Financial Market Participation, Cost Volatility, and Demand Shocks

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Introduction

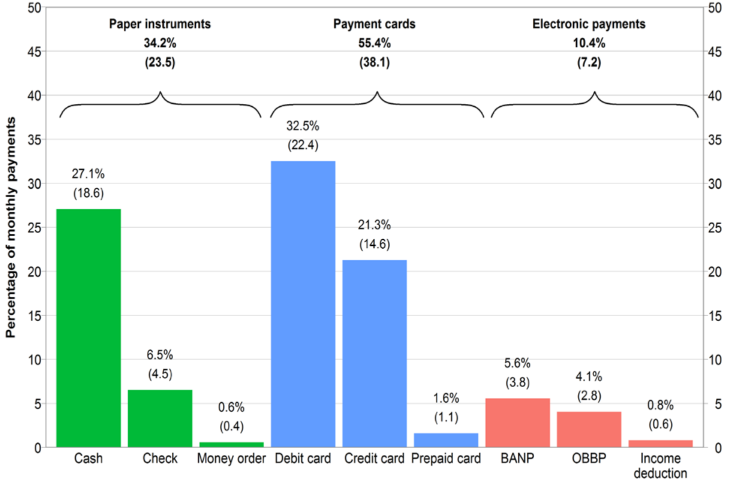
Money Demand

- Importance of understanding money demand
  - Welfare cost of inflation
  - Open market operation
- One crucial observation about money demand
  - Low interest-elasticity in the short-run
  - High interest-elasticity in the long-run
- DSGE models cannot match with both short-run and long-run
  - Aruoba and Schorfheide (2011), Schorfheide (2013)

Coexistence of Money and Credit

- Trade-offs
  - Liquid money versus interest-bearing assets
  - Easy-of-use credit associated with credit cost
- Credit cost may affect money holding decision
- The Survey of Consumer Payment Choice (SCPC)
  - At least 70% of U.S. have credit cards (2011, 2012)
  - Credit and charge card payment declined in 2009 and rebounded
- We consider the *extensive margin* of money holding

Payment Instruments



Source: 2015 Survey of Consumer Payment Choice, Table 29. *Note:* Number of payments in parentheses.

Figure 12: Percentage share and number of consumer payments in a typical month, by type of payment instrument, 2015

Extensive Margin in Economics

- Extensive margin is included in macro-labor literature to explain labor supply elasticity
  - Rogerson (1988) , Chang and Kim (2006)
- Extensive margin in international trade literature
  - Melitz (2003), Chaney (2008)
- Extensive margin is closely related with *heterogeneity*
- Extensive margin has strong impact on the aggregate behavior of the economy
- Mulligan and Sala-i-Martin (2000) argues that "the relevant monetary decision for the majority of U.S. households is not the fraction of assets to be held in interest bearing form, but whether to hold any asset at all"

Credit Access and the Cost of Credit

- Managing portfolios requires significant resources
  - Optimal mixture of financial assets
  - Choosing method of payments
- Fixed cost to gain credit access
  - Credit card membership fee
  - Opportunity cost of research
  - Cost of adopting financial technologies
- Fixed cost called as *credit cost*
- Credit cost is *idiosyncratic*: cross-sectional distribution
  - Becker (1957) "Taste-based" discrimination
  - Access to professional financial information
  - High cost loans including payday lending, car title loans, and overdraft loans
  - Terms and conditions of credit cards

Time-Varying Cross-Sectional Distribution

- Rapid development and deepening of financial markets
- Ambiguous effects on the cross-sectional distribution of credit costs
  - Easier access to credit: competition
  - More elaborate research: varieties to choose from
- Time-varying cross-sectional distribution of credit cost
  - Mean-shifting with fixed volatility
  - *Mean-preserving spread*

This Paper

- Lagos-Wright framework with two subperiod markets
  - DM: Search-theoretic decentralized market
  - CM: Walrasian centralized market
- By introducing the credit cost to the DM, the extensive margin is modeled as the agent's decision
- Credit cost is drawn from a mean-preserving spread, with volatility changing over time
- The CM is modeled as new Keynesian fashion following Aruoba and Schorfheide (2011)
- Bayesian analysis of linearized model with quarterly U.S. data

Preview of Results

- Threshold level of cost for the credit access exists: Households with higher credit cost opt out of credit access
- Impulse responses to the inflation target shock are *approximately* consistent with VAR
- The aggregation is achieved through the threshold level: Changes in cross-sectional volatility deliver the first-order dynamic effect
- Credit spread shock behaves as money demand shock and causes negative relationship between money and output in the short run, as happened during the global financial crisis
- Due to the aggregation property of the model, the mean-shifting shock model would deliver the same result

The Model

Model Economy

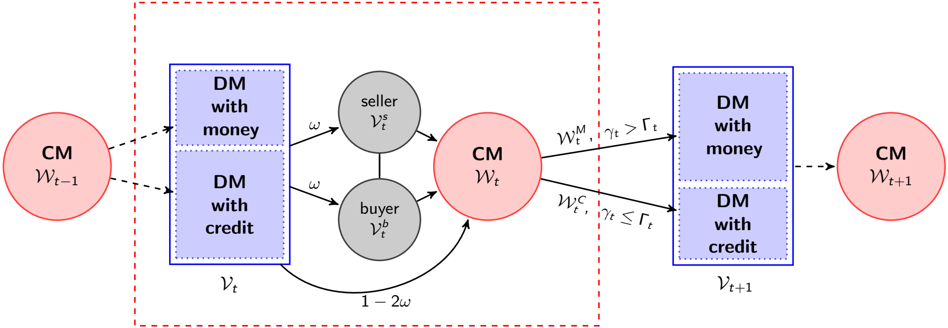
- Based on Aruoba and Schorfheide (2011)
  - Extension of Lagos and Wright (2005)
    - Money is essential in the DM
    - New Keynesian economy in the CM
  - With the credit access decision (related to extensive margin)
  - Without the DM preference shock, but with time-varying cross-sectional distribution
- Households are heterogeneous in two dimensions
  - Search frictions in the DM
  - Credit costs, realized during the CM

Two Dimensions of Heterogeneity

- Credit cost
  - Household faces idiosyncratic cost $\gamma_t \sim \Phi_t(\cdot)$
  - Realized at the beginning of the CM
  - Given the cost, she decides over
    gain credit access in the next period DM (a credit holder)
    and opt out of it and carry money (a money holder)
  - Independently distributed across households

- Search friction ω in the DM
  - Buyer (consumer) with prob. ω
  - Seller (producer) with prob. ω
  - Buyer and seller always matched
  - Unmatched households with prob. $1 - 2\omega$

Market Structure



Households in the CM

- P_t the aggregate price level in the CM
  R_t the gross nominal interest rate on one-period bonds
  W_t be the real wage,
  R_t^k the rental rate of capital
  $\mathcal{S}_t$ the set of aggregate shocks
  γ_t the idiosyncratic credit cost to the next period DM.
- The household with γ_t solves the following programming problems

$$\begin{aligned}&\mathcal{W}_t(\hat{m}_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t)\\&\quad = \max\left\{\mathcal{W}_t^M(\hat{m}_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t), \mathcal{W}_t^C(\hat{m}_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t)\right\}\end{aligned}$$

DM Money Holder's Value Function

$$\mathcal{W}_t^M\left(\hat{m}_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t\right) =$$
$$\max_{x_t, h_t, i_t, b_{t+1}, k_{t+1}, m_{t+1}} \left\{ U(x_t) - Ah_t + \beta \mathbf{E}_t \left[\mathcal{V}_{t+1}(m_{t+1}, k_{t+1}, i_t, b_{t+1}, \mathcal{S}_{t+1}, \gamma_t) \right] \right\}$$

subject to

$$P_t x_t + P_t i_t + b_{t+1} + m_{t+1} \leq P_t W_t h_t + P_t R_t^k k_t + R_{t-1} b_t + \hat{m}_t + \Pi_t - T_t + \Omega_t$$

$$k_{t+1} = (1-\delta)k_t + \left[1 - S\left(\frac{i_t}{i_{t-1}}\right)\right] i_t$$

- Quasi-linear CM preference
  - Decision on x_t is identical regardless of the continuation value
  - Replacing h_t, the individual state does not affect the decision

DM Credit Holder's Value Function

$$\mathcal{W}_t^C\left(\hat{m}_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t\right) \;=$$
$$\max_{x_t, h_t, i_t, b_{t+1}, k_{t+1}} \left\{ U(x_t) - Ah_t + \beta \mathbf{E}_t \left[\mathcal{V}_{t+1}(0, k_{t+1}, i_t, b_{t+1}, \mathcal{S}_{t+1}, \gamma_t) \right] \right\}$$

subject to

$$P_t x_t + P_t i_t + b_{t+1} \leq P_t W_t h_t + P_t R_t^k k_t + R_{t-1} b_t + \hat{m}_t + \Pi_t - T_t + \Omega_t$$

$$k_{t+1} = (1-\delta)k_t + \left[1 - S\left(\frac{i_t}{i_{t-1}}\right)\right] i_t$$

- No money holding
- The level of m_{t+1} does not affect the expected marginal value on capital and bond holdings

  (k_{t+1}, b_{t+1}) distribution degenerates if i_0 for all agents are identical

Households in the DM

- Money holder:

$$
\begin{aligned}
\mathcal{V}_t(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_{t-1}) &= \omega \mathcal{V}_t^b(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_{t-1}) \\
&+ \omega \mathcal{V}_t^s(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_{t-1}) \\
&+ (1-2\omega)\mathbf{E}_t \left[\mathcal{W}_t(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t) \right]
\end{aligned}
$$

- Credit holder:

$$
\begin{aligned}
\mathcal{V}_t(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_{t-1}) &= -\gamma_{t-1} \\
&+ \omega \mathcal{V}_t^b(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_{t-1}) \\
&+ \omega \mathcal{V}_t^s(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_{t-1}) \\
&+ (1-2\omega)\mathbf{E}_t \left[\mathcal{W}_t(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t) \right]
\end{aligned}
$$

where the value functions for a buyer and a seller are given by

$$\begin{aligned}
\mathcal{V}_t^b(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_{t-1}) &= u(q_t^b) + \mathbf{E}_t\left[\mathcal{W}_t(m_t - d_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t)\right] \\
\mathcal{V}_t^s(m_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_{t-1}) &= -c\left(q_t^s, Z_t\right) \\
&\quad + \mathbf{E}_t\left[\mathcal{W}_t(m_t + d_t, k_t, i_{t-1}, b_t, \mathcal{S}_t, \gamma_t)\right]
\end{aligned}$$

Kalai Bargaining

- The terms of trade in the DM is decided by

$$
\begin{aligned}
(q, d) \;=\; & \quad \operatorname{argmax} && u(q) - U'(x)\frac{d}{P} \\
& \quad \text{subject to} && d \leq \text{liquidity} \\
& && u(q) - U'(x)\frac{d}{P} = \frac{\theta}{1-\theta}\left[U'(x)\frac{d}{P} - c(q, Z)\right]
\end{aligned}
$$

- The solution (q^*, d^*) satisfies

$$\frac{d^*}{P} = \frac{g(q^*, Z)}{U'(x)}$$

where $g(q, Z) = (1-\theta)u(q) + \theta c(q, Z)$

- In the monetary trade where the liquidity is binding, $(q^*, d^*) = (q^M, m)$

- In the credit trade, $(q^*, d^*) = (q^C, d^C)$ with $u'(q^C) = c_q(q^C, Z)$

Household Optimality Conditions

$$U'(x_t) = \frac{A}{W_t}$$

$$1 = \mu_t \left(1 - S_t - S_t' \cdot \frac{i_t}{i_{t-1}}\right) + \beta \mathbf{E}_t \left[\frac{U'(x_{t+1})}{U'(x_t)} \mu_{t+1} S_{t+1}' \cdot \left(\frac{i_{t+1}}{i_t}\right)^2 \right]$$

$$k_{t+1} = (1-\delta)k_t + \left[1 - S\left(\frac{i_t}{i_{t-1}}\right)\right] i_t$$

$$1 = \beta \mathbf{E}_t \left[\frac{U'(x_{t+1})}{U'(x_t)} \cdot \frac{R_t}{\pi_{t+1}} \right]$$

$$\mu_t = \beta \mathbf{E}_t \left[\frac{U'(x_{t+1})}{U'(x_t)} \left(R_{t+1}^k + (1-\delta)\mu_{t+1}\right) \right]$$

$$1 = \beta \mathbf{E}_t \left[\frac{U'(x_{t+1})}{U'(x_t)\pi_{t+1}} \left(1 - \omega + \frac{\omega u'(q_{t+1}^M)}{g_q(q_{t+1}^M, Z_{t+1})}\right) \right]$$

$$g(q_t^M, Z_t) = U'(x_t) \frac{m_t}{P_t}$$

$$u'(q_t^C) = c_q(q_t^C, Z_t)$$

Credit Access Decision

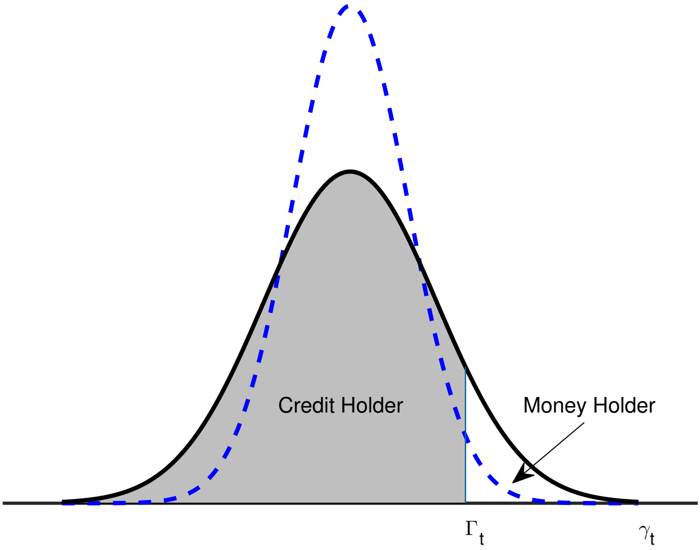
- There exists Γ_t such that if $\gamma_t > \Gamma_t$ the household carries money, and if $\gamma_t \leq \Gamma_t$ the household gains credit access.

- Moreover, the threshold Γ_t is given by

$$
\begin{aligned}
\Gamma_t \quad = \quad & \omega \mathbf{E}_t \left[u\left(q^C_{t+1}\right) - g\left(q^C_{t+1}, Z_{t+1}\right) \right] \\
& - \omega \mathbf{E}_t \left[u\left(q^M_{t+1}\right) - g\left(q^M_{t+1}, Z_{t+1}\right) \right] \\
& + \left(1 - \frac{1}{R_t}\right) \mathbf{E}_t \left[g(q^M_{t+1}, Z_{t+1}) \left(1 - \omega + \frac{\omega u'(q^M_{t+1})}{g_q(q^M_{t+1}, Z_{t+1})}\right)\right]
\end{aligned}
$$

- Net expected gain from being a credit holder is equivalent to the cost
- Nominal interest rate and inflation affect the credit access decision and the extensive margin

Threshold



Firms in the CM

- In the DM, a household turns into a producer (a seller) or a consumer (a buyer)
- Firms are operational in the centralized market

- New Keynesian economy with
  - Final good producer as a packager in a competitive market
  - Monopolistically competitive intermediate good producing firms, with elasticity of substitution $(1+\lambda)/\lambda$

$$Y_t = \left[\int Y_t(j)^{\frac{1}{1+\lambda}} dj \right]^{1+\lambda}$$

  - Firms are heterogeneous *a la Calvo*, ζ, with partial price indexation, ι

$$P_t(j) = \begin{cases} P_t^o(j) & \text{with } 1-\zeta \\ P_{t-1}(j)\pi_{t-1}^{\iota} & \text{with } \zeta \end{cases}$$

Aggregate Resource Constraints

- Government runs a balanced budget subject to government spending shock

$$G_t = \left(1 - \frac{1}{g_t}\right)\mathcal{Y}_t$$

- The resource constraint in the CM is

$$X_t + I_t + G_t = Y_t,$$

Aggregate Output

- Total real money balance is

$$\mathcal{M}_t = \left[1 - \Phi_{t-1}\left(\Gamma_{t-1}\right)\right] \frac{m_t}{P_{t-1}}$$

- DM price level: the weighted average

$$\begin{aligned} P_t^{DM} &= \Phi_{t-1}(\Gamma_{t-1}) \frac{d_t^C}{q_t^C} + \left[1 - \Phi_{t-1}\right] (\Gamma_{t-1}) \frac{m_t}{q_t^M} \\ &= \left[\Phi_{t-1}(\Gamma_{t-1}) \frac{g(q_t^C, Z_t)}{q_t^C \, U'(X_t)} + \frac{\mathcal{M}_t}{q_t^M \pi_t}\right] P_t \end{aligned}$$

- Total output in terms of the CM final good price

$$\mathcal{Y}_t = Y_t + \omega \Phi_{t-1}(\Gamma_{t-1}) \frac{g(q_t^C, Z_t)}{U'(X_t)} + \frac{\omega \mathcal{M}_t}{\pi_t}$$

Aggregate Price and GDP

- The DM output shares in the steady state

$$s_* = \frac{\omega \Phi_*(\Gamma_*) \frac{g(q_*^C, Z_*)}{U'(X_*)} + \frac{\omega \mathcal{M}_*}{\pi_*}}{\mathcal{Y}_*}$$

- The GDP deflator is defined accordingly

$$\pi_t^{GDP} = \pi_t^{1-s_*} \left(\pi_t^{DM} \right)^{s_*}$$

and the real GDP that is consistent with the GDP deflator as

$$\mathcal{Y}_t^{GDP} = \mathcal{Y}_t \cdot \frac{P_t}{P_t^{GDP}}$$

Taylor Rule

- The central bank adjust the target rate to accommodate the current economic situation:

$$R_{*,t} = r_* \pi_{*,t} \left(\frac{\pi_t^{GDP}}{\pi_{*,t}} \right)^{\psi_1} \left(\frac{\mathcal{Y}_t^{GDP}}{\mathcal{Y}_{t-1}^{GDP}} \right)^{\psi_2}$$

- The nominal interest rate responds to the target rate with inertia

$$R_t = R_{*,t}^{1-\rho_R} R_{t-1}^{\rho_R} \exp(\epsilon_{R,t})$$

Aggregate Shocks

- There are *five aggregate shocks* in the economy
- Specified as AR(1) in logarithm

1. Technology shock Z_t affecting both CM and DM production
2. Government spending shock g_t
3. Monetary policy shock $\epsilon_{R,t}$
4. Inflation target shock $\pi_{*,t}$ with unit root
5. Mean-preserving spread shock σ_t

$$\begin{aligned}\log\gamma &\sim \mathbf{N}\left(\log\gamma^*, \sigma_t^2\right)\\ \log\sigma_t &= (1-\rho_\sigma)\log\sigma_* + \rho_\sigma\log\sigma_{t-1} + \sigma_\sigma\epsilon_{\sigma,t}\end{aligned}$$

Alternative Models

- Instead of mean-preserving spread shock...
- Preference shock in the DM:
  - Aruoba and Schorfheide (2011)
  - No participation decision (intensive margin only)

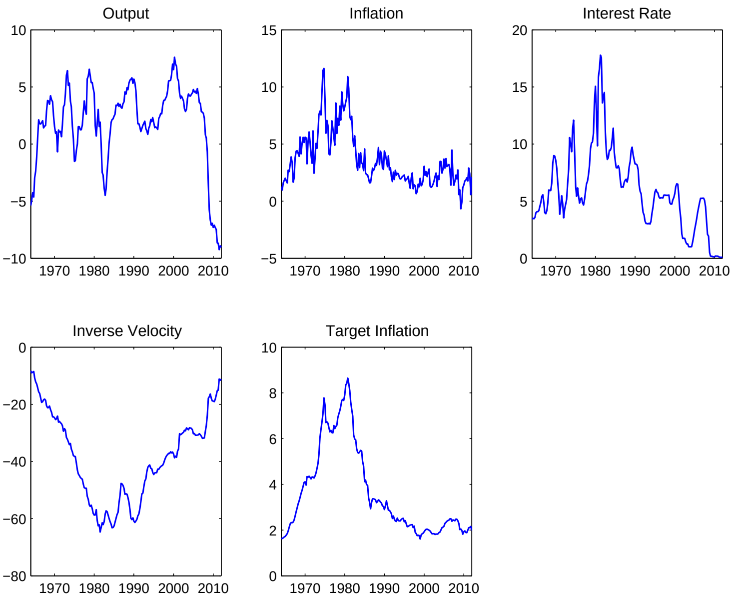
$$\chi_t u(q_t)$$
$$\log \chi_t = (1 - \rho_\chi) \log \chi_* + \rho_\chi \log \chi_{t-1} + \sigma_\chi \epsilon_{\chi,t}$$

Empirical Results

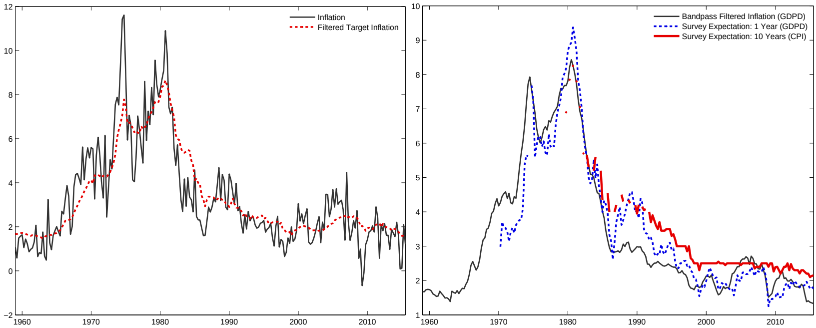
Data and Estimation

- Quarterly U.S. data from 1965Q1–2012Q1
  - Real GDP (in logs, linearly detrended)
  - GDP deflator inflation
  - Fed fund rate
  - M1 inverse velocity (in logs)
  - Inflation expectation / Target inflation
- Auroba and Schorfheide (2011)
- Bayesian estimation to construct the posterior distribution

Quarterly U.S. Data



Target Inflation



- The band-psss filter by Chriastiano-Fitzgerald (CF)

Fixed Parameters

Name	Value	Note
κ	0.0001	DM preference lower bound
δ	0.014	depreciation rate
$\mathcal{F}$	0	int. good production fixed cost
ψ_1	1.7	policy reaction to inflation gap
π_*	4	steady state inflation
r_A	2.5	steady state real rate
g_*	1.2	steady state government spending
$\mathcal{Y}_*$	1	steady state output
$\mathcal{M}_*/\mathcal{Y}_*$	0.6839	steady state inverse velocity
H_*/Y_*	0.035	steady state CM hour-output ratio
γ_*	0.0001	Credit cost shock: mean
σ_*	15	Credit cost shock: longrun stdev
χ_*	1	DM to CM utility ratio

Prior and Posterior

	Prior Distribution			Posterior Distribution			
				Spread Shock		Preference Shock	
Parameter	Density	Mean	S.D.	Mean	90% Interval	Mean	90% Interval
				Households			
θ	Beta	0.75	0.10	0.91	[0.89, 0.94]	0.91	[0.89, 0.94]
2ω	Beta	0.40	0.20	0.25	[0.20, 0.30]	0.34	[0.27, 0.42]
				Firm			
α	Beta	0.30	0.03	0.29	[0.25, 0.33]	0.30	[0.26, 0.34]
λ	Gamma	0.15	0.05	0.14	[0.06, 0.21]	0.17	[0.09, 0.24]
ζ	Beta	0.60	0.15	0.87	[0.84, 0.90]	0.81	[0.76, 0.87]
ι	Beta	0.50	0.20	0.81	[0.66, 0.97]	0.15	[0.02, 0.29]
S''	Gamma	2.50	1.00	1.51	[0.85, 2.14]	2.88	[1.71, 4.07]
				Central Bank			
ψ_2	Gamma	0.20	0.10	0.93	[0.78, 1.08]	0.68	[0.56, 0.80]
ρ_R	Beta	0.50	0.20	0.48	[0.38, 0.58]	0.60	[0.55, 0.66]
$100\sigma_R$	InvGamma	0.50	Inf	0.54	[0.44, 0.63]	0.37	[0.33, 0.43]
$100\sigma_\pi$	InvGamma	0.05	Inf	0.05	[0.05, 0.05]	0.05	[0.05, 0.05]
				Shocks			
ρ_g	Beta	0.80	0.10	0.83	[0.79, 0.86]	0.87	[0.84, 0.90]
$100\sigma_g$	InvGamma	1.00	Inf	0.93	[0.83, 1.03]	1.13	[1.01, 1.25]
ρ_z	Beta	0.80	0.10	0.91	[0.88, 0.95]	0.93	[0.90, 0.96]
$100\sigma_z$	InvGamma	1.00	Inf	0.97	[0.78, 1.14]	1.18	[0.90, 1.45]
ρ_σ	Beta	0.80	0.10	0.96	[0.94, 0.98]		
$100\sigma_\sigma$	InvGamma	1.00	Inf	5.47	[4.84, 6.09]		
ρ_χ	Beta	0.80	0.10			0.98	[0.97, 0.99]
$100\sigma_\chi$	InvGamma	1.00	Inf			1.41	[1.27, 1.56]
	Marginal Data Density			-1254.81		-1136.76	

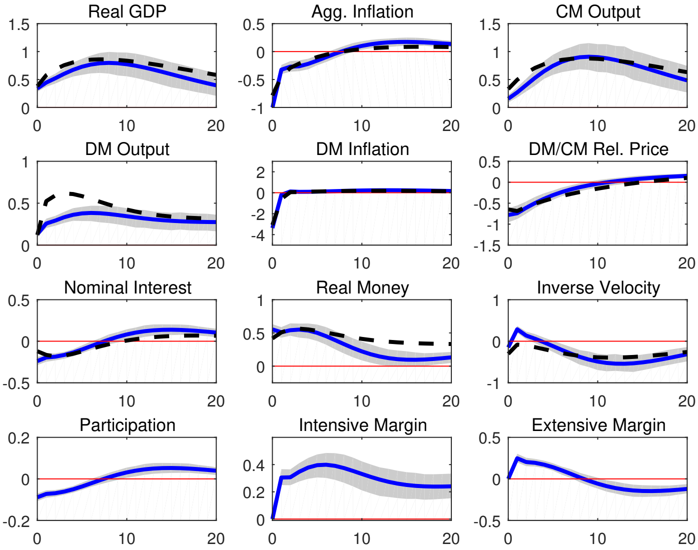
Posterior Moments

	Spread Shock		Preference Shock	
	Mean	90% Interval	Mean	90% Interval
A	13.5	[11.2, 15.7]	36.7	[31.1, 42.4]
B	0.35	[0.28, 0.42]	1.20	[1.01, 1.42]
Z_*	5.21	[3.84, 6.69]	4.88	[3.47, 6.28]
$I_*/\mathcal{Y}_*$	0.13	[0.11, 0.16]	0.16	[0.13, 0.18]
$K_*/\mathcal{Y}_*$	9.53	[8.04, 11.2]	11.4	[9.57, 13.0]
$W_* H_*/Y_*$	0.62	[0.56, 0.67]	0.60	[0.55, 0.65]
Overall Markup	0.24	[0.17, 0.32]	0.22	[0.15, 0.29]
DM Share	0.25	[0.20, 0.30]	0.12	[0.09, 0.14]
DM Markup	0.57	[0.31, 0.81]	0.61	[0.35, 0.83]
Credit Holders	64.3	[63.8, 64.6]		

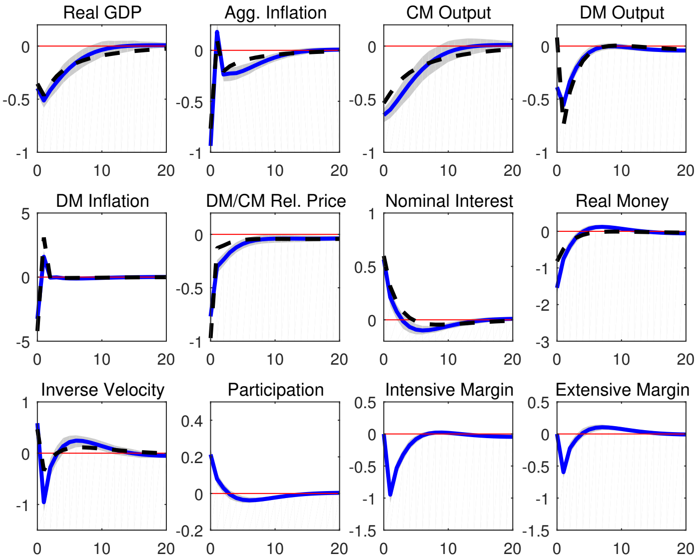
Posterior Variance Decomposition

Shock	Spread Shock Mean	Spread Shock 90% Interval	Preference Shock Mean	Preference Shock 90% Interval
Output				
Technology	0.385	[0.272, 0.501]	0.433	[0.326, 0.548]
Gov Spending	0.346	[0.257, 0.423]	0.388	[0.311, 0.469]
Monetary Policy	0.261	[0.179, 0.335]	0.158	[0.095, 0.219]
Target Inflation	0.008	[0.002, 0.013]	0.004	[0.001, 0.006]
Money Demand	0.000	[0.000, 0.000]	0.017	[0.012, 0.023]
Inflation				
Technology	0.593	[0.503, 0.682]	0.583	[0.515, 0.650]
Gov Spending	0.187	[0.129, 0.242]	0.151	[0.117, 0.186]
Monetary Policy	0.164	[0.118, 0.211]	0.141	[0.085, 0.196]
Target Inflation	0.056	[0.036, 0.072]	0.092	[0.068, 0.120]
Money Demand	0.000	[0.000, 0.000]	0.033	[0.021, 0.044]
Inverse Velocity				
Technology	0.044	[0.014, 0.074]	0.019	[0.008, 0.031]
Gov Spending	0.432	[0.384, 0.486]	0.518	[0.462, 0.580]
Monetary Policy	0.041	[0.027, 0.057]	0.015	[0.009, 0.021]
Target Inflation	0.013	[0.009, 0.017]	0.001	[0.001, 0.002]
Money Demand	0.469	[0.413, 0.525]	0.446	[0.385, 0.503]
Real Money Balances				
Technology	0.069	[0.044, 0.090]	0.126	[0.084, 0.166]
Gov Spending	0.242	[0.200, 0.280]	0.139	[0.107, 0.173]
Monetary Policy	0.158	[0.117, 0.194]	0.129	[0.096, 0.164]
Target Inflation	0.009	[0.006, 0.012]	0.006	[0.002, 0.009]
Money Demand	0.522	[0.472, 0.583]	0.600	[0.542, 0.667]

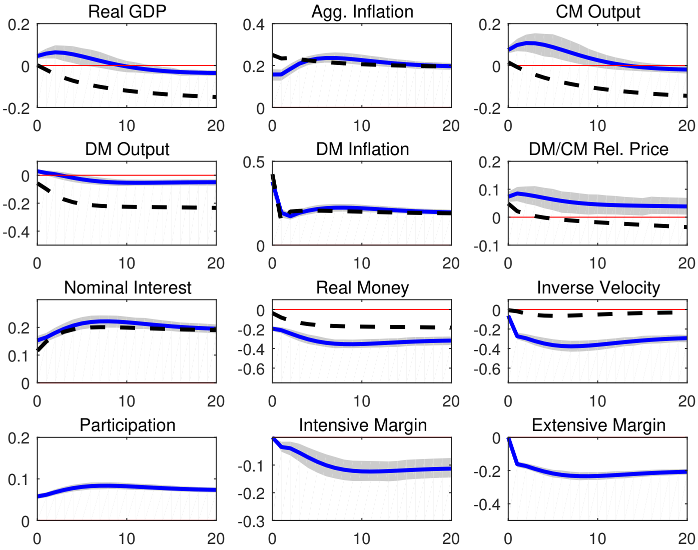
Impulse Responses to Technology Shock



Impulse Responses to Money Supply Shock



Impulse Responses to Target Inflation Shock



Impulse Responses to Target Inflation Shock

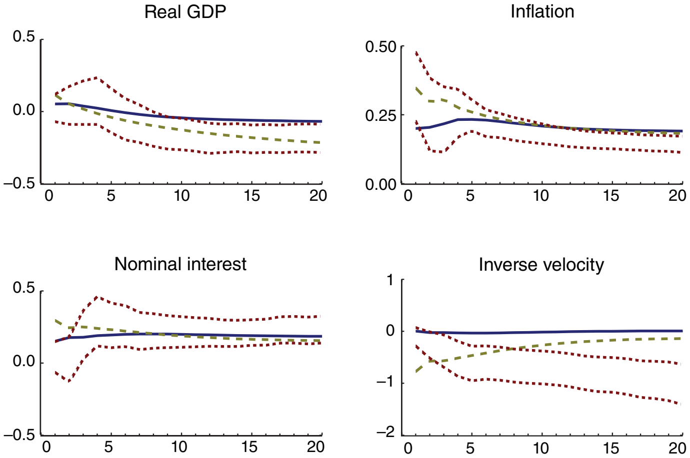
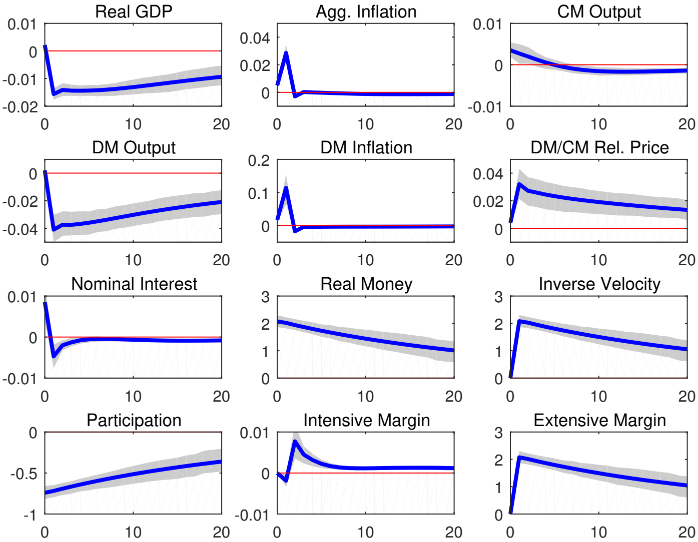


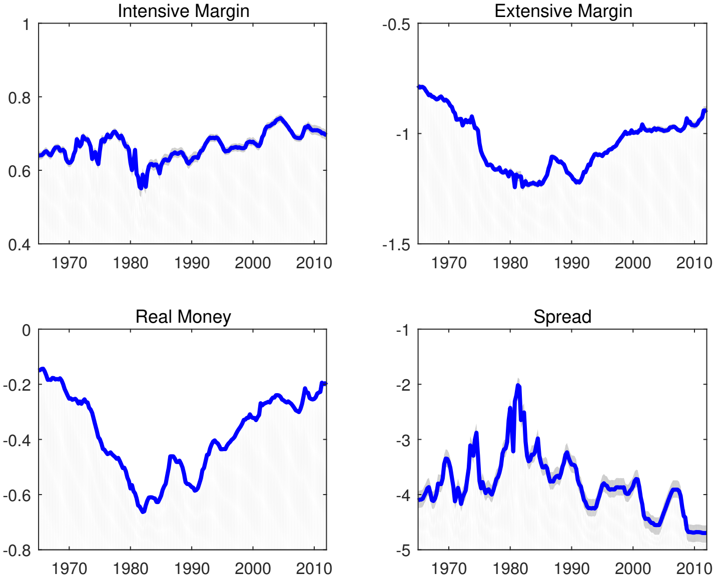
FIGURE 3. IMPULSE RESPONSES TO INFLATION TARGET $(\epsilon_{\pi,t})$ SHOCK

Notes: Figure depicts pointwise posterior 90 percent credible intervals of impulse responses for VAR (short dashes) and posterior mean responses for SBM(B): σ estimated (solid); $\sigma = 0.06$ (long dashes). Responses of inflation and fed funds rate are measured in annualized percentages and responses of real output and inverse velocity are measured in percentage deviations from the steady state.

Impulse Responses to Spread Shock



Intensive and Extensive Margins



Summary

- Introduce heterogeneous participation cost to generate the fluctuation in the extensive margin
- Impulse responses to the target inflation shock are *approximately* consistent with VAR
- The aggregation is achieved through the threshold level: Changes in cross-sectional volatility deliver the first-order dynamic effect
- Mean-preserving spread shock as money demand shock
- Credit spread shock causes negative relationship between money and output in the short run, as happened during the global financial crisis
- Due to the aggregation property of the model, the mean-shifting shock model would deliver the same result