(0.330)	(0.402)
L12.GIV	0.000	-0.042	-0.064	-0.063
	(0.017)	(0.039)	(0.053)	(0.048)
L13.GIV	-0.009	-0.014	-0.025	-0.019
	(0.017)	(0.037)	(0.044)	(0.028)
L14.GIV	0.004	-0.014	0.010	0.109*
	(0.004)	(0.039)	(0.052)	(0.061)
L.GDP	1.026***	1.910***	1.629***	1.098***
	(0.038)	(0.289)	(0.412)	(0.323)
L2.GDP	-0.024	-0.943***	-0.770*	-0.394
	(0.038)	(0.302)	(0.430)	(0.281)
L.Leverage	0.023	0.110	0.539**	0.666*
	(0.026)	(0.138)	(0.255)	(0.386)
L2.Leverage	-0.028	-0.173	-0.671**	-0.889**
	(0.026)	(0.148)	(0.266)	(0.411)
L.Deflator	-0.020	0.419*	0.452	0.230
	(0.051)	(0.218)	(0.319)	(0.383)
L2.Deflator	-0.001	-0.682***	-0.961***	-0.954***
	(0.051)	(0.258)	(0.325)	(0.345)
L.3-month OIS	0.963***	0.656	-2.276*	-2.834*
	(0.165)	(1.753)	(1.192)	(1.581)
L2.3-month OIS	-0.923***	-0.822	2.179	3.872***
	(0.165)	(1.508)	(1.657)	(1.119)
L.Leverage (EA)	-0.140	-3.177***	-1.018	-0.949
	(0.126)	(1.144)	(1.082)	(0.905)
L2.Leverage (EA)	0.074	2.444**	-0.371	-1.153
	(0.125)	(1.043)	(0.985)	(0.751)
L.GDP (EA)	-0.049	-0.517**	-1.440**	-1.753***
	(0.047)	(0.252)	(0.569)	(0.320)
L2.GDP (EA)	0.021	0.225	0.703**	0.376**
	(0.048)	(0.219)	(0.319)	(0.183)
L.Deflator (EA)	0.131	0.022	-1.507	-0.444
	(0.148)	(0.969)	(1.281)	(0.880)
L2.Deflator (EA)	-0.089	0.336	2.424*	2.243**
	(0.148)	(1.022)	(1.460)	(1.002)
N	1,900	1,780	1,660	1,540

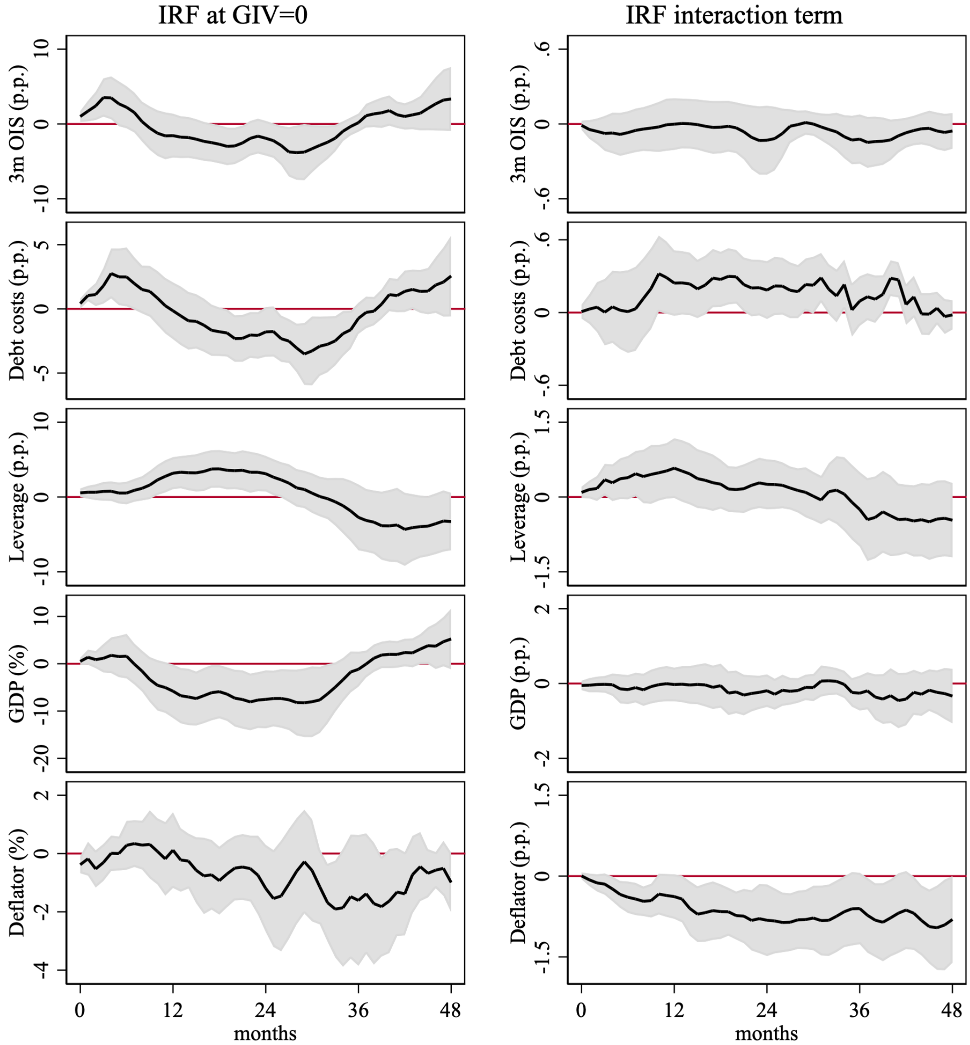
Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. $^{***}/^{**}/^{*}$ indicate the 1%/5%/10% significance level.

Table D.5: Baseline estimates (deflator).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	-0.331**	0.102	-1.037	-1.397
	(0.154)	(0.682)	(0.784)	(1.179)
MP*L12.GIV	0.004	-0.380	-0.819**	-0.602
	(0.038)	(0.249)	(0.403)	(0.401)
L.MP	0.114	-0.508	-1.894*	-1.335
	(0.216)	(0.730)	(1.090)	(1.480)
L2.MP	-0.315	-0.960*	-2.187**	-1.701
	(0.211)	(0.506)	(0.999)	(1.136)
L.MP*L13.GIV	-0.068	-0.393	-0.882**	-0.794*
	(0.045)	(0.299)	(0.410)	(0.466)
L2.MP*L14.GIV	-0.040	-0.410	-0.756**	-0.733
	(0.039)	(0.284)	(0.349)	(0.460)
L12.GIV	0.001	-0.006	0.001	0.020
	(0.007)	(0.027)	(0.032)	(0.031)
L13.GIV	-0.011	-0.008	-0.012	-0.019*
	(0.009)	(0.012)	(0.013)	(0.011)
L14.GIV	0.008	0.013	0.004	-0.020
	(0.005)	(0.025)	(0.042)	(0.047)
L.Deflator	1.236***	1.495***	1.824***	1.897***
	(0.041)	(0.176)	(0.282)	(0.329)
L2.Deflator	-0.246***	-0.643***	-1.184***	-1.526***
	(0.041)	(0.174)	(0.286)	(0.334)
L.Leverage	0.004	0.009	0.162	0.249*
	(0.016)	(0.077)	(0.162)	(0.143)
L2.Leverage	-0.004	-0.019	-0.179	-0.290**
	(0.016)	(0.075)	(0.158)	(0.141)
L.GDP	-0.028	0.256***	0.508***	0.659***
	(0.017)	(0.051)	(0.101)	(0.180)
L2.GDP	0.035**	-0.157***	-0.326***	-0.424**
	(0.017)	(0.055)	(0.090)	(0.181)
L.3-month OIS	-0.011	0.446**	0.496	-0.389**
	(0.063)	(0.225)	(0.552)	(0.193)
L2.3-month OIS	0.008	-0.474**	-0.696	-0.028
	(0.064)	(0.189)	(0.518)	(0.290)
L.Leverage (EA)	-0.072	0.148	-0.556*	-0.316*
	(0.072)	(0.302)	(0.296)	(0.169)
L2.Leverage (EA)	0.065	-0.273	0.262	-0.114
	(0.072)	(0.287)	(0.273)	(0.160)
L.GDP (EA)	-0.011	0.093	-0.106	-0.288**
	(0.026)	(0.081)	(0.065)	(0.131)
L2.GDP (EA)	0.021	-0.085	0.074	0.188**
	(0.027)	(0.075)	(0.060)	(0.073)
L.Deflator (EA)	-0.150*	-0.462*	-0.887***	-1.084***
	(0.083)	(0.258)	(0.268)	(0.278)
L2.Deflator (EA)	0.144*	0.487*	1.024***	1.429***
	(0.084)	(0.260)	(0.303)	(0.228)
N	1,900	1,780	1,660	1,540

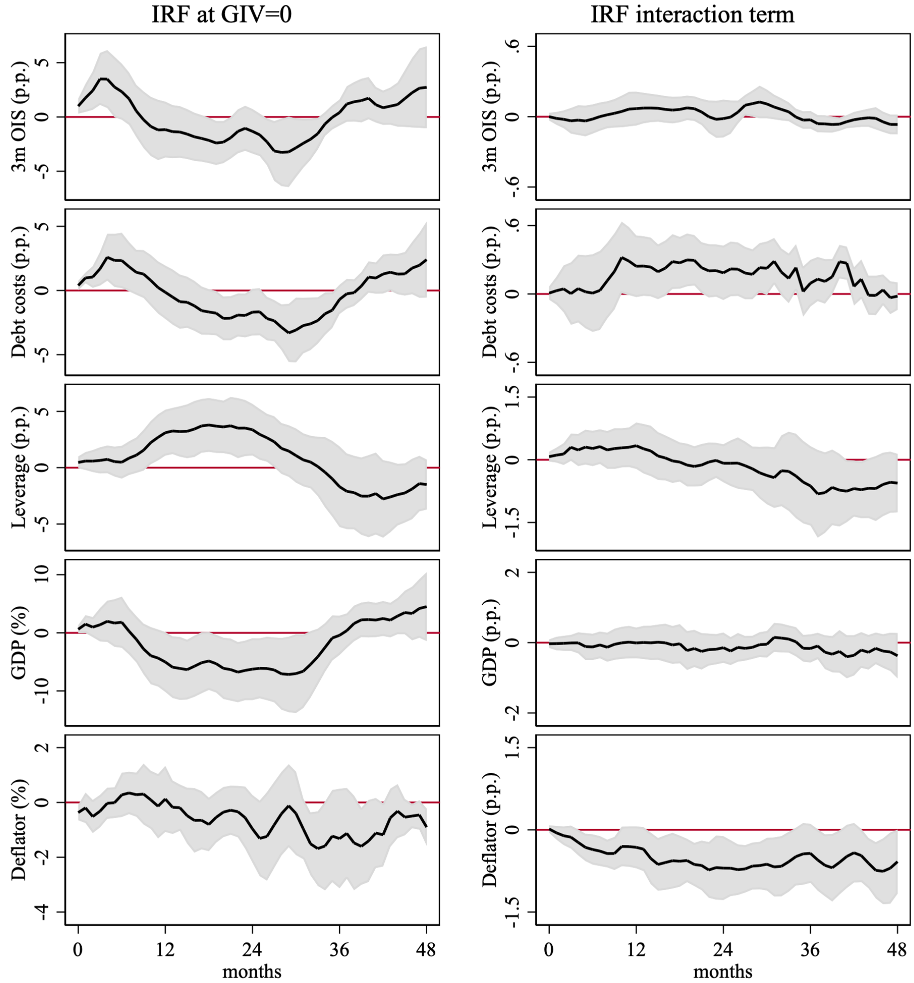
Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

Figure D.1. Impulse responses in absence of leverage shocks and interaction term (full sample).



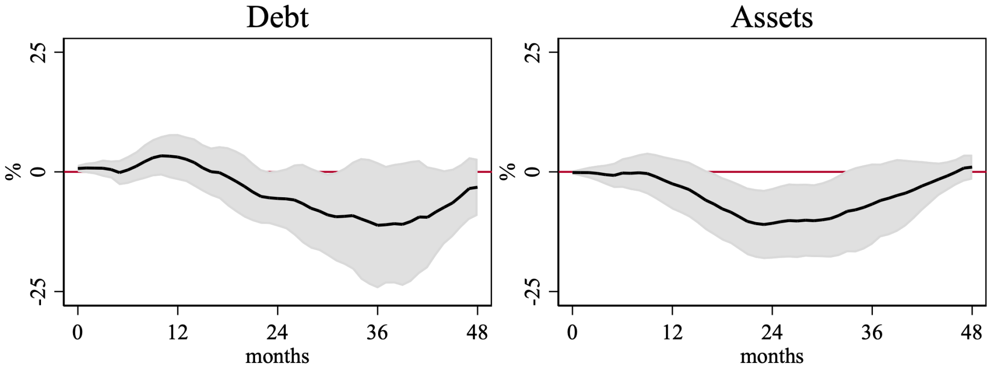
Note: The IRFs are estimated from equation (5). The left column shows the IRFs for $\beta_{0,h}$, which are normalized to a 100 bps impact response in the 3-month OIS rate. The right column shows the IRFs for the interaction term β_h. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data. The grey area is the 90% confidence interval using Driscoll and Kraay (1998) standard errors.

Figure D.2. Impulse responses in absence of leverage shocks and interaction term (short sample).



Note: The IRFs are estimated from equation (5). The left column shows the IRFs for $\beta_{0,h}$, which are normalized to a 100 bps impact response in the 3-month OIS rate. The right column shows the IRFs for the interaction term β_h. All IRFs are estimated from a shorter sample starting in 2004. The grey area is the 90% confidence interval using Driscoll and Kraay (1998) standard errors.

Figure D.3. Impulse responses in absence of leverage shocks (leverage components).



Note: The IRFs are estimated from equation (5) and are normalized to a 100 bps impact response in the 3-month OIS rate. The dependent variables are specified as log of total debt and total assets of the corporate sectors, which are the numerator and denominator for the corporate leverage variable. The grey area is the 90% confidence interval using Driscoll and Kraay (1998) standard errors.

E Additional results GDP components

Table E.1: Estimates GDP components (investment).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	5.033*	-12.160	-18.285*	-1.259
	(2.674)	(9.165)	(9.591)	(4.953)
MP*L12.GIV	1.563	0.874	-1.595	-0.985
	(1.057)	(1.056)	(1.690)	(0.907)
L.MP	0.227	-19.570*	-21.596	4.381
	(2.416)	(10.935)	(13.083)	(5.314)
L2.MP	1.556	-16.289	-12.737	8.628
	(2.209)	(9.904)	(12.385)	(5.260)
L.MP*L13.GIV	0.576	0.855	-1.302	-0.893
	(0.704)	(1.226)	(1.649)	(0.970)
L2.MP*L14.GIV	-0.907	-0.074	-1.638	-0.936
	(0.692)	(1.253)	(1.567)	(0.888)
L12.GIV	0.064	-0.149	-0.078	-0.241*
	(0.072)	(0.188)	(0.264)	(0.141)
L13.GIV	0.085	-0.025	-0.062	-0.029
	(0.115)	(0.117)	(0.088)	(0.067)
L14.GIV	-0.128	0.047	-0.193	0.155
	(0.090)	(0.243)	(0.193)	(0.160)
L.Investment	0.594***	0.186***	0.078	-0.035
	(0.153)	(0.056)	(0.053)	(0.052)
L2.Investment	0.194	0.135**	-0.020	-0.004
	(0.129)	(0.055)	(0.065)	(0.040)
L.Leverage	0.416	-0.091	0.386	0.774
	(0.272)	(1.005)	(0.685)	(1.024)
L2.Leverage	-0.433	-0.094	-0.764	-1.359
	(0.272)	(1.012)	(0.675)	(1.103)
L.GDP	1.110***	4.733***	3.057**	0.774
	(0.334)	(0.989)	(1.323)	(0.766)
L2.GDP	-0.700**	-3.595***	-1.694	0.442
	(0.316)	(0.957)	(1.429)	(0.852)
L.Deflator	0.316	2.677	2.048***	-0.137
	(0.791)	(1.864)	(0.715)	(0.681)
L2.Deflator	-0.486	-3.634*	-3.842***	-2.276***
	(0.801)	(1.902)	(0.833)	(0.721)
L.3-month OIS	0.694	4.127	-1.922	-7.492*
	(0.770)	(4.590)	(3.551)	(4.007)
L2.3-month OIS	-0.139	-2.839	2.114	9.317***
	(0.777)	(3.756)	(4.779)	(3.364)
L.Leverage (EA)	-2.370**	-7.461***	-5.496**	-0.166
	(1.027)	(2.695)	(2.663)	(1.992)
L2.Leverage (EA)	2.003**	4.862*	1.446	-5.585***
	(1.007)	(2.502)	(2.355)	(1.697)
L.GDP (EA)	0.128	-0.861	-2.577	-3.357***
	(0.413)	(0.786)	(1.841)	(1.263)
L2.GDP (EA)	-0.070	0.224	1.121	0.374
	(0.462)	(0.766)	(1.180)	(0.484)
L.Deflator (EA)	0.812	-1.167	-3.442	-4.555
	(1.711)	(2.892)	(3.070)	(3.221)
L2.Deflator (EA)	-0.731	2.343	5.723	8.888**
	(1.654)	(2.976)	(3.514)	(3.590)
N	1,900	1,780	1,660	1,540

Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

Table E.2: Estimates GDP components (domestic demand).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	-0.035	-3.778	-4.568	-0.101
	(0.513)	(3.208)	(4.034)	(2.678)
MP*L12.GIV	-0.348*	-0.578	-0.869	-1.157*
	(0.194)	(0.486)	(0.588)	(0.617)
L.MP	-0.469	-5.722	-3.882	2.963
	(0.576)	(4.544)	(5.082)	(1.994)
L2.MP	-0.956*	-4.857	-2.248	3.229*
	(0.519)	(3.828)	(4.682)	(1.793)
L.MP*L13.GIV	0.051	-0.294	-0.627	-1.169
	(0.168)	(0.570)	(0.643)	(0.775)
L2.MP*L14.GIV	-0.141	-0.178	-0.746	-0.965
	(0.119)	(0.635)	(0.717)	(0.753)
L12.GIV	-0.043*	-0.083	-0.176**	-0.084
	(0.025)	(0.078)	(0.077)	(0.062)
L13.GIV	0.051*	-0.006	0.047	-0.016
	(0.030)	(0.048)	(0.061)	(0.025)
L14.GIV	-0.023	0.009	0.073*	0.188***
	(0.018)	(0.052)	(0.041)	(0.060)
L.Domestic demand	0.862***	0.644***	0.671***	0.492***
	(0.096)	(0.135)	(0.179)	(0.148)
L2.Domestic demand	0.073	0.393***	0.402***	0.329**
	(0.100)	(0.114)	(0.124)	(0.128)
L.Leverage	0.111*	0.109	0.337	0.596*
	(0.059)	(0.273)	(0.211)	(0.320)
L2.Leverage	-0.116*	-0.219	-0.567***	-0.944***
	(0.059)	(0.268)	(0.186)	(0.346)
L.GDP	0.244**	1.384***	0.771	0.453
	(0.100)	(0.340)	(0.541)	(0.564)
L2.GDP	-0.164*	-1.482***	-1.069**	-0.643*
	(0.099)	(0.341)	(0.424)	(0.365)
L.Deflator	-0.025	0.137	0.533	0.275
	(0.137)	(0.481)	(0.538)	(0.643)
L2.Deflator	0.019	-0.564	-1.364***	-1.368***
	(0.138)	(0.497)	(0.486)	(0.477)
L.3-month OIS	0.684***	1.107	-1.328	-1.765
	(0.174)	(1.608)	(1.368)	(1.371)
L2.3-month OIS	-0.628***	-0.523	2.752	3.747***
	(0.172)	(1.463)	(1.952)	(1.127)
L.Leverage (EA)	-0.341*	-3.033**	-0.734	-0.692
	(0.191)	(1.295)	(0.947)	(0.886)
L2.Leverage (EA)	0.260	1.967*	-1.284	-2.091**
	(0.191)	(1.158)	(0.910)	(0.819)
L.GDP (EA)	-0.092	-0.760***	-1.597***	-2.015***
	(0.072)	(0.288)	(0.608)	(0.404)
L2.GDP (EA)	0.067	0.161	0.160	0.234
	(0.075)	(0.229)	(0.302)	(0.211)
L.Deflator (EA)	0.158	0.435	-0.827	0.351
	(0.248)	(0.899)	(1.053)	(0.937)
L2.Deflator (EA)	-0.148	0.436	2.817**	2.291**
	(0.244)	(0.991)	(1.215)	(1.015)
N	1,900	1,780	1,660	1,540

Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

Table E.3: Estimates GDP components (exports).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	2.933	-13.409	-14.039**	-0.949
	(2.110)	(8.393)	(5.428)	(5.370)
MP*L12.GIV	0.085	1.062	0.627	1.867***
	(0.264)	(0.697)	(0.820)	(0.644)
L.MP	-0.185	-19.195**	-15.287*	6.699
	(1.530)	(9.507)	(7.965)	(8.887)
L2.MP	-3.997*	-19.750**	-11.613	11.175
	(2.069)	(8.542)	(8.241)	(9.680)
L.MP*L13.GIV	0.321	0.950	0.350	1.735***
	(0.437)	(0.867)	(0.827)	(0.614)
L2.MP*L14.GIV	0.455*	0.559	0.396	1.143*
	(0.241)	(0.703)	(0.647)	(0.665)
L12.GIV	0.060*	-0.073	0.065	0.023
	(0.036)	(0.101)	(0.066)	(0.101)
L13.GIV	-0.092*	-0.013	-0.067**	-0.020
	(0.055)	(0.071)	(0.031)	(0.064)
L14.GIV	0.041	-0.019	-0.069	0.144
	(0.044)	(0.092)	(0.131)	(0.129)
L.Exports	0.699***	0.338***	0.207**	0.294***
	(0.033)	(0.076)	(0.094)	(0.076)
L2.Exports	0.234***	0.176**	0.294***	0.063
	(0.034)	(0.070)	(0.112)	(0.061)
L.Leverage	-0.079	-0.452	1.066**	0.574
	(0.115)	(0.414)	(0.447)	(0.665)
L2.Leverage	0.076	0.424	-1.101**	-0.704
	(0.115)	(0.423)	(0.438)	(0.682)
L.GDP	0.215*	1.353***	0.604	-0.774**
	(0.121)	(0.372)	(0.393)	(0.385)
L2.GDP	-0.185	-1.133***	-0.547	0.715*
	(0.123)	(0.356)	(0.406)	(0.398)
L.Deflator	0.622***	-0.874	-2.259***	-2.690**
	(0.217)	(0.538)	(0.667)	(1.132)
L2.Deflator	-0.731***	0.088	1.456**	1.861
	(0.218)	(0.456)	(0.638)	(1.190)
L.3-month OIS	4.179***	4.338	-5.003*	-9.106
	(0.594)	(5.000)	(2.631)	(5.528)
L2.3-month OIS	-4.219***	-6.714*	0.018	7.563
	(0.592)	(3.900)	(3.826)	(4.614)
L.Leverage (EA)	0.364	-5.738**	-1.331	0.488
	(0.616)	(2.855)	(2.249)	(3.027)
L2.Leverage (EA)	-0.459	4.550*	0.164	-2.698
	(0.605)	(2.590)	(2.074)	(2.778)
L.GDP (EA)	0.534**	0.902	-1.343	-1.364*
	(0.206)	(0.568)	(0.915)	(0.738)
L2.GDP (EA)	-0.530***	-0.867	1.571*	0.084
	(0.200)	(0.569)	(0.843)	(0.407)
L.Deflator (EA)	0.752	1.792	-1.384	-1.031
	(0.612)	(2.617)	(2.241)	(1.814)
L2.Deflator (EA)	-0.522	-0.696	2.016	3.537
	(0.614)	(2.486)	(2.615)	(2.204)
N	1,900	1,780	1,660	1,540

Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

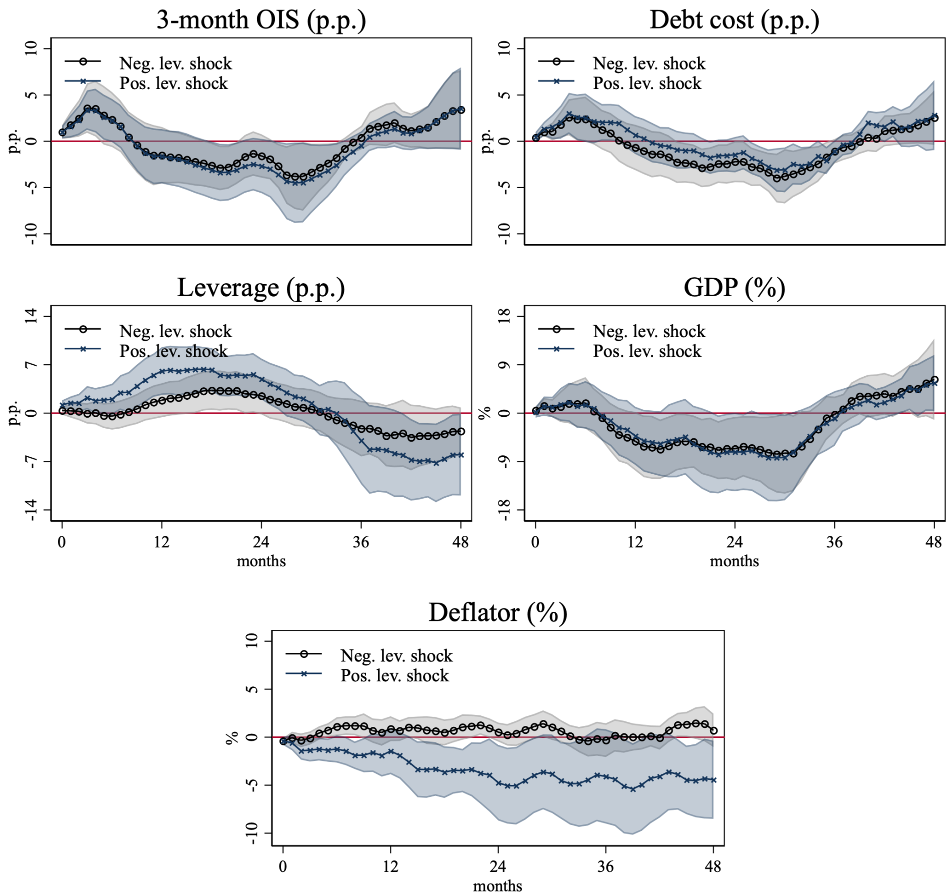
Table E.4: Estimates GDP components (imports).

	$h = 0$	$h = 12$	$h = 24$	$h = 36$
MP	1.588	-12.049	-10.412	0.214
	(1.668)	(7.337)	(6.312)	(4.122)
MP*L12.GIV	-0.642	-0.728	-1.657	-0.758
	(0.441)	(1.055)	(1.448)	(0.880)
L.MP	-1.349	-17.945*	-10.741	7.944
	(1.499)	(9.882)	(9.169)	(6.843)
L2.MP	-3.322*	-17.058*	-7.724	10.584
	(1.786)	(8.822)	(9.493)	(7.187)
L.MP*L13.GIV	0.392	-0.494	-1.396	-1.257
	(0.538)	(1.463)	(1.535)	(1.115)
L2.MP*L14.GIV	-0.110	-0.482	-1.799	-0.806
	(0.295)	(1.396)	(1.176)	(0.875)
L12.GIV	-0.050	-0.154	-0.146	0.029
	(0.048)	(0.115)	(0.105)	(0.104)
L13.GIV	0.025	-0.032	0.070	-0.056*
	(0.063)	(0.076)	(0.055)	(0.032)
L14.GIV	0.010	0.008	0.061	0.316***
	(0.045)	(0.137)	(0.087)	(0.120)
L.Imports	0.805***	0.526***	0.399***	0.224***
	(0.045)	(0.093)	(0.065)	(0.055)
L2.Imports	0.151***	0.250***	0.319***	0.171**
	(0.046)	(0.075)	(0.065)	(0.078)
L.Leverage	0.109	0.057	1.217***	1.623**
	(0.110)	(0.489)	(0.322)	(0.706)
L2.Leverage	-0.118	-0.195	-1.530***	-2.154***
	(0.109)	(0.496)	(0.348)	(0.780)
L.GDP	0.349**	2.285***	0.729**	-0.065
	(0.141)	(0.379)	(0.359)	(0.342)
L2.GDP	-0.293**	-2.109***	-0.791**	0.147
	(0.140)	(0.393)	(0.364)	(0.297)
L.Deflator	0.388*	-0.049	-0.467	-0.665
	(0.230)	(0.865)	(0.632)	(0.752)
L2.Deflator	-0.457**	-0.656	-0.732	-0.962*
	(0.230)	(0.860)	(0.647)	(0.546)
L.3-month OIS	3.215***	2.699	-5.260*	-7.236
	(0.464)	(4.648)	(2.948)	(4.687)
L2.3-month OIS	-3.213***	-3.848	3.731	8.062**
	(0.455)	(3.818)	(4.295)	(3.862)
L.Leverage (EA)	0.037	-6.325**	-1.903	-0.200
	(0.521)	(2.760)	(2.073)	(2.698)
L2.Leverage (EA)	-0.171	4.704*	-0.648	-3.774
	(0.508)	(2.577)	(1.872)	(2.395)
L.GDP (EA)	0.283	-0.108	-2.439**	-2.562***
	(0.203)	(0.533)	(1.210)	(0.679)
L2.GDP (EA)	-0.313	-0.697	0.784	0.011
	(0.196)	(0.451)	(0.874)	(0.484)
L.Deflator (EA)	0.697	-0.051	-2.968	-0.665
	(0.557)	(2.599)	(2.543)	(2.020)
L2.Deflator (EA)	-0.562	1.171	5.207*	4.842**
	(0.557)	(2.601)	(2.932)	(2.338)
N	1,900	1,780	1,660	1,540

Note: The table shows estimates from regression equation (5). The Driscoll and Kraay (1998) standard errors are given in parenthesis. ***/**/* indicate the 1%/5%/10% significance level.

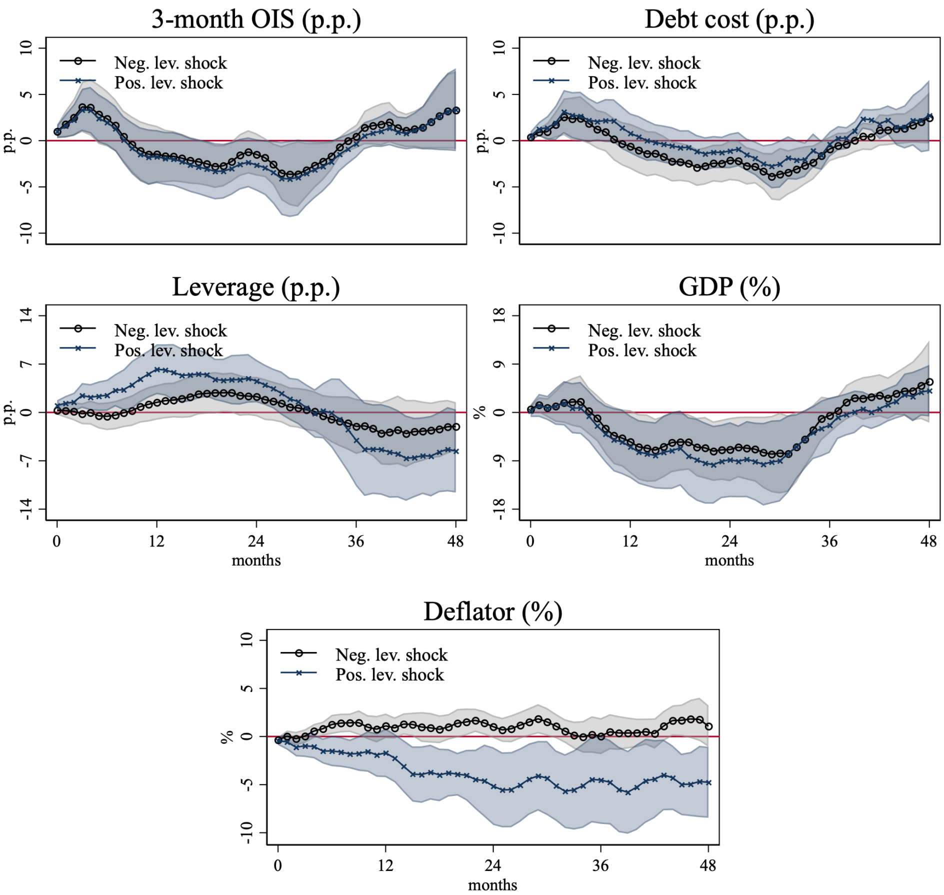
F Figures robustness

Figure F.1. Impulse responses at 10*th* and 90*th* percentile of the GIV (controlling for business cycle asymmetries).



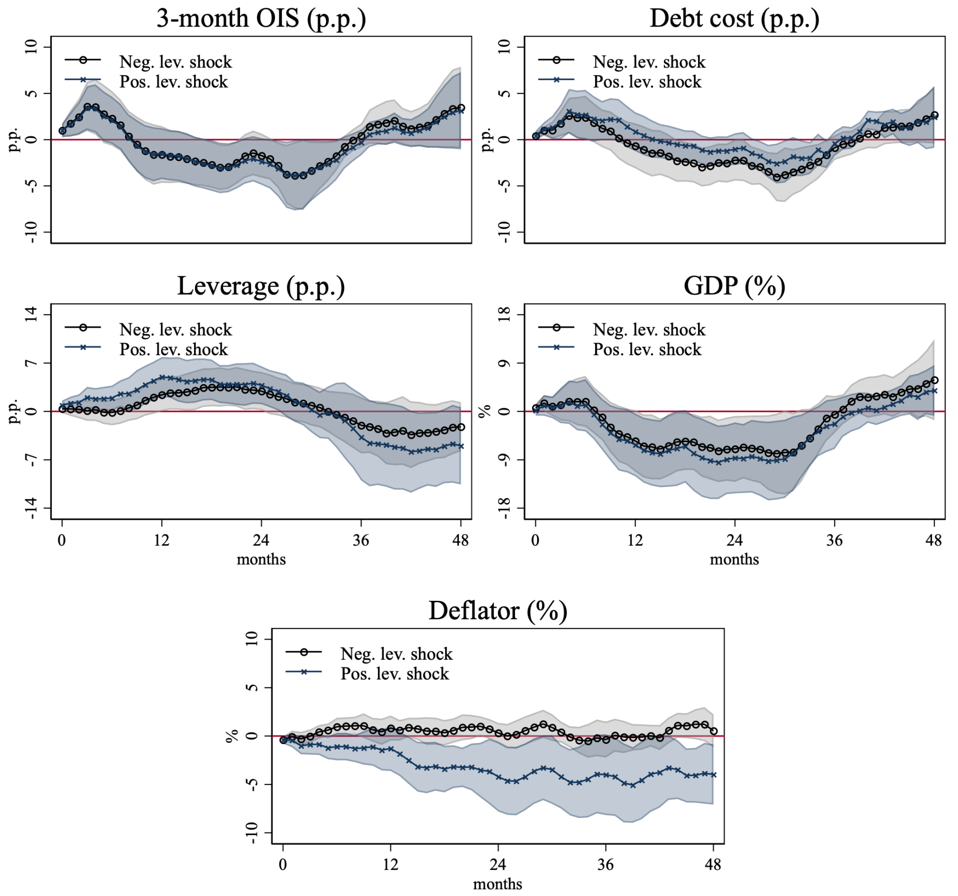
Note: The IRFs are estimated from equation (5) and evaluated at the 10*th* percentile (negative leverage shock) and 90*th* percentile (positive leverage shock) of the GIV. The baseline regression has been extended through a recession indicator and its interaction with the monetary policy shock. The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the 10*th* (90*th*) percentile of the GIV. The gray (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay (1998) standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

Figure F.2. Impulse responses at 10th and 90th percentile of the GIV (winsorized firm-level shocks).



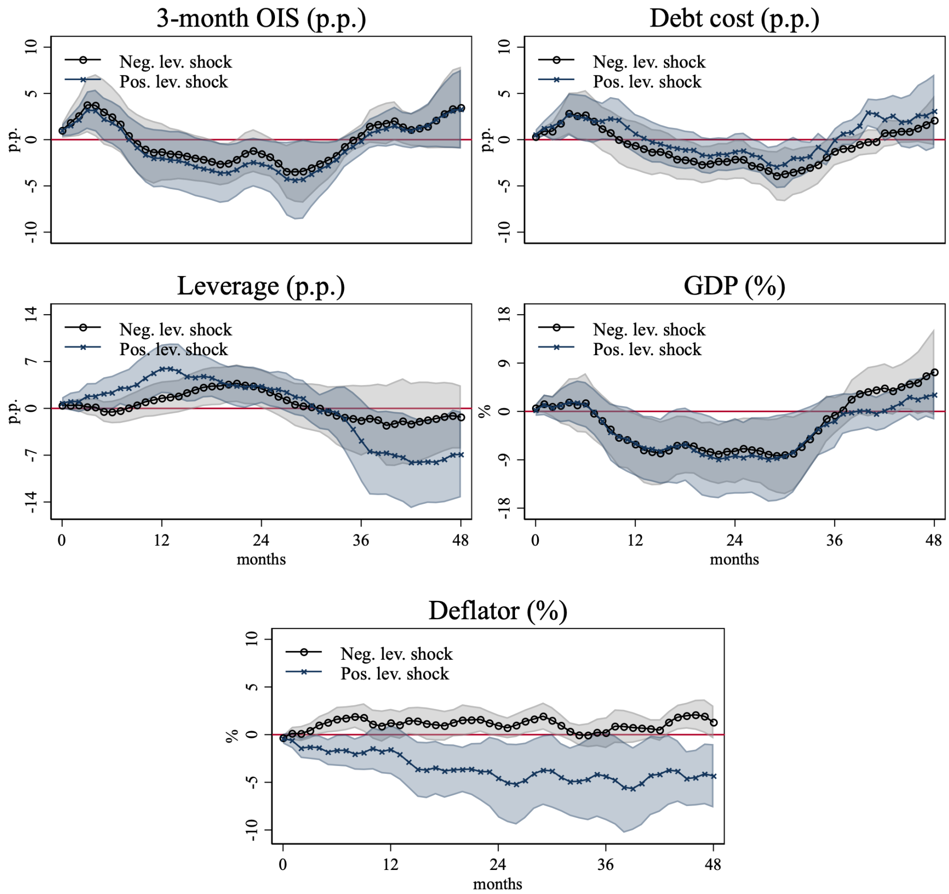
Note: The IRFs are estimated from equation (5) and evaluated at the 10th percentile (negative leverage shock) and 90th percentile (positive leverage shock) of the GIV. The GIV variable from the baseline has been exchanged by a version where the estimated firm-level shocks are winsorized at the 1% and the 99% level before aggregation. The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the 10th (90th) percentile of the GIV. The gray (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay (1998) standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

Figure F.3. Impulse responses at $10th$ and $90th$ percentile of the GIV (winsorized debt shares).



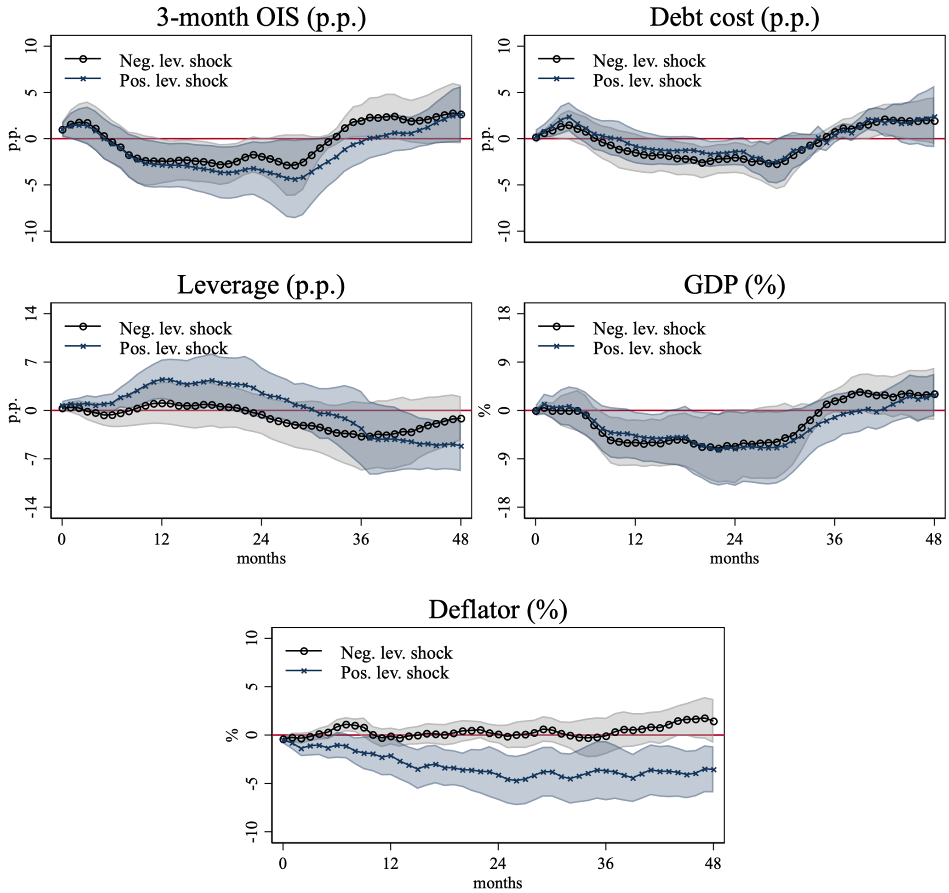
Note: The IRFs are estimated from equation (5) and evaluated at the $10th$ percentile (negative leverage shock) and $90th$ percentile (positive leverage shock) of the GIV. The GIV variable from the baseline has been exchanged by a version where the debt shares are winsorized at the 1% and the 99% level before aggregation. The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the $10th$ ($90th$) percentile of the GIV. The gray (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay (1998) standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

Figure F.4. Impulse responses at 10th and 90th percentile of the GIV (generalized GIV).



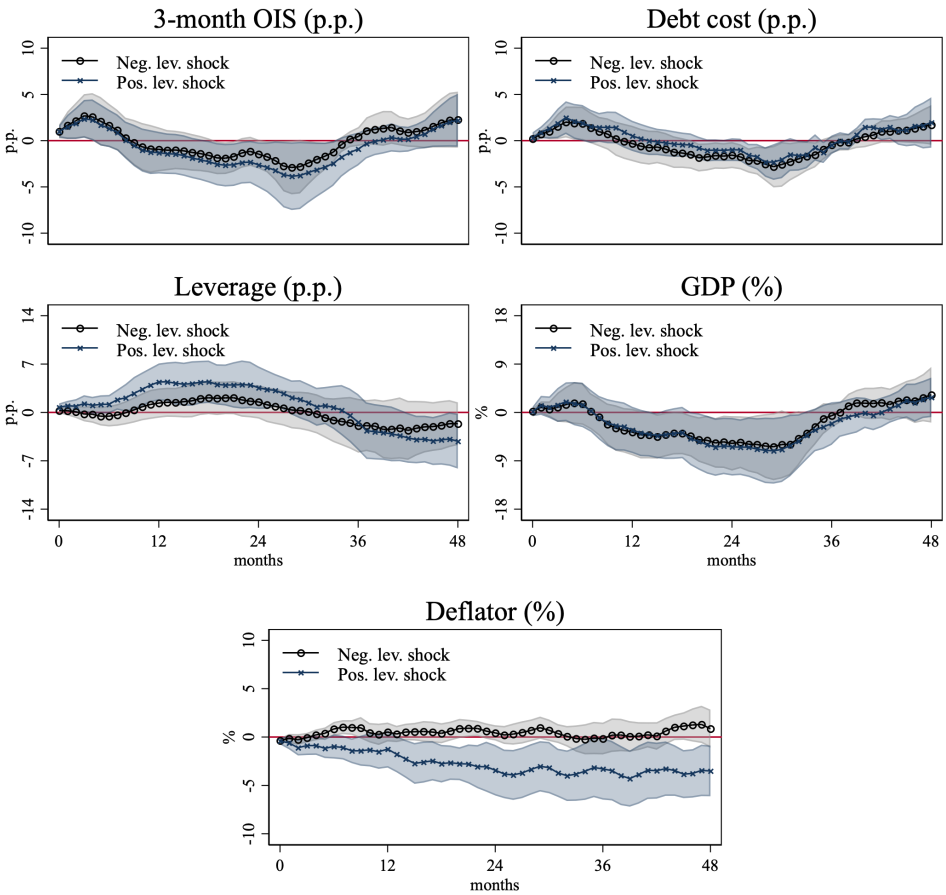
Note: The IRFs are estimated from equation (5) and evaluated at the 10th percentile (negative leverage shock) and 90th percentile (positive leverage shock) of the GIV. The GIV variable from the baseline has been exchanged by a version where the estimated firm-level shocks have been regressed on a principal component from the shocks before aggregation. The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the 10th (90th) percentile of the GIV. The gray (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay (1998) standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

Figure F.5. Impulse responses at $10th$ and $90th$ percentile of the GIV (monetary policy shock from 3-month OIS).



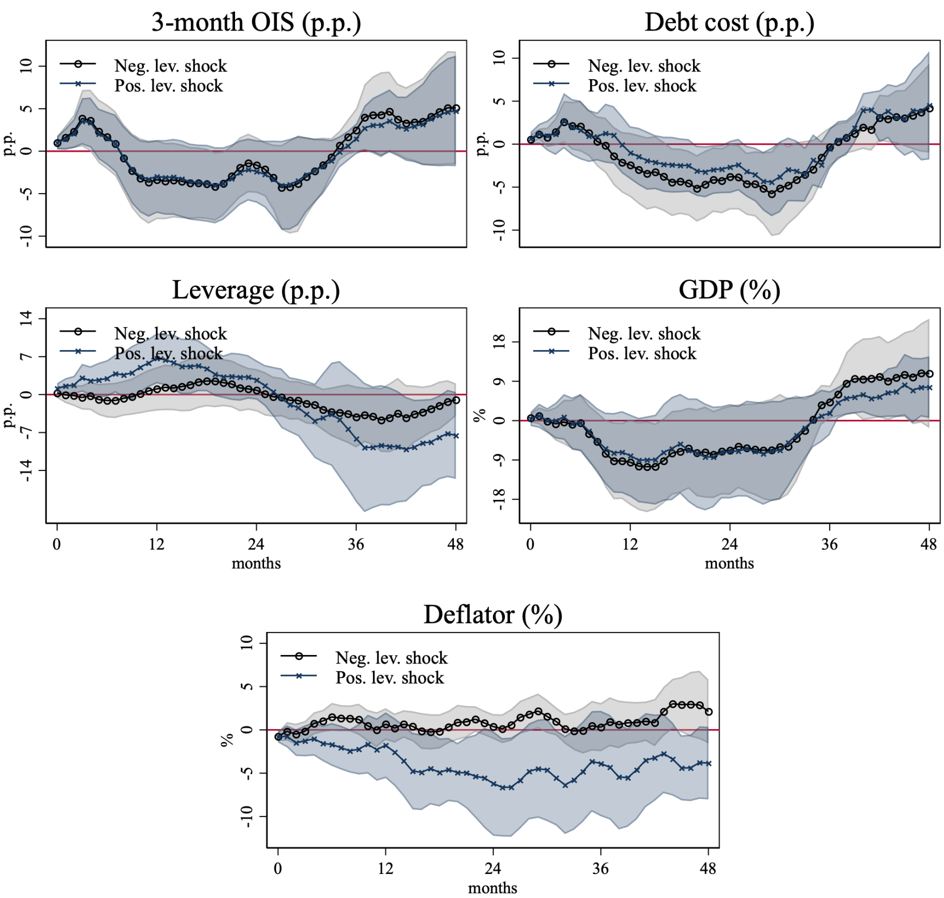
Note: The IRFs are estimated from equation (5) and evaluated at the $10th$ percentile (negative leverage shock) and $90th$ percentile (positive leverage shock) of the GIV. The monetary policy shock from the baseline has been replaced by the monetary policy shocks from the 3-month OIS rate. The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the $10th$ ($90th$) percentile of the GIV. The gray (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay (1998) standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

Figure F.6. Impulse responses at $10th$ and $90th$ percentile of the GIV (monetary policy shock from principal component of surprises).



Note: The IRFs are estimated from equation (5) and evaluated at the $10th$ percentile (negative leverage shock) and $90th$ percentile (positive leverage shock) of the GIV. The monetary policy shock from the baseline has been replaced by the first principal component from the monetary policy shocks from the 1-week to 2-year OIS rates. The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the $10th$ ($90th$) percentile of the GIV. The gray (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay (1998) standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

Figure F.7. Impulse responses at $10th$ and $90th$ percentile of the GIV (time-weighted monetary policy shock).



Note: The IRFs are estimated from equation (5) and evaluated at the $10th$ percentile (negative leverage shock) and $90th$ percentile (positive leverage shock) of the GIV. The monetary policy shock from the baseline has been replaced by the time-weighted series of 1-year OIS shocks. The IRFs are normalized to a 100 bps impact response in the 3-month OIS rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the $10th$ ($90th$) percentile of the GIV. The gray (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay (1998) standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

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