Public Debt and Private Investment: The Role of Firm Leverage*

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Abstract

This paper shows that financial heterogeneity matters in firms' investment responses to rising public debt. We provide novel empirical evidence that higher public debt leads to lower investment for low-leveraged firms rather than high-leveraged firms. Low-leverage firms also have significantly lower profitability after government debt rises, while public debt does not predict excess returns across leverage-sorted portfolios. We rationalize our empirical findings in a heterogeneous firm model in which public debt drives the tax rate, the price of capital, and the discount rate. In the calibrated model, fiscal policy weakens cash flows of low-leverage firms more because they have higher growth opportunities. As they have a larger movement in the marginal benefit curve relative to marginal costs, low-leveraged firms are more responsive to rising public debt. Our results underline that heterogeneous investment responses are shaped by a cash flow channel of fiscal policy distinct from the standard discount rate mechanism.

Keywords: Fiscal Policy, Debt to GDP, , Financial Leverage, Investment

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1 Introduction

On May 16, 2025, Moody's Ratings downgraded the creditworthiness of U.S. Treasuries from Aaa to Aa1, citing "the increase over more than a decade in government debt and interest payment ratios to levels that are significantly higher than similarly rated sovereigns". This move means the U.S. government debt no longer holds perfect ratings across the three major credit rating agencies.[1] Economists are left to wonder about the impact of growing public debt on future economic activity as government debt plays a crucial role in capital accumulation, particularly through crowding out the private investment (Fisher, 1933, Diamond, 1965, Friedman, 1978). With U.S. debt-to-GDP reaching 122% by the end of 2024, understanding how public debt shapes private investment has become increasingly vital. This paper contributes to this debate by examining whether financial heterogeneity matters in firm investment responses to changes in government debt.

Financial leverage is a natural key factor in determining how firms shape their investment decisions. However, ex-ante, it is unclear if high or low leverage firms would be more affected by changes in government debt. On the one hand, high leverage firms are more sensitive to interest rate fluctuations (e.g., Croce, Kung, Nguyen, and Schmid, 2012). A positive debt shock can drive up borrowing rates, making default more likely while leading to lower investment. On the other hand, low-leverage firms are likely to be relatively young firms with more growth opportunities. (e.g., Gomes and Schmid, 2010, Gomes and Schmid, 2021). If a positive debt shock causes future cash flow growth to decline, low-leverage firms may have to disinvest more.

In this paper, we show that firm leverage matters for the investment response to fiscal policy, both empirically and theoretically. On the empirical front, we provide novel evidence that heterogeneity in firm leverage is an important determinant of the semi-elasticity of investment to changes in government debt (measured by the change in debt-to-GDP ratio, $\Delta DGDP$ in short). Crucially, low-leverage firms drive these het-

[1] S&P lowered the credit rating for U.S. debt in 2011, and Fitch Ratings downgraded it in 2023.

erogeneous responses, disinvesting more than other firms when government debt increases. The fact that low-leverage firms, rather than highly leveraged ones, are more responsive to $\Delta DGDP$ is hard to reconcile from the perspective of firms' financing through interest rates, suggesting an alternative explanation. We propose a cash flow channel of fiscal policy, demonstrating that a higher $\Delta DGDP$ predicts weaker cash flows for low-leverage firms over a one-year horizon. By contrast, we do not find evidence supporting a risk premium channel (e.g., Croce, Nguyen, Raymond, and Schmid, 2019) as $\Delta DGDP$ does not predict return in leverage-sorted portfolios over the same horizon.

To rationalize our empirical findings, we build a model of heterogeneous firms with financial frictions and analyze the effect of fiscal policy. In the model, higher government debt raises expected taxation, reducing firms' expected cash flows and, in turn, depressing investment. Lower investment costs—due to a reduced price of capital—and higher interest savings - due to an increased discount rate - partly offset this negative cash flow effect. In our calibrated model, as in the data, fiscal policy predicts lower cash flows for low-leverage firms because they are the firms with higher growth options. As such, they load up more on the cash flow channel and hence cut investment more following a rise in government debt. By contrast, high-leverage firms are less exposed to the cash flow channel, while they also benefit more from lower investment costs and higher interest savings given their higher credit spreads. As a result, they are less responsive to fiscal policy.

Our empirical analysis begins by showing that the impact of $\Delta DGDP$ on firms' investment depends on their leverage levels. We find that the semi-elasticity of investment with respect to the interaction between firm leverage and $\Delta DGDP$ is significantly *positive*, amounting to roughly 13% of average quarterly investment in response to a one standard deviation (around 1.3%) increase in government debt. Additionally, panel local projections reveal that this investment responsiveness persists for up to three years after a change in government debt. These findings are robust to controlling for permanent differences across firms, differences in cyclical sensitivities across firms,

past capital growth of firms, and other firm-level covariates and fiscal policy interactions. Our results also hold when we replace $\Delta DGDP$ with an alternative measure of government debt shock from a recursive vector autoregression (VAR) in empirical analysis. In separate regressions for high and low-leverage (terciles) firms, we demonstrate that low-leverage firms cut investment following a rise in government debt. In contrast, high-leverage firms' investment response to $\Delta DGDP$ is muted (statistically not different from zero). Government debt crowds out corporate investment primarily through its effect on low-leverage firms.

To identify the exogenous effect of fiscal policy, we employ an instrumental variable approach. Specifically, we conduct a two-stage least squares (2SLS) analysis, instrumenting $\Delta DGDP$ with the changes in the federal debt held by foreign investors. Since international investors globally favor U.S. Treasury securities, we interpret this instrument as a demand shock to U.S. Treasuries that is exogenous to the investment activity of domestic firms. The 2SLS results show that investment response to changes in government debt driven by foreign investor demand depends on financial leverage. Consistent with previous findings, low-leverage firms disinvest more when demand-driven government debt increases.

We investigate the economic mechanism behind the heterogeneous investment responses by examining four key channels through which fiscal policy may operate: cash flow, discount rates, default risk, and debt maturity. First, we show that $\Delta DGDP$ predicts future cash flows, measured by return on assets (ROA), differently for low vs. high-leverage firms. In particular, an increase in government debt is associated with weaker cash flows for low-leverage firms over short horizons (up to four quarters) compared to other firms, supporting a cash flow channel of fiscal policy. In contrast, we find no evidence that $\Delta DGDP$ predicts differential expected returns (i.e., cost of capital) for leverage-sorted portfolios within the same forecast window. Those results suggest that a risk premium channel (e.g., Croce, Nguyen, Raymond, and Schmid, 2019) is an unlikely explanation for the observed heterogeneity in investment responses.

Given their natural connection to firm leverage, we also examine whether a firm's default risk or debt maturity contributes to the heterogeneous investment responses to fiscal policy. First, we show that our baseline results remain robust when we control for either Moody's "distance-to-default" (DD) measure or the financial constraint index from Whited and Wu (2006) in our panel regressions. Second, we find that the heterogeneous investment responses are primarily driven by short-term, rather than long-term, leverage. Our findings suggest that mechanisms dependent on long-term debt, such as debt overhang, debt stickiness (e.g., Gomes, Jermann, and Schmid, 2016), or floating rate liabilities (e.g., Gürkaynak, Karasoy-Can, and Lee, 2022), are unlikely to explain our empirical findings. Overall, our results emphasize the dominant role of the cash flow channel, which outweighs other potential drivers of investment responses.

To interpret our empirical results, we develop a general equilibrium model with heterogeneous firms and a fiscal rule for government spending and debt that drives the dynamics of tax rates. Firms with idiosyncratic productivity invest in capital using either internal funds or external borrowing, and they are subject to default. The government finances its spending by raising taxes on corporate profits and issuing debt, following a fiscal rule that helps tax smoothing. For simplicity, the fiscal rule is modeled separately from the investment side of the economy in the spirit of Schmitt-Grohé and Uribe (2007) and Fernández-Villaverde, Guerrón-Quintana, Kuester, and Rubio-Ramírez (2015), linking the fiscal block to the heterogeneous firm environment only through the tax rate. Fiscal policy determines the dynamics of corporate tax rates, thus impacting firms' internal cash flows and associated investments. Fiscal policy also impacts aggregate prices, such as the relative price of capital and the real rate, through general equilibrium. We calibrate the model and verify that its steady-state behavior matches the key features of the data. In the calibrated model, as in the data, firms with low leverage have higher growth options (i.e., Tobin's q) and higher levels of investment (i.e., capital growth). Those model features are crucial for rationalizing how government debt impacts investment in the cross-section.

Ultimately, the firm's investment response is determined by equating marginal ben-

efit to marginal cost. In equilibrium, for the investment rate to decline, the marginal benefit curve has to shift down, or the marginal cost curve has to shift up. In the model, fiscal policy drives a firm's marginal benefit and marginal cost of investment directly through the tax rate, and through its general equilibrium effect on the relative price of capital, q, and the real interest rate. An expansionary debt-to-GDP shock induces a higher tax rate and a lower q. Higher tax rate lowers the firm's cash flow on the benefit side for both high- and low-leverage firms. At the same time, a lower relative price of capital decreases the firm's net worth because the value of undepreciated capital falls, leading to a lower marginal benefit of investment. On the marginal cost side, a lower q makes investing in the extra unit of capital cheaper. However, this effect is amplified for highly levered firms because they have a higher interest rate spread that serves as a multiplier on q relative to low-leveraged firms. In our calibrated model, as in the data, low-leveraged firms have higher responsiveness in marginal benefit (i.e., cash flows) because they have higher investment rates and Tobin's Q. As a result, low-leveraged firms have greater investment sensitivity in the calibrated model due to the larger movement in their marginal benefit curve.

We quantitatively analyze our model by simulating an economy with a panel of firms and replicating the empirical exercises from our analysis. The model successfully generates the observed investment responses to fiscal policy for both high- and low-leverage firms. Consistent with the data, low-leverage firms reduce investment following a rise in government debt. The model also reproduces the cash flow predictability across heterogeneous firms in response to fiscal policy, where rising government debt leads to negative cash flows for low-leverage firms, underscoring the significance of the cash flow channel in driving investment effects. Furthermore, we compare our baseline model with two counterfactual economies that shut down either the cash flow or the interest rate channel. Our counterfactual analysis reveals that removing the interest rate channel leads to minimal impact on the investment responses of firms. In contrast, shutting down the cash flow channel reverses our baseline results, leading to positive investment responses for both high- and low-leveraged firms.

Overall, those findings highlight the critical role of the cash flow channel in explaining the heterogeneous investment reactions to fiscal policy.

Related Literature: Our paper contributes to three strands of the literature. First, our paper belongs to a growing body of literature exploring the effects of fiscal policy on economic activity (e.g., Gomes, Michaelides, and Polkovnichenko, 2013, Croce, Kung, Nguyen, and Schmid, 2012, Born and Pfeifer, 2014, Fernández-Villaverde, Guerrón-Quintana, Kuester, and Rubio-Ramírez, 2015, Gomes, Jermann, and Schmid, 2016, Bianchi, Faccini, and Melosi, 2023). We contribute to this literature by focusing on the cross-sectional impact of the changes in government debt on corporate decisions, namely corporate investment, both empirically and theoretically. We document that the crowding-out effect of government debt on corporate investment is primarily driven by low-leverage firms. Several studies focus mainly on how fiscal policy affects asset prices through its impact on the cost of capital and risk premia (e.g., Belo, Gala, and Li, 2013, Belo and Yu, 2013, Croce, Nguyen, Raymond, and Schmid, 2019, Liu, 2023). By contrast, we emphasize a cash flow channel that leads to an investment response without a significant role of cost of capital and risk premia. As such, our model deliberately features a simple log utility to rationalize the empirical evidence; hence, it differs from a class of models that emphasize the long-run growth risks due to fiscal uncertainty (e.g., Croce, Kung, Nguyen, and Schmid, 2012, Croce, Nguyen, Raymond, and Schmid, 2019, Croce, Nguyen, and Raymond, 2021, Liu, Schmid, and Yaron, 2020).

Second, our paper also relates to the literature that connects leverage and investment dynamics across firms. (e.g., Lang, Ofek, and Stulz, 1996, Tsyplakov, 2008, Ozdagli, 2012). We contribute to this literature by highlighting that the investment policy of low-leverage firms is more exposed to fiscal policy due to their cash flow risk. Our structural argument builds on Gomes and Schmid (2010) in emphasizing that financial leverage captures the maturity and growth opportunities of a firm in addition to its financial risks. Our model emphasizes a cash flow channel of fiscal policy in contrast to studies that feature a key role of credit risk in investment responses to aggregate

shocks (e.g., Ottonello and Winberry, 2020, Gomes and Schmid, 2021)

Lastly, our paper also expands on the literature on the importance of firm heterogeneity for the transmission of government policy, such as monetary and fiscal policy. While a large literature explores the effect of monetary policy, only a few studies focus on fiscal policy, such as Cohen, Coval, and Malloy (2011) and Kim and Nguyen (2020). Those studies primarily examine the impact of government spending, while our work exploits the change in government debt to assess the transmission of fiscal policy and focus solely on financial leverage. Moreover, unlike those studies, we provide a quantitative model to characterize a plausible mechanism that rationalizes the empirical findings. Our modeling approach borrows from the recent monetary policy literature on heterogeneous-firm models of monetary policy literature, such as Ottonello and Winberry (2020). We achieve parsimony in the model by keeping fiscal and heterogeneous firms separate in the spirit of Schmitt-Grohé and Uribe (2007) and Fernández-Villaverde, Guerrón-Quintana, Kuester, and Rubio-Ramírez (2015).

The paper is organized as follows. In Section 2, we describe the data and present empirical results on heterogeneous responses to government debt and possible mechanisms. In Section 3, we describe the model. In Section 5, we provide details on the quantitative analysis of the model, including calibration and the simulation results. Section 6 concludes.

2 Empirical Results

The standard theory suggests that an increase in public debt crowds out aggregate private investment (Fisher, 1933, Diamond, 1965, Friedman, 1978). In this section, we explore whether financial leverage matters in how firm investment responds to changes in government debt to GDP ratio ($\Delta DGDP$). We first use panel data regressions to document that the response of firms' capital growth to changes in government debt depends on firm leverage. We then employ dummy variables for low-leverage firms to underline that the heterogeneity in investment responses is primarily driven by firms

in the lowest leverage terciles. Finally, we examine four potential mechanisms—cash flows, default risk, debt maturity, and expected returns— that may explain these heterogeneous responses to government debt.

In our main analysis, we employ market leverage to measure a firm's financial position. In the presence of financial frictions, there exists a strong theoretical link between leverage and investment, which depends on the investment opportunities, the riskiness, and the maturity of a firm (e.g., Gomes and Schmid, 2010). Since market leverage captures the valuation of a firm's growth options, its underlying risks to equity holders, and its stage in the life cycle, it serves as a proper measure of financial position when investment and financing decisions are examined jointly (e.g., Gomes and Schmid, 2021). Nevertheless, in Online Appendix IA2.7, we show that our baseline results hold when we use book leverage instead of market leverage as a proxy for a firm's financial position.

2.1 Data Description

Our quarterly macroeconomic data are sourced from the Federal Reserve Bank of St. Louis (FRED). We use changes in the U.S. Total Public Debt as a Percent of the Gross Domestic Product (FRED: GFDEGDQ188S), referred to as the U.S. government debt ratio, as our main proxy for fiscal policy.

We combine the debt-to-GDP series with Compustat data on firm-level fundamentals to construct our sample with quarterly frequency from 1990:Q1–2019:Q4.[2] Our main explanatory variable is market leverage, which we proxy with the ratio of the total debt to the market value of assets. Our main measure of investment is the net change in log capital $\Delta \log k_{i,t}$ where $k_{i,t}$ is the book value of the firm i's capital stock at the end of period t. To construct firm-level capital stock series, we apply a perpetual inventory method to fixed assets. Online Appendix IA1.1 describes the sample selection procedures and Online Appendix IA1.2 provides details for all the (main and

[2]We purposely stop before the onset of the COVID-19 pandemic. The literature is still debating how to incorporate few extreme pandemic observations that may bias the estimated response.

	Mean	SD	p5	p25	p50	p75	p95
Total Asset, billion	3.607	12.128	0.005	0.043	0.256	1.558	17.383
Financial Leverage	0.162	0.173	0.000	0.013	0.110	0.250	0.522
Operating Leverage	0.300	0.243	0.048	0.147	0.246	0.381	0.735
Tobin's Q	2.373	3.508	0.802	1.139	1.543	2.374	5.917
Cash Ratio	0.097	0.122	0.002	0.018	0.054	0.128	0.340
ROA	0.016	0.083	-0.079	0.010	0.028	0.045	0.081
Capital Growth	0.013	0.092	-0.074	-0.016	0.001	0.027	0.141
Δ DGDP	0.004	0.013	-0.013	-0.004	0.003	0.010	0.025

Table 1: Summary Statistics of Firm-Level Variables. This table reports the descriptive statistics for our constructed firm sample from 1990Q1 through 2019Q4. For details on the definition of variables, see Online Appendix IA1.2.

control) variable definitions, and a description of the construction method for log capital growth.

Table 1 reports the summary statistics of the variables used in our main empirical analysis. The quarterly mean market leverage is 16.2% with a standard deviation of 17.3%. The quarterly mean log capital growth (investment) is about 1% with a standard deviation of 12.2%. Table 1 also documents the distribution of the change in government debt ratio time series. The mean is approximately zero and the standard deviation is 1.3%.

Table 2 displays the cross-sectional relation between market leverage and various financial indicators. Specifically, firms are grouped into five portfolios based on market leverage, with the average firm characteristic for each portfolio shown in the corresponding row. The table highlights the established positive correlation between leverage and firm size (measured by total assets), as well as the negative correlations between leverage and Tobin's q (Rajan and Zingales, 1995).

2.2 Heterogeneous Responses to Government Debt

Here, we study how the interaction between financial leverage and government debt impacts firms' capital growth. Our focus is on identifying heterogeneous responses that arise from temporary variations in financial positions, rather than from ex-ante

Leverage Rank	Assets	Financial. Leverage	Tobin's Q	ROA	Capital Growth	Cash Ratio	Operating Leverage	Distance-to Default
1	0.487	0.005	3.287	0.013	0.022	0.186	0.291	25.163
2	2.241	0.034	3.140	0.014	0.021	0.111	0.328	20.359
3	5.488	0.114	2.167	0.021	0.013	0.075	0.309	12.706
4	5.639	0.224	1.701	0.019	0.008	0.061	0.289	8.065
5	3.957	0.441	1.576	0.013	-0.001	0.056	0.281	3.470

Table 2: This table reports mean firm characteristics for quintile portfolios of firms sorted based on their market leverage. Our sample is from 1990Q1 through 2019Q4. For details on the definition of variables, see Online Appendix IA1.2.

permanent heterogeneity. There exists substantial ex-ante firm heterogeneity, which is a key determinant of firm dynamics and life cycle (e.g., Sterk, Sedláček, and Pugsley, 2021). As permanent heterogeneity has its own dynamics, which may or may not be related to fiscal policy, it can obscure the drivers of investment responses to fiscal policy. To address this, our model in Section 3 abstracts from permanent heterogeneity by assuming firms are ex-ante homogeneous but become heterogeneous ex-post due to idiosyncratic shocks. To maintain consistency between the model and the data, therefore, we demean financial leverage to estimate how a firm responds to government debt when it has higher or lower leverage than usual. Nevertheless, in Online Appendix IA2.7, we show that our baseline results hold when we use market leverage without demeaning as a proxy for a firm's financial position.

In particular, we employ the following empirical specification to study the heterogeneous response of a firm's investment to government debt:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta(Lev_{i,t-1} - \mathbb{E}_i[Lev_{i,t}])\,\Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t} \qquad (1)$$

where $\Delta \log k_{it}$ is the firm's investment (growth in capital stock) in quarter t, $Lev_{i,t}$ is the firm's market leverage, $\Delta DGDP_t$ is the change in government debt, and $\epsilon_{i,t}$ is a regression residual. $Lev_{i,t-1} - \mathbb{E}_i[Lev_{i,t}]$ represents the demeaned leverage within a firm, subtracting the permanent heterogeneity in financial position as discussed above. α_i is a firm fixed effect that captures permanent differences in investment behavior across firms. $\alpha_{s,t}$ is a sector s by quarter t fixed effect that captures differences in how

broad sectors are exposed to the changes in government debt.[3] $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We lag all variables to ensure that they are predetermined at the time of the change in government debt.

The coefficient of interest is β, which measures how the sensitivity of investment to a change in government debt depends on leverage. Leverage is standardized over the entire sample, so the units of the β coefficient are standard deviations relative to the mean. Standard errors are clustered two-way at the firm and quarter levels.

Panel A of Table 3 reports the results from estimating the baseline specification (1). Column (1) presents the results without firm-level controls and sector-time fixed effects. We observe that firm investment responsiveness depends positively on the interaction between changes in government debt and leverage. After adding sector-by-quarter fixed effects and firm-level controls (columns (2) and (3)), we continue to see a statistically significant interaction effect of government debt with leverage. In particular, the interaction effect in Column (3) implies that a firm with one standard deviation higher leverage than the average firm has approximately a 0.127 higher investment response to government debt. The economic magnitude of investment responses to government debt is also significant. For example, the interaction effect in column (3) implies a $12.7\% \times 1.3\% = 0.0017$ increase in capital growth for a firm with one standard deviation higher leverage, in response to a one standard deviation (1.3%) change of debt-to-gdp ratio. Such capital amounts to roughly 13% of average quarterly capital growth (1.3%, see Table 1).

We also relax the baseline specification by adding the changes in government debt (i.e., $\Delta DGPD$) instead of sector-by-quarter fixed effects into the specification. As such, we aim to assess the average effect of $\Delta DGPD$ and compare it to the estimated interaction effect β. Column (4) presents the results for this alternative specification. The results indicate that the coefficient on government debt is of similar magnitude to the interaction coefficient. Hence, our β coefficient in the previous column implies an eco-

[3]The sectors s considered in our analysis are described in Appendix IA1.2.

(a) Panel A: Leverage Measure

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
Leverage x $\Delta DGDP$	0.132^{***}	0.126^{***}	0.127^{***}	0.144^{***}
	(5.340)	(4.962)	(5.925)	(6.163)
$\Delta DGDP$				-0.231^{***}
				(-2.842)
Leverage	-0.013^{***}	-0.012^{***}	-0.010^{***}	-0.011^{***}
	(-29.046)	(-29.746)	(-27.056)	(-25.411)
Firm controls	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	298,799	298,799	269,638	269,638
R^2	0.061	0.065	0.115	0.082

(b) Panel B: Low Leverage Dummy

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
$\mathbf{1}_{LowLev}$ x $\Delta DGDP$	-0.457^{***}	-0.401^{***}	-0.150^{***}	-0.174^{***}
	(-4.972)	(-4.933)	(-3.773)	(-4.260)
$\Delta DGDP$				-0.158^{*}
				(-1.888)
$\mathbf{1}_{LowLev}$	0.023^{***}	0.023^{***}	0.003^{***}	0.002^{**}
	(24.310)	(26.303)	(4.278)	(2.306)
Firm controls	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	298,799	298,799	269,638	269,638
R^2	0.055	0.058	0.115	0.082

Table 3: Heterogeneous responses to Changes in Government Debt. This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta Lev_{i,t-1}\, \Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ represents either the firm's demeaned leverage at quarter t (Panel A) or a dummy variable that is 1 if the firm is at the lowest leverage tercile and 0 otherwise at quarter t (Panel B). $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize demeaned leverage over the entire sample so the units of the interaction coefficient are standard deviations relative to the mean. Standard errors are two-way clustered by firm and quarter. t-stats are reported in parentheses.

nomically meaningful degree of heterogeneity. In all, the semi-elasticity of a firm's investment in response to $\Delta DGPD$ depends on leverage.

The evidence in Panel A implies that the semi-elasticity of firm investment with respect to a change in government debt depends on firm leverage. Crucially, we cannot assert from Panel A alone whether firms with low or high leverage drive the heterogeneous responses. Therefore, we further explore which firms are most responsive to changes in government debt and how they react. To this end, we sort firms into three groups (terciles) based on their market leverage each quarter, and then estimate the following panel regression with the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta \, \mathbf{1}_{LowLev} \, \Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t} \tag{2}$$

where $\Delta \log k_{it}$ is the firm's investment (growth in capital stock) in quarter t, $\mathbf{1}_{LowLev}$ represents the dummy variable that takes on the value of one if the firm is in the lowest tercile of leverage sorts and zero otherwise. Panel B of Table 3 provides the results. The additional analysis with a dummy variable shows that firms with low financial leverage mainly drive the heterogeneity in investment responses. Quantitatively, a low leverage firm (bottom tercile) has about $15\% \times 1.3\% = 0.00195\%$ lower capital growth relative to other firms in response to a one standard deviation (1.3%) increase in government debt. Such investment corresponds to 15% of the average quarterly capital growth in our sample. Overall, this alternative specification confirms that the negative response of low-leverage firms determines the average role of leverage in the transmission of fiscal policy to firm investment. As such, low-leverage firms cut investment more than high-leverage firms in response to a rise in government debt.

To provide more detailed evidence on how the investment response to government debt varies with leverage, we also form quintile groups (ranks) of firms sorted on their leverage and explore the investment response of each group *separately*. Specifically, we sort firms into five groups based on their market leverage each quarter, and then

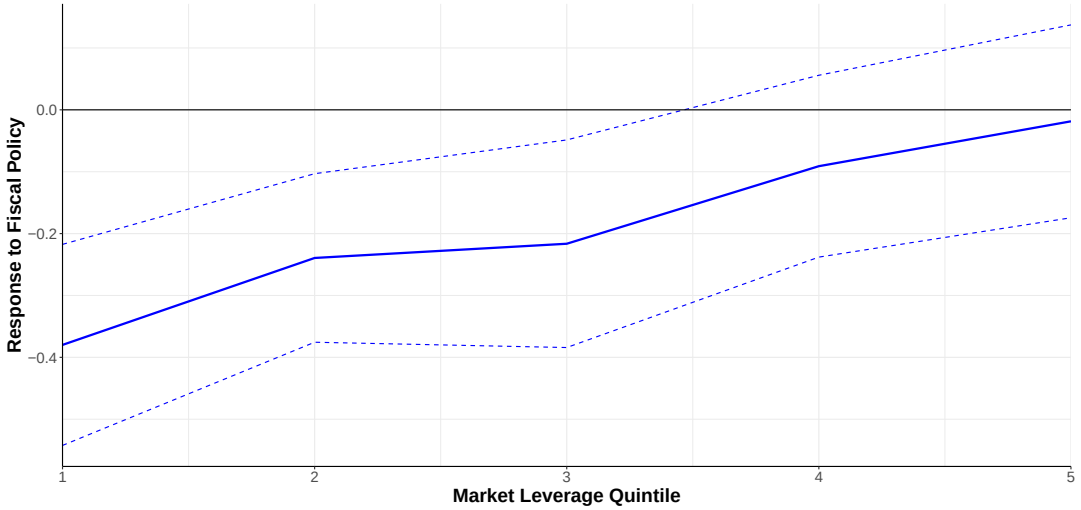


Figure 1: Heterogeneous responses to Changes in Government Debt by Leverage Quintiles. This figure displays the coefficient estimate for the change in government debt from the following quarterly regressions for each market leverage quintile:

$$\Delta \log k_{i(g),t+1} = \alpha_{i(g)} + \beta_g \Delta DGDP_t + \Gamma_1' Z_{i(g),t-1} + \epsilon_{i(g),t} \ , \ g = 1, \ldots, 5$$

where $i(g)$ denotes firms i in group (leverage quintile) g, $\Delta k_{i(g)t}$ is the firm's investment measured as the growth in capital stock at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. $\alpha_{i(g)}$ represents firm fixed effects, and $Z_{i(g),t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. Standard errors are two-way clustered by firms and quarter. Dashed lines indicate the 90% confidence bands.

estimate the following panel regression for each group g:

$$\Delta \log k_{i(g),t+1} = \alpha_{i(g)} + \beta_g \Delta DGDP_t + \Gamma_1' Z_{i(g),t-1} + \epsilon_{i(g),t} \ , \ g = 1, \ldots, 5 \tag{3}$$

where $i(g)$ denotes those firms i in group g, and all variables are as defined in Eq. (1).

Figure 1 displays the β_g estimates from these regressions conducted for each leverage rank. The results show that investment responds negatively to $\Delta DGPD$, and more so (in absolute value) the lower the firm leverage is. The bottom and middle quintiles show a negative and statistically significant response of -0.38 and -0.22, respectively, while the response for the top quintile is insignificant at -0.02. These results suggest that low-leverage firms reduce investment following an increase in government debt, while high-leverage firms exhibit a more muted investment response. Overall, this alternative specification also emphasizes that the crowding-out effect of fiscal policy on corporate investment works through firms with lower leverage.

2.2.1 Heterogeneous Responses to Government Debt: Instrumental Variables Approach

To foster our evidence on the heterogeneous response of investment to government debt, we conduct a two-stage least square (2SLS) instrumental variable analysis. We instrument the change in government debt using the changes in the federal debt held by foreign investors.[4] We normalize this series with lagged total debt to interpret it as a demand shock for US Treasury securities.[5]

We start by estimating the following first-stage time-series regression:

$$\Delta DGDP_t = \alpha + \Delta FrgDebtR_t + \varepsilon_t \tag{4}$$

where $\Delta DGDP_t$ is the change in government debt in quarter t, and $\Delta FrgDebtR_t$ is the change in foreign debt ratio in quarter t. In the second stage, we use the predicted change in government debt, $\Delta\widehat{DGDP}$ from (4) in the following panel regression:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta \left(Lev_{i,t-1} - \mathbb{E}_i[Lev_{i,t}]\right) \Delta\widehat{DGDP} + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t} \tag{5}$$

where Z represents a set of control variables, and α_i and $\alpha_{s,t}$ captures fund and industry-time fixed effects as before.

Panel A of Table 4 summarizes the results. The first stage yields an F-statistic of approximately 40, and the second stage provides coefficient estimates that are notably similar in terms of magnitude and significance to those reported in our baseline specification in Table 3. Therefore, this analysis confirms that within-firm investment responses to government debt are heterogeneous and depend crucially on market leverage.

As in our baseline analysis, we also explore whether high or low-leverage firms are most responsive to changes by replacing our analysis with the dummy variable,

[4]The series is available at https://fred.stlouisfed.org/series/FDHBFIN.

[5]We arrive at similar conclusions when normalizing debt held by foreign investors with lagged GDP instead of total outstanding debt. See Appendix Table IA1.

(a) Panel A: 2SLS - Leverage Measure

	1st Stage $\Delta DGDP$	2nd Stage $\Delta \log k_{t+1}$			
Leverage x $\Delta\widehat{DGDP}$		0.175***	0.226***	0.192***	0.176***
		(3.465)	(4.119)	(3.573)	(2.873)
$\Delta\widehat{DGDP}$					−0.509***
					(−2.925)
Leverage		−0.013***	−0.012***	−0.010***	−0.011***
		(−25.710)	(−26.719)	(−23.722)	(−21.382)
$\Delta FrgDebtR$	642.662***				
	(6.562)				
Firm controls		No	No	Yes	Yes
Firm FE		Yes	Yes	Yes	Yes
Sector-Time FE		No	Yes	Yes	No
Observations	184	298,799	298,799	269,638	269,638
Adjusted R^2	0.187	0.047	0.079	0.097	0.067
F Statistic	43.056*** (df = 1; 182)				

(b) Panel B: 2SLS - Low Leverage Dummy

	1st Stage $\Delta DGDP$	2nd Stage $\Delta \log k_{t+1}$			
$\mathbf{1}_{LowLev}$ x $\Delta\widehat{DGDP}$		−0.894***	−0.363***	−0.267**	−0.310***
		(−3.808)	(−2.957)	(−2.440)	(−2.806)
$\Delta\widehat{DGDP}$					−0.393**
					(−2.328)
$\mathbf{1}_{LowLev}$		0.025***	0.022***	0.004***	0.002**
		(19.674)	(22.353)	(4.489)	(2.484)
$\Delta FrgDebtR$	642.662***				
	(6.562)				
Firm controls		No	No	Yes	Yes
Firm FE		Yes	Yes	Yes	Yes
Sector-Time FE		No	Yes	Yes	No
Observations	184	298,799	298,799	269,638	269,638
Adjusted R^2	0.187	0.040	0.073	0.097	0.067
F Statistic	43.056*** (df = 1; 182)				

Table 4: Heterogeneous responses to Changes in Government Debt - Instrumental Variable. This table reports first and second-stage results from the 2SLS regressions described in Equations (4) and (5), in which we instrument changes in foreign debt ratio for the changes in government debt. Firm-level controls include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize demeaned leverage over the entire sample so the units of the interaction coefficient are standard deviations relative to the mean. Standard errors are two-way clustered by firms and quarter. t-stats are reported in parentheses.

and running the second stage regression in (5) with the indicator variable for the bottom leverage tercile ($\mathbf{1}_{LowLev}$) rather than demeaned leverage ($Lev_{i,t-1} - \mathbb{E}_i[Lev_{i,t}]$). The results in Panel B confirm that firms with lower financial leverage disinvest more following a rise in foreign demand-driven government debt, consistent with our baseline results.

2.2.2 Heterogeneous Responses to Government Debt: Dynamics

We conduct panel local projections to estimate the role of financial leverage in the dynamics of firms' investment response to government debt. Formally, we estimate:

$$\log k_{i,t+h} - \log k_{i,t} = \alpha_{i,h} + \alpha_{s,t,h} + \beta_h (Lev_{i,t-1} - \mathbb{E}_i[Lev_{i,t}])\, \Delta DGDP_t + \Gamma_h' Z_{i,t-1} + \epsilon_{i,t,h}, \tag{6}$$

where $h = 1, \ldots, 12$ quarters, and β_h measures how the cumulative response of investment in quarter $t + h$ to an innovation in debt-to-gdp varies across firms as a function of market leverage.

Figure 2 presents the estimated β_h coefficients over horizon h. The figure shows that leverage drives the heterogeneous response of investment to government debt in a persistent way. The response rises during the first four quarters and remains statistically significant up to three years after a change in government debt.

We also conduct panel local projections for firms in the highest and lowest leverage quintiles to show the dynamics of those firms' investment response to government debt separately.[6] Figure 3 presents the estimated β_h coefficients over horizon h. The figure shows that it is the capital of firms with lower financial leverage that falls persistently more. The investment response of low-leverage firms is statistically significant up to eleven quarters after a change in government debt, whereas the investment response of high leverage remains statistically insignificant at 90% level.

[6]Note that we do not rebalance the portfolios; rather, we form quintiles at time t and track the investment of firms up to h-periods after sorting.

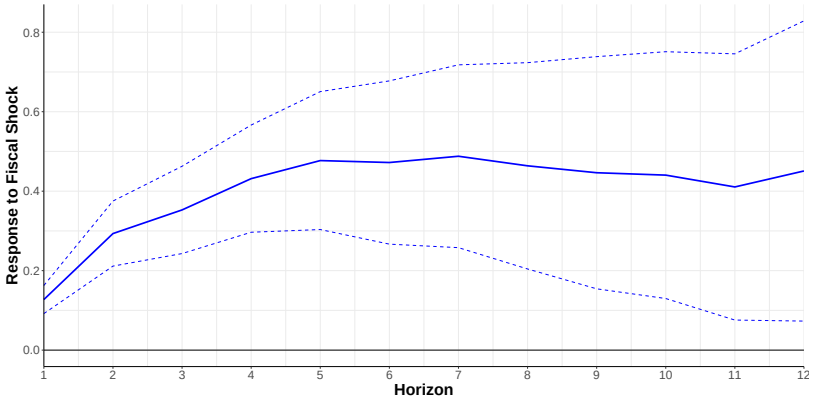


Figure 2: Dynamics of Differential Responses to Changes in Government Debt. This figure displays the dynamics of the interaction coefficient β_h estimated from the following local projection specification over horizon h:

$$\log k_{i,t+h} - \log k_{i,t} = \alpha_{i,h} + \alpha_{s,t,h} + \beta(Lev_{i,t-1} - \mathbb{E}_i[Lev_{i,t}])\,\Delta DGDP_t + \Gamma_h' Z_{i,t-1} + \epsilon_{i,t,h} \tag{7}$$

where $\log k_{i,t+h} - \log k_{i,t}$ is the firm's capital growth over the horizon h, $Lev_{i,t}$ is the firm's market leverage at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t,h}$ is a regression residual. For $h = 1$, this is the same specification reported in column (3) of Table 3. $\alpha_{i,h}$ represents firm fixed effects, $\alpha_{s,t,h}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. β_h measures how the cumulative response of investment in quarter $t+h$ to an innovation in debt-to-gdp varies across firms as a function of market leverage. We standardize leverage over the entire sample so the units of the interaction coefficient are standard deviations relative to the mean. Standard errors are two-way clustered by firms and quarter. Dashed lines indicate the 90% confidence bands.

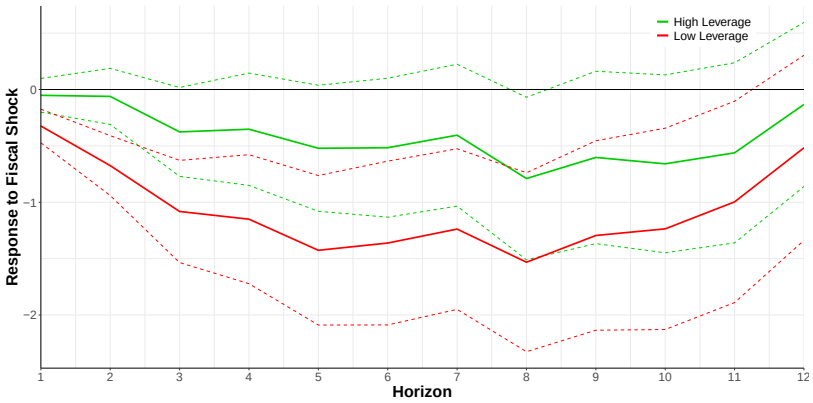


Figure 3: Dynamics of Investment Responses to Changes in Government Debt - High vs. Low Leverage Firms. This figure displays the dynamics of the coefficient estimate for the change in government debt β_h estimated from the following local projection specification over horizon h for firms in the highest and lowest market leverage quintile:

$$\log k_{i(g),t+h} - \log k_{i(g),t} = \alpha_{i(g),h} + \beta_h \Delta DGDP_t + \Gamma_h' Z_{i(g),t-1} + \epsilon_{i(g),t,h}\ ,\ g \in 1, 5 \tag{8}$$

where $i(g)$ denotes firms i in highest (5) or lowest (1) group (leverage quintile) g, $\log k_{i,t+h} - \log k_{i,t}$ is the firm's capital growth over the horizon h, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t,h}$ is a regression residual. $\alpha_{i(g),t}$ represents firm fixed effects, and $Z_{i(g),t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. Standard errors are two-way clustered by firms and quarter. Dashed lines indicate the 90% confidence bands. Standard errors are two-way clustered by firms and quarter. Dashed lines are 90% confidence bands.

2.2.3 Heterogeneous Responses to Government Debt: Robustness

Online Appendix IA2 contains a number of robustness checks of our main specification. In Appendix IA2.2, we add the interaction of leverage with lagged GDP growth to control for differences in cyclical sensitivities across firms. This control is unimportant for the on impact response of investment: the coefficient on the interaction continues to be precisely estimated, and it is of similar magnitude to the one in the baseline specification (0.132 vs 0.107; c.f. specification (3) in Tables 3 and IA2). Controlling for differences in cyclical sensitivities mainly affect the dynamics of the response: in this case, we fail to reject that the differences disappear after 11 quarters (see Figure IA1).

Eberly, Rebelo, and Vincent (2012) show that lagged investment is a powerful predictor of current investment in a balanced panel of large firms in Compustat. Motivated by this finding, Appendix IA2.3 shows that our main results continue to hold when we control for firm-level lagged investment. Moreover, Appendix IA2.4 shows that our results are robust to controlling for other firm-level covariates such as size, ROA, Tobin's q, R&D, and cash. In each case, the coefficients on leverage remain statistically significant and stable at about 0.132. In sum, the heterogeneous response by leverage that we have documented passes several robustness checks regarding firm-level heterogeneity.

Finally, we construct an alternative measure of government debt shock from a recursive vector autoregression (VAR) framework as outlined in Online Appendix IA3. Appendix Table IA8 replicates the main analysis from Table 3, substituting changes in government debt with the shock identified from the VAR. The results reveal a statistically significant and stable coefficient on the interaction term that is rather stable across specifications. Additionally, we repeat our analysis for leverage quintiles using the VAR-identified government debt shock. Figure IA4 shows that low-leverage firms reduce investment in response to the shock, confirming the robustness of our findings when using VAR shocks instead of changes in the debt-to-GDP ratio.

2.3 Exploring the Mechanism

In this section, we investigate the drivers behind the heterogeneous investment responses to fiscal policy. We focus on four key channels: cash flow, default risk, debt maturity, and expected returns. Overall, our results indicate that the cash flow channel dominates the other possible drivers of investment responses. As such, these results shape our modeling choices in Section 3 in rationalizing the empirical results.

2.3.1 Leverage and Cash Flows

To highlight the cash flow channel of fiscal policy, we investigate whether changes in government debt also predict future cash flows differently depending on firm leverage. We measure cash flows as the cumulative change in gross profit in $t+h$ relative to t as a fraction of total assets in t. We then conduct the following predictive regressions for future horizons up to four quarters:

$$ROA_{i,t+h} = \alpha_i + \alpha_{s,t} + \beta Lev_{i,t-1}\,\Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t} \tag{9}$$

where $ROA_{i,t+h}$ is the firm's cumulative gross profit over the horizon h normalized by its assets at quarter t, $Lev_{i,t}$ represents either the firm's demeaned leverage or a dummy variable that is 1 if the firm is at the lowest leverage tercile and 0 otherwise at quarter t. $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls

Table 5 presents the results. Column (1) shows that an increase in government debt interacts with firm leverage to generate a positive effect on cash flows. Columns (2) to (4) demonstrate that this effect is persistent. As before, the average effects are particularly driven by low-leverage firms. Columns (5) to (8) indicate that firms with low leverage have lower cash flows relative to firms with high leverage, as shown by the negative coefficient on the interaction between the low leverage indicator and the

	$ROA(t+h)$							
	h=1	h=2	h=3	h=4	h=1	h=2	h=3	h=4
Leverage x $\Delta DGDP$	0.063***	0.149***	0.182**	0.224**				
	(2.789)	(3.067)	(2.373)	(2.214)				
$\mathbf{1}_{LowLev}$ x $\Delta DGDP$					−0.152***	−0.208*	−0.251	−0.338*
					(−2.639)	(−1.796)	(−1.515)	(−1.709)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	262,923	257,072	251,455	245,911	262,923	257,072	251,455	245,911
Adjusted R^2	0.374	0.469	0.486	0.491	0.374	0.469	0.486	0.491

Table 5: This table reports the coefficient estimates from the following specification:

$$ROA_{i,t+h} = \alpha_i + \alpha_{s,t} + \beta Lev_{i,t-1}\,\Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $ROA_{i,t+h}$ is the firm's cumulative gross profit over the horizon h normalized by its assets at quarter t, $Lev_{i,t}$ represents either the firm's demeaned leverage or a dummy variable that is 1 if the firm is at the lowest leverage tercile and 0 otherwise at quarter t. $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize demeaned leverage over the entire sample. Standard errors are clustered two-way at the firm and quarter levels. T-stats are reported in parentheses.

changes in government debt. Overall, these results provide strong evidence that current and expected future cash flows change in response to government debt surprises based on the firms' leverage.[7]

2.3.2 Leverage and Default Risk

In structural models of default risk (e.g., Merton, 1974), there exists a direct relationship between default risk and firms' capital structure (hence, their leverage). Consequently, financial leverage has been used as a proxy of default risk in past studies (e.g., Ottonello and Winberry, 2020). In Section 2.2, we demonstrated that only firms with lower leverage (hence lower default risk and financial constraints) reduce investments in response to a change in government debt. This suggests a limited role for default

[7]Our results remain robust if we replace sales with total revenue (REVT) to measure gross profits as in Novy-Marx (2013); or if we use a log transformation of profitability at time $t+1$ as $\log\left(1+\frac{E_{t+1}}{B_t}\right)$, where B_t is the book value and E_{t+1} is next year's gross profit as in Fama and French (1995); Vuolteenaho (2002). Those results are also available upon request.

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
Leverage x $\Delta DGDP$	0.127***		0.106***	0.131***
	(5.925)		(3.880)	(4.666)
DD x $\Delta DGDP$		−0.032	0.006	0.046**
		(−1.482)	(0.288)	(2.156)
$\Delta DGDP$				−0.255***
				(−4.420)
DD		0.001**	0.001**	0.002***
		(2.397)	(2.062)	(2.734)
Leverage	−0.010***	−0.010***	−0.011***	−0.011***
	(−27.056)	(−18.881)	(−19.041)	(−19.191)
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	269,638	116,319	116,319	116,319
R^2	0.115	0.135	0.135	0.110

Table 6: This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta(Lev_{i,t-1} - \mathbb{E}_i[Lev_{i,t}])\,\Delta DGDP_t + \gamma DD_{i,t-1}\,\Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's market leverage at quarter t, $DD_{i,t}$ is the firm's distance-to-default at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize demeaned leverage over the entire sample so coefficients reflect standard deviations relative to the mean. Standard errors are clustered two-way at the firm and quarter levels. T-stats are reported in parentheses.

risk as a channel through which fiscal policy operates. To further test this, we include a proxy for default risk in our baseline specifications as a possible channel that fiscal policy works through.

We use Moody's "distance-to-default" (DD) as a main proxy for default risk and replicate our baseline regressions. Table 6 shows that our main result (reproduced in column (1)) remains robust when we incorporate the interaction between distance-to-default and the change in debt-to-GDP ratio as a control in Columns 3 and 4. Those results suggest that default risk is unlikely to be the primary driver of our outcomes, supporting our evidence in Section 2.2 on the key importance of lower, rather than higher, leverage firms in driving the results.

In Online Appendix IA2.5, we also use Whited-Wu (WW) index proposed in Whited and Wu (2006) instead of DD as a proxy for financial constraints (which may also reflect default risk). Our main result holds when we include the interaction between the WW index and the change in debt-to-GDP ratio as a control.

We also conduct panel data analysis for a quintile group of firms sorted on DD measure separately, similar to our approach with leverage in Section 2.2. Figure 4 presents coefficient estimates from regression analyses conducted on quintile samples, segmented by distance-to-default ranks. Consistent with the negative correlation between leverage and distance-to-default implied by classic structural models (which is also seen in the data in Table 2), Figure 4 reveals that firms with high distance-to-default reduce investment the most. These results confirm that the observed reduction in investment is primarily attributable to low-leverage firms with high distance-to-default (signifying low default risk) rather than riskier firms with low distance-to-default. Overall, our findings support the conclusion that default risk is not the main channel driving the heterogeneous investment responses to government debt across firms.

2.3.3 Leverage and Debt Maturity: Short-term vs. Long-Term Debt

Our measure of leverage is the firm's debt-to-asset ratio, where debt comprises both short-term and long-term debt, and assets are the market value of assets. In Table 7, we decompose leverage into long-term and short-term debt and replicate our main specification (1). The results show that the heterogeneous responses across firms are primarily driven by short-term debt (defined as debt coming due in less than one year). This suggests that "debt overhang", which relies on long-lived debt, is unlikely to explain our empirical results. If it were, we would expect more pronounced differences attributable to long-term debt, given the long-lived nature of investments and the stickiness of debt (e.g., Gomes, Jermann, and Schmid, 2016). Similarly, the cash flow exposure due to floating rate liabilities (e.g., Gürkaynak, Karasoy-Can, and Lee, 2022) is also unlikely to explain the data, as floating rate obligations are important

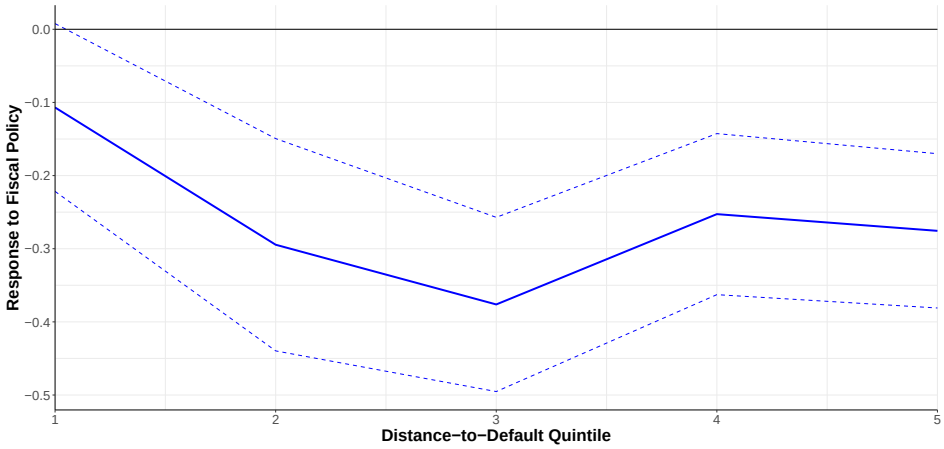


Figure 4: Heterogeneous responses to Changes in Government Debt by Distance-to-Default Quintiles. This figure displays the coefficient estimate for the change in government debt from the following quarterly regressions for each distance-to-default quintile:

$$\Delta \log k_{i(g),t+1} = \alpha_{i(g)} + \beta_g \Delta DGDP_t + \Gamma_1' Z_{i(g),t-1} + \epsilon_{i(g),t}\ ,\ g = 1, \ldots, 5 \tag{10}$$

where $i(g)$ denotes firms i in group (distance-to-default quintiles) g, $\Delta k_{i(g)t}$ is the firm's investment measured as the growth in capital stock at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. $\alpha_{i(g)}$ represents firm fixed effects, and $Z_{i(g),t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. Standard errors are two-way clustered by firms and quarter. Dashed lines indicate the 90% confidence bands.

for long-lived debt. Our findings indicate that the disparities in investment responses across firms are more pronounced for short-term debt maturing in less than one year. As such, in Section 3, our model will feature short-term liabilities to rationalize the empirical evidence.

2.3.4 Leverage and Expected Returns

High government indebtedness corresponds to bad states of the world for investors, leading to higher aggregate and cross-sectional risk premiums (e.g., Croce, Nguyen, Raymond, and Schmid, 2019). Given our interest in the relationship between leverage and investment, we investigate whether this expected return channel explains the heterogeneous investment response to government debt. In Online Appendix IA2.6, we run predictive return regressions for quintile portfolios sorted on firms' leverage and find that changes in government debt do not significantly forecast returns for leverage-

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
Leverage x $\Delta DGDP$	0.120***			
	(4.742)			
LT Leverage x $\Delta DGDP$		−0.283		−0.215
		(−1.036)		(−0.779)
ST Leverage x $\Delta DGDP$			0.091***	0.081***
			(3.713)	(3.680)
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	Yes	Yes	Yes	Yes
Observations	287,058	287,058	287,058	287,058
R^2	0.066	0.060	0.057	0.066

Table 7: This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta Lev_{i,t-1}\, \Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's short or long-term leverage at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include short or long-term leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize short and long-term leverage over the entire sample so coefficients reflect standard deviations relative to the mean. Standard errors are clustered two-way at the firm and quarter levels. T-stats are reported in parentheses.

sorted portfolios. Specifically, the sensitivity of average returns does not differ between high- and low-leverage firms over either short- or long-term horizons. These results contrast with, e.g., Croce, Nguyen, Raymond, and Schmid (2019) that finds a link between government debt and the cost of capital for high and low R&D firms.[8] Overall, our evidence suggests that rising discount rates are unlikely to account for the differential investment responses of high- and low-leverage firms to fiscal policy. Accordingly, the model in Section 3 emphasizes cash flow effects rather than discount rates as the primary mechanism.

[8]Note that Croce, Nguyen, Raymond, and Schmid (2019) finds a link between *level*, not the change, in government debt and expected returns. Their choice is motivated by the economic intuition behind the relation between government debt, innovation, and the cost of capital. By contrast, our study focuses solely on changes in government debt.

3 Model

To rationalize the empirical evidence, we develop a heterogeneous firm general equilibrium model in which the government has a tax rule driven by its exogenous spending and debt issuance needs. The fiscal block is separate from the heterogeneous firm and representative household blocks, and it is only linked to the firm problem through the tax rate. We model the heterogeneous firms that are subject to default in the spirit of Ottonello and Winberry (2020).

3.1 Fiscal Block:

Government: We model a stochastic expenditure stream for government spending G_t as follows:

$$\begin{aligned} \frac{G_t}{GDP_t} &= \frac{1}{1+\exp^{-gy_t}} \\ gy_t &= (1-\rho_{gy})\mu_{gy} + \rho_{gy} gy_{t-1} + \varepsilon_t^{gy}, \qquad \varepsilon_t^{gy} \sim N(0, \sigma_{gy}) \end{aligned} \tag{11}$$

The government accumulates public debt, B_t^G, to help smooth taxes over time. We model the government's debt management rule with the following law of motion for the government's debt-to-GDP with ε_t^{dgdp} as a pure policy shock:

$$\frac{B_t^G}{GDP_t} = (1-\rho_{dgdp})\mu_{dgdp} + \rho_{dgdp}\frac{B_{t-1}^G}{GDP_{t-1}} + \varepsilon_t^{dgdp}, \qquad \varepsilon_t^{dgdp} \sim N(0, \sigma_{dgpd}) \tag{12}$$

The government finances its expenditures by raising public debt or by levying corporate taxes at a time-varying tax rate τ_t. There are various ways to model fiscal rule that enable the government to smooth taxes (e.g., Leeper, Plante, and Traum, 2010). For simplicity, we specify a linear fiscal rule that keeps the fiscal block separate from the firm (investment) side of the economy while enabling tax smoothing in the spirit of Schmitt-Grohé and Uribe (2007) and Fernández-Villaverde, Guerrón-

Quintana, Kuester, and Rubio-Ramírez (2015). Accordingly, the fiscal regime is defined by the following fiscal rule:

$$\tau_t = \phi^G \frac{G_t}{GDP_t} + \phi^D \frac{B_t^G}{GDP_t} \tag{13}$$

where ϕ^G captures the intensity of smoothing with respect to expenditure shocks, and ϕ^D captures public debt repayment behavior.

Aggregate Capital: We define the law of motion for aggregate capital K_t as follows:

$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right) K_t + (1-\delta)K_t \tag{14}$$

where $\Phi(\frac{I_t}{K_t}) = \frac{\delta^{1/\phi}}{1-1/\phi}(\frac{I_t}{K_t})^{1-1/\phi^K}$, I_t is the aggregate investment, δ is the depreciation rate, and ϕ^K is the aggregate adjustment cost parameter. The law of motion for the aggregate capital implies the equilibrium price of capital q_t as follows:

$$q_t = \left(\frac{I_t/K_t}{\delta}\right)^{1/\phi^K} \tag{15}$$

3.2 Heterogeneous Firms

Production and Investment: Each firm j uses the production function y_{jt} to produce its goods:

$$y_{jt} = z_{jt}(\omega_{jt}k_{jt})^{\theta} l_{jt}^{\nu} \tag{16}$$

where z_{jt} denotes a firm-specific productivity shock for firm j at time t, $\omega_{j,t}$ denotes the capital quality shock for firm j at time t, k_{jt} denotes the firm j's capital input at time t.

The idiosyncratic productivity shock follows a log-normal process given by:

$$\log z_{jt+1} = \rho_z \log z_{jt} + \sigma_z \varepsilon_{jt+1} \tag{17}$$

where $\varepsilon_{jt+1} \sim N(0, \sigma_z)$

The capital quality shock follows a truncated log-normal process with a normal distribution within $[-4\sigma_\omega, 0]$. As such, no capital shock is realized with a probability of p_ω, and it is drawn within the support $[-4\sigma_\omega, 0]$. The capital quality shock induces cost on capital (depreciation obsolescence etc.) given by $(1-\delta)\omega_{jt}k_{jt}$, where δ is the depreciation parameter. Firms purchase next-period capital k_{jt+1} at the relative price of capital q.

Firm Net Worth: Firms' net worth $n_{j,t}$ is defined as follows:

$$n_{jt} = \max_{l} (1-\tau_t)\left(z_{jt}(\omega_{jt}k_{jt})^{\theta} l_{jt}^{\nu} - w_t l_{jt} - \xi\right) + q_t(1-\delta)\omega_{jt}k_{jt} + \tau_t q_t \delta \omega_{jt} k_{jt} - b_{jt} \quad (18)$$

where τ_t is the corporate tax rate at time t, w_t denotes the real wage that firms use to hire labor l_{jt} from a competitive labor market, b_{jt} is the firm's outstanding debt and ξ denotes a fixed operating cost. The third term in the firm's net worth ($\tau_t q_t \delta \omega_{jt} k_{jt}$) represents the depreciation tax shield.

A firm's net worth characterizes the total amount of resources available to a firm and works as a key state variable in a firm's optimization and default decisions. As such, the net worth simplifies the numerical solution of the model by summarizing multiple state variables (such as capital and debt) in one key variable.

Financing: Firms can issue new one-period nominal debt with real face value b_{jt}. There is a representative financial intermediary that lends to firms with a price schedule, $Q_t(z_{jt}, k_{jt+1}, b_{jt+1})$ that is decreasing in the amount of borrowing b_{jt+1} due to default risk. If the firm defaults, it permanently exits the economy, and the lender recovers a fraction of the firm's capital stock (α) of the market capital of stock $(1-\delta)\omega k$, and the remaining capital is transferred to the household. As such, the debt price schedule is given by:

$$Q_t(z_{jt}, k_{jt+1}, b_{jt+1}) = \mathbb{E}_t\left[M_{t+1}\left(1 - \Xi\left(1 - \min\{\frac{\alpha q_t(1-\delta)\omega_{jt+1}k_{jt+1}}{b_{jt+1}}, 1\}\right)\right)\right] \quad (19)$$

where $\Xi = \pi_d \chi^1(n_{jt+1}) + (1-\pi_d)\chi^2_{t+1}(z_{jt+1}, n_{jt+1}))$ is the probability of exit implied by the indicator variables $(\chi^1(n), \chi^2_t(z,n))$ for default conditional the realization of exit shocks, and M_t is the stochastic discount factor.

A firm defaults when its net worth is lower than the default threshold and can't satisfy the non-negative dividend constraint. That is, the default for firm j is characterized by a default threshold $\bar{n}_t$ and the condition $n_{jt} < \bar{n}_t$ such that $d_j \geq 0$. We define dividend constraint d_j in Equation (20) below.[9]

Firm Optimization: The equity value of the firm is defined as the discounted sum of all future equity distributions. As such, firms solve the following Bellman Equation to maximize their equity value subject to a budget constraint for dividend payouts:

$$V_t = \max_{k_{jt+1}, b_{jt+1}} d_{jt} + \mathbb{E}_t \left[M_{t+1} \left(\pi_d \chi^1(n_{jt+1}) n_{jt+1} + (1-\pi_d)\chi^2_{t+1}(z_{jt+1}, n_{jt+1}) V_{t+1} \right) \right]$$

$$s.t. \quad d_{jt} = n_{jt} - q_t k_{jt+1} + Q_t(z_{jt}, k_{jt+1}, b_{jt+1}) b_{jt+1} + \tau_t (1 - Q_t(z_{jt}, k_{jt+1}, b_{jt+1})) b_{jt+1} \geq 0 \tag{20}$$

where d_{jt} represents dividend payout for firm j at time t, π_d represents the probability of exit, $\chi^1(n), \chi^2_t(z,n)$ are the indicator variables related to default conditional on exit shocks,n_{jt} represents the firm's net worth, and M_t is the stochastic discount factor. The last part of the dividend constraint $(\tau_t(1 - Q_t(z_{jt}, k_{jt+1}, b_{jt+1}))b_{jt+1})$ represents the interest tax shield for a firm's choice of debt. Although it is not explicitly stated in the optimization problem above, the firm takes into account the evolution of taxes τ determined by the fiscal policy described in Section 3.1.

Each firm also solves $q_t = \mathbb{E}_t \left[M_{t+1} MRPK_{t+1}(z_{t+1}, k_{t+1}) \right]$ where $MRPK_{t+1}(z_{t+1}, k_{t+1})$

[9]Note that the model allows for firms that are unconstrained ($n_{jt} \geq \bar{n}_t$) with no default risk. For those firms, any combination of debt and dividend policy that leaves them unconstrained is optimal. Still, we choose to include those firms in our numerical analysis since they are also subject to cash flow risks of fiscal policy despite their zero probability of default. Unconstrained firms represent a small (less than 1%) of firms in calibrated economies, and simulation results are qualitatively similar when they are excluded from the analysis.

is the marginal rate of return on capital given by:

$$MRPK_{jt+1}(z_{t+1}, k_{t+1}) = \mathbb{E}_{\omega_{t+1}}\left[\frac{\partial}{\partial k_{jt+1}}\left(\max_{l}(1-\tau_{t+1})\left(z_{jt+1}(\omega_{jt+1}k_{jt+1})^{\theta}l_{jt+1}^{\nu} - w_{t+1}l_{jt+1}\right)\right.\right.$$
$$\left.\left. +q_{t+1}(1-\delta)\omega_{jt+1}k_{jt+1} + \tau_{t+1}q_{t+1}\delta\omega_{jt+1}k_{jt+1}\right)\right] \tag{21}$$

the definition of $MRPK_{jt+1}$ highlights that marginal return (i.e., benefit) of firms' investment decision is governed by the evolution of cash flows, which is influenced by the fiscal policy not only directly through taxes τ (as described in Section 3.1) but also through general equilibrium effects on capital prices q.

3.3 Entry & Exit:

Firms receive an i.i.d. exit shock with probability π_d and exit the economy after producing. Firms that do not receive the exit shock will be allowed to continue into the next period. If firms choose to default, they also exit the economy as defined above.

When a firm exits due to default, a new firm enters the economy so that the total number of firms is fixed in each period. Each of these new entrants draws an idiosyncratic productivity shock z_t from the time-invariant distribution:

$$\mu_{Ent}(z) = \log\mathcal{N}\left(-m\frac{\sigma_z}{\sqrt{(1-\rho_z^2}}, \frac{\sigma_z}{\sqrt{(1-\rho_z^2}}\right) \tag{22}$$

where $m \geq 0$ is a parameter calibrated to match the average size and growth rates of new entrants. New entrants are endowed with k_0 units of capital and have zero units of debt.

3.4 Household

There exists a representative household with a log utility. The representative agent maximizes its utility over both consumption and labor:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t - \Psi L_t\right)$$

$$\text{s.t.} \quad C_t + P_t S_t + B_{t+1} = (1 + r_{f,t}) B_t + S_{t-1}(D_t + P_t) + T_t,$$

where β is the discount factor and Ψ denotes the disutility of labor. S_t is number of equity shares (normalized to $S_t = 1$ for all t in equilibrium), P_t is the ex-dividend price per share, D_t is the aggregate dividends. The household owns all firms in the economy. Bonds (B_t) are in zero net supply and represent the funds lent to the representative financial intermediary. Taxes T_t are rebated to the representative household as a lump sum.

The stochastic discount factor and the real interest rate are then linked through the Euler equation for bonds. The first-order condition for aggregate consumption yields

$$1 = \beta \mathbb{E}_t \left[(1 + r_{f,t}) \left(\frac{C_t}{C_{t+1}} \right) \right] \tag{23}$$

which implies the stochastic discount factor as $M_{t+1} = \beta \left(\frac{C_t}{C_{t+1}} \right)$. By contrast, the first-order condition for labor implies $w_t = \Psi C_t$.

3.5 Equilibrium

A recursive equilibrium consists of a set of policy functions ($k_{t+1}, b_{t+1}, n_{t+1}$), value functions ($V_t(z_t, n_t)$), prices ($Q_t(z_t, k_{t+1}, b_{t+1})$, M_{t+1}, q_t), fiscal quantities ($\frac{G_t}{GDP_t}$, $\frac{B_t^G}{GDP_t}$), wages (w_t), taxes (τ_t), aggregate capital, production, labor and investment (K, Y, I, L) such that firms optimize, the household optimizes and markets clear. Online Appendix IA4.1 provides the full characterization of the equilibrium.

4 Economic Intuition

Because the model does not admit a closed-form solution, we numerically solve for its recursive equilibrium. Before turning to the quantitative analysis, however, we first outline the economic intuition underlying the key sources of heterogeneity in firms' responses.

For any firm j, the optimal choice on k_{jt+1} and b_{jt+1} satisfy the following two equations (suppressing the firm subscript j for notational convenience):

$$q_t k_{t+1} = n_t + Q_t(z_t, k_{t+1}, b_{t+1}) b_{t+1}, \tag{24}$$

$$\begin{aligned} &\left(q_t - \varepsilon_{Q,k_{t+1}}(z_t, k_{t+1}, b_{t+1}) \frac{Q_t(z_t, k_{t+1}, b_{t+1}) b_{t+1}}{k_{t+1}}\right) \left(\frac{R^{sp}(z_t, k_{t+1}, b_{t+1})}{1 - \varepsilon_{R,b_{t+1}}(z_t, k_{t+1}, b_{t+1})}\right) \\ &= \frac{1}{R_t} \mathbb{E}_t \left[MRPK_{t+1}\right] + \frac{1}{R_t} \frac{\mathbb{COV}_t \left(MRPK_{t+1}(z_{t+1}, k_{t+1}), 1 + \lambda_{t+1}(z_{t+1}, n_{t+1})\right)}{\mathbb{E}_t[1 + \lambda_{t+1}(z_{t+1}, n_{t+1})]} \end{aligned} \tag{25}$$

where $\varepsilon_{Q,k_{t+1}}$ accounts for the elasticity of bond price with respect to investment, $\varepsilon_{R,b_{t+1}}$ accounts for the elasticity of interest rate schedule with respect to borrowing, R^{sp} is the bond's interest rate spread relative to risk-free rate, $MRPK_{t+1}$ is the marginal return on capital described in Equation (21), and λ_{t+1} is the Lagrange multiplier on the dividend constraint (Equation (24)), representing the shadow cost of resources for the firm. Equation (25) is the intertemporal Euler equation for capital, in which the left-hand side captures the marginal cost of investment, while the right-hand side reflects its marginal benefit.

In the model, fiscal policy impacts both the marginal cost and the marginal benefit of investment. On the marginal cost side, the first parenthesis represents the capital price (q_t) net of interest rate savings. Looking at this expression only, the marginal cost of investment depends on the fiscal policy through its general equilibrium effect on q_t as well as the bond price schedule Q_t. The second parenthesis represents the borrowing cost based on the interest rate spread.

On the marginal benefit side, the first term captures the expected return of capital discounted by the risk-free rate, while the second term reflects a risk-premium arising from the covariance of marginal return on capital with the shadow cost of resources.[10] Together, these terms imply that the marginal benefit of investment is shaped by fiscal policy through two channels: 1) its impact on $MRPK_{t+1}$, hence the cash flow channel, 2) its impact on R_t, hence the discount rate channel.

The heterogeneous effect of fiscal policy on investment depends on its relative impact on the marginal cost and marginal benefit of investment for high vs. low leverage firms. On the marginal benefit side, fiscal policy increases the risk-free rate R_t, the same for both high and low leveraged firms, thus the heterogeneous investment responses must arise primarily through the differential $MRPK_{t+1}$ (Equation (21)), hence the expected cash flow responses to fiscal policy. Intuitively, fiscal policy affects cash flows through the sensitivity of both the tax rate and the capital price to a debt-to-GDP shock. First, a positive debt-to-GDP shock reduces cash flows by directly raising the tax rate τ_t through the fiscal rule. This tax effect is larger for firms with higher growth rates relative to their net worth. Second, a positive debt-to-GDP shock reduces cash flows by lowering the relative price of capital q_t through general equilibrium (i.e., a decline in aggregate investment demand). Capital price affects firms' cash flows as it directly affects the value of undepreciated capital stock (the second term on the right-hand side of equation (21)). If the value of undepreciated capital is closely tied to firm valuation, then this mechanism amplifies the effect of fiscal policy for firms with higher valuations relative to their net worth.[11] The combined impact of tax rates and capital prices induces a differential response of cash flows, hence the marginal benefit, in our model economy. Whether high or low leveraged firms are more responsive to the marginal benefit of investment depends on the relative size of the combined effects.

[10] There is a third item on the right-hand side of Equation (25) that captures the impact of incremental investment on the value of the firm through changing default probability. Since this term is negligible relative to other channels in our calibration, we omit this term in our discussion for convenience.

[11] The link between firm valuation and the value of undepreciated capital stock arises because undepreciated capital contributes to net worth, which in turn is discounted to determine the firm's overall value.

Two terms on the left-hand side of Equation (25) affect marginal cost: the relative price of capital, q_t, and the interest savings from the extra unit of installed capital. A decline in q_t following a positive debt-to-GDP shock directly reduces the marginal cost of investment for both high- and low-leverage firms. This effect is amplified for high-leverage firms, which face higher credit spreads R^{sp} and therefore load more heavily on the decline in q_t. As a result, the marginal cost of high-leverage firms is more sensitive to the expansionary debt-to-GDP shock.

Overall, the differential responses of investment for high vs. low leveraged firms depend on the relative size of fiscal policy's impact on marginal cost and marginal benefit channels. Theoretically, the size of the shifts in two channels may result in either low or high-leveraged firms cutting more investment in response to a fiscal shock. However, our empirical analysis in Section 2 suggests a crucial link between higher investment and expected cash flow (i.e., marginal benefit) responsiveness of low leveraged firms to fiscal policy. Our quantitative exercise aims to govern those channels and reproduce the key empirical findings in the data by calibrating relevant cross-sectional characteristics that vary with leverage (e.g., Tobin's Q, capital growth rates, etc.).

5 Quantitative Analysis

We rationalize the empirical results with a quantitative simulation of our model. To do so, we first calibrate a number of parameters to match the target moments of the data in Section 5.1. Then, in Section 5.2, we demonstrate how the steady state of the calibrated model replicates the key firm heterogeneity of the data that is not targeted by the calibration. Next, we solve the model and simulate an economy by computing the perfect foresight transition path. We discuss the details of the transition path solution in Online Appendix IA4.2. Based on the simulation output, Section 5.3 studies the heterogeneous effects of government debt across firms and demonstrates results consistent with the data. Online Appendix IA4.3 presents the impulse responses of key aggregate variables to policy shocks.

5.1 Calibration

We calibrate the model in two steps. First, we set those parameters commonly used in the literature to standard values (fixed parameters). Second, we calibrate the remaining parameters to match the target moments of the data (calibrated parameters). The model period equals one quarter.

Fixed Parameters. Table 8 summarizes all fixed parameters. On the household side, the discount factor is set at $\beta = 0.99$, implying a quarterly steady-state interest rate of $r_f = 1\%$. For the firms, we adopt a capital coefficient of $\theta = 0.21$ and a labor coefficient of $\nu = 0.64$, following Ottonello and Winberry (2020). Together, the capital and labor coefficients imply a standard decreasing return to scale of 85%. The persistence parameter for the idiosyncratic TFP process is set to $\rho = 0.90$, in line with other heterogeneous firm models (e.g., Ottonello and Winberry, 2020, Gomes and Schmid, 2021, Begenau and Palazzo, 2021) and the value reported in İmrohoroğlu and Tüzel (2014). The quarterly depreciation rate is $\delta = 2.5\%$. The loan recovery rate is chosen as $\alpha = 0.45$, which is standard in models with default risk (e.g., Gomes and Schmid, 2021), and implies an average face value recovered from defaulted bonds.

On the fiscal block, we set the steady state tax rate as 0.20. The coefficients for the average quarterly debt-to-gdp ratio ($\mu_{dgdp} = 2.4$) and the average quarterly log government spending-gdp ratio ($\mu_{gy} - 1.39$) are taken from Croce, Nguyen, Raymond, and Schmid (2019). Those coefficients imply a government spending ratio ($1/(1 + e^{\mu_{gy}})$) of 20% and debt-to-output ratio of 60& at the steady state as in Croce, Nguyen, Raymond, and Schmid (2019). Finally, the tax policy response coefficient to government spending is set as $\phi^G = 0.90$.

Calibrated Parameters. Table 9 summarizes all calibrated parameters. We calibrate the remaining heterogeneous firm parameters to match key empirical moments on the financing and investment behavior of firms in the data. We choose the parameters for

Fixed Parameters

Description	Parameter	Value
Preferences		
Discount Factor	β	0.99
Heterogeneous Firms		
Capital coefficient	θ	0.21
Labor Coefficient	ν	0.64
Persistence of id. prod. shock	ρ_z	0.90
Depreciation	δ	0.025
Loan Recovery Rate	α	0.45
Fiscal Block		
Steady State Tax Rate		0.2
Average quarterly debt-to-GDP ratio	μ_{dgdp}	2.4
Average quarterly log gov. spending-to-GDP ratio	μ_{gy}	-1.39
Policy response to gov. spending	ϕ^G	0.9

Table 8: This table provides the parameters that are exogenously set in the calibration. See the main text for details.

the operating cost (ξ) and the volatility of the idiosyncratic TFP process (σ_z) to match the dispersion of investment rate reported in Cooper and Haltiwanger (2006). We set the volatility of capital quality shock (σ_ω) to target the average firm-level leverage ratio of 34% and average default rate of 3% reported in Crouzet and Mehrotra (2020) and Gomes and Schmid (2021), respectively.

For the fiscal block, we follow Croce, Nguyen, Raymond, and Schmid (2019) and set the volatility of government expenditure to gdp (σ_{gy}) and debt to gdp (σ_{dgdp}) to replicate the moments in the US quarterly data. However, the persistence parameters for both processes are chosen to achieve a transition path that converges back to the steady state over a reasonable period of 10 quarters. The tax policy response coefficient to government debt (ϕ^D) is calibrated to fit the steady state tax rate of 0.20. The aggregate adjustment cost parameter (ϕ^K) is set to calibrate the peak aggregate invest-

Calibrated Parameters

Description	Parameter	Value
Heterogeneous Firms		
Operating Cost	ξ	0.05
SD of id.prod. shock	σ_z	0.03
SD of capital quality shock	σ_ω	0.03
Fiscal Block		
Persistence of gov.spending-to-GDP	ρ_{gy}	0.3
Persistence of debt-to-GDP	ρ_{dgdp}	0.3
SD of gov.spending-to-GDP	σ_{gy}	0.04
SD of debt-to-GDP	σ_{dgdp}	0.02
Policy response to debt-to-gdp	ϕ^D	0.033
Aggregate Capital AC	ϕ^K	2.5
Lifecycle Dynamics		
Mean Shift of entrants prod.	m	3.00
Initial capital	k_0	0.16
Exit Rate	π_d	0.03

Table 9: This table provides the parameters that are calibrated to match key empirical moments. See the main text for details.

Calibration Targets & Model Fit

Target	Model	Data
SD of Investment Rate	0.36	0.34
Mean Leverage Ratio	0.47	0.34
Mean Default Rate (%)	2.69	3.00
Mean Exit Rate	0.11	0.09
Share of age 1 firms	0.10	0.11
Share of age 2 firms	0.09	0.08

Table 10: This table reports the empirical targets in the calibration for internal parameters. See the main text for data sources.

ment response close to 1% relative to the steady state.

For the lifecycle dynamics, we follow Ottonello and Winberry (2020) and set the exogenous exit rate of π_d, the parameters of the entrant distribution (m) and the parameter for initial capital at entry (k_0) to match the average exit rate and the share of firms in the economy at ages one and two computed from the Business Dynamics Statistics (BDS). Table 10 demonstrates that the model matches the data reasonably well.

5.2 Steady State Results

Here, we show how steady-state distributions of firm characteristics vary with leverage. Notably, these distributions are not directly targeted in our calibration. In the data, the firms with low leverage have higher growth options (i.e., Tobin's q) and higher levels of investment (i.e., capital growth). The model replicates these features, which are crucial for understanding how government debt impacts investment in the cross-section.

Figure 5 shows median values of leverage, Tobin's q, ROA and capital growth across the terciles of the firm's leverage distribution for the steady state of the model and the data. First, the model's financial leverage is slightly higher but still comparable to the Compustat data. The model generates a relatively high leverage (also shown in Table 10) in order to match the default rate of the data. Second, in the model, both Tobin's q and capital growth (i.e., investment) decrease with firm leverage, consistent with the data. As a result, the model generates that low leverage firms have more growth opportunities, making them more sensitive to shocks affecting investment at the firm level. Through this link between leverage, Tobin's q and growth, the model explains why low-leverage firms are more exposed to changes in government debt.

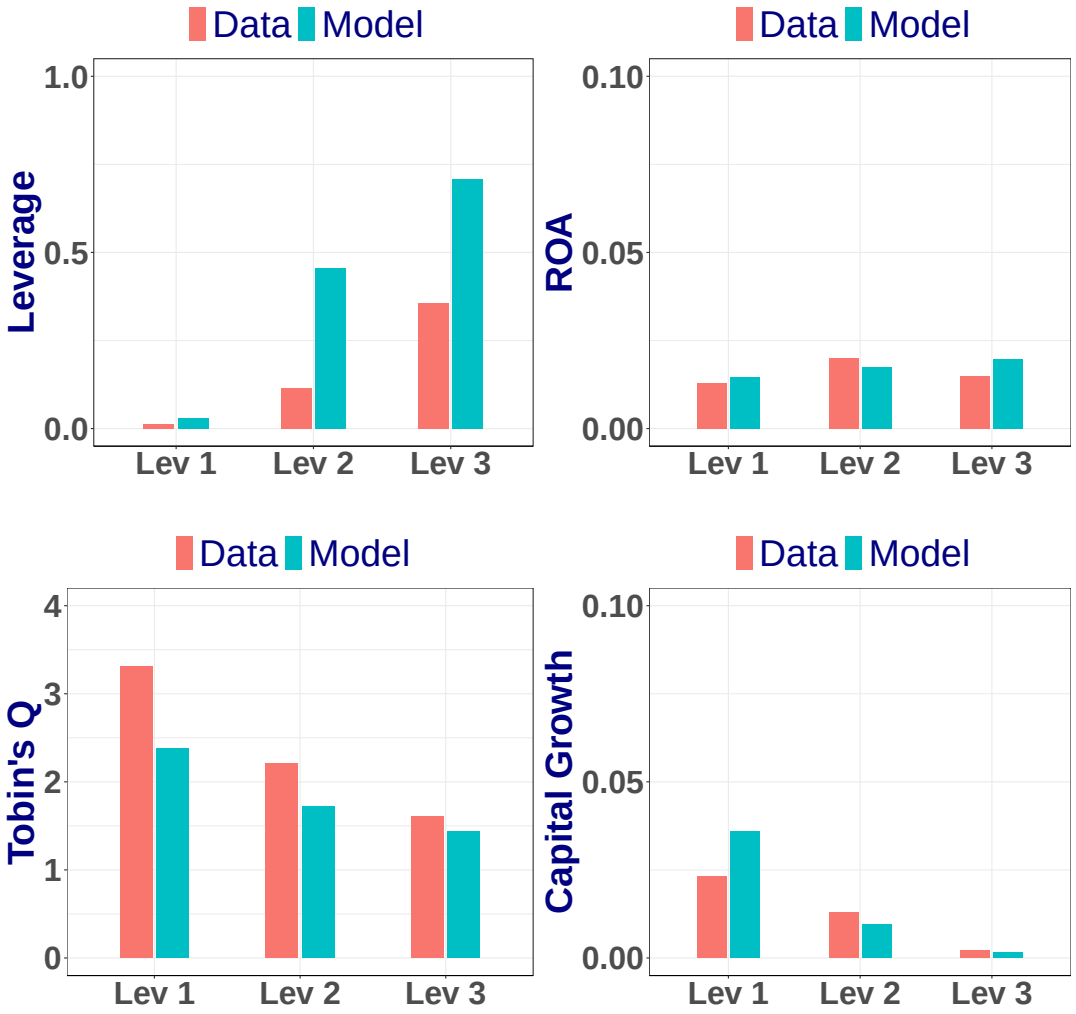


Figure 5: Steady State - Firm Variables by Leverage Tercile This figure displays the distribution of leverage, profitability, Tobin's q and capital growth for leverage terciles in the model vs the data. Model moments are computed from the steady state of the model.

5.3 Heterogeneous effects of government debt

In this section, we analyze our model quantitatively and demonstrate that heterogeneous responses to government debt across firms are consistent with the data. To do so, we simulate an economy by computing the perfect foresight transition path as discussed in Online Appendix IA4.2. Using the simulation output, we conduct the panel data analysis similar to our empirical section 2.2. In all analysis, we include firm-level controls such as leverage, Tobin's q, profitability, and size, which are available both in the data and the model. Since the model lacks industry classification, we use time-fixed

	$\Delta \log k_{t+1}$			
	Data	Model	Data	Model
	(1)	(2)	(3)	(4)
Leverage x $\Delta DGDP$	0.140***	0.205		
	(6.419)			
$\mathbf{1}_{LowLev}$x $\Delta DGDP$			−0.179***	−0.326
			(−4.397)	
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Adjusted R^2	0.089	0.098	0.079	0.098

Table 11: This table reports the data-implied vs. model-implied coefficient estimates from running the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_t + \beta Lev_{i,t-1}\, \Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ represents either the firm's demeaned leverage or a dummy variable that is 1 if the firm is at the lowest leverage tercile and 0 otherwise at quarter t. $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, α_t represents time fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, and profitability. We standardize demeaned leverage over the entire sample. Standard errors are two-way clustered by firms and quarter. t-stats are reported in parentheses.

effects instead of industry-time fixed effects in the baseline regressions.

Baseline Results Table 11 shows that our baseline regression results, based on specification (1), are consistent with the data. Columns (1) and (2) indicate that the semi-elasticity of a firm's investment in response to government debt shocks depends on leverage, both in the model and the data. Furthermore, we show that the negative response of low-leverage firms determines the semi-elasticity of firm investment to government debt. To illustrate this, we replace de-meaned leverage with a low-leverage indicator, which equals 1 if the firm is in the lowest leverage tercile in quarter t, and 0 otherwise. Columns (3) and (4) show that the model replicates the negative investment response of the firms with low leverage.

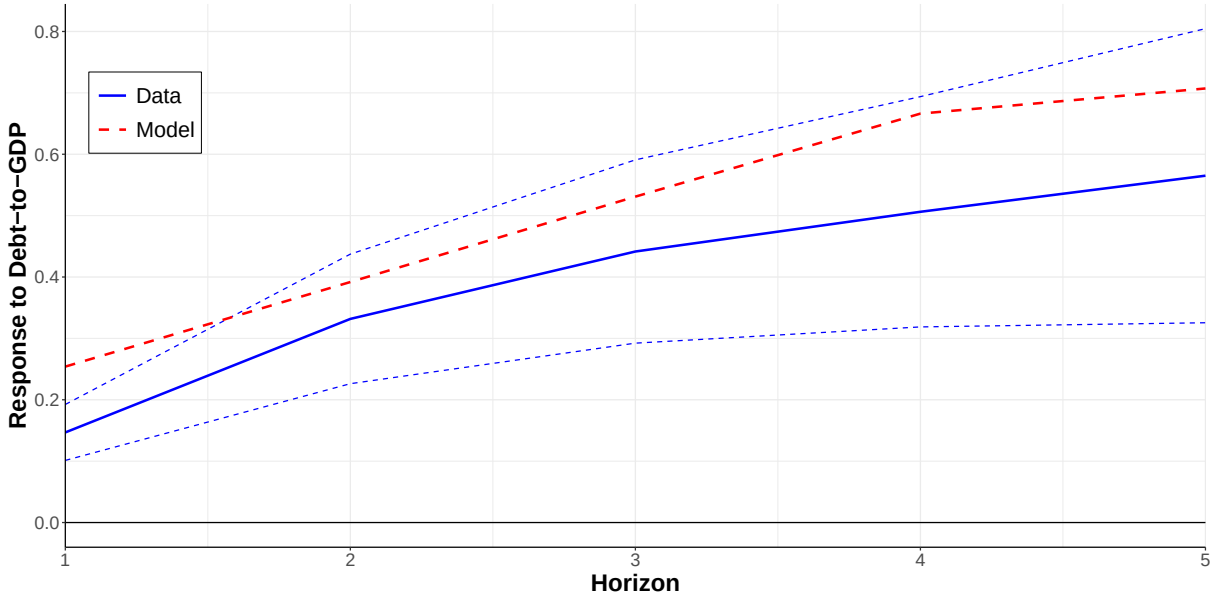


Figure 6: Dynamics of Differential Responses to Changes in Government Debt. This figure displays the dynamics of the model-implied interaction coefficient estimated from the local projection specification 6 over horizon h for the model vs. the data. Dashed lines indicate 90% confidence bands.

Local Projections We also estimate local projections (c.f., specification (6)) on model-simulated data to demonstrate the persistence of investment responses to government debt. Figure 6 shows that the heterogeneous responses of capital growth are persistent in the model as in the data. Similar to the empirical results, the differential effect on firm investment increases over time, reaching its peak a few quarters after the shock.

The Role of Cash Flows We also compare the predictability of firm profitability by the government debt in the model vs. the data. As in Section 2.3.1, we focus on low-leverage firms and regress cumulative profitability on the interaction of changes in government debt with a low-leverage indicator that captures firms in the lowest leverage tercile at quarter t. Table 12 shows that the model replicates the negative response of firm profitability of firms with low leverage to government debt. These results support our model's intuition that fiscal policy affects investment primarily through a cash flow channel. Specifically, an increase in government debt leads to poor cash flows for low-leverage firms, making fiscal policy more impactful on their investment decisions.

	ROA_{t+h}							
	Data	Model	Data	Model	Data	Model	Data	Model
	h=1		h=2		h=3		h=4	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\mathbf{1}_{LowLev}$ x $\Delta DGDP$	-0.152^{***}	-0.033	-0.208^{*}	-0.088	-0.251	-0.170	-0.338^{*}	-0.279
	(-2.639)		(-1.796)		(-1.515)		(-1.709)	
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.374	0.164	0.469	0.265	0.485	0.369	0.490	0.470

Table 12: This table reports the data-implied vs. model-implied coefficient estimates from running the following specification::

$$ROA_{i,t+h} = \alpha_i + \alpha_t + \beta \mathbf{1}_{LowLev} \Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $ROA_{i,t+h}$ is the firm's cumulative gross profit over the horizon h normalized by its assets at quarter t, $\mathbf{1}_{LowLev}$ represents a dummy variable that is 1 if the firm is at the lowest leverage tercile and 0 otherwise at quarter t. $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, α_t represents time-fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, and profitability. We standardize demeaned leverage over the entire sample. Standard errors are clustered two-way at the firm and quarter levels. T-stats are reported in parentheses.

Inspecting the Mechanism We investigate the sources of heterogeneous firm responses by examining whether changes in government debt affect investment through the cash flow or discount rate channels. As we discussed in Section 4, fiscal policy affects cash flows mainly through its impact on the tax rate and the capital price. As such, we first quantify the cash flow channel of fiscal policy by feeding in the aggregate path of tax and capital price while holding the discount rate fixed at its steady state, and simulate a new transition path for the economy. Second, we evaluate the discount rate channel of fiscal policy by solely feeding in the path of real interest rate while keeping all other aggregate quantities fixed at their steady state, and simulate another transition path for the economy. For each transition path, we then estimate a panel regression on the simulated data for firms in low and high leverage terciles separately.

Figure 7 presents the regression coefficients on the change in government debt. The figure shows that the heterogeneous responses in our model are driven by the cash

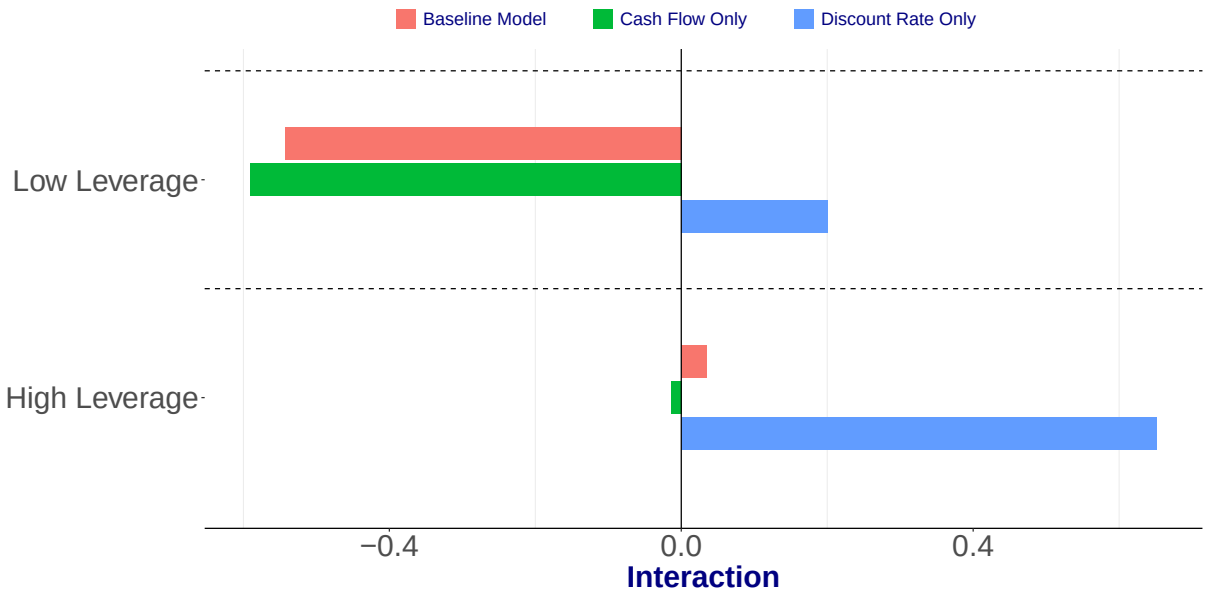


Figure 7: Inspecting the Mechanism This figure displays the investment responses of firms with low vs. high leverage to the changes in government debt with the simulated data in counterfactual economies. "Baseline Model" refers to our calibrated model. "Cash Flow Only" feeds the path of aggregate tax and capital price while keeping the discount rate fixed at the steady state. "Discount Rate Only" feeds only the path of real interest rate (hence, the stochastic discount factor) while keeping other aggregate quantities fixed at the steady state.

flow channel of fiscal policy. In the baseline calibration (orange bars), firms in the lowest leverage tercile reduce their investment in response to changes in government debt, consistent with the data. Similarly, the muted (though slightly positive) investment response of high-leverage firms to government debt in the baseline calibration aligns with the empirical evidence.

In the "Cash Flow Only" counterfactual economy (green bars), we observe that the negative investment response of low-leverage firms and the muted response of high-leverage firms is preserved. As low-leveraged firms have high Tobin's Q (i.e., firm valuation) and higher capital growth rates in our calibration, the cash flow effect is larger for low-leveraged firms, consistent with our intuition presented in Section 4. Those results highlight that the differential exposure of firms' cash flow to fiscal policy (c.f., Table 12) is substantial and generates heterogeneity in investment across firms, even in the absence of discount rate changes.

By contrast, the "Discount Rate Only" counterfactual economy (blue bars) reverses

the baseline results, leading to a positive investment response for both firms. In this counterfactual economy, even though the discount rate rises, the impact of fiscal policy shock on the marginal benefit of investment is minimal without a fall in cash flows (i.e., $MRPK_{t+1}$) due to the unchanged tax rate and the capital price on the transition path. However, there is still a sizeable drop in the marginal cost of investment due to higher interest savings ($\varepsilon_{Q,k_{t+1}} \frac{Q_t b_{t+1}}{k_{t+1}}$ term in Equation 25) following a rise in the discount rate. Thus, firms are more likely to invest in the absence of a countering decline in the marginal benefit of investment. Since high-leverage firms have larger loadings due to higher credit spreads (the second term in parentheses in Equation 25) on the reduction of marginal costs, their investment responds more to the fiscal shock in this counterfactual economy.

Overall, our simulation experiments underline that the cash flow channel is crucial in generating the negative investment response of firms with low leverage observed in the data.

6 Conclusion

This paper shows that financial leverage matters for the crowding-out effect of fiscal policy on corporate investment. First, we present novel empirical evidence that the semi-elasticity of investment to changes in government debt depends positively on firm leverage. Crucially, the heterogeneous responses are particularly driven by low-leverage firms, as they disinvest more than other firms in response to rising government debt. Moreover, we highlight that a rise in government debt predicts weaker cash flows, but not higher expected returns on capital or risk premiums, for low-leverage firms. Those results suggest a cash flow channel through which fiscal policy transmits to corporate investment. Second, we show that a general equilibrium model with heterogeneous firms and a fiscal rule with tax smoothing rationalizes cross-sectional evidence of the data. In the model, as in the data, low-leverage firms are also firms

with higher growth opportunities, thus with a higher exposure to expected cash flows. In our calibrated model, as in the data, a rise in government debt weakens the future cash flows of low-leverage firms with higher investment rates and Tobin's Q the most. As their marginal benefit of investment falls more with weakened expected cash flows, low-leverage firms cut investment more in response to fiscal policy.

Our work contributes to the debate on how fiscal policy impacts private economic activity. Our results highlighted the relevance of firm heterogeneity in the transmission of fiscal policy, which is mostly overlooked in the current policy debate. Future work should examine cross-sectional differences between firms besides financial leverage to assess other possible transmission channels. For parsimony, our model deliberately restricts itself to a simple preference structure in highlighting cross-sectional effects and the relevance of the cash flow channel. By contrast, previous work demonstrates a risk premium channel of fiscal policy via long-run growth risks and early resolution of uncertainty. Since both cash flow and risk premium effects could be important, a rigorous analysis of the aggregate effects of firm heterogeneity requires a model that blends and interacts with both channels. We also leave this interesting research direction for future work.

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Online Appendix

for

Public Debt and Private Investment: The Role of Firm Leverage

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IA1 Panel Data

This section describes the firm-level variables used in our empirical analysis. All variables are constructed based on quarterly Compustat data downloaded from WRDS. Sample period is from January 1990 to December 2015.

IA1.1 Sample Selection

We conduct a sample selection procedure as follows:

- First, we exclude:
    1. Firms that are not incorporated in the United States.
    2. Firms in the financial industry (SIC code between 6000 and 6700) and the utilities sector (SIC code between 4900 and 4999)
    3. Firm-quarter observations with acquisitions (*acqy*, item 91) larger than 5% of total assets
    4. Firm-quarter observations that have missing total assets.
- Next, we eliminate extreme observations:
    1. Quarterly sales growth above 1 or below -1.
    2. Investment Rate is in the top and bottom 0.5% of the distribution.
    3. Leverage higher than 10.
    4. Cash ratio is in the top and bottom 0.5% of the distribution.
- After sample selection, we also winsorize all control variables at the top and bottom 0.5% of the observations.

IA1.2 Data Construction

The definition of variables follow standard procedures in the literature.

1. *Investment* ($\Delta \log k_t$) is given by the log difference of the capital stock k. First, we set k as the level of gross plant, property, and equipment ($ppegtq$) in the first period in which this variable is non-missing. Staring from this period, we find cumulative capital stock by adding the changes of net plant, property, and equipment ($ppentq$) to k in each period. If an observation is missing, we use linear interpolation to approximate a $ppentq$ value in between two non-missing observations. If two or more consecutive observations are missing, we don't do any interpolation. Following Ottonello and Winberry (2020), we only consider investment series with 40 quarters or more to precisely estimate fixed effects.[12]

2. *Market Value of Assets* is given by the book value of assets (atq) plus the market value of equity ME (cshoq $\times$ prccq) plus deferred taxes (txditcq) less the book value of equity (ceqq).

3. *Market Leverage* is defined as the ratio of the total debt (the sum of short term $(dlcq)$ and long term $(dlttq)$ debt) to the market value of assets.

4. *Cash Ratio* is given by the ratio of cash and short-term investments ($cheq$) to total assets (atq).

5. *Size* is given by the log of market value of assets.

6. *Market Cap* is given by common shares outstanding ($cshoq$) times quarterly closing price of the firm ($prccq$).

7. *Tobin's* q is the ratio of market to book value of assets. Market Value of Assets is given by the book value of assets (atq) plus the market value of equity ME ($cshoq * prccq$) plus deferred taxes ($txditcq$) less the book value of equity ($ceqq$).

8. *Return on Assets* is the ratio of gross profits to lagged book value of assets. Gross profits are given by sales ($saleq$) minus cost of goods sold ($cogsq$) and sales and administrative expenses ($xsgaq$).

[12] Our results are qualitatively similar if include investment spells less than 40 quarters and available upon request.

9. *Operating Leverage* is the sum of cost of goods sold ($cogsq$) and selling & administrative expenses ($xsgaq$) divided by total assets. Gross profits is given by sales ($saleq$) minus cost of goods sold ($cogsq$).

10. *Sector dummies:* I follow OW to construct sector dummies at 4-digit level. The sectors are given by: (i) agriculture, forestry, and fishing: $SIC < 1000$; (ii) mining: $SIC \in [1000; 1400]$; (iii) construction: $SIC \in [1500; 1700]$; (iv) manufacturing: $SIC \in [2000; 3900]$; (v) transportation, communications, electric, gas, and sanitary services: $SIC \in [4000; 4900]$; (vi) wholesale trade: $SIC \in [5000; 5100]$; (vii) retail trade $SIC \in [5200; 5900]$; (viii) services: $SIC \in [7000; 8900]$ and public administration $SIC \in [9100; 9700]$. As discussed in Section IA1.1, our sample does not include financial and utilities firms.

IA2 Heterogeneous Responses To Changes in Government Debt: Robustness Checks

IA2.1 Instrumental Variables Approach

In Section 2.2.1 we investigated the heterogeneous response of investment to government debt using a two-stage least squares (2SLS) instrumental variable analysis. Here, we replicate the same analysis, with a key modification: we normalize changes in federal debt held by foreign investors with lagged GDP instead of total debt. The findings in Table IA1 reveal that the first stage produces a notably high F-statistic, around 55. Moreover, the second stage confirms that the within-firm investment reactions to government debt vary and are significantly influenced by market leverage.

	1st Stage $\Delta DGDP$	2nd Stage $\Delta \log k_{t+1}$			
Leverage x $\Delta\widehat{DGDP}$		0.178***	0.181***	0.150***	0.185***
		(3.655)	(3.192)	(2.738)	(3.179)
$\Delta\widehat{DGDP}$					−0.415**
					(−2.611)
Leverage		−0.013***	−0.012***	−0.010***	−0.011***
		(−24.356)	(−23.793)	(−21.897)	(−20.614)
$\Delta FrgDebtR$	1.151***				
	(7.447)				
Firm controls		No	No	Yes	Yes
Firm FE		Yes	Yes	Yes	Yes
Sector-Time FE		No	Yes	Yes	No
Observations	184	298,799	298,799	269,638	269,638
Adjusted R^2	0.229	0.047	0.079	0.097	0.067
F Statistic	55.458*** (df = 1; 182)				

Table IA1: Heterogeneous responses to Changes in Government Debt (normalized with lagged GDP) - Instrumental Variable. This table reports first and second-stage results from the 2SLS regressions described in Equations (4) and (5), in which we instrument changes in foreign debt ratio for the changes in government debt. Firm-level controls include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize leverage over the entire sample so the units of the interaction coefficient are standard deviations relative to the mean. Standard errors are two-way clustered by firms and quarter. t-stats are reported in parentheses.

IA2.2 Cyclical Sensitivities Across Firms

We add the interaction between leverage with lagged GDP growth as a control to the baseline specification to control for differences in cyclical sensitivities across firms:

$$\Delta \log k_{i,t+h} = \alpha_{i,h} + \alpha_{s,t,h} + \beta_h Lev_{i,t-1} \Delta DGDP_t + \gamma_h Lev_{i,t-1} Y_{t-1} + \Gamma_1 h' Z_{i,t-1} + + \epsilon_{i,t,h} \tag{IA1}$$

where β_h captures the differential response of investment for firms that have higher market leverage at the time of the innovation in debt-to-gdp, and Y_t is GDP growth. Table IA2 presents the results.

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
Leverage x $\Delta DGDP$	0.140^{***}	0.133^{***}	0.107^{***}	0.124^{***}
	(5.110)	(5.154)	(4.606)	(4.724)
Leverage x GDP growth	-0.179^{***}	-0.165^{***}	-0.149^{***}	-0.201^{***}
	(-3.409)	(-3.339)	(-3.240)	(-3.916)
$\Delta DGDP$				-0.191^{*}
				(-1.898)
GDP growth				0.487^{***}
				(3.144)
Leverage	-0.021^{***}	-0.021^{***}	-0.020^{***}	-0.021^{***}
	(-25.331)	(-26.941)	(-26.869)	(-23.772)
Firm controls	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	325,639	325,639	287,058	287,058
R^2	0.053	0.056	0.066	0.063

Table IA2: This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + + \alpha_{s,t} + \beta Lev_{i,t-1} \Delta DGDP_t + \gamma Lev_{i,t-1} Y_{t-1} + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's market leverage at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability, and Y_t represents GDP growth. We standardize leverage over the entire sample so coefficients reflect standard deviations relative to the mean. Standard errors are clustered two-way at the firm and quarter levels. t-stats are reported in parentheses.

Figure IA1 presents the estimated β_h coefficients over horizon h. Compared to Figure 2, the long-run differences are estimated less precisely, with the interaction coefficient being statistically indistinguishable from zero at an horizon h =12 quarters.

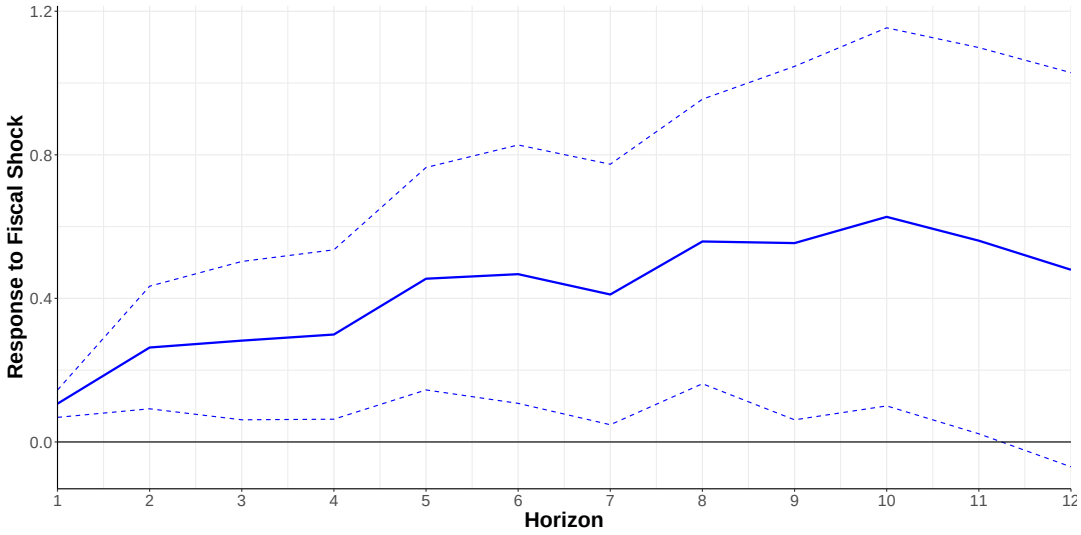


Figure IA1: This figure displays the dynamics of the interaction coefficient β_h estimated from the local projection specification (IA1) over horizon h. Dashed lines indicate the 90% confidence bands.

IA2.3 Lagged Investment

Table IA3 shows that our main results continue to hold when we control for lagged investment. The coefficient on the interaction continues to be precisely estimated and it is of similar magnitude to the one in the baseline specification (0.132 in specification (3) of both Tables 3 and IA3).

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
Leverage x $\Delta DGDP$	0.168***	0.159***	0.132***	0.149***
	(6.369)	(6.393)	(5.716)	(5.594)
$\Delta DGDP$				−0.247**
				(−2.566)
$\Delta \log k_{t-1}$	0.031***	0.030***	0.027***	0.028***
	(5.956)	(5.948)	(4.901)	(4.867)
Leverage	−0.022***	−0.021***	−0.021***	−0.022***
	(−27.014)	(−29.282)	(−28.475)	(−25.559)
Firm controls	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	323,287	323,287	285,075	285,075
R^2	0.058	0.060	0.069	0.066

Table IA3: Heterogeneous responses to Changes in Government Debt after Controlling for Lagged Investment. This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta Lev_{i,t-1}\, \Delta DGDP_t + \gamma \Delta \log k_{i,t-1} + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's market leverage at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability.We standardize leverage over the entire sample so the units of the interaction coefficient are standard deviations relative to the mean. Standard errors are two-way clustered by firms and quarter. t-stats are reported in parentheses.

IA2.4 Interaction With Other Firm-Level Covariates

Table IA4 shows that our main results are not driven by differences in firms' size, ROA, Cash, Tobin's q, or R&D.

	$\Delta \log k_{t+1}$				
	(1)	(2)	(3)	(4)	(5)
Leverage x $\Delta DGDP$	0.136***	0.133***	0.126***	0.132***	0.132***
	(5.694)	(5.718)	(5.347)	(5.717)	(5.722)
Size x $\Delta DGDP$	−0.030				
	(−0.495)				
ROA x $\Delta DGDP$		−0.057			
		(−1.546)			
Cash x $\Delta DGDP$			−0.021		
			(−0.739)		
TobinQ x $\Delta DGDP$				−0.008	
				(−0.200)	
R&D x $\Delta DGDP$					−0.112***
					(−5.122)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-Time FE	Yes	Yes	Yes	Yes	Yes
Observations	287,058	287,058	287,058	287,058	287,058
R^2	0.066	0.066	0.066	0.066	0.066

Table IA4: Heterogeneous responses to Changes in Government Debt after Controlling for Other Firm-Level Covariates. This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta Lev_{i,t-1}\, \Delta DGDP_t + \gamma z_{i,t-1}\, \Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's market leverage at quarter t, $Lev_{i,t}$ is the firm's market leverage at quarter t, $z_{i,t} \in \{size, ROA, cash, TobinQ, R\&D\}$ is the other firm-level covariate, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize leverage over the entire sample so the units of the interaction coefficient are standard deviations relative to the mean. Standard errors are two-way clustered by firms and quarter. t-stats are reported in parentheses.

IA2.5 Leverage and Financial Constraints

Table IA5 shows that shows that our main results hold when we control for the interaction between financial constraints (proxied with the Whited Wu Index) and the change in debt-to-gdp ratio.

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
Leverage x $\Delta DGDP$	0.132***		0.094***	0.131***
	(5.703)		(4.223)	(5.076)
WW Index x $\Delta DGDP$		−0.028	−0.030	−0.066*
		(−0.660)	(−0.696)	(−1.934)
$\Delta DGDP$				−0.228**
				(−2.431)
WW Index		0.0003	0.001*	0.001**
		(0.659)	(1.736)	(2.104)
Leverage	−0.021***		−0.020***	−0.021***
	(−28.723)		(−24.623)	(−22.485)
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	287,058	180,252	180,252	180,252
R^2	0.066	0.063	0.077	0.075

Table IA5: This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta Lev_{i,t-1}\, \Delta DGDP_t + \gamma WW_{i,t-1}\, \Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's market leverage at quarter t, $WW_{i,t}$ is the firm's Whited Wu index value at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize leverage over the entire sample so coefficients reflect standard deviations relative to the mean. Standard errors are clustered two-way at the firm and quarter levels. T-stats are reported in parentheses.

Figure IA2 displays the coefficient estimates from quintile sample split regressions conducted for each WW index rank.

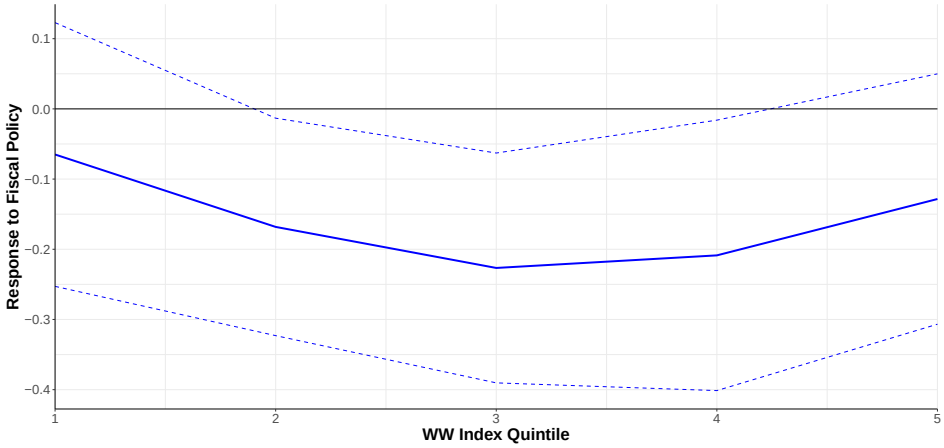


Figure IA2: Heterogeneous responses to Changes in Government Debt by Distance-to-Default Quintiles. This figure displays the coefficient estimate for the change in government debt from the following quarterly regressions for each distance-to-default quintile:

$$\Delta \log k_{i(g),t+1} = \alpha_{i(g)} + \beta_g \Delta DGDP_t + \Gamma_1' Z_{i(g),t-1} + \epsilon_{i(g),t} \ , \ g = 1, \ldots, 5$$

where $i(g)$ denotes firms i in group (WW Index quintiles) g, $\Delta k_{i(g)t}$ is the firm's investment measured as the growth in capital stock at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. $\alpha_{i(g)}$ represents firm fixed effects, and $Z_{i(g),t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. Standard errors are two-way clustered by firms and quarter. Dashed lines indicate the 90% confidence bands.

IA2.6 Leverage and Cost of Capital

Here, we investigate whether the cost of capital channel of fiscal policy matters in the cross-section of firm. To do so, we conduct standard predictive return regressions for each quintile portfolio sorted on firms' leverage as follows:

$$R^g_{t+h} = \beta^g_0 + \beta^g_1 \, \Delta DGDP_t + \epsilon^g_{t+h} \, , \; g = 1, \ldots, 5$$

where $R^g_{t+h} = \sum_{j=1}^{h} r_{t+j}$ is the h-quarter ahead cumulative excess return of value-weighted leverage sorted portfolios for group (quintile) g and $\Delta DGDP_t$ is the change in government debt at quarter t. We examine top (High-Leverage) and bottom (Low-Leverage) quintile portfolios, as well as a portfolio long in the High-Leverage stocks and short in the Low-Leverage stocks (HML-Leverage). Table IA6 shows our results.

The results suggest that a change in debt-to-GDP is not a strong predictor for the cost of capital of high-leverage and low-leverage firms across most horizons. A positive change in government debt weakly forecasts higher expected returns for Low-Leverage portfolios in long horizons more than 2 years. Still, the statistically insignificant coefficients for the HML portfolio suggest that the cost of capital of low-leverage firms is not necessarily more sensitive to government debt. Those results highlight that a channel other than the cost of capital drives the heterogeneous investment responses to fiscal policy for the leverage cross-section.

	R_{t+h}				
	h=1	h=2	h=4	h=8	h=12
High-Leverage	1.416***	3.006	4.647	4.962	3.116
	(3.180)	(1.634)	(1.481)	(1.398)	(0.754)
R^2	0.026	0.060	0.087	0.072	0.022
Low-Leverage	0.756	1.077	2.742	5.424*	6.179*
	(1.366)	(1.265)	(1.488)	(1.666)	(1.800)
R^2	0.009	0.010	0.034	0.075	0.072
HML-Leverage	0.660	1.929	1.905	−0.463	−3.063
	(1.171)	(1.157)	(0.603)	(−0.135)	(−0.537)
R^2	0.010	0.033	0.014	0.0004	0.011

Table IA6: The table reports the coefficient estimates from the following predictive regression:

$$R_{t+h} = \beta_0 + \beta_1 \, \Delta DGDP_t + \epsilon_{t+h}$$

where R_{t+h} is the h-quarter ahead cumulative excess return for value-weighted portfolios sorted by leverage and $\Delta DGDP_t$ is the change in government debt at quarter t. We report results for top quintile (High-Leverage) and bottom quintile (Low-Leverage) portfolios and a portfolio long in stocks in the High-Leverage quintile and short in stocks in the Low-Leverage quintile (HML-Leverage). Newey-West standard errors with automatic lag selection are used to compute t-statistics reported in parentheses.

IA2.7 Robustness Checks for Leverage Measures

In the main part of the paper, we use demeaned market leverage (normalized by the market value of assets) as the main proxy for firms' financial position. Table IA7 shows that our baseline results are robust to 1) using the level of market leverage measure without demeaning (Panel A) and 2) using book leverage (normalized by the book value of assets) instead of market leverage in specification 1 (Panel B).

(a) Panel A: The Level of Market Leverage - Robustness

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
Market Leverage x $\Delta DGDP$	0.155***	0.144***	0.110***	0.118***
	(6.446)	(6.421)	(4.754)	(5.634)
$\Delta DGDP$				−0.221***
				(−2.710)
Firm controls	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	298,799	298,799	269,638	269,638
R^2	0.061	0.065	0.115	0.082

(b) Panel B: Demeaned Book Leverage - Robustness

	$\Delta \log k_{t+1}$			
	(1)	(2)	(3)	(4)
Book Leverage x $\Delta DGDP$	0.086***	0.077***	0.069**	0.108***
	(3.579)	(3.185)	(2.356)	(3.377)
$\Delta DGDP$				−0.244***
				(−3.009)
Book Leverage	−0.005***	−0.005***	−0.007***	−0.009***
	(−10.156)	(−9.707)	(−12.744)	(−13.711)
Firm controls	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	298,799	298,799	269,638	269,638
R^2	0.045	0.049	0.109	0.074

Table IA7: Robustness checks for leverage measures This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + \alpha_{s,t} + \beta Lev_{i,t-1}\, \Delta DGDP_t + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{it}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's market leverage (Panel A) or demeaned book leverage (Panel B) at quarter t, $\Delta DGDP_t$ is the change in government debt at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize demeaned leverage over the entire sample so the units of the interaction coefficient are standard deviations relative to the mean. Standard errors are two-way clustered by firms and quarter. t-stats are reported in parentheses.

IA3 DGDP shock from Recursive VAR

Our main results provide evidence that low leverage firms cut investment more in response to changes in government debt. A natural concern is that the change in government debt is due to its reaction to other macroeconomic shocks so that firms are actually responding to those events. In this section, we aim to alleviate this concern by providing an econometric framework that capture shocks to government debt orthogonal to other macroeconomic variables. We then use the constructed shock to replicate our empirical analyses in Section 2.

Constructing Recursive DGDP Shock: To construct a debt shock orthogonal to macro variables, we use the vector autoregression (VAR) framework of Liu, Schmid, and Yaron (2020) that traces out the innovations to government debt from the dynamic relationship among other variables. In particular, we estimate the following eight-variable VAR with recursive ordering:

$$Z_t = \Phi Z_{t-1} + u_t$$

$$Z_t = [ffr_t, \Delta ip_t, vol_t, r_t^{ex}, DGDP, GZ_t, GZp_t, repo_t]$$

where ffr is the fed funds rate, Δip is industrial production growth, vol is stock return volatility, r^{ex} is corporate bond excess return, $DGDP$ is debt-to-GDP ratio, GZ and GZp are corporate bond spread and the premium in Gilchrist and Zakrajšek (2012), and $repo$ is the spread between general collateral repo rates and treasury bill rates. Following such a recursive ordering, we identify innovations to $DGDP$ as an increase of government debt (i.e., a debt-to-GDP shock).[13]

Figure IA3 provides the estimated impulse-responses to a shock to $DGDP$. The impact of a debt shock on other macro variables is qualitatively similar to the evidence presented in Liu, Schmid, and Yaron (2020).

[13] GZ and GZp data are available until 2015Q, therefore the sample period is from 1990Q1 to 2015Q3 for VAR analysis.

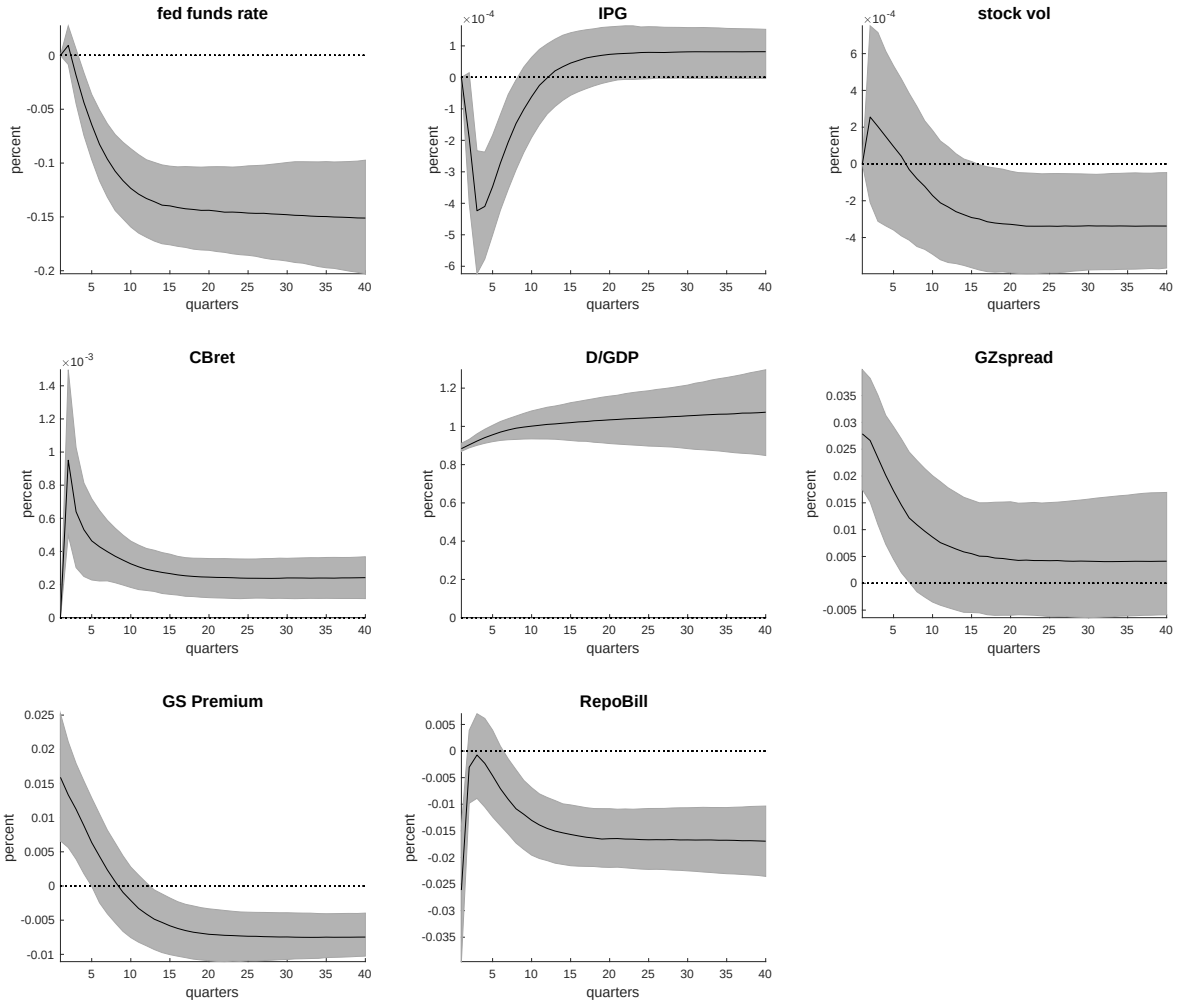


Figure IA3: The figure plots the impulse response functions to a shock to the debt-to-GDP ratio, based on the Liu, Schmid, and Yaron (2020) VAR. The VAR includes the fed funds rate (ffrt), industrial production ex growth (Δip_t), stock return volatility (vol_t), corporate bond excess return (r^{ex}), debt-to-GDP ratio (DGDP), corporate bond spread and premium in Gilchrist and Zakrajsek (2012), and the spreads between the general collateral repo rate and the treasury bill rate. We use a recursive identification strategy and identify orthogonalized innovations to the debt-to-GDP (the fifth variable) as a non-discretionary increase of government debt, that is, a debt shock. The sample period is from Q1 1973 until Q3 2016.

Empirical Results: We use the $DGDP$ shock from the recursive VAR (ε^{DGDP}) to replicate our empirical analysis that investigates the role of leverage in transmission of fiscal policy to firm investment.

	Δk_{t+1}			
	(1)	(2)	(3)	(4)
Leverage x ε^{DGDP}	0.128***	0.112**	0.099**	0.103**
	(2.754)	(2.462)	(2.180)	(2.264)
ε^{DGDP}				−0.001
				(−0.022)
Leverage	−0.028***	−0.028***	−0.022***	−0.022***
	(−27.017)	(−28.298)	(−24.044)	(−23.576)
Firm controls	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	Yes	Yes	No
Observations	445,243	445,243	384,023	384,023
R^2	0.089	0.092	0.112	0.111

Table IA8: Heterogeneous responses to a shock to the debt-to-GDP ratio, based on a VAR. This table reports the coefficient estimates from the following specification:

$$\Delta \log k_{i,t+1} = \alpha_i + +\alpha_{s,t} + \beta Lev_{i,t-1}\, \varepsilon_t^{DGDP} + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}$$

where $\Delta \log k_{i,t}$ is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's market leverage, ε_t^{DGDP} is the $DGDP$ shock from the recursive VAR, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. We standardize leverage over the entire sample so the units of the interaction coefficient are standard deviations relative to the mean. Standard errors are two-way clustered by firms and quarter. t-stats are reported in parentheses.

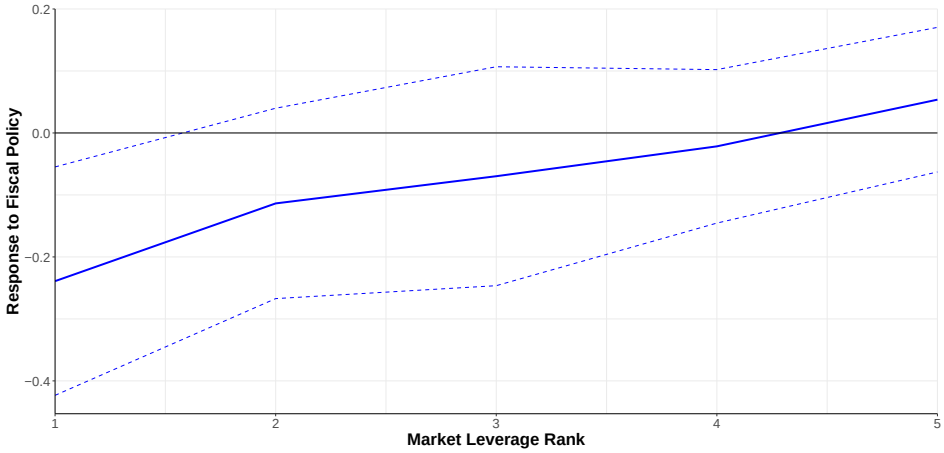


Figure IA4: Heterogeneous responses to Changes in Government Debt by Leverage Quintiles. This figure displays the interaction coefficient estimates from the following quarterly regressions for each market leverage quintile:

$$\Delta \log k_{i,t+1} = \alpha_i + +\alpha_{s,t} + \beta_i \varepsilon_t^{DGDP} + \Gamma_1' Z_{i,t-1} + \epsilon_{i,t}, \tag{IA2}$$

where Δk_{it} is the firm's investment measured as the growth in capital stock at quarter t, $Lev_{i,t}$ is the firm's market leverage at quarter t, ε_t^{DGDP} is the $DGDP$ shock from the recursive VAR at quarter t, and $\epsilon_{i,t}$ is a regression residual. α_i represents firm fixed effects, $\alpha_{s,t}$ is sector s by quarter t fixed effects, and $Z_{i,t}$ represents firm-level controls that include leverage, Tobin's q, size, operating leverage, cash ratio, and profitability. I standardize leverage over the entire sample so coefficients reflect standard deviations relative to the mean. Standard errors are clustered two-way at the firm and quarter levels. T-stats are reported in parentheses.

IA4 Model Appendix

IA4.1 Equilibrium Definition

A recursive equilibrium consists of a set of policy functions (k_{t+1}, b_{t+1}), value functions ($V_t(z_t, n_t)$), prices ($Q_t(z_t, k_{t+1}, b_{t+1})$, M_{t+1}, q_t), fiscal quantities ($\frac{G_t}{GDP_t}$, $\frac{B_t^G}{GDP_t}$), wages (w_t), aggregate taxes (τ_t), aggregate capital, production, labor and investment (K, Y, I, L) such that:

1. **Firm optimization:** Given prices M_t, q_t and aggregate state vector $\mathbf{s}$, $V_t(\Omega, \mathbf{s})$ solves the maximization problem (20) with associated policy rules $k_{t+1}, b_{t+1}, n_{t+1}$.

2. **Default:** The representative financial intermediary prices firm debt according to the pricing schedule given in (19).

3. **Fiscal Block:** Government spending ($\frac{G_t}{GDP_t}$), Debt-to-GDP ($\frac{B_t^G}{GDP_t}$) and aggregate taxes (τ_t) evolve according to the rules (11), (12) and (13), respectively.

4. **Aggregate Capital:** The aggregate capital K_t follows the law of motion given by (14).

5. **Household Optimization:** The Euler equation (23) holds. The stochastic discount factor is given by $M_{t+1} = \beta \left(\frac{C_t}{C_{t+1}} \right)$. Wages are given by $w_t = \Psi C_t$.

6. **Market Clearing:** At each t, aggregate capital is given by $K_t = \int_j k_{jt} d\mu_t(\Omega)$, aggregate investment is given by $I_t = \int_j i_{jt} d\mu_t(\Omega)$, and aggregate production is given by $Y_t = \int_j y_{jt} d\mu_t(\Omega)$. For all $\mathbf{s}$, aggregate consumption holds for the general equilibrium condition $C_t = Y_t - I_t - N * \xi$, where N is the total number of firms.

7. **Firm Distribution:** The joint distribution of heterogeneous firms $\hat{\mu}$ includes firms that survive and firms that enter the economy. For a mass $\bar{\mu}$ of new firms that

enter the economy, the distribution of firms is given by:

$$\begin{aligned}\hat{\mu}_t(z,n) = &\int \left(\pi_d \chi^1(n_t) + (1-\pi_d)\chi_t^2(z_t,n_t)\right) d\mu_t(z,n) \\ &+ \bar{\mu}_t \int \left(\pi_d \chi^1(n_t) + (1-\pi_d)\chi_t^2(z_t,n_t)\right) d\mu_{Ent}(z)\end{aligned} \tag{IA3}$$

The joint distribution $\hat{\mu}$ evolves consistent with firm decision rules.

IA4.2 Solution Method

Solution Method To quantitatively analyze the model, we compute the perfect foresight transition path of the economy in response to shocks to government spending and debt-to-gdp policy. Specifically, the economy is initially at the steady state and simultaneously receives one time unexpected shocks of ε^{gy} and ε^{dgdp} to the governments expenditure stream (11) and the public debt stream (12), respectively. After the initial shocks, agents have perfect foresight of all aggregate variables for all periods as the economy converges back to the steady state over 10 quarters.

We initially guess the paths for the price of capital and marginal utility of consumption, and then solve for the firm's problem backwards by assuming that the economy will reach the steady state in the final period. Then, we check whether aggregate investment and aggregate consumption in the transition path is numerically close enough to the quantities implied by the prices, i.e., whether the market is cleared. If our initial guesses on prices don't provide an equilibrium, we update the prices, re-run the transition path again until convergence is achieved. We assume convergence when the maximum error for aggregate investment and consumption becomes less than 0.05%.

IA4.3 Aggregate Impulse Responses

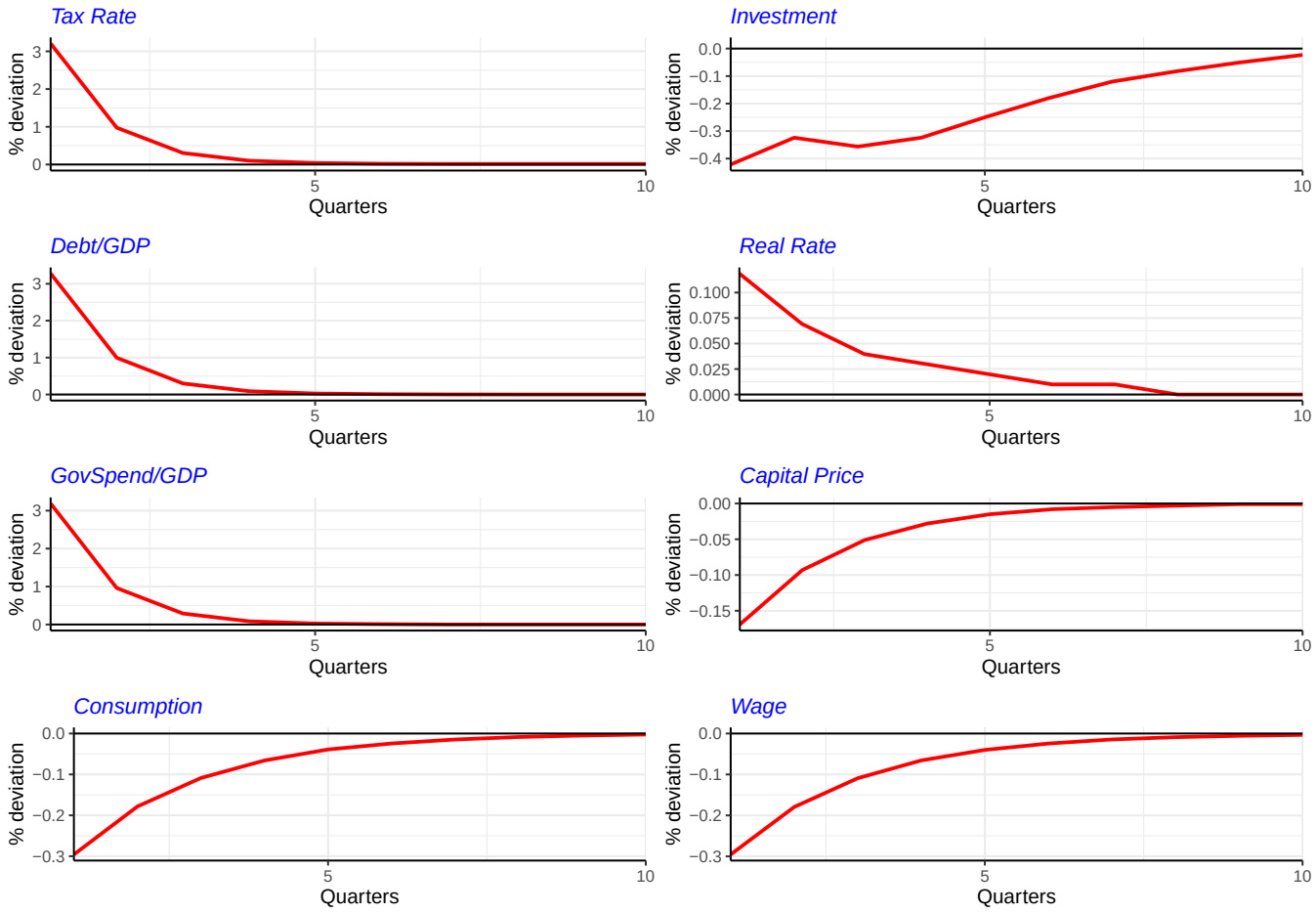


Figure IA5: Aggregate IRFs from the Model. This figure displays model-implied aggregate impulse-responses to shocks to one-time unexpected shocks of ε^{gy} and ε^{dgdp} to the governments expenditure stream (11) and the public debt stream (12). The details on the solution method are given in IA4.2.