Discussion Paper Series – CRC TR 224

Discussion Paper No. 675
Project C 03

Financial Constraints and the Micro Origins of Aggregate Equity Shocks in Capital Markets

Tobias König[1]

March 2025

[1]University of Bonn, Email : tkoenig@uni-bonn.de

Support by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) through CRC TR 224 is gratefully acknowledged.

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Financial Constraints and the Micro Origins of Aggregate Equity Shocks in Capital Markets*

Tobias König†

University of Bonn

This version: March 2025

Abstract

I examine how financial constraints shape the transmission of aggregate external equity financing shocks to firms' equity issuance, outstanding debt, and investment. I construct a novel instrument for aggregate equity financing shocks from firm-level data using the Granular Instrumental Variable (GIV) strategy. I find that financially unconstrained firms–characterized by high cash holdings and dividend-paying status–increase equity issuance by 1.8–2.0 percentage points, substitute equity for debt, and boost investment when capital market conditions improve. Highly leveraged firms, in contrast, refuse both to issue new equity and to reduce outstanding debt, consistent with the leverage ratchet effect. The debt overhang of highly leveraged firms results in 1.9 percentage points lower investment rates compared to the average firm. These results emphasize the crucial role of financial constraints in external equity financing and highlight the broader macroeconomic implications of debt overhang.

JEL: E22, E44, G30, G32

Keywords: Capital Markets; External Equity Financing; Financial Constraints; Granular Instrumental Variable

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*This paper was previously circulated under the name "Firm Heterogeneity and the Capital Market". I thank Franziska Bremus, Michael C. Burda, Thomas Dengler, Anna Goeth, Wouter den Haan, Martin B. Holm, Alexander Kriwoluzky, Ragnar Juelsrud, Joachim Jungherr, Adrian Ochs, Michael O'Grady, Mauricio Salgado-Moreno, Pascal Paul, Ulrich Roschitsch, Farzad Saidi, Lutz Weinke, and Leopold Zessner-Spitzenberg for very helpful comments. Funding from the Leibniz Competition (through the project "European capital markets and macroeconomic stability: The role of equity and debt") and the German Research Foundation (DFG) through CRC TR 224 (Project C03) is gratefully acknowledged.

†E-mail address: tkoenig@uni-bonn.de.

1 Introduction

Capital markets play a crucial role in firms' acquisition of funds, with ever-increasing importance in recent decades. Since the early 1980s, the frequency of adjustments to firms' outstanding equity positions has increased significantly. External equity financing defines a significant proportion of the firm's financing mix (Fama and French, 2005), and the firm's financing conditions in turn affect aggregate investment and the macroeconomy (Covas and Haan, 2011; Jermann and Quadrini, 2012; Begenau and Salomao, 2018). The trend of increased importance of equity financing is not only observable in the United States, but also in most European economies (Raposo and Lehmann, 2019).[1] With the increasing importance of external equity financing as an alternative to debt financing, it becomes crucial to understand which firms sell or repurchase stocks and how net equity issuance affects firm investment. In other words, which firms benefit when the financing conditions on the aggregate equity market of a country improve?

The field of corporate finance has a long tradition of studying the determinants of firms' capital structure and the timing of equity issuance (see amongst others, Marsh, 1982; Jung et al., 1996; Fama and French, 2005; Begenau and Salomao, 2018; Dittmar and Thakor, 2007; Ma, 2019). However, few studies investigate the firm-level effects on net equity issuance, outstanding debt, and investment in response to an aggregate improvement in external equity financing conditions. Studying firms' behavior when they all experience the same aggregate shock to external equity financing allows one to test several corporate finance theories related to highly indebted firms such as the role of the leverage ratchet effect (Admati et al., 2018) on the willingness to issue new equity, the role of debt overhang on firm investment (Myers, 1977; Hennessy, 2004; Cai and Zhang, 2011), and the substitution of equity for debt when external equity issuance becomes cheaper (Hennessy and Whited, 2007).

In this paper, I will therefore study firms' net equity issuance in response to an aggregate external equity financing shock. I investigate the role of financial constraints for the shock transmission on net external equity issuance. In addition, I examine whether highly indebted firms utilize the shock to deleverage and substitute debt for equity (Hennessy and Whited, 2007) or whether leveraged firms refrain from issuing new equity (Admati et al., 2018)—a reluctance that ultimately harms firm investment (Hennessy, 2004; Kalemli-Özcan et al., 2022).

I contribute to the literature by constructing an instrument for aggregate external equity

[1] In the Euro Area, policy proposals such as the "Capital Market Union" by the European Commission will most likely enhance this development (European Commission, 2020).

financing shocks. I construct a Granular Instrumental Variable (GIV) as an instrument for aggregate external equity financing shocks by utilizing the granularity of firms' external equity issuance in my dataset. Granular Instrumental Variables (GIVs) were first introduced by Gabaix and Koijen (2024). I am the first in the literature to obtain an instrument for aggregate external equity financing shocks using GIVs and firm-level data.

The construction of a relevant Granular Instrumental Variable (GIV) requires the existence of granularity in firms' market capitalization with a few very large firms. In a first step, I estimate firm-specific innovations to net equity issuance. The construction of the GIV purges out all potentially confounding common components from the firm equity innovations resulting in an aggregate equity financing shock series. I show that the GIV series is a relevant instrument for aggregate external equity with a value of 15.4 for the Kleibergen-Paap F-statistic. By including estimated external equity financing common components and a large set of macroeconomic factors and control variables, I demonstrate that the exogeneity assumption of the GIV holds.

Following Jordà (2005) and Jordà et al. (2016), I estimate the impulse responses of firm equity and firm share prices to a positive aggregate equity financing shock using a two-stage local projection instrumental variable (LP-IV) regression framework. I find that the average firm increases net equity issuance by 1.2 percentage points within the first year following the shock. Simultaneously with the increase in issued equity, share prices of the average firm increase by about 13.5 percentage points within the first four quarters following the positive shock.

As a next step, I analyze the role of financial constraints in the transmission of aggregate equity financing shocks on firm-level net-issued equity. I use six different endogenous financial firm variables to proxy the degree of financial constraints. I follow the literature and take some of the most prevalent measures such as: (i) Tobin's Q (Ehrmann and Fratzscher, 2004; Hennessy and Whited, 2007; Covas and Haan, 2011), (ii) book leverage (Ottonello and Winberry, 2020; Cai and Zhang, 2011; Kalemli-Özcan et al., 2022), (iii) firm liquidity (Jeenas, 2023), (iv) whether firms pay dividends (Cloyne et al., 2023), (v) firms' indebtedness relative to their earnings (Lian and Ma, 2021; Drechsel, 2023), or firm size Gertler and Gilchrist (1994).

I find that firms with high levels of cash holdings and dividend-paying firms issue significantly more equity in response to the aggregate equity financing shock relative to the average firm in my sample. One year after the shock, high-cash firms have increased their equity issuance by 1.8 percentage points, a difference of about 0.6 percentage points to the average firm. Five years after the shock, the difference in the cumulative net equity issuance to the average firm is already at 2.5 percentage points. Highly leveraged firms with a high ratio of debt to assets issue significantly less equity in response to the favorable aggregate equity financing shock. Highly indebted firms issue -3.8 percentage points less equity five years after the shock. In addition, I find that highly leveraged firms refuse to reduce their outstanding total debt and have a significantly lower investment rate than the average firm. The difference in investment amounts to -1.9 percentage points. These results are in line with theoretical corporate finance models on the role of corporate debt overhang on low firm investment (Myers, 1977; Hennessy, 2004) and the leverage ratchet effect (Admati et al., 2018). The reluctance to issue equity even when aggregate external equity financing conditions are favorable fits well with the leverage ratchet effect mechanism. By issuing equity to reduce leverage, highly indebted firms' shareholders would transfer wealth to creditors due to the reduced default risk, which would not be in the interest of the shareholders (Admati et al., 2018).

Firms with high cash holdings take advantage of the unexpected favorable shock by issuing new equity to boost investment and reduce their overall debt. These firms substitute debt for equity. These results are in line with existing evidence from the literature that firms substitute both sources of external funding with each other depending on their current relative costs (see for example, Ma, 2019). These results on the role of leverage and cash holdings for the transmission of an aggregate equity financing shock remain robust even when controlling for monetary policy shocks. I confirm that my instrument for aggregate equity financing shocks is not confounded by heterogeneous firm factor loadings on monetary policy shocks by showing that my results remain robust even when monetary policy shocks are included.

How do the macroeconomy and the monetary policy maker respond to a positive aggregate equity financing shock? I use aggregate macro-level data to answer this question. I find that one year after the shock, the real capital stock increases by 3.5%, the unemployment rate declines by 0.8 percentage points, and the consumer price index rises by 3.1 percentage points. In response to the higher inflation and the lower unemployment level, the monetary policy maker increases the Fed funds rate up to 1.6 percentage points. The aggregate equity financing shock starts a boom in capital markets with firms issuing more equity that eventually causes aggregate firm investment to increase, the number of unemployed to decrease, and monetary policy to become more contractionary over time.

I show that the contractionary monetary policy mitigates the capital market boom by lowering the direct positive impact of the aggregate equity financing shock on firms' equity issuance over the medium- and the long-term. My results align with (Almeida et al., 2024), which show that equity-constrained firms increase their equity issuance to a greater extent following an expansionary monetary policy shock.

The remainder of this paper is structured as follows. I describe the firm-level dataset and the macro-level data that I use in Section 2. Section 3 describes the construction of the Granular Instrumental Variable for the aggregate equity financing shocks. Next, both the average equity issuance response of firms to an aggregate equity financing shock and the role of financial frictions for the transmission of the shock on firms' equity issuance, firms' investment rates, and the outstanding number of total debt are estimated in Section 4. I use a two-staged regression framework to estimate firm-level local projections. Finally, Section 5 concludes.

Literature Review. This paper relates to a strand of literature studying the interplay of macroeconomic environment and firm external equity financing. Earlier contributions in this field focus on the cyclical component of stock sales and stock repurchases over the business cycle (Korajczyk and Levy, 2003; Levy and Hennessy, 2007; Covas and Haan, 2011; Jermann and Quadrini, 2012; Begenau and Salomao, 2018). Covas and Haan (2011) investigate the macroeconomic consequences of firm stock sales using firm-level data. They highlight that firm stock issuance is procyclical. I add to this literature by focusing on firm-level responses in net issued equity (net sales of shares) to a macroeconomic shock to aggregate external equity financing. Only a few empirical papers study equity issuance in response to an improvement in aggregate equity market conditions (Hanselaar et al., 2019; Calomiris et al., 2021). Hanselaar et al. (2019) for example study IPOs and SEOs in response to an increase in aggregate market liquidity. To mitigate endogeneity concerns, the authors study the relationship in a cross-country panel using macroeconomic data instead of using firm-level data. My approach is different. I construct an instrument for aggregate equity financing shocks using firm-level data and study the firm-level net equity issuance in response to such a shock.

Which firm issues equity and at which point in time is a widely studied question in corporate finance (see amongst others, Baker and Wurgler, 2002; Fama and French, 2005; Begenau and Salomao, 2018; Ma, 2019). A variety of firm characteristics are found to be relevant for explaining changes in net equity issuance. Several studies show that the relative level of a firm's share price drives the decision to issue new equity (Asquith and Mullins Jr, 1986; Loughran and Ritter, 1995; Baker and Wurgler, 2002; Dittmar and Thakor, 2007). Firms sell stocks when individual share prices are high and repurchase stocks when their share prices are low. Ma (2019) finds evidence that firms act as cross-market arbitrageurs by timing the market. Companies sell equity and retire debt or repurchase equity and issue new debt depending on the relative firm-level costs of equity and debt. In addition, the degree of financial constraints influences firms' net equity issuance. For example, highly indebted firms might issue additional equity to reduce leverage to appear less financially constrained (Hennessy and Whited, 2007). My analysis sheds light on the firm-level determinants of capital market financing when all firms face the same favorable aggregate shock to external equity financing.

I add to the literature on the role of financial constraints on equity issuance and firm investment. More specifically, I study both the consequences of corporate debt overhang and the role of liquidity for investments and stock sales. High levels of corporate debt limit the ability of firms to invest (Myers, 1977; Hennessy, 2004; Barbiero et al., 2020; Ottonello and Winberry, 2020; Kalemli-Özcan et al., 2022), which can affect macroeconomic growth at the country level. Existing empirical papers analyze the adverse effects of debt overhang during crisis periods (Barbiero et al., 2020; Kalemli-Özcan et al., 2022), adverse monetary policy (Ottonello and Winberry, 2020) or the cross-sectional relationship between extreme levels of debt and firm profits and investment (Hennessy, 2004; Ahn et al., 2006; Cai and Zhang, 2011). My focus differs from the existing literature by studying the role of debt overhang on investment during episodes of exogenous improvements of firms' external equity financing conditions. I explicitly study whether highly indebted firms are reluctant to reduce leverage by issuing new equity even when aggregate external equity financing conditions are exogenously improved. Therefore, my findings shed light on the relevance of the leverage ratchet effect Admati et al. (2018).

The last strand of literature this paper is related to is the growing strand of literature on the micro origins of aggregate shocks (Gabaix, 2011; Acemoglu et al., 2012; di Giovanni and Levchenko, 2012; Baqaee and Farhi, 2019). I construct an instrument for aggregate external equity financing shocks using the Granular Instrumental Variable (GIV) method outlined in Gabaix and Koijen (2023) and Gabaix and Koijen (2024). Several studies use GIVs as instruments to circumvent endogeneity concerns (Chodorow-Reich et al., 2020; Camanho et al., 2022; Adrian, 2022). Galaasen et al. (2023) use GIVs to purge out heterogeneous loadings and time-varying confounding factors from firm-level innovations to value added to ensure the exogeneity of idiosyncratic firm shocks. I use GIVs as an instrument for aggregate macroeconomic shocks.

2 Data

I use quarterly data from Compustat to study the effects of aggregate shocks to net equity on non-financial companies in the United States. I construct an instrument for aggregate equity financing shocks using data on the change in firms' net equity positions. My sample starts in 1984q1 [2] and ends in 2020q2 .

I merge the Compustat data with a large set of macroeconomic factors, which I identify using the FRED-QD database (see McCracken and Ng, 2016, 2020, for a description of the FRED-MD and the FRED-QD databases). I use the macroeconomic factors as control variables in the regressions specified in Section 4.

2.1 Firm-Level Data

Compustat provides data on firms' net external equity positions both at market value and at book value. First, I follow Fama and French (2005) by defining the real change in a firm's net equity position at book value. I define the reliance on external equity as the difference between real shareholder equity and real retained earnings:

$$E_{i,t}^{bv,real} = Equity_{i,t}^{Shareholder,real} - Earnings_{i,t}^{Retained,real} \tag{1}$$

and net equity issuance as the change in $E_{i,t}$:

$$\frac{\Delta E_{i,t}^{bv}}{Assets_{i,t-1}} = \frac{\Delta Equity_{i,t}^{Shareholder} - \Delta Earnings_{i,t}^{Retained}}{Assets_{i,t-1}}. \tag{2}$$

In addition, following again Fama and French (2005), I define the market-based net equity issuance as:

$$\frac{\Delta E_{i,t}^{mv}}{Assets_{i,t-1}} = \frac{(Price_{i,t}^{SharesOut} - Price_{i,t-1}^{SharesOut})\Delta SharesOut_{i,t}^{adj}}{Assets_{i,t-1}}. \tag{3}$$

I will use both measures as dependent variables in the local projections. As a measure of firms' financial conditions, I define six variables. All variables are common proxies in the literature for financial constraints on the firm level. I define the debt ratio as the sum of long-term debt and short-term debt divided by total assets (Ottonello and Winberry, 2020), the liquidity ratio as the ratio of cash to total assets (Jeenas, 2023), the debt-to-earnings ratio

[2] I chose this starting date for two reasons. First, the number of reporting firms on issued equity was significantly lower before 1984. Second, by doing so, I exclude years of high inflation rates.

(EBITDA) as a proxy for earning-based constraints (EBC) (Lian and Ma, 2021; Drechsel, 2023), firm size (Gertler and Gilchrist, 1994), and Tobin's Q (Ehrmann and Fratzscher, 2004; Hennessy and Whited, 2007; Covas and Haan, 2011). For Tobin's Q I use the formula provided in Younge and Marx (2012) and Cloyne et al. (2023). In addition, I construct a dummy for dividend-paying firms (Cloyne et al., 2023). Table A.2 in Appendix A visualizes the correlation between all six measures. I provide a detailed description of the variable definition in Appendix A.

I restrict my sample in the following ways. I exclude non-US firms, financial firms, and utilities from my sample. In addition, I drop observations with negative values in capital, assets, sales, debt, and negative interest expenses on debt. To ensure that the changes in firm-level net equity are not driven by firms with an untypical degree of financial distress, I exclude firms with a negative difference between shareholder equity and retained earnings.[3] I also restrict the debt ratio to values between zero and ten (as in Ottonello and Winberry, 2020). The real investment rate, real sales growth, real total debt growth, real long-term debt growth, and the net external equity issuance variables are trimmed on the top and bottom 0.5 percentiles. Following Ottonello and Winberry (2020), I exclude firm observations where acquisitions account for more than five percent of firms' assets and firms with an investment spell of less than forty quarters. Table 1 summarizes the mean, median, standard deviation, 10th percentile, 90th percentile, and the number of observations for several key variables in the sample.

2.2 Macroeconomic Factors and Controls

I augment several firm-level regressions in the subsequent sections of this paper by using macroeconomic factors as additional controls. I take 249 macroeconomic time series from the FRED-QD dataset to estimate six macroeconomic factors [4] Following McCracken and Ng (2020). I apply a principal components analysis to reduce the dimensionality of the FRED-QD dataset by estimating the six factors. The decision to include six macroeconomic factors is based on the scree plot visualized in Figure A.1 in the appendix. The first factor is mainly related to output and employment and explains 28% of the volatility of the macroeconomic data. The first factor can be regarded as a measure of the real US business cycle. The second factor explains 13% of the variation in the data and is related to US consumer prices.

[3] Around 3.8% of firms in Compustat have a negative value in shareholder equity minus retained earnings.

[4] The database can be downloaded e.g. from the Michael W. McCracken subpage on the St. Louis FED website: `https://research.stlouisfed.org/econ/mccracken/fred-databases/`.

Table 1: Summary Statistics of Firm-Level Variables

	Mean	Median	S.D.	P10	P90	Obs.
Equity issuance	1.87	0.03	9.39	-0.25	2.50	268,855.00
Investment rate	0.43	-0.58	7.36	-4.98	6.59	293,621.00
Total debt issuance	-0.11	-0.22	5.18	-4.10	4.18	288,645.00
Debt-to-equity	0.78	0.47	2.68	0.01	2.18	289,883.00
Debt ratio	0.32	0.26	0.39	0.03	0.61	293,621.00
Tobins' Q	1.92	1.41	1.80	0.92	3.24	247,364.00
Cash-to-assets	0.12	0.06	0.16	0.01	0.33	292,850.00
Debt-to-ebitda	8.07	5.83	29.51	-4.60	25.76	257,780.00
Dividend-paying	0.12	0.00	0.33	0.00	1.00	293,594.00

Notes: This table summarizes key firm-level variables of US firms from the Compustat sample between 1984q1 and 2020q2 . All growth rates are reported in real terms.

The remaining factors are related to (iii) producer prices, (iv) housing, and (v) financial markets. The last factor, factor six, only explains less than 3% of the entire variation in the macroeconomic data and is mainly related to oil prices and terms of trade. All six factors explain together more than 62% of the entire variation in the macroeconomic series of the US.[5] Appendix A.3 provides a detailed overview of each factor and the estimation procedure.

In addition to the six macroeconomic components, I collect the following macroeconomic time series from FREDS: (i) real GDP growth rates, (ii) CPI inflation rates, (iii) the FED funds rate, (iv) the federal unemployment rate, and (v) aggregate capital stock growth rate. I use these series as additional controls or dependent variables in the subsequent sections.

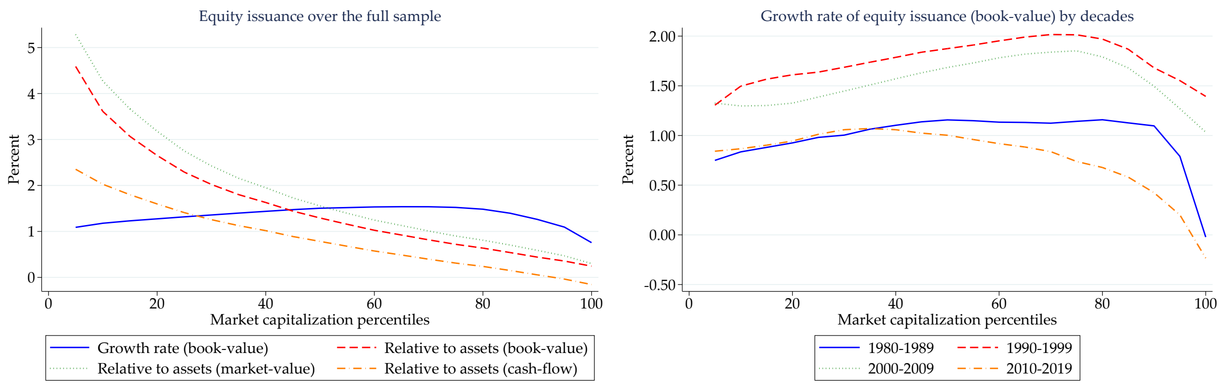
2.3 External Equity Financing Along the Firm Size Distribution

In this Section, I visualize the relationship between equity issuance and firm size. Figure 1 shows the average issuance of equity in percentiles of the market capitalization distribution.

In the left panel of Figure 1 I plot four alternative equity issuance measures using

[5] It is important to understand that the factors are by construction orthogonal to each other and the first factors explain more data volatility than the latter factors. This means that the producer price factor only captures those features that are not already explained by the business cycle factor (factor 1) or the consumer price factor (factor 2).

Figure 1: Average Equity Issuance by Market Capitalization



Notes: The figures depict the relationship between average equity issuance and firms' market capitalization. The graph on the left-hand side visualizes the average equity issuance for each market capitalization percentile using the entire sample. I plot the following four equity issuance measures: (i) the log-difference between shareholder equity and retained earnings (approximating the growth rate of external equity financing), (ii) the issued-equity-to-asset ratio using the book-value approach, (iii) the issued-equity-to-asset ratio using the market-value approach, and (iv) the issued-equity-to-asset ratio using the cash-flow-based approach. The figure on the right-hand side plots the log difference of external equity over the market capitalization percentiles for each decade separately. All reported numbers are in percentage points.

my entire firm sample. The first three measures are based on equations (1)-(3): (i) the log-difference in the real book value of external equity (see equation 1 for the definition of real external equity), the book value of issued equity to lagged assets (see equation 2), and the market value of issued equity relative to lagged assets (see equation 3). Alternatively, one can measure the net equity issuance of Compustat firms by using the cash flow statement of firms: The differences between net stock sales and net stock purchases(Jermann and Quadrini, 2012; Begenau and Salomao, 2018). I call this variable the cash-flow-based external equity issuance measure.

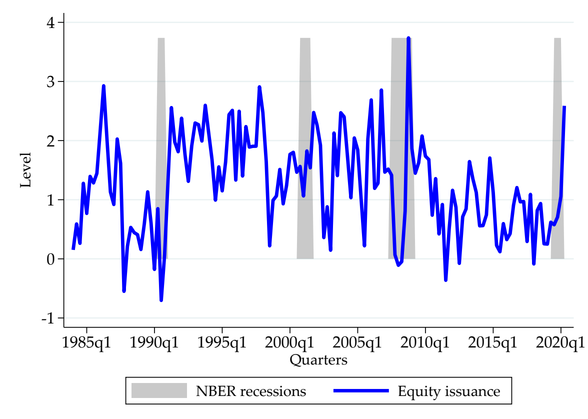
The left panel of Figure 1 indicates that all measures of net issued equity relative to firm assets behave similarly, that net equity issuance is steadily decreasing in firms' market capitalization. Whereas the smallest firms issue on average around 2.4% to 5.3% of net equity relative to their asset value, the change in net equity relative to lagged assets of the largest firms lies around −0.2% to 0.3%. Using the book-value approach or the market-based value yields little difference in the net equity issuance numbers, whereas the cash-flow-based issuance variable yields lower absolute values. When plotting the growth rate of external equity over the market capitalization percentiles, the results change. Small and large firms have the smallest growth rate of external equity, about 0.8%, and the average growth rate of external equity of medium-sized companies is 1.5%. This difference in the relationship between firm size and external equity issuance can be attributed to total assets growing more rapidly than net issued equity.[6]

In the right panel of Figure 1, I split the growth rate of external equity by decades and plot each growth rate over the market capitalization percentiles. Across all periods, one result remains robust: the growth rate of issued equity of large companies is the smallest. In fact, in the most recent decade, the top 5% of firms on average even reduced their outstanding equity positions by buying back their outstanding shares.

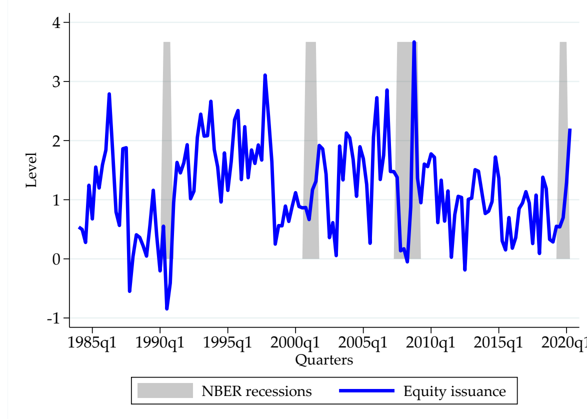
Next, I study how firm equity issuance evolved. Figure 2a plots the cross-sectional mean in issued equity evaluated at market prices over time. I observe a steady increase in net equity issuance between 1984 and 2000. The observation that firms adjusted their equity position less frequently in the 1980s compared to the 1990s is in line with existing evidence from the literature (Macnamara, 2019). Equity growth was high in the 1990s and, on average, has fallen afterward. Next, I split the time series of mean growth rates by firm size. From the mid-2000s onward, on average, the largest 25% of firms reduced the amount of outstanding equity in several periods (Figure 2c). This behavior is even more accentuated when looking at the top 10% of firms (Figure 2d). The latter group of firms purchased a significant number of their shares. In that decade, the bottom 75% of firms, in turn, issued on average around 1% of equity every quarter, without any significant share buybacks in this period (Figure 2b).

[6] Figure A.9 in the appendix shows that the average firm's equity issuance in response to aggregate shocks is robust across different measures of net issued equity.

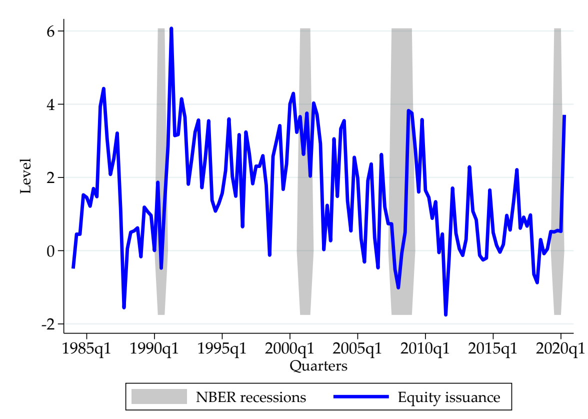
Figure 2: Average Equity Issuance Over Time.



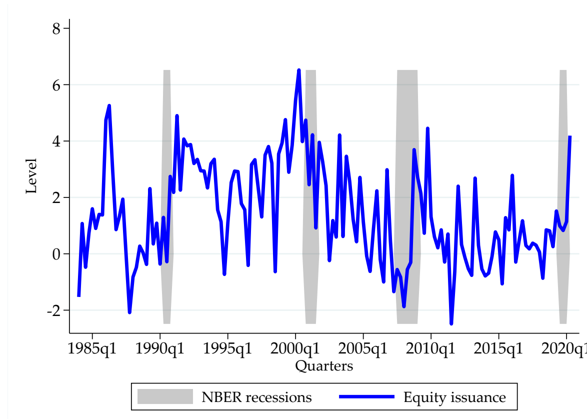
(a) Entire sample.



(b) Bottom 75% of firms.



(c) Top 25% of firms.



(d) Top 10% of firms.

Notes: The figures plot the average equity issuance between 1984q1 and 2020q2 . Equity issuance is measured as defined in equation (3) by net issued equity evaluated at market prices divided by lagged firm assets. The graph in panel (a) reports the average equity issuance for the entire sample. In panel (b) I report the equity issuance for the bottom 75% of firms in the market capitalization distribution. Panel (c) visualizes the equity issuance for the largest 25% of firms and panel (d) reports the equity issuance for the top 10% of firms with the highest market capitalization. All reported numbers are in percentage points. The dark grey shaded areas represent NBER recessions.

3 Aggregate Equity Financing Shocks

In this section, I construct an instrument for the aggregate external equity financing shock. As a first step, I estimate idiosyncratic firm innovations to firms' equity issuance. These innovations measure the unexplained variation in firms' equity issuance. Idiosyncratic firm shocks are in many cases the granular origin of macroeconomic volatility. This is especially true when the firm size distribution follows a power law (see among others, Gabaix, 2011; Acemoglu et al., 2012; di Giovanni and Levchenko, 2012). As a consequence, aggregate shocks originate in many cases from idiosyncratic shocks to large firms. In principle, changes in the net equity of large firms can affect the share prices and issued equity of firms in the same sector (Erwin and Miller, 1998; Bradley and Yuan, 2013). However, changes in the net equity position of both small- and medium-sized and large companies are likely correlated with macroeconomic shocks at the country level. Hence, in a second step, I remove the potential confounding common components from the estimated firm-specific innovations to equity by using the Granular Instrumental Variable strategy first introduced in Gabaix and Koijen (2023, 2024). The procedure yields an instrument for an aggregate equity financing shock.

3.1 Firm-Specific Innovations to Equity Financing

First, I estimate $\hat{\epsilon}^e_{i,t}$, the firm-specific innovations to external equity financing. The estimation strategy I use follows the specifications used in the literature when identifying firm-specific bank lending shocks (Landier et al., 2017; Galaasen et al., 2023; Bremus et al., 2021). Instead of loans, the dependent variable in my specification is the log-difference in real external equity: $\Delta \ln E^{bv,real}_{i,t}$.[7]

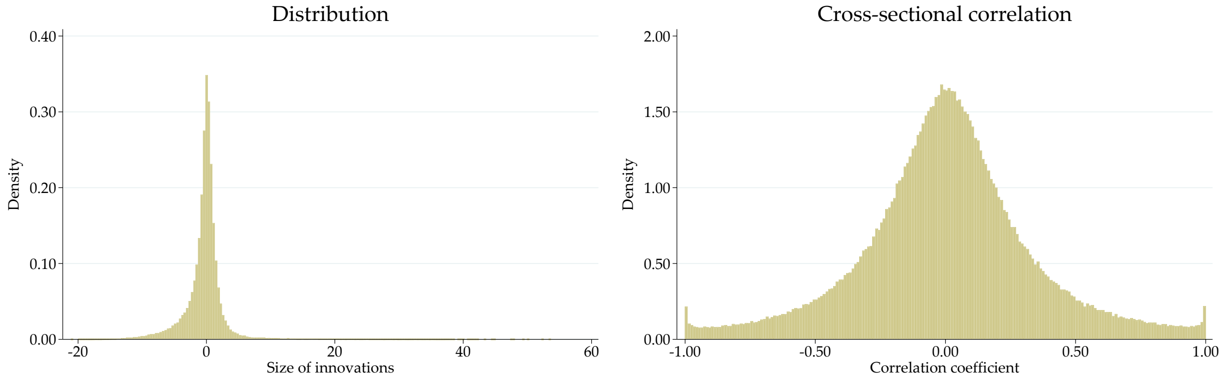
The regression equation is defined as:

$$\Delta \ln E^{bv,real}_{i,t} = \alpha_i + \nu_{st} + \sum_{k=1}^{4} \beta^f_k X_{i,t-k} + \epsilon^e_{it}, \tag{4}$$

with α_i denoting firm fixed effects, ν_{st} denoting sector-quarter fixed effects, and the vector $X_{i,t-k}$ includes a set of lagged firm-specific controls, such as the sales growth rate, the investment rate, growth rate of long term debt, the growth rate of total debt, the growth rate of net equity issuance, and the closing price of outstanding shares. The estimated innovations $\hat{\epsilon}^e_{i,t}$ represent the fraction of unexplained volatility in firms' equity issuance and are exogenous to the firm controls $X_{i,t-k}$, macroeconomic conditions, and any time-varying sectoral confounding factors.

[7]As I explain on the following pages, the construction of the Granular Instrumental Variable (GIV) requires a granular equity issuance distribution with firm-specific shocks to larger firms affecting the aggregate capital market more. However, dividing equity issuance by lagged firm assets would bias the estimated firm-specific residuals towards smaller firms as highlighted in Figure 1. Therefore, I use the log difference of real external equity for the estimation of the firm-specific residuals and the construction of the GIV.

Figure 3: Firm Innovations to Equity Issuance



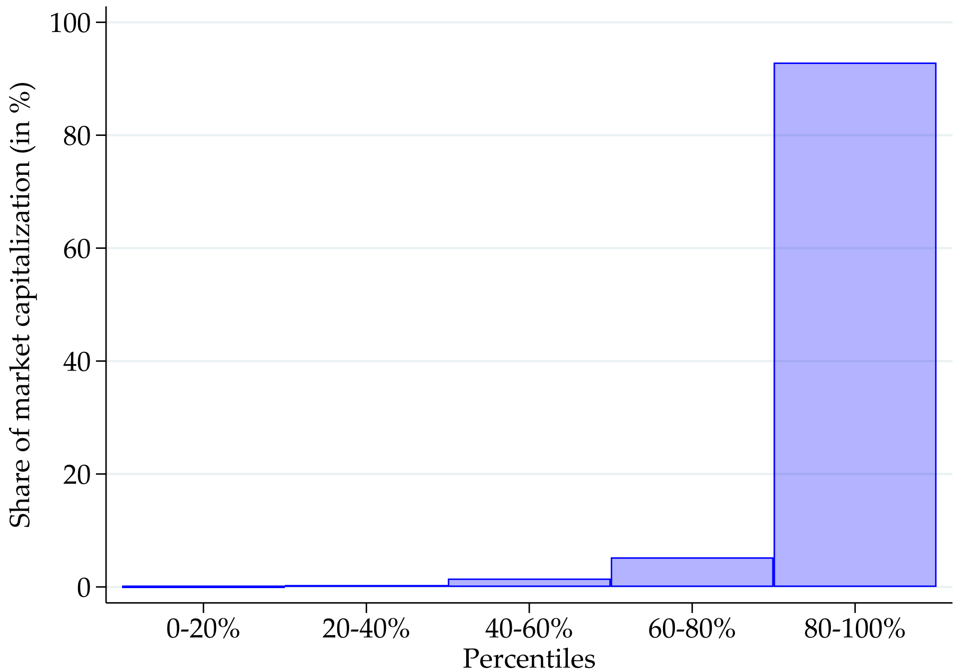
Notes: The figures visualize the density of the realizations of the estimated firm-specific innovations $\hat{\epsilon}^e_{i,t}$ to firms' equity issuance (left panel) and the cross-sectional correlation between the firm innovations to equity issuance (right panel). $\hat{\epsilon}^e_{i,t}$ are the estimated residuals from regression equation (4).

The distribution of innovations to firm-specific equity is plotted in the left panel of Figure 3. The x-axis describes the size of the innovation in percentage points. Nearly all innovations lie between values of -20 and 20 percentage points and are centered around zero. The majority of firm-specific innovations are not correlated with each other at all, or at least only weakly correlated. This finding is visualized in the right panel of Figure 3. If all firm-specific innovations are perfectly uncorrelated along the cross section, $\hat{\epsilon}^e_{it}$ would represent the true idiosyncratic firm shocks that are all orthogonal to common components. In general, firm innovations can be decomposed into $\epsilon^e_{it} = \lambda_{i,t}\eta_t + u^e_{it}$, with some common components η_t and a idiosyncratic firm-level shock u_{it}. $\lambda_{i,t}$ represents the factor loadings of firm i on the common components. The cross-sectional correlation coefficients in Figure 3 do not approach zero across firms, suggesting that some firm-level innovations may be influenced by aggregate shocks. In the next section, I remove these common aggregate shocks, denoted by η_t.

3.2 Granular Instrumental Variables for Equity Issuance

The Granular Instrumental Variable strategy enables the removal of common components from the firm-specific innovations $\hat{\epsilon}^e_{it}$. The resulting instrument is an aggregate time series driven by idiosyncratic shocks to the equity issuance of large companies. Thus, the instrument picks up the micro-level origins of aggregate equity shocks. I, therefore, add to a growing strand of literature that identifies micro-level shocks as the origin of aggregate

Figure 4: Granularity of Market Capitalization



Notes: These figures depict the granularity of firms' market capitalization over the entire sample. The reported numbers are calculated as follows: First, I calculate the share of firms' market capitalization relative to the aggregate market capitalization for each period. Next, I calculate the relative market capitalization share for each quintile and take the average over all periods. Reported numbers are in percentage points.

fluctuations (Gabaix, 2011; Acemoglu et al., 2012; di Giovanni and Levchenko, 2012; Baqaee and Farhi, 2019).

For shock identification, the GIV strategy requires the firm size distribution in the dataset to be granular with a few very large companies (Gabaix and Koijen, 2024). When the underlying firm distribution for equity financing is granular–with few firms having a very high market capitalization and many other firms having a rather low market capitalization–an idiosyncratic shock to large firms' issued equity can affect the entire aggregate equity market outcome.

In my sample, firms within the top quintile of the market capitalization distribution contribute more than 90% to the total aggregate market capitalization in the US. Figure 4 visualizes the granularity of the market capitalization distribution for US companies. I calculate quintiles of relative market capitalization for each period and then plot the average quintile values over time in Figure 4. My results illustrate one example of the well-known $80-20$ Pareto principle, which is commonly found in many applications in economics and finance (Gabaix, 2009). Figure A.3 in the appendix visualizes the granularity of market capitalization by plotting the actual market share of each firm in a histogram. The largest US firm in 2019 - Microsoft - has a market capitalization share of about 8%. More formally, I test whether the share distribution is fat-tailed by fitting a Pareto type I distribution. The estimated power-law coefficient value is 0.10. Values below 2 imply that idiosyncratic shocks do not die out (Gabaix, 2011; Galaasen et al., 2023).

After establishing that idiosyncratic shocks to the equity issuance of large companies survive and do not die out, I construct the Granular Instrumental Variable for equity financing. Therefore, I subtract the equally weighted firm-specific innovations from the size-weighted firm-specific innovations:

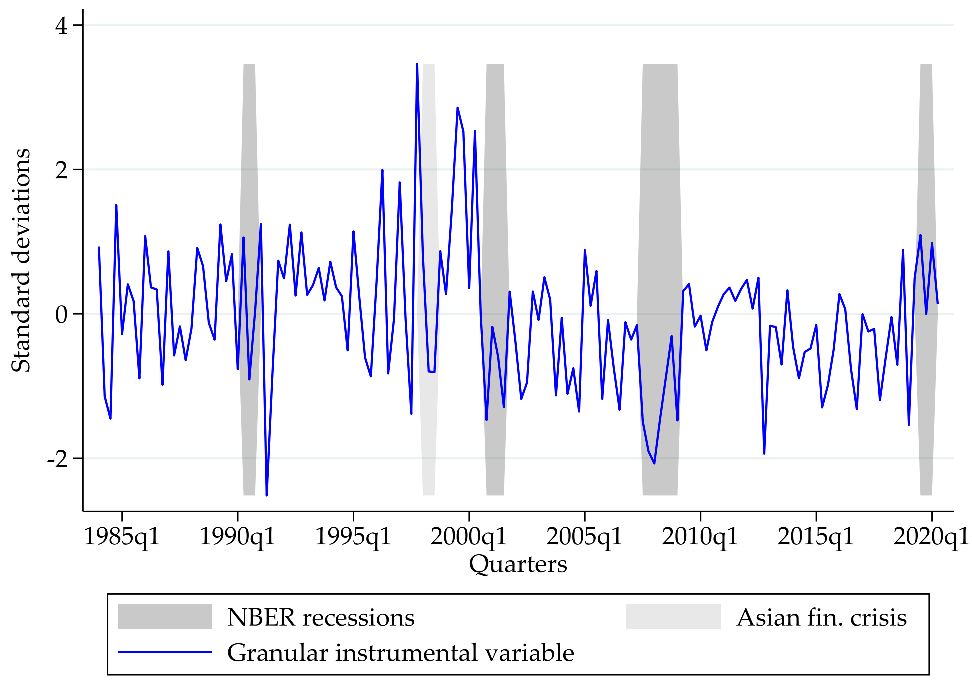
$$\hat{u}_t^{e,giv} = \sum_{i=1}^{N} \tilde{S}_{i,t-1} \hat{\epsilon}_{i,t}^{e} - \frac{1}{N} \sum_{i=1}^{N} \hat{\epsilon}_{i,t}^{e}. \tag{5}$$

The size weights $\tilde{S}_{i,t-1}$ are firm i's outstanding shares at market value in period $t-1$, divided by the total aggregate outstanding shares at market value for a specific period $t-1$. Since identification requires that weights and innovations are not correlated, I use lagged values to ensure that the weights are not affected by the firm-specific innovation in period t. The Granular Instrumental Variable defined in equation (5) fulfills the exogeneity assumption if $\mathbf{E}[\hat{u}_t^{e,giv}\eta_t] = 0$. When the factor loadings λ_i on the common components η_t are homogeneous across firms, η_t cancels out from equation (5) and my instrument is exogenous. The case of heterogeneous factor loadings is discussed in subsection 3.2.1. The relevance of the instrument will be reported in Section 4.

The resulting shock series is plotted in Figure 5. The aftermath of the recession in the early 1990s, the years following the Dot-Com Crisis, and the Great Recession are characterized by large negative shocks to equity issuance. The shocks in the 1990s are, on average, more positive and exhibit higher volatility compared to the post-2000 shocks.

The estimated GIV series is mainly driven by firms operating in either the manufacturing sector (SIC codes 2000–3990) or the service sector (SIC codes 7000–8900). I visualize this finding in Table 2. The table reports the correlation between the equity GIV $u_t^{e,giv}$ and the separately estimated sector-specific equity GIVs. The sector-specific equity GIVs are constructed by first estimating regression (4) for each 1-digit SIC code separately and by applying equation (5) to the estimated sector-specific residuals. A high correlation between $u_t^{e,giv}$ and a sector-specific GIV indicates that the size-weighted firm innovations of that sector extraordinarily contribute to the aggregate time series visualized in Figure 5. A great number of quite different companies are members of either the manufacturing sector or the

Figure 5: Granular Instrumental Variable for Aggregate Equity Financing Shocks



Notes: These figures depict the granular instrumental variable for an aggregate external equity financing shock between 1984q1 and 2020q2 . I construct the instruments using the GIV method described in equation (5). The dark grey shaded areas represent NBER recessions and the light grey shaded area highlights the Asian Financial Crisis in 1997.

service sector. To better understand which companies exactly contribute the most to the construction of the aggregate equity GIV series $u_t^{e,giv}$, I collect for each date the 4-digit SIC code of the 50 firms with the largest absolute value of size-weighted innovations to equity $\tilde{S}_{i,t-1}\hat{\epsilon}^e_{i,t}$. In the next step, I report the relative frequency of these collected 4-digit SIC codes within each decade in Figure A.4 in the appendix. Two stylized facts are worth noting.

First, companies in the oil sector (SIC codes 1311 and 2911), pharmaceutical and medical sector (SIC codes 2834–2836, and 3845), semiconductor manufacturers (SIC code 3674), telecommunication (SIC codes 4812 and 4813), and software service companies and digital service companies (SIC codes 7370–7373) contribute the most to the aggregate equity GIV series $u_t^{e,giv}$. Second, the type of sectors with the largest absolute value in idiosyncratic firm equity innovations changed over the most recent decades. Companies providing software and other digital services contribute more to the size-weighted idiosyncratic firm innovations after 2000. Innovations to firm equity issuance for companies operating in the telecommunication sector became less important for explaining the aggregate equity GIV series after 2000. The

Table 2: Correlation Between GIVs and Sector-Specific GIVs

GIV Variable	$\hat{u}_t^{e,giv}$	$\hat{u}_t^{e,giv,manu}$
$\hat{u}_t^{e,giv}$	1.00	0.31
$\hat{u}_t^{e,giv,manufact}$	0.31	1.00
$\hat{u}_t^{e,giv,utility}$	0.21	-0.03
$\hat{u}_t^{e,giv,service}$	0.18	0.02
$\hat{u}_t^{e,giv,retail}$	0.14	0.24
$\hat{u}_t^{e,giv,construction}$	0.05	0.01
$\hat{u}_t^{e,giv,mining}$	0.05	0.06
$\hat{u}_t^{e,giv,public}$	0.04	0.14
$\hat{u}_t^{e,giv,agricultur}$	0.00	0.04
$\hat{u}_t^{e,giv,chemical}$	-0.03	0.14
$\hat{u}_t^{e,giv,wholesale}$	-0.07	0.00

Notes: This table reports the correlation between the granular instrumental variable (GIV) for the aggregate equity financing shock and the separately estimated equity GIVs for each sector using 1-digit SIC codes. The first column reports the correlation coefficients between the GIV for equity issuance $\hat{u}_t^{e,giv}$ and the sectoral equity issuance GIVs. The second column reports the correlation coefficients between the manufacturing sector GIV for equity issuance $\hat{u}_t^{e,giv,manu}$ and the remaining GIVs.

reported numbers in Table 2 and Figure A.4 demonstrate that (i) the aggregate equity GIV is affected by the changes in the relative market capitalization of sectors (e.g. more weight on software companies and semiconductor producers and less weight on telecommunication after the year 2000) and (ii) medical manufacturing firms matter extraordinarily for explaining the aggregate volatility of the equity GIV series.

In Table A.3 in the appendix, I report narrative evidence for the three largest positive realizations of the equity GIV series and for the three most negative realizations.

3.2.1 Controlling for Heterogeneous Factor Loadings

The exogeneity assumption for the instrument for aggregate equity financing shocks requires that the GIV is uncorrelated to any common components η_t, which means $\mathbf{E}[\hat{u}_t^{e,giv}\eta_t] = 0$ has to hold. Equation (5) implies that the exogeneity assumption automatically holds when the factor loadings $\lambda_{i,t}$ for any firm i are homogeneous across firms and hence are uncorrelated with firm size $\tilde{S}_{i,t-1}$. If instead, the factor loadings are heterogenous, the construction of the

GIV does not completely purge out η_t and the exogeneity assumption is violated. In this subsection, I will explain how I control for heterogenous factor loadings.

As suggested by Gabaix and Koijen (2023, 2024), I estimate the common components η_t separately using principal component analysis and add the estimated components as control variables to the empirical analysis in Section 4. First, I standardize the change of issued equity by defining the new variable $\breve{e}_{i,t} = \frac{\Delta \ln E_{i,t}^{bv,real} - \mathbf{E}[\Delta \ln E_{i,t}^{bv,real}]}{\sigma^{E^{bv,real}}}$. Let $\mathbf{X}$ be the entire $N \times T$ panel dataset of standardized changes in firms' equity $\breve{e}_{i,t}$. I estimate the eigenvalues and eigenvectors of the covariance matrix of standardized equity issuance $\mathbf{X}^T\mathbf{X}$ via the eigendecomposition:

$$(\mathbf{X^T X})\eta^{\mathbf{PCA}} = \lambda \eta^{\mathbf{PCA}}, \tag{6}$$

with λ denoting a vector of k eigenvalues and $\eta^{\mathbf{PCA}}$ denoting a $T \times k$ matrix with the columns of $\eta^{\mathbf{PCA}}$ given by the k eigenvectors.

To determine the number of components used in $\hat{\eta}^{PCA}$, I base my decision (i) on the scree plot in Figure A.5 in the appendix and, further, (ii) I exclude all components that explain less than 1% of the variance of the data. The number of equity-financing common components used in the subsequent section of this paper is nine. I stack the nine estimated equity components with the largest eigenvalues in the vector $\hat{\eta}^{PCA}$. The components are plotted over time in Figure A.6 in the Appendix.

4 Transmission of the Aggregate Equity Shocks

In this section, I investigate the dynamic firm-level responses to the aggregate equity financing shock. First, I calculate the firm-level impulse responses in equity issuance and firms' share prices to the aggregate equity financing shock using a two-stage instrumental variable local projections (IV-LP) framework. I investigate whether small- and medium-sized companies respond differently to equity issuance shocks compared to the largest companies. By investigating the share price responses to the aggregate equity financing shock, I analyze whether the shock is received as a positive market signal consistent with an increase in the demand for firm shares by investors. In a second exercise, I study the role of firm-level financial constraints for equity issuance in response to the aggregate equity financing shock. I focus in particular on how cash holdings and high debt levels influence investment, equity issuance, and outstanding debt. Finally, I explore the interaction between endogenous monetary policy responses and aggregate equity financing shocks.

4.1 Transmission on Firm-Level Equity Issuance

In this section, I analyze the responses of firm equity to a positive aggregate equity financing shock. In contrast to existing literature that studies the spillover of equity issuance or stock repurchase announcements of one specific company on competitors (see among others, Slovin et al., 1992; Erwin and Miller, 1998; Bradley and Yuan, 2013), I aim to study the effects of an exogenous aggregate equity issuance shock on the average firm's net equity issuance and share prices. I instrument the aggregate equity financing shock by the Granular Instrumental Variable introduced in Section 3.2.

The GIV series is predominantly driven by idiosyncratic shocks to the net equity positions of large companies. Hence, a positive equity financing GIV value indicates that, on average, the idiosyncratic shocks to large companies' net equity were positive in that quarter. The spillover effects, in terms of both magnitude and sign, of such a shock on the remainder of firms, e.g. small- and medium-sized companies, are *a priori* unknown. The literature on the spillovers of seasoned equity offerings (SEO) of individual companies identified two competing effects that might potentially affect my results: the "contagion effect" and the "competitive effect". Under the contagion effect, the equity issues of a (large) company in a given sector might convey information about the economic outlook, causing other companies to also issue equity in the same or subsequent quarters. Under the competitive effect in turn, the change in net equity of a given company is interpreted as a signal about an advantage (or disadvantage) the company has over its rivals in the same sector (see Bradley and Yuan, 2013, for a discussion of both competing effects).

In the subsequent paragraphs, I address three key questions: (i) Does a positive aggregate external equity shock significantly increase net equity issuance for the average firm in my sample? (ii) Does net equity issuance in response to the shock differ between small- and medium-sized companies and the largest firms? (iii) Does the constructed instrument for the aggregate external equity shock lead to an increase or decrease in share prices?

I follow Jordà et al. (2015) and define a two-stage regression to estimate the average effect of positive aggregate equity financing shocks on the average firms' net issued equity and share prices.[8] The local projection instrumental variable estimation (LP-IV) is described by the following two regression equations.

First stage - Aggregate net equity issuance on GIV: The equity granular instrumental

[8]The two-stage regression setting is required since I am using an instrument rather than the true unobservable shock series. Otherwise, the local projection coefficient estimation would be biased (Stock and Watson, 2018).

Figure 6: Equity Issuance and Share Price Responses to a Positive Aggregate Equity Financing Shock

Notes: These figures depict the local projections of firm-level net issued-equity-to-assets at market value, the debt-to-shareholder-equity ratio, share prices, and outstanding shares to a one standard deviation positive aggregate equity financing shock. The local projections are specified in equation (8). The blue solid lines visualize the average response using the entire firm sample. The green-dotted lines visualize the responses of firms within the bottom 80% of the firm size distribution, and the red-dashed lines depict the responses of firms within the top 20% of the firm size distribution. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

variable proxies a shock to the aggregate external equity issuance in the US. I aggregate the net equity issuance at market prices. I use the market prices of firm-level net issued equity relative to lagged firm-level assets, $\Delta E^{mv}_{i,t}/assets_{i,t-1}$, and calculate the size-weighted cross-sectional average. I label the resulting aggregate net equity issuance variable: $\Delta E^{aggr,mv}_t = \sum_i^N \omega_{i,t}\Delta E^{mv}_{i,t}/assets_{i,t-1}$, with $\omega_{i,t}$ denoting the market capitalization of firm i relative to the aggregate market capitalization. In the first stage, I regress the aggregate net equity issuance $\Delta E^{aggr,mv}_t$ on the GIV $\hat{u}^{e,giv}_t$:

$$\Delta E^{aggr,mv}_t = \beta^{giv,eq} u^{e,giv}_t + \sum_{k=1}^{4} \Psi^{1st}_k F_{t-k} + \Upsilon^{1st}\hat{\eta}^{PCA}_t + e^{1st}_t. \tag{7}$$

Table 3: Equity Issuance in Response to a Positive Aggregate Equity Financing Shock

	$\Delta Equity_{i,t}$	$\Delta Equity_{i,t+4}$	$\Delta Equity_{i,t+8}$	$\Delta Equity_{i,t+12}$
ΔE_t^{aggr}	0.334*	1.239	0.450	-0.347
	(0.145)	(0.706)	(0.923)	(1.064)
R^2	0.04	0.06	0.05	0.05
F-statistic (Kleibergen-Paap)	15.39	15.40	15.45	15.49
Number firms	4,808	4,813	4,696	4,126
Number observations	110,903	111,004	105,266	85,162

Notes: The numbers in this table report the local projections of net equity-issuance-to-assets of the average firm in the sample to a one standard deviation positive aggregate equity financing shock. As the dependent variable, I use the market value of issued equity as defined in equation (3). The local projections are based on regression equation (8). Standard errors are calculated by using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

When using granular instrumental variables, one of the main challenges for identification is that one does not control sufficiently for heterogeneous factor loadings (Gabaix and Koijen, 2023). To mitigate the issue of omitted factors, I control for the contemporaneous equity components $\hat{\eta}_t^{PCA}$. I ensure that the current instrument is not affected by past aggregate shocks by controlling for four lags of real GDP, inflation, unemployment rate, FED funds rate, and the macroeconomic factor variables. All macroeconomic controls are collected in the vector F_{t-k}. By controlling for F_{t-k}, I ensure that the GIV series satisfies the "lead-lag exogeneity" condition (Stock and Watson, 2018). By scaling the second stage by $\hat{\beta}^{giv,eq}$, the estimated coefficients in the second stage measure the firm-level responses to a one standard deviation positive aggregate external equity shock.

Second stage - Mean net equity issuance and share prices: In the second step, I estimate the average firm-level responses in net equity issuance, the debt-to-equity ratio (i.e. total debt to shareholder equity), closing price of shares, and the outstanding number of adjusted shares to an exogenous one standard deviation increase in external equity issuance. I use the equity GIV as an instrument for the increase in aggregate equity financing ΔE_t^{aggr}. Letting $y_{i,t+h}$ be the forecast of the firm variable of interest, I follow Jordà (2005) and Jordà et al. (2016) and define the local projection regression as:

$$\Delta y_{i,t+h} = \alpha_i^h + \beta^h \Delta E_t^{aggr,mv} + \sum_{k=1}^{4} \Gamma_k^h Z_{i,t-k} + \sum_{k=1}^{4} \Psi_k^h F_{t-k} + \Upsilon^h \hat{\eta}_t^{PCA} + e_{i,t}^h. \tag{8}$$

with α_i denoting firm fixed effects. The macroeconomic controls are the same as in equation (7). In addition, I control for four lags of the following firm-specific characteristics: long-term debt issuance, net equity issuance, investment rate, debt-to-equity, debt ratio, and Tobin's Q.

The results depicted in Figure 6 demonstrate that firms in my sample significantly increase their net equity issuance by about 1.2% on average within the quarters following the favorable aggregate equity financing shock. Firms in addition increase their equity position relative to their total debt causing a significant decline of -1.3% within the first quarters following the shock in the firms' debt-to-equity position, indicating that the Granular Instrumental Variable captures indeed a positive shock to equity financing and not just an improvement of the general funding conditions of firms in the US. When measuring equity issuance by changes in the number of outstanding shares, I also observe a significant increase by 0.5% within the first quarters following the aggregate external equity shock. Small- and medium-sized companies–i.e. the bottom 80% of the firm size distribution–increase their net equity issuance by more relative to the largest firms in the sample. This finding is also robust to measuring equity issuance as a decline in the debt-to-equity ratio or an increase in the number of outstanding shares. Taken together, the findings suggest that the equity GIV effectively captures the overall improvement in equity financing conditions for the average publicly listed firm. This finding is neither trivial nor by construction. The equity GIV series is predominantly constructed from the net equity issuance of the largest US companies, making its effect on smaller firms *a priori* unclear. My results indicate that the equity GIV can be used as a proxy for an aggregate equity financing shock that increases on average equity issuance of all firms regardless of firm size. My results do not provide any evidence that the constructed equity GIV has a "competitive effect" on SME's equity issuance.

Instead, the share price responses indicate that market participants interpret the shock, instrumented by the GIV, as a positive signal for small- and medium-sized companies. Share prices increase on average by about 13.5% after the shock. Again the increase is stronger for firms in the bottom 80% of the firm size distribution. These findings support the hypothesis of a granular origin of the aggregate equity financing shock used in this paper. These findings are consistent with a "contagion effect" channel. Positive idiosyncratic shocks to the equity issuance of firms with high market capitalization are received as a positive market signal. Further, the positive and significant increase in share prices and number of shares would be in addition consistent with an increase in the demand for equity from market participants rather than a supply-side story.

I also report the regression outcome of the net issued equity impulse responses to the favorable aggregate equity financing shock in Table 3. The effect within the first quarters is significant on a 5% level. The equity GIV is a relevant instrument with a Kleibergen-Paap F-statistic of 15.4.

Robustness. I investigate the robustness of the external equity and share price local projection in Appendix C.

I show in Figure A.7 that the responses of net issued equity, the debt-to-equity ratio, the firm share prices, and the number of outstanding shares are all robust to the exclusion of the equity common components and the exclusion of the macroeconomic controls.

The depicted local projections in Figure A.8 demonstrate that the responses to the aggregate equity financing shock do not change when including additional firm-level financial controls such as firm size, the cash-to-asset ratio, the debt-to-earnings ratio, or an indicator for whether firms pay dividends.

Equity issuance of firms in Compustat can be measured by using different approaches. One can take the book-value difference between the change in shareholders' equity and the change in retained earnings or the market-value of changes in outstanding shares multiplied by the average closing share price between two periods (Fama and French, 2005). As a third measure, one can use the net equity issuance using the net cash-flow difference between stock sales and net stock purchases (Jermann and Quadrini, 2012; Begenau and Salomao, 2018). Figure A.9 plots the responses of all alternative external equity financing measures and demonstrates that the equity issuance of the average firms in response to the aggregate equity financing shock is significant regardless of the used measure.

The depicted impulse responses in Figure A.10 show that my baseline results remain unchanged when simultaneously controlling for monetary policy shocks. I conclude that the constructed equity GIV is a valid instrument for aggregate equity financing shocks and is not confounded by heterogeneous firm factor loadings on monetary policy shocks.

4.2 Financial Constraints and Firms' Equity Issuance

In this section, I investigate the role of financial constraints in the effect of a positive aggregate equity financing shock on firms' equity issuance. A broad strand of literature focuses on how to measure the degree of financial constraints. Some studies highlight the role of Tobin's Q as a proxy for firm-level financial constraints when studying the equity issuance decisions of firms (Ehrmann and Fratzscher, 2004; Hennessy and Whited, 2007; Covas and Haan, 2011). Other studies use proxies such as book leverage (Ottonello and Winberry, 2020), firm liquidity (Jeenas, 2023), whether firms pay dividends (Cloyne et al., 2023), or firms' indebtedness relative to their earnings (Lian and Ma, 2021; Drechsel, 2023).

In the following, I augment the second stage local projection regression from Section 4.1 and interact the aggregate equity financing shock with the previously discussed proxies for firm-level financial constraints. The vector $FC_{i,t-1}$ includes the lagged values of the following six financial constraint proxies: (i) Tobin's Q, (ii) the debt ratio, (iii) firm size, (iv) the cash-to-asset ratio, (v) the debt-to-earnings ratio, and (vi) an indicator for whether firms pay dividends. The second stage local projection (LP-IV) regression equation is defined as:

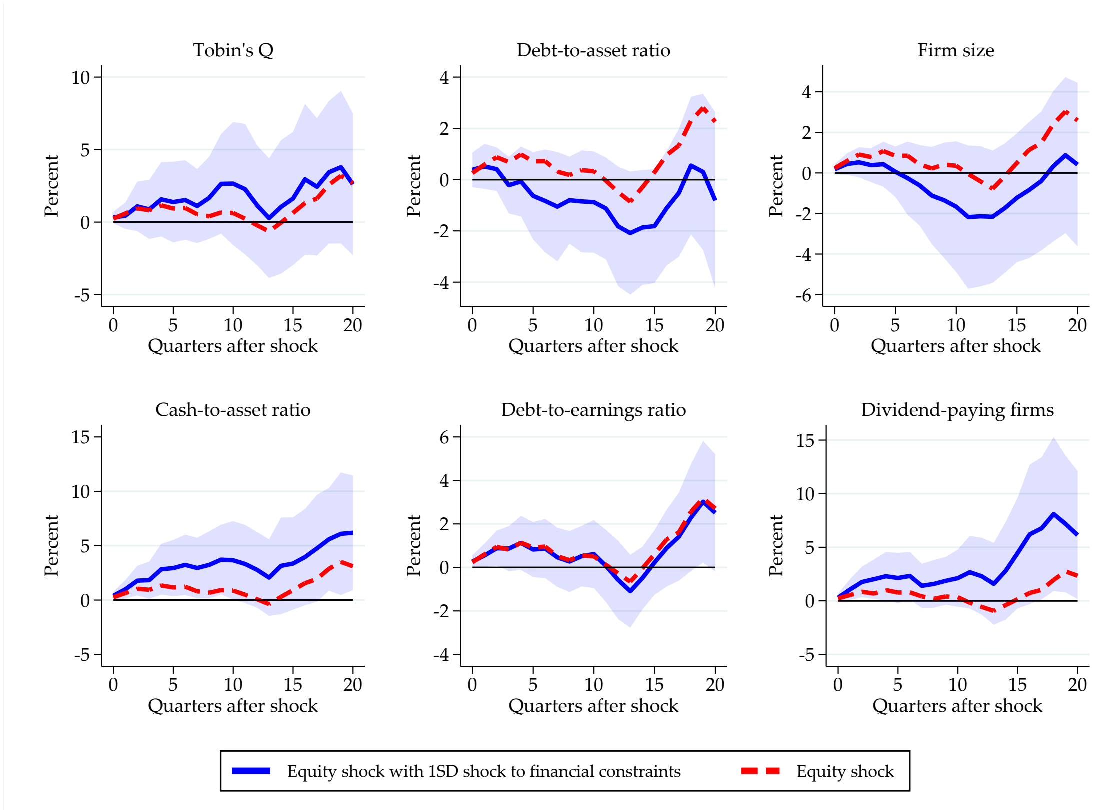
$$\begin{aligned}\Delta y_{i,t+h} =& \alpha_i^h + \beta^h \Delta E_t^{aggr} + \gamma^h [FC_{i,t-1} \times E_t^{aggr}] + \sum_{k=1}^{4} \Gamma_k^h Z_{i,t-k} + \sum_{k=1}^{4} \Psi_k^h F_{t-k} \\ &+ \Upsilon^h \hat{\eta}_t^{PCA} + \sum_{k=1}^{4} \Omega_k^h FC_{i,t-k} + e_{i,t}^h \end{aligned} \tag{9}$$

with α_i^h denoting firm fixed effects. In addition to the inclusion of the interaction of financial variables and the aggregate shock, I control for four lags of the financial variables $FC_{i,t-k}$. The remaining controls are identical to those used in regression (8): The vector $Z_{i,t-k}$ includes firm-level controls, F_{t-k} controls for macroeconomic conditions, and $\hat{\eta}^{PCA}$ denote the estimated equity common components.

Figure 7 depicts the response of net issued equity to a one standard deviation positive aggregate equity financing shock for firms with one standard deviation higher level in one of the six proxies for financial constraints. Firms paying dividends issue about 2.0% more equity within the first two years after the aggregate shock. Fama and French (2001) highlight that dividend-paying firms are both on average more profitable and larger than non-dividend-paying firms. The evidence in Figures 6 and 7 shows that large companies issue less equity. I interpret the significant marginal effects for dividend-paying firms as supporting evidence that these firms are less financially constrained (as highlighted in Cloyne et al., 2023) and more profitable (in line with Fama and French, 2001) and hence can raise more equity when the conditions on the aggregate equity market improve.

The second group of firms that issue relatively more equity consists of firms with a higher cash-to-asset ratio. These firms issue 1.8% additional equity after the shock materializes. Why would cash-rich firms with plenty of internal funds increase their equity issuance more than the average firm in the sample? One explanation in line with corporate finance theory is that financially unconstrained firms, i.e. firms with high levels of cash holdings, use the opportunity of improved capital market financing conditions to replace debt with equity to reduce leverage and strengthen their financial position. Ma (2019) shows that firms act as

Figure 7: Firm Equity Issuance and Financial Constraints

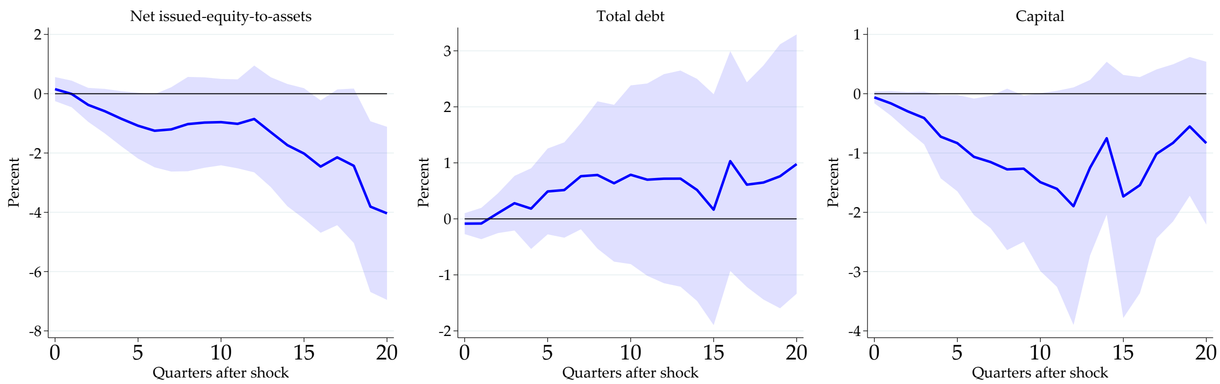


Notes: The figures visualize the local projections of firm-level net issued-equity-to-assets to a one standard deviation positive aggregate equity financing shock. As the dependent variable, I use the market value of issued equity as defined in equation (3). The blue lines depict the response in net issued equity to the equity shock for firms with one standard deviation higher level in one of the following financial constraint proxies: (i) Tobin's Q, (ii) the debt ratio, (iii) firm size, (iv) the cash-to-asset ratio, (v) the debt-to-earnings ratio, and (vi) an indicator for whether firms pay dividends. The red lines depict the response in net issued equity of the average firm in the sample. The estimations are based on the regression equation (9). The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

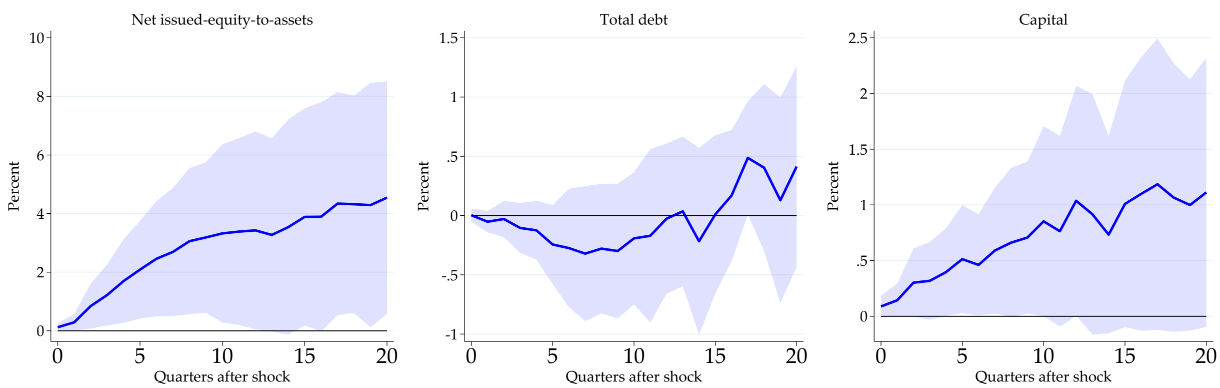
cross-market arbitrageurs. Firms issue equity and repurchase debt when their share prices are high and issue new debt and repurchase equity when share prices are low. I visualize in panel (b) of Figure 8 that high-cash firms indeed substitute debt for equity. The impulse response in Figure 8 depicts the marginal effects of the interaction of the aggregate equity financing shock with the cash-to-asset ratio and with the debt-to-asset ratio. I plot the marginal local projections for net issued equity, total debt, and capital. Focusing on the marginal effect of the interaction allows me to include quarterly time-sector fixed effects to control for macroeconomic confounding factors, such as aggregate shocks on the

Figure 8: Marginal Effects of Leverage and Cash on Firm Responses to a Positive Aggregate Equity Shock

(a) Debt-to-Asset Ratio



(b) Cash-to-Asset Ratio



Notes: The figures visualize the marginal effects of the debt-to-asset ratio and the cash-to-asset ratio on the local projections of real net issued equity, real total debt, and real capital to a one standard deviation positive aggregate equity financing shock. The estimations are based on a modified version of the regression equation (9) by including quarterly time-sector fixed effects: $\Delta y_{i,t+h} = \alpha_i^h + \nu_{st}^h + \gamma^h[FC_{i,t-1} \times E_t^{aggr}] + \sum_{k=1}^4 \Gamma_k^h Z_{i,t-k} + \sum_{k=1}^4 \Omega_k^h FC_{i,t-k} + e_{i,t}^h$. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

country level, and for time-varying sector-specific confounding variables. The behavior of cash rich firms depicted in Figure 7 and panel (b) of Figure 8 can be interpreted as follows: Financially unconstrained firms with high levels of cash holdings utilize the (unexpected) favorable shock to aggregate capital market financing conditions by issuing up to 4.3% more new equity relative to the average firm to finance 1.2% more investment projects and to reduce their total number of outstanding debt by -0.3% compared to the average firm in the sample. The difference to Ma (2019) is that firms in Ma (2019) time the capital market and plan their equity issuance well ahead. Equity issuance of an individual firm in Ma (2019) can be predicted by the firm's previous increases in its share price. As I show in Appendix D, firms cannot time the aggregate equity financing shock, and previous increases in firms' share prices do not predict higher equity issuance. Instead, my results shed light on the question, of which type of firms issue more (or less) equity in response to an unexpected aggregate equity financing shock and for which reasons.

Next, I focus on the responses of highly indebted–i.e. firms with a high level of total debt to assets. Some papers use the debt-to-asset ratio as a proxy for the extent of financial constraints (Ottonello and Winberry, 2020). However, whether highly leveraged firms issue more or less equity than the average firm in response to the favorable equity financing shock is *a priori* not obvious. When equity financing conditions are favorable, i.e. when the cost of equity issuance is low, highly indebted firms can substitute equity for debt to appear less financially constrained (Hennessy and Whited, 2007). In contrast, a high degree of debt overhang could prevent firms from issuing additional equity to finance promising investment projects (Myers, 1977; Hennessy, 2004; Barbiero et al., 2020; Kalemli-Özcan et al., 2022). In addition, the leverage ratchet effect predicts that once debt levels are high, shareholders refrain from reducing leverage by issuing equity (Admati et al., 2018). The evidence in Figure 7 indicates that highly indebted firms, i.e. firms with high levels in the debt-to-asset ratio, issue significantly less equity in response to the aggregate equity financing shock. The difference in equity issuance between firms with one standard deviation higher levels in the debt-to-asset ratio and the average firm amounts to -3.8 percentage points after five years. As visualized in panel (a) of Figure 8, highly leveraged firms reduce their outstanding total debt by less on the short horizon and instead temporarily increase their outstanding total debt. The difference in the growth rate of total debt between the average firm in the sample and firms with one standard deviation higher debt-to-asset ratios amounts to 1.0 percentage points. The lower equity issuance translates into lower firm investment. Firms with a one standard deviation higher level in the debt-to-asset ratio have a lower investment rate of -1.9 percentage points two years after the shock compared to the average firm in the sample.

The results on the role of the debt-to-asset ratio for the transmission of a favorable aggregate equity financing shock are in line with theoretical corporate finance models on the role of corporate debt overhang on low firm investment (Myers, 1977; Hennessy, 2004) and the leverage ratchet effect (Admati et al., 2018). Kalemli-Özcan et al. (2022) find empirical evidence that corporate debt overhangs decrease firm investment rates during economic crises. I add to the empirical literature by demonstrating that debt overhang depresses firm investment even when firms are hit by a favorable aggregate equity financing shock that allows the average US firm to issue more equity. The low investment rate of highly leveraged firms, coinciding with a reluctance to issue equity even when conditions are favorable, and the reluctance to reduce outstanding debt can be explained by the leverage ratchet effect. By agreeing to issue equity and to reduce leverage in response to the favorable aggregate equity shock, highly indebted firms' shareholders would transfer wealth to creditors due to the reduced default risk (Admati et al., 2018).

Robustness. I discuss the robustness of the estimated marginal effects of the different financial constraint proxies in Appendix D. Figure A.11 shows that my results are robust in estimating jointly the marginal effects of the six interaction terms in the same regression. In addition, Figure A.11 also proves that the marginal effects of the six interaction terms barely change when controlling for sector-time (quarters) fixed effects. I include quarterly time-by-sector fixed effects to control for macroeconomic confounders—such as aggregate country-level shocks—and time-varying, sector-specific factors. Again, only dividend-paying firms or firms with a high level of cash holdings issue significantly more net equity following the aggregate positive equity financing shocks.

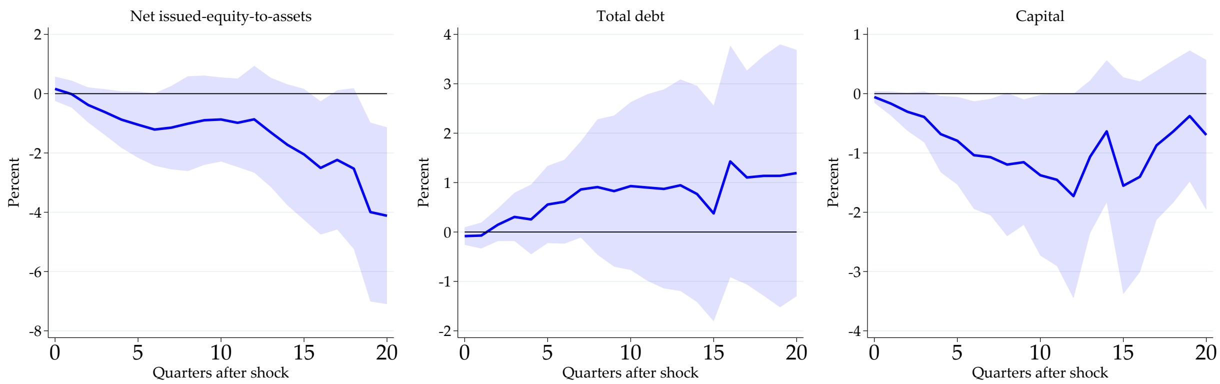
Existing evidence from the literature suggests that firms time capital markets when deciding to issue or purchase equity (Begenau and Salomao, 2018; Ma, 2019). A firm issues more equity when its share prices are relatively high (see among others, Marsh, 1982; Jung et al., 1996; Baker and Wurgler, 2002; Dittmar and Thakor, 2007). I show in Figure A.12 that the firm-specific stock price dynamics do not predict higher net equity issuance in response to an aggregate equity financing shock. This is evidence that firms cannot time a positive realization of the aggregate equity financing shock. As a consequence, the exogeneity assumption of the Granular Instrumental Variable is not violated. If an economy-wide peak in share prices could predict a positive value in the GIV equity financing shock series, the instrument would not be exogenous to firms' fundamentals. Second, the result implies that firms with previously increasing share prices and firms without increasing share prices benefit both from the aggregate equity financing shock.

4.3 Equity Granular Instrumental Variables and Monetary Policy

The purpose of this section is threefold. First, I demonstrate that the results outlined in Sections 4.1 and 4.2 are robust to the inclusion of monetary policy shocks on the right-hand side of the local projection regression equations. Second, I study the aggregate responses to a favorable aggregate equity financing shock proxied by the equity GIV using macro-level

Figure 9: Marginal Effects of Leverage and Cash on Firm Responses to a Positive Aggregate Equity Shock—Controlling for Monetary Policy Shocks

(a) Debt-to-Asset Ratio

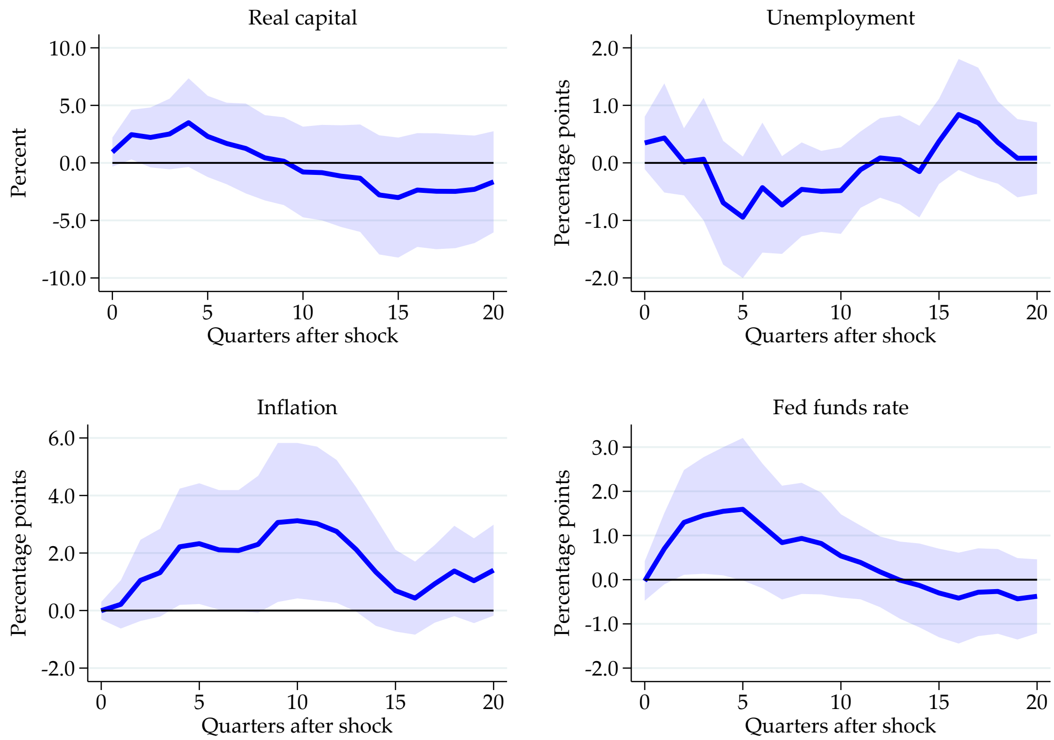


(b) Cash-to-Asset Ratio

Notes: The figures visualize the marginal effects of the debt-to-asset ratio and the cash-to-asset ratio on the local projections of real net issued equity, real total debt, and real capital to a one standard deviation positive aggregate equity financing shock. The estimations are based on a modified version of the regression equation (9) by including quarterly time-sector fixed effects ν_{st} and monetary policy shocks ϵ_t^{mon} from Bauer and Swanson (2023): $\Delta y_{i,t+h} = \alpha_i^h + \nu_{st}^h + \gamma^h[FC_{i,t-1} \times E_t^{aggr}] + \sum_{k=1}^4 \Gamma_k^h Z_{i,t-k} + \sum_{k=1}^4 \Omega_k^h FC_{i,t-k} + \beta^{h,mon}[FC_{i,t-1} \times \epsilon_t^{mon}] + e_{i,t}^h$. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

data. I visualize the monetary policy response of the FED by estimating the local projections of the FED funds rate to understand how the monetary policy response to a favorable aggregate equity financing shock. Third, I examine firms' equity issuance and share price movements while controlling for monetary policy, which allows me to disentangle the more direct effects of the equity financing shock on firm equity from those driven by endogenous monetary policy responses.

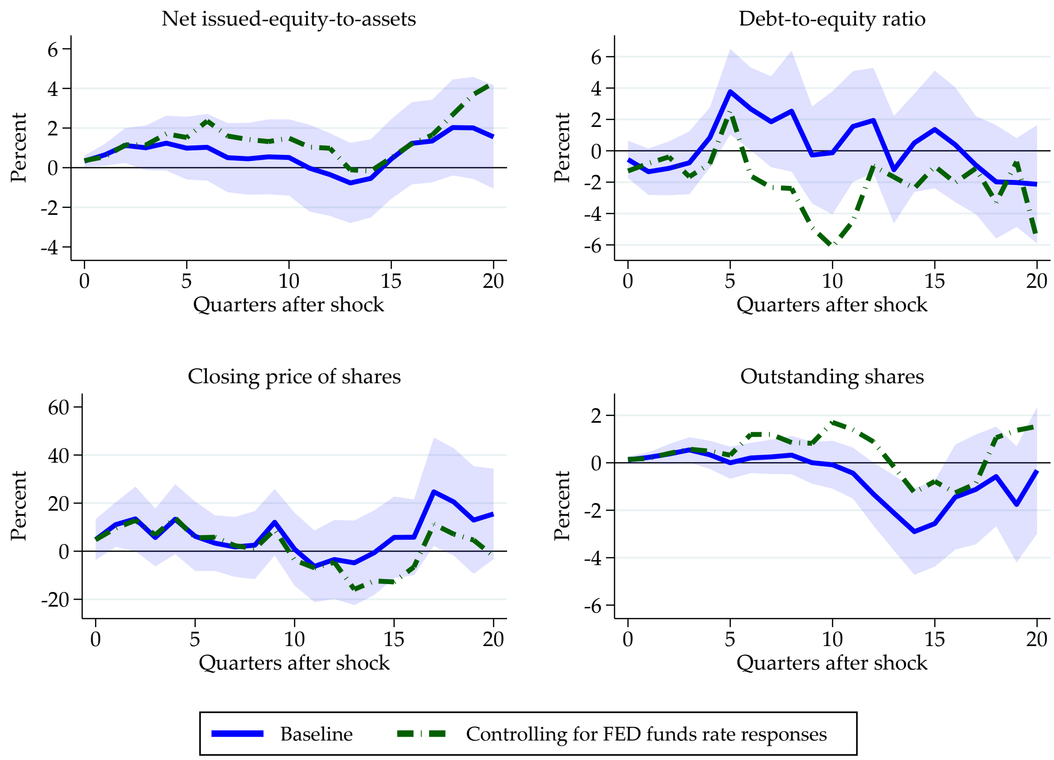
Figure 10: Macro-Level Responses to a Positive Aggregate Equity Shock



Notes: These figures depict the local projections of aggregate capital stock, unemployment, inflation, and the FED funds rate to a one standard deviation positive aggregate equity financing shock using macro-level data from FRED. The local projections are specified in equation (11). The blue shaded area reports the 95% confidence interval using heteroskedasticity-consistent standard errors. Reported numbers are in percentage points.

There exists a large literature on the role of firm-level financial constraints for the transmission of monetary policy shocks on firm investment. Highly leveraged firms' investment rates are less responsive to adverse monetary policy shocks (Ottonello and Winberry, 2020) and the level of firms' cash holding can explain firm investment responses to monetary policy (Jeenas, 2023). In this section, I demonstrate that my previous results on the role of firm leverage and cash holdings for the transmission of an aggregate equity financing shock on equity issuance, changes in total debt, and firm investment remain robust even when accounting for heterogeneous factor loadings on monetary policy shocks. As I explained in Section 3.2, by constructing the equity GIV, I remove potential confounding monetary policy shocks from the firm-specific equity financing shock. This procedure, however, cannot purge out common shocks when firm factor loadings on these shocks are heterogeneous. I account

Figure 11: Equity Issuance and Share Price Responses to a Positive Aggregate Equity Shock—Controlling for FED funds rate responses



Notes: These figures depict the local projections of firm-level net issued equity, the debt-to-shareholder-equity ratio, the share prices, and the outstanding number of shares to a one standard deviation positive aggregate equity financing shock when controlling simultaneously for the responses in the FED funds rate. The blue solid lines visualize the baseline response using regression equation (8) and the dashed red lines depict the responses when controlling for the FED funds rate responses as defined in regression equation (12). The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

for heterogeneous factor loadings in the local projections specified in Sections 4.1 and 4.2 by including the equity components η^{PCA}. In the first exercise in this section, I control for monetary policy shocks in my local projections to demonstrate that the constructed equity GIV is orthogonal to monetary policy shocks.

In the following, I use the Bauer and Swanson (2023) monetary policy shock series (hereafter BS23). The BS23 series is robust to information effects of monetary policy[9] and covers

[9]For a detailed discussion of the information effect of monetary policy see, among others, Nakamura and Steinsson (2018), Miranda-Agrippino and Ricco (2021), and Bauer and Swanson (2023).

the period between 1988q1 and 2020q2 . I add the interaction of firm-level financial variables and monetary policy and quarterly time-sector fixed effects ν_{st} to regression equation (9), resulting in the following specification:

$$\begin{aligned}\Delta y_{i,t+h} =& \alpha_i^h + \nu_{st}^h + \gamma^h[FC_{i,t-1} \times E_t^{aggr}] + \sum_{k=1}^{4} \Gamma_k^h Z_{i,t-k} + \sum_{k=1}^{4} \Omega_k^h FC_{i,t-k} \\ &+ \beta^{h,mon}[FC_{i,t-1} \times \epsilon_t^{mon}] + e_{i,t}^h, \end{aligned} \tag{10}$$

with $FC_{i,t-1}$ including the lagged values of either one of the following variables: (i) the debt-to-asset ratio, or (ii) the cash-to-asset ratio.

I report the coefficients γ^h of the interactions in Figure 9. All results on the role of leverage and firms' cash holdings for the transmission of an aggregate equity financing shock are robust to the inclusion of monetary policy shocks. Differences between the responses depicted in Figure 8 and 9 are barely present, indicating that any heterogeneous firm factor loadings on monetary policy shocks do not confound my baseline results. Figure A.10 in Appendix C shows that the same holds for the equity issuance and share price responses of the average firm.

Next, I study how the macroeconomy and in particular monetary policy endogenously respond to the positive aggregate equity financing shock. I estimate local projections using macro-level data for real capital stock, unemployment, CPI inflation, and the Fed funds rate in a two-stage least-square regression. The second stage is defined as:

$$\Delta y_{t+h} = \alpha^h + \beta^h \Delta E_t^{aggr,mv} + \sum_{k=1}^{1} \Gamma_k^h x_{t-k} + \sum_{k=1}^{1} \Psi_k^h F_{t-k} + \Upsilon^h \hat{\eta}_t^{PCA} + e_t^h, \tag{11}$$

using the equity GIV as an instrument for the aggregate equity growth rate $E_t^{aggr,mv}$. The vector x_{t-k} includes one lag of the real capital stock growth rate, change in the unemployment rate, the inflation rate, the Fed funds rate, and the real GDP growth rate.

The impulse responses shown in Figure 10 indicate that the macroeconomy expands in response to a positive aggregate equity financing shock. Five quarters after the shock, the real capital stock increases by 3.5%, the unemployment rate drops by 0.8 percentage points, and the consumer price index increases by 3.1 percentage points. As a consequence, the monetary policy maker increases the Fed funds rate endogenously by 1.6 percentage points in total before lowering the rates again. The aggregate equity financing shock can therefore be interpreted as the starting point of a capital market boom that causes firms to issue more equity (Figure 6) that eventually causes firms to increase investment, which reduces the number of unemployed in the economy, and monetary policy to become contractionary.

How much does the endogenous contractionary monetary policy response counteract the boom in the capital markets? To answer this question, I estimate the net equity issuance and share price responses and simultaneously control for the projected path of the Fed funds rate. I extend the second stage regression (8) by including the forward-looking changes in the Fed funds rate ffr_{t+j}:

$$\begin{aligned}\Delta y_{i,t+h} =& \alpha_i^h + \beta^h \Delta E_t^{aggr,mv} + \sum_{k=1}^{4} \Gamma_k^h Z_{i,t-k} + \sum_{k=1}^{4} \Psi_k^h F_{t-k} + \Upsilon^h \hat{\eta}_t^{PCA} \\ &+ \sum_{j=1}^{h} \Delta ffr_{t+j} + e_{i,t}^h. \end{aligned} \tag{12}$$

My estimation strategy follows the specification used in the literature on the isolation of the direct effects of monetary policy on e.g. household consumption by controlling for the endogenous path of household income changes (Holm et al., 2021).

In Figure 11, I report the impulse responses of equity issuance and share prices when controlling for the endogenous monetary policy responses. Firms issue relatively more equity and reduce their outstanding debt by more. The local projections indicate that the contractionary monetary policy mitigates the direct impact of the aggregate equity financing shock on firms' equity issuance over the medium- and long term. My results align with the existing literature, which shows that equity-constrained firms increase their equity issuance to a greater extent following an expansionary monetary policy shock (Almeida et al., 2024).

The three exercises in this section demonstrate that although the equity GIV is not confounded by heterogeneous factor loadings on monetary policy shocks, the policymaker responds to the equity financing shock by increasing the policy rate which in turn dampens the capital market boom.

5 Conclusion

This study provides insights into the micro origins of aggregate equity financing shocks. By applying the Granular Instrumental Variable strategy (Gabaix and Koijen, 2024) to construct an instrument for exogenous improvements in external equity financing conditions, I can shed light on the net equity issuance of small and large publicly listed firms. My results demonstrate that firms' financial conditions critically determine their response to favorable external financing conditions. In particular, financially unconstrained firms with high cash holdings and dividend-paying firms exhibit a significantly higher increase in equity issuance and a corresponding substitution of debt with equity, thereby enhancing their investment capacity. In contrast, highly leveraged firms remain reluctant to adjust their capital structure, lending support to the predictions of the leverage ratchet effect (Admati et al., 2018) and highlighting the adverse implications of debt overhang on firm investment.

My findings carry relevant policy implications. Deepening capital markets by improving aggregate external equity financing conditions can have divergent benefits across firms, depending on their underlying financial health.

Overall, the paper contributes to the literature on corporate finance and macro-financial linkages by providing robust empirical evidence that the micro origins of equity financing shocks play a significant role in shaping aggregate investment dynamics.

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A Data Appendix

A.1 Definitions of Firm-Level Variables

Table A.1: Construction of firm-level variables

Variable	Compustat Code
Assets	atq
Sales	saleq
Firms' initial capital stock	ppegtq
Capital stock	Initial capital stock + Δ ppentq
Long-term debt	dlttq
Total debt	dlcq + dlttq
Debt-ratio	(dlcq + dlttq)/atq
Cash/Total Assets	cheq/atq
Equity-issuance-to-assets (market value)	(prccq/ajex+L.prccq/L.ajex)/2*Δ (cshoq/ajex)/atq
Equity issuance growth rate (book value)	Δ (seqq - req) / (seqq - req)
Size	log(atq/CPIAUCSL)
Tobin's Q	(atq + (prccq/ajex+L.prccq/L.ajex)/2 *cshoq - ceqq + txditcq)/atq
Ebitda	saleq - cogsq - xsgaq
Interest on debt over cash-flow	xintq/Ebitda
Debt over cash-flow	Total debt/Ebitda

I use quarterly data on publicly listed firms from Compustat, available on the Wharton Research Data Services website for the firm-level analysis. I limit my sample to the period between 1984q1 and 2020q2 .

Table A.1 summarizes the construction of my firm-level variables as they appear in the Compustat dataset.

For the definition of the capital stock I used the perpetual inventory method (see among others, Ottonello and Winberry, 2020; Jeenas, 2023, for a detailed description). I take the first firm-quarter observation in Compustat's *ppegtq* variable as the initial capital stock of a firm. Then I calculate firms' firm-quarter investment as the change in variable *ppentq*, and add the investment to the previous quarter's capital stock:

$$k_{i,t+1} = k_{i,t} + ppentq_{i,t+1} - ppentq_{i,t},$$

with $k_{i,1} = ppegtq_{i,1}$ for the first firm-quarter observation.

For the definition of Tobin's Q I follow Younge and Marx (2012) and Cloyne et al. (2023) and take the sum of total outstanding shares multiplied by the average stock price of the quarter (average between closing price at the beginning of a quarter and the closing price at the end of the quarter), plus total assets minus common equity, plus deferred taxes and investment tax credit, and divide the sum by total assets. Using the difference in common shareholders' equity and assets is less data-intensive than using total liabilities and liquidation value of preferred stocks and stock dividends as done in Chung and Pruitt (1994) and Covas and Haan (2011). The correlation of both formulas in my sample is close to one. However, the latter approach of Chung and Pruitt (1994) and Covas and Haan (2011), generates 50,000 additional missing values.

Table A.2: Correlation of Firms' Financial Conditions

	Firm size	Debt-to-asset ratio	Tobin's Q	Cash-to-asset ratio	Debt-to-earnings ratio	Dividend-paying firms
	Firm size	Debt-to-asset ratio	Tobin's Q	Cash-to-asset ratio	Debt-to-earnings ratio	Dividend-paying firms
Firm size	1.00					
Debt-to-asset ratio	-0.08	1.00				
Tobin's Q	-0.22	0.21	1.00			
Cash-to-asset ratio	-0.15	-0.15	0.32	1.00		
Debt-to-earnings ratio	0.11	0.10	-0.09	-0.10	1.00	
Dividend-paying firms	0.04	0.08	-0.00	-0.07	0.02	1.00

Notes: This table summarizes key firm-level variables of US firms from the Compustat sample between 1984q1 and 2020q2 . All growth rates are reported in real terms.

A.2 Sample Selection Firm-Level Dataset

I drop the following firm-quarter observations from my firm-level sample:

1. Financial firms (SIC codes between 6000 and 6900) or utilities (SIC codes between 4900 and 4999)

2. Firms with non-positive values in one of the following characteristics:

   - non-positive capital stock
   - non-positive assets
   - negative long-term debt
   - negative current debt
   - non-positive sales
   - negative value in shareholder equity - retained earnings
   - negative interest costs

3. Drop firms with acquisitions larger 5% of assets

4. Firms with less than 40 quarters of consecutive investment spells

5. Firms with a leverage value below 0 or above 10.

6. Trim these growth rates between 0.5% and 95.5%

   - investment rate
   - sales growth rate
   - total debt growth rate
   - long-term debt growth rate
   - net equity issuance

7. Further I balance the sample by keeping only non-missing values in:

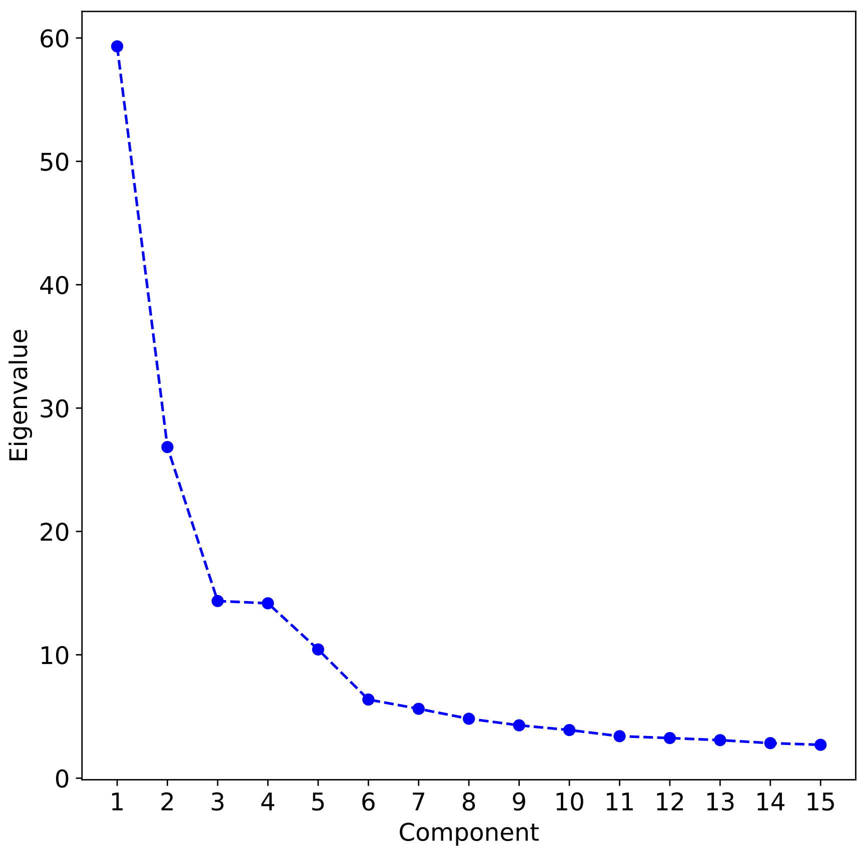
   - sales growth rate
   - investment rate
   - long-term debt growth rate

- net equity issuance
- debt ratio

The final sample thus consists of 293,621 firm-quarter observations.

A.3 Estimation of the Macroeconomic Factors

Figure A.1: Eigenvalues of Macroeconomic Factors



Notes: The figure visualizes the eigenvalues of each estimated macroeconomic component in descending order. The estimation is based on a principal component analysis using the 249 macroeconomic time series from the FRED-QD dataset as dependent variables.

This section provides additional material to the estimation of the macroeconomic factors that are used as additional control variables in the regressions in the main body of the paper.

The FRED-QD dataset includes 249 distinct macroeconomic time series, which then are dimensionally reduced to six macroeconomic factors by following McCracken and Ng (2016, 2020). The eigenvalues of the first 15 components are plotted in Figure A.1 in descending order. This scree plot can be used as an analytical tool to determine the number of relevant components. The last non-trivial factor - explaining at least one percent of the variance - that is included, is the one with the corresponding eigenvalue immediately at the end of the straight scree line Cattell (1966). Here the cut-off is at six components as depicted in Figure A.1 .

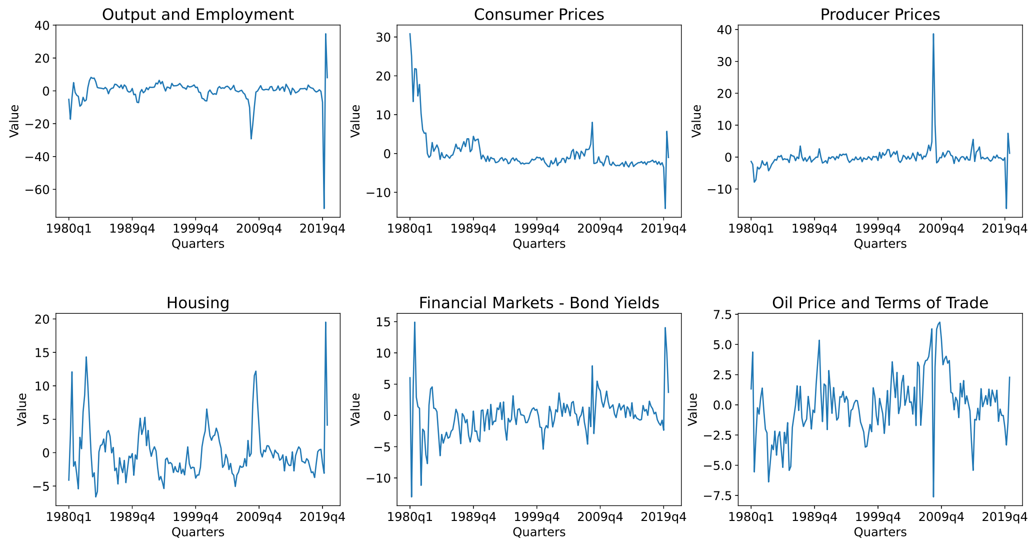
The six components explain together more than 62% of the entire volatility of the FRED-QD database. I impose economic meaning on the estimated macroeconomic components by first calculating the correlation coefficient between each individual component and the macroeconomic variables. The interpretation and the explained volatility of the six components is as follows:

1. Factor: Output and Employment (28%)
2. Factor: Consumer Prices (13%)
3. Factor: Producer Prices (7%)
4. Factor: Housing and Housing Permits (7%)
5. Factor: Financial Markets - Bond Yields (5%)
6. Factor: Oil Price and Terms of Trade (3%)

The macroeconomic factors used in the main text of the paper are plotted in figure A.2.[10]

[10] After estimating the components I switched the original sign of Factor 1 and Factor 6 for reasons of interpretability.

Figure A.2: Estimated Macroeconomic Factors



Notes: The figures plot the six estimated macroeconomic factors over time. The estimation is based on a principal component analysis using the 249 macroeconomic time series from the FRED-QD dataset as dependent variables.

B Equity Granular Instrumental Variables

This section provides additional information on estimating the equity Granular Instrumental Variable (GIV). First, in Section B.1 I visualize the granularity of the market capitalization distribution of publicly listed US companies. Section B.2 visualizes which sectors contribute the most to the variation in the equity GIV. Section B.3 visualizes the nine equity common components and discusses the estimation of the components.

B.1 Granularity of Market Capitalization

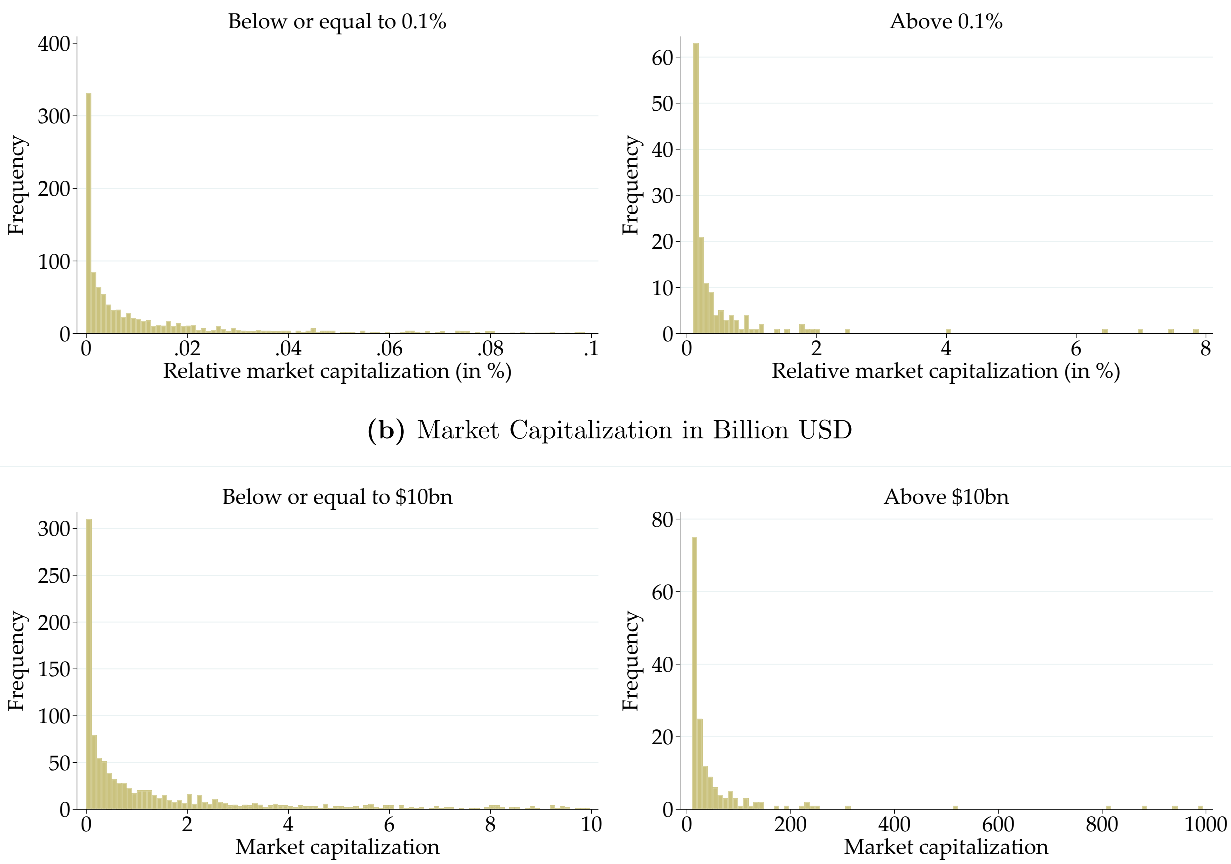
The distribution of US firms' market capitalization is highly granular. The majority of firms contribute less than one per thousand to the total aggregate market capitalization. I visualize this fact in panel (a) of Figure A.3. The graphs visualize the market capitalization of US firms in the year 2019.[11] The US firms with the highest market capitalization contribute

[11] I picked the year 2019 as the reference year because it is the most recent year for which I have observations for all four quarters.

Figure A.3: Market Capitalization of Firms in 2019

(a) Relative Market Capitalization in Percent

(b) Market Capitalization in Billion USD

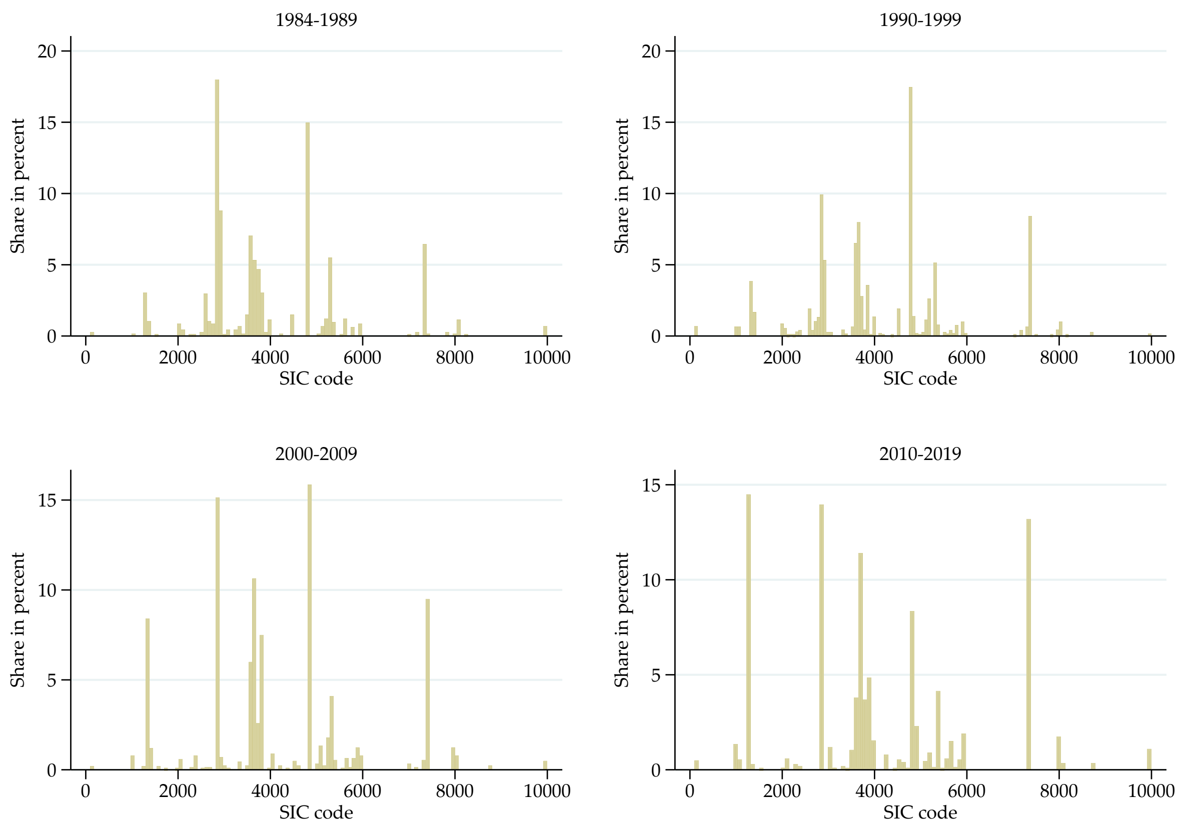


Notes: These figures depict the distribution of firms' market capitalization for the reference year 2019. The reported numbers are based on the firm-level average market capitalization in 2019. The graphs in the upper panel visualize firms' market capitalization relative to the US's aggregate market capitalization. Reported numbers in the upper panel are in percentage points. The graphs in the lower panel visualize the nominal market capitalization of US firms. Reported numbers in the lower panel are reported in billions of US dollars.

about 7% − 8% to the aggregate market capitalization.[12] These firms in the right tail of the market capitalization distribution correspond to a capitalization of 800 billion to 1 trillion US dollars, visualized in panel (b) of Figure A.3.

B.2 Contribution of Sectors to the Equity GIV

Figure A.4: Sectors With the Largest Innovations to Firm Equity Financing



Notes: These figures depict the relative number of firms with the 50 largest absolute value of size-weighted innovations to equity $\tilde{S}_{i,t-1}\hat{\epsilon}^{e}_{i,t}$ split by sectors (4-digit SIC code). Reported numbers are in percentage points.

Table A.3 links the three largest and the smallest realizations in the equity GIV series

[12]The graphs are calculated based on the Compustat sample, after excluding non-US firms, utilities, financial firms, and firms with negative values in assets, sales, or capital stock. The numbers can therefore deviate slightly from official statistics because the denominator in my sample–the total aggregate market capitalization in the US–might be underestimated.

Table A.3: Innovations to Firm Equity Around Largest and Smallest Equity GIV Values

Date	Firm	SIC Code	Firm Equity Innovations (weighted)	Equity GIV Value
1999Q3	Home Depot Inc	5211	0.32	2.29
1999Q4	Lucent Technologies Inc	7373	0.55	2.78
2000Q1	Lucent Technologies Inc	7373	-0.79	-3.49
2004Q1	Intel Corp	3674	-0.21	-2.41
2011Q3	Oracle Corp	7370	0.13	2.09
2020Q2	Amazon.Com Inc	5961	-0.25	-2.36

Notes: This table lists the companies contributing the most to the three largest equity GIV values (1997Q4, 1999Q3, and 1999Q4) and the smallest equity GIV values (1991Q2, 2008Q1, and 2012Q4).

to the US companies contributing the most to each realization. In the following, I report narrative evidence for each of the firm-specific firm equity innovations. The narrative evidence confirms that large absolute values in the size-weighted equity innovations represent real events with economic consequences that are uncorrelated with the broader economic environment and are not predictable by previous quarters' share price development, debt growth rates, or past equity issuance strategies.

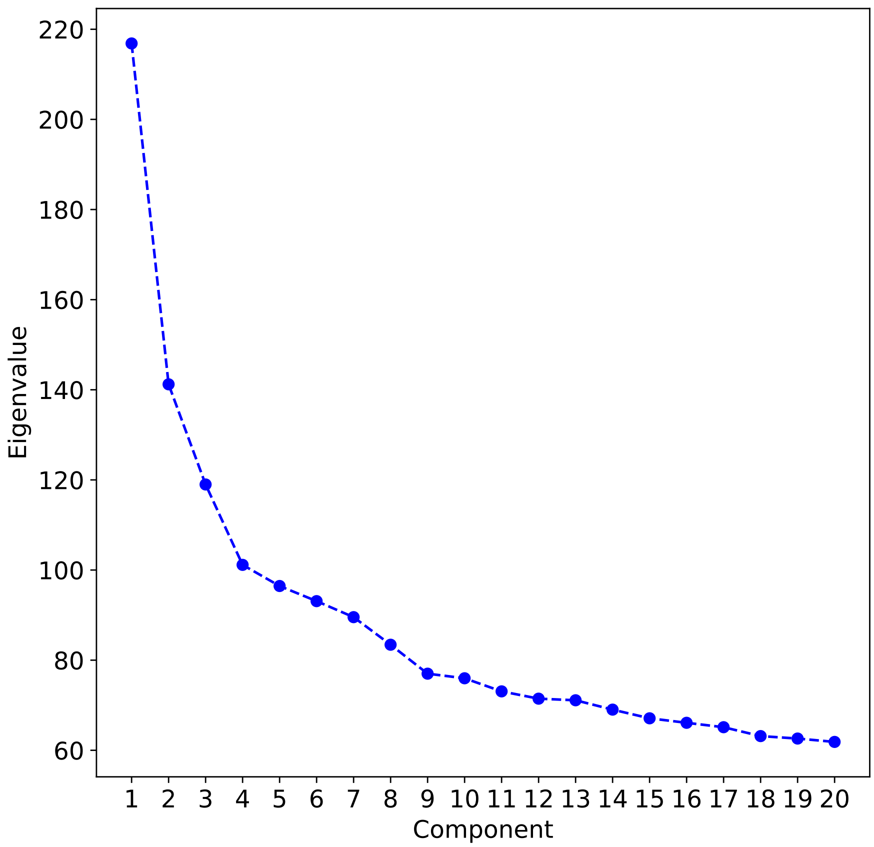
In 1997Q4 Intel issued a large amount of new equity to acquire the company Chips and Technologies. The issuance was a one-time issuance in which Intel deviated from its ongoing share repurchase program (Intel, 1997).

In 1999Q3 $661 million of convertible debt of the International Business Machines Corp. (IBM) was converted into new common shares. The issuance amounts to about $22.6 million. IBM repurchased in 1999 about $75 million in outstanding shares under its existing share buyback program (Internation Business Machines Corp., 1999). The overall reduction in net equity was lower than previously expected, accounting for a positive innovation to net equity issuance.

In 2008 Procter & Gamble repurchased shares worth $10 billion. The company previously announced in 2007 to repurchase between $8 and $10 billion in shares per year. The share repurchase in the previous year were worth $5.6 billion (Procter & Gamble Co, 2008).

In 2012 Walmart Inc. repurchased shares worth $7.6 billion.

Figure A.5: Eigenvalues of Equity Financing Components



Notes: The figure visualizes the eigenvalues of each estimated equity component in descending order. The estimation is based on the principal component analysis (6) from the main body of the paper using changes in firm-specific equity financing $\Delta E_{i,t}$ as the dependent variable.

B.3 Estimation of Equity Financing Common Components

In this section, I provide additional material to the principal component analysis (PCA) when estimating the equity financing common components. As highlighted in equation (6) from the main body of the paper, I apply the PCA on the change in firm-specific equity financing $\Delta E_{i,t}$. The PCA helps to determine common components that might drive firms' equity issuance. I have to determine the number of equity components I should include for robustness in the IV regression in the main body of the paper.

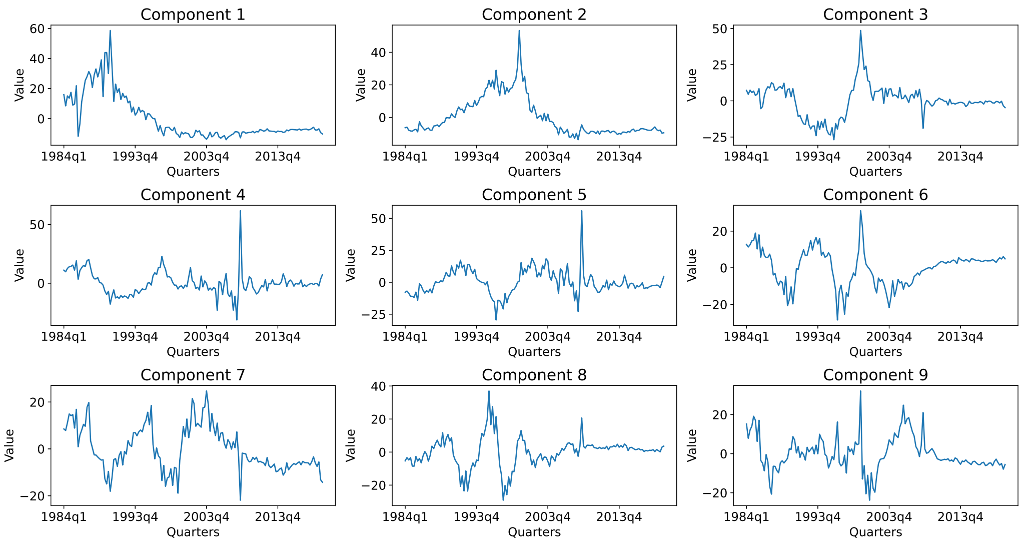
I use a so-called scree plot to determine the number of components. The scree plot is visualized in Figure A.5. The figure depicts the eigenvalues for each component in descending order. Cattell (1966) established a criterion for selecting the number of relevant components, that became later standard in statistics and machine learning: The last non-trivial factor (that explains at least 1% of the variance) included, is that immediately at the end of the straight scree line. The scree plot A.5 depicts a kink at component nine, implying that the number of selected components should be nine in my application. The nine equity components are plotted in figure A.6.

I report the correlation between the estimated equity common components $\eta_t^{1,PCA}$ to $\eta_t^{9,PCA}$ and constructed Granular Instrumental Variable for the aggregate equity financing shock in Table A.4. The correlation between the equity GIV and the nine equity common components is either close to zero or weak. In Section C of the appendix, I test the robustness of firm-level responses to an aggregate equity financing shock when excluding the principal components from the right-hand side of the regression equation.

Table A.4: Correlation Between Equity GIV and the Nine Estimated Equity Components

	$\hat{\eta}_t^{pca,1}$	$\hat{\eta}_t^{pca,2}$	$\hat{\eta}_t^{pca,3}$	$\hat{\eta}_t^{pca,4}$	$\hat{\eta}_t^{pca,5}$	$\hat{\eta}_t^{pca,6}$	$\hat{\eta}_t^{pca,7}$	$\hat{\eta}_t^{pca,8}$	$\hat{\eta}_t^{pca,9}$
$\hat{u}_t^{e,GIV}$	0.07	0.33	-0.01	0.07	-0.06	0.10	-0.16	-0.11	-0.02

Figure A.6: Estimated Equity Common Components



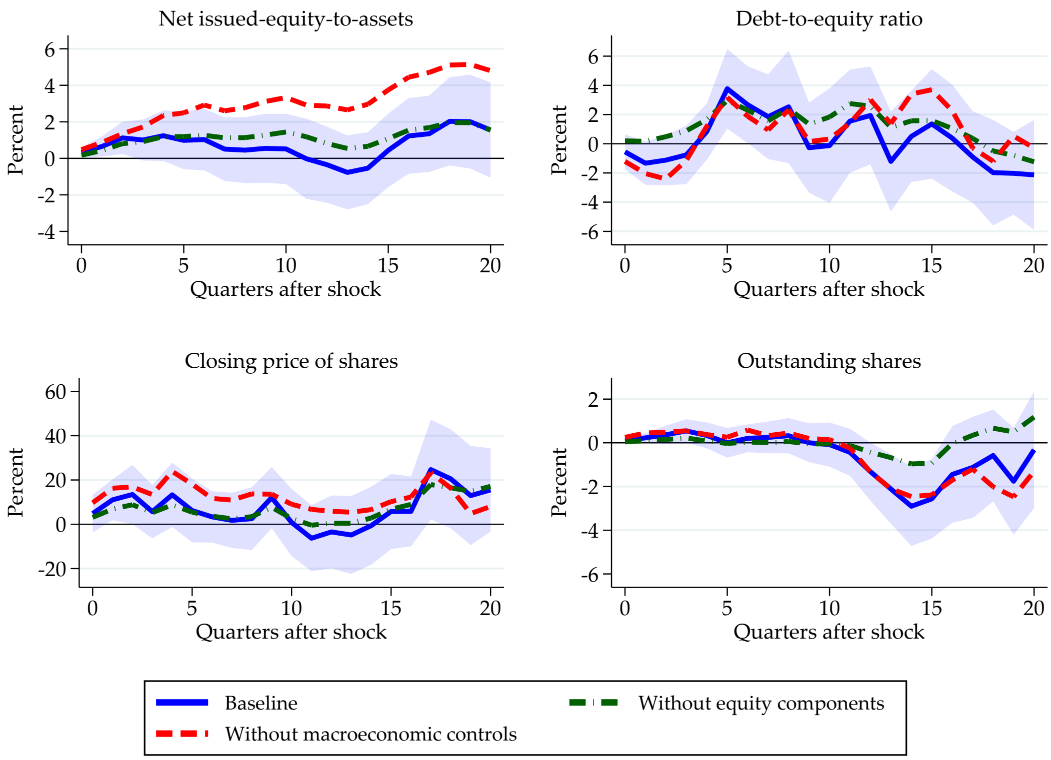
Notes: The figures plot the estimated common equity components over time. The estimation is based on the principal component analysis (6) from the main body of the paper using changes in firm-specific equity financing $\Delta E_{i,t}$ as the dependent variable.

C Robustness: The Equity Issuance of the Average Firm

In this section, I investigate the robustness of the firm-level equity responses, visualized in Section 4.1 in the main body of the paper, to the aggregate equity financing shock. In the first exercise, I estimate the local projections described in regression equation (8) but exclude the estimated equity financing common components $\hat{\eta}_t^{PCA}$ from the right hand side of the equation. Including the equity financing common components in my baseline regression allows me to control for heterogeneous factor loadings on the common components η_t that might violate the exogeneity assumption of the GIV $\mathbf{E}[u_t^{e,giv}\eta_t] = 0$. In a second exercise, I remove the macroeconomic controls F_{t-k} from the regression equation (8).

As depicted in Figure A.7, the responses of net issued equity, the debt-to-equity ratio, the firm share prices, and the number of outstanding shares are all robust to the exclusion the equity common components (green dotted-dashed lines) and the exclusion of the macroeconomic controls (red dashed lines). All responses but the responses of net issued equity on the long horizon lie within the 95% confidence bands. Omitting the equity common components

Figure A.7: Equity Issuance and Share Price Responses to a Positive Aggregate Equity Financing Shock–Role of Macroeconomic Controls and Equity Components



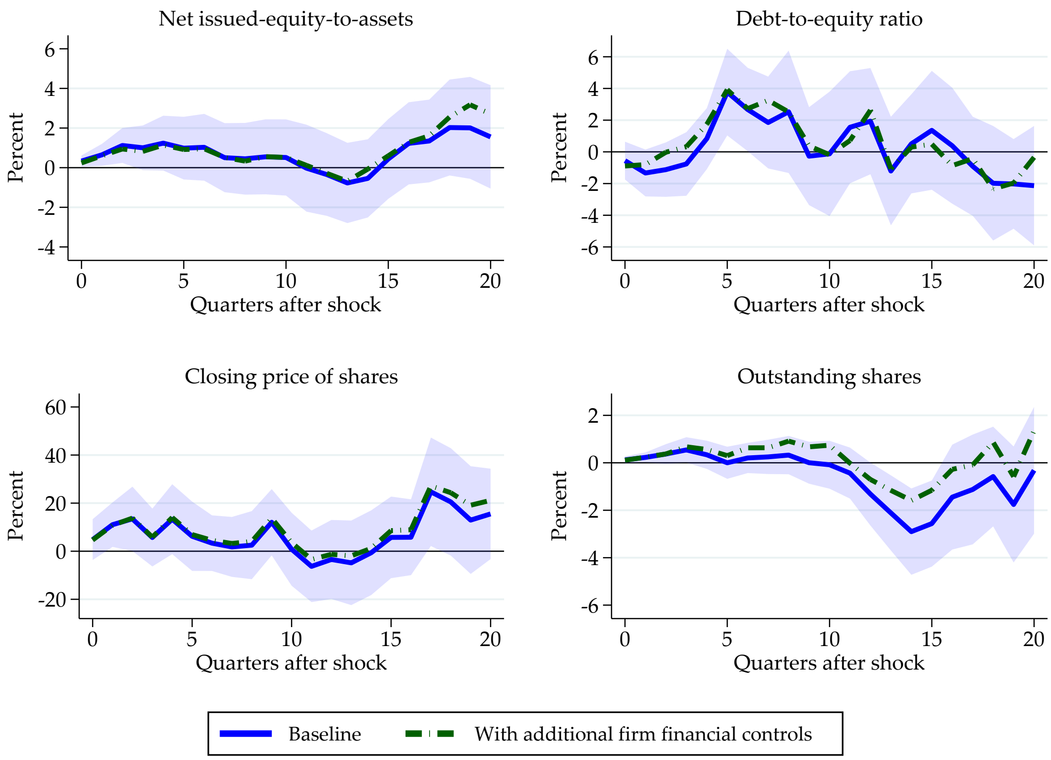
Notes: These figures depict the local projections of firm-level net issued equity, the debt-to-shareholder-equity ratio, the share prices, and the outstanding number of shares to a one standard deviation positive aggregate equity financing shock. The local projections are based on regression equation (8) and I probe for robustness by (i) excluding the estimated equity common components (green dotted-dashed lines) and (ii) excluding the macroeconomic controls from the regression. The blue solid lines visualize the baseline response from the main body of the paper. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

would slightly underestimate the magnitude of firms' equity and share price responses to an aggregate equity financing shock. Excluding the macroeconomic controls from the regression slightly overestimates the magnitude of net issued equity and share prices.

In a third exercise, I probe for robustness by including additional firm-level financial controls in the regression equation (8). I add four lags of the following variables to the vector $Z_{i,t-k}$: (i) firm size, (ii) the cash-to-asset ratio, (iii) the debt-to-earnings ratio, and (iv) an indicator for whether firms pay dividends.

I show in Figure A.8 that the responses of net issued equity, the debt-to-equity ratio, firm share prices, and the number of outstanding shares are all robust to the inclusion of the

Figure A.8: Equity Issuance and Share Price Responses to a Positive Aggregate Equity Financing Shock–Additional Firm Controls

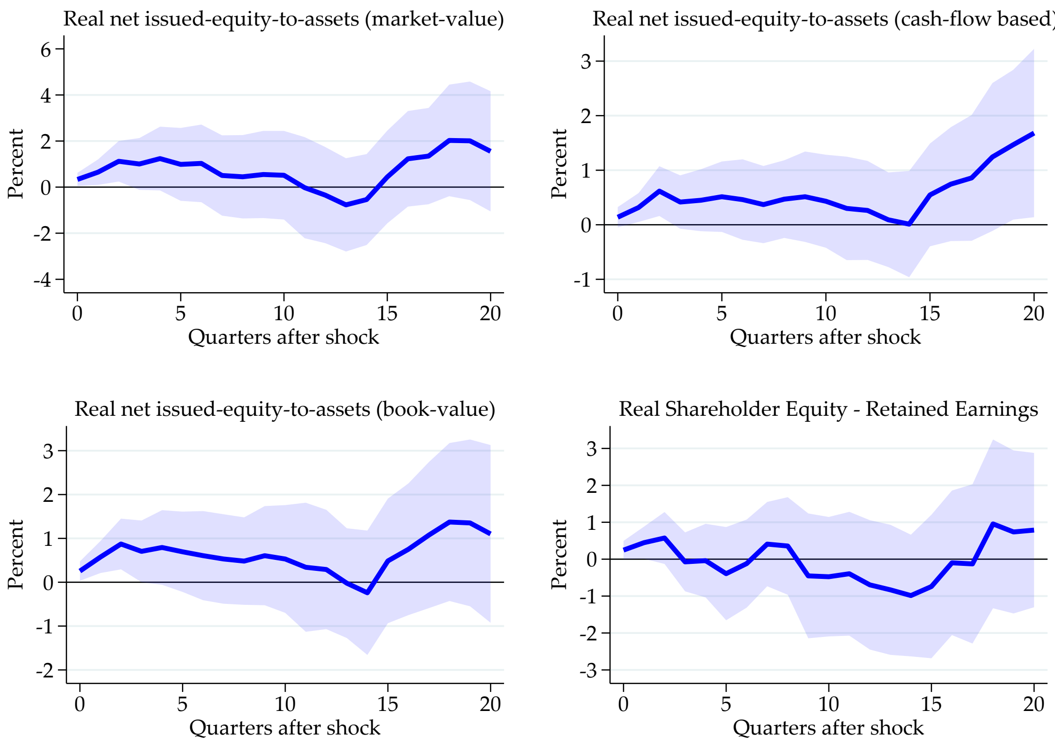


Notes: These figures depict the local projections of firm-level net issued equity, the debt-to-shareholder-equity ratio, the share prices, and the outstanding number of shares toa one standard deviation positive external equity shock. The local projections are based on regression equation (8) and I probe for robustness by including the following firm-level financial controls to the regression: (i) firm size, (ii) the cash-to-asset ratio, (iii) the debt-to-earnings ratio, and (iv) an indicator for whether firms pay dividends. The blue solid lines visualize the baseline response from the main body of the paper. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

four financial controls. The deviations from the baseline responses from the main body of the paper are only marginal.

In the fourth exercise, I estimate the responses of alternative measures for firms' net equity issuance to the aggregate equity financing shock. Fama and French (2005) measures external equity financing of firms in Compustat in two ways: (i) change in shareholders equity - change in retained earnings and (ii) the change in outstanding shares multiplied by the average closing price of shares between both periods. In the following, I label the first equity variable the book-value measure and the second variable the market-based measure. Alter-

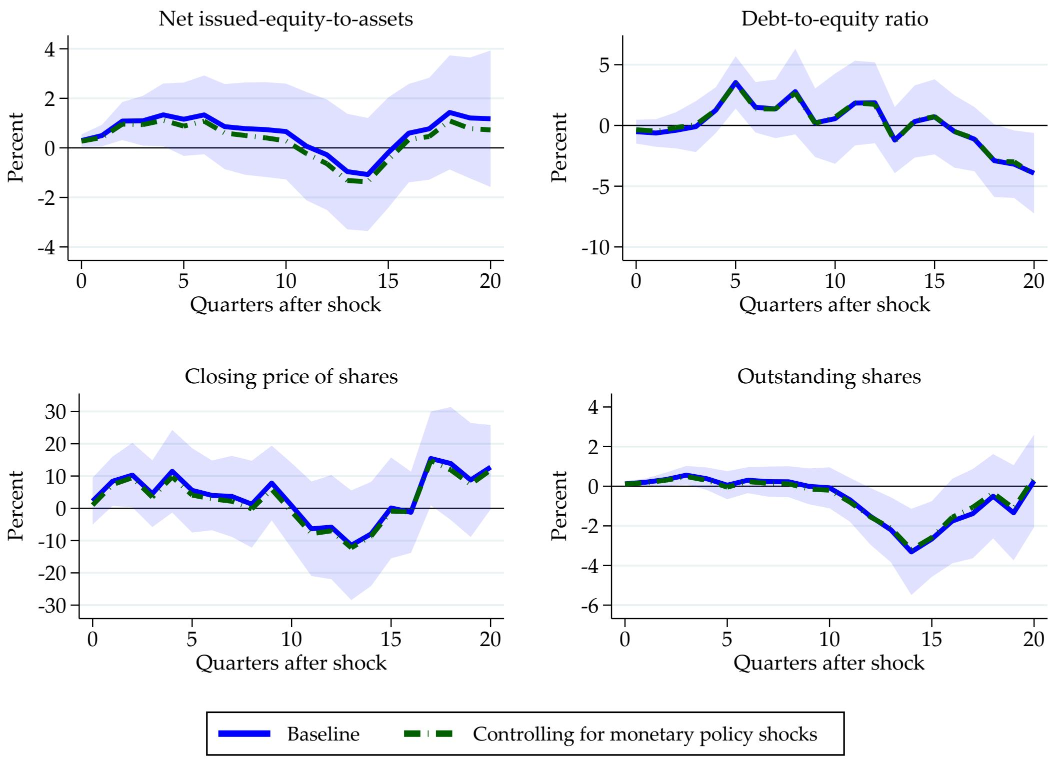
Figure A.9: Equity Responses to a Positive Aggregate Equity Financing Shock Using Alternative Equity Issuance Measures



Notes: These figures depict the local projections of net issued equity issuance to a one standard deviation positive aggregate equity financing shock. I plot the responses for the following four different external equity issuance variables: (i) the real net issued-equity-to-asset ratio using the market-value approach, (ii) the real net issued-equity-to-asset ratio using the cash-flow-based approach, (iii) the real net issued-equity-to-asset ratio using the book-value approach, and (iv) the log-difference between real shareholder equity and real retained earnings (approximating the real growth rate of external equity financing). The local projections are based on regression equation (8). The blue solid lines visualize the baseline response from the main body of the paper. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

natively, one can measure the net equity issuance of Compustat firms by using the cash-flow differences between net stock sales and net stock purchases(Jermann and Quadrini, 2012; Begenau and Salomao, 2018). I call this variable the cash-flow based external equity issuance measure. Based on regression equation (8), I estimate the local projections for the following four different external equity issuance variables: (i) the real issued-equity-to-asset ratio using the market-value approach, (ii) the real issued-equity-to-asset ratio using the cash-flow-based approach, (iii) the real issued-equity-to-asset ratio using the book-value approach, and (iv)

Figure A.10: Equity Responses to a Positive Aggregate Equity Financing Shock–Controlling for Monetary Policy Shocks



Notes: These figures depict the local projections of firm-level net issued equity, the debt-to-shareholder-equity ratio, the share prices, and the outstanding number of shares toa one standard deviation positive aggregate equity financing shock. The local projections are based on regression equation (8) and I probe for robustness by controlling for monetary policy shocks ϵ_t^{mon} from Bauer and Swanson (2023). The blue solid lines visualize the baseline response from the main body of the paper. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

the log-difference between real shareholder equity and real retained earnings (approximating the real growth rate of external equity financing).

Figure A.9 reports the responses of the four equity issuance variables to a one standard deviation positive aggregate equity financing shock. I observe a significant increase in net issued equity in the first quarters for all four variables. The magnitude of net issued equity within the first year ranges between 0.6 and 1.2 percentage points.

In another exercise, I control for monetary policy shocks. The monetary policy shocks of Bauer and Swanson (2023) covering the period between 1988q1 and 2020q2 are added to the regression equation (8). By doing so, I test whether my baseline results are confounded by any heterogeneous firm factor loadings on monetary policy shocks. The depicted responses in Figure A.10 are unchanged when controlling for monetary policy shocks. I conclude that the constructed equity GIV that I use as an instrument for the aggregate equity financing shocks is orthogonal to monetary policy shocks.

D Robustness: Which Type of Firm Issues More Equity?

In this section, I discuss the robustness of the estimated marginal effects of the six financial constraint proxies discussed in Section 4.2 of the main body of the paper. First, I jointly estimate the marginal effects of the six interaction terms in the same regression. In addition, I control for sector-time (quarters) fixed effects. Sector-time fixed effects allow me to control for macroeconomic confounding factors, e.g. aggregate US-wide shocks, and for time-varying sector-specific confounding variables. More specifically, I estimate the following local projections:

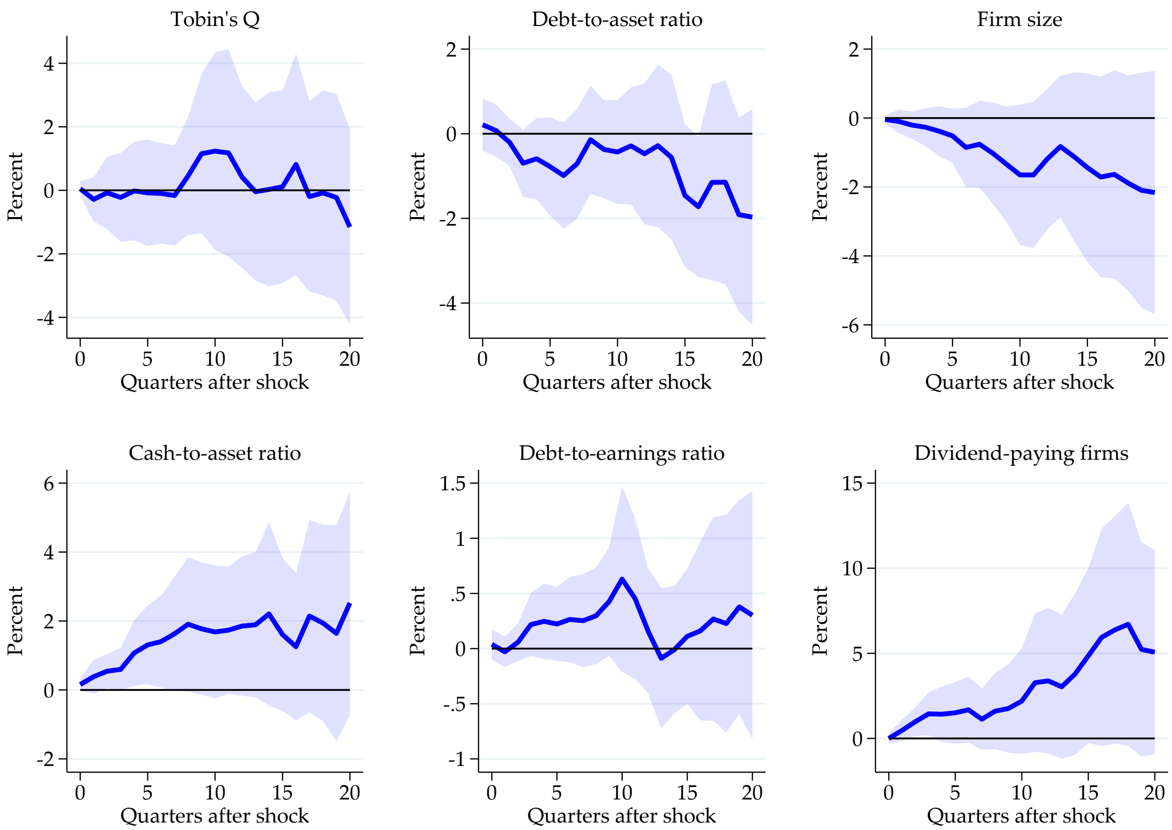
$$\begin{aligned}\Delta y_{i,t+h} =& \alpha_i^h + \nu_{st}^h + \beta^h \Delta E_t^{aggr} + \gamma^{h,joint}[\mathbf{FC}_{i,t-1} \times E_t^{aggr}] + \sum_{k=1}^{4} \Gamma_k^h Z_{i,t-k} + \sum_{k=1}^{4} \Psi_k^h F_{t-k} \\ &+ \Upsilon^h \hat{\eta}_t^{PCA} + \sum_{k=1}^{4} \Omega_k^h FC_{i,t-k} + e_{i,t}^h, \end{aligned} \tag{A.1}$$

with ν_{st}^h denoting sector-quarter fixed effects and $\mathbf{FC}_{i,t-1}$ denoting a vector including the following six financial constraint proxies: (i) Tobin's Q, (ii) the debt ratio, (iii) firm size, (iv) the cash-to-asset ratio, (v) the debt-to-earnings ratio, and (vi) an indicator for whether firms pay dividends. Several of the financial constraint proxies are correlated as highlighted in Table A.2. By estimating the coefficients of all six interaction terms jointly, I control for these correlations. [13]

Figure A.11 also proves that the marginal effects of the six interaction terms barely change compared to the baseline results in the main body of the paper. Only dividend-paying firms or firms with a high level of cash holdings issue significantly more net equity following the aggregate positive equity financing shock. Highly leveraged firms instead issue less external equity than the average firm in response to the equity financing shock. The same holds for large companies but the effect is less significant.

[13] Cao et al. (2023) uses a similar approach when studying the role of different dimensions of firm heterogeneity for the transmission of monetary policy on firm investment.

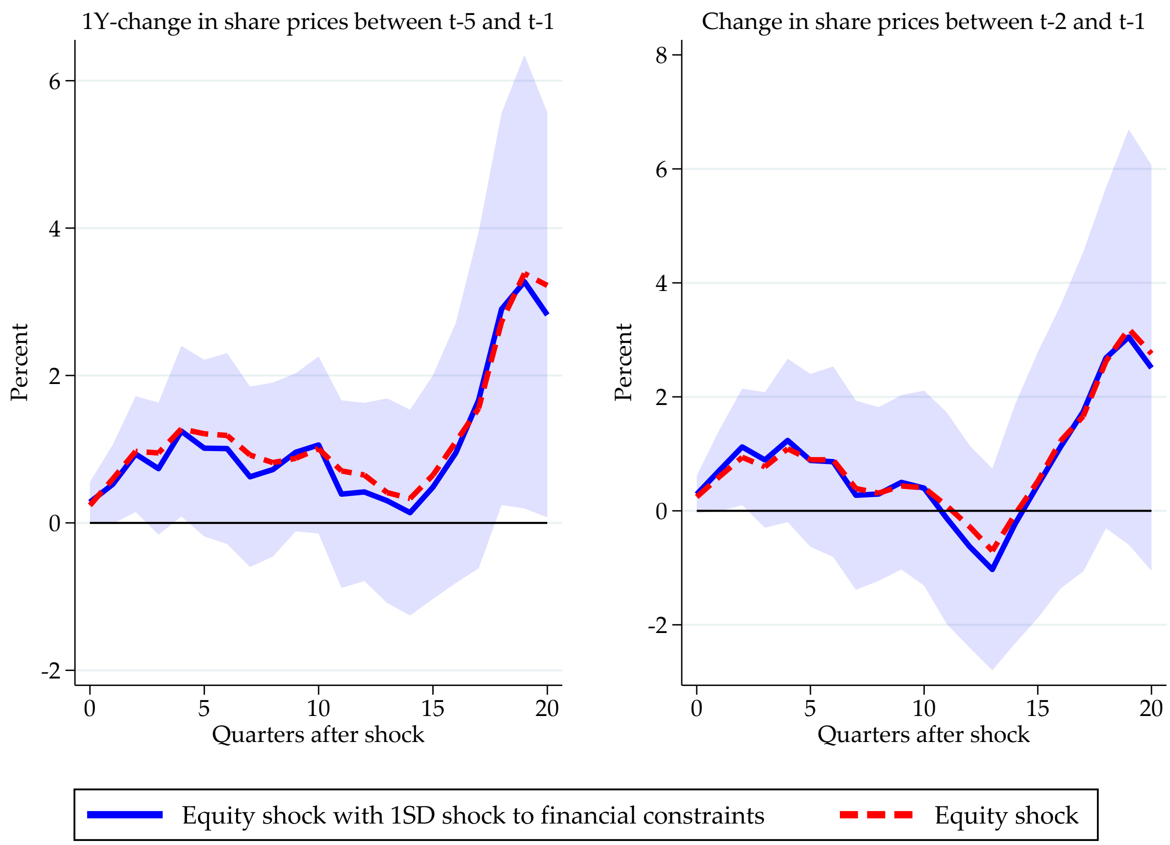
Figure A.11: Firm Equity Issuance and Financial Constraints–Jointly Estimated



Notes: The figures visualize the marginal effects of financial constraints on the firm-level net issued equity responses toa one standard deviation positive aggregate equity financing shock. The blue lines depict the vector of coefficients $\gamma^{h,joint}$ from regression (A.1) when controlling for quarter-sector fixed effects and jointly estimating the marginal effects of the following financial constraint proxies: (i) Tobin's Q, (ii) the debt ratio, (iii) firm size, (iv) the cash-to-asset ratio, (v) the debt-to-earnings ratio, and (vi) an indicator for whether firms pay dividends. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

Next, I study whether past increases in firms' share prices cause a significantly higher level of net equity issuance in response to the aggregate equity financing shock. Firms often time the capital markets when deciding to issue or repurchase equity (Ma, 2019). Firms increase their net equity issuance when their share prices are relatively high (see among others, Asquith and Mullins Jr, 1986; Jung et al., 1996; Baker and Wurgler, 2002; Dittmar and Thakor, 2007; Ma, 2019). I study the role of previous increases in firms' share prices for the responses to the aggregate equity financing shock by interacting lagged changes in share price with the aggregate shock. The estimated local projections follow the regression

Figure A.12: The Role of Past Share Prices for Firms' Equity Issuance Responses



Notes: The figures visualize the marginal effects of past firm-level share price changes on the firm-level net issued equity responses toa one standard deviation positive aggregate equity financing shock. The estimations are based on a modified version of the regression equation (9) by including quarterly time-sector fixed effects: $\Delta y_{i,t+h} = \alpha_i^h + \nu_{st}^h + \gamma^h[\Delta_j Price_{i,t-1}^{SharesOut} \times E_t^{aggr}] + \sum_{k=1}^4 \Gamma_k^h Z_{i,t-k} + \sum_{k=1}^4 \Omega_k^h \Delta Price_{i,t-k}^{SharesOut} + e_{i,t}^h$, with $j = \{1, 4\}$. The variable $\Delta_j Price_{i,t-1}^{SharesOut}$ measures the change in firms' share prices between period $t-j$ and period t. The blue lines depict the response in net issued equity to the aggregate equity financing shock for firms with one standard deviation higher level in one of the following measures: (i) the change in firm share prices between period $t-5$ and period $t-1$, and (ii) the change in firm share prices between period $t-2$ and period $t-1$. The blue shaded area reports the 95% confidence interval using Driscoll and Kraay (1998) standard errors. Reported numbers are in percentage points.

specification outlined in equation (9). I use two different measures for the changes in the price of shares for the interaction terms: (i) the change in the price of shares over one year between period $t-5$ and period $t-1$ and (ii) the lagged change in the previous quarter from period $t-2$ to period $t-1$.

The responses shown in Figure A.12 show no difference in net equity issuance in response to the aggregate equity financing shock when firms experience a one standard deviation higher increase in their past share prices. My results indicate that firms without previously increasing share prices benefit in the same way from the aggregate equity financing shock as firms with increasing share prices. This is evidence that firms cannot time a positive realization of the aggregate equity financing shock. Consequently, the exogeneity assumption of the Granular Instrumental Variable is not violated. If an economy-wide peak in share prices could predict a positive value in the GIV equity financing shock series, the instrument would no longer be exogenous to firms' fundamentals.