The Transmission of Monetary Policy through Redistribution and Durable Purchases

Vincent Sterk and Silvana Tenreyo

Presented by
Skand Goel

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Central Question

- Standard mechanisms based on nominal rigidities and don't account for redistribution.
- Study a different channel of monetary policy, complementary to standard channel.

Key features

- Monetary policy shock through open market operations has a wealth effect.
- Open market operations not irrelevant.
- Key role for durables.
- Prices not sticky - add frictions later (not the focus today)

Outline

- Some (motivating) evidence from VAR and past work. Aggregate + distributional.
- Construct a model with no nominal rigidities to match this.
- (A variant with search and matching frictions.)
- Representative agent - Ricardian equivalence.
- Helicopter drops - implementation matters.

Related literature

- Non standard channels of monetary policy transmission - Grossman Weiss (1983), Alvarez and Lippi (2012), Auclert (2015)
- Heterogenous agent models of monetary policy - Deopke and Schneider (2006), Meh et al (2010), Algan et al (2012), Gottlieb (2012)
- Barsky, House and Kimball (2007)

Motivating evidence - Aggregates

- Following Gertler Karadi (2015), dynamic linear economy

$$\mathbf{A}\mathbf{Y}_t = \sum_{j=1}^{S} \mathbf{C}_j \mathbf{Y}_{t-j} + \epsilon_t$$

  - $\mathbf{Y}_t$: vector of non-policy variables and a policy indicator ,
  - ϵ_t: vector of structural white noise shocks

- In reduced form

$$\mathbf{Y}_t = \sum_{j=1}^{S} \mathbf{B}_j \mathbf{Y}_{t-j} + \mathbf{u}_t$$

  - $\mathbf{u}_t = \mathbf{S}\epsilon_t$,
  - $\mathbb{E}[\mathbf{u}_t \mathbf{u}_t^{'}] = \mathbb{E}[\mathbf{S}\mathbf{S}^{'}] = \Sigma$.

Motivating evidence - Aggregates

$$\mathbf{Y}_t = \sum_{j=1}^{S} \mathbf{B}_j \mathbf{Y}_{t-j} + \mathbf{u}_t$$

- In standard framework, policy *instrument* - e.g. current period funds rate.
- Here, want to account for forward guidance as well, so policy *indicator*.
  - $\mathbf{Y}_t^p =$ one-year government bond rate.
- Non-policy variables: CPI, expenditure on durables and non-durables, Excess bond premium, Total public debt.
- Monthly data, starting July 1979.
- $S = 12$.

Identification

- For impulse responses to monetary shocks, we need

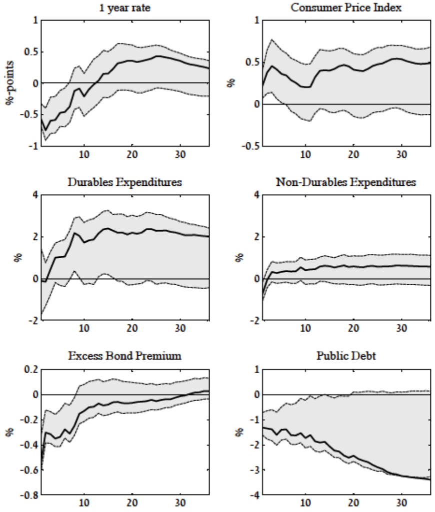
$$\mathbf{Y}_t = \sum_{j=1}^{S} \mathbf{B}_j \mathbf{Y}_{t-j} + \mathbf{s}\epsilon_t^p$$

where $\mathbf{s}$ is p^{th} column of $\mathbf{S}$, and ϵ_t^p is the policy shock.

- Standard identification assumption - all terms of $\mathbf{s}$, except for the p^{th} term, are 0.
- Does not work here, so external instruments approach.
- **Instrument:** Three-month ahead futures rate during a 30 minute window around announcements by the Federal Open Market Committee.

Results

Figure 1: Responses to an Expansionary Monetary Policy Shock in the VAR.



Note: horizontal axes denote months after the shock.

More evidence - Redistribution

- Deopke and Schneider (2006)/ Adam and Zhou (2014) - Two levels of redistribution:
  - old households to young households - by altering incentives to work/save.
  - households to government -
    1. More remittance by central bank to treasury
    2. Lower value of public debt (Govt. net debtor)
- Wong (2014) + Authors -
  - consumption of young relative to old increases,
  - increase driven by durables purchases.

Summary: Facts for the model

Following monetary policy expansion:

- Prices increase quickly,
- Durables expenditure increases, somewhat gradually,
- Insignificant increase in non-durables,
- Young gain relatively more to old,
- Gains of young reflected in durables,
- Public debt falls significantly.

The model

- Closed economy.
- Continuum of households
  - OLG, simple lifecycle.
  - Utility from two goods - stock of durables d, flow of non-durables c - and stock of money m.
- Continuum of firms.
- Government:
  - Treasury issues bonds, paying net nominal interest rate r.
  - Monetary policy conducted through open market operations by the Central bank.

Demographics

- Young agents retire and turn old with time-invariant probability ρ_o.
- Once old, die with with time-invariant probability ρ_x.
- Constant population size 1.
- Constant age distribution: ν young and $1-\nu$ old. This fixes ν

$$\rho_o \nu = \rho_x (1 - \nu + \rho_o \nu)$$

- Notation: Young agents $\{\mathrm{n}, \mathrm{y}\}$, Old agents $\{\mathrm{o}\}$.

Old agents problem

$$V^{o}(a,\Gamma) = \max_{c,d,m,b} U(c,d,m) + \beta(1-\rho_x)\mathbb{E}V^{o}(a^{'},\Gamma^{'})$$

$$\text{s.t.}$$

$$c + d + m + b = a + \tau^{o}$$

$$a^{'} \equiv (1-\delta)d + \frac{m}{1+\pi^{'}} + \frac{(1+r)b}{1+\pi^{'}}$$

$$c, d, m \geq 0$$

- Γ : aggregate state. Monetary policy shock, and distribution of wealth and asset holdings.
- $U_j(c,d,m) > 0$, $U_{jj}(c,d,m) < 0$ and inada conditions.

Old agents problem

$$V^{o}(a,\Gamma) = \max_{c,d,m,b} U(c,d,m) + \beta(1-\rho_x)\mathbb{E}V^{o}(a',\Gamma')$$

$$\text{s.t.}$$

$$c + d + m + b = a + \tau^{o}$$

$$a' \equiv (1-\delta)d + \frac{m}{1+\pi'} + \frac{(1+r)b}{1+\pi'}$$

$$c, d, m \geq 0$$

- π: net rate of inflation.
- b is the real value of nominal bonds.
- No utility from bequest. Wealth of deceased equally distributed among currently young, i.e. $\{\mathrm{n}, \mathrm{y}\}$.

Young agents

$$
\begin{aligned}
V^{\mathsf{s}}(a,\Gamma) = & \max_{c,d,m,b,h} U(c,d,m) - \zeta \frac{h^{1+\kappa}}{1+\kappa} \\
& + \beta(1-\rho_o)\mathbb{E}V^{\mathsf{y}}(a^{'},\Gamma^{'}) + \beta\rho_o(1-\rho_x)\mathbb{E}V^{\mathsf{o}}(a^{'},\Gamma^{'}) \\
& \mathsf{s} = \{\mathsf{n},\mathsf{y}\} \\
& \text{s.t.} \\
c+d+m+b = & \; a + wh + \tau^{bq} + \tau^{\mathsf{s}} \\
a^{'} \equiv & \; (1-\delta)d + \frac{m}{1+\pi^{'}} + \frac{(1+r)b}{1+\pi^{'}} \\
c,d,m \geq & \; 0
\end{aligned}
$$

- Death shock hits immediately after retirement.

Firms

- Continuum of perfectly competitive identical firms.
- Production technology producing one good

$$y_t = h_t$$

- Profit maximization $\implies$ $w = 1$.
- Durables and non-durables have same production technology $\implies$ same price.

Central Bank

- Exogenous process for M_t (law of motion for π_t)

$$\frac{m_t}{m_{t-1}}(1+\pi_t) = 1 + z_t$$

$$z_t = \xi(\bar{m} - m_{t-1}) + \epsilon_t, \ \xi \in (0,1)$$

- Accomodated through OMO

$$B_t^{cb} - B_{t-1}^{cb} = M_t - M_{t-1}$$

- Transfers accounting profit to Treasury

$$\tau_t^{cb} = \frac{r_{t-1} b_{t-1}^{cb}}{1+\pi_t}$$

Treasury

- Maintains balanced budget

$$\nu\rho_o\tau_t^{\mathrm{n}} + \nu(1-\rho_o)\tau_t^{\mathrm{y}} + (1-\nu)\tau_t^{\mathrm{o}} = \frac{r_{t-1}b_{t-1}^g}{1+\pi_t} + \tau_t^{cb}.$$

- Transfers governed by

$$\begin{aligned}\tau_t^{\mathrm{n}} &= a_t^{\mathrm{y}} + \tau_t^{\mathrm{y}} \\ \tau_t^{\mathrm{o}} &= 0\end{aligned}$$

$\Longrightarrow$ Representative young agent

- Bequests of the deceased transferred as well

$$\tau_t^{bq} = \frac{\rho_x a_t^{\mathrm{o}} + \rho_o\rho_x a_t^{\mathrm{y}}}{\nu}$$

Recursive Competitive Equilibrium

- Optimal policy rules: $c^s(a,\Gamma)$, $d^s(a,\Gamma)$, $m^s(a,\Gamma)$, $b^s(a,\Gamma)$, $h^s(a,\Gamma)$
- Given laws of motion: π_t, r_t, Γ_t
- Market clearing

$$
\begin{aligned}
c_t + d_t &= \nu h_t^Y + (1-\delta)d_{t-1} && \text{(Goods)}\\
m_t &= \nu m_t^Y + (1-\nu)m_t^O && \text{(Money)}\\
0 &= b_t^g + b_t^{cb} + \nu b_t^Y + (1-\nu)b_t^O && \text{(Bonds)}
\end{aligned}
$$

- Government budget constraint and fiscal policy.

Solving the model

- Representative young agent by construction.
- First order perturbation $\implies$ certainty equivalence.
- Decision rules for old linear in wealth $\implies$ aggregation for old.
- Aggregate state reduced to relative wealth between young and old.
- For simulations

$$U(c,d,m) = \frac{\left\{\left[c^{\frac{\epsilon-1}{\epsilon}} + \eta d^{\frac{\epsilon-1}{\epsilon}} + \mu m^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}\right\}^{1-\sigma} - 1}{1-\sigma}$$

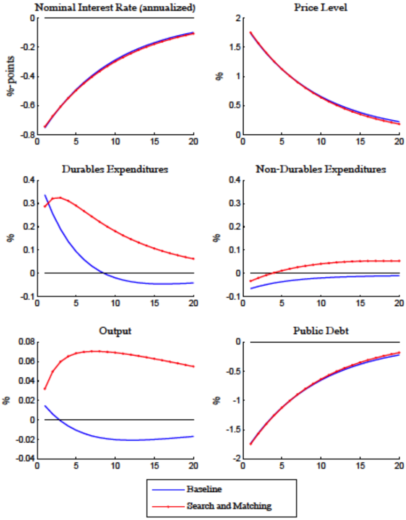
- Search-matching extension: Inelastic labor supply conditional on employment.

Calibration

	value	motivation
β	0.9732	target 4% s.s. annual interest rate
η	0.31	target 20% s.s. spending on durables (NIPA)
μ	0.0068	target 1.8 s.s. M2 velocity ($\frac{y}{m}$) (FRB/NIPA)
σ	1	convention macro literature
ϵ	1	convention macro literature
κ	1	convention macro literature
ζ	0.5795	normalize aggregate quarterly output to one
ρ_o	0.0063	average duration working life 40 years
ρ_x	0.0125	average duration retirement 20 years
δ	0.04	Baxter (1996)
b_0^g	-2.4	government debt 60% of annual output
b_0^{cb}	0	no initial central bank debt
ξ	0.15	half life response nominal interest rate 2.5 years

Results - Aggregates

Figure 2: Responses to an Expansionary Monetary Policy Shock in the Baseline Model and the Model with Search and Matching Frictions.



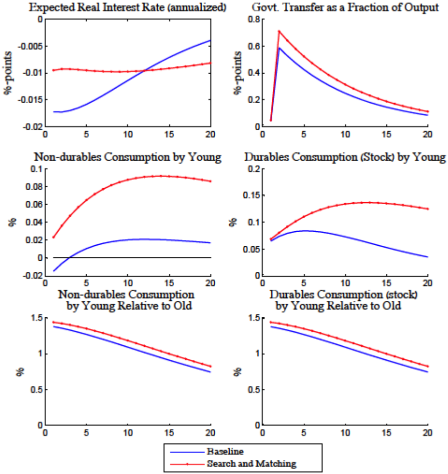
Note: horizontal axes denote quarters after the shock.

Results - Aggregates

- Price rise - Increase in stock of M_t and substitution between m and c
- Permanent income shock (wealth effect) $\rightarrow$ more savings (long-run + precautionary) $\rightarrow$ more labor supply, less consumption $\rightarrow$ more output $\rightarrow$ in equilibrium, increase in durables.
- Better fiscal position of government - more seigniorage, lower interest payments, lower money liabilities.

Results - by demographics

Figure 3: Responses to an Expansionary Monetary Policy Shock in the Baseline Model and the Model with Search and Matching Frictions.



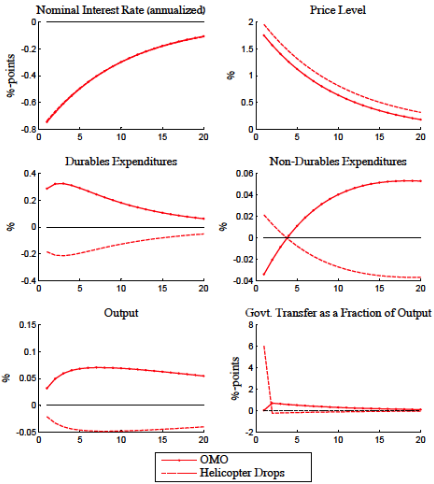
Note: horizontal axes denote quarters after the shock.

More intuition - Representative agent

- $\rho_x = 1$ and log utility $\implies$ representative agent with $\tilde{\beta} = \beta(1 - \rho_o)$.
- Monetary policy does not affect real variables. FOCs for d, h and aggregate resource constraint pins down real variables.
- Monetary policy creates no wealth effects. Revaluation of wealth compensated by transfers.

More intuition - Helicopter drops

Figure 4: Responses to an Expansionary Monetary Policy Shock in the Model with Search and Matching Frictions: OMO versus Helicopter Drops.



Note: horizontal axes denote quarters after the shock.

Conclusion

- A novel transmission channel based on new motivational evidence.
- Importance of durables and how monetary policy implemented.
- Addressing criticism of Barsky et al (2007).
- Understanding how government redistributes wealth for future work.

Identification

- "External" instruments - Stock and Watson (2012).
- For valid instruments $\mathbf{Z}_t$

$$\mathbb{E}[\mathbf{Z}_t \epsilon_t^{p'}] \neq 0,$$
$$\mathbb{E}[\mathbf{Z}_t \epsilon_t^{q'}] = 0.$$

- To obtain such an instrument, look at High Frequency Identification literature.
- **Instrument:** Three-month ahead futures rate during a 30 minute window around announcements by the Federal Open Market Committee.
- Among other reasons, it predicts one-year government bond rate well.

Estimation

- First, get estimates of $\mathbf{B}_j$ and therefore $\mathbf{u}_t$ from the reduced form VAR

$$\mathbf{Y}_t = \sum_{j=1}^{S} \mathbf{B}_j \mathbf{Y}_{t-j} + \mathbf{u}_t$$

- Two components of $\mathbf{u}_t$ - u_t^p and $\mathbf{u}_t^q$. Now, 2SLS.
    - First stage: Regress u_t^p on $\mathbf{Z}_t$ to get fitted values $\hat{u_t^p}$.
    - Second stage:

$$\mathbf{u}_t^q = \left[\frac{\mathbf{s}^q}{s^p} \right] \hat{u_t^p} + \eta_t$$

- s^p can be written as a function of Σ, hence consistently estimated.
- So, $\mathbf{s}^q$ is identified.