The Transmission of Monetary Policy through Redistributions and Durable Purchases

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- monetary policy implemented through open market operations
  - contrast to "helicopter drops"

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- *Fiscal authorities do not "undo" the redistributive effects from MP*
  - when researchers estimate the transmission mechanisms, these effects are present...

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Expansionary OMO triggers:

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  - breakdown Ricardian Equivalence

Empirical evidence

VectorAutoRegresson

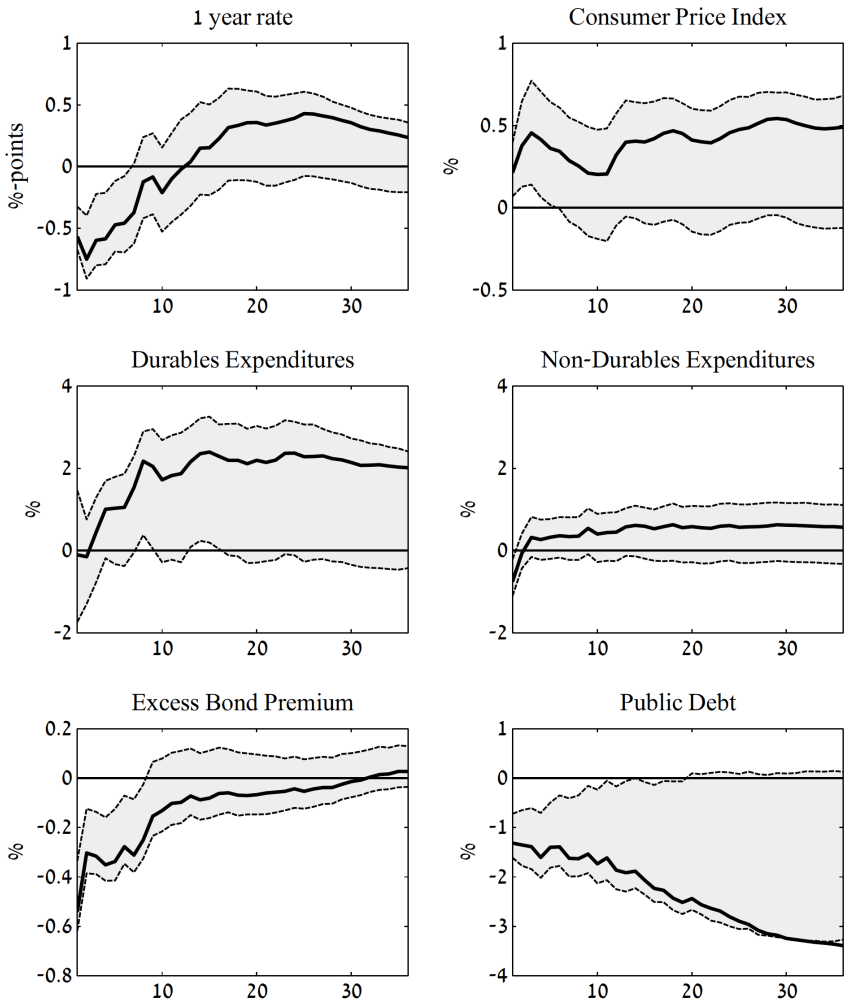

Figure: Responses to an expansionary monetary policy shock, identified following Gertler and Karadi (2015).

Model

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- Following retirement, immediate death shock may occur.
- Population size normalized to one. Stationary population:

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

where ν is the fraction of young agents in the population (#newborn=#aging=#dying).

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- Agents can also save in bonds (b_t)

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- The treasury makes a transfer $\tau_t^{\mathbf{s}}$ to each household of type $\mathbf{s}$. We denote an agent's life-cycle status by superscript $\mathbf{s} \in \{\mathbf{n}, \mathbf{y}, \mathbf{o}\}$, with $\mathbf{n}$ denoting a newborn young agent, $\mathbf{y}$ a pre-existing young agent, and $\mathbf{o}$ an old agent.

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- Wealth of deceased agents equally distributed among the young.

Old agents

Optimization problem old agent ($\mathbf{s} = \mathbf{o}$) in real terms:

$$
\begin{aligned}
& V^{\mathbf{o}}(a, \Gamma) = \max_{c,d,m,b} U(c, d, m) + \beta \left(1 - \rho_x\right) \mathbb{E} V^{\mathbf{o}}(a', \Gamma') \\
& s.t. \\
& c + d + m + b = a + \tau^{\mathbf{o}} \\
& a' \equiv (1 - \delta) d + \frac{m}{1 + \pi'} + \frac{(1 + r) b}{1 + \pi'}, \\
& c, d, m \geq 0,
\end{aligned}
$$

where $V^{\mathbf{o}}(a, \Gamma)$ is the value function, a denotes individual wealth, Γ is the aggregate state and π is the net rate of inflation. Also, β is the agents' subjective discount factor, δ is the depreciation rate of durables and $\mathbb{E}$ is the conditional expectations operator.

Young agents

Optimization problem young agents ($\mathbf{s} = \mathbf{n}, \mathbf{y}$)

$$V^{\mathbf{s}}(a,\Gamma) = \max_{c,d,m,b,h} U(c,d,m) - \zeta \frac{h^{1+\kappa}}{1+\kappa} + \beta\left(1-\rho_o\right)\mathbb{E}\,V^{\mathbf{y}}(a',\Gamma') + \beta\rho_o\left(1-\rho_x\right)\mathbb{E}\,V^{\mathbf{o}}(a',\Gamma')$$

$s.t.$

$$c + d + m + b = a + wh + \tau^{\mathbf{bq}} + \tau^{\mathbf{s}},$$

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

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

where w is the wage rate and $\tau^{\mathbf{bq}}$ is a bequest transfer. In the utility function $\zeta > 0$ is a scaling's parameter and $\kappa > 0$ determines the Frisch elasticity of labor supply.

Central Bank

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- To analyze monetary policy shocks, we assume that M_t is driven by an exogenous process subject to stochastic shocks.

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$$\frac{r_{t-1} b^{\mathbf{g}}_{t-1}}{1+\pi_t} + \tau^{\mathbf{cb}}_t = \nu \rho_o \tau^{\mathbf{n}}_t + \nu \left(1-\rho_o\right) \tau^{\mathbf{y}}_t + \left(1-\nu\right) \tau^{\mathbf{o}}_t$$

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  where the total amount of transfers is adjusted to balance the government's budget
- Net beneficiary is the government. Key how it redistributes gain.

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  where $a_t^{\mathbf{y}}$ is the *average* wealth among pre-existing young agents.
- What arises is a *representative young agent*. We preserve heterogeneity between old and young agents, as well as heterogeneity among old agents.

Market clearing

- Market clearing constraints durables and non-durables:

$$\begin{aligned} c_t &= \nu c_t^{\mathbf{y}} + (1-\nu)\, c_t^{\mathbf{o}} \\ d_t &= \nu d_t^{\mathbf{y}} + (1-\nu)\, d_t^{\mathbf{o}}, \end{aligned}$$

- Resource constraint, clearing conditions for money and bond market:

$$\begin{aligned} c_t + d_t &= \nu h_t^{\mathbf{y}} + (1-\delta)\, d_{t-1}, \\ m_t &= \nu m_t^{\mathbf{y}} + (1-\nu)\, m_t^{\mathbf{o}}, \\ 0 &= b_t^{\mathbf{g}} + b_t^{\mathbf{cb}} + \nu b_t^{\mathbf{y}} + (1-\nu)\, b_t^{\mathbf{o}} \end{aligned}$$

- Magnitude bequest transfer:

$$\tau_t^{\mathbf{bq}} = \frac{\rho_x \int_{i:\mathbf{s}=\mathbf{o}} a_{i,t}\, di + \rho_o \rho_x \nu a_t^{\mathbf{y}}}{\nu}$$

Equilibrium

Definition. *A recursive competitive equilibrium is defined by policy rules for non-durable consumption,* $c^{\mathbf{s}}(a,\Gamma)$*, durable consumption,* $d^{\mathbf{s}}(a,\Gamma)$*, money holdings,* $m^{\mathbf{s}}(a,\Gamma)$*, bond holdings,* $b^{\mathbf{s}}(a,\Gamma)$*, labor supply,* $h^{\mathbf{s}}(a,\Gamma)$*, with* $\mathbf{s} = \mathbf{n}, \mathbf{y}, \mathbf{o}, \mathbf{cb}, \mathbf{g}$*, as well as laws of motion for inflation, the nominal interest rate and the real wage, such that*

- *households optimize their expected life-time utility subject to their constraints and the law of motion for the aggregate state,*
- *the treasury and central banks follow their specified policies,*
- *the markets for bonds, money, goods and labor clear in every period.*

The aggregate state Γ *includes the value of the monetary policy shock, the distribution of wealth among agents, as well as the initial holdings of assets by households, the treasury and the central bank.*

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- Given the transfers to newborns, the model becomes observationally equivalent to one with an infinitely-lived representative agent with subjective discount factor $\widetilde{\beta} = \beta (1 - \rho_o)$.
- Easy to show that monetary policy becomes neutral with respect to real activity when utility is separable in money and consumption. No wealth effects (Weil (1991)).

Monetary neutrality

- Following arguments similar to Sidrauski (1967) one can show that, provided that money and goods enter the utility function separably, monetary policy does not affect real outcomes.
- To show this, consider the representative agent's first-order conditions for durables, labor supply, and the aggregate resource constraint:

$$\begin{aligned} U_{c,t} &= U_{d,t} + \widetilde{\beta}\,(1-\delta)\,\mathbb{E}_t\, U_{c,t+1} \\ U_{c,t} &= \zeta h_t^{\kappa} \\ c_t + d_t &= h_t + (1-\delta)\, d_{t-1} \end{aligned}$$

  where $U_{c,t}$ and $U_{d,t}$ are, respectively, the agents' marginal utilities with respect to non-durables and durables.
- Under preference separability, this is a closed dynamic system of 3 equations and 3 endogenous variables. No nominal variables enter this system.

Adding search and matching frictions

- Diamond-Mortensen-Pissarides style matching friction.
- Young workers live in representative family, as in Merz (1995) and Andolfatto (1996).
- Workers are born without a job, lose job with fixed probability. Search for jobs when unemployed, accept any job offer in equilibrium.
- $\Rightarrow$ shut off labour supply chanel. Employment determined by firms' endogenous vacancy posting decision. $\Rightarrow$ worker-firm relationships are durables.

Quantitative implementation

Computation

- Models with wealth heterogeneity and aggregate fluctuations typically difficult to solve, because wealth distribution is part of the economic state (Krusell and Smith (1998)).

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- Despite the presence of heterogeneity, our model can be solved using standard methods (first-order perturbation), under the following preferences:

$$\begin{aligned} U(c_{i,t}, d_{i,t}, m_{i,t}) &= \frac{u_{i,t}^{1-\sigma} - 1}{1-\sigma}, \\ u_{i,t} &\equiv \left[c_{i,t}^{\frac{\epsilon-1}{\epsilon}} + \eta d_{i,t}^{\frac{\epsilon-1}{\epsilon}} + \mu m_{i,t}^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}}, \end{aligned}$$

$\sigma, \epsilon, \eta, \mu > 0$. Baseline: $\sigma = \epsilon = 1$ (separability).

Shock process

Money growth rule:

$$\frac{M_t}{M_{t-1}} = 1 + z_t$$

where z_t is a mean reverting process following:

$$z_t = \xi \left(\overline{m} - m_{t-1} \right) + \varepsilon_t, \ \xi \in [0, 1),$$

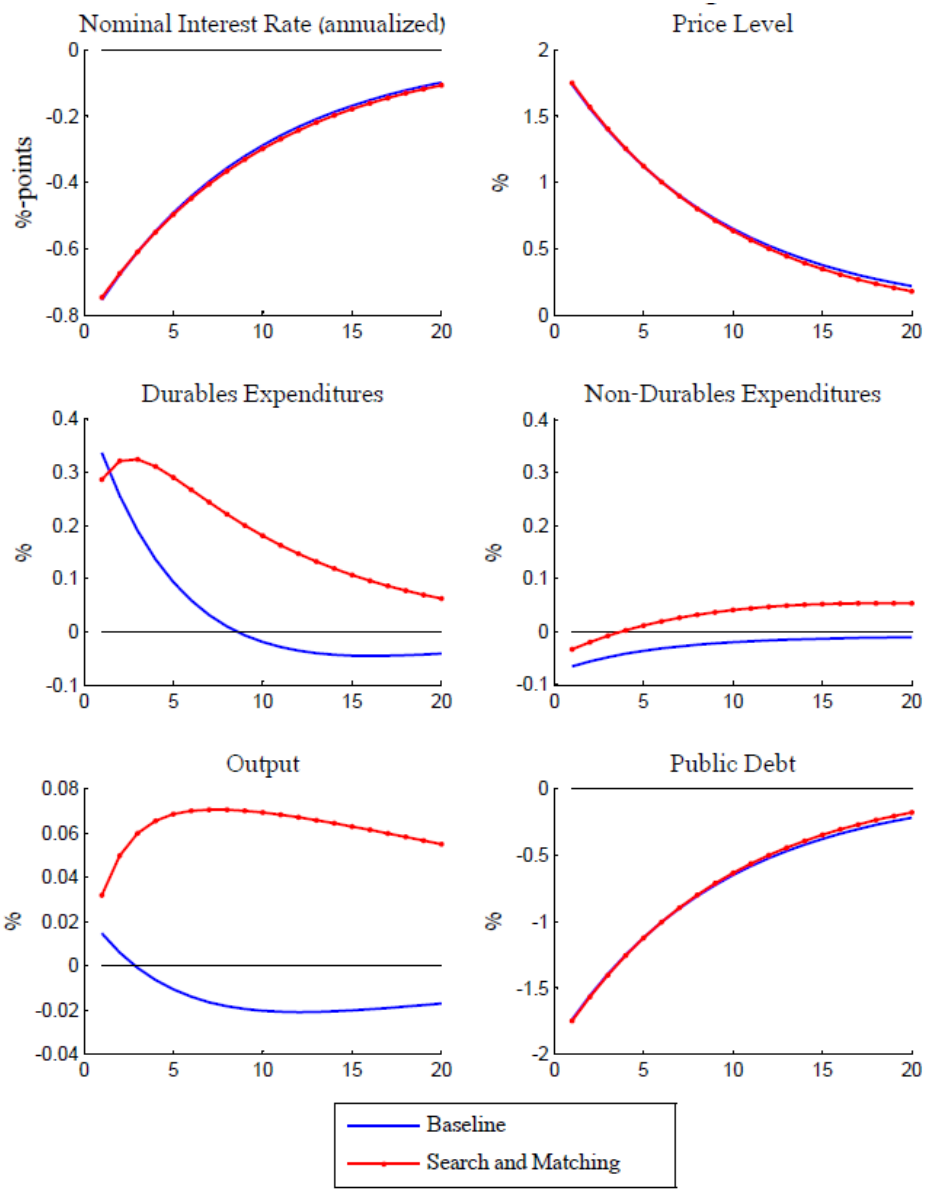
where ε_t is an i.i.d. shock innovation. (Implicit inflation target is zero.)

Parameter values (quarterly model)

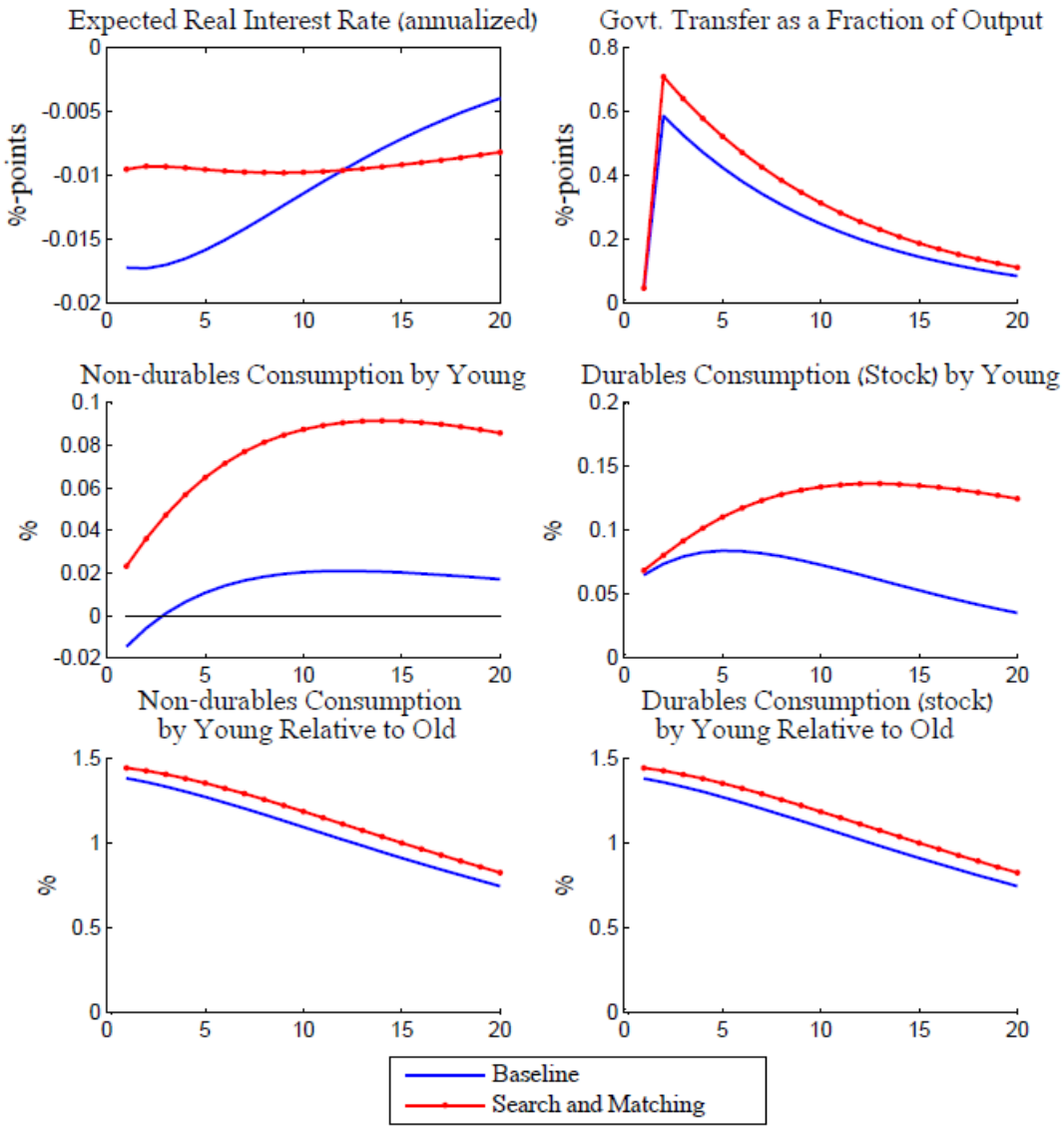
Table 1. Parameter values for the baseline model and the Search and Matching (SaM) model.

	baseline	SaM	description	motivation
β	0.9732	0.9755	subjective discount factor	4% s.s. annual interest rate
η	0.31	0.31	durables preference param.	20% s.s. spending on durables (NIPA)
μ	0.0068	0.0049	money preference param.	1.8 s.s. M2 velocity ($\frac{y}{m}$) (FRB/NIPA)
σ	1	1	coef. rel. risk aversion	convention literature
ϵ	1	1	intratemp. elast. of subst.	convention literature
κ	1	–	inv. elasticity labour supply	convention literature
ζ	0.5795	–	disutility of labor	normalize agg. output to one
ρ_o	0.0063	0.0063	ageing probability	avg duration working life 40 years
ρ_x	0.0125	0.0125	death probability	avg duration retirement 20 years
δ	0.04	0.04	depreciation rate durables	Baxter (1996)
b_0^g	-2.4	-2.4	initial bonds Treasury	government debt 60% of annual output
b_0^{cb}	0	0	initial bondsCentral Bank	no initial central bank debt/bonds
ξ	0.2	0.4	coefficient monetary rule	half life nominal interest rate 2.5 years
χ_0	–	0.0044	variable hiring cost	$\chi_1/\chi_0 = 10$ (Pissarides (2009))
χ_1	–	0.0004	fixed hiring	$\chi_1/\chi_0 = 10$ (Pissarides (2009))
α	–	0.5	matching function elasticity	convention search literature
ν	–	0.7	scaling matching function	vacancy filling probability 0.74

Expansionary monetary policy shock

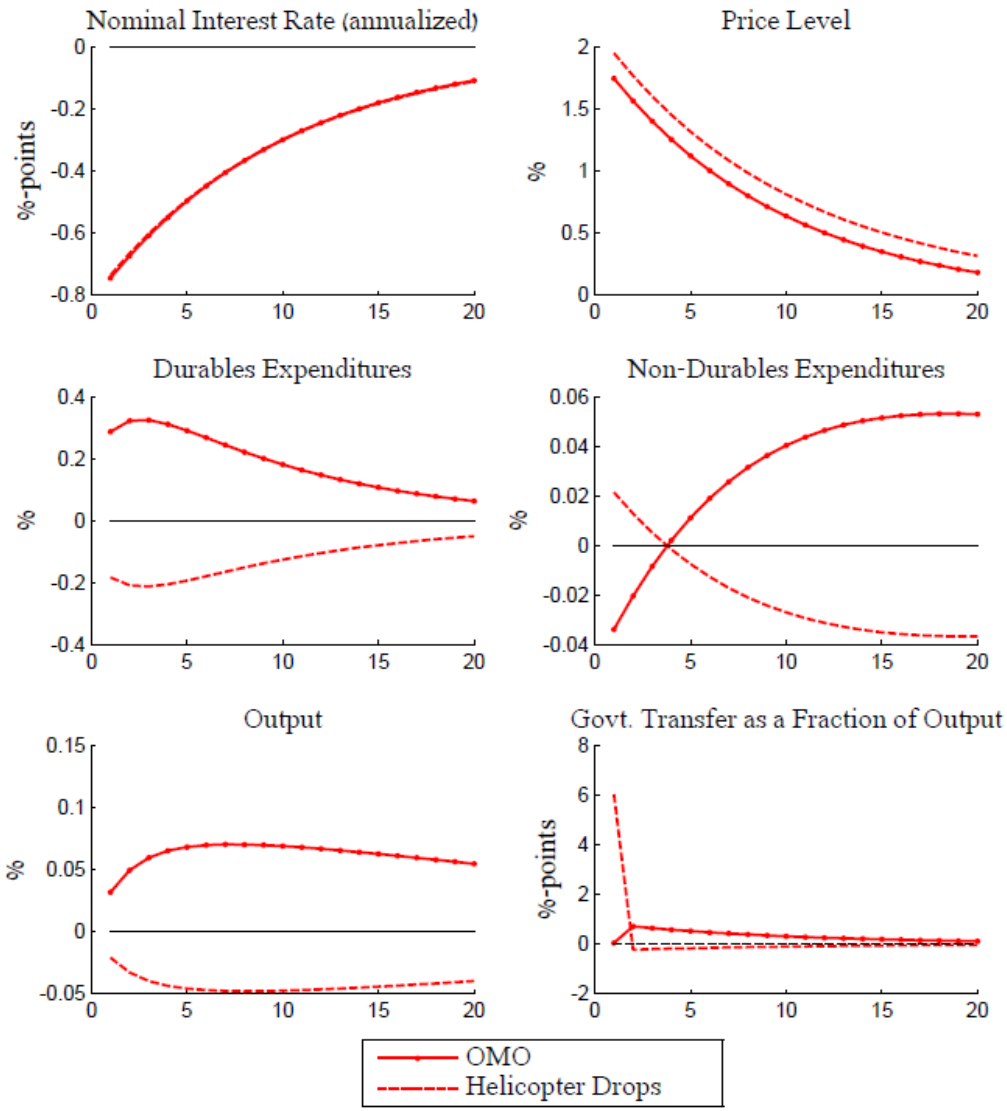


Young versus old



Monetary expansion

OMO vs helicopter drop



Conclusions

- Simple life-cycle DSGE model without nominal rigidities
- Responses to monetary policy shocks in line with VAR evidence: key role for durables
  - can help the NK model in fitting the data
- Transmission mechanism: two redistributional channels:
  - Among households
  - Between households and government
- Implementation of monetary policy matters (OMO vs helicopter drop)