Monetary Policy, Employment, and Firm Heterogeneity

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Introduction

Motivation:

- Employment is an important goal for monetary policy
- Distributional effects of monetary policy in employment under explored

Research questions:

- Which firms respond more to monetary policy in employment?

- What transmission channel explains the heterogeneous responses?

Contribution

▶ Distributional effects of monetary policy on firms' **employment**

Ramey (2016); Bahaj et al. (2020); Casiraghi, McGregor, and Palazzo (2021); Singh, Suda, and Zervou (forthcoming)

Contribution: Characterize the role of firms **size** and **age**

▶ Transmission channel of monetary policy through **housing prices**

Gertler and Gilchrist (1994); Crouzet and Mehrotra (2020); Ottonello and Winberry (2020); Lakdawala and Moreland (2021)

Contribution: Quantify the role of **housing collateral**

1. Macro-level evidence

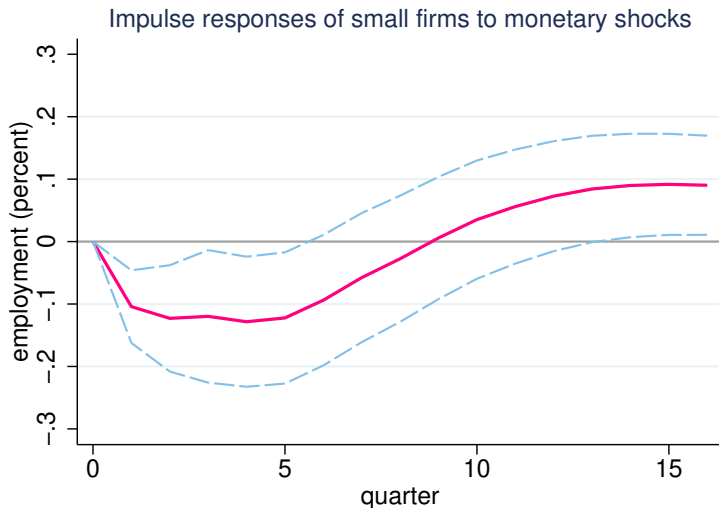# Macro level: empirical method

▶ SVAR reduced-form representation:

$$y_t' = x_t'\Phi + u_t', u_t \sim \mathcal{N}(0, \Sigma)$$

$$y_t = \begin{bmatrix} \text{industrial production} \\ \text{employment} \\ \text{consumer price index} \\ \text{commodity price index} \\ \text{Romer and Romer shock} \end{bmatrix} x_t = \begin{bmatrix} y_{t-1}' \\ y_{t-2}' \\ \vdots \\ y_{t-p}' \\ 1 \end{bmatrix}$$

▶ Identification method: recursive ordering
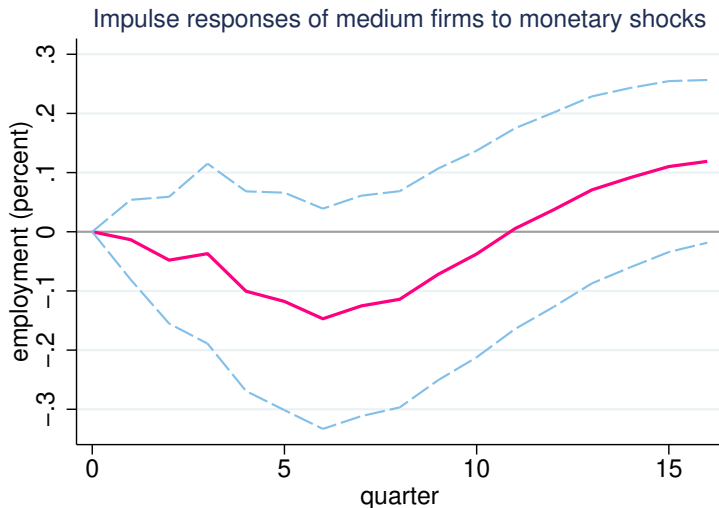
Data

Small firms (0-19 employees)

Impulse responses of small firms to monetary shocks

The shock size is an equivalence of 25 basis point interest rate increase

Medium firms (20-499 employees)

Impulse responses of medium firms to monetary shocks

The shock size is an equivalence of 25 basis point interest rate increase

Large firms (500+ employees)

Impulse responses of large firms to monetary shocks
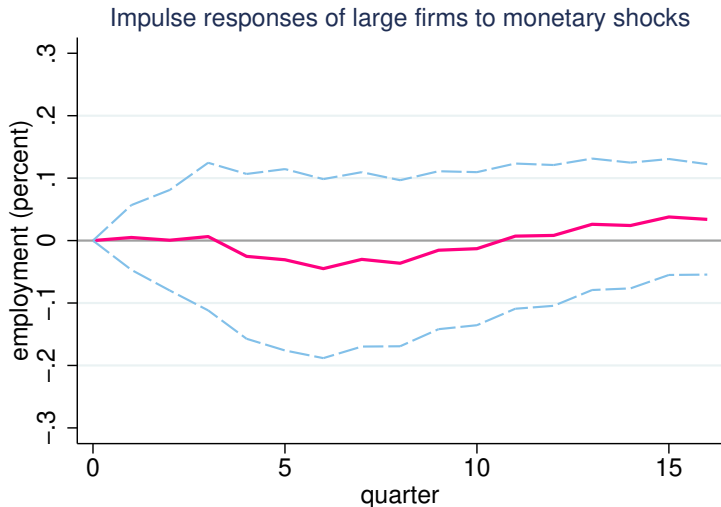
The shock size is an equivalence of 25 basis point interest rate increase

Startups (0-1 age)

Impulse responses of young firms to monetary shock
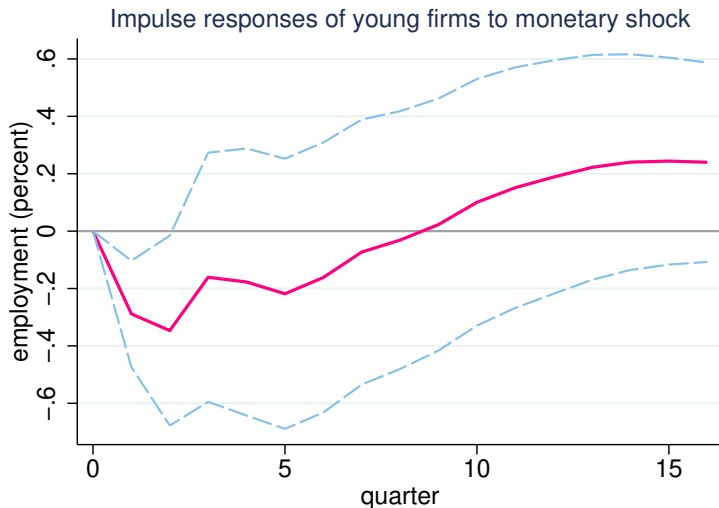
The shock size is an equivalence of 25 basis point interest rate increase

Older firms (2+ age)

Impulse responses of old firms to monetary shock
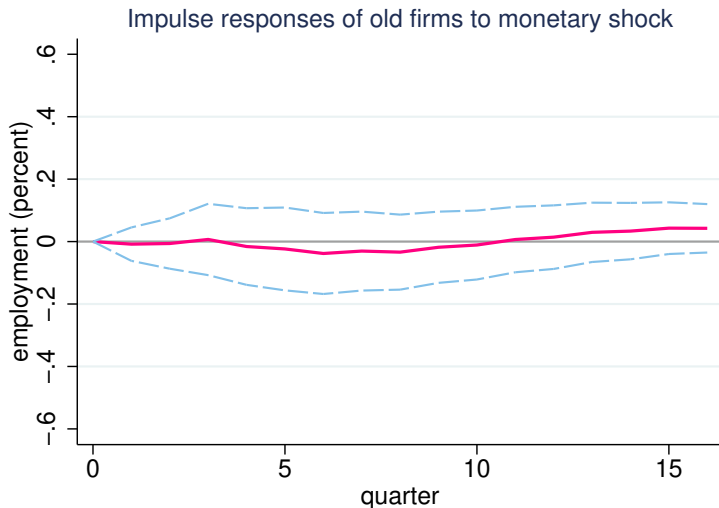
The shock size is an equivalence of 25 basis point interest rate increase

2. Micro-level evidence

Micro level: empirical method

$$\Delta ln(emp)_{i,t} = \alpha_i + \alpha_{st} + \sum_g \delta_g D_{g,i,t-1} + \sum_g \beta_g D_{g,i,t-1} \xi_t^m + \epsilon_{i,t}$$

- ▶ LHS: change of log employment for firm i in a quarter
- ▶ α_i: firm fixed effect
- ▶ α_{st}: sector-time fixed effect
- ▶ $D_{g\,i,t-1}$: dummy for firm groups (small, young, small and young etc.)
- ▶ ξ_t^m: monetary shock details

data

Micro empirical results: size 20 age 1

Heterogeneous Responses of Employment to Monetary Shocks

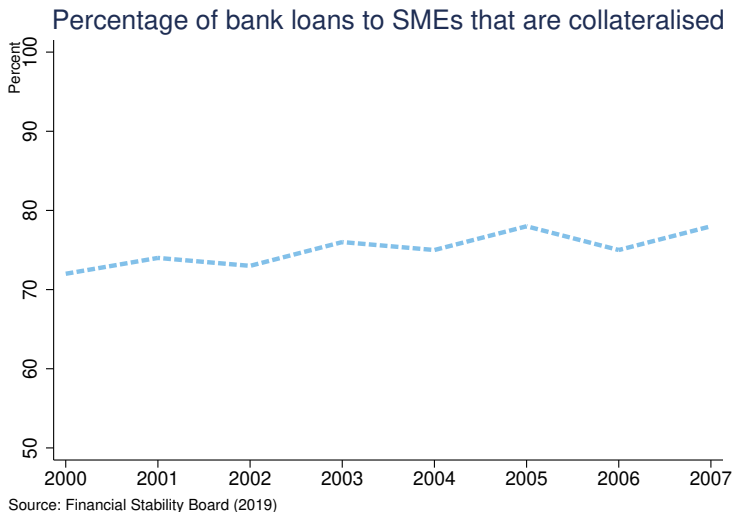| Variables	(1)	(2)	(3)
Small×shocks	−0.278**		
	0.126		
Young×shocks		−0.875***	
		0.218	
Small and young×shocks			−2.376***
			0.238
Small and old×shocks			−0.0569
			0.106
Large and young×shocks			−1.795**
			0.887
Observations	86,390,000	86,390,000	86,390,000
R^2	0.069	0.061	0.063
Firm FE	Yes	Yes	Yes
Time×Industry FE	Yes	Yes	Yes

* indicates statistical significance at 5% level,** at 1% level, and *** at 0.1% level.
Shock size is an equivalence of 100 basis points interest rate increase

Alternative

3. Transmission mechanism

Small business finance

Percentage of bank loans to SMEs that are collateralised

Source: Financial Stability Board (2019)

In 2003, 29% small businesses pledge personal residence as collateral to obtain loans. Meisenzahl (2011)

Startup finance

Soures of financing for 2004 startups
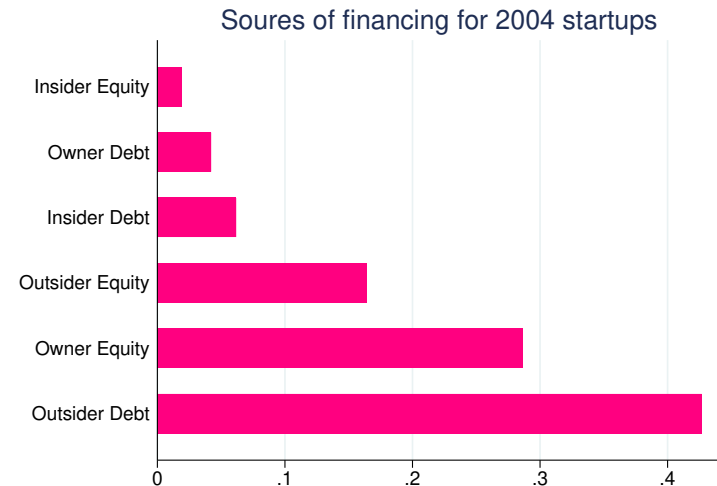
Source: Robb and Robinson (2012)

Balance Sheet

Transmission mechanism: IV method

$$Y_{mt} = \sum_t \lambda_t I_t + \sum_m \lambda_m I_m + \beta HP_{mt} + \theta X_{mt} + \epsilon_{mt}$$
$$HP_{mt} = \sum_t \delta_t I_t + \sum_m \delta_m I_m + \gamma Z_m X_{mt}^* + \theta X_{mt} + \eta_{mt}$$

▶ Y_{mt}: log change in loan amount for MSA m and year t

▶ HP_{mt}: log change in house price for MSA m and year t

▶ I_t: dummy for year t

▶ I_m: dummy for MSA m

▶ Z_m: Saiz's housing supply elasticity or sensitivity elasticity (Guren et. al.)

▶ X_{mt}: controls unemployment rate and population growth

▶ β: response of loan amount to local house price

▶ Assumption: $E(Z_m X_{mt}^*, \epsilon_{mt}) = 0$

Data   Summary Statistics   Collateral

Transmission mechanism: IV results

The effect of housing prices on loans to small and young businesses

Variables	(1) OLS	(2) FE	(3) IV_Saiz	(4) IV_GMNS
Housing prices	0.305***	0.329***	1.775***	0.415***
	0.0885	0.0950	0.582	0.104
Observations	6,020	6,020	6,020	6,020
Number of msa	215	215	215	215
Year FE	YES	YES	YES	YES
MSA FE	NO	YES	YES	YES
F-test			76.03	1483

* indicates statistical significance at 5% level,** at 1% level, and *** at 0.1% level.

DSGE model

▶ How much can housing collateral channel explain the heterogeneous employment responses?

▶ Components
- Production sector
  - Business owners (small/young firms)
  - Corporate sector (large/old firms)
- Household sector
- Retailer
- Central bank

▶ Feature
- Housing as collateral
- Build on (Iacoviello 2005)

Responses to a monetary shock
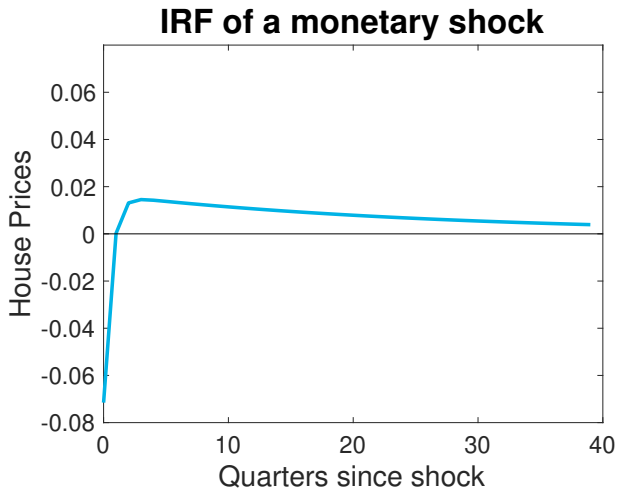
IRF of a monetary shock

The shock size is an equivalence of 25 basis point interest rate increase

Responses to a monetary shock

IRF of a monetary shock

The shock size is an equivalence of 25 basis point interest rate increase
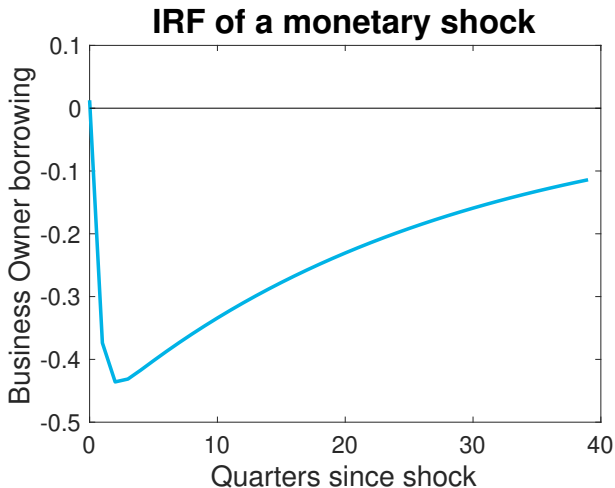
Responses to a monetary shock

IRF of a monetary shock

The shock size is an equivalence of 25 basis point interest rate increase
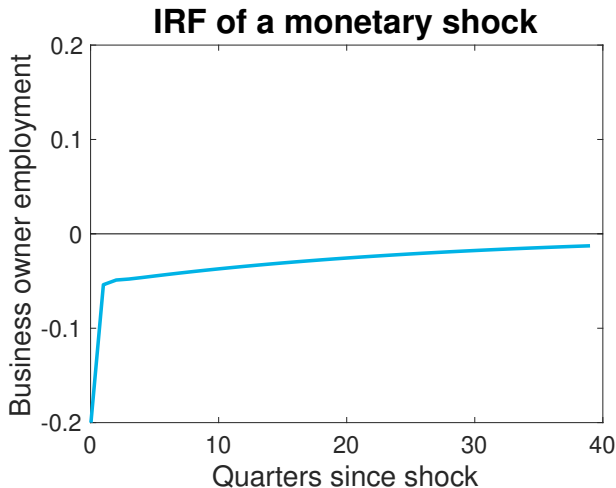
Responses to a monetary shock

IRF of a monetary shock
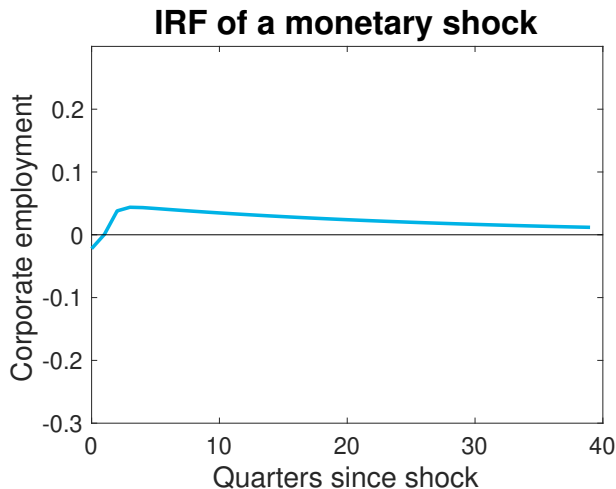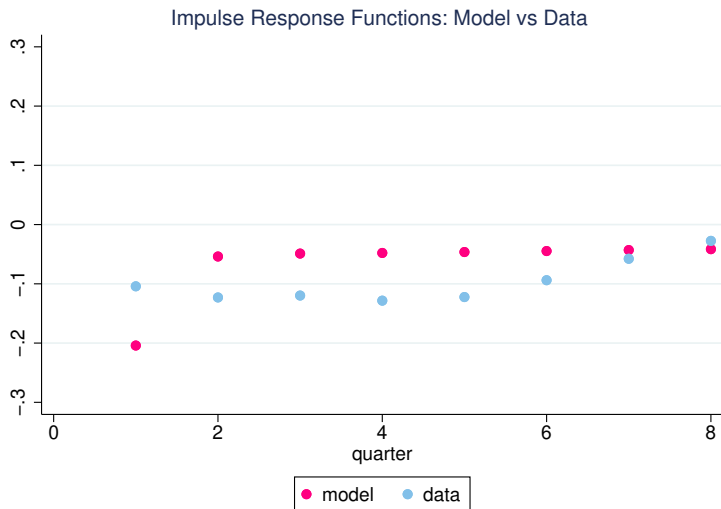
The shock size is an equivalence of 25 basis point interest rate increase

Compare model and data

Impulse Response Functions: Model vs Data

The model accounts for 67% of the cumulative responses in the data.

Conclusion

▶ New empirical facts

- Macro: Smaller or younger firms respond more
- Micro: Smaller and younger firms respond most

▶ Mechanism

- Evidence: Reliance on housing collateral to obtain loans
- Quantification: DSGE model accounts for 67% of the cumulative responses in the data

Appendix

LEHD states approved

- ▶ Arizona, California, Colorado, Connecticut, Delaware, Indiana, Kansas, Maine, Maryland, Nebraska, Nevada, New Jersey, New Mexico, New York, North Dakota, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Utah, Virginia, Washington, Wisconsin

Imputation method

▶ Use QWI to impute BDS 1977A1-2007A1 to 1977Q1-2007Q1

- Step 1 Construct $\eta = \frac{QWI - \tilde{QWI}}{QWI}$, $e = \frac{emp - \tilde{emp}}{emp}$

- Step 2 Regress $\eta = \alpha + \beta_1 Q + \beta_2 e$ (for 1993Q1-2017Q2)

- Step 3 Predict $\eta = \alpha + \beta_1 Q + \beta_2 e$ (for 1977Q1-1992Q4)

- Step 4 Construct $BDS = \frac{\tilde{BDS}}{1-\eta}$

Macro level: time series data
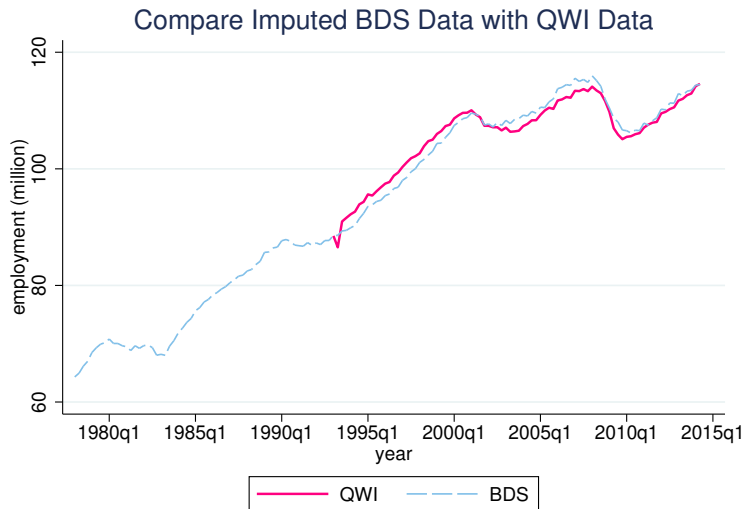
▶ Business Dynamics Statistics (BDS)
- Annually
- 1977-2007
- Lower frequency with longer period

▶ Quarterly Workforce Indicators (QWI)
- Quarterly
- 1993-2007
- Higher frequency with shorter period

Imputation method   Imputation results   back

Imputation result

Compare Imputed BDS Data with QWI Data

Imputation result

Compare Imputed BDS Data with QWI Data
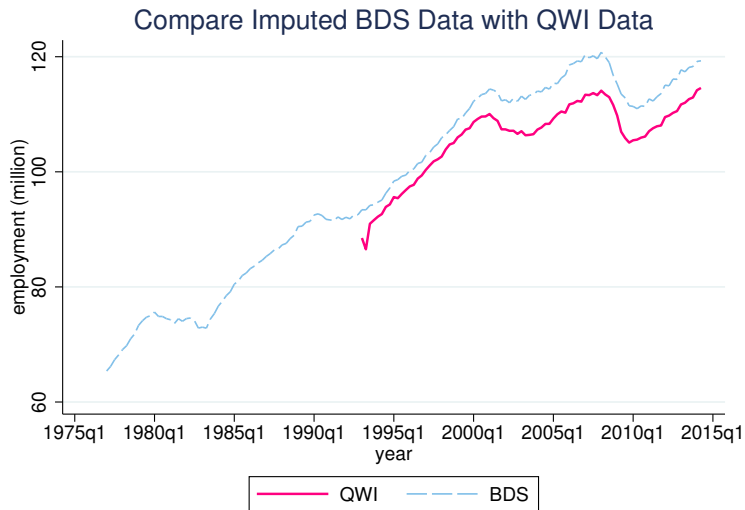
Micro level: firm panel data

- ▶ Census Bureau restricted microdata

  - Establishment and firm level
  - Quarterly frequency
  - Comprehensive coverage
  - Characteristics firm size and age

- ▶ The Longitudinal Employer-Household Dynamics (LEHD)

  - Quarterly Workforce Indicators (QWI)

    - 1990-2007 (Quarterly)
    - Employment, NAICS

  - Employer Characteristics File (ECF)

    - 1990-2007 (Quarterly)
    - Firm age and size

Monetary shocks

▶ High-frequency event study approach (Gorodnichenko and Weber (2016) and Ottonello and Winberry (2020))
  - 1994-2007 (Daily $\rightarrow$ Quarterly)
  - $\xi_t^m = \tau(t)(ffr_{t+\Delta_+} - ffr_{t+\Delta_-})$

Variable	Mean	SD
Smoothed shock	$-.0240906$	.0860484
Summed shock	$-.0216807$	.1077584

Micro empirical results: size 5 age 1

Heterogeneous Responses of Employment to Monetary Shocks

Variables	(1)	(2)	(3)
Small×shocks	−0.594***		
	0.0841		
Young×shocks		−0.875***	
		0.218	
Small and young×shocks			−4.684***
			0.255
Small and old×shocks			−0.595***
			0.0844
Large and young×shocks			−2.486***
			0.411
Observations	86,390,000	86,390,000	86,390,000
R^2	0.090	0.061	0.076
Firm FE	Yes	Yes	Yes
Time×Industry FE	Yes	Yes	Yes

* indicates statistical significance at 5% level,** at 1% level, and *** at 0.1% level.
Shock size is an equivalence of 100 basis points interest rate increase

Micro empirical results: size 20 age 1 unweighted shock

Heterogeneous Responses of Employment to Monetary Policy

Variables	(1)	(2)	
Small×shocks	-0.277**		
	0.1		
Young×shocks		-1.385***	
		0.171	
Small and young×shocks			-2.192***
			0.188
Small and old×shocks			0.0176
			0.0842
Large and young×shocks			-1.788***
			0.675
Observations	86390000	86390000	86390000
R^2	0.069	0.061	0.063
Firm FE	Yes	Yes	Yes
Time×IndustryFE	Yes	Yes	Yes

Micro empirical results: size 5 age 1 unweighted shock

Heterogeneous Responses of Employment to Monetary Policy

Variables	(1)	(2)	
Small×*shocks*	-0.498***		
	0.0668		
Young×*shocks*		-1.385***	
		0.171	
Small and young×*shocks*			-3.448***
			0.201
Small and old×*shocks*			-0.511***
			0.0671
Large and young×*shocks*			-2.726***
			0.32
Observations	86390000	86390000	86390000
R^2	0.09	0.061	0.076
Firm FE	Yes	Yes	Yes
Time×*IndustryFE*	Yes	Yes	Yes

Micro empirical results: size 500 age 1 weighted shock

Heterogeneous Responses of Employment to Monetary Policy

Variables	(1)	(2)	
Small×*shocks*	-0.943		
	0.638		
Young×*shocks*		-0.875***	
		0.218	
Small and young×*shocks*			-0.740***
			0.257
Small and old×*shocks*			-0.302*
			0.156
Large and young×*shocks*			104.5***
			9.878
Observations	86390000	86390000	86390000
R^2	0.062	0.061	0.061
Firm FE	Yes	Yes	Yes
Time×*IndustryFE*	Yes	Yes	Yes

Micro empirical results: size 500 age 1 unweighted shock

Heterogeneous Responses of Employment to Monetary Policy

Variables	(1)	(2)	
Small$\times$shocks	0.325		
	0.507		
Young$\times$shocks		-1.385***	
		0.171	
Small and young$\times$shocks			-1.047***
			0.203
Small and old$\times$shocks			0.142
			0.123
Large and young$\times$shocks			78.04***
			7.238
Observations	86390000	86390000	86390000
R^2	0.062	0.061	0.061
Firm FE	Yes	Yes	Yes
Time$\times$IndustryFE	Yes	Yes	Yes

Transmission mechanism: role of housing collateral
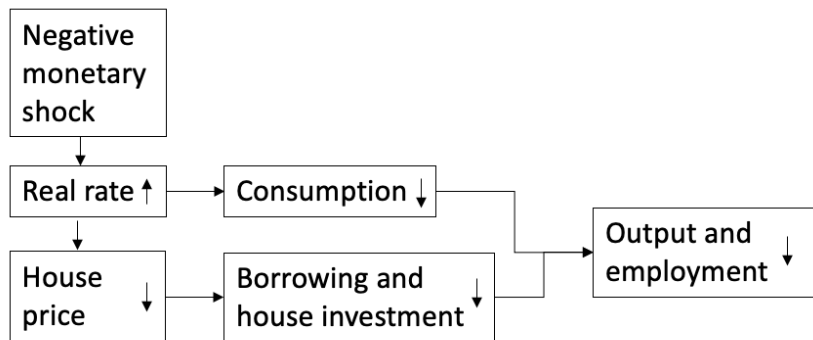
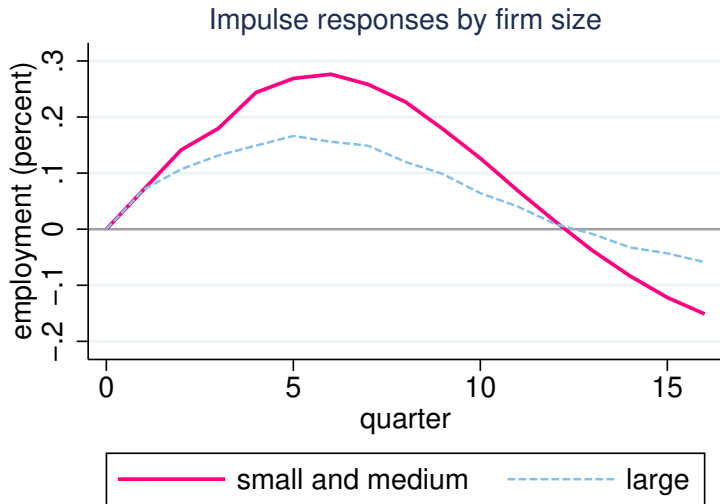# Transmission mechanism: SVAR method

▶ Reduced-form representation:

$$y_t' = x_t'\Phi + u_t', u_t \sim \mathcal{N}(0, \Sigma)$$

$$y_t = \begin{bmatrix} \text{industrial production} \\ \text{employment} \\ \text{consumer price index} \\ \text{house price index} \\ \text{commodity price index} \\ \text{Romer and Romer shock} \end{bmatrix} \quad x_t = \begin{bmatrix} y_{t-1}' \\ y_{t-2}' \\ \vdots \\ y_{t-p}' \\ 1 \end{bmatrix}$$
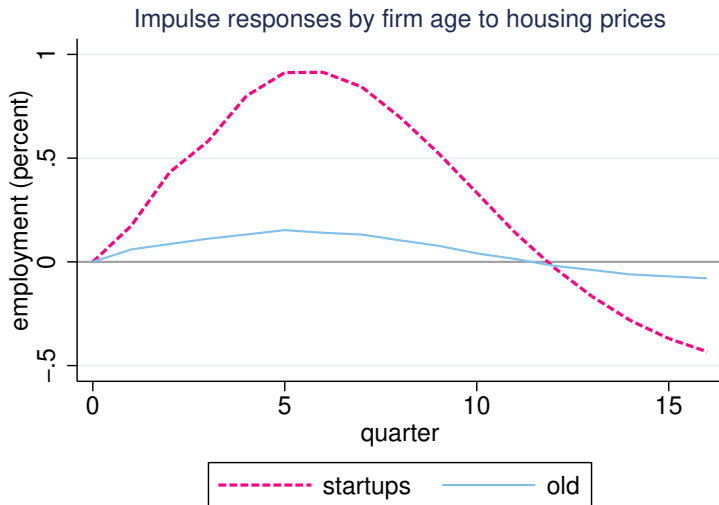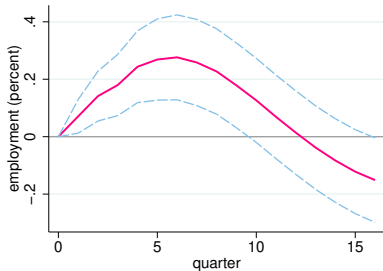
▶ Correlation between house price and firms' employment
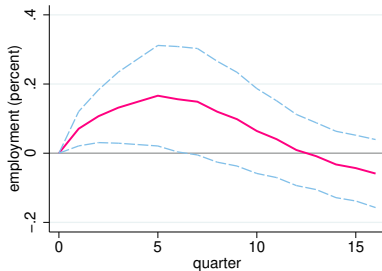
Responses to housing prices shock by firm size

Impulse responses by firm size

small and medium — large

Responses to housing prices shock by firm age

Impulse responses by firm age to housing prices

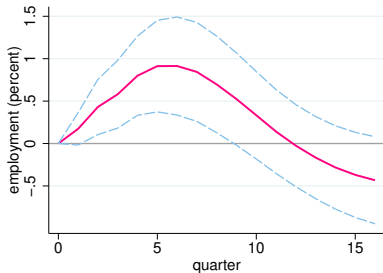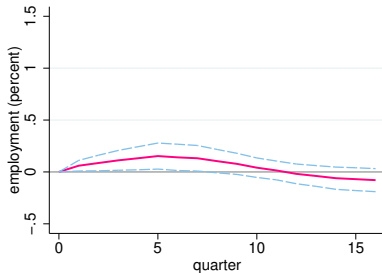# Responses to housing prices shock by firm size

(a) Small

(b) Large

Responses to housing prices shock by firm age

(a) Young
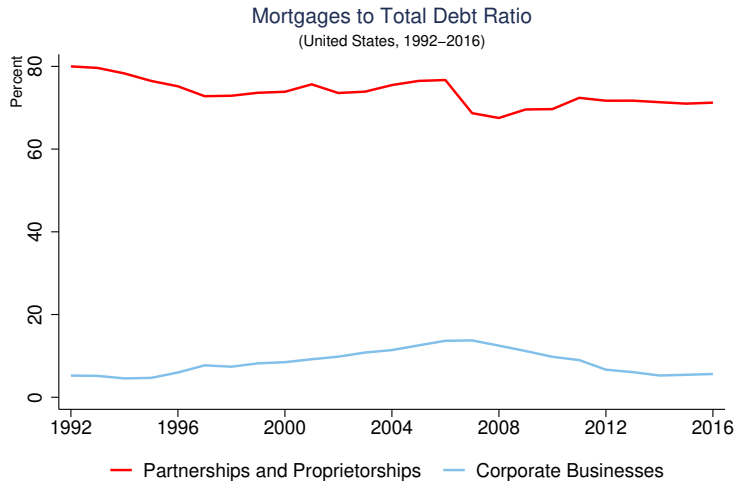
(b) Old

HP

Transmission mechanism: balance sheet evidence

Mortgages to Total Debt Ratio
(United States, 1992–2016)

Partnerships and Proprietorships — Corporate Businesses

Source: Federal Reserve Board

back

Transmission mechanism: housing prices response to monetary shocks

Impulse responses of housing prices to monetary shock
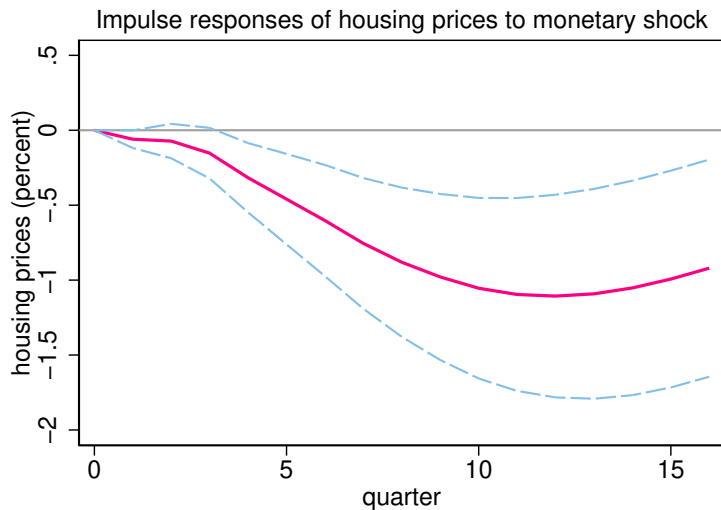
Main data

- Loan data from Small Business Administration
  - key variables: loan amount; approval year; borrowers' zip code
  - 1991-2019
- House price from Federal Housing Finance Agency
  - MSA level
  - 1981-2019
- IV1: Local housing supply elasticity from Saiz (2010)
  - MSA level
- IV2: Local housing price sensitivity from Guren et al. (2020)
  - MSA level

Role of personal residence as collateral in SBA loans

NORTH DAKOTA DISTRICT OFFICE

Collateral and Credit

By: Dale Van Eckhout
Senior Area Manager, Bismarck Area Office
North Dakota District Office

What is required to obtain financing for my business? Lenders consider each unique situation, however they will look at some variation of the five C's of credit and "collateral" (one of the 5 C's) is still a basis for most loans made. Collateral serves as a secondary means of repaying the loan. The lender does not want to own the collateral and wants the business to succeed. The borrower must put their assets (collateral) at risk or in other words have "skin in the game" in order to obtain the needed financing for their business.   Collateral includes assets such as real estate and office or manufacturing equipment. Accounts receivable and inventory may be pledged as collateral. Collateral may also include personal assets and commonly, a second mortgage on a home. Before approaching a lender, you should assume that all assets financed with borrowed funds will be used as collateral for the loan. Depending on how much equity is contributed toward the purchase of these assets, the lender may require other assets as collateral.

Summary Statistics

Variable	Mean
Firm size	23.55
Firm age	11.72

LEHD Summary Statistics[2]

Variable	Mean
Firm size	12.46
Firm age	6.74

SBA Summary Statistics[3]

back

2. Author's calculation based on LEHD data
3. Source: Brown and Earle (2013)

Equilibrium

▶ Definition: An equilibrium is an allocation
$\{h_t^e, h_t^h, L_t^e, L_t^c, L_t^h, c_t^e, c_t^h, b_t^e, b_t^h, Y_t\}_{t=0}^{\infty}$, together with the
sequence of price $\{W_t, R_t, P_t, P_t^w, P_t^*, q_t, \}_{t=0}^{\infty}$, such that,
given the sequence of monetary shocks $\{e_{R,t}\}$:

1. Business owners optimize: $\{c_t^e, b_t^e, h_t^e, L_t^e\}$ solves P1.
2. Corporations optimize: $\{d_t, Y_t, L^c\}$ solves P2.
3. Households optimize: $\{c_t^h, b_t^h, h_t^h, L_t^h\}$ solves P3.
4. Retailers optimize: $\{P_t^*\}$ solves P4.
5. Labor market clears: $L_t^e + L_t^c = L_t^h$.
6. House market clears: $h_t^e + h_t^h = H$.
7. Goods market clears: $c_t^e + c_t^h = Y_t$.
8. Loans market clears: $b_t^e + b_t^h = 0$.

Business Owner

- Produce homogeneous intermediate goods Y_t^c
- Pledge personal housing as a collateral

$$\mathrm{P1} \quad \max_{c_t^e, b_t^e, h_t^e, L_t^e} \mathbb{E}_0 \sum_{t=0}^{\infty} \gamma^t \ln c_t^e \quad s.t.$$

$$Y_t^e \frac{P_t^w}{P_t} + b_t^e = c_t^e + q_t \triangle h_t^e + \frac{R_{t-1} b_{t-1}^e}{\pi_t} + w_t L_t^e$$

$$b_t^e \leq m \mathbb{E}_t \left(\frac{q_{t+1} h_t^e \pi_{t+1}}{R_t} \right)$$

$$Y_t^e = (h_{t-1}^e)^v (L_t^e)^{1-v}$$

location

Corporate

- Produce homogeneous intermediate goods Y_t^c
- Not financially constrained
- Owned by households

$$\text{P2} \quad \max_{d_t, Y_t, L^c} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{t,k} d_t \quad s.t.$$

$$d_t = \frac{P_t^w}{P_t} Y_t^c - w_t L_t^c$$

$$Y_t^c = A(L_t^c)^\mu$$

Households

- Purchase final goods from retailers and consume c_t^h
- Supply labor L_t^h
- Invest in house h_t^h and lend b_t^h to business owner
- Own corporations and retailers, receiving d_t, F_t

$$P3 \quad \max_{c_t^h, b_t^h, h_t^h, L_t^h} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \big(\ln c_t^h + \rho \ln h_t^h - \frac{(L_t^h)^{(1+\frac{1}{\eta})}}{1+\frac{1}{\eta}} \big) \quad s.t.$$

$$c_t^h + q_t \triangle h_t^h - b_t^h = w_t L_t^h - \frac{R_{t-1} b_{t-1}^h}{\pi_t} + d_t + F_t$$

New Keynesian block

- ▶ Retailers
  - Monopolistic competition (retailers indexed by z)
  - Buy intermediate goods at wholesale price P_t^w
  - Differentiate goods w/o cost and sell $Y_t(z)$ at price $P_t(z)$
  - Total final goods are $Y_t = (\int_0^1 Y_t(z)^{\epsilon-1/\epsilon} dz)^{\epsilon/\epsilon-1}$
  - Change price with probability $1 - \theta$, following Calvo (1983)
  - Aggregate price evolves: $P_t = (\theta P_{t-1}^{1-\epsilon} + (1-\theta)(P_t^*)^{1-\epsilon})^{\frac{1}{1-\epsilon}}$

$$\text{P4} \quad \max_{P_t^*} \sum_{t=0}^{\infty} \theta^k \mathbb{E}_{t-1}\left[\Lambda_{t,k} \frac{P_t^* - P_{t+k}^w}{P_{t+k}} Y_{t+k}^* \right] \quad s.t.$$

$$Y_{t+k}^*(z) = \left(\frac{P_{t+k}^*(z)}{P_{t+k}} \right)^{-\epsilon} Y_{t+k}^f$$

- ▶ Central bank

$$R_t = (R_{t-1})^{r_R}(\pi_{t-1}^{1+r_\pi}(\frac{Y_{t-1}}{Y})^{r_Y} \bar{r}r)^{1-r_R} e_{R,t}$$

Set parameters

Description	Parameter	Value	Source
Households discount factor	β	0.99	Iacoviello (2005)
Business owners discount factor	γ	0.98	Iacoviello (2005)
Households labor supply elasticity	η	0.18	Brown (2009)
Steady-state gross markup	X	1.05	Iacoviello (2005)
Probability fixed price	θ	0.75	Iacoviello (2005)
Loan-to-value ratio	m	0.75	Chang (2020)

Externally set parameters

Description	Param	Value	Target	Model	Data
HH weight on housing	ρ	0.041	Residential Housing Value over GDP	1.28	1.28
BO housing elasticity	υ	0.026	Business Owners Share of Households	0.17	0.17
Corp. labor elasticity	μ	0.76	Share of Employment of large firms	0.51	0.52
Corp. technology	A	1.06	Share of Output of large firms	0.55	0.53

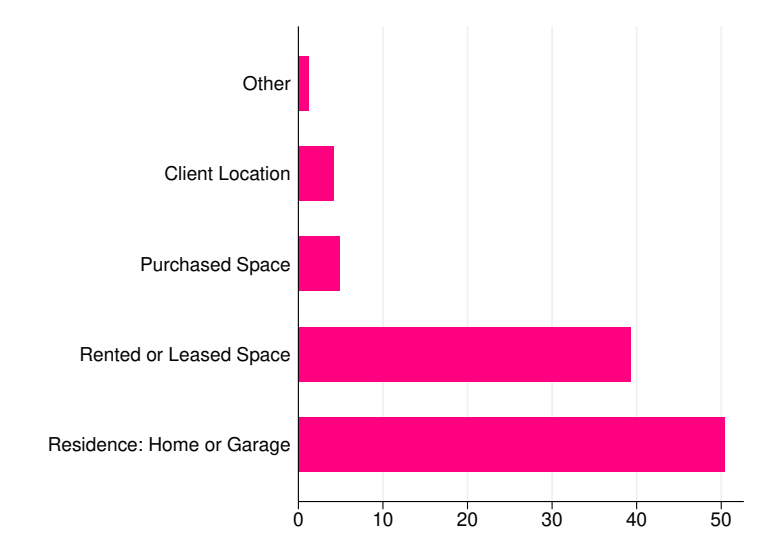Calibrated parameters

Business Location

Figure 3: Primary Business Location of Firms in the Kauffman Firm Survey, 2004, Lowrey (2009)