Tractable Heterogeneous Agents Models

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Last session

- compared HANK to RANK model
- equivalence for TFP and MP shocks under acyclical risk
- limitations:
  - constant unemployment risk
  - zero liquidity

This session

- Countercyclical risk
- Endogenous countercyclical risk
- Positive liquidity
- QE

Readings for this session

- [Ravn and Sterk, 2020] (simplified substantially)
- [Cui and Sterk, 2018] (simplified substantially)
- Material from this session is based upon Vincent Sterk's notes.
- Follow up readings:
  - [Sims and Wu, 2019] QE in the simplest possible set up.
  - [Feiveson et al., 2020] review of distributional consequences of monetary policy + analysis of makeup policy (AIT) using HANK.

Time-varying risk

- The models discussed last session featured either constant or pro-cyclical idiosyncratic earnings risk.
- Empirical studies typically find that idiosyncratic earnings risk is countercyclical.
  - countercyclical unemployment
- We now introduce (exogenous) time variation in the job loss probability and study the macro effects.

Risk shock

- Let the job loss probability be given by:

$$p_t^{eu} = \bar{p}^{eu} + z_t^{eu}$$

  where z_t^{eu} follows an AR(1) process.

- Assume that the job finding probability (p_t^{ue}) fluctuates in a perfectly correlated way, such that the unemployment rate u remains constant over time.
  - *risk shock*

Euler Equation

- The Euler equation for the employed is given by:

$$C_{e,t}^{-\sigma} = \beta \mathbb{E}_t \frac{R_t}{\Pi_{t+1}} \left(p_t^{eu} \vartheta^{-\sigma} + \left(1 - p_t^{eu}\right) C_{e,t+1}^{-\sigma} \right)$$

- Two sources of risk:
  - Endogenous, procyclical (earnings loss falls in recessions, see last session)
  - Exogenous: time-varying job loss probability (countercyclical)

Euler Equation

- Log-linearize the Euler equation:

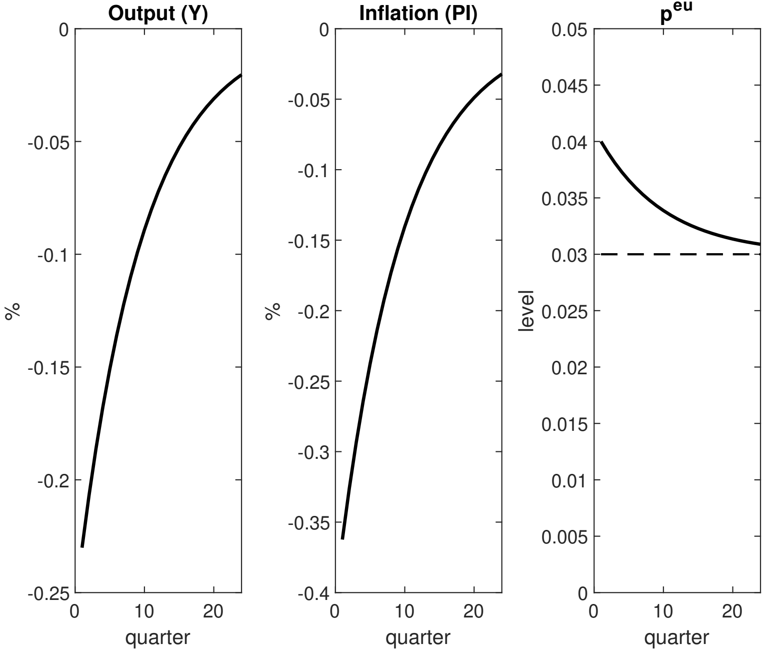
$$-\sigma \widehat{C}_{e,t} + \sigma \beta \bar{R} \left(1 - \bar{p}^{eu}\right) E_t \widehat{C}_{e,t+1} - \beta \bar{R} \left(\left(\frac{\vartheta}{C_e} \right)^{-\sigma} - 1 \right) \bar{p}^{eu} \widehat{p}_t^{eu} = \widehat{R}_t - E_t \widehat{\Pi}_{t+1}$$

- Shock introduces an exogenous, time-varying wedge in the Euler equation.
- Shuts down when it is the case that in the steady state:
  - there is no unemployment risk ($\hat{p}^{eu} = 0$), or
  - households are perfectly insured against unemployment ($\theta = C_e$)

Implications?

- No effect on determinacy.
- No effects on responses to TFP shocks, monetary policy shocks, etc. (to 1st order approx)
- One extra shock, observationally equivalent to discount factor shock (shock to β)

Response to a Risk Shock



Risk Shock

Intuition:

- higher unemployment risk
- stronger precautionary saving motive
- demand for saving $\uparrow$
- demand for goods $\downarrow$, inflation $\downarrow$
- aggregate output $\downarrow$ (sticky prices)

Endogenous countercyclical risk

- Ad hoc relation between output and job loss probability:

$$\frac{p_t^{eu}}{p^{eu}} = \left(\frac{Y_t}{Y}\right)^{\zeta}$$

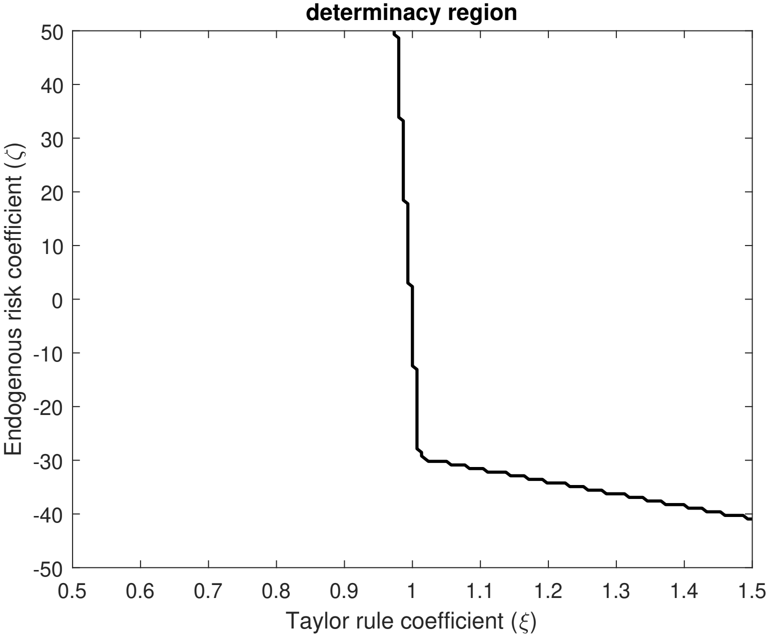
Will set $\zeta = -20$ in simulations.[1]

- Euler Equation

$$\left(-\sigma + \beta\bar{R}\left(\left(\frac{\vartheta}{C}\right)^{-\sigma} - 1\right)\bar{p}^{eu}\zeta\right)\widehat{Y}_t + \sigma\beta\bar{R}\left(1 - \bar{p}^{eu}\right)E_t\widehat{Y}_{t+1} = \widehat{R}_t - E_t\widehat{\Pi}_{t+1}$$

[1] Negative values are more interesting as in a recession the endogenous risk increases. In this case the Central Bank has got an extra motive to respond strongly to inflation.

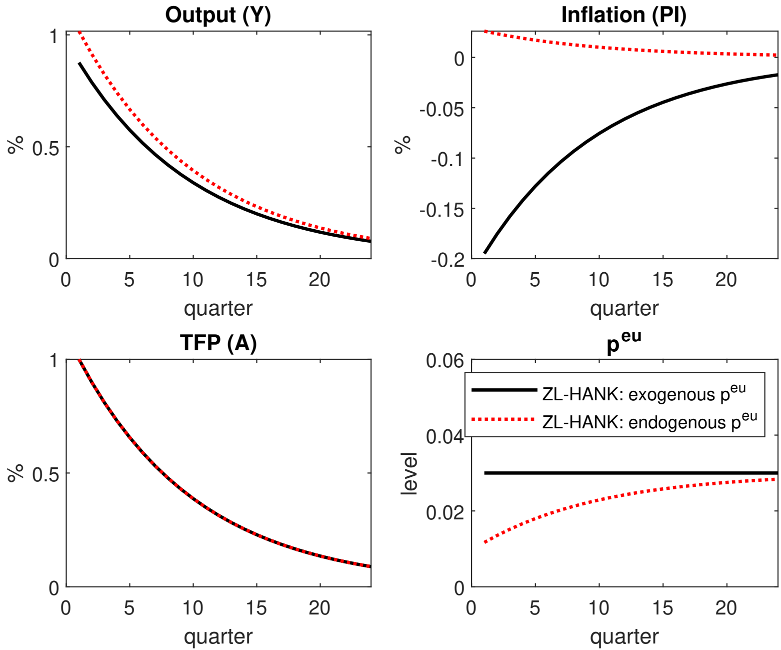
Determinacy



Determinacy

- When earnings risk is procyclical, the intended steady-state is locally determinate subject to the Taylor principle.
- Countercyclical earnings risk implies that local indeterminacy can arise even when the "Taylor Principle" is satisfied.
- Intuitively, monetary policy must not only rule out local indeterminacy due to nominal rigidities, but also address the demand-supply interaction.

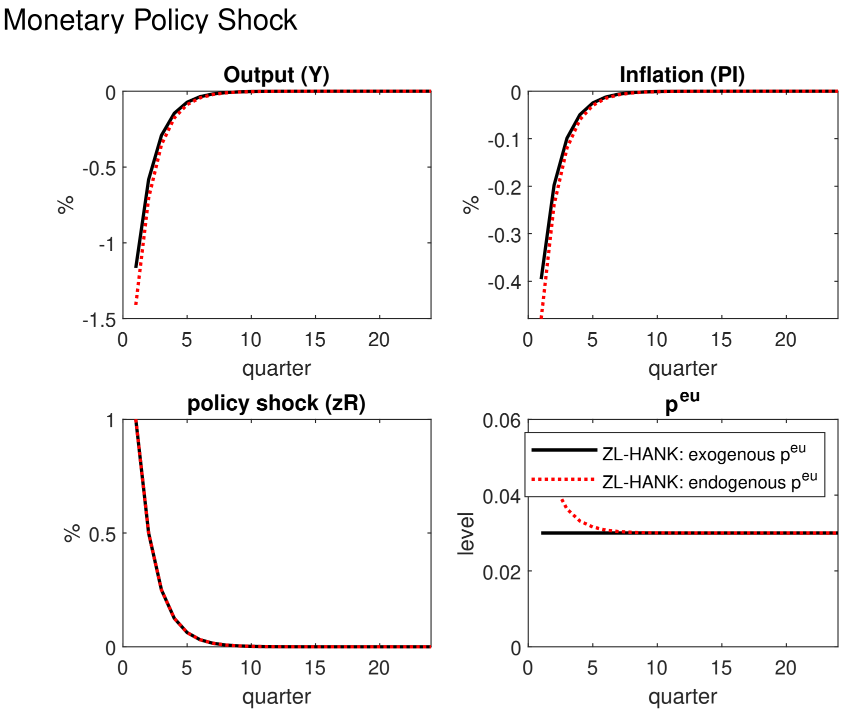
Productivity Shock



Productivity Shock: Intuition

Demand effect (decrease in the precautionary savings motive) dominates and so inflation increases:

- Productivity $\uparrow$
- aggregate output and income $\uparrow$, inflation $\downarrow$
- job loss probability $\downarrow$
- precautionary saving motive $\downarrow$
- aggregate demand $\uparrow$, inflation $\uparrow$
- aggregate output and income $\uparrow$
- job loss probability $\downarrow$
- etc...
- Countercyclical earnings risk introduces an amplification mechanism, due to a demand-supply side interaction.


Monetary Policy Shock
Output (Y)
Inflation (PI)
policy shock (zR)
p^eu
%
level
quarter
0
-0.5
-1
-1.5
-0.1
-0.2
-0.3
-0.4
1
0.5
0.06
0.04
0.02
5
10
15
20
ZL-HANK: exogenous p^eu
ZL-HANK: endogenous p^eu

Monetary Policy Shock

- Countercyclical risk makes monetary policy shocks more powerful.

- the systematic component of monetary policy becomes more important as it can counteract the amplification mechanism, by cutting interest rates when demand is low and earnings risk is high.

Search and Matching frictions

- They way we have introduced countercylical income risk is obviously ad hoc.
- [Ravn and Sterk, 2020] model endogenous risk in a more micro-founded way by introducing search and matching frictions in the labor market.
- See their paper for details also on adding capital accumulation. All replication codes available on the EEA members area and I believe will be publicly available on the OUP website once the paper is published.
- Here we will skip this but I will just summarize the main takeovers.

Steady states

- Consider a version of the model without any aggregate shocks.
- An important difference with complete-markets NK literature is that although aggregate variables are constant in the steady state, the labor market participants still face idiosyncratic risk due to lack of insurance against earnings risk.
- The solution for the steady-state wage can be expressed as function of the job finding rate , $w(\eta)$ (see appendix in Ravn and Sterk).
- Model summary:

$$\phi(1-\beta)(\Pi-1)\Pi = 1-\varepsilon+\varepsilon\left(w(\eta)+\left(\kappa\eta^{\alpha/(1-\alpha)}-\lambda_v\right)(1-\beta(1-\omega))\right), \quad \text{(PC)}$$

$$1 = \beta\frac{\max\left\{\bar{R}\Pi^{\xi},1\right\}}{\Pi}\Theta^{SS}(\eta), \quad \text{(EE)}$$

where

$$\Theta^{SS}(\eta) \equiv 1+\omega(1-\eta)\left[(\vartheta/w(\eta))^{-\sigma}-1\right] \geq 1$$

- Endogenous risk wedge in the Euler, new term that arises due to incomplete markets.
- Its going to collapse to 1 in two cases, if job finding rate equal 1 ot if $\theta = w$ and if $\sigma = 1$.

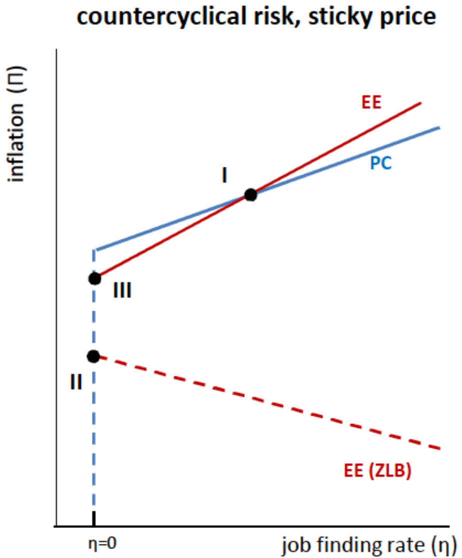
Steady states

- PC and EE can both be considered as defining a relationship between the job finding rate η and the inflation rate Π and the steady-state equilibria relate to the intersections of these relationship.
- PC defines a + relationship between Π and η.
  - high job finding rates imply low vacancy filling rates and higher wages, as the competition for workers intensifies. this increases marginal costs and hence prices.
- EE also defines a relationship between Π and η. The slope of it will be crucial for the steady-state equilibria and model's properties.
- Slope depends on
  1. Whether $\Theta^{SS}(\eta)$ is increasing or decreasing in η, which in turns depends on the cyclicality of earning risk.
  2. Whether or not the ZLB on the nominal interest rate binds.

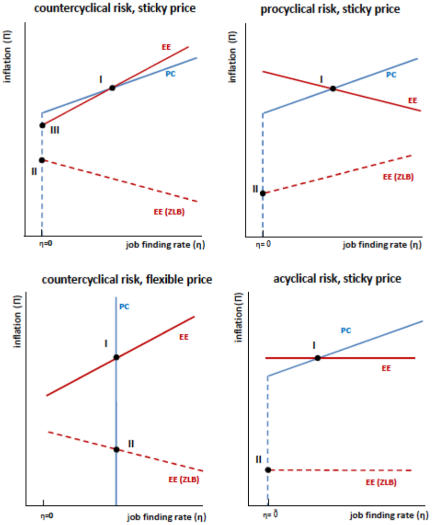
EE slope

- When wages are unresponsive to the job finding rate, ($w'(\eta) = 0$), earnings risk is countercyclical and $\Theta^{SS}(\eta)$ is decreasing in η.
- When jobs are easier to find, employed workers have less reason to save for precautionary reasons, as unemployment is less likely.
- When wages are sufficiently elastic ($w'(\eta) >> 0$), overall earnings risk becomes procyclical and $\Theta^{SS}(\eta)$ is increasing in η.
- While the slope of EE schedule depends on $\Theta^{SS}(\eta)$, the sign of the slope reverses under a binding ZLB.

Steady states



Steady states



I: intended steady state

II: liquidity trap

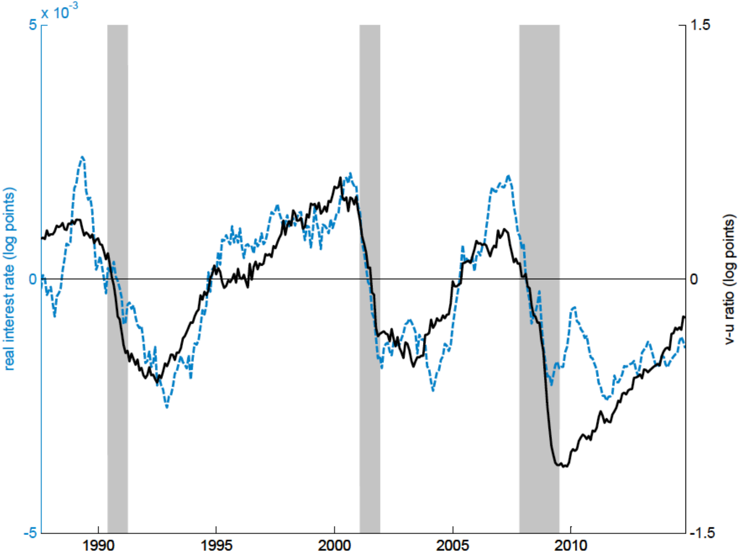
III: unemployment trap

Unemployment Trap

- The possible emergence of a third steady state depends critically on the interaction between countercyclical risk and sticky prices.
- The unemployment trap can arise in the presence of both sticky prices and countercyclical risk, and its likelihood is higher when monetary policy reacts little to inflation and/or labor market tightness, and hiring costs are limited.
- This steady state arises when endogenous risk is sufficiently countercyclical, so that expectations of poor labor market conditions trigger such an increase in desired savings that the economy spirals towards an equilibrium in which firms anticipate that posting vacancies is pointless because of lack of demand for their goods.
- For this to be possible, endogenous risk must be sufficiently countercyclical that the Euler equation schedule becomes steeper than the Phillips curve schedule.

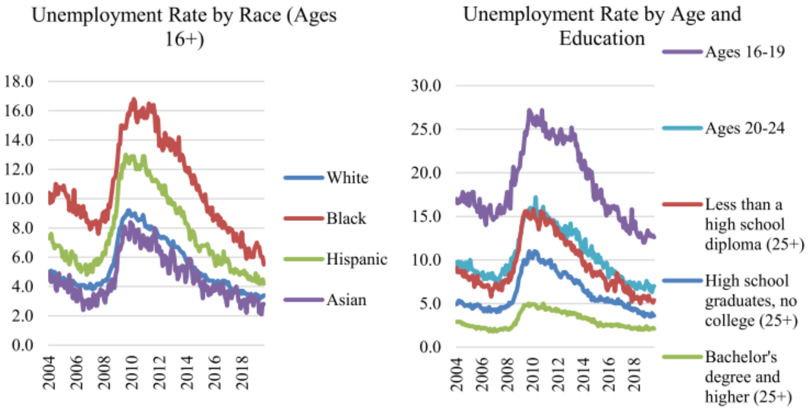
Empirical Perspective: Is income-risk pro- counter- or a-cyclical?

People really want to save in recession. Because that is when is more likely that you loose your job.



[Feiveson et al., 2020]

Figure 1: Unemployment Rates by Race and by Age and Education, 2004–19



Note: All rates are seasonally adjusted.
Source: U.S. Bureau of Labor Statistics, Employment Situation, http://stats.bls.gov/news.release/pdf/empsit.pdf.

Taking stock

- Endogenous cyclicality of idiosyncratic risk key determinant of the impact of heterogeneity on aggregate fluctuations.
- Countercyclical risk appears most plausible from an empirical perspective.
- Under countercyclical endogenous risk we obtain a feedback between aggregate demand and idiosyncratic risk:
  - additional steady state: ”unemployment trap”
  - amplification of shocks
  - potentially indeterminacy, even when Taylor Principle is satisfied (see the paper).
- Results potentially even stronger when introducing physical capital (see the paper).

Positive Liquidity

- So far we have analyzed models with zero liquidity
  - tractability
- Now introduce positive liquidity
  - must keep track of the distribution of wealth
- [Cui and Sterk, 2018]: can still solve very easily as long as the amount of liquidity is not too high
  - realistic for e.g. U.S. where households on average hold very little liquidity
  - can start thinking about liquidity policy (QE)

Positive Liquidity

- Explore how much the introduction of positive liquidity matters.
- Same model as before without labor market frictions
  - households decide on labor supply when employed; produce at home when unemployed
  - no borrowing: $B_t(i) \geq 0$, $i \in [0, 1]$
- Aggregate amount of liquid assets now given by $\bar{B} > 0$
  - $\bar{B}$ is liability to the government, kept constant over time
  - government budget constraint:

$$\frac{R_{t-1}}{\Pi_t}\bar{B} = \bar{B} + T_t$$

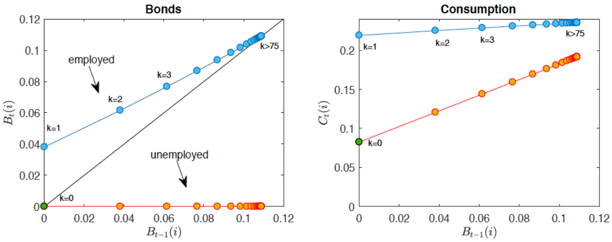
  where T_t is a lump sum tax paid by all agents.
- If $\bar{B}$ is sufficiently low you can still solve this model easily.

Model equations

$$
\begin{aligned}
C_t^{-\sigma}(i) &\geq \beta \mathbb{E}_t \frac{R_t}{\Pi_{t+1}} C_{t+1}^{-\sigma}(i), i \in [0,1] \\
\kappa N_t(i)^{\varphi} &= \mathbf{1}_t^e(i) w_t C_t(i)^{-\sigma}, i \in [0,1] \\
C_t(i) + B_t(i) &= \mathbf{1}_t^e(i) \left(w_t N_t(i) + \frac{Div_t}{1-u} \right) + \left(1 - \mathbf{1}_t^e(i)\right) \vartheta + \frac{R_{t-1}}{\Pi_t} B_{t-1}(i) - T_t, i \in [0,1] \\
B_t(i) &\geq 0, i \in [0,1] \\
\int_0^1 B_t(i) di &= \bar{B} \\
T_t &= \frac{R_{t-1}}{\Pi_t} \bar{B} - \bar{B} \\
R_t &= z_t \bar{R} \left(\Pi_t\right)^{\xi} \\
1 - \varepsilon + \varepsilon \frac{w_t}{A_t} &= \phi \left(\Pi_t - 1\right) \Pi_t - \phi \mathbb{E}_t \beta \frac{Y_{t+1}}{Y_t} \left(\Pi_{t+1} - 1\right) \Pi_{t+1} \\
Div_t &= \left(A_t - w_t\right) N_t - \phi \left(\Pi_t - 1\right)^2 Y_t \\
Y_t &= A_t N_t \\
N_t &= \int_0^1 N_t(i) di
\end{aligned}
$$

Moderate Liquidity: tractability

- Let $k = 0$ denote households unemployed for at least one period and $k = 1, 2, ...$ be households employed for precisely k periods.
  - Let $\psi_{k,t}$ denote corresponding population shares.
- Suppose aggregate liquidity is positive but not too large. Upon job loss, households spend all their wealth and hit the borrowing constraint. Decision rules (illustration):



Moderate Liquidity: tractability

- At some point (about $k \approx 20$ in this case) employed have accumulated enough precautionary savings
- If you become unemployed you eat all your savings in the first quarter.
- Everyone moving from unemployment to employment will make the same decision, $k = 1$, the same for who has been employed for $k = 2$.... so we just need to keep track of k's
- The more assets you had accumulated the higher will be your consumption once you become unemployed.

Moderate Liquidity: tractability

- Need to check that all unemployed eat all the savings. Otherwise you cannot assume that everyone coming out of unemployment will be the same.

- The following condition must be satisfied

$$\left(C_{k=0}^{-\sigma} + \frac{R}{\Pi}\bar{B}\right)^{-\sigma} > \beta \frac{R}{\Pi}\left(\left(1 - p^{ue}\right)\vartheta^{-\sigma} + p^{ue} C_{k=1}^{-\sigma}\right)$$

- means $\bar{B}$ cannot be too large

- The condition states that upon job loss, even the richest agent will spend all liquid assets within the first quarter of unemployment, and hit the borrowing constraint.

  - every unemployed household exactly the same at the end of the period (zero liquid assets; borrowing-constrained)

  - every household which has been employed for exactly $k = 1; 2; 3, ..$ periods makes exactly the same choices

  - can keep track of "cohorts" of employed agents

Moderate Liquidity

Write the model as:

$$
\begin{aligned}
C_{k=0,t} &= \vartheta - T_t \\
B_{k=0,t} &= 0 \\
C_{k,t}^{-\sigma} &= \beta \mathbb{E}_t \frac{R_t}{\Pi_{t+1}} \left(p^{eu} \left(C_{k=0,t+1}^{-\sigma} + \frac{R_t}{\Pi_{t+1}} B_{k,t} \right)^{-\sigma} + \left(1 - p^{eu}\right) C_{k+1,t+1}^{-\sigma} \right), \quad k = 1, 2, 3, \ldots \\
\kappa N_{k,t}^{\varphi} &= w_t C_{k,t}^{-\sigma}, \quad k = 1, 2, 3, \ldots \\
C_{k,t} + B_{k,t} &= w_t N_{k,t} + \frac{Div_t}{1 - u} + \frac{R_{t-1}}{\Pi_t} B_{k-1,t-1}(i) - T_t, \quad k = 1, 2, 3, \ldots \\
\sum_{k=0}^{\infty} B_{k,t} \psi_k &= \bar{B} \\
\sum_{k=1}^{\infty} N_{k,t} \psi_k &= N_t \\
T_t &= \frac{R_t}{\Pi_t} \bar{B} - \bar{B} \\
R_t &= z_t \bar{R} \left(\Pi_t\right)^{\xi} \\
1 - \varepsilon + \varepsilon \frac{w_t}{A_t} &= \phi \left(\Pi_t - 1\right) \Pi_t - \phi \mathbb{E}_t \beta \frac{Y_{t+1}}{Y_t} \left(\Pi_{t+1} - 1\right) \Pi_{t+1} \\
Div_t &= \left(A_t - w_t\right) N_t - \phi \left(\Pi_t - 1\right)^2 Y_t \\
Y_t &= A_t N_t
\end{aligned}
$$

Moderate Liquidity

Truncate at a sufficiently high level of $k = K$. Write the household block as:

$$C_{k=0,t} = \vartheta - T_t$$
$$B_{k=0,t} = 0$$
$$C_{k,t}^{-\sigma} = \beta \mathbb{E}_t \frac{R_t}{\Pi_{t+1}} \left(p^{eu} \left(C_{k=0,t+1}^{-\sigma} + \frac{R_t}{\Pi_{t+1}} B_{k,t} \right)^{-\sigma} + (1 - p^{eu}) \, C_{k+1,t+1}^{-\sigma} \right), k = 1, 2, .., K - 1$$
$$\kappa N_{k,t}^{\varphi} = w_t C_{k,t}^{-\sigma}, \quad k = 1, 2, 3, \ldots, K - 1$$
$$C_{k,t} + B_{k,t} = w_t N_{k,t} + \frac{Div_t}{1-u} + \frac{R_{t-1}}{\Pi_t} B_{k-1,t-1}(i) - T_t, \quad k = 1, 2, 3, .., K - 1$$
$$C_{k,t}^{-\sigma} = \beta \mathbb{E}_t \frac{R_t}{\Pi_{t+1}} \left(p^{eu} \left(C_{k=0,t+1}^{-\sigma} + \frac{R_t}{\Pi_{t+1}} B_{k,t} \right)^{-\sigma} + (1 - p^{eu}) \, C_{k+1,t+1}^{-\sigma} \right), \quad k = K$$
$$\kappa N_{k,t}^{\varphi} = w_t C_{k,t}^{-\sigma}, \quad k = K$$
$$C_{k,t} + B_{k,t} = w_t N_{k,t} + \frac{Div_t}{1-u} + \frac{R_{t-1}}{\Pi_t} B_{k,t-1}(i) - T_t, \quad k = 1, 2, 3, .., K$$
$$\sum_{k=0}^{\infty} B_{k,t} \psi_k = \bar{B}$$
$$\sum_{k=1}^{\infty} N_{k,t} \psi_k = N_t$$

Only difference is that the savings of K co-hort are the same as previous one.

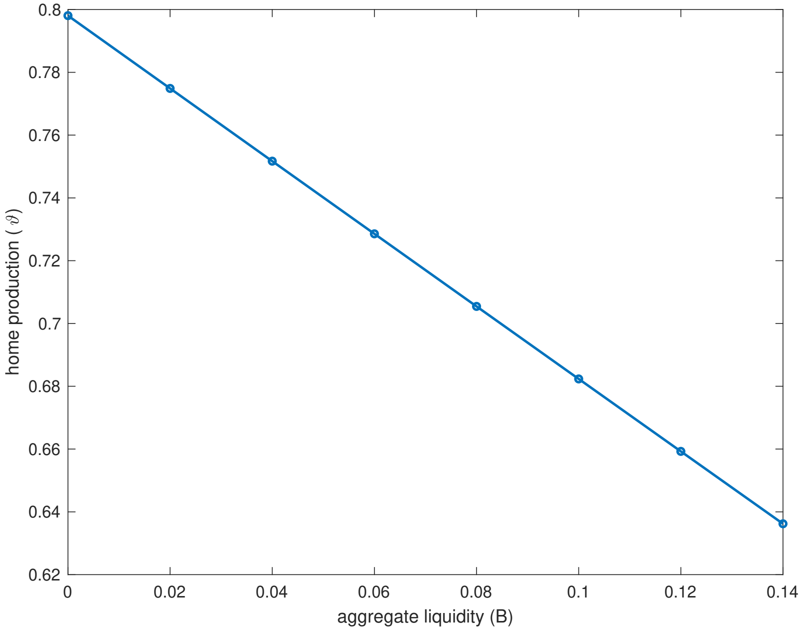
Dynare code (household block)

```
// unemployed >= 1 quarter
C_0 = theta - T;
B_0 = 0;
N_0 = 0;
// Employed agents and newly unemployed agents (by employment duration)
@#for k in 1:K-1
C_@{k}^(-sig) = beta * R / PI(+1)*(peu*(C_0(+1) + B_@{k}*R/PI(+1))^(-sig)
+ (1-peu)*C_@{k+1}(+1)^(-sig));
w*C_@{k}^(-sig) = kappa*N_@{k}^phi;
C_@{k} + B_@{k} = w*N_@{k} + B_@{k-1}(-1)*R(-1)/PI + Div/(1-u) - T;
@#endfor
C_@{K} + B_@{K} = w*N_@{K} + B_@{K}(-1)*R(-1)/PI + Div/(1-u) - T;
C_@{K}^(-sig) = beta * R / PI(+1)*(peu*(C_0(+1) + B_@{K}*R/PI(+1))^(-sig) +
(1-peu)*C_@{K}(+1)^(-sig));
w*C_@{K}^(-sig) = kappa*N_@{K}^phi;
// market clearing liquid assets
Bbar = @#for k in 1:K
+ B_@{k}*psi_@{k}
@#endfor;
// market clearing labor
N = @#for k in 1:K
+ N_@{k}*psi_@{k}
@#endfor;
```

Calibration

- We now compare outcomes in the model for different levels of aggregate liquidity (including zero liquidity)
- Each time we target:
  - aggregate s.s. labor supply at $N = 1 - u$
  - the s.s. inflation rate at $\Pi = 1$
  - the s.s. at $R = \bar{R} = 1.01^{1/4}$
- For this purpose we use the parameters $\bar{\Pi}$, κ and ϑ

Liquidity vs insurance

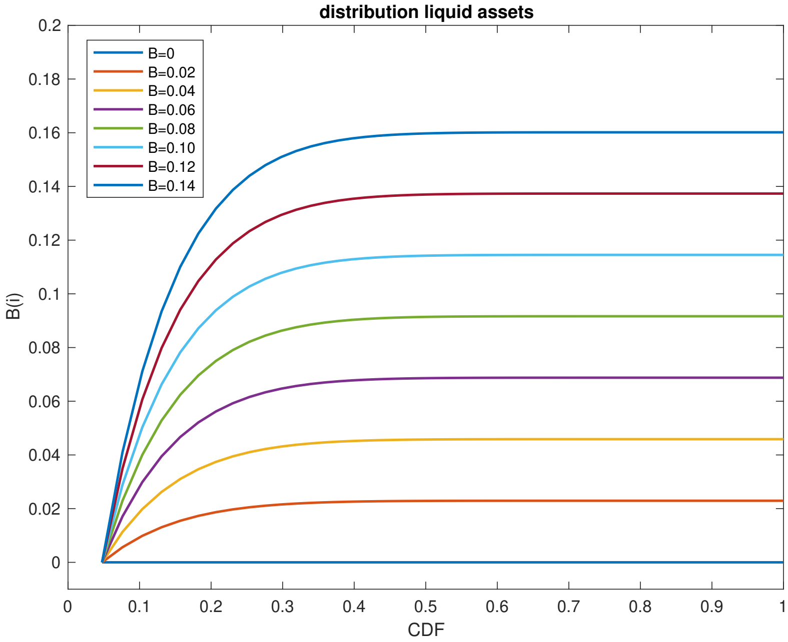


Distribution of liquidity

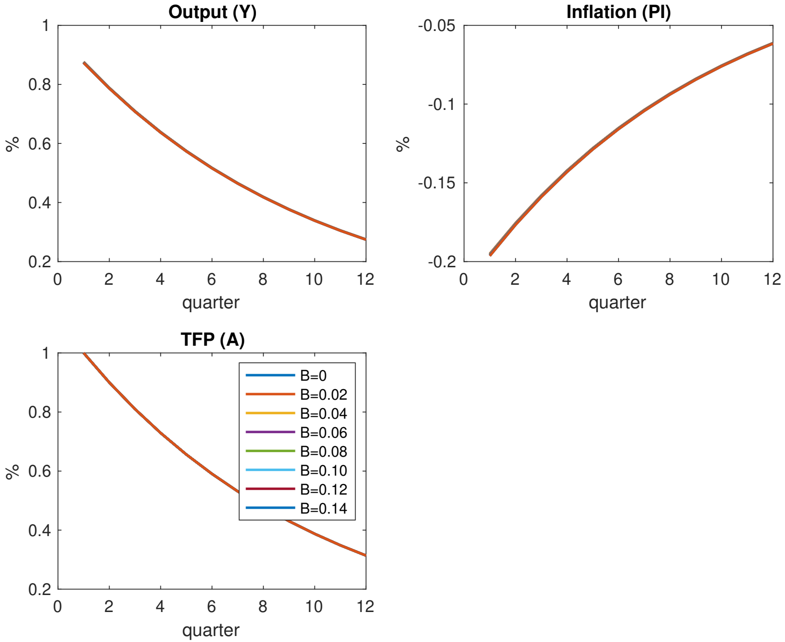
- If there is liquidity there is higher self insurance for households so they can accumulate higher savings for when they get unemployed.

- This would push down the steady state interest rate therefore you need less home production to keep the interest rate at the usual value

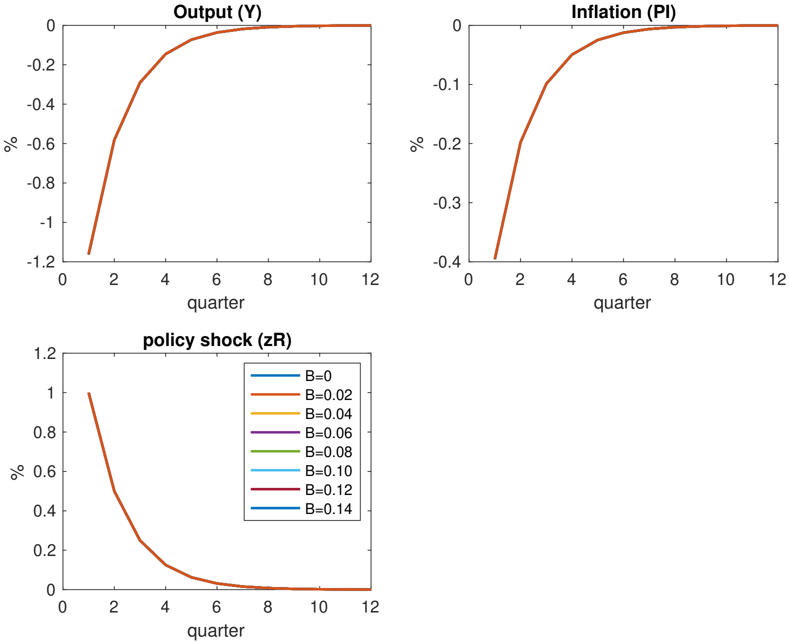
Liquidity vs insurance



Productivity Shock



Monetary Policy Shock



Summary so far

How do household heterogeneity and incomplete markets - to a first order - alter aggregate responses to TFP and conventional MP shocks?

- MPC heterogeneity? X
- Reduced ”forward-lookingness” X
- Dynamics of the wealth distribution? X
- Cyclicality of endogenous risk ✓

Why?

Positive Liquidity

- We just explored the importance of amount of liquidity but **kept it constant over time**.
- Let's now move beyond ZL-HANK and look at fluctuations in liquidity.
  - Shocks to the borrowing limit.
  - Aggregate liquidity policy (QE).

Liquidity shocks

- So far we kept the borrowing limit fixed. We now explore the effects of shocks to the borrowing limit (see also [Guerrieri and Lorenzoni, 2017]).

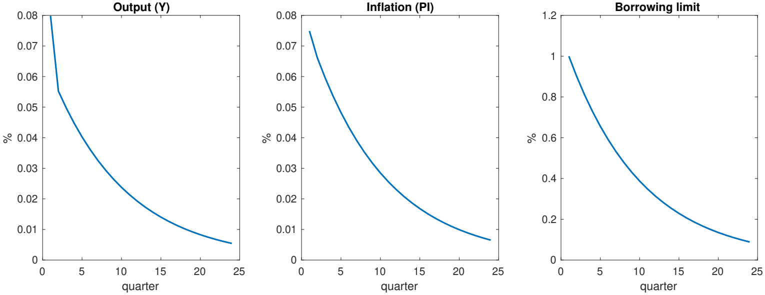
- Generalize the liquidity constraint to:

$$B_t(i) \geq \underline{B}_t,$$

  where $\underline{B}_t$ is a time-varying borrowing limit, which we assume follows an AR(1) process.

- Explore macroeconomic effects of a liquidity shock. Using the same calibration as before. For simplicity we start from$\underline{B} = 0$ in the steady state. This implies that sometimes the limit will be + and sometimes -.

Liquidity Shock



Liquidity policy

- Suppose now that the central bank has a way of determining $\underline{B}_t$ and vary it systematically over the business cycle. Could this be a stand-in for conventional interest rate policy?

- Suppose the central bank sets the borrowing limit according to the following rule:

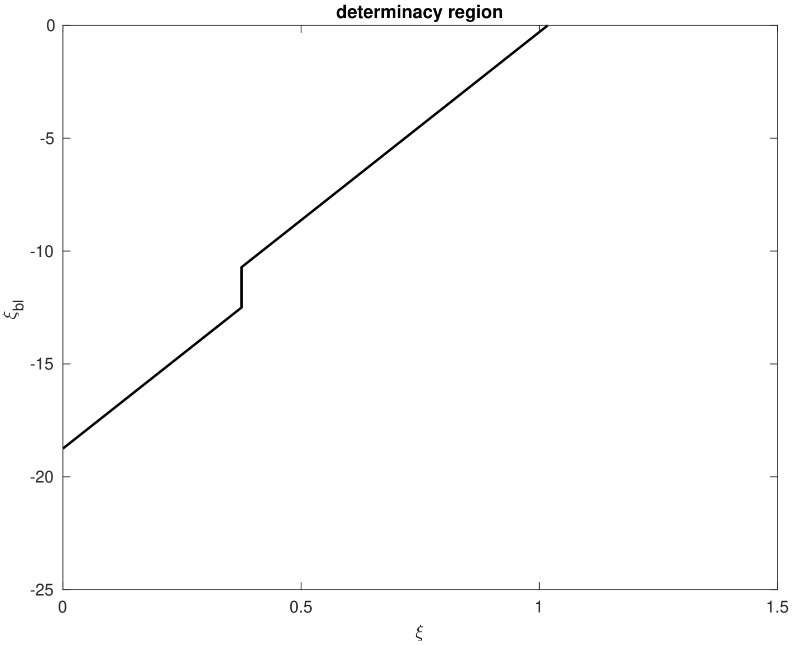
$$-\underline{B}_t = -\underline{B} + \xi_{bl}\left(\Pi_t - 1\right)$$

  where $\xi_{bl} \leq 0$.

- In addition, the central bank can vary in the nominal interest rate.

- Let's explore the determinacy, varying ξ_{bl} as well as the interest rate coefficient ξ.

Liquidity policy



QE

- We have seen that in a HANK model variations in liquidity, – via the borrowing limit – can have important effects at the aggregate level.
- Another way in which the central bank could affect liquidity is to buy up relatively illiquid assets, financed by selling liquid assets. (Quantitative Easing (QE))
- We now (briefly) summarize the effects of QE in this set up.
  - See [Cui and Sterk, 2018] for all the details.
  - Even if tractable the model will feature richer wealth inequality than so far
  - Crucial is the distinction between liquid and illiquid assets.

Questions

- How **effective** is QE?
  - How does it transmit to the macro economy?
  - Is it a good replacement for conventional monetary policy?
  - Did it dampen Great Recession, and if so by how much?
- How **desirable** is QE?
  - How does it affect inequality?

Theory

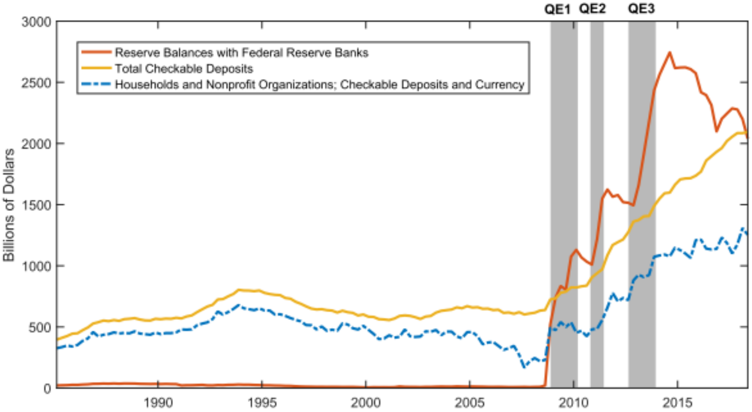
- [Wallace, 1981] $\rightarrow$ Strong neutrality result: open market operations have no effects on the price level and real outcomes.
- This results break down in HANK if...

Empirics

- [Carpenter et al., 2015]: Central bank buys long-term government debt from mutual funds $\rightarrow$ deposit creation. (flow of funds data).
- Mutual funds do not hold on deposits (and cannot directly hold deposits with the FED).
  - To the mutual funds deposits offer low returns, but no liquidity advantage.
  - Mutual funds therefore use the deposits to buy new assets. [Goldstein et al., 2018]
  - Deposits flow to households, who value liquidity for self-insurance reasons. (Flow of funds)
- Increased household liquidity stimulates aggregate demand (high MPC out of liquid wealth). [Fagereng et al., 2018][Fagereng et al., 2019]

QE in the US

Source: Cui and Sterk (2018) using Flow of Funds data



Aggregate demand: a simple formula

- Aggregate consumption demand: $C = (L, I, \Gamma)$
- Effect of QE on aggregate demand:

$$\frac{\partial C}{\partial QE} = \underbrace{MPC^I - MPC^L}_{direct\ \ effect} + \underbrace{GE}_{indirect\ \ effect}$$

- Empirical studies: $MPC^L = 63\%$ ([Fagereng et al., 2018]), $MPC^I = 9\%$ ([Maggio et al., 2018]).
- increase in deposits held by household following QE: 5% of GDP $\rightarrow$ direct effect = 2.7% of GDP

Cui Sterk (2018) model in one slide

- HANK with incomplete markets as before +
  - **Households** hold assets with different degrees of liquidity and returns (*deposits* vs *mutual funds wealth*).
  - **Mutual funds** own firm equity shares + long term government debt. They hold no deposits and replace debt sold to the central bank with newly issued debt.
  - **Banks** provide deposits to households, backed by reserves at the central bank.
  - **Government** targets a constant real level of debt.
  - **Central Bank** issues reserves, control the nominal interest rate but can also buy long-term government debt from mutual funds.
    - two models: one with conventional Taylor rule and the other with fixed R and QE.

Cui Sterk (2018) model tractability

- Making the model tractable now involves two steps.

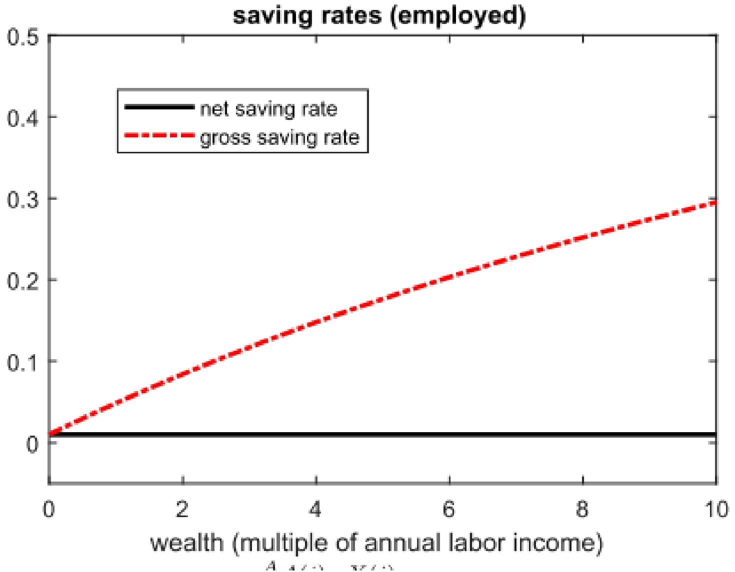
  1. Exploit limited liquidity to keep track of distribution of liquid wealth (as before).

  2. Calibration implies no limit to the distribution of mutual funds wealth. This can therefore be dropped as an economic state variable even though it moves endogenously over time.

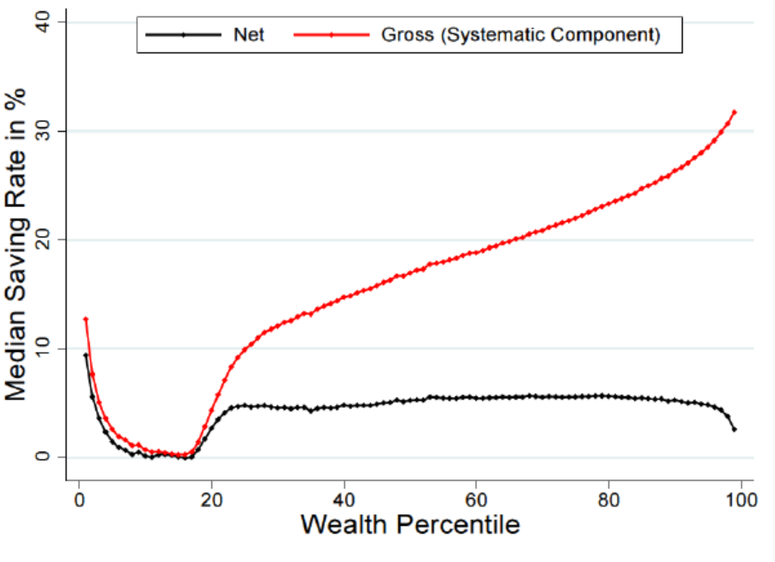
     - The disconnect between the withdrawal decision of illiquid wealth and the level of wealth has direct cross-sectional implications which can be compared to the data. In particular, it implies that gross saving rates (i.e. including capital gains) are increasing in wealth, as households save capital gains rather than spending them.

Saving by holding

Source: Cui and Sterk (2018)



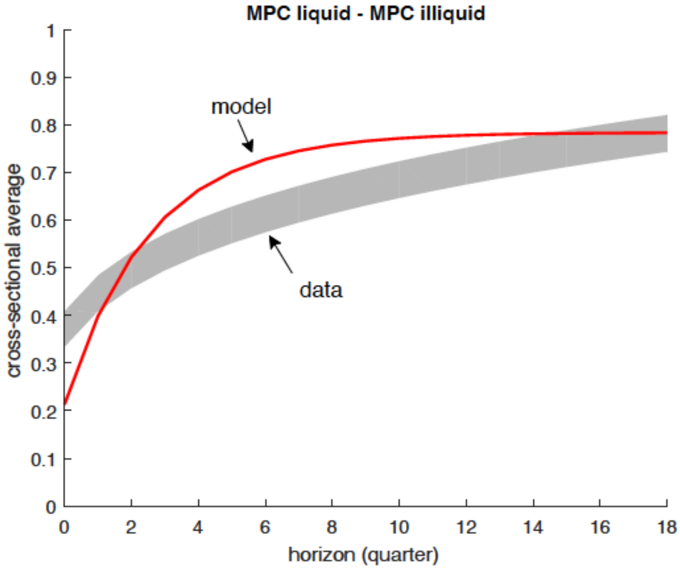
Saving by holding



Source: Fagereng et al. (2019).

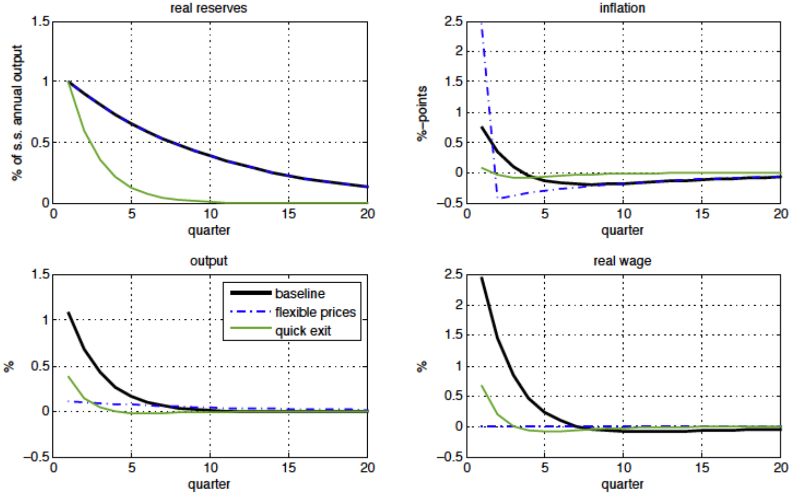
MPC

Source: Cui and Sterk (2018)



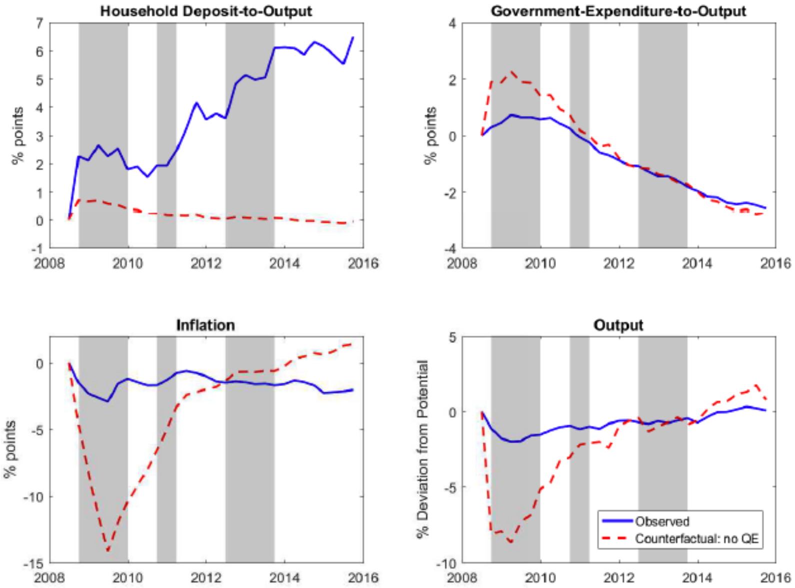
The effects of a QE shock

Source: Cui and Sterk (2018)



QE since the Great Recession

Source: Cui and Sterk (2018)



QE vs conventional MP policy

- QE better at
  - Anchoring expectations (as we saw with the simple liquidity policy before)
  - Stabilize business cycle (because it generates a co-movement between Y and Π due to AD effects)
- QE has **strong side effects** when it comes to welfare.
  - When CB create deposits it varies the extent to which households can insure themselves against idiosyncratic income risk.
  - Welfare costs of periods of low insurance insurance are relatively large (dominate gains from period of high insurance).
  - Generates stronger fluctuations in consumption inequality.

Tanking stock

- Time varying liquidity has strong implications in HANK.
- One can study the effects of QE in a model with moderate liquidity and liquid and illiquid wealth.
- QE emerges as a very effective macro stabilization tool...
  - The Great Recession would have been much deeper without QE
  - anchors expectations under wide range of parameters
  - policy trade-off eased by more positive co-movement between output and inflation
- ... but it comes with strong side effects which tend to lower welfare.
  - time-varying scope for self insurance is costly inflation

[Feiveson et al., 2020]

Table 2: Main Redistributive Effects of Looser Monetary Policy

	Working-Age Households	Retirees
Low Income	(+) Less unemployment and higher labor earnings (+) Lower real interest on consumer loans and student debt (+) Higher inflation decreases the real value of outstanding nominal debt (-) Cost of living increases relative to those with higher incomes	(-) Cost of living increases relative to those with higher incomes
Middle Income	(+) Capital gains on housing assets and retirement savings due to lower real interest rates (+) Higher inflation decreases the real value of outstanding nominal debt (+) Lower real interest rates on mortgages and consumer loans	(-) Lower interest income
High Income	(+) Higher business income (-) Lower interest income (+) Capital gains on financial wealth due to lower real interest rates (-) Higher inflation decreases real asset values	

Source: Authors' calculations.

Codes for this session

- Folder endogenous risk: reproduces the figures with countercyclical endogenous risk.
- Folder ML-HANK constant liquidity: reproduces the figures with moderate constant liquidity.
- Folder QE: reproduces the figures with moderate endogenous liquidity.

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