Incomplete credit markets and monetary policy

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Pre-crises monetary policy analysis

- Monetary policy models in central banks
  - Nominal rigidities in prices as key frictions
  - Woodford (2003)

- Pre-crisis consensus for monetary policy
  - optimal to target inflation
  - short-term interest rate and Taylor rule

Post-crises monetary policy analysis

- The 2007-2009 financial crisis increased attention to private credit markets and interactions of households with these markets.
  - Contracts in private credit markets often expressed in nominal terms and non-state-contingent.
- Emphasis on credit market frictions
  - Bernanke, Gertler, Gilchrist (1999), Kiyotaki, Moore (1997)
  - Gertler, Karadi (various), Gertler, Kiyotaki, Jermann, Quadrini, ...
  - Bielecki, Brzoza-Brzezina, Kolasa, Makarski, Suda, Wesołowski, ...
- New targets for optimal monetary policy
  - price level targeting
  - nominal GDP targeting
- New tools for monetary policy
  - forward guidance, quantitative easing, ...

This paper: the return of private credit markets

- We study an economy with a large private credit market essential to good macroeconomic performance.
- Key friction: Non-state contingent nominal contracting (NSCNC).
- **Main questions**:
  - Can the monetary policy complete incomplete markets? How does such policy look like?
  - Can this policy maintain a smoothly operating credit market when the ZLB threatens?

What we do

- Stylized overlapping generations model with
  - two assets: privately-issued debt and currency,
  - non-state contingent nominal contracts in credit markets (NSCNC),
  - segmented markets: credit sector (participants) and cash sector (non-participants),
  - stochastic income growth.
- Policymaker (central bank)
  - supplies currency (and effectively controls price level),
  - wants to implement social-planner equilibrium
    - substitute for the missing state-contingent contracts but do not address segmented markets,
  - faces, for certain policies and shocks, the threat of the zero lower bound.

What we find

- Monetary policy can implement social planner equilibrium
  - Counter-cyclical price level restores optimal risk sharing in the credit market.
  - Optimal monetary policy resembles "nominal GDP targeting", Koenig (2013) and Sheedy (2014)
- This policy is not unique, e.g.
  - expected inflation targeting,
  - strict nominal GDP targeting,
  - ...

  ... and different implementations differ with respect to inflation volatility.
- Under certain policy implementations the ZLB threatens to bind
  - but higher than usual price level addresses this problem and restores complete market allocation.

Literature

- *Non-state contingent nominal contracts (NSCNC)*:
  Bohn (1988), Chari, Christiano, Kehoe (1991), Chari, Kehoe (1999), Schmitt-Grohe and Uribe (2004), Siu (2004)

- *Monetary policy and NSCNC*:
  Koening (2013), Sheedy (2014), Garriga, Kydland, Sustek (2017)

- *OLG, monetary policy and ZLB*:
  Eggertsson, Mehrotra, Robbins (2018), Bielecki, Brzoza-Brzezina, Kolasa (2019)

- *Nominal GDP targeting*:
  Woodford (2012), Sumner (2014), Garín, Lester, Sims (2016), Billi (2017)

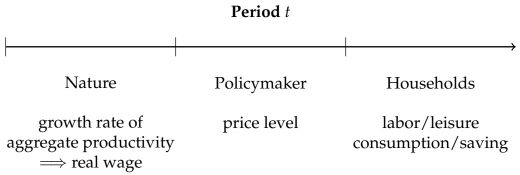
Environment

Life-cycle model with segmented markets

- $T+1$-period DSGE life-cycle economy with segmented markets.
- Two assets: *private debt* (consumption loans) and *currency*.
- Two types of households: *participants* and *non-participants*.
  - *Participants* can hold either asset, but in the stationary equilibria we study they will not hold currency as it is dominated in rate of return.
  - *Non-participants* can only hold currency.
- *Central bank*: controls currency stock and (effectively) price level.
- Linear production function and exogenous stochastic productivity.
- Other assumptions:
  - Within-cohort agents are identical, no population growth, inelastic labor supply, time-separable log preferences, no discounting, no capital, no default, flexible prices, no borrowing constraint.

    Bullard and DiCecio (2019), Bullard and Singh (*JMCB, fothcoming*)

Timing protocol



- At the beginning of date t, agents enter the period with nominal contracts set in $t-1$, $R^N(t-1,t)$
- Nature moves first and chooses productivity $\lambda(t-1,t)$, which implies value for wages $w(t)$.
- The policymaker moves next and chooses the price level $P(t)$.
- Households then decide how much to consume and save/borrow at $R^N(t,t+1)$.

Stochastic structure

- Exogenous real wage $w(t)$ follows

$$w(t+1) = \lambda(t,t+1)w(t), \tag{1}$$

with labor productivity growth process given by

$$\lambda(t,t+1) = (1-\rho)\lambda + \rho\lambda(t-1,t) + \sigma\eta(t+1) \tag{2}$$

where $\lambda > 1$ is the average growth rate, $\eta(t+1) \sim N(0,1)$.

- We assume that σ and ρ are chosen such that encounters with the zero lower bound are relatively rare and relatively shallow.

Participant households problem

- Agent born at date t maximizes life-time utility

$$E_t \sum_{j=0}^{T} \ln c_t(t+j)$$

subject to

$$c_t(t+j) + \frac{a_t(t+j)}{P(t+j)} = e_j w(t+j) + \frac{R^N(t+j-1, t+j) a_t(t+j-1)}{P(t+j)}$$

- Total income in the credit sector at date t is $w(t) \sum_{j=0}^{T} e_j$.
- Euler equation for any generation j at date t is given by

$$R^N(t, t+1)^{-1} = E_t \left[\frac{c_{t-j}(t)}{c_{t-j}(t+1)} \frac{P(t)}{P(t+1)} \right].$$

Life-cycle productivity

- Credit market participating agents are endowed with an identical productivity profile over their lifetime.
  - Agents supply labor inelastically at the competitive wage.
  - The productivity profile is symmetric and peaks in the middle period of the life cycle.

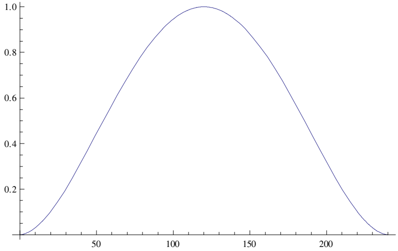


Figure: A schematic productivity endowment profile for credit market participant households.

Key friction: NSCNC

- Financial markets are incomplete.
- Loan repayments are in nominal terms and are not contingent on future income realizations.
- Non-state-contingent-nominal contract (NSCNC) friction is important:
  - Sheedy (2014): both sticky price and NSCNC frictions are present; argues that the NSCNC friction is the more important of the two in a calibrated case.
  - Garriga, Kydland, and Sustek (2017): consider the effect of non-state contingent nominal contracting in housing markets. Quantitatively significant effects of NSCNC.

Non-participants

- Completely precluded from credit market.
  - 2017 FDIC survey: 6.5% of US households unbanked; 18.7% underbank (FDIC, 2018)
- *No life cycle aspect* to productivity or consumption.
  - Inactive in the stage of life period $s = 0$.
  - Productivity endowment γ is “small”
  - Earn $\gamma w(t+s)$ in odd-dated stages, $s = 1, 3, 5, ..., T-1$.
  - Consume in even-dated stages $\ln c_t(t+s)$, $s = 2, 4, 6, ..., T$.
  - Real money demand given by

$$h^d(t) = \frac{T}{2}\gamma w(t)$$

  where $h^d(t) = H^d(t)/P(t)$.
- Non-participants work only intermittently and save all income by holding currency.

The central bank

- The central bank supplies currency to the cash sector of the economy, which determines $P(t)$.

- The policy rule for $P(t)$ will be designed to complete credit markets.

- Seigniorage earned by the central bank is rebated back to cash using agents.

Currency provision

- Currency stock at date t

$$H^s(t) = \theta(t-1,t)\, H^s(t-1).$$

- The money market equilibrium

$$H^s(t) = H^d(t), \qquad \forall t.$$

implies

$$h^d(t)P(t) = \theta(t-1,t)h^d(t-1)P(t-1)$$

Currency provision

- Demand for money implies

$$\frac{T}{2}\gamma w(t)P(t) = \theta\left(t-1,t\right)\frac{T}{2}\gamma w(t-1)P(t-1).$$

- The central bank completely controls the date t price level via the gross growth rate of currency creation, $\theta\left(t-1,t\right)$, which is

$$\theta\left(t-1,t\right) = \frac{P\left(t\right)}{P\left(t-1\right)}\frac{w\left(t\right)}{w\left(t-1\right)}.$$

- By choosing $\theta\left(t-1,t\right)$, central bank determines $P(t)$.

Nominal interest rate

- The non-state contingent nominal interest rate, the contract rate, is given by

$$R^N(t, t+1)^{-1} = E_t\left[\frac{c_{t-j}(t)}{c_{t-j}(t+1)}\frac{P(t)}{P(t+1)}\right].$$

- This rate depends on the expected rate of consumption growth and the expected rate of inflation.

Stationary equilibria

- Let $t \in (-\infty, +\infty)$.
- We only consider stationary equilibria under perfectly credible policy rules governing $P(t)$.
- Stationary equilibrium is a sequence $\left\{R^N(t, t+1), P(t)\right\}_{t=-\infty}^{+\infty}$ such that households solve their optimization problem, the policymaker credibly adheres to a stated policy rule governing $P(t)$ and markets clear.
- Key condition is clearing of aggregate asset holding

$$\frac{A(t)}{P(t)} = \frac{\sum_{j=0}^{T-1} a_{t-j}(t)}{P(t)} = 0, \qquad \forall t.$$

Social Planner Allocation

Social planner

- Assume social planner takes market segmentation as given,

  but chooses consumption allocation to maximize utility of households in their markets.

- Social planner solves

$$\max_{\{c(t)_{t-i}, c^{np}(t)_{t-i}\}_{i=0}^{T}} \{(1-\omega)\left(\ln c_t(t) + \ldots + \ln c_{t-T}(t)\right) + \omega\left(\ln c^{np}_{t-2}(t) + \ldots + \ln c^{np}_{t-T}(t)\right)$$

subject to resource constraints

$$c_t(t) + c_{t-1}(t) + \ldots + c_{t-T}(t) \leq (e_0 + e_1 + \ldots + e_T)w(t)$$

$$c^{np}_{t-2}(t) + c^{np}_{t-4}(t) + \ldots + c^{np}_{t-T}(t) \leq \frac{T}{2}\gamma w(t)$$

Consumption and income

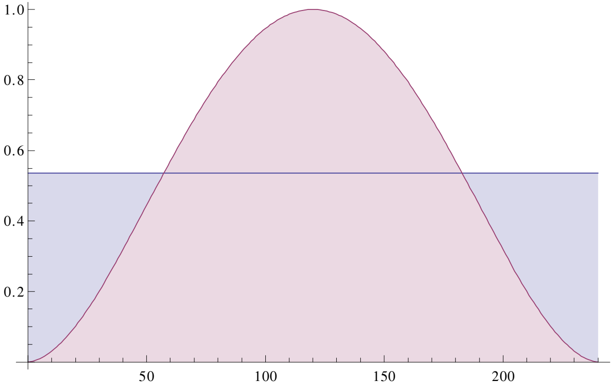


Figure: Schematic representation of consumption, the flat line, versus income, the bell shaped curve, by cohort along the complete markets balanced growth path with $w(t) = 1$. The private credit market completely solves the point-in-time income inequality problem.

Non-stochastic net asset holding

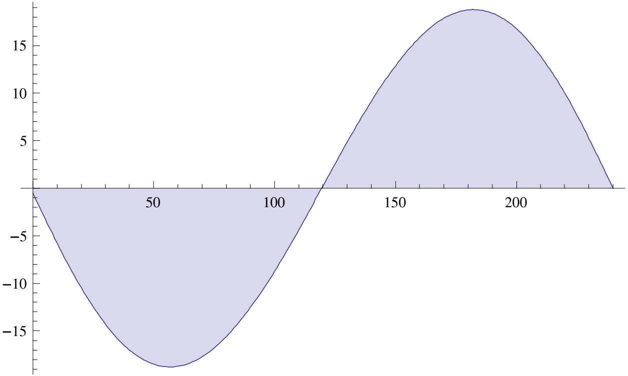


Figure: Net asset holding by cohort along the balanced growth path. Borrowing, the negative values to the left, peaks at stage 60 of the life cycle, roughly age 35, while positive assets peak at stage of life 120, roughly age 65.

Key features

- All income earned within any period is divided equally among all participants alive in the economy at that time.

$$c_{t-i}(t) = \frac{w(t)\sum_{i=0}^{T} e_i}{T+1}.$$

  - *Households have an "equity share" in the economy.*
  - Consumption and asset holdings fluctuate from period to period *but in proportion to the value of $w(t)$.*
  - There is perfect risk-sharing within each (participants and non-participants) market.

Policy

Monetary Policy with NSCNC

- Borrowers and lenders contract on $R^N(t-1,t)$ at date $t-1$ which is non-state contingent.
- The objective of the central bank is to implement social planner allocation.
- It achieves it by setting money supply that implies the *countercyclical price level rule*.
- The generic form of *countercyclical price level rule*,

$$P(t) = \frac{R^{op}(t)}{\lambda(t-1,t)} P(t-1),$$

  for some $R^{op}(t)$, depends on productivity and delivers complete-market allocation.
    - This rule provides missing private sector state-contingency.
    - Inflation is high (low) when growth is low (high).
- It can be interpreted as nominal GDP targeting

Interpretation as nominal GDP targeting

- At date $t+1$, nominal GDP equals

$$\begin{aligned} Y^n(t+1) &= P(t+1)w(t+1)\left[\frac{T\gamma}{2}+\sum_{i=0}^{T} e_i\right], \\ &= \frac{P(t+1)}{P(t)}\lambda(t,t+1)P(t)w(t)\left[\frac{T\gamma}{2}+\sum_{i=0}^{T} e_i\right], \\ &= \frac{P(t+1)}{P(t)}\lambda(t,t+1)Y^n(t) \end{aligned}$$

- Under the countercyclical price level rule

$$Y^n(t+1) = R^{op}(t+1)Y^n(t)$$

- Optimal policy has form of nominal GDP targeting.

Interest rates with NSCNC

- The equilibrium (ex-post) real interest rate is exactly equal to the output growth rate at every date, even in the stochastic economy

$$R\left(t-1,t\right)=\lambda\left(t-1,t\right),$$

  - can be interpreted as the Wicksellian natural real rate of interest = rate that would occur in a competitive equilibrium without any friction.

- Under this rule nominal interest rate equals

$$R^{N}(t-1,t)^{-1}=E_{t}\left[\frac{c_{t-j}(t-1)}{c_{t-j}(t)}\frac{P(t-1)}{P(t)}\right]=R^{op}(t)^{-1}$$

- It is not unique: works for any value of $R^{N}(t-1,t)$.

Policy 1: expected inflation targeting

- Central bank sets the price level such that expected inflation equals inflation target π^*

$$\tilde{P}(t) = \frac{\pi^*}{E_{t-1}\left(\lambda(t-1,t)^{-1}\right)} \frac{1}{\lambda(t-1,t)} \tilde{P}(t-1)$$

so that the expected inflation

$$E_t \tilde{\pi}(t+1) = \pi^*$$

- Given this policy nominal interest rate $\tilde{R}^N(t,t+1)$ equals

$$\tilde{R}^N(t,t+1) = \frac{\pi^*}{E_t \lambda(t,t+1)^{-1}}$$

Policy 1: expected inflation targeting

- However, the nominal interest rate $\tilde{R}^N(t, t+1) < 1$ following a large negative productivity shock for sufficiently persistent process.
- Example of shock size for ZLB.
- The planner's allocation can non longer be implemented:
  - if the nominal interest rate were allowed to be zero, the saver segment of participant households would want to hold currency, $\Longrightarrow$ without additional intervention by CB, credit market is disrupted.

Policy 1: ZLB intervention

- Let the price level policy rule equal

$$\tilde{P}(t+1) = \begin{cases} \frac{\pi^*}{E_t[\lambda(t,t+1)]}\frac{1}{\lambda(t,t+1)}\tilde{P}(t) & \text{if} \quad \tilde{R}^N(t,t+1) > 1 \\ \frac{\pi^*(1+\vartheta_p(t+1))}{E_t[\lambda(t,t+1)]}\frac{1}{\lambda(t,t+1)}\tilde{P}(t), & \text{if} \quad \tilde{R}^N(t,t+1) \leq 1 \end{cases}$$

  with $\vartheta_p(t+1) > 0$ such that $\pi^*[1+\vartheta_p(t+1)]/E_t[\lambda(t,t+1)^{-1}] = 1^+$.
- Then, at date $t+1$:
  - $\tilde{R}^N(t,t+1) \geq 1^+$.
  - $R(t,t+1) = \lambda(t,t+1)$.
  - Consumption moves with income.
- Increase the future price level (higher inflation) whenever ZLB threatens.
- Complete markets allocation for the credit users.

Policy 2: strict nominal GDP targeting

- Central bank can avoid ZLB by setting $R^{op}(t) > 1$.
- Let the price level policy rule equal

$$\hat{P}(t) = \frac{\pi^* \bar{\lambda}}{\lambda(t-1,t)} \hat{P}(t-1)$$

and assume $\pi^* \bar{\lambda} > 1$.

- The nominal interest rate is now constant

$$\hat{R}^N(t,t+1) = \pi^* \bar{\lambda} > 1,$$

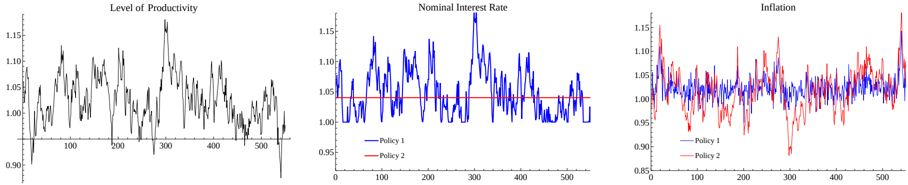
- and nominal GDP equals

$$Y^n(t+1) = \hat{R}^N(t,t+1) Y^n(t) = (\pi^* \bar{\lambda} Y^n(t).$$

- (Note that real interest rate still equals $R(t,t+1) = \lambda(t,t+1)$.) but the inflation rate is more volatile

Policy 2: strict nominal GDP targeting

- But the inflation rate is more volatile under Policy 2



- Inflation (and its volatility) have no impact on real allocation in our stylized economy.

Conclusion

Conclusion

- The model features an important credit market and the friction is NSCNC.
- Restoring market completeness requires counter-cyclical price level.
- This policy resembles nominal GDP targeting
- This paper suggests a method of conducting monetary policy when the ZLB threatens.
  - Higher than *usual* price level.
- This method look somewhat different from what has been done in the last 5 years, even though the desire behind many actual policy choices has been to help credit markets perform better.

Reaching ZLB

- Assume that economy is in the steady-state at date $t-1$, $\lambda(t-2, t-1) = \lambda$.
- For $E_t \lambda(t, t+1) \leq 1$, it must be the case that

$$\eta(t) \leq \frac{1-\lambda}{\sigma\rho}.$$

- Since $\eta(t) \sim N(0,1)$, the probability of ZLB at date $t+1$ equals

$$P\left(\eta(t) \leq \frac{1-\lambda}{\sigma\rho}\right) = \Phi\left(\frac{1-\lambda}{\sigma\rho}\right).$$

Back

Staying at ZLB

- Let the economy at date $t-1$ be at the zero-lower bound, $E_{t-1}\lambda(t-1,t) = 1$, or $\lambda(t-2,t-1) = \frac{1-(1-\rho)\lambda}{\rho}$.
- The economy will stay at the bound at date t when

$$\eta(t) \leq \frac{(1-\rho)(1-\lambda)}{\sigma\rho}.$$

- This will happen with probability $\Phi\left(\frac{(1-\rho)(1-\lambda)}{\sigma\rho}\right)$.

Back