Liquidity Trap and Excessive Leverage

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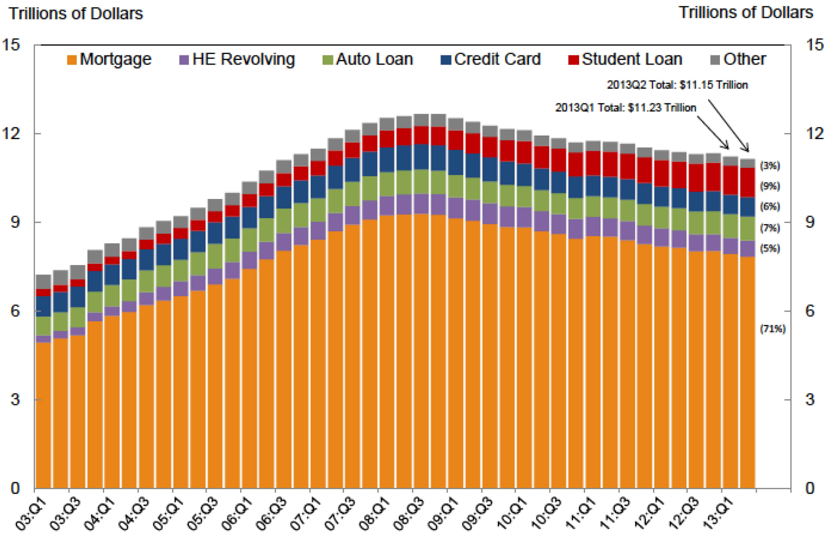
Motivation


Trillions of Dollars
Trillions of Dollars
Mortgage
HE Revolving
Auto Loan
Credit Card
Student Loan
Other
2013Q2 Total: $11.15 Trillion
2013Q1 Total: $11.23 Trillion
(3%)
(9%)
(6%)
(7%)
(5%)
(71%)
15
12
9
6
3
0
03:Q1
03:Q3
04:Q1
04:Q3
05:Q1
05:Q3
06:Q1
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08:Q1
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09:Q3
10:Q1
10:Q3
11:Q1
11:Q3
12:Q1
12:Q3
13:Q1

Motivation

Tractable model with

- tight borrowing constraints ⇒ deleveraging ⇒ liquidity trap
- borrowers endogenously accumulate leverage
- competitive equilibrium is constrained inefficient

Ex-ante macroprudential optimal policy:

- restrict *excessive leverage* before deleveraging starts
- insurance requirements

Motivation

Why constrained inefficiency?
Aggregate demand externality:

- liquidity trap ⇒ aggregate demand drops ⇒ deeper recession
- aggregage demand externality dominates *pecuniary externality* - low interest benefit for borrowers
- misallocation of wealth between borrowers and lenders

Related Literature

Borrower deleveraging lead to a decline in interest rates:

- Eggertsson and Krugman (2012), impatient borrowers and patient lenders, *ex-post*

Aggregate demand externality:

- Farhi and Werning (2013), general theory with applications to liquidity traps and currency unions

Outline

- Introduction
- Baseline model
- Policy analysis
- Two extensions

Environment

Infinite discrete time, single consumption good

Households:

- borrowers and lenders, $\beta^b \leqslant \beta^l$
- measure $\frac{1}{2}$ each

Outstanding debt:

- households choose d^h_{t+1} given initial debt d^h_0
- one period interest rate $r_{t+1} \geqslant \underline{r}_{t+1}$

Key ingredient #1

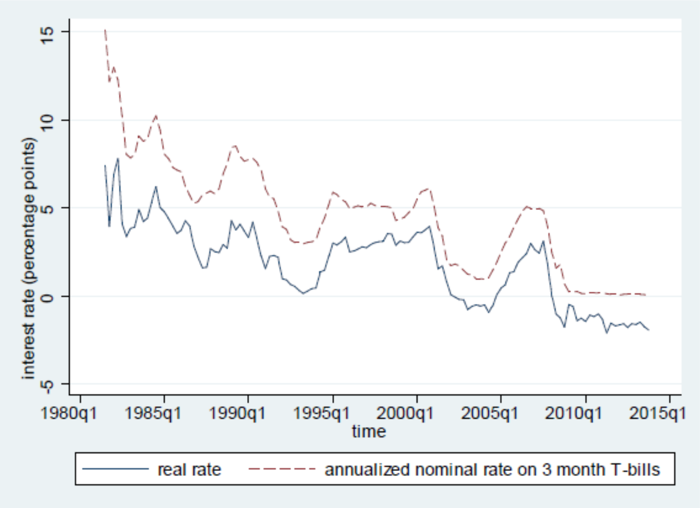
Borrowing constraints:

- date 0: Choose d_1^h without any constraint
- date 1: financial shock hits
- from date 1: $d_{t+1}^h \leqslant \phi$, ϕ exogenous
- future constraints known at time 0

Model extension in uncertainty about financial shock

Key ingredient #2

Lower bound on real interest rate (2%?):



Key ingredient #2

Exogenous lower bound on real interest rate:

- zero lower bound on nominal interest rate
- stickiness of price and inflation expectations

Normalize to zero (model extension in changing of lower bound)

Demand side

Net consumption

$$c_t^h = \tilde{c}_t^h - v\left(n_t^h\right)$$

Household's problem

$$\max_{\left\{c_t^h, d_{t+1}^h, n_t^h\right\}} \sum_{t=0}^{\infty} \left(\beta^h\right)^t u\left(c_t^h\right) \tag{1}$$

s.t.

$$c_t^h = e_t^h - d_t^h + \frac{d_{t+1}^h}{1 + r_{t+1}}$$

$$e_t^h = w_t n_t^h + \Pi_t - v\left(n_t^h\right)$$

$$d_{t+1}^h \leqslant \phi_{t+1}$$

Supply side

Linear production technology. Efficient level of net income

$$e^* \equiv \max_{n_t} n_t - v(n_t)$$

Competitive goods sector solves

$$\Pi_t = \max_{n_t} n_t - w_t n_t \tag{2}$$

subject to

$$\begin{cases} 0 \leqslant n_t & \text{if } r_{t+1} \geqslant \underline{r}_{t+1} = 0 \\ \underbrace{0 \leqslant n_t \leqslant \frac{\bar{c}_t^b + \bar{c}_t^l}{2}}_{\text{rationing constraint}} & \text{if } r_{t+1} = \underline{r}_{t+1} = 0 \end{cases}$$

solve $\bar{c}$

Equilibrium

Path of allocations $\{c_t^h, d_{t+1}^h, n_t^h, e_t^h\}$ and real prices, profit $\{w_t, r_{t+1}, \Pi_t\}$

- households solves (1)
- final good sector solves (2)
- market clear

Anticipated demand-driven recession

For decentralized equilibrium

- equilibrium labor supply n_t^h and net income e_t^h are the same for both households
- debt market clearing in equilibrium $d_t^l = -d_t^b = -d_t$
- assume constraint for real interest rate is binding

$$\frac{u'\left(2e^*\right)}{u'\left(e^* + \phi\left(1 - \beta^l\right)\right)} < \beta^l$$

Anticipated demand-driven recession

Date $t > 1$

- $d_{t+1} = \phi$, borrowers' constraint binds at all dates
- real interest rate is $r_{t+1} = \frac{1}{\beta_l} - 1$, lenders are not constrained
- $w_t = 1$
- $c_t^b = e^* - \phi\left(1 - \beta^l\right)$, $c_t^l = e^* + \phi\left(1 - \beta^l\right)$ at $t \geqslant 2$

Anticipated demand-driven recession

Date $t = 1$

- borrowers' constrained consumption $c_1^b = e_1 - \left(d_1 - \frac{\phi}{1+r_2}\right)$
- lenders' consumption $c_t^l = e_1 + \left(d_1 - \frac{\phi}{1+r_2}\right)$, absorbing slack in aggregate demand
- lenders unconstrained case $\frac{u'\left(c_1^l\right)}{\beta^l u'\left(c_2^l\right)} = 1 + r_2$
- lenders increase consumption ⇒ drop in interest rate ⇒ lower bound on real interest rate set an upper bound on lender's consumption

Anticipated demand-driven recession

Consumption upper bound given by

$$u'\left(\bar{c}_1^l\right) = \beta^l \left(1 + r_2\right) u'\left(e^* + \phi\left(1 - \beta^l\right)\right)$$

Plug $r_2 = 0$ and $\bar{c}_1^l$ into lender's consumption,

$$\underbrace{d_1 - \phi}_{\text{deleveraging}} \lesseqgtr \underbrace{\bar{c}_1^l - e_1}_{\text{lenders absorb}}$$

with $e_1 \leqslant e^*$

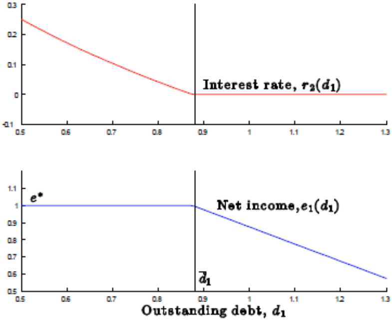
Equilibrium depends on relative size of $d_1 - \phi$ and $\bar{c}_1^l - e^*$

Anticipated demand-driven recession

$$d_1 - \phi \lesseqgtr \bar{c}_1^l - e^*$$

If LHS $<$ RHS, $r_2 > 0$ and $e_1 = e^*$
If LHS $>$ RHS, $r_2 = 0$ and $c_1 = \bar{c}_1^l$

- $e_1 = \frac{c_1^b + c_1^l}{2} = \frac{e_1 - (d_1 - \phi) + \bar{c}_1^l}{2} < e^*$, demand shortage and rationing



Anticipated demand-driven recession

Date 0 households are unconstrained, Euler equations hold

$$\frac{1}{1+r_1} = \frac{\beta^l u'\left(c_1^l\right)}{u'\left(c_0^l\right)} = \frac{\beta^b u'\left(c_1^b\right)}{u'\left(c_0^b\right)}$$

Proposition

Two conditions that triggers liquidity trap recession

- *Either borrowers are sufficiently impatient,* $\beta^b < \bar{\beta}^b\left(d_0\right)$
- *... or sufficiently indebted,* $d_0 > \bar{d}_0\left(\beta^b\right)$

Constrained inefficiency

$t = 0$, No borrowing constraint or real interest rate lower bound:

- Pareto efficient

$t \geqslant 2$, Debt limits, interest rate not binding:

- unconstrained lender can adjust price to hold FOC
- constrained Pareto efficient

$t = 1$, Debt limit ("deleveraging") and interest rate lower bound binding:

- lenders cannot adjust price to hold FOC
- constrained Pareto inefficient

Aggregate demand externality - Source of inefficiency

Consider constrained (can only change d_1) planner
Value functions:

$$V^b\left(\underbrace{d_1}_{\text{individual}}, \underbrace{D_1}_{\text{aggregate}}\right) = u\left(e_1\left(D_1\right) - d_1 + \frac{\phi}{1 + r_2\left(D_1\right)}\right) + \underbrace{\sum_{t=2}^{\infty}\left(\beta^b\right)^t u\left(c_t^b\right)}_{\text{continuation}}$$

$$V^l\left(d_1, D_1\right) = u\left(e_1\left(D_1\right) + d_1 - \frac{\phi}{1 + r_2\left(D_1\right)}\right) + \sum_{t=2}^{\infty}\left(\beta^l\right)^t u\left(c_t^l\right)$$

In equilibrium $d_1 = D_1$

Aggregate demand externality

Calculate $\frac{\partial V^h}{\partial D_1}$ for externality

When debt level is sufficiently low $(D_1 \leqslant \bar{d}_1)$ picture

- pecuniary externality dominates
- $e_1(D_1) = e^*$, output not influenced by demand
- low interest rate redistributes welfare from lenders to borrowers
- date 0 equilibrium is constrained efficient

When debt level is high $(D_1 > \bar{d}_1)$

- aggregate demand externality dominates
- liquidity trap $(r_2 = 0)$
- household net income decreasing in leverage level
- redistributes welfare from borrowers to lenders
- constrained inefficient

Policy analysis

Planner's problem

$$\max_{\left(\left(c_0^h, n_0^h\right), D_t\right)} \sum_h \gamma^h \left(u\left(c_0^h\right) + \beta^h V^h \left(D_1, D_1\right) \right)$$

s.t.

$$\sum_h c_0^h = \sum_h n_0^h - v\left(n_0^h\right)$$

Proposition

Constrained efficiency iff $e_0 = e^*$ *and one of the following*

- $D_1 < \bar{d}_1$ picture
- $D_1 = \bar{d}_1$, *distorted Euler inequality holds*

$$\frac{\beta^l u'\left(c_1^l\right)}{u'\left(c_0^l\right)} \geqslant \frac{\beta^b u'\left(c_1^b\right)}{u'\left(c_0^b\right)}$$

Extension 1: Uncertainty and underinsurance

Assume the economy in state $\{H, L\}$ from date 1 on

- H is unconstrained state similar to date 0
- L is deleveraging state with debt limit

Assume starting from date 1 $\beta^b = \beta^l$, $\beta_0^b \leqslant \beta_0^l$, $\pi_H^b \geqslant \pi_H^l$
Equilibrium:

- in state L, result like before
- in state H, jumps to good steady state
- date 0, agents insure across two states

Extension 1: Uncertainty and underinsurance

Proposition

There is a deleveraging-induced recession in state L date 1, if either

- *borrowers are sufficiently impatient*
- *sufficiently indebted*
- *sufficiently optimistic at date 0*

Planner: impose mandatory insurance (for the sake of next period demand)

Extension 2: Preventive monetary policies

Can we lean against the bubble by raising interest rate?
Extension to baseline model:

- date 0: set lower bound $\underline{r}_1$ higher than "natural" interest rate
- date 0: policy-induced recession

Extension 2: Preventive monetary policies

Raising interest rate will not decrease leverage

- temporary recession ⇒ borrowers' income drops ⇒ greater debt
- wealth transfer from borrowers to lenders, increasing debt
- these two effects dominate effect of higher interest rate

Planner: contractionary monetary policy fails

Conclusion

A tractable model which features

- interest rate fail to decline enough when borrowers have to deliver
- ... hence plunging the economy into liquidity trap
- *ex-ante* constraint inefficient

Ex-ante macroprudential policies

- debt limits, mandatory insurance requirements
- contrationary monetary policy cannot work in this setting