Liquidity, Capital Pledgeability and Inflation Redistribution

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Disclaimer

Motivation

- Ongoing debate on monetary policy and inequality

- What are the distributional effects of expected inflation?

- Consider economy with:
  money, capital, borrowing and lending

- Capital characterized by several features:
  - productive asset
  - can be used as collateral
  - accumulation affected by inflation

- Key framework elements:
  microfounded model of money
  analytical tractability

Why collateralized debt?

- Expected inflation and uncollateralized debt:

  borrowing interest rate adjusts perfectly for inflation

  no redistributive effect of inflation from borrowing and lending

- Expected inflation and collateralized debt:

  redistributive effect of inflation from borrowing and lending...

  ...provided that inflation affects capital accumulation

Related Literature

- Modeling framework: Lagos and Wright (2005), Aruoba, Waller and Wright (2011), Boel and Waller (2019).

- Collateral constraints: Kiyotaki and Moore (1997), Del Negro, et al. (2017), Kiyotaki and Moore (2018).

- Distributional effects of expected inflation:

  Erosa and Ventura (2002), Albanesi (2007), Boel and Camera (2009), Camera and Chien (2014) (inflation acts as a regressive tax).

  Levine (1991), İmrohoroğlu (1992), Bhattacharya, Haslag, and Martin (2005), Molico (2006), Manuelli and Sargent (2010), Rocheteau, Weill, and Wong (2018), Chiu and Molico (2010, 2011), Chatterjee and Corbae (1992) (inflation acts as a progressive tax).

Model

Basic Environment

- Two sequential rounds of trade in every period: DM and CM

DM:

- agents can trade (produce or consume) with equal probability $\sigma/2$, or be idle with probability $1-\sigma$
- agents anonymous
- no record keeping and no public communication (Kocherlakota, 1998)

CM:

- everyone trades
- agents choose money $+$ capital $+$borrowing/lending for next period
- quasi-linear preferences $\Rightarrow$ analytical tractability

Essentiality of money

- Frictions imply money is essential for trade in the DM
- Competitive pricing

Heterogeneous Preferences

- Heterogeneity in time preferences
- Discount factor $\beta_j \in \{\beta_L, \beta_H\}$, with $\beta_L < \beta_H$
- Type H agents in proportion $\rho \in (0, 1)$

Monetary Policy

- $M_t = \pi M_{t-1}$ (deterministic)
- Lump-sum nominal transfers in CM: $\tau = (\pi - 1) M_{t-1}$

Physical capital

- Productive asset (for now only in DM)
- Can be used as collateral
- Depreciates at rate δ
- Cannot be used as medium of exchange in DM

Borrowing and lending

- Agents can buy or sell one-period nominal bonds a_j at price p_a
- Borrowing is subject to a collateral constraint: only a fraction θ of capital can be collateralized (Kiyotaki and Moore, 1997)
- CM bonds repaid in following CM (no default)

DM Problem

- Agent of type j begins period with portfolio $\omega_j \equiv (m_j, k_j, a_j)$ and experiences trade shock $z = b, s, o$
- Expected lifetime utility:

$$V_j(\omega_j) = \frac{\sigma}{2} V_j^b(\omega_j) + \frac{\sigma}{2} V_j^s(\omega_j) + (1-\sigma) V_j^o(\omega_j)$$

- Seller's problem, trivial:

$$V_j^s(\omega_j) = W_j(\omega_j^s)$$

- Buyer's problem:

$$\begin{aligned} V_j^b(\omega_j) &= \max_{q_j} \; u(q_j) + W_j(\omega_j^b) \quad \text{s.t.} \\ \text{s.t.} \quad & pq_j \leq m_j \quad \text{buyer's budget constraint} \end{aligned}$$

CM Problem

- After trading in DM $\Rightarrow$ enter CM with:

$$\begin{aligned} \text{buyer:} \quad & m_j^b = m_j - pq_j,\ (1-\delta)k_j,\ \ a_j \\ \text{seller:} \quad & m_j^s = m_j + pf(k_j),\ (1-\delta)k_j,\ \ a_j \\ \text{idle:} \quad & m_j^o = m_j,\ (1-\delta)k_j,\ \ a_j \end{aligned}$$

- The problem of an agent at the start of a CM is:

$$\begin{aligned} W_j(\omega_j^z) \quad = \quad & \max_{x_j^z, n_j^z, m_j', k_j', a_j'} U(x_j^z) - n_j^z + \beta_j V_j'(\omega_j') \\ \text{s.t.} \quad & x_j^z + a_j + k_j' + \pi m_j' = (1-\delta)k_j^z + m_j^z + \tau + p_a \pi a_j' \\ & a_j' \leq \theta k_j' \quad \text{(collateral constraint)} \\ & m_j' \geq 0 \\ & k_j' \geq 0 \end{aligned}$$

Findings

- DM:

  $u'(q_j) = p(1 + \lambda_j) \quad (\lambda_j > 0 \text{ if constrained buyer})$

- CM:

  Asset choices:
  untied from past shocks
  current-type dependent

Intertemporal Decisions

- Consumption/saving decisions must satisfy:

$$\begin{aligned}
m\text{:} \quad & \pi = \beta_j \left[1 + \frac{\sigma}{2p} \left(u'(q_j) - p \right) \right] \\
k\text{:} \quad & 1 = \beta_j \left[(1-\delta) + \frac{\sigma}{2} p f'(k_j) \right] + \mu_j^k + \theta \lambda_j^a \\
a\text{:} \quad & \pi p_a = \beta_j + \lambda_j^a
\end{aligned}$$

- Monetary policy π, β_j, δ and σ affect consumption and asset accumulation

Stationary Equilibrium

Given initial money stock $\bar{M} > 0$ and a government policy as specified by π, τ, a competitive stationary monetary equilibrium is a list of:

quantities: m_j, k_j, a_j, x_j^z, n_j^z, q_j

prices: p, p_a that:

solve the agents' problems in the DM and CM

satisfy the govt budget constraint $\tau = [\rho m_H + (1-\rho) m_L](\pi - 1)$

satisfy the goods and assets market clearing conditions

Theoretical Results

Result 1: Return on Money

Any stationary monetary equilibrium must be such that $\pi \geq \beta_H$.

- Intuition:

  Suppose $\pi < \beta_H \quad \Rightarrow \quad 1/\pi > 1/\beta_H$

  Return on cash > desired return of H

  Arbitrage opportunity for H

- Economic consequence:

  Money costlier for type L agents

Result 2: Equilibrium with borrowing and lending

A stationary monetary equilibrium exists with:

$$p_a = \frac{\beta_H}{\pi},\ a_L = \frac{\theta k_L}{\beta_H},\ a_H = -\frac{(1-\rho)\theta k_L}{\rho\beta_H}$$

Intuition:

- Type L borrow and type H lend
- Why? Heterogeneity in discount factors
- For L agents, borrowing at rate π/β_H cheaper than carrying money across periods at cost π/β_L.

- Price of bonds adjusts for expected inflation.
- Does inflation affect borrowing and lending affected via collateral constraint?

Result 3: Coexistence

Let $\pi \geq \beta_H$ and $f''(k_L) < 0$. There exists a stationary monetary equilibrium with $m_H > m_L > 0$, $k_H > k_L > 0$, $a_L = \theta k_L$ and $a_H = -\theta \rho k_L / (1 - \rho)$.

- Intuition:
  - Patient agents lend, impatient agents borrow.
  - Unequal demand for other assets. Why?
  - Different discounted returns for L and H agents.

Result 4: Pledgeability and portfolio choices

Let $\pi \geq \beta_H$, $a_L = \theta k_L$ *and* $a_H = -(1-\rho)k_L/k_H$. *Then,* $dp/d\theta < 0$, $dq_H/d\theta > 0$, $dq_L/d\theta > 0$, $dk_H/d\theta < 0$ *and* $dk_L/d\theta > 0$.

- Intuition:
  - $\theta \uparrow \Rightarrow k_L \uparrow$. Why? Type L want to borrow as much as possible.

  $\Rightarrow$ Collateral constraints reduce wealth inequality.

Result 5: Inflation and portfolio choices

Let $\pi \geq \beta_H$, $a_L = \theta k_L$ and $a_H = -(1-\rho)k_L/k_H$. Then $dq_H/d\pi < 0$ and $dk_j/d\pi < 0$ for $j = H, L$.

$dq_L/d\pi < 0$ if $f(k)$ isoelastic and type L sufficiently risk averse.

- Intuition:
  - If $\pi \uparrow$, real value of money and total consumption decrease.
  - $\Rightarrow$ Lower incentive to accumulate capital if sellers.

Overall effects of inflation?

- Increase in long-run inflation leads to:
  - lower labor effort to pay off borrowing
  - higher inflation tax, but unevenly distributed
  - reduction in consumption
  - lower production overall
- Ambiguous balance of these effects $\Rightarrow$ overall must be determined quantitatively.

Quantitative Analysis

Functional Forms

- DM:
  $u(q) = \ln(q)$, $f(k) = k^{\alpha}$

- CM:
  $U(x) = B\ln(x)$

Vector of parameters to identify is $(\beta_H, \beta_L, \delta, \theta, \rho, \alpha, \sigma, B)$.

Parameterization

- We set the following parameters:

  - $\beta_H = 0.97$ and $\beta_L = 0.89$, consistent with empirical estimates of distributions of discount factors.

  - $\delta = 0.07$ as in Aruoba, Waller and Wright (2011).

  - $\theta = 0.85$ consistent with Iacoviello and Neri (2010).

  - $\rho = 0.40$, in line with Boel and Camera (2009).

- We calibrate α, σ and B simultaneously to match:
  - money demand $L = M/PY$.

  - share of cash consumption transactions.

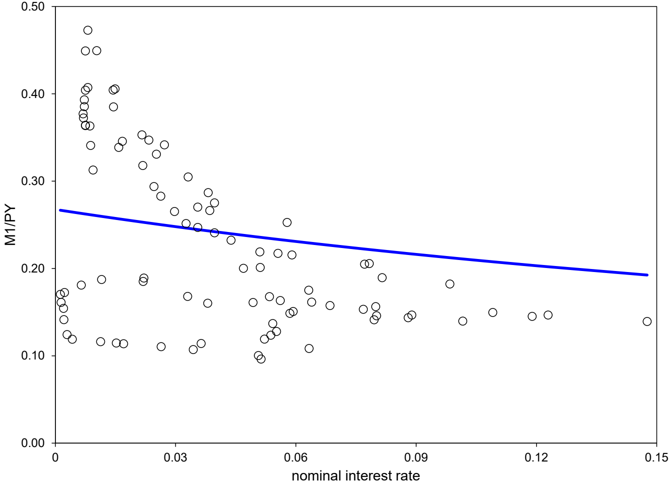
  - collateralized loan origination/GDP.

Calibrated Parameters

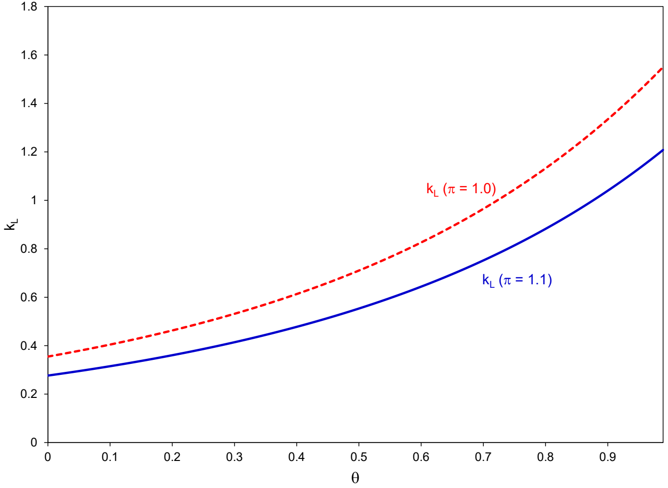
Calibrated parameters

Parameter	Value
β_H	0.97
β_L	0.89
θ	0.85
ρ	0.40
α	0.70
δ	0.07
B	2.84
σ	0.61

Money Demand Fit



k_L against θ



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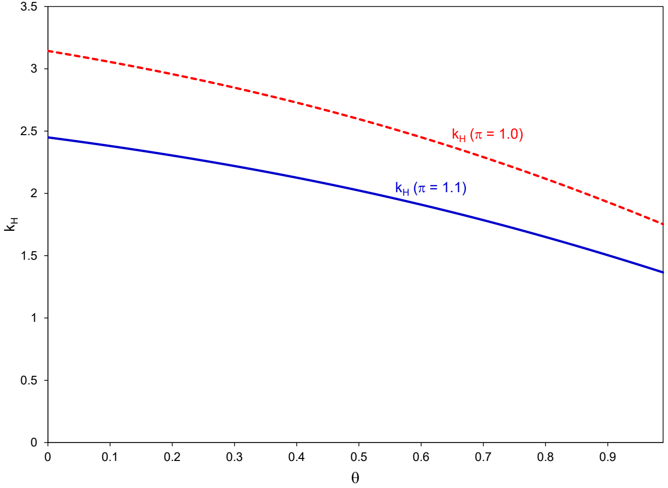


Welfare Cost of Inflation

Ex-Ante Equilibrium Welfare

Expected lifetime utility for agent of type $j = H, L$ when inflation is π:

$$(1-\beta_j)V_j(\omega_{j\pi}) = \overbrace{\frac{\sigma}{2}[u(q_{j\pi}) - q_{j\pi}]}^{\text{DM trade surplus}} + \overbrace{U(x^*) - x^*}^{\text{CM trade surplus}} + \overbrace{\frac{\sigma}{2}f(k_{j\pi}) - \delta k_{j\pi}}^{\text{return on capital}}$$

$$+ \overbrace{(\pi - 1)(\bar{m}_\pi - m_{j\pi})}^{\text{inflation tax}} - \overbrace{a_{j\pi}(1-\beta_H)}^{\text{borrowing/lending}}$$

Reduce π to γ inflation and adjust consumption by proportion $\bar{\Delta}_{j\gamma}$:

$$(1-\beta_j)V_j(\omega_{j\gamma}) = \frac{\sigma}{2}[u(\bar{\Delta}_{j\gamma}q_{j\gamma}) - q_{j\gamma}] + U(\bar{\Delta}_{j\gamma}x^*) - x^* + \frac{\sigma}{2}f(k_{j\gamma}) - \delta k_{j\gamma}$$

$$+(\gamma - 1)(\bar{m}_\gamma - m_{j\gamma}) - a_{j\gamma}(1-\beta_H)$$

Welfare Cost of π Inflation

- Standard compensating variation measure $\Delta_{j\gamma} = 1 - \bar{\Delta}_{j\gamma}$ satisfying $V_{j\pi} = V_{j\gamma}$

- If $\Delta_{j\gamma} > 0$, then the agent is indifferent between:

  π inflation, or

  γ inflation *and* consumption reduced by $\Delta_{j\gamma}$ percent

Welfare Cost of 10% Inflation: Results

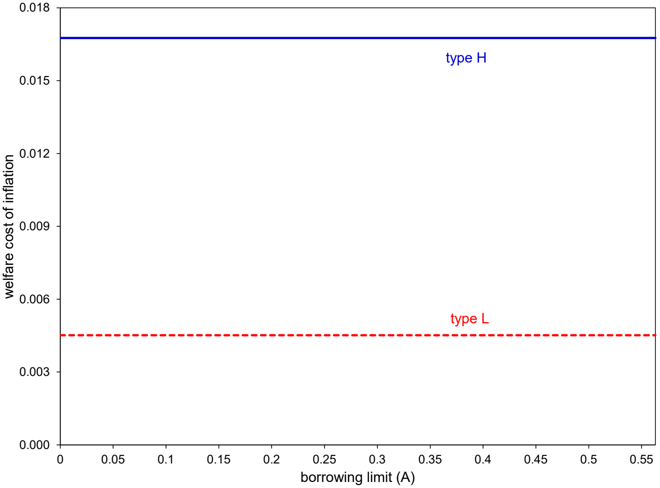
Welfare cost of 10% inflation relative to zero inflation and Friedman rule.

Model	Zero Inflation			Friedman Rule		
	Type L	Type H	Average	Type L	Type H	Average
No credit	0.45	1.68	0.94	0.53	2.27	1.23
Fixed borrowing limit	0.45	1.68	0.94	0.53	2.27	1.23
Collateralized borrowing	0.55	1.43	0.90	0.68	1.92	1.17

Uncollateralized borrowing:

1. Inflation is a progressive tax...
2. ...but expected inflation does not generate redistributive effects via the credit channel.

No Collateral Constraint



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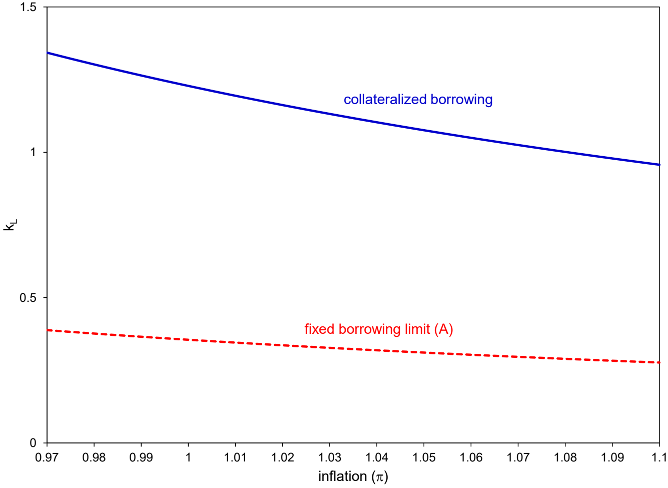
With collateral constraints:

1. Inflation still acts as a progressive tax overall...
2. ...but collateralized borrowing induces regressive redistributive effects of inflation. Why?
3. k_L more sensitive to inflation w/ collateral constraints.

k_L against π



Conclusion

- We construct a model w/ coexistence of money, capital and borrowing/lending.

- Expected inflation affects borrowing and lending when collateral constraints are present.

- When we calibrate our model using US data, we find:

1. Inflation acts as a progressive tax overall...
2. ...but the redistributive effects of inflation generated solely by collateralized borrowing are regressive. Why?
3. Borrowers' capital more sensitive to inflation when debt is collateralized.