

Online Appendix for
“Reassessing the Relevance of Financial Shocks
in an Estimated Heterogeneous Firm Model”

Xing Guo

Bank of Canada

A. Data and Empirical Evidence

A.1 Cross-sectional Variation in Investment and Financing

Data I use the Compustat quarterly data between 1985Q1 and 2016Q4 to measure the cross-sectional variation in firms' investment and financing behaviors. All the non-US firms and those from financial sectors (SIC 6000-6999), regulated utility sectors (SIC 4900-4999), and quasi-governmental sectors (SIC 9000-9999) are removed from the sample. All nominal values are converted to real values using the GDP deflator with 2015 as the base year. Following the standard cleaning procedure used in the literature, I dropped all the firms with total book value of assets (`atq`) smaller than \$1 million. I also discard the observations with mergers and acquisitions (`aqcy`) larger than 5% of their book value assets since there could be significant changes in the capital structure of these firms.

Measurement I measure the firm-level investment rate by the ratio between the investment flow, which equals to the sum of the change in *net value of property, plant, and equipment* (`ppentq`) and the *depreciation* (`dpq`), and the lagged *net value of property, plant, and equipment*. The firm-level leverage ratio is measured by the ratio between the total debt stock, which is measured as the sum of the *debt in current liability* (`d1cq`) and the *long-term debt* (`d1ttq`), and the lagged *total assets* (`atq`). The firm-level equity financing flow is measured by the difference between the gross issuance of common and preferred stocks and the sum of dividends (`dvy`) and stock repurchase (`prstkcy`)²⁸. Here, the gross issuance of common and preferred stocks is not directly measured by the item `sstky` reported in Compustat because a large part of the stock issuance reported in this item actually comes from employees exercising their stock options. These options are typically viewed as compensation, with years of delay between being granted and being exercised. To be consistent with the model where financing flows are determined by managerial decisions in the current

²⁸All the flows reported in accumulated figures have been converted to the non-cumulative figure before being used to construct the firm-level flows.

period, I eliminate this employee-driven equity issuance by applying the filter proposed by [McKeon \(2015\)](#). The debt financing flow is measured as the difference between the sum of the changes in current debt (`clcchy`) and issuance of long-term debt (`dltisy`), and the reduction of long-term debt (`dltry`).

Extracting the Difference across Leverage Groups Since firms' size and leverage are highly correlated in the distribution and firms' size plays an important role in determining firms' desire to invest even without financial frictions, we need to control the firms' size when extracting the effects of firms' financial positions on their investment. Following this reasoning, I first divide the firms into two groups by population-level median size, where I measure a firm's size by its lagged total assets. Then within each size group, I use the median lagged leverage within each size group to further split the firms into two subgroups. Moreover, due to the importance of ex-ante heterogeneity in shaping the observed heterogeneity in firms' size and leverage, I first filter out the firm-level fixed effects in their size and leverage, then use the filtered characteristics to categorize the firms into different size-leverage groups. When I run the regression (13) to extract the difference between high and low-leverage firms, I use firms' size as the weight so the coefficient β can be interpreted as the difference between the aggregates of high and low-leverage sub-samples.

A.2 Aggregate Financing Flows

Data I measure the quarterly aggregate financing flows using the Financial Accounts of the United States (Z.1). For the gross equity issuance flows, I use the underlying details of equity issuance and retirement by non-financial corporations in the United States published on <https://www.federalreserve.gov/releases/efa/efa-project-equity-issuance-retirement.htm>.

Measurement The debt financing flow is measured as the sum of *net issuance of debt security by corporate sector* (`FA104122005.Q`), *net issuance of loan by corporate sector* (`FA104123005.Q`),

and *net issuance of loan by non-corporate sector* (FA114123005.Q). The equity financing flow is measured as the sum of *net equity issuance by corporate business* (FA103164103.Q) and *net change of proprietors' equity in noncorporate business* (FA112090205.Q), net of *net dividends paid by corporate business* (FA106121075.Q). The aggregate net financing flows are normalized by the lagged total asset. The total asset k_t is constructed using the equation

$$k_{t+1} = k_t - \text{Depreciation}_t + \text{Investment}_t, \quad (\text{A.1})$$

where depreciation is measured by the sum of *depreciation in corporate business* (FA106300005.Q) and *non-corporate business* (FA116300005.Q); investment is measured as the sum of *capital expenditure in corporate business* (FA105050005.Q) and *non-corporate business* (FA115050005.Q). Then we construct the time-series of total asset by choosing k_{1952Q1} such that the ratio between k_t and total gross value added, which is measured as the sum of *gross value added in corporate business* (FA106902501.Q) and *non-corporate business* (FA116902501.Q), does not display any trend between 1952Q1 and 2016Q4²⁹. As for the gross equity issuance, since there is no data available for the equity issuance of non-corporate business, I measure the aggregate gross equity issuance flow by the gross equity issuance of corporate business normalized by the lagged total assets of corporate business. The gross equity issuance of corporate business includes both the equity issuance through IPO and SEO by the public firms, as well as the equity issuance through venture capital, private equity, and private placement by private firms³⁰. The total asset of corporate business is constructed using the same method as I use in constructing the aggregate-level total asset.

Discussion of the Aggregate Financing Flows Table A.1 summarizes the average size and cyclical properties of the aggregate financing flows constructed in this paper. There are two key takeaways. First, on average, the magnitude of gross equity issuance is comparable

²⁹I follow Jermann and Quadrini (2012) to construct the time-series of capital stock in this way.

³⁰See the William R. *et al.* (2017) for more details about the underlying data source.

to debt financing flow. This implies that equity financing market is not a negligible source of financing for the aggregate economy, even though most of firms are not issuing equity in each period. Second, gross equity issuance behaves quite differently from net equity financing flow over the business cycle: net equity financing is counter-cyclical, but gross equity issuance is pro-cyclical; debt financing is positively correlated with gross equity issuance, but negatively correlated with net equity financing flow. These differences highlight that the time-variation of net equity financing is mostly driven by the dividend payment flow, but not by gross equity issuance. Due to this difference, I use the time-variation in aggregate gross equity issuance, rather than net equity financing flow, in the estimation to help identify the equity financing shocks.

Table A.1: Summary Statistics of Aggregate Financing Flows

	Average (annual, %)	Correlation	
		w/ log-GDP	w/ debt fin.
Debt financing flow	2.67	0.78	1
Net equity financing flow	-3.14	-0.57	-0.61
Gross equity issuance flow	2.07	0.44	0.39

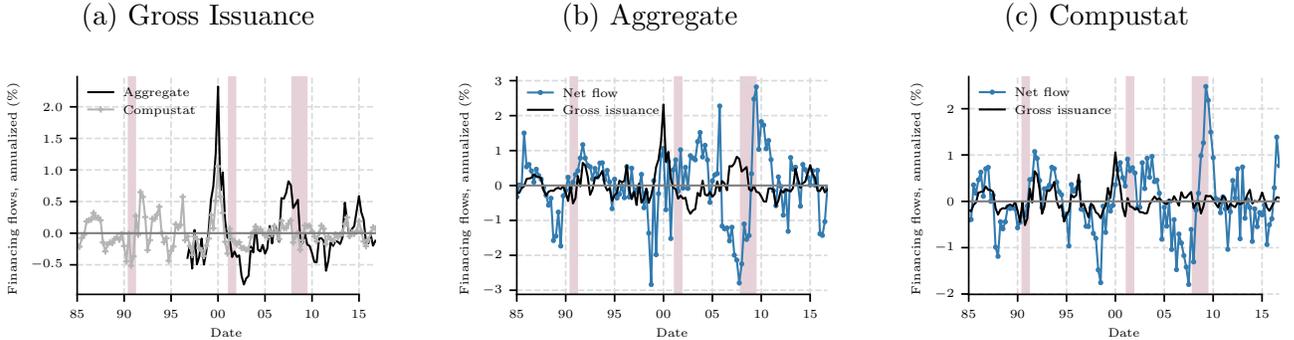
Notes: See the text for the details about the measurement of these aggregate financing flows. All the time-series are HP filtered before calculating the correlation.

Gross Equity Issuance in the Estimation The reported aggregate gross equity issuance of corporate sector starts from 1996Q4. For the periods between 1985Q1 and 1996Q3, I use the time-variation in the gross equity issuance of Compustat firms. As shown in Panel (a) of Figure A.1, the gross equity issuance of Compustat firms was highly correlated with the aggregate before 2001. But since the burst of tech bubble in 2001, IPO became less attractive since and private equity has grown much faster than the public equity issuance³¹. As shown in Panel (b) and (c) in Figure A.1, gross equity issuance and net equity financing flows, both at the aggregate level and within the Compustat sample, were highly correlated before

³¹This fact has been discussed extensively in the literature, e.g. Gao *et al.* (2013) and Ewens and Farre-Mensa (2020).

2001 but diverged dramatically after 2001. This further highlights the important distinction between gross and net equity financing flows in terms of their cyclical properties.

Figure A.1: Equity Financing Flows over the Business Cycle



Notes: See the text for the details of measurement. In Panel (b), the *Gross issuance* combines the gross issuance flow at the aggregate-level since 1996Q4 and the gross equity issuance flow of Compustat firms during 1985Q1 and 1996Q4. All the time-series are converted to the annual rate and HP filtered.

A.3 Aggregate Non-financial Quantities and Prices

I use the data from FRED to measure the aggregate non-financial quantities and prices used in the estimation. The output Y_t is measured by the real GDP (GDPC1); the aggregate investment Y_t^I is measured by the real gross private domestic investment (GDPIC1); the consumption is measured by real private consumption (PCECC96); and the government spending G_t is the real government expenditure and investment (GCE). The nominal wage W_t is measured by the manufacturing hourly earnings (USAHOUREAQISMEI); the nominal price level P_t is measured by the GDP deflator (USAGDPDEFQISMEI); the nominal capital goods price Q_t is measured by the price deflator of investment (INVDEF). Following Bayer *et al.* (2020), I use the shadow Federal Funds Rate constructed by Wu and Xia (2016) as the nominal interest rate R_t in the estimation due to concern about the nominal rate hitting the zero lower bound after 2008. This shadow rate started from 1990Q1, but because it was very close to the effective Federal Funds rate between 1990 and 2007, I use the quarterly average of the effective Federal Funds Rate (FEDFUNDS) as the nominal rate before 1990 in the estimation. All the time-variations are linearly detrended and HP filtered before being taken into estimation.

B. Baseline Model

B.1 The Setup of New Keynesian Block

I present the decisions in log-linearized forms in this section, where \tilde{X}_t denotes the deviation of X_t from its detrended steady-state level.

Final Goods Supply and Inflation Dynamics The final good producers maximize their expected total discounted profits by choosing their input of retailed goods. Given the demand from final good producers, retailers maximize their expected total discounted profits by setting the nominal price of their goods. Following [Calvo \(1983\)](#), it is assumed that only a randomly chosen fraction $(1 - \xi_p)$ of the retailers can reset their price in each period. The decisions of final good producers and retailers jointly determine the aggregate supply of final goods and inflation dynamics:

$$\tilde{Y}_t = \tilde{Y}_t, \tag{B.2}$$

$$\begin{aligned} \tilde{\pi}_t = & \frac{\xi_p \cdot \iota_p}{\xi_p \cdot (1 + \iota_p \cdot \Gamma \cdot \Lambda_{ss})} \cdot \tilde{\pi}_{t-1} \\ & + \frac{(1 - \xi_p) \cdot (1 - \xi_p \cdot \Gamma \cdot \Lambda_{ss})}{\xi_p \cdot (1 + \iota_p \cdot \Gamma \cdot \Lambda_{ss})} \cdot (\tilde{p}_t + \eta_{p,t}) + \frac{\xi_p \cdot \Gamma \cdot \Lambda_{ss}}{\xi_p \cdot (1 + \iota_p \cdot \Gamma \cdot \Lambda_{ss})} \cdot \mathbb{E}_t [\tilde{\pi}_{t+1}], \end{aligned} \tag{B.3}$$

where Y_t is the total output of final goods, \hat{Y}_t is the total output of homogeneous intermediate goods, and \hat{p}_t is the intermediate good price in real terms.

Labor Demand and Wage Dynamics The labor packer maximizes their expected total discounted profits by choosing their input of differentiated labor services. Given the demand from the labor packer, labor unions maximize their expected total discounted profits by setting the nominal wage of their differentiated labor service. It is also assumed that only a randomly chosen fraction $(1 - \xi_w)$ of the labor unions can reset their wages in each period. The decisions of the labor packer and labor unions jointly determine the aggregate demand

for the households' labor and wage dynamics:

$$\tilde{N}_t = \tilde{L}_t, \quad (\text{B.4})$$

$$\begin{aligned} \tilde{w}_t = & \frac{(1 - \xi_w) \cdot (1 - \xi_w \cdot \Gamma \cdot \Lambda_{ss})}{1 + \xi_w^2 \cdot \Gamma \cdot \Lambda_{ss}} \cdot (\hat{w}_t + \eta_{w,t}) - \frac{\xi_w \cdot (1 + \Gamma \cdot \Lambda_{ss} \cdot \iota_w)}{1 + \xi_w^2 \cdot \Gamma \cdot \Lambda_{ss}} \cdot \tilde{\pi}_t \\ & + \frac{\xi_w}{1 + \xi_w^2 \cdot \Gamma \cdot \Lambda_{ss}} \cdot (\iota_w \cdot \tilde{\pi}_{t-1} + \tilde{w}_{t-1}) + \frac{\xi_w \cdot \Gamma \cdot \Lambda_{ss}}{1 + \xi_w^2 \cdot \Gamma \cdot \Lambda_{ss}} \cdot \mathbb{E}_t [\tilde{w}_{t+1} + \tilde{\pi}_{t+1}], \end{aligned} \quad (\text{B.5})$$

where \hat{N}_t denotes the quantity of households' labor, L_t denotes the total final labor service used by the intermediate good firms, and w_t and \hat{w}_t are the wages of final labor service and household labor in real terms.

Capital Good Supply and Capital Good Price Dynamics The investment good producer and the capital good producer maximize their expected total discounted profits by choosing their inputs Y_t^I and output \hat{I}_t . Based on their optimal choice, the total supply of investment good and the price of investment good satisfies:

$$\tilde{I}_t = \tilde{Y}_t^I - \eta_{q,t}, \quad (\text{B.6})$$

$$\tilde{q}_t = \eta_{q,t}. \quad (\text{B.7})$$

The total supply of the capital good and the capital good price dynamics are:

$$\tilde{I}_t = \tilde{I}_t \quad (\text{B.8})$$

$$\tilde{q}_t = \hat{q}_t + \phi^I \cdot \left[\left[\tilde{I}_t - \tilde{I}_{t-1} \right] - \Lambda_{ss} \cdot \mathbb{E}_t \left[\tilde{I}_{t+1} - \tilde{I}_t \right] \right], \quad (\text{B.9})$$

where \hat{q}_t and q_t denote the prices of the investment good and capital good in real terms.

Labor Supply and Stochastic Discounting Factor Dynamics The representative household maximizes its utility specified in (8) subject to their budget constraint in (9).

The consumption Euler equation and labor supply are:

$$0 = \mathbb{E}_t \left[\tilde{\Lambda}_{t,t+1} + \tilde{R}_t - \tilde{\pi}_{t+1} \right] \quad (\text{B.10})$$

$$\tilde{w}_t = \eta_{u,t} + \nu_l \cdot \tilde{N}_t - \widetilde{MU}_t. \quad (\text{B.11})$$

The dynamics of the real stochastic discounting factor (SDF) is disciplined by:

$$\widetilde{MU}_t = \eta_{u,t} - \nu_c \cdot \left[\frac{1}{1-h} \cdot \tilde{C}_t - \frac{h}{1-h} \cdot \tilde{C}_{t-1} \right] \quad (\text{B.12})$$

$$\tilde{\Lambda}_{t,t+1} = \widetilde{MU}_{t+1} - \widetilde{MU}_t. \quad (\text{B.13})$$

B.2 Compustat Subsample: Model vs. Data

To evaluate the sample selection I use to construct the counterpart of Compustat sample in the model, I compute a group of sample characteristics of public firms in both model and data. As summarized in Table B.2, the Compustat sample selected in the model matches the data well overall. The only big gap between the model and data occurs in relative size difference between public and private firms: the size difference in the model is a magnitude smaller than that in data. This is mostly due to the lack of ex-ante heterogeneity in the model. For the very same reason, it is very important to filter out the firm-level fixed effects in firms' size and financial positions when calculating the moments about the cross-sectional variation in firms' financial positions and investment behaviors.

B.3 External Validation of the Estimated Model

In this section, I discuss how the effects of financial and monetary shocks implied from the estimated baseline model compare with the empirical evidence.

Table B.2: Subsample Characteristics of Public Firms: Model vs. Data

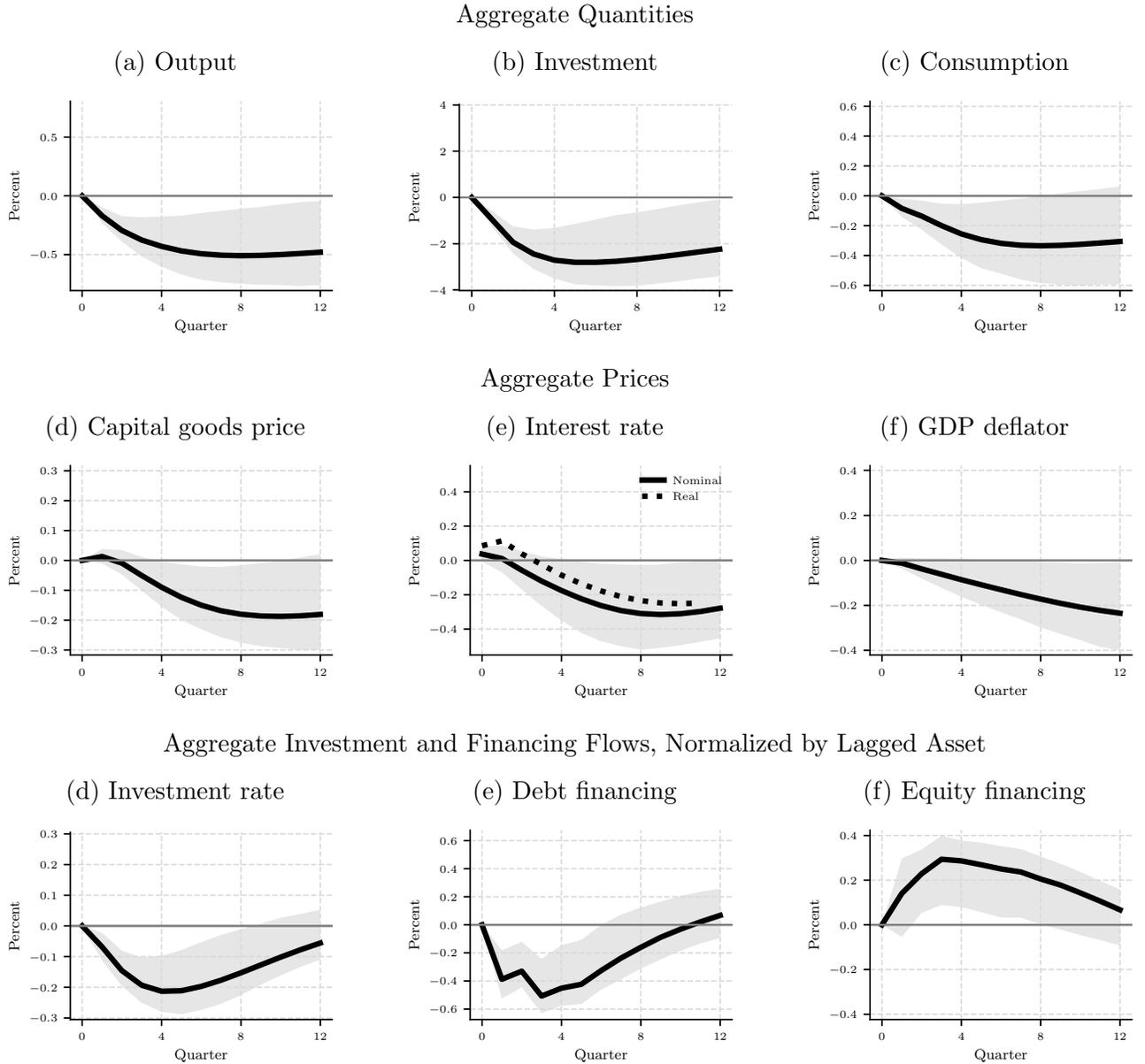
	Model	Data
Panel 1. Relative to private firms		
Average age: $\frac{\mathbb{E}[age_j public]}{\mathbb{E}[age_j private]}$	1.52	2.18
Average employment: $\frac{\mathbb{E}[l_j public]}{\mathbb{E}[l_j private]}$	1.7	62
Dispersion of annual employment growth: $\frac{\text{std}[\frac{l_{j,t}-l_{j,t-1}}{(l_{j,t}+l_{j,t-1})/2} public]}{\text{std}[\frac{l_{j,t}-l_{j,t-1}}{(l_{j,t}+l_{j,t-1})/2} private]}$	0.67	0.65
Panel 2. Relative to the full firm population		
Average leverage (weighted): $\frac{\mathbb{E}[d_j public]/\mathbb{E}[k_j public]}{\mathbb{E}[d_j all\ firms]/\mathbb{E}[k_j all\ firms]}$	0.93	0.98
Average investment rate (weighted): $\frac{\mathbb{E}[i_j public]/\mathbb{E}[k_j public]}{\mathbb{E}[i_j all\ firms]/\mathbb{E}[k_j all\ firms]}$	1.03	0.88

Notes: This table summarizes the sample characteristics of public firms in the model and data. In the model, the statistics are calculated based on a sample of the largest firms by output that account for 44% of the aggregate output. In the data, the statistics are calculated based on the Compustat sample. The empirical moments in Panel 1 come from the Table 17 in [Ottonello and Winberry \(2020\)](#). The empirical moments in Panel 2 are calculated based on the Compustat data and the statistics from [Crouzet and Mehrotra \(2020\)](#) and [Zwick and Mahon \(2017\)](#).

B.3.1 Effects of Financial Shocks

Empirical specification Since there is no available financial shock that directly measures the variation in equity issuance cost or the tightness of collateral constraint, I use the excess bond premium (EBP) shocks constructed by [Gilchrist and Zakrajšek \(2012\)](#) for the validation checks of the estimated baseline model. I examine the effects of EBP shocks using the exact VAR specification as [Gilchrist and Zakrajšek \(2012\)](#). The VAR includes the following endogenous variables: (1) log-difference of real personal consumption expenditures (PCE); (2) log-difference of real private domestic investment (PDI); (3) log-difference of real GDP; (4) growth rate of real capital goods price measured as the ratio between the deflator of private investment and the deflator of GDP; (5) inflation as measured by the log-difference of the GDP price deflator; (6) the quarterly average of the EBP; (7) the quarterly (value-weighted) excess stock market return from CRSP; (8) the ten-year (nominal) Treasury yield; and (9) the shadow federal funds rate constructed by [Wu and Xia \(2016\)](#). The VAR is estimated over the same sample period as in the baseline model estimation, i.e., from 1985Q1 to 2016Q4, using two lags of each endogenous variable.

Figure B.2: Empirical Aggregate Effects of EBP Shocks



Notes: This figure depicts the effects of an orthogonalized shock to the excess bond premium (see the text of Appendix B.3 for details). The responses of output, investment, consumption, investment goods price, and GDP deflator have been accumulated. In Panel (e), the response of real interest rate is calculated as the difference between the response of nominal interest rate and the leaded response of inflation rate. Shaded bands indicate the 90-percent confidence intervals based on 1,000 bootstrap replications.

Model vs. Data: Aggregate Effects Figure B.2 summarizes the aggregate effects of an orthogonalized shock to the EBP. Following a one-standard-deviation EBP shock, there is a contraction of output by 0.5%, investment by 3%, and consumption by 0.3%. In terms of

aggregate prices, the EBP shock also leads to a decrease in real capital goods price by 0.2%, a reduction of real interest rate by 0.2%, and a decrease in aggregate price level by 0.2%. In terms of the magnitudes, the peak impacts of both equity and debt financing shocks in the estimated model align well with these estimates.

To examine the responses of aggregate financing flows, I replace the aggregate investment in the VAR with the aggregate flows of investment, equity financing, and debt financing. All these flows are measured using the Financial Accounts of the United States (Z1) data and normalized by the lagged total asset (see Appendix A.2 for details of measurement). The EBP shock triggers a decline in investment and debt financing flows, but an increase in the net equity financing flows. This combination of responses implies that the EBP shocks, which capture the disturbance in the debt market by construction, are more or less isomorphic to the debt financing shocks in the model. Moreover, the magnitudes of the peak responses of debt and equity financing flow to the debt financing shocks in the estimated model (see Figure 2 for details) are comparable to the empirical estimates.

All the above comparisons validate the estimated baseline model to capture the financial and non-financial aggregate effects of the financial disturbances in the U.S. economy. This is crucial for the objective of this paper to evaluate the empirical relevance of different GE dampening mechanisms in the transmission of financial shocks.

Model vs. Data: Heterogeneous Effects To investigate how different firms' investment responds differently to financial shocks, I first run the regression³²

$$y_{j,t} = \alpha_j + \gamma \cdot \mathbf{1}_{\mathcal{I}_{j,t}^{\text{size}} = \text{small}} + \sum_{\tau,l} \beta_{\tau}^l \cdot \mathbf{1}_{\mathcal{I}_{j,t}^{\text{leverage}} = l} \cdot \mathbf{1}_{t=\tau} + \epsilon_{j,t} \quad (\text{B.14})$$

³²In this regression, α_j is the firm-level fixed effects to absorb the ex-ante heterogeneity in firms' investment rate. The estimates for β_{τ}^l capture the time-variation in the average investment rate of the firms in the leverage group l . The regression is estimated using firms' size as the weight so that the estimates can be interpreted as the variations in the aggregate investment rates of each group.

using the Compustat data to extract the time-variation in the average investment rates of each leverage group $l \in \{\text{low}, \text{high}\}$ after controlling for their size group. Then I replace the aggregate investment in the baseline VAR with these time-variations and summarize the group-wise responses in Panel 1 of Figure B.3. Following an adverse EBP shock, the high-leverage firms' investment rate experiences a significant decline. The low-leverage firms' investment increase temporarily, but this increase is not statistically significant. This implies that some low-leverage firms do increase their investment rate after the adverse financial shocks, but these firms do not play a dominant role within the low-leverage firms. The response of the aggregate investment rate further validates this point. There is a significant decrease in the aggregate investment rate, which clearly shows that the negative comovement of different firms' investment responses does not significantly cancel out the aggregate effects of financial shocks.

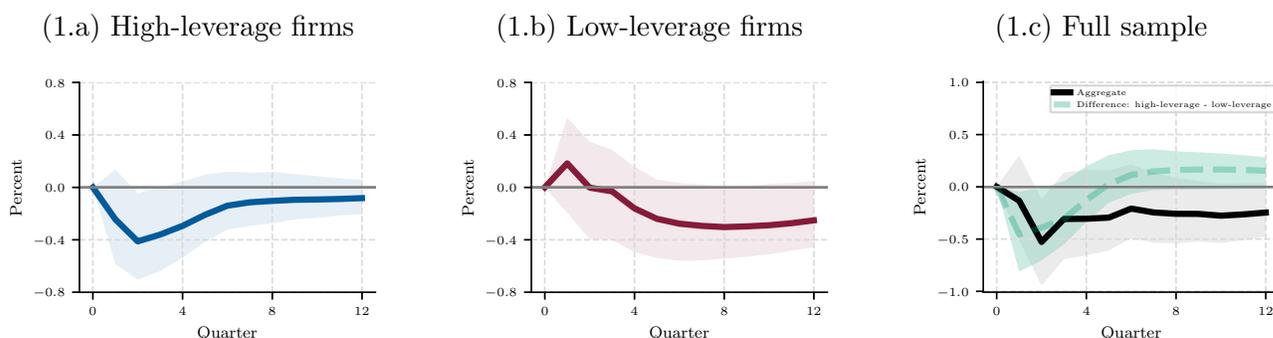
In Figure B.3, Panel 2 and 3 summarize the model-implied heterogeneous investment responses across different leverage groups. Following an adverse financial shock, all high-leverage firms reduce their investment. Among the low-leverage firms, some firms that are not financially constrained do increase their investment given the lower investment cost, but these firms' responses do not stop the aggregate investment rate from declining. Consistent with the empirical evidence, the model also implies that some low-leverage firms increase investment following the adverse financial shocks, but these firms' responses play a limited role in shaping the aggregate investment response.

To further check the model's empirical plausibility regarding its implied heterogeneity in firms' investment responses, I also examine the response of the difference between high and low-leverage firms' average investment rate, i.e., $\hat{\beta}_t^{\text{high}} - \hat{\beta}_t^{\text{low}}$, to the EBP shocks and compare it with the model implication. As shown in Figure B.3, following an adverse EBP shock, high-leverage firms decrease their investment rate significantly more than low-leverage firms. Consistent with the empirical evidence, the model also implies a larger decline in high-leverage firms' investment rates following the adverse financial shocks. What's more, the

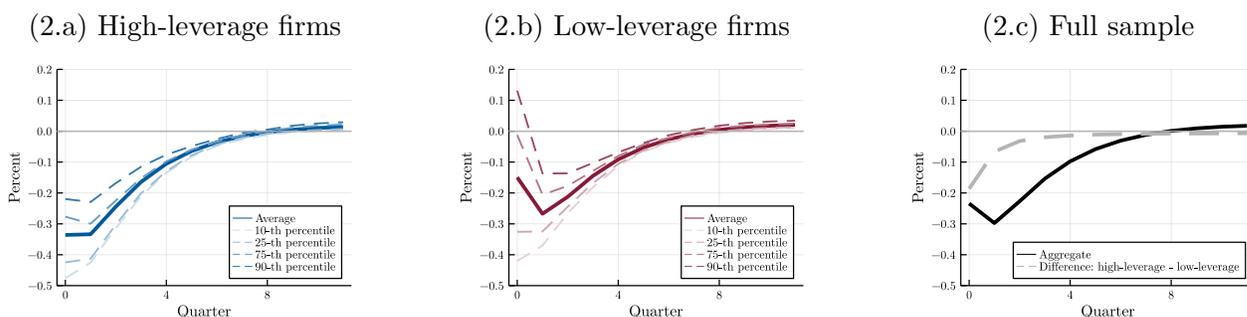
magnitude of the difference is also comparable with its empirical counterpart.

Figure B.3: Heterogeneous Effects of Financial Shocks: Model vs. Data

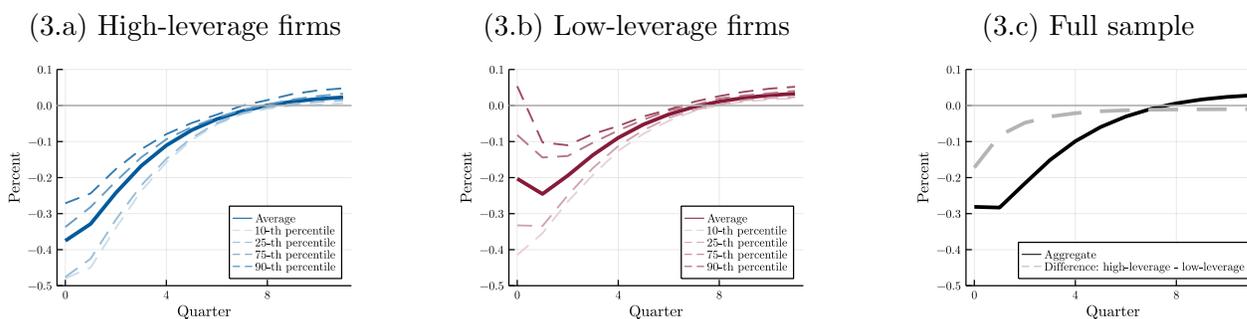
Panel 1: Empirical Investment Rate Responses to EBP Shocks



Panel 2: Model-implied Investment Rate Responses to Debt Financing Shocks



Panel 3: Model-implied Investment Rate Responses to Equity Financing Shocks



Notes: Panel 1 depicts the effects of an orthogonalized shock to the excess bond premium on firms’ investment rates (see the text of Appendix B.3 for details), where the shaded bands indicate the 90-percent confidence intervals based on 1,000 bootstrap replications. Figure (1.a) and (1.b) are based on the average investment rate of high and low-leverage firms that are extracted using the regression (B.14). In plot (1.c), the response labeled by “*Difference: high-leverage - low-leverage*” indicates the response of the difference between the high-leverage and low-leverage firms’ average investment rate. Panels 2 and 3 depict the model-implied investment rate responses to one-standard-deviation adverse debt and equity financing shocks. The empirical evidence in Panel 1 is based on the Compustat sample. For the consistency between model and data, the model implications in Panels 2 and 3 are produced based on the model-counterpart Compustat sample. “*High-leverage firms*” and “*Low-leverage firms*” refer to the firms whose leverage ratio is above and below the median within their size group, respectively.

B.3.2 Effects of Monetary Shocks

Empirical specification I examine average impacts of monetary policy shocks on firms' investment using the regression specification³³:

$$\Delta \frac{i_{j,t}}{k_{j,t}} = \alpha_j + \alpha_{s,q} + \alpha_{fq} + \beta^{avg} \cdot \Delta R_t + \gamma_X \cdot X_{j,t} + \gamma_Y \cdot Y_t + \varepsilon_{j,t}, \quad (\text{B.15})$$

where α_j , $\alpha_{s,q}$, and α_{fq} separately denotes the firm fixed-effect, sector-time fixed-effect, and the fixed-effect for the starting quarter of each firm's fiscal year; $X_{j,t}$ denotes the firm-level controls including the firm's lagged sales growth rate, leverage ratio, and the log of total asset; Y_t denotes the aggregate controls including the GDP growth rate, unemployment rate, and inflation rate over the past 4 quarters; and the change in Federal Funds Rate ΔR_t is instrumented by the high-frequency monetary policy shock used in [Ottonello and Winberry \(2020\)](#)³⁴. Then the estimate of β^{avg} can be interpreted as the average impact on firms' investment rate of a monetary shock that increases nominal interest rate (annualize) by 1%. To investigate the heterogeneous impacts of monetary policy shocks, I run a modified regression:

$$\begin{aligned} \Delta \frac{i_{j,t}}{k_{j,t}} = & \alpha_j + \alpha_{s,q} + \alpha_{fq} + \left[\beta^0 + \beta^{size} \cdot \mathbf{1}_{I_{j,t}^{size}=\text{small}} + \beta^{leverage} \cdot \mathbf{1}_{I_{j,t}^{leverage}=\text{high}} \right] \cdot \Delta R_t \\ & + \gamma_X \cdot X_{j,t} + \gamma_Y \cdot Y_t + \varepsilon_{j,t}, \end{aligned} \quad (\text{B.16})$$

where the estimate for β^{size} captures the response difference of small firms relative to large firms, and the estimate for $\beta^{leverage}$ captures the response difference of high-leverage firms relative to the low-leverage firms.

³³This regression design follows the similar idea with [Ottonello and Winberry \(2020\)](#) and [Cloyne *et al.* \(2018\)](#).

³⁴[Ottonello and Winberry \(2020\)](#) construct the high-frequency monetary policy shocks following the approach of [Refet S Gürkaynaka and Swanson \(2005\)](#) and [Gorodnichenko and Weber \(2016\)](#).

Model vs. Data In the model, I experimented with a monetary shock that leads to a 25 bp decrease in nominal interest rate. Then I replicate the estimation of regression (B.15) and (B.16) without firm-level fixed effect and aggregate controls, using the model-implied investment responses of the model-counterpart Compustat firms. The estimates from the data and model are summarized in Table B.3, where the average and heterogeneous investment responses implied from the baseline model are comparable to the corresponding empirical estimates.

Table B.3: Impact of a 25 b.p. Decrease in Interest Rate on Firms’ Investment Rate

	Data	Model
Average response	1.00 (0.47, 1.54)	0.95
Heterogeneous response		
High vs. low-leverage: β^{leverage}	-0.17 (-0.66, 0.32)	-0.22
Small vs. large: β^{size}	0.22 (-0.12, 0.56)	0.58

Notes: This table summarize the empirical and model-implied estimates of regression (B.15) and (B.16). The brackets underlying the point estimate indicate the 90% confidence interval based on the standard errors that are two-way clustered by firm and quarter.

B.4 Transmission of Financial Shocks within Different Firm Groups

Heterogeneity in PE Investment Elasticity To understand the heterogeneity in the transmission of financial shocks, I first summarize the heterogeneity in firms’ different PE investment elasticities in Table B.4. Compared with the low-leverage firms, the high-leverage firms have higher PE elasticities to financial frictions, larger elasticities to purchase cost of capital goods, and larger elasticity to cash flow.

Heterogeneity in the Composition of Transmission As summarized in Table B.5, compared with the high-leverage firms, the GE effects play a more significant role in damp-

Table B.4: Partial-equilibrium Elasticities of Investment (Quarterly)

	Aggregate	Groups by size and leverage			
		Small		Large	
		High	Low	High	Low
w.r.t. equity issuance cost	-1.59	-3.84	-1.21	-2.39	-0.59
w.r.t. collateral constraint	2.34	5.45	1.61	3.87	0.89
w.r.t. purchase cost of capital goods	-6.87	-5.41	-5.30	-8.44	-7.93
w.r.t. cash flow	0.49	0.75	0.42	0.63	0.36

Notes: This table summarizes the different PE elasticities of investment at both aggregate and dis-aggregate levels. The PE elasticities of investment with respect to *equity issuance cost*, *collateral constraint*, *purchase cost of capital goods*, and *cash flow* are defined as $\frac{\partial \log(\sum_j i_{j,t})}{\partial \phi_t^e}$, $\frac{\partial \log(\sum_j i_{j,t})}{\partial \phi_t^d}$, $-\frac{\partial \log(\sum_j i_{j,t})}{\partial \tau_t^d}$, and $\frac{\partial \log(\sum_j i_{j,t})}{\partial \log \lambda_t}$ respectively. The size-leverage groups are constructed as described in [A.1](#).

ening the PE effects of financial shocks among the low-leverage firms.

Table B.5: Decomposition of Investment Responses to Financial Shocks

	Aggregate	Groups by size and leverage			
		Small		Large	
		High	Low	High	Low
Panel 1. Effects of Contractionary Debt Financial Shocks					
Net (%)	-2.85	-5.67	-1.42	-5.16	-1.69
PE (%)	-3.87	-5.93	-2.22	-6.27	-3.15
Fraction of firms w/ positive response (%)	7.11	0.00	11.58	0.03	14.33
GE by channels, relative to the PE effects					
Capital goods price	-0.38	-0.13	-0.52	-0.27	-0.60
Real interest rate	-0.06	-0.04	-0.12	-0.04	-0.07
Wage	-0.07	-0.03	-0.07	-0.06	-0.11
Intermediate goods price	0.24	0.16	0.34	0.19	0.31
Total	-0.26	-0.04	-0.36	-0.18	-0.46
Panel 2. Effects of Contractionary Equity Financial Shocks					
Net (%)	-2.76	-4.70	-1.74	-4.52	-1.89
PE (%)	-3.33	-4.81	-2.21	-5.10	-2.74
Fraction of firms w/ positive response (%)	5.29	0.00	5.96	0.01	12.49
GE by channels, relative to the PE effects					
Capital goods price	-0.34	-0.13	-0.41	-0.26	-0.54
Real interest rate	-0.11	-0.08	-0.16	-0.08	-0.13
Wage	-0.11	-0.05	-0.10	-0.10	-0.18
Intermediate goods price	0.39	0.24	0.45	0.33	0.53
Total	-0.17	-0.02	-0.21	-0.11	-0.31

Notes: Panel 1 and 2 depict the decomposition of the investment responses at both the aggregate and disaggregate levels to an one-standard-deviation contractionary equity and debt financing shock respectively. *Net* refers to the net effects; *PE* refers to the investment response solely due to the financial shocks; *Fraction of firms w/ positive response* refers to the fraction of firms with positive peak investment response. For the general equilibrium effects, GE through *capital goods price* refers to the investment response solely due to the endogenous variation in capital goods price; GE through *real interest rate* refers to the investment response solely due to the endogenous variations in nominal interest rate and inflation rate; GE through *wage* refers to the investment response solely due to the endogenous variation in real wage; and GE through *intermediate goods price* refers to the investment response solely due to the endogenous variation in intermediate goods price. All the reported effects are based on the investment responses in the period when the aggregate investment response reaches its peak. To facilitate interpretation, all the GE effects are normalized by the corresponding PE effects. The size-leverage groups are constructed as described in [A.1](#).

C. Role of Investment Elasticity to Aggregate Prices

C.1 Construction of the high-elasticity economy

To understand the importance of PE price elasticity of investment in determining the strength of GE dampening effects, I construct a comparison economy with three features: 1) it looks similar to the baseline economy in terms of firms' average investment and financing behavior; 2) the PE effects of financial shocks have similar magnitude with the baseline model; 3) the PE price elasticity of investment is larger than the baseline model.

Relevant takeaways from [Zetlin-Jones and Shourideh \(2017\)](#) The construction of this high-elasticity economy is largely motivated by [Zetlin-Jones and Shourideh \(2017\)](#). Their model features two groups of firms: a group of financially constrained firms that are subject to collateral constraint; and another group of firms who are unconstrained and invest at the frictionless level. Since there is no physical frictions on firms' investment, the PE price elasticity of unconstrained firms is tremendously large³⁵. Given the significant share of unconstrained firms in the firm population³⁶, this would lead to a very large PE price elasticity of aggregate investment. Following this insight, I construct the high-elasticity economy mostly by removing the physical frictions on investment so the investment of unconstrained firms become much more elastic to aggregate prices.

Setup I revise the baseline model to construct a high-elasticity economy sharing similar features with [Zetlin-Jones and Shourideh \(2017\)](#). The first and the most important change I make is that I remove all the physical frictions on investment except for the downward capital adjustment cost. I keep the downward capital adjustment cost because it is necessary to keep

³⁵In a simple setup without any physical friction on investment, the frictionless level of investment for a firms with (z, k, d) is $i = \left[\frac{\mathbb{E}[z'|z] \cdot \theta_k}{R_t q_t - (1-\delta) \cdot \mathbb{E}_t[q_{t+1}]} \right]^{\frac{1}{1-\theta_k}} - (1-\delta) \cdot k$, where $\theta_k \equiv \frac{\theta \cdot \alpha}{1-\theta \cdot (1-\alpha)}$ denotes the effective return-to-scale of capital. In the steady state, the quarterly PE elasticity of investment to the cost of purchasing investment goods $\frac{\partial \log i}{\partial q_t}$ is approximately equal to -2737 based on the baseline calibration in this paper.

³⁶In the baseline calibration of [Zetlin-Jones and Shourideh \(2017\)](#), unconstrained firms account for 59% of the firm population.

unconstrained firms from choosing to bind the collateral constraint and maintain the PE effects of debt financial shocks at a magnitude that is comparable to the baseline model³⁷. Moreover, to make the model as similar as that in [Zetlin-Jones and Shourideh \(2017\)](#), I further assume that the characteristics of entrant firms are randomly drawn from the exiting firms and set $\psi^e = 0$.

Calibration I keep using the same value for the parameters in [Table 1](#) and recalibrate the remaining parameters (summarized in [Table C.6](#)) to make the high-elasticity economy comparable to the baseline model in the sense that 1) they share the similar average investment and financing behaviors; and 2) the magnitudes of the PE elasticity of investment to financial shocks are similar in these two economies.

C.2 Aggregate Relevance of Financial Shocks in the High-elasticity Economy

Strength of GE dampening Besides the capital goods price q_t , there are another three aggregate prices determining the strength of GE dampening effects: real interest rate r_t , wage w_t , and intermediate goods price \hat{p}_t . The sensitivity of these prices is governed by four parameters: ν_c , ν_l , ξ_w , and ξ_p . Given the importance of interest rate response in dampening the aggregate effects as emphasized in [Zetlin-Jones and Shourideh \(2017\)](#), I conduct a comparative static study over ν_c , which is similar to the one about ϕ^I in [Section 4.2](#). [Figure C.4](#) summarizes the variation in the peak aggregate investment response to financial shocks and [Figure C.7](#) summarizes the variation in the underlying peak responses

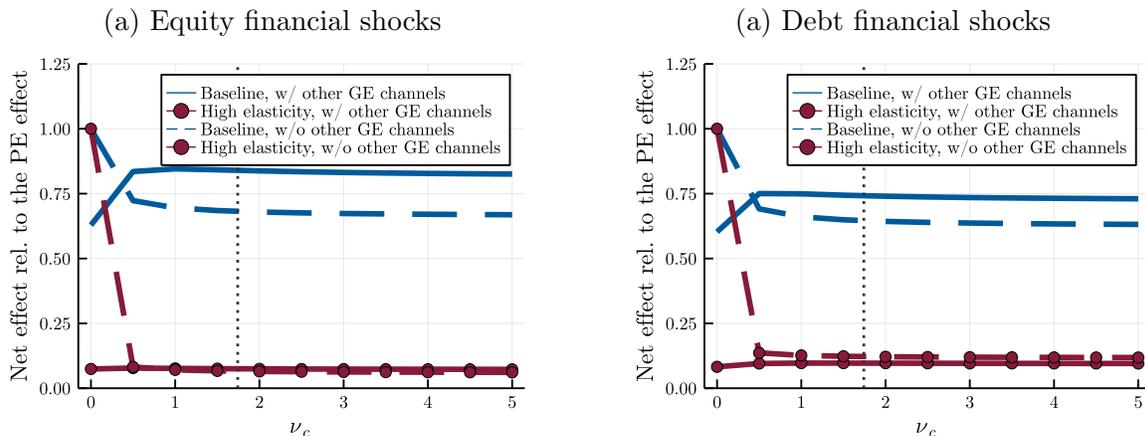
³⁷In [Zetlin-Jones and Shourideh \(2017\)](#), since they don't need to distinguish debt and equity financing, they did not have tax benefit of borrowing. But in this paper, this is an important dimension and I cannot set $\tau = 0$. When there is no downward capital adjustment cost, firms, especially the unconstrained firms, always choose to bind the collateral constraint due to the tax benefit of borrowing. In this case, the optimal decision of unconstrained firms is: 1) due to the tax benefit, they will always borrow to the limit and pay dividends; 2) since the total borrowing limit depends on the capital stock, so they will factor this value of capital into consideration and a looser collateral constraint will motivate them to invest more because they can get more cheaper funding by borrowing. Then, a looser collateral constraint works almost like an interest rate cut because firms always use the cheap debt financing to the limit and how much a firm can borrow will determine the effective opportunity cost of funding. To make sure that the magnitude of the PE effects of debt financing shock are relatively comparable to the baseline model, I have to keep the downward capital adjustment cost to make sure that unconstrained firms are precautionary enough to avoid binding collateral constraint.

Table C.6: Calibration of High-elasticity Economy

Parameter		High-elasticity	Baseline
Idiosyncratic risk			
ρ_a	Idiosyncratic TFP process, persistence	0.94	0.868
σ_a	-, standard deviation of the innovation	0.06	0.043
Physical frictions on firms' capital accumulation			
δ	Depreciation rate	0.025	0.02
$\bar{\psi}^k$	Upper bound of the fixed cost to invest	0	0.04
ϕ_+^k	Capital adjustment cost, upward	0	6
ϕ_-^k	-, downward	0.15	6.639
Financial frictions on firms' capital accumulation			
ψ^y	Fixed cost in production (relative to steady-state wage)	0.043	0.116
ψ^e	Equity issuance cost, coefficient of the quadratic term	0	0.387
ϕ_{ss}^e	-, coefficient of the linear term in steady state	0.055	0.095
ϕ_{ss}^d	Collateral constraint in steady state	0.47	0.42

Notes: The dis-utility of working Ψ is calibrated to target the steady-state level of labor supply at $1/3$.

Figure C.4: Aggregate Effects of Financial Shocks under Different ν_C



Notes: These figures summarize how the peak aggregate investment response to a standard-deviation contractionary financial shocks varies with the sensitivity of interest rate. Within each model (baseline economy vs. high-elasticity economy), the peak aggregate investment responses are normalized by the PE peak aggregate investment response, i.e. the peak investment response when the responses of all aggregate prices are shut off. “w/ other GE channels” labels the effects when all the other parameters are set to the baseline estimates (i.e. the mode estimates in Table 5); while “w/o other GE channels” labels the effects when the endogenous response of other aggregate prices are shut down (i.e. $\nu_c, \nu_l, \xi_p, \xi_w$ are all set to 0).

of aggregate prices.

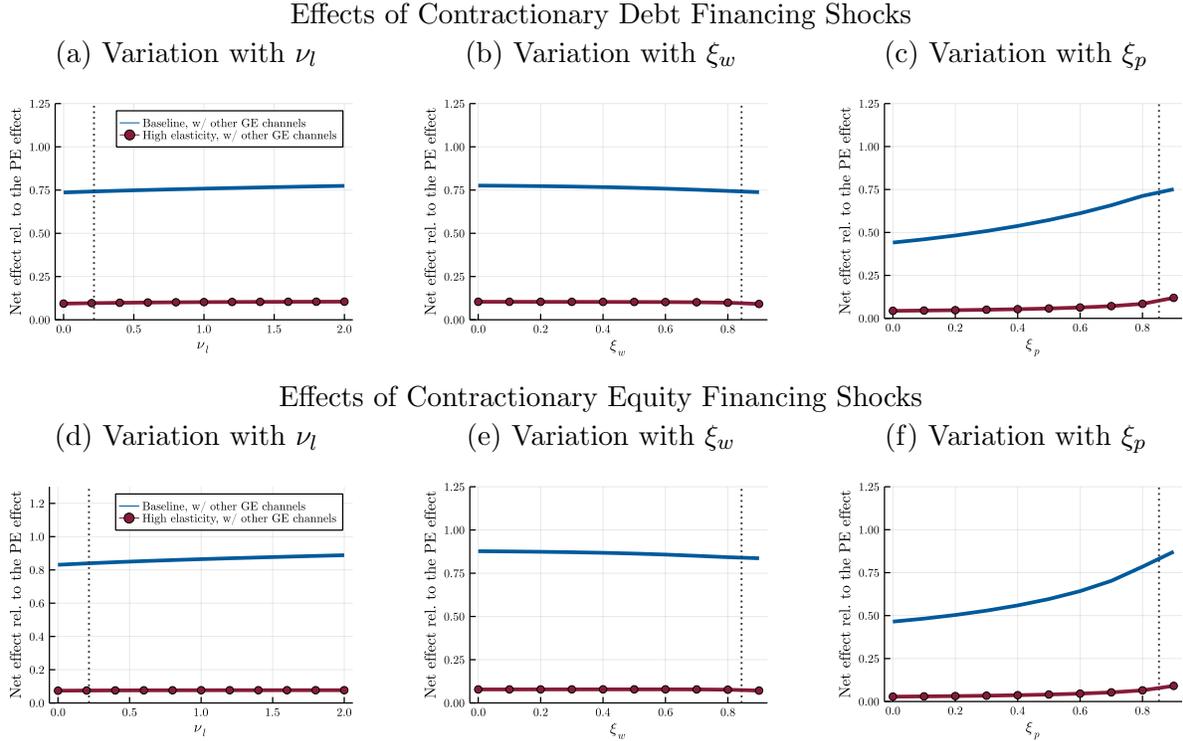
As shown in Figure C.4, when all the other GE mechanisms are shut off in the high-

elasticity model, the endogenous variation of interest rate itself can dampen 95% of the partial-equilibrium impacts of financial shocks even with a small ν_c . However, when all the other GE mechanisms are operating, the marginal dampening effects due to the response of interest rate become almost negligible. The relevance of the GE dampening effect through the response of capital goods price displays a different pattern. As shown in Figure 5, even with all the other GE dampening mechanisms operating in the background, the response of capital goods price still contributes sizable marginal dampening effects. This difference highlights that the endogenous response of capital goods price is also the most relevant GE dampening mechanism in the high-elasticity model. In Zetlin-Jones and Shourideh (2017), due to the setup with a fixed capital goods price, the endogenous response of interest rate shows up as the most relevant GE dampening mechanism, which is consistent with pattern displayed in Figure C.4.

Another detail worth to be discussed in Figure C.4 is that the aggregate investment response actually increases with ν_c when all the other GE mechanisms are operating. This is due to the induced larger decrease in intermediate goods price (see Figure C.7 for details), which leads to a larger amplification of the financial shocks' effects.

I also conduct the similar comparative static studies about parameter ν_l , ξ_w , and ξ_p , and summarize the results in Figure C.5. I would like to highlight three takeaways from these comparative static studies. First, the GE dampening effects are much stronger in the high-elasticity model and the variations in ν_l , ξ_w , and ξ_p have little impact on the overall relevance of GE dampening effects. This further indicates that the strong GE dampening effects are a robust feature in the high-elasticity model with general equilibrium effects, no matter how little the aggregate prices are responding. Second, the variation in ν_l and ξ_w , which control the endogenous response of real wage, has negligible impacts on the overall relevance of GE dampening effects, even in the baseline model. This actually echos the finding in Section 4.1 that the wage responses play a relatively minor role as a GE dampening mechanism. Third, when ξ_p increases, the decrease in real intermediate goods price becomes larger and

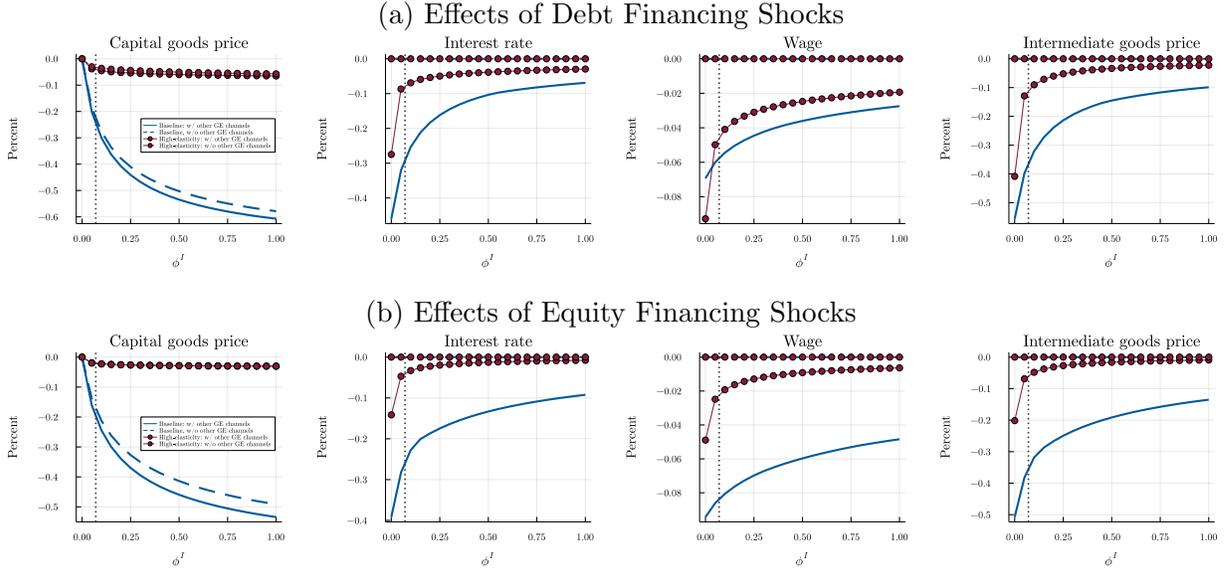
Figure C.5: Aggregate Effects of Financial Shocks under Different ν_l , ξ_w , and ξ_p



Notes: These figures summarize how the peak aggregate investment response to a standard-deviation contractionary financial shocks varies with the sensitivity of different aggregate prices. Within each model (baseline economy vs. high-elasticity economy), the peak aggregate investment responses are normalized by the PE peak aggregate investment response, i.e. the peak investment response when the responses of all aggregate prices are shut off. In each experiment, all the other parameters are set to the baseline estimates (i.e. the mode estimates in Table 5).

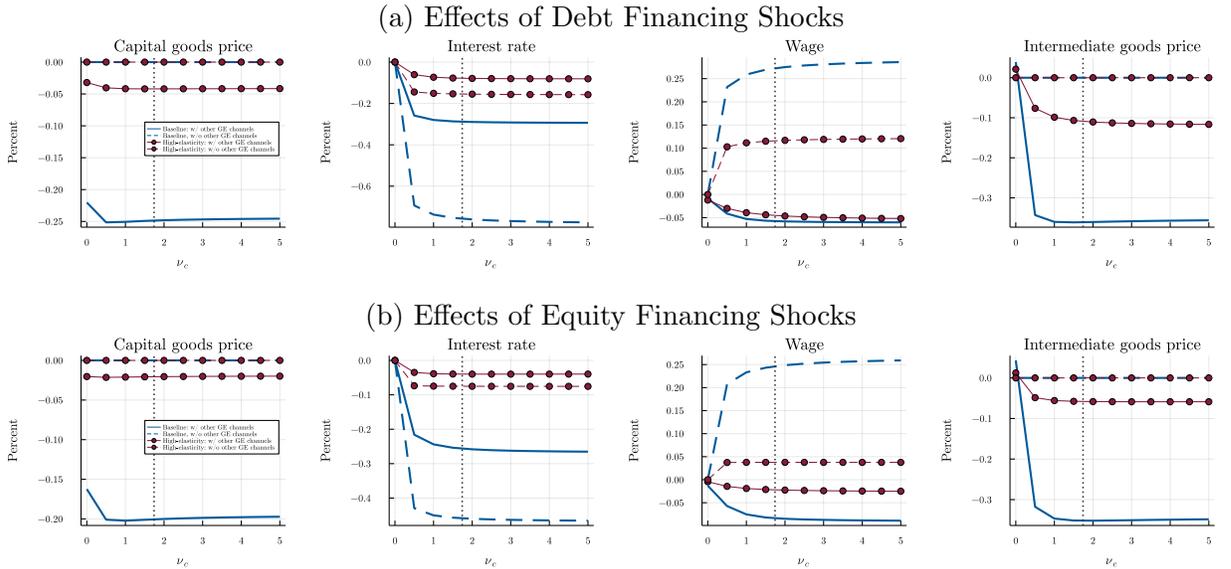
the induced amplification effects becomes stronger, hence the aggregate effects of financial shocks increase with ξ_p .

Figure C.6: Variations in Peak Responses of Aggregate Prices with ϕ^I



Notes: These figures summarize how the peak responses of aggregate prices to a standard-deviation contractionary financial shocks vary with ϕ^I . “w/ other GE channels” labels the effects when all the other parameters are set to the baseline estimates (i.e. the mode estimates in Table 5); while “w/o other GE channels” labels the effects when the endogenous response of other aggregate prices are shut down (i.e. ν_c , ν_l , ξ_p , ξ_w are all set to 0).

Figure C.7: Variations in Peak Responses of Aggregate Prices with ν_c



Notes: These figures summarize how the peak responses of aggregate prices to a standard-deviation contractionary financial shocks vary with ν_c . “w/ other GE channels” labels the effects when all the other parameters are set to the baseline estimates (i.e. the mode estimates in Table 5); while “w/o other GE channels” labels the effects when the endogenous response of other aggregate prices are shut down (i.e. ν_c , ν_l , ξ_p , ξ_w are all set to 0).

D. Comparison with Representative Firm Model

To understand the difference between RFM and HFM in terms of their implication about the transmission of financial shocks, I construct the RFM to share the same New Keynesian block with the HFM. Then the discussion about their difference will focus on the responsiveness of firms' investment to financial shocks and various aggregate prices.

Quantification The responsiveness of firms' investment is governed by two groups of parameters. The first group is the parameters collected in Table 1, which are calibrated to the same value as in the baseline HFM. The second group includes five remaining parameters: the operation fixed cost ψ^y , the steady-state level of collateral constraint tightness ϕ_{ss}^d and equity financing cost ϕ_{ss}^e , the capital adjustment cost ϕ^k , and the curvature of equity financing cost ψ^e . Since ϕ_{ss}^e just serves as a normalization factor of the marginal value of the firms' financial asset and has little impact on the model solution, I calibrate it to the value in the baseline HFM. For the remaining parameters, ϕ_{ss}^d directly determines the steady-state leverage ratio and ψ^y determines the steady-state size of equity financing flow. Thus, I calibrate them to match the average leverage ratio and size of equity financing flow in the baseline HFM. ϕ^k and ψ^e do not affect the average steady-state moments of the model, but they determine the PE elasticities of investment. Since the PE elasticities of investment fully capture the PE effects of financial shocks and the strength of GE dampening effects, the calibration of ϕ^k and ψ^e becomes the most essential part of the analysis on the difference between RFM and HFM.

There are three key PE elasticities of investment for analyzing the aggregate effects of financial shocks: $\epsilon_{\phi^d}^I$, $\epsilon_{\phi^e}^I$, and ϵ_q^I . $\epsilon_{\phi^d}^I$ and $\epsilon_{\phi^e}^I$ determine the magnitudes of the PE effects of financial shocks on aggregate investment, and ϵ_q^I captures the strength of the GE dampening effects. As illustrated in Figure 6, it is infeasible to calibrate the RFM to match the HFM-level of $\epsilon_{\phi^e}^I$ and ϵ_q^I at the same time. Therefore, I choose to calibrate the RFM in two ways for the purpose of comparing it with HFM in terms of their implication about the aggregate

effects of financial shocks. In the first calibrate, I calibrate ϕ^k and ψ^e to match the PE effects of debt financing shocks and the overall GE dampening effects conditional on debt financing shocks in HFM. As indicated by Figure 6, this calibrated RFM would feature larger PE effects of equity financing shocks than HFM does. In the second calibration, I calibrate the RFM to match the PE effects of both debt and equity financing shocks in HFM. In this case, the RFM would feature weaker GE dampening effects than HFM does.

Aggregate Relevance of Financial Shocks Table D.7 summarizes the details about the effects of financial shocks in RFM under these two alternative calibrations. Under the calibration I, compared with the baseline HFM, RFM features the exactly same PE and net effects of debt financing shocks, but larger PE and net effects of equity financing shocks. Under the calibration II, the RFM has the same PE effects of both types of financial shocks as HFM, but larger net effects of debt financing shocks due to the weaker GE dampening effects. The results of these two calibrations verify the implication from the Figure 6: RFM tends to imply a larger effects of financial shocks than HFM does because of the tight link between $\epsilon_{\phi^e}^I$ and ϵ_q^I , or between the PE effects of financial shocks and GE dampening effects in a more general sense.

The above results focus on the difference between RFM and HFM in their implied aggregate investment responses to financial shocks. However, to evaluate the overall aggregate relevance of financial shocks in a context with other aggregate shocks, one also need to consider how RFM could differ from HFM in terms of the implied effects of non-financial shocks. Actually, since the non-financial shocks affect firms' investment decision through the variation of the aggregate prices, the difference between RFM and HFM in the non-financial shocks' effects can also be analyzed through the discussion about their implied ϵ_q^I . Following the above discussion, when RFM is calibrated to have the same $\epsilon_{\phi^e}^I$ and $\epsilon_{\phi^d}^I$ as the HFM, it will have a lower ϵ_q^I than the HFM. This implies that when a RFM features the same PE effects of financial shocks as HFM, it does not only have weaker GE dampening effects in

Table D.7: Alternative Calibration of RFM

	Calibration I		Calibration II	
Panel 1: Calibrated parameters				
ϕ_{ss}^d	0.31		0.31	
ϕ_{ss}^e	0.095		0.095	
ϕ^k	9.87		12.16	
ψ^e	0.89		1.09	
Panel 2: Aggregate relevance of financial shocks				
	Debt	Equity	Debt	Equity
<i>Peak response of aggregate investment</i>				
Net effect (%)	-2.85	-3.15	-3.08	-2.75
PE (%)	-3.87	-4.04	-3.87	-3.33
<i>GE by channels, relative to the PE effects</i>				
Capital goods price	-0.27	-0.17	-0.21	-0.14
Real interest rate	-0.01	-0.07	-0.01	-0.06
Wage	-0.01	-0.04	0.00	-0.03
Intermediate goods price	0.02	0.06	0.02	0.06
Total	-0.26	-0.22	-0.20	-0.17
<i>Contribution to the unconditional variance of investment</i>				
Variance decomposition	16	46	24	42

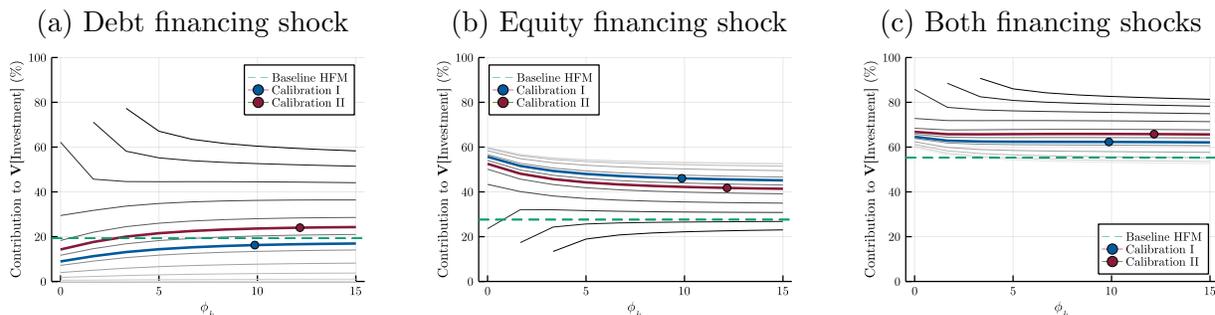
Notes: In the calibration, ψ^y is always calibrated to match the steady-state level of equity financing flow in the baseline HFM. In Panel 2, *Net effect* refers to the peak investment response to one-standard-deviation contractionary financial shocks; *PE* refers to the investment responses when all the aggregate prices are fixed at their steady-state level; *GE* refers to the investment responses solely due to the endogenous variations in the aggregate prices. All the *GE* effects are normalized by the *PE* effects, so its size can be interpreted as the fraction of *PE* that is dampened by the *GE*. The parameters in the New Keynesian block are fixed at the same values as in the baseline HFM such that the comparison between the RFM and HFM is based on the same price responsiveness and aggregate shocks.

the event of financial shocks, but also weaker aggregate response to the non-financial shocks. Adding these points together, RFM tends to imply a larger aggregate relevance of financial shocks than HFM does. In Table D.7, I also compute the contribution of financial shocks to the unconditional variance of aggregate shocks in each calibrated RFM. Under both calibrations, RFM does imply a larger contribution of financial shocks to the aggregate investment fluctuations.

To further solidify this result, I conduct a series of numerical experiments over the whole space of (ϕ^k, ψ^e) and compute the financial shocks' contribution to the variance of aggregate

investment at each combination of (ϕ^k, ψ^e) . As summarized in Figure D.8, even though RFM could imply a smaller aggregate relevance of a specific type of financing shock than HFM, its implied overall aggregate relevance of financial shocks is always larger than the HFM. At a given level of ϕ_k , increasing ψ^e can increase the relevance of debt financing shocks (as shown in the panel (a) of Figure D.8) but lower the relevance of equity financing shocks (as shown in the panel (b) of Figure D.8). In net, the variation in ψ^e does not change the overall relevance of financial shocks by much (as shown in the panel (c) of Figure D.8). At a given level of ψ^e , a larger ϕ^k leads to smaller effects of both financial and non-financial shocks, and the relative importance of financial shocks does not change by much, either. To sum up, it is a robust feature of RFM to imply a larger aggregate relevance of financial shocks than HFM.

Figure D.8: Contribution of Financial Shocks to $\mathbb{V}[\text{Aggregate Investment}]$

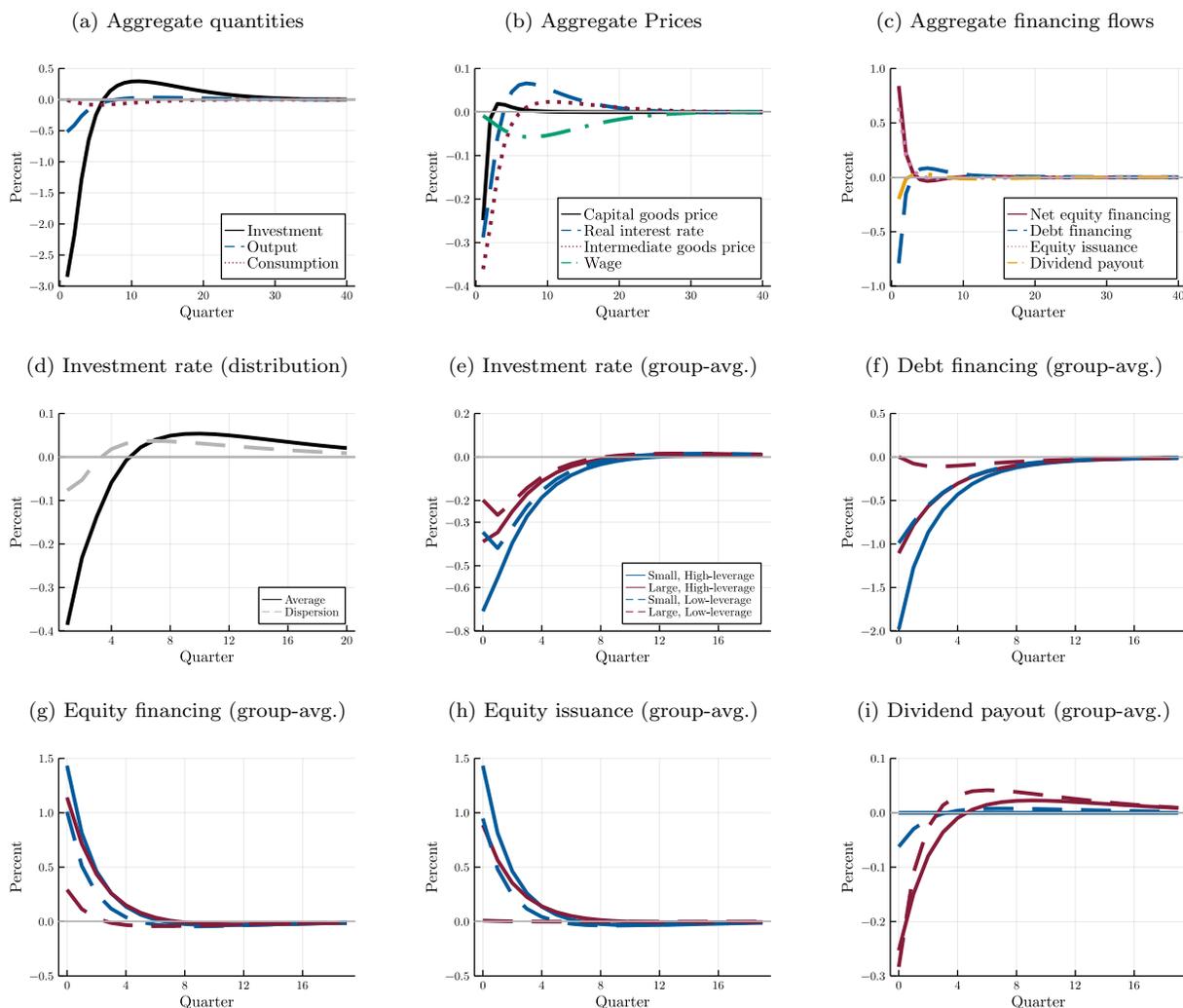


Notes: Panel (a), (b), and (c) depict the contribution of debt financing shocks, equity financing shocks, and both types of financing shocks to the unconditional variance of aggregate investment respectively. In each panel, each line depicts the variation of the shocks' aggregate relevance at different ϕ_k while keeping ψ^e at a given level. The depth of the line's color indicates the value of ψ^e , where a darker color indicates a larger ψ^e . *Baseline HFM* labels the level of aggregate relevance implied by the baseline HFM model. *Calibration I* and *Calibration II* label the results based on the two calibrated RFM as summarized in Table D.7. The parameters in the New Keynesian block are calibrated to the same values as the baseline HFM underlying each evaluation.

E. Extra Quantitative Results

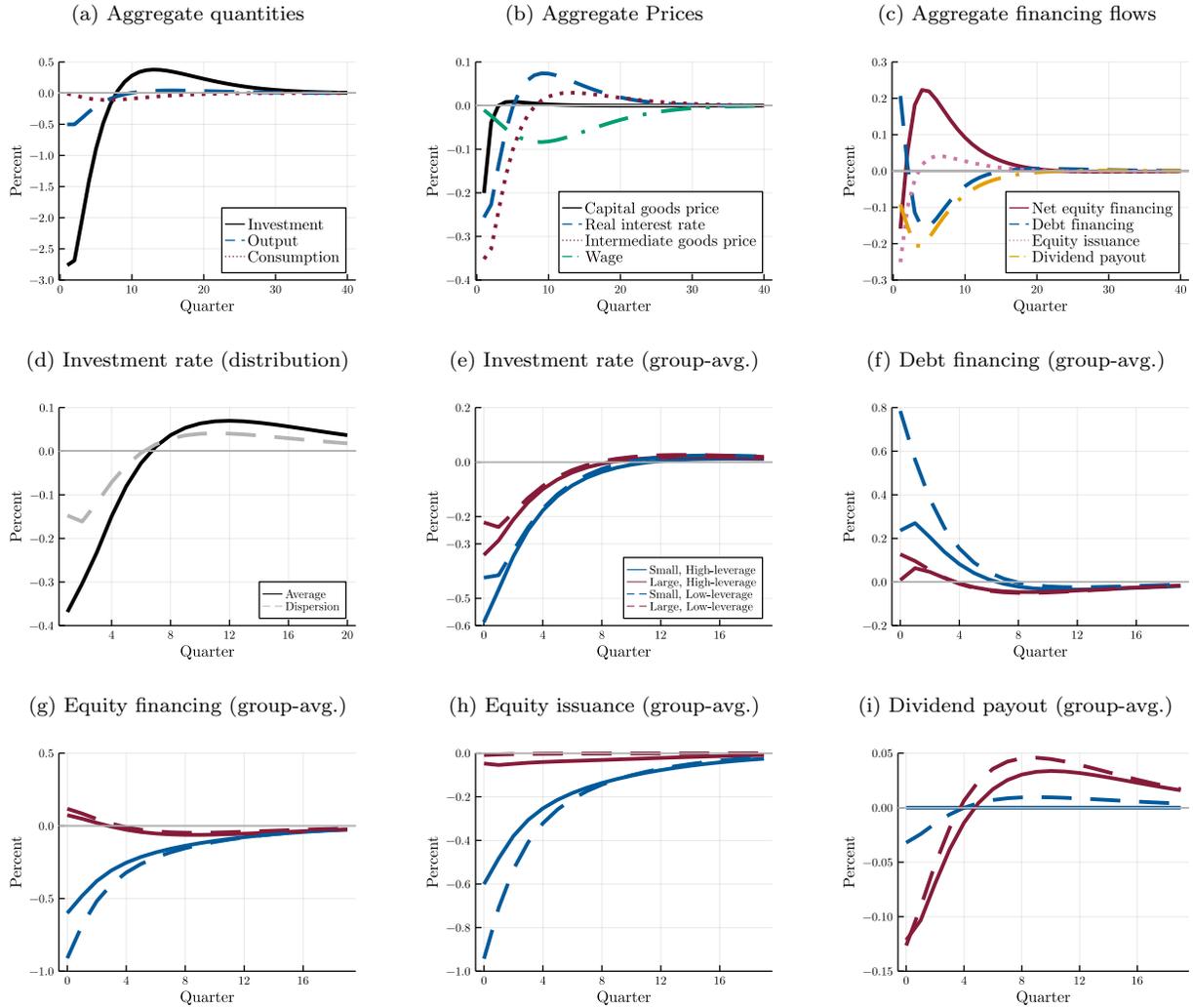
E.1 Impulse Responses of Different Aggregate Shocks

Figure E.9: Impulse Responses to Debt Financing Shocks



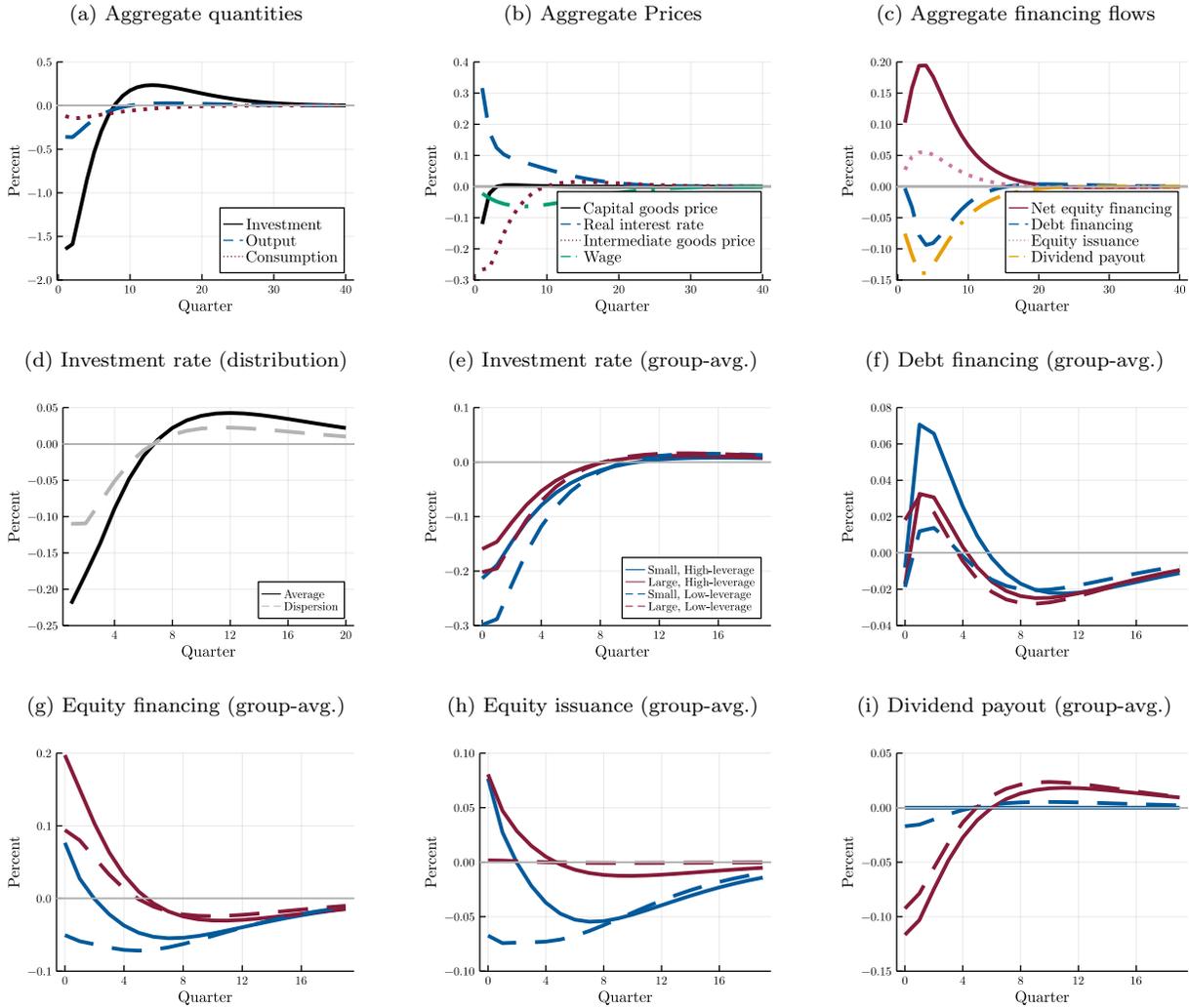
Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Debt Financing* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

Figure E.10: Impulse Responses to Equity Financing Shocks



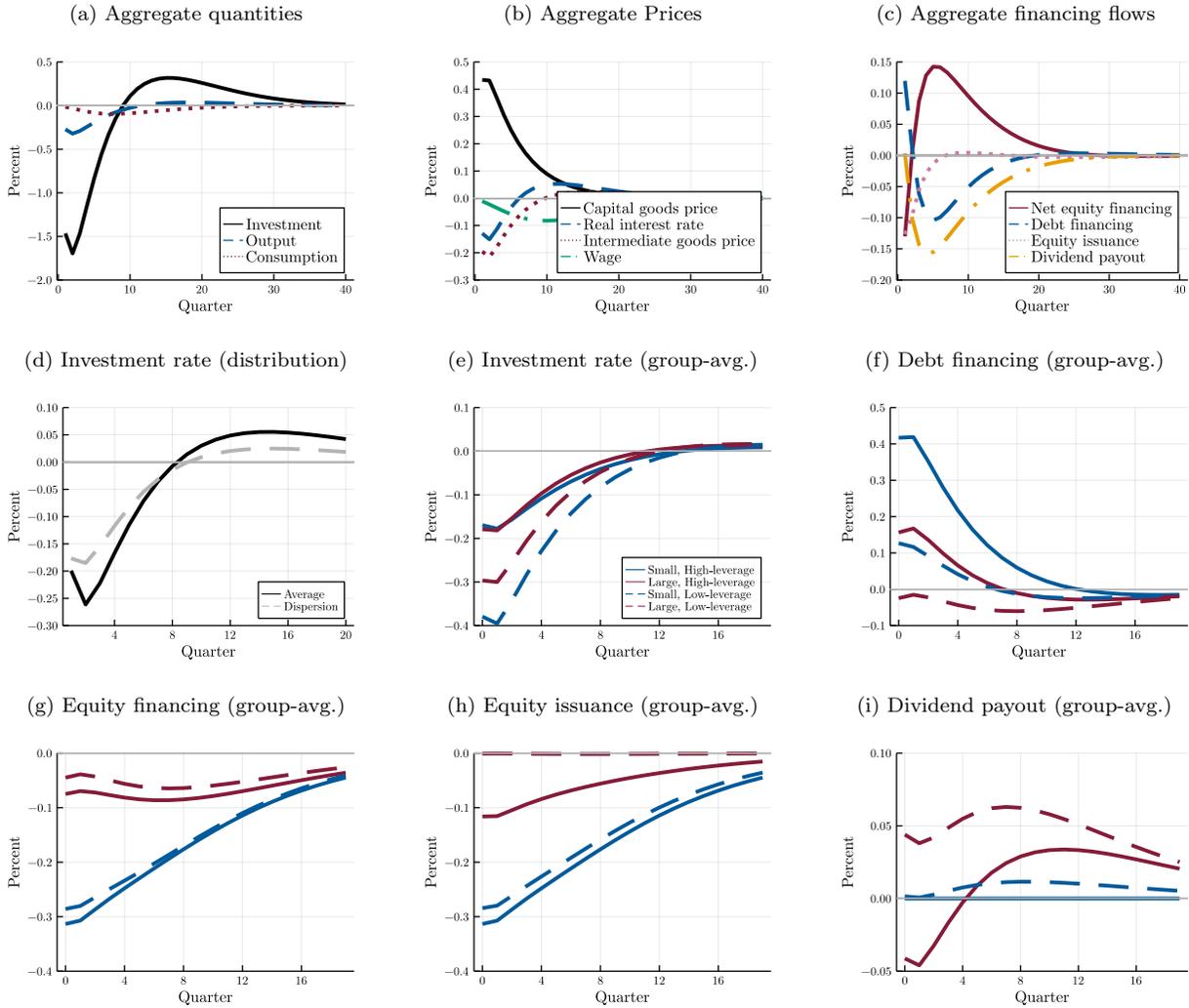
Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Equity Financing* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

Figure E.11: Impulse Responses to Monetary Shocks



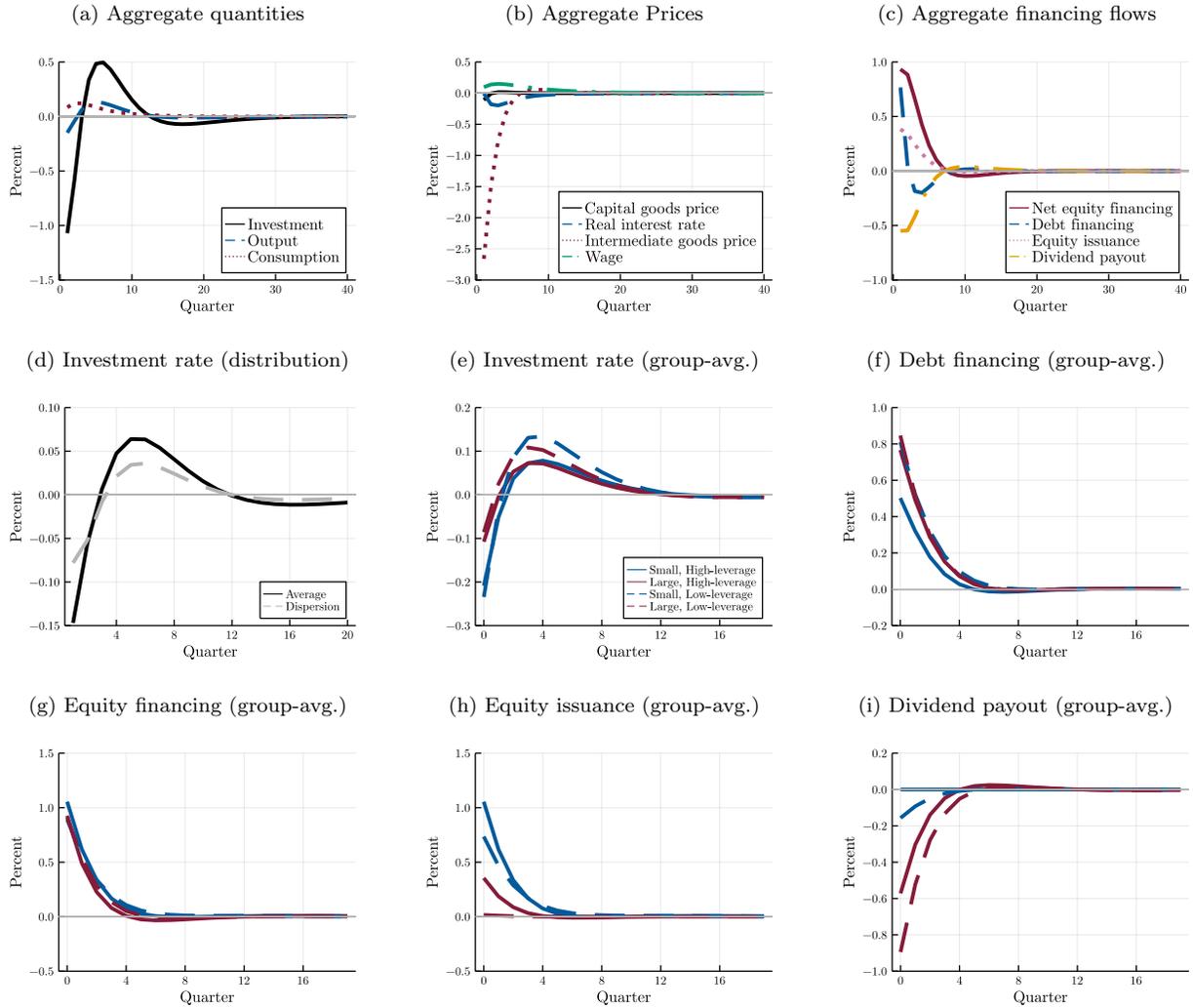
Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Monetary* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

Figure E.12: Impulse Responses to Investment Technology Shocks



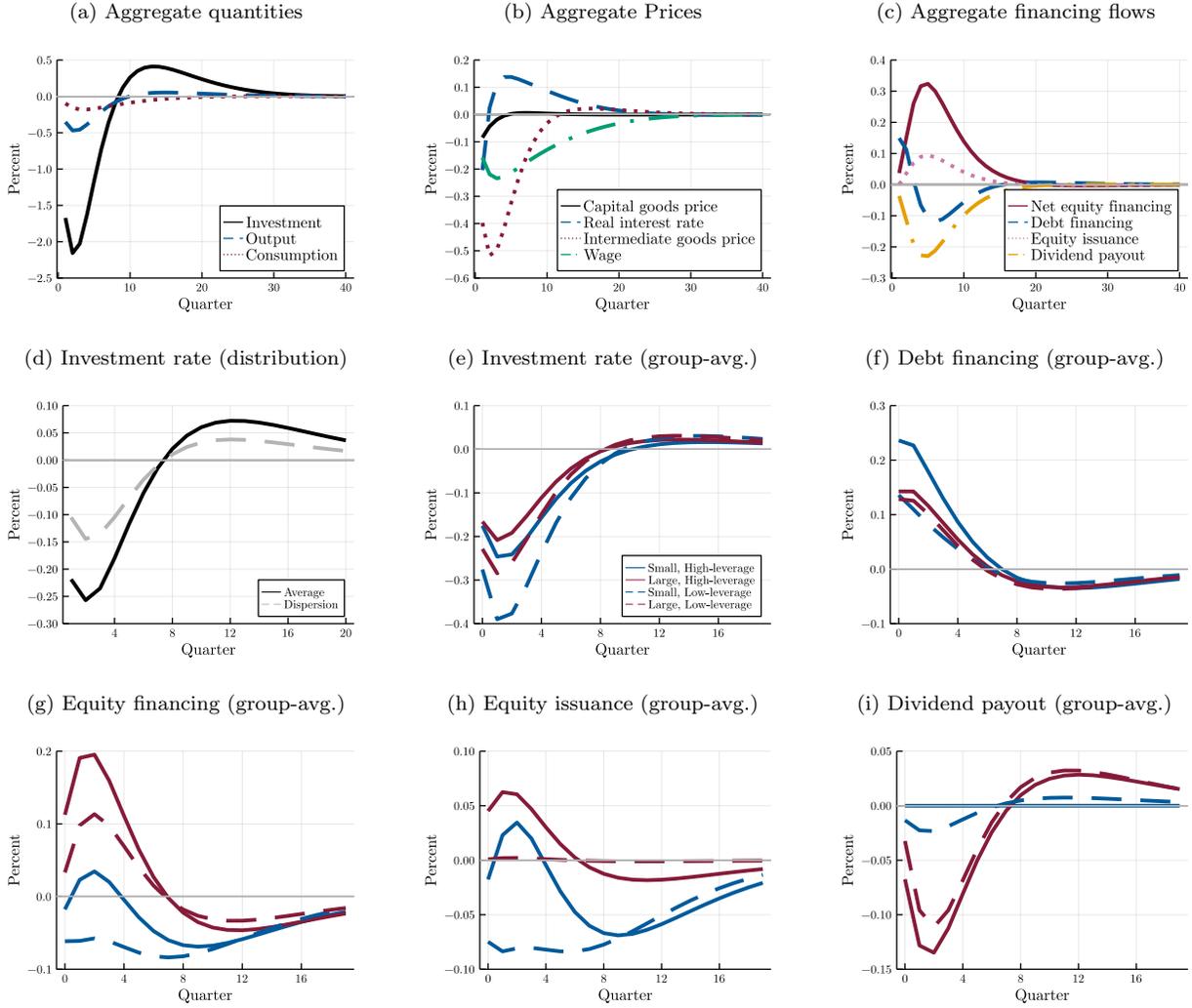
Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Investment Technology* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

Figure E.13: Impulse Responses to Aggregate TFP Shocks



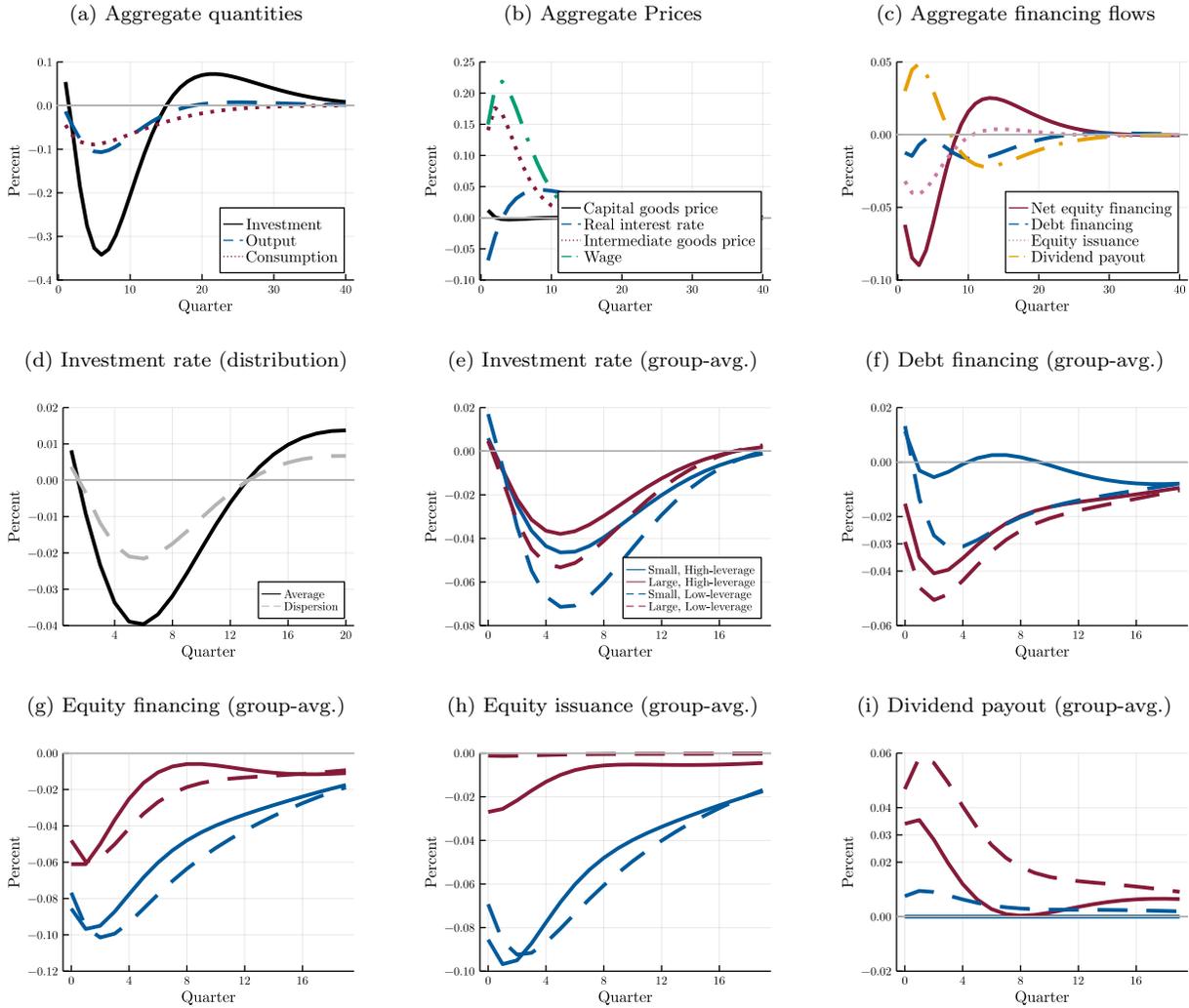
Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Aggregate TFP* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

Figure E.14: Impulse Responses to Price-markup Shocks



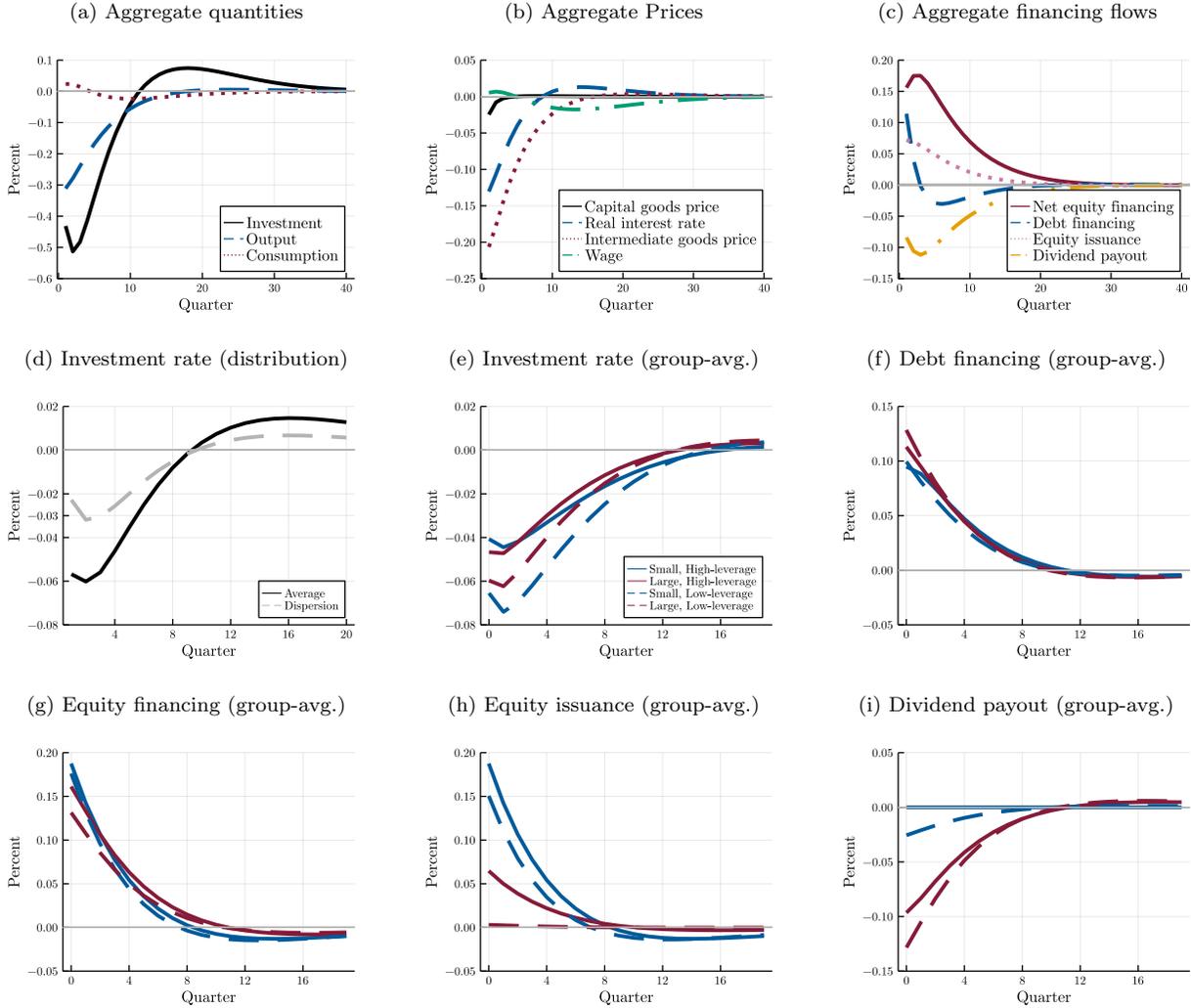
Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Price-markup* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

Figure E.15: Impulse Responses to Wage-markup Shocks



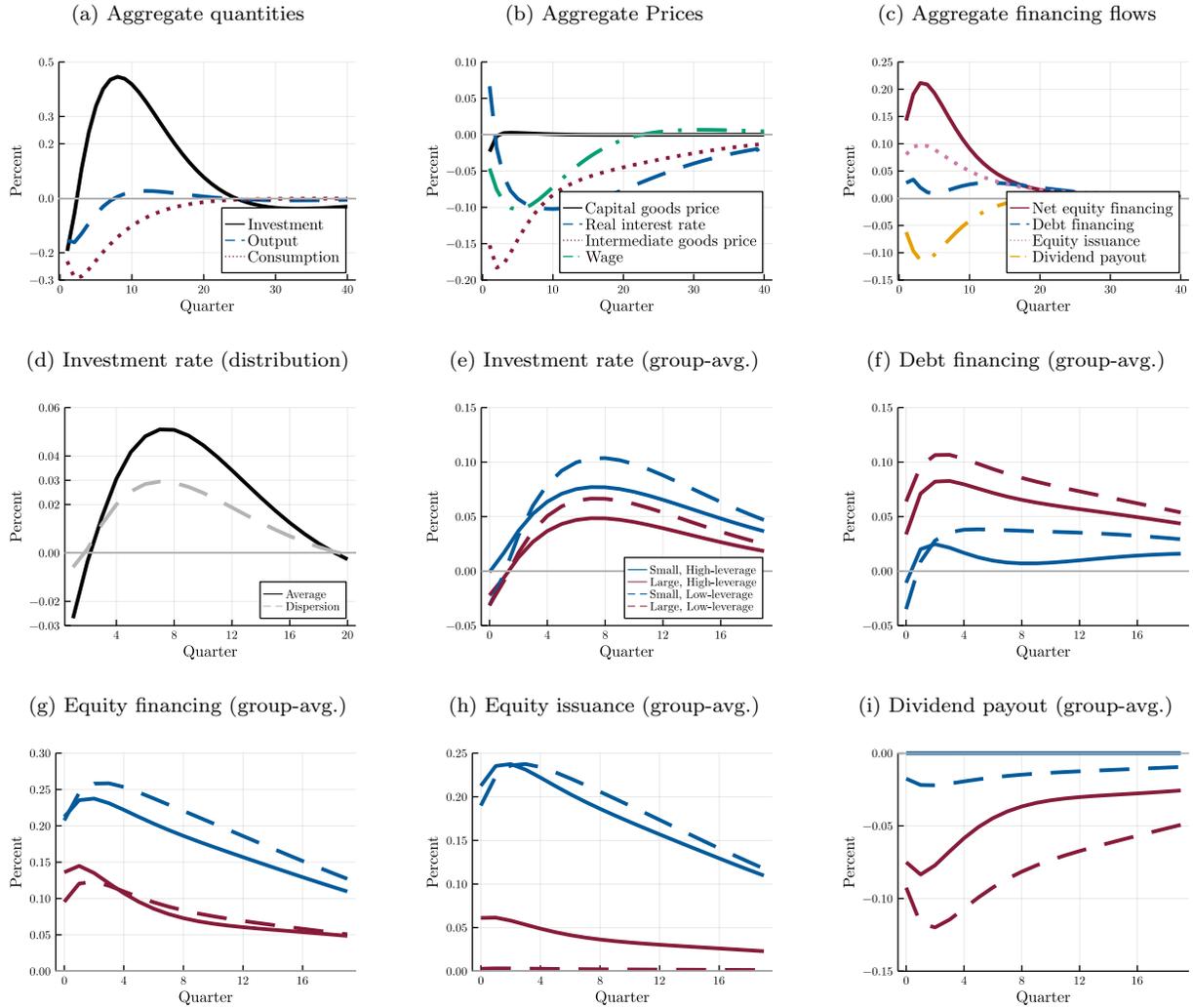
Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Wage-markup* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

Figure E.16: Impulse Responses to Government Spending Shocks



Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Government Spending* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

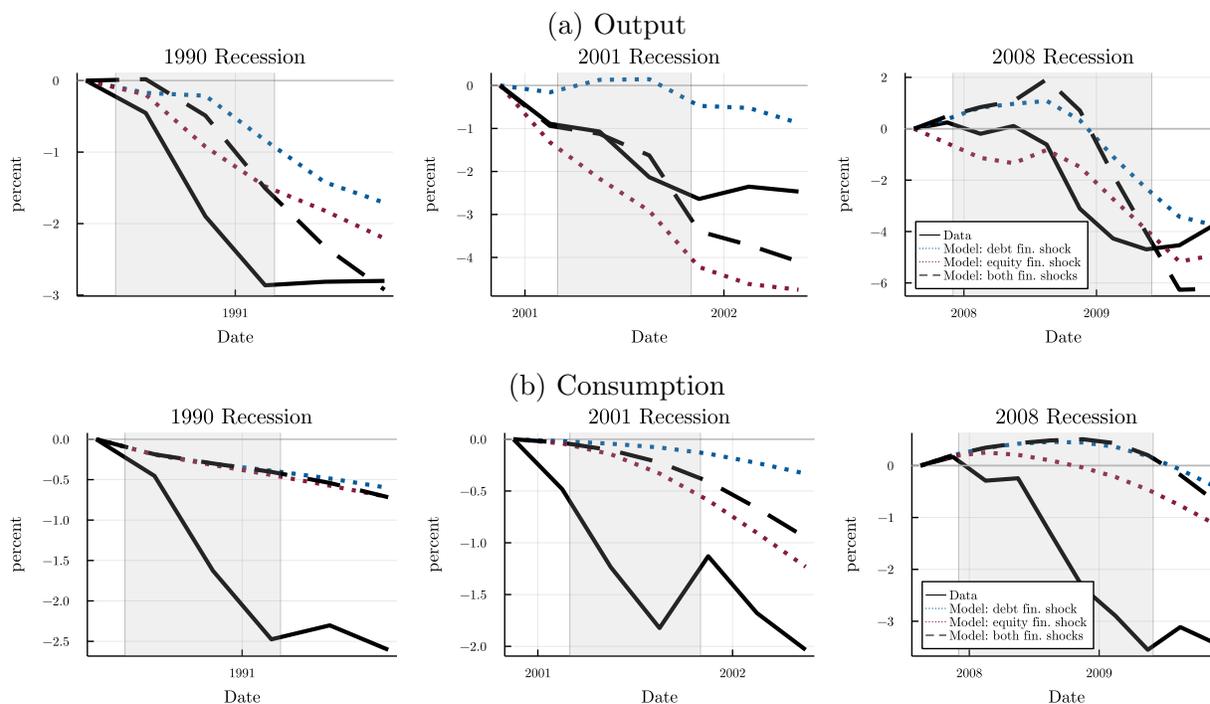
Figure E.17: Impulse Responses to Preference Shocks



Notes: This figure depicts the impulse responses following an one-standard-deviation adverse *Preference* shocks. Panel (a) summarizes the log-deviation of aggregate quantities from their steady state. Panel (b) summarizes the deviation of various aggregate prices (all in real terms) from their steady state, where the real interest rate has been converted to annual rate. Panel (c) summarizes the deviation of aggregate financing flows from their steady state. All the aggregate financing flows are normalized by the lagged total asset and converted to the annual rate. Panel (d) summarizes the deviation of the average (weighted by firms' size) and standard deviation of investment rate (annual rate) from their steady-state levels. Panel (e)-(i) summarize the responses of the investment and financing flows by size-leverage groups. All the investment and financing flows in Panel (e)-(i) are measured in the same way as in Panel (c) and (d). See the text for the construction of the size-leverage groups.

E.2 Details of the Aggregate Relevance of Financial Shocks

Figure E.18: Counterfactual Trajectories Only with Financial Shocks



Notes: To construct the counterfactual trajectory during each recession episode, I first recover the underlying economic states using the Kalman smoother, then compute the counterfactual aggregate output (Panel (a)) and consumption (Panel (b)) with the smoothed history of financial shocks while keeping all the other aggregate shocks switched off. To facilitate interpretation, I take log-difference between the counterfactual history of the aggregate quantities and their initial level and multiply it by 100.

Table E.8: Variance Decomposition of Aggregate Fluctuations (%)

	ϵ_d	ϵ_e	ϵ_z	ϵ_p	ϵ_w	ϵ_q	ϵ_m	ϵ_u	ϵ_g
Aggregate quantities									
Output	14.7	22.6	2.6	23.5	2.1	11.0	11.8	2.3	9.4
Investment	19.2	28.6	3.0	21.5	0.9	13.1	10.1	2.2	1.4
Consumption	4.1	8.1	5.5	18.1	6.2	7.4	10.6	39.4	0.5
Net financing flows									
Equity	15.6	5.8	48.3	11.9	0.7	3.3	4.3	6.0	4.0
Debt	38.4	8.3	39.5	5.6	0.1	4.1	2.3	0.7	1.1
Details of equity financing flows									
Equity issuance	41.7	7.5	32.5	4.3	0.7	2.7	1.6	6.7	2.3
Payout	2.3	11.6	46.5	15.7	0.7	9.2	5.7	4.0	4.3
Aggregate prices									
Capital goods price	6.7	4.5	1.4	1.0	0.0	84.7	1.6	0.1	0.1
Nominal interest rate	7.4	11.0	11.4	6.4	2.4	6.1	5.5	45.5	4.3
Inflation	0.9	2.1	25.8	23.6	3.2	1.6	1.5	39.4	1.9
Real wage	3.0	7.0	11.7	37.0	21.1	7.6	4.0	8.1	0.4

Notes: This table summarizes the decomposition of the unconditional variance of various variables based on the parameter values in Table 5. ϵ_E , ϵ_D , ϵ_Z , ϵ_P , ϵ_W , ϵ_Q , ϵ_U , ϵ_M , and ϵ_G refer to equity financing shock, debt financing shock, aggregate TFP shock, price markup shock, wage markup shock, investment technology shock, utility shock, monetary shock, and government spending shock.