The optimum quantity of money at the Zero Lower Bound

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Introduction

- Non conventional monetary policy : What is the effect of money injection at the ZLB?
- Money is back in the macroeconomy
- Often cashless, "Old" models of money used: MIUF (1954) CIA (1976) often used BUT:
- Recent empirical investigations of money demand (Alvarez and Lippi, 2009, 2013; Cao et al. 2012; Ragot, 2014).
  - Financial frictions are crucial to understand money demand: **Limited participation models** (Baumol-Tobin) + risks (Bewley) best reproduces the data.
  - **Lots of heterogeneity across agents** in the data. More than implies by MIU or CIA (Gini of money is 0.8 in the US, consumption 0.3).

Introduction

- Simplest model with recent developments in money theory : Heterogeneous agents; limited participation.
- Introduce a deleveraging shock, pushes the economy at the ZLB
- Derive optimal monetary policy at the ZLB.

Main Results

1. At the ZLB money creation has a real effects (due to redistribution) : Unlike Eggertsson and Woodford (2003)

2. At the ZLB, monetary policy can restore the first best.

3. At the ZLB Open market operations (OM) allow to reach some allocations that can not be reached by lump-sum transfers (HD).

Literature Review

Empirical analysis of money demand. Alvarez and Lippi, (2009, 2013); Cao, Meh Rios-Rull, Terajima (2012); Ragot, (2014).

Monetary policy with heterogenous agents (Endogeneous share of credit constraint agents). Erosa and Ventura (2002), Akyol (2004), Algan and Ragot (2010), Algan, Allais, Challe, Ragot (2015); Nakamura, McKay Steinson (2013); HANK : Kaplan, Moll, Violante (2016), Sterk and Tenreyro (2015); Challe, Matheron, Ragot, Rubio-Ramirez (2016).

Redistributive effect of monetary policy with different agents. Bilbiie (2008), Sheedy (2014), Azariadis, bullard, singh and suda (2015).

ZLB in NK models . Eggertson Woodford (2003), Auerbach and Obsfeld (2003), Adam Billi (2007), Werning (2012)

ZLB in monetary models .(Buera and Nicolini, 2014; Bachetta, Benhima, and Kalantzis, 2015)

The model : Key Assumptions

1. Limited participation (Baumol-Tobin): Some agents always participate in financial markets, other agents never participate : Bricker, Dettling, Henriques, Hsu, Moore, Sabelhaus, Thompson, and Windle (2014); Alvarez Lippi (2014)
2. Non-participating agents use money to smooth consumption (Bewley 1980) : Deterministic income fluctuations (Woodford 1990).
3. Non-participating agents face a tightening of the credit constraint (Guerrieri and Lorenzoni (2011); Eggertsson and Krugman (2012)),

The model

- Unit mass of households. *CRRA* utility from consumption, discount factor β.
  - A fraction Ω of households does not participate in financial markets
  - A fraction $1 - \Omega$ participates
- A representative firm produces with capital and labor
- State issues debt and raises taxes.
- Central bank creates money by open market operations (OM) or (HD).

Households

Non-participating

- Fraction Ω.
  - $\Omega/2$ consumes every odd period and work even period.
  - $\Omega/2$ consumes every even period and work odd period.(Woodford, 1990)
- Unit endowment 1.
- Real transfer τ_t to all agents.
- Households consuming c_t^n don't save in money (Guess and verify)
- Households not consuming save everything in money and hit the credit constraint

$$m_t^n = 1 + \tau_t - d_{t-1}$$

$$c_t^n = \frac{m_{t-1}^n}{1+\pi_t} + \tau_t + q_t d_t$$

Households

Participating : fraction

$1 - \Omega$

- Income 1
- Save in bonds and money

$$
\begin{aligned}
& q_t b_t^h + b_t^g + m_t^p + c_t^p \\
& = 1 + \tau_t + b_{t-1}^h + \frac{m_{t-1}^p}{1+\pi_t} + \frac{1+i_{t-1}}{1+\pi_t} b_{t-1}^g
\end{aligned}
$$

ZLB $1 + r_t^n = (1 + r_t^r)(1 + \pi_t)$

$$1 + \pi_{t+1} \geq q_t \text{ and } m_t^p = 0 \text{ if } 1 + \pi_{t+1} > q_t$$

OM and HD

- $\theta = 1$: HD : money given to households
- $\theta = 0$: OM, central bank buys bonds and redistributes its profits to households

$$\tau_t = \theta m_t^{CB} + \frac{(1-\theta)\, m_{t-1}^{CB}}{q_{t-1}}$$

Market equilibrium

$$3m_t^{tot} = \frac{1}{3}m_t^n + \frac{1}{3}m_t^p$$

$$\frac{1}{3}b_t^g + (1-\theta)\, m_t^{CB} = \overline{b}$$

$$c_t^p + c_t^n = 2$$

Optimal allocation

Tilda = optimal choices.

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left(u\left(\tilde{c}_t^n\right) + \omega_p u\left(\tilde{c}_t^p\right)\right)$$

The budget constraint of the planner is

$$\tilde{c}_t^n + \tilde{c}_t^p = 2$$

We have

$$\tilde{c}_t^p / \tilde{c}_t^n = \omega_p^{-\frac{1}{\sigma}}$$

Define ω_P such that optimal inflation is 0 in steady state.

The shock

- Unexpected decrease in d_t in period 1.
- Tightening of the credit constraint for non-participating agents.
- Only redistributive effects : no effects on endowment.

Optimal monetary policy when ZLB does not bind : Proposition

For $\theta \in [0,1]$ the first best can be implemented when the ZLB doesn't bind. Money creation must follow the rule, for $t \geq 0$

$$m_t^{CB} = \frac{(d^* - d_{t-1}) - \beta\,(d^* - d_t)}{3 - 2\theta} + 2\frac{1-\theta}{3-2\theta}\frac{m_{t-1}^{CB}}{\beta} \qquad (1)$$

Distortions of the market economy: Proposition

If $m_t^{CB} = 0$:
1) A deleveraging shock (a decrease in d_0) decreases both the real interest rate and the inflation rate.
3) There is a threshold d_0^{thres}

$$d_0^{thres} \equiv \frac{1 + \frac{1-\bar{d}^*}{\beta}\left(\left(\frac{\beta}{1+\bar{d}^*} + 1\right)\frac{\bar{d}^*}{1+\bar{d}^*} - 1\right)}{1 + \frac{1-\bar{d}^*}{\beta}\left(\frac{\beta}{1+\bar{d}^*} + 1\right)\frac{1}{1+\bar{d}^*}}$$

such that the ZLB binds in period 0 if $d_0 < d_0^{thres}$. In this case $m_0^P > 0$.

ZLB: Effects of HD

Assume $d_0 < d_0^{Threshold}$.
If $\theta = 1$ (lump-sum money creation):
1) Period 0 lump-sum money creation $m_0^{CB} > 0$ changes consumption levels
2) The first-best allocation cannot be implemented.

ZLB : Effects of OM

Assume $d_0 < d_0^{Threshold}$.
If $\theta = 0$ (open–market operations), the first-best allocation can be implemented. The process of money creation is

$$m_0^{CB} = \left(\frac{1}{\beta} - 1\right)(d^* - 1)\,,\; m_1^{CB} = -\frac{m_0^{CB}}{3\beta}$$

$$\text{and } m_t^{CB} = \frac{2m_{t-1}^{CB}}{3\beta}, t \geq 2$$

KEY difference : OM allows progressively undoing the effects of money transfers

Extensions

1. Tightening of the credit constraints for many periods
2. Production economy and capital accumulation.

Extensions : Nominal Frictions

Bilbiie and Ragot (2016) : "Money, inflation and redistribution : The case for helicopters"
using Bilbiie (2008) and reduced heterogeneity equilibria Challe and Ragot (2015) and Challe, Matheron, Ragot, Rubio-Ramirez (2016).

- Uninsrable idiosyncratic risks smoothed by mone demand.
- Derive optimal monetary policy in NK model with microfounded money demand.
- Three equations model, Second order approximation to Welfare
- Additional gain of HD compared to OM : lower inflation volatility under optimal monetary policy.

Conclusion

- Simple model to obtain insights about money creation at the ZLB
- Captures recent developments in monetary heterogeneous agents economics.
- At the ZLB:
  - optimal monetary policy doesn't avoid the ZLB
  - OM is better than HD, allows progressively undoing the effect of money creation
- Quantitative developments
  - nominal frictions
  - Rich heterogeneity