Money Allocation, Unemployment and Monetary Policy

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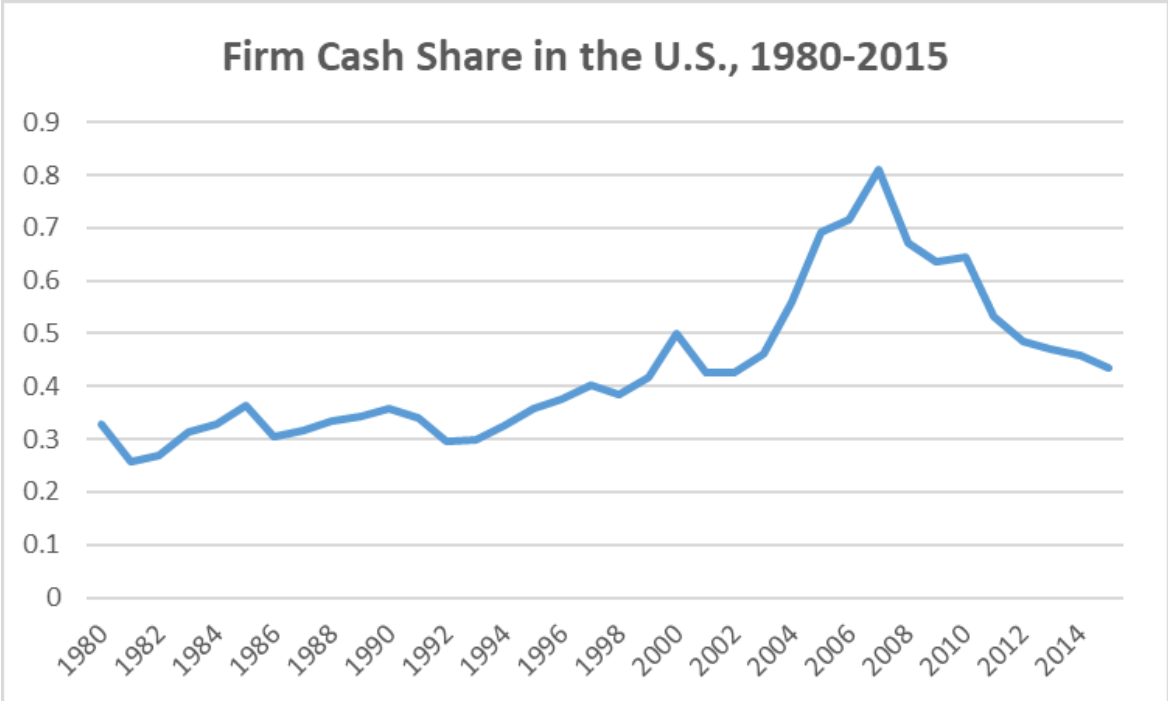
Motivation

- Empirical and theoretical studies of money usually study money holdings by consumers or firms in isolation.
- Not a problem if certain dichotomy exists. For example, if money does not flow between consumers and firms.
- However,

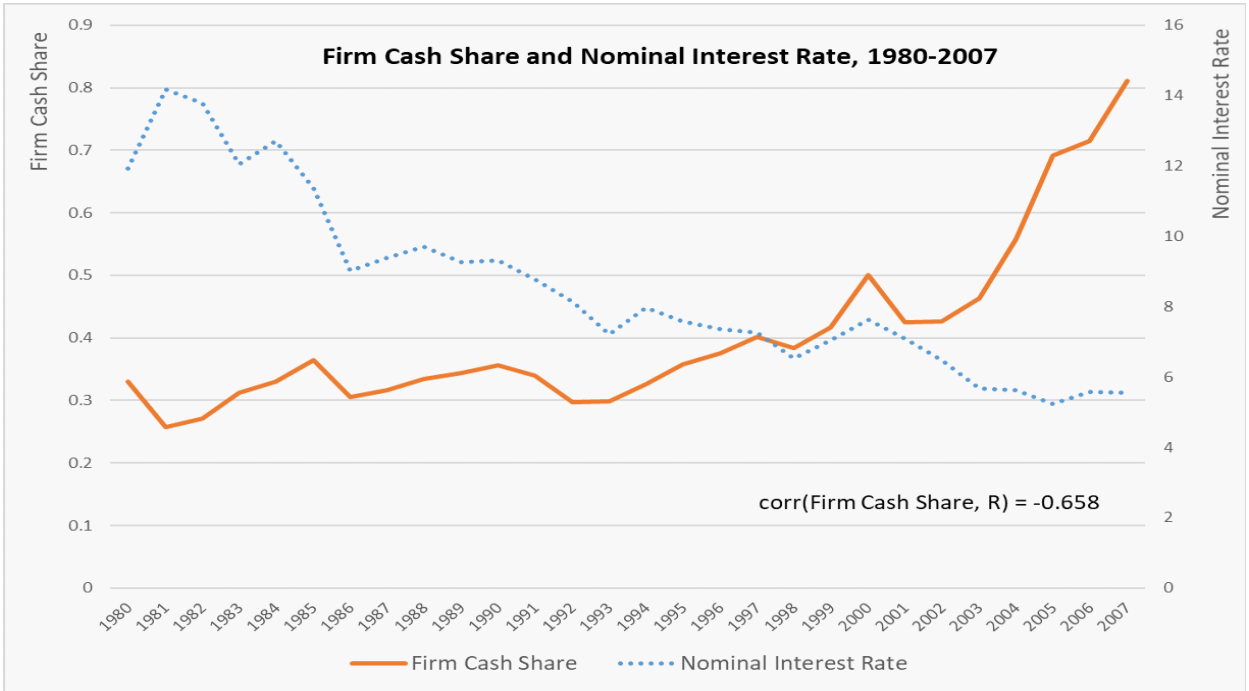
Money Holdings in the U.S.

- Measures of money: **checkable deposits and currency** by nonfinancial business and households, financial account in the United States, the Federal Reserve.



$$\text{firm money share} = \frac{\text{firm money}}{\text{firm money} + \text{consumer money}} * 100\%.$$

Nominal Interest Rate and Firm Money Share



- The negative correlation suggests that the monetary policy might play some role in understanding the pattern of firm money share.

Research Questions

- How does monetary policy affect the relative movements in cash holdings?
- How do firm money and consumer money interact?
- Are there any monetary policy implications for labor market outcomes?

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- How does monetary policy affect the relative movements in cash holdings?
- How do firm money and consumer money interact?
- Are there any monetary policy implications for labor market outcomes?
- A study with only the need for money by either firms or consumers **cannot** answer these questions.

What We Do

- A theory of money allocation between consumers and firms.
  - Consumers need money for consumption goods.
  - Firms need money for capital purchase required for investment (in job vacancies).
  - Endogenous money allocation between the two needs.
- A quantitative study of
  - Effects of monetary policy on unemployment.

What We Find

- Consideration of two uses of money provides interesting and important insights:
  1. Both types of money demands imply a positive effect of long run inflation on unemployment, suggesting an **amplifying** effect of monetary policy.
  2. Consumer money is **complementary** to firm money.

Quantitative Findings

Effect of Monetary Policy

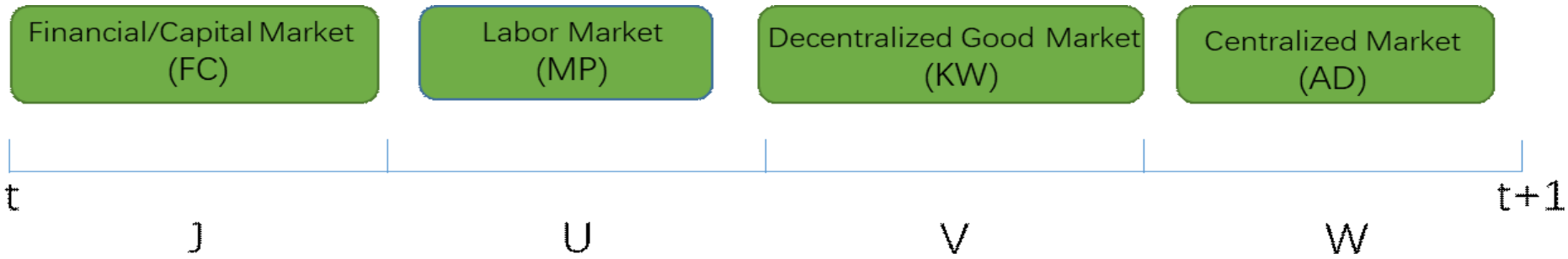
- In the baseline calibration, when inflation rises from 2.6% to 6.1%,
  - Unemployment increases by **2.85** percentage points (5.0% $\longrightarrow$ 7.85%), in line with data.
- Quantitative importance of the consideration of having two money demands:
  - Removing the direct effect of inflation on firm money, unemployment only rises by 1.35 percentage points.
  - Including firm money contributes **53** percent of the overall response of unemployment.

Literature Review

- New Monetarist
  - Consumer cash: Lagos and Wright (2005), Aruoba et al. (2011), Berentsen et al. (2011).
  - Firm cash: Rocheteau et al. (2018) and Wright et al. (2018).
- Long-Run Effects of MP on Unemployment
  - Berentsen et al. (2011), Rocheteau and Rodriguez-Lopez (2014)
  - Dong and Xiao (2018) and Gomis-Porqueras et al. (2020)
- Firm Cash
  - Bates et al., (2009), Begenau and Palazzo (2017), Rempel (2019), and Graham and Leary (2018)

Model: Environment

Discrete Time



- Households
- Firms:
  - FC: obtain cash from HH, buy k units of capitals (for v).
  - MP: open vacancies, job separations happen.
  - KW: matched firm produce in KW.
  - AD: pay wages and dividend, replenish depreciated capitals.
- Capital suppliers:
  - AD: transform AD goods $\longrightarrow$ capitals, free entry.
  - FC in $t+1$: sell to firms with funds.

Bellman Equations in FC

- Households choose the number of firms to fund (**cash allocation decision**): n

$$\begin{aligned} J_{et}^{h}(b,m,s) &= \max_{n} U_{e}^{h}(b,\hat{m},s,n) \\ s.t. \quad \underbrace{\hat{\mathbf{m}}}_{\text{money for consumption}} &= m - \underbrace{\mathbf{n}\kappa\mathbf{p}_{k}}_{\text{money used to fund firms}}, \end{aligned}$$

$$\begin{aligned} b &: \textit{bond holdings}, \\ m &: \textit{money holdings}, \\ s &: \textit{number of operating firms owned}. \end{aligned}$$

- Trade-off between money demands for consumption and investment in job vacancies.

Bellman Equations in MP

- Household's value:

$$\begin{aligned} U_{1t}^{h}\left(b_t, \hat{m}_t, s_t, n_t\right) &= \delta V_{0t}^{h}\left(b_t, \hat{m}_t, s_{t+1}, n_t, z_t\right) \\ &\quad + \left(1-\delta\right) V_{1t}^{h}\left(b_t, \hat{m}_t, s_{t+1}, n_t, z_t\right). \end{aligned}$$

$$\begin{aligned} U_{0t}^{h}\left(b_t, \hat{m}_t, s_t, n_t\right) &= \lambda_{ht} V_{1t}^{h}\left(b_t, \hat{m}_t, s_{t+1}, n_t, z_t\right) \\ &\quad + \left(1-\lambda_{ht}\right) V_{0t}^{h}\left(b_t, \hat{m}_t, s_{t+1}, n_t, z_t\right). \end{aligned}$$

- Law of motions:

$$\begin{aligned} \textit{new vacancies} &: v_t = n_t \gamma_{ft}, \\ \textit{operating firms} &: s_{t+1} = v_t \lambda_{ft} + s_t\left(1-\delta\right), \text{ and} \\ \textit{destroyed matches} &: z_t = s_t \delta. \end{aligned}$$

Bellman Equations in KW

- Household's value:

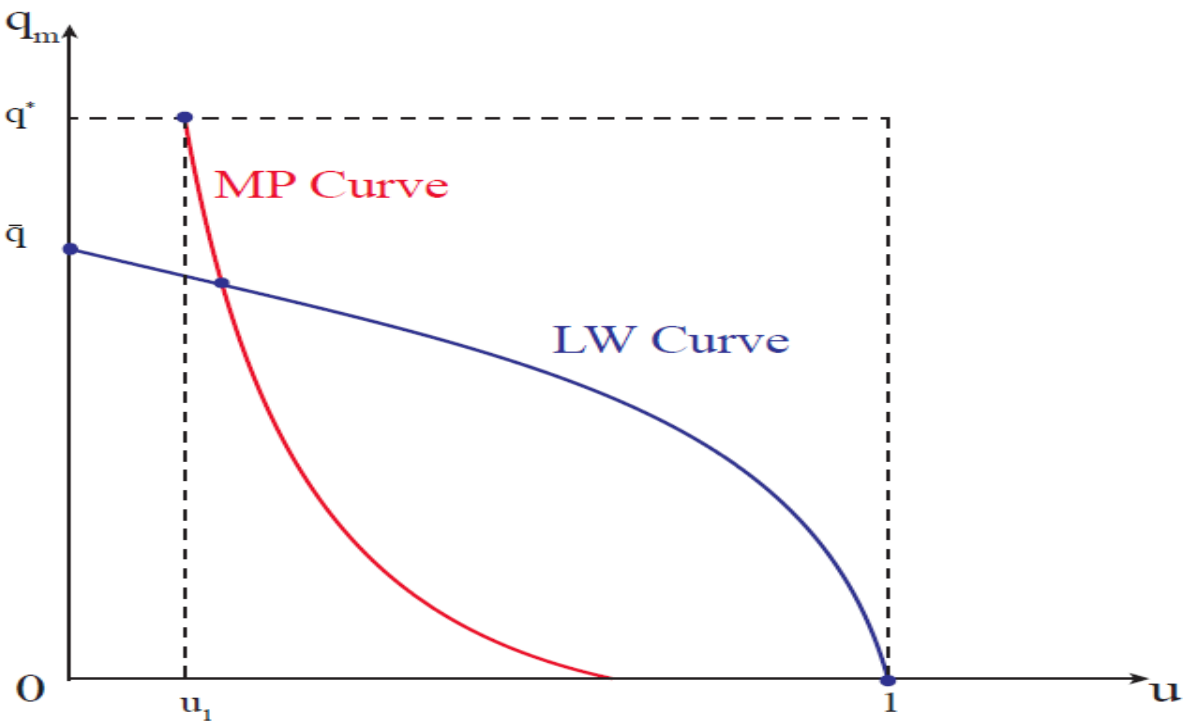
$$\begin{aligned} & V_{et}^{h}\left(b_{t}, \hat{m}_{t}, s_{t+1}, n_{t}, z_{t}\right) \\ = \quad & \alpha_{ht}\left[v\left(q_{mt}\right)+W_{et}^{h}\left(b_{t}, \hat{m}_{t}-d_{mt} / \phi_{t}, s_{t+1}, n_{t}, z_{t}\right)\right] \\ & +\left(1-\alpha_{ht}\right) W_{et}^{h}\left(b_{t}, \hat{m}_{t}, s_{t+1}, n_{t}, z_{t}\right). \end{aligned}$$

Bellman Equations in AD

- Households

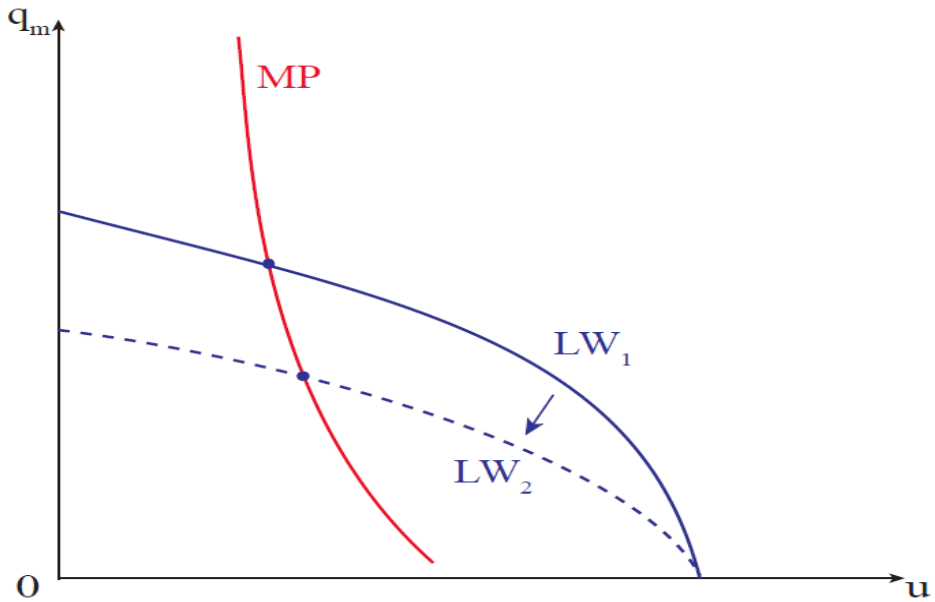
$$
\begin{aligned}
W_{et}^{h}\left(b_t, m_t, s_{t+1}, n_t, z_t\right) &= \max_{x_t, m_{t+1}, b_{t+1}} \left\{ x_t + \beta J_{et+1}^{h}\left(b_{t+1}, m_{t+1}, s_{t+1}\right) \right\}, \\
s.t.\ x_t + b_{t+1} + \phi_t m_{t+1} &= ew_t + (1-e)\varsigma + \phi_t T_t \\
&\quad + b_t(1+r) + m_t\phi_t \\
&\quad + s_{t+1}(R_t - w_t - \delta_k \kappa / A) \\
&\quad + n_t(1-\gamma_{ft})\kappa p_{kt}\phi_t \\
&\quad + n_t\gamma_{ft}(1-\lambda_{ft})\kappa / A \\
&\quad + z_t\eta_f \kappa / A.
\end{aligned}
$$

Model Equilibrium



Shift of LW

In response to an inflation rise



- Inflation $\uparrow \Longrightarrow$ the opportunity cost of carrying money $\uparrow \Longrightarrow q_m$ in KW $\downarrow \Longrightarrow$ real profits in KW $\downarrow \Longrightarrow$ incentive to invest in vacancies $\downarrow$ (lower desire for holding money by firms) $\Longrightarrow u \uparrow$

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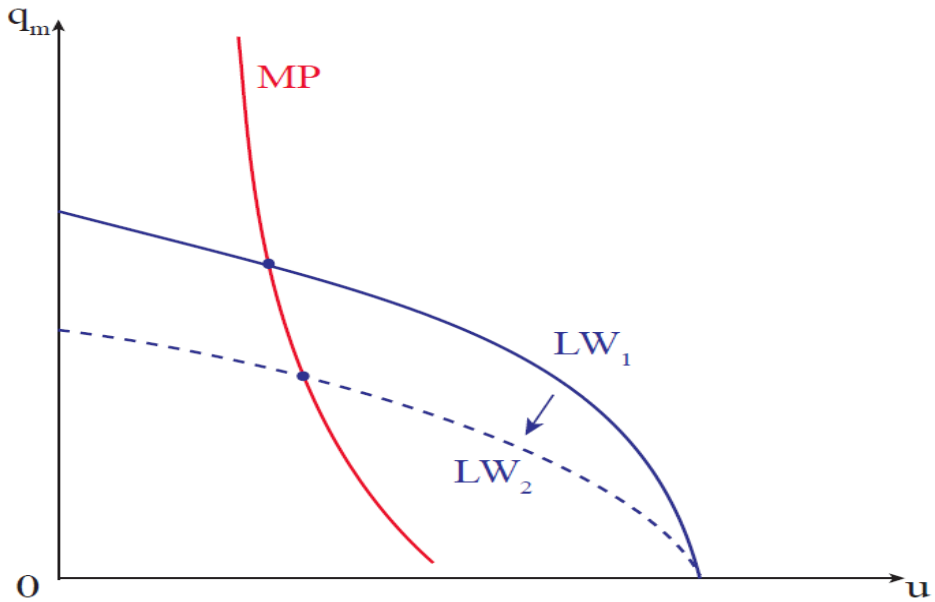

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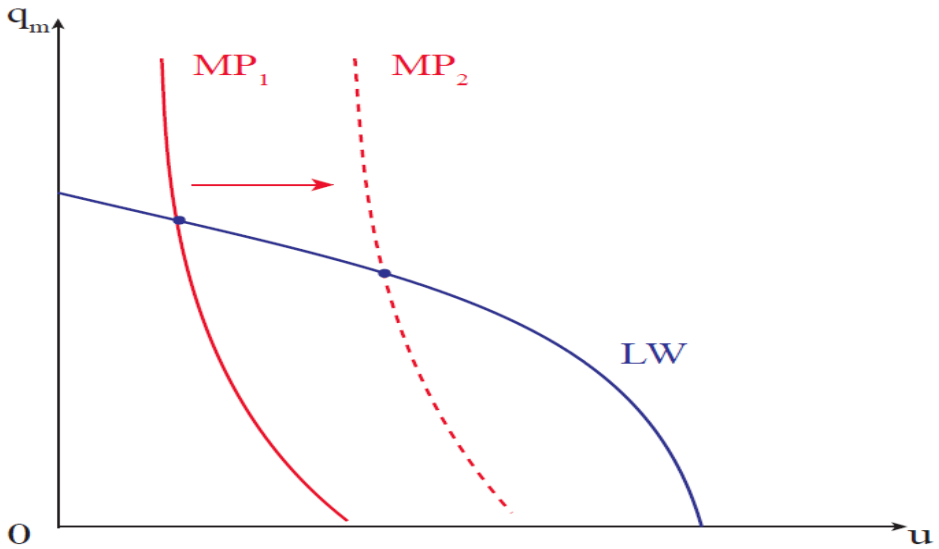
- Direct effect on consumer money, **indirect** effect on firm money (**complementarity**).

Shift of MP

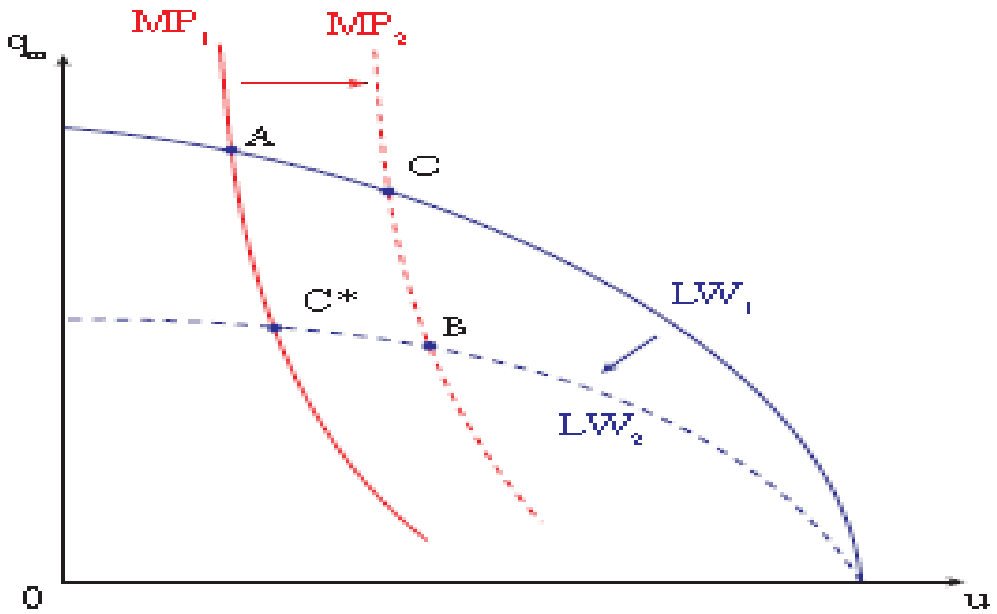
In Response to an Inflation Rise



$$\textbf{MP curve}: U_0^f = \frac{\lambda_f \left(R - w - \delta_k \kappa/A + \beta\delta\eta_f \kappa/A\right)}{1-\beta(1-\delta)} + \left(1-\lambda_f\right)\left(1-\delta_k\right)\kappa/A.$$

- Inflation $\uparrow \Rightarrow$ the cost of funding a firm $\uparrow \Rightarrow$ the value of a job vacancy $U_0^f \uparrow \Rightarrow$ a higher trading probability λ_f in MP for a given q_m (fixed R) $\Rightarrow$ suggesting $v \downarrow$ and $u \uparrow$.
- Direct effect on firm money.

Effect of Inflation Rise on Equilibrium



Quantitative Analysis

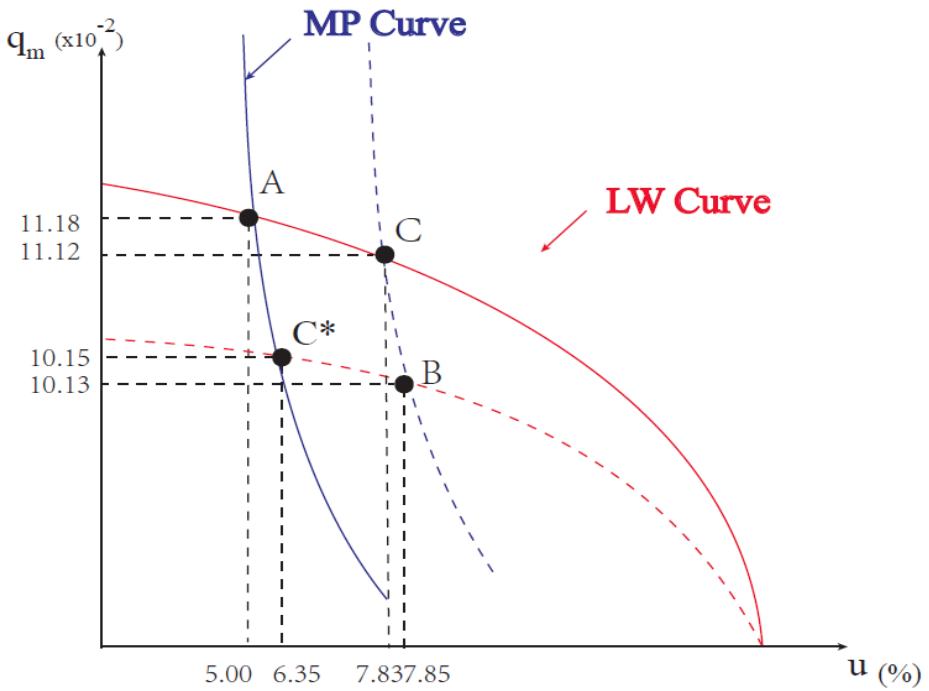
- Purpose:
  - Quantify the importance of modeling two money demands when the model economy is subject to changes in inflation.
- Strategy adopted:
  - Two inflation episodes: low-inflation vs. high-inflation.
  - Calibrate to match key features in capital, labor, and good market in the U.S. during the low-inflation episode.
  - Simulate the effect on unemployment in response to a rise in inflation.
  - Explore the relative importance of including firm money.

Calibration

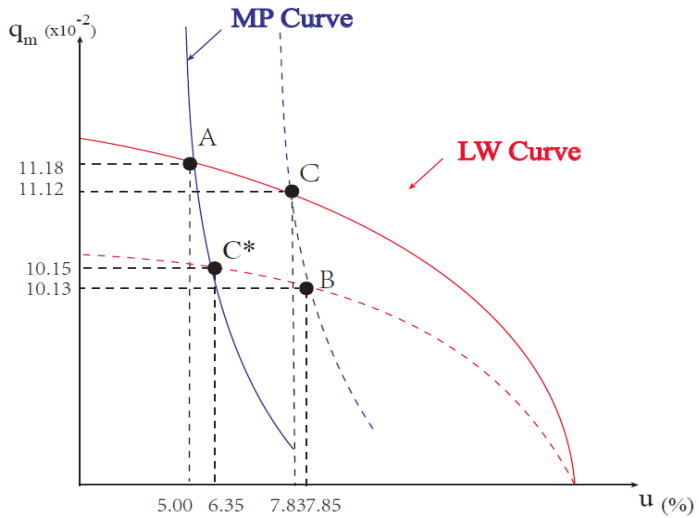
Table 1 Calibration targets

Variables		Target Descriptions	Target Values
Discount factor	β	annual real interest rate	0.048
Productivity in a formed match	y	normalization	1
UI benefits	ς	Zhang and Faig (2012), Shimer (2005)	0.4/0.25
Elasticity parameter in MP matching func.	ζ^{MP}	Shimer (2005)	0.28
Firm's bargaining power in MP	χ	Hosios' rule	0.28
Curvature parameter in $c(q)$	φ	normalization, BMW (2011)	1
Separation rate	δ	Shimer (2005)	0.033
The probability of using credit card	μ	Aruoba *et al*.(2011)	0.15
Fra. of capital returned in destroyed match	η_f	random pick	0/1
Technology parameter in producing capital	A	random pick	1
Scale parameter in matching func. in MP	μ^{MP}	unemployment in Shimer (2005)	0.0565
Capital producer's bargaining power in FC	σ	labor market tightness in Hall (2005)	0.539
Parameter in matching func. in FC	κ	K/Y in Aruoba *et al*. (2011)	2.34
Firm's bargaining power in KW	θ	mark-up ratio in Faig and Jerez (2005)	0.30
No. of capitals required in a job creation	ζ^{FC}	ratio of business liquidity to household liquidity	0.714
Scale parameter in utility func.	B	real demand for money in Aruoba *et al*. (2011)	0.186
Curvature parameter in utility func.	a	elasticity of money demand w.r.t. i in BMW (2011)	-0.556

Effect of Monetary Policy on Unemployment



Importance of Including Firm money



- Shutting down the shift in MP (removing firm money), unemployment rises by only 1.35 percentage points
- **Including firm money** $(C^* \longrightarrow B)$: accounting for 53% of the overall movement in u $\left(= \frac{7.85-6.35}{7.85-5.00}\right)$, in line with Berentsen *et al*. (2011).
- **Complementarity** $(A \longrightarrow C^*)$: accounting for 70% of the overall movement in the firm money share.

Conclusions

- We construct a quantitative framework incorporating both consumer money and firm money.
- The framework with two types of money demands proves useful in evaluating the effects of monetary policy on unemployment.
- The policy-related response of unemployment operates through both the consumer money channel and firm money channel, and the latter channel, absent in the existing literature, is quantitiatively important.