Financial Integration and Crises

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Outline

Liquidity trap (Krugman, 1999)

Lecture 4: Liquidity Trap and Policy Response

What is the liquidity trap? (an intertemporal approach)

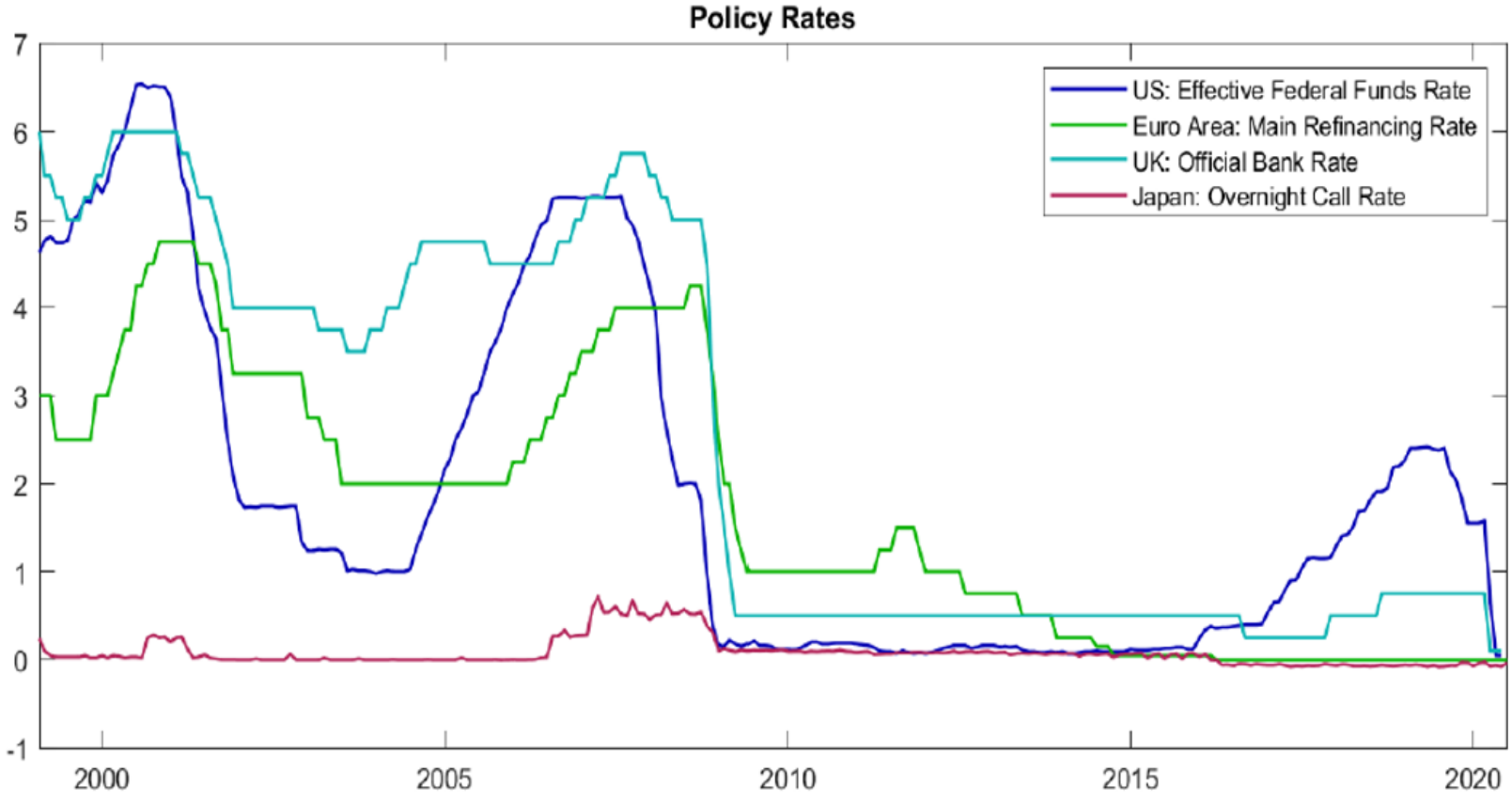
- A liquidity trap is defined as a situation in which the short-term nominal interest rate is zero.
- The old Keynesian literature (IS-LM model) emphasized that increasing money supply has no effect in a liquidity trap so that monetary policy is ineffective. The modern literature, in contrast, emphasizes that, even if increasing the current money supply has no effect, monetary policy is far from ineffective at zero interest rates.
- What is important, however, is not the current money supply but managing expectations about the future money supply in states of the world in which interest rates are positive.

Lecture 4: Liquidity Trap and Policy Response

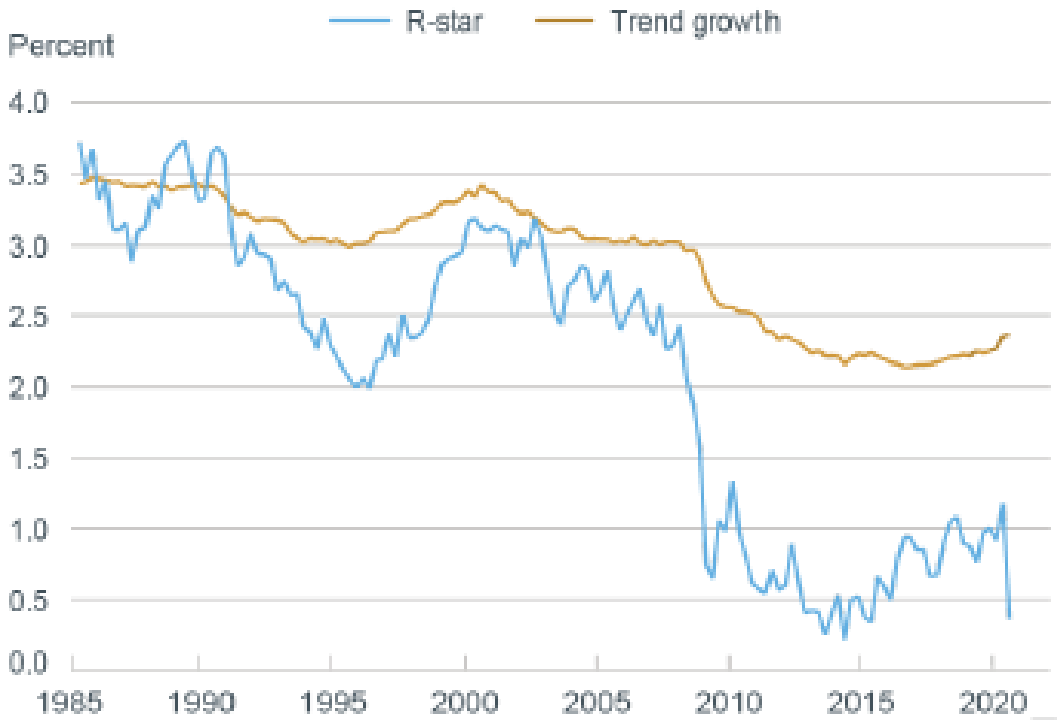
Background (history)

- The ideas that underlie the liquidity trap were conceived during the Great Depression. In that period the short-term nominal interest rate was close to zero.
  - At the beginning of 1933, for example, the short-term nominal interest rate in the United States – as measured by three-month Treasuries – was 0.05 per cent. As the memory of the Great Depression faded many economists begun to regard it as a theoretical curiosity.
- The liquidity trap received much more attention again in the late 1990s with the arrival of new experiences. The short-term nominal interest rate in Japan collapsed to zero in the second half of the 1990s.
  - The Bank of Japan (BoJ) more than doubled the monetary base through traditional and non-traditional measures to increase prices and stimulate demand. The BoJ policy of 'quantitative easing' from 2001 to 2006, for example, increased the monetary base by over 70 per cent in that period. By most accounts, however, the effect on prices was sluggish at best. (As long as five years after the beginning of quantitative easing, the changes in the CPI and the GDP deflator started to approach positive territory)

Liquidity Trap

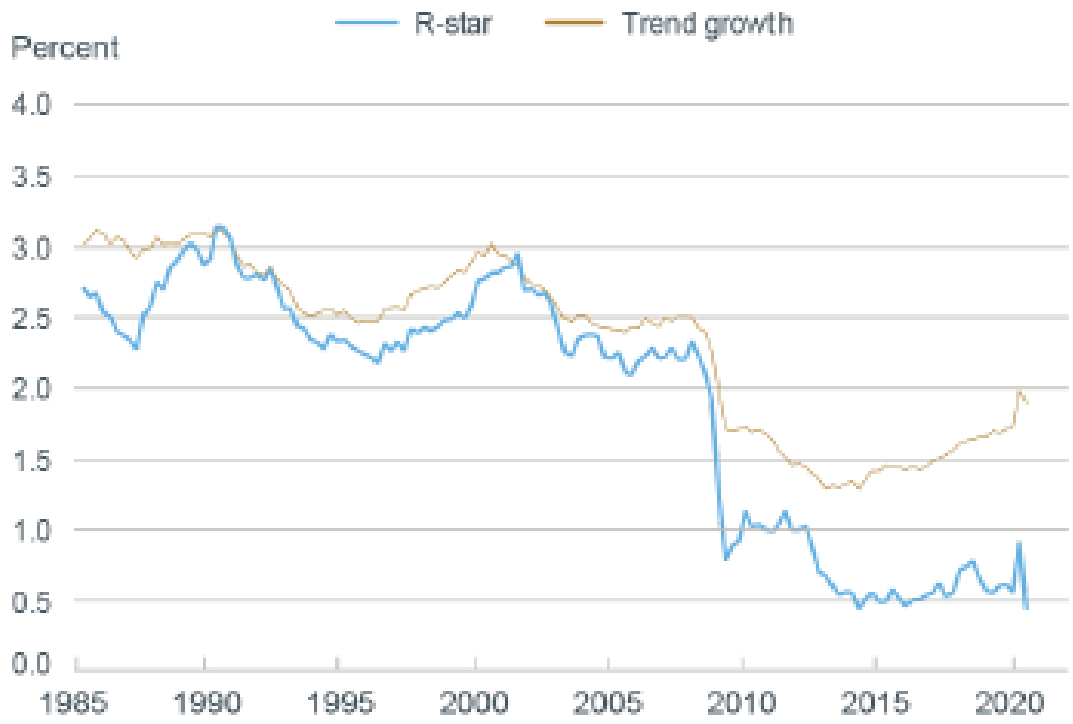


Liquidity Trap: the natural rate of interest



Source: Laubach and Williams (2003).
Note: We plot estimates of the natural rate of interest (r-star) along with those for the trend growth rate of the U.S. economy, a source of change driving r-star.

Liquidity Trap: the natural rate of interest



Sources: Holston, Laubach, and Williams (2017); Organisation for Economic Co-operation and Development (OECD).
Notes: Estimates are GDP-weighted averages across the United States, Canada, the Euro Area, and the United Kingdom. We use OECD estimates of GDP at purchasing power parity. For dates prior to 1995, Euro-Area weights are the summed weights of the eleven original Euro-Area countries.

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap (closed economy)

A Simple model of prices, output, money and interest rates

- Assumptions:

1) Preferences:

$$U = u(C_1) + \beta u(C_2)$$

where $\beta \in [0, 1]$ is the discount factor. C is consumption good and u is the period utility function with $u' > 0$ and $u'' < 0$. (note that we are abstracting from uncertainty)

2) Individuals needs cash to buy consumption goods (cash in advance constraint):

$$P_t C_t \leq M_t$$

From previous equation there is a proportional relationship between money supply and the price level in normal times.

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap

3) Individuals receive endowments in every period so that their intertemporal budget constraint becomes:

$$P_1 C_1 + \frac{P_2 C_2}{1+i} = P_1 Y_1 + \frac{P_2 Y_2}{1+i}$$

where $1+i$ is the gross nominal interest rate between period 1 and period 2.

4) Money is created by open market operations by the policy authority that also makes transfers or collects taxes and satisfy its own budget constraint. We initially assume that government keeps money supply fixed:

$$M_1 = M_2$$

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap

- Under normal circumstances (i.e. $i > 0$), individuals will hold just enough cash to buy consumption goods:

$$P_t C_t = P_t Y_t = M_t$$

and from here we can determine the price level in every period:

$$P_t = \frac{M_t}{Y_t}$$

- From consumer maximization problem we obtain the usual Euler equation:

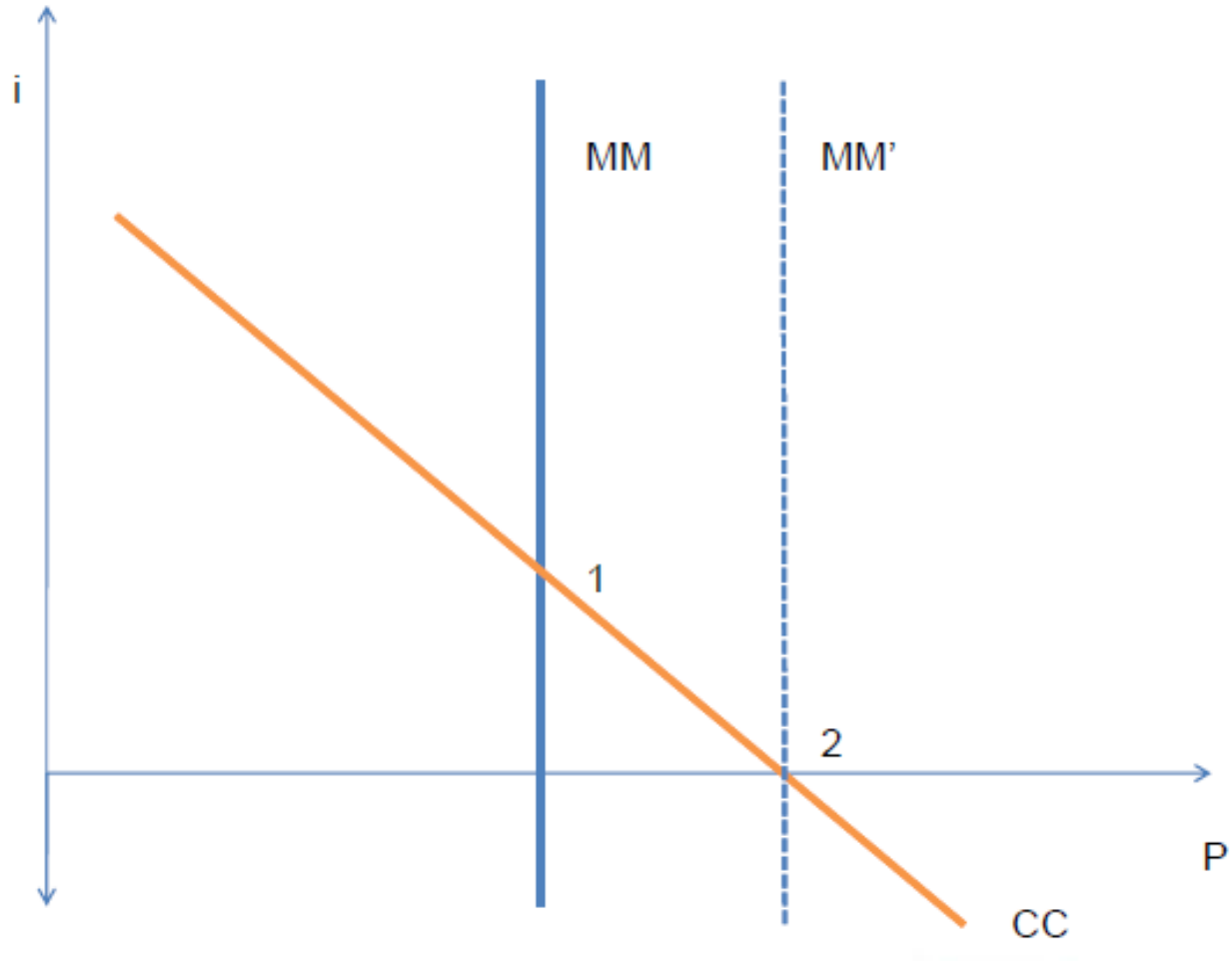
$$\frac{\beta u'(C_2)}{u'(C_1)} = \frac{P_2}{(1+i)\,P_1}$$

from which we can determine the nominal interest rate by imposing goods market equilibrium conditions ($C_t = Y_t$):

$$(1+i) = \frac{u'(Y_1)P_2}{\beta u'(Y_2)P_1}$$

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap (period 1 equilibrium)



Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap

- Suppose the policy authority increases money supply in the first period ($\Delta M_1 > 0$): this increases the price level in the first period and decrease the nominal interest rate as long as money supply increase is limited to the first period.
- There is a given level of money in the first period for which the equilibrium interest rate becomes negative. At this point money becomes more valuable than bonds, MM curve becomes irrelevant and spending is no longer constrained by money.
- Note that in this simple economy the real interest rate is fixed or taken as given:

$$(1+r) = \frac{u'(Y_1)}{\beta u'(Y_2)}$$

so that we can rewrite the CC curve as

$$(1+i) = (1+r)\frac{P_2}{P_1}$$

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap

Why does a monetary authority pursue an expansionary policy?

- Policy would try to achieve the equilibrium interest rate by engineering the right rate of inflation or deflation for given policy in the second period.
- If the real interest rate is lower, the nominal interest rate is decreases by increasing money supply in the first period (or for given policy in the second period by lowering the inflation rate or deflating the economy.
- Policy would try to push the economy for a negative nominal interest rate when the equilibrium real interest rate is negative:

$$(1+r) = \frac{u'(Y_1)}{\beta u'(Y_2)} < 1$$

  or when the economy is shrinking.
- Liquidity trap in this context would arise when the current money supply is so large compared with the future supply that the nominal rate is zero but the real rate needs to be negative.
- In this case liquidity trap does not have any adverse real consequences. With flexible price the economy deflate now in order to provide inflation later.

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap: the sticky price case

- We consider now a model with nominal rigidities in which output is produced in the first period and in which there is a maximum productive capacity in the first period Y^f while prices are predetermined at $\bar{P}_1$. Now, in the first period, output is demand determined (i.e. output adjust to consumption):

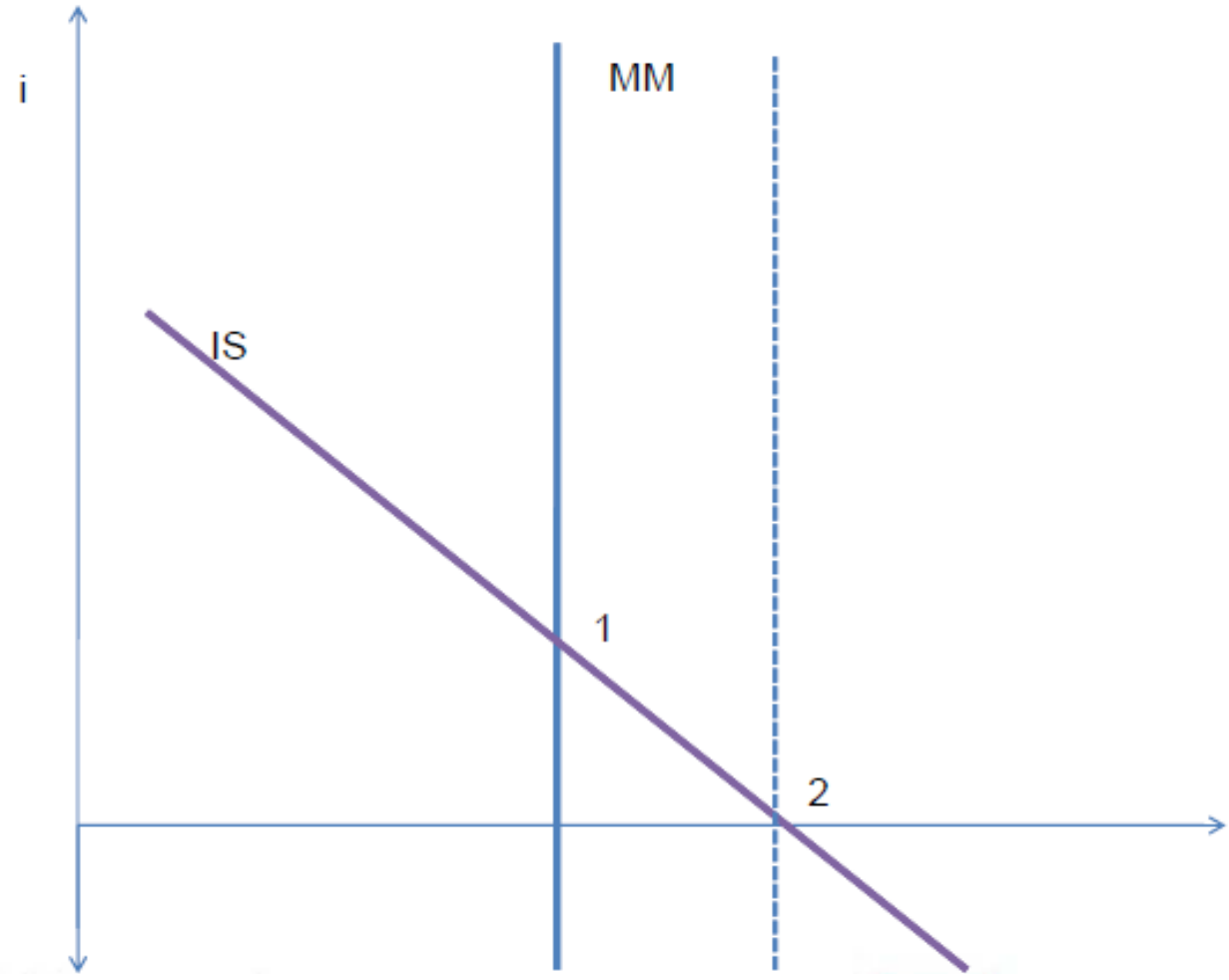
$$u'(C_1) = \frac{\beta u'(Y_2)(1+i)\bar{P}_1}{P_2}$$

  in which $C_1 = Y_1$.

- Now in the first period we determine output and the nominal interest rate.

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap: the sticky price case



Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap: the sticky price case

Why does a monetary authority pursue an expansionary policy?

- Policy would try to achieve the maximum productive capacity Y^f by increasing or decreasing the nominal interest rate.
- There is a limit to monetary policy if Y^f could be reached only for negative nominal interest rates.
- Liquidity trap would occur if $\bar{P}_1$ is to high compared with future prices P_2 (people expect deflation so that even a zero nominal rate is a high real rate) or Y^f is too high compared to future productive capacity.
- When people have low expectations about their future income, they will want to save more than what the economy can absorb even at zero nominal interest rate so that whatever the policy authority does with current money supply there is no possibility to reflate the economy to restore full-employment.

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap: policy response

Three possible answers (Japan's experience): structural reform, fiscal expansion, and unconventional monetary policy.

1) Structural reform:

1. Some examples of structural reform: clean up banks, deregulate service sector, labor market deregulation and so on. In terms of graphical analysis structural reform will move Y^f to the right (supply side). Measures that raise supply capacity but leave demand where it is will not help the situation;
2. Structural reform must somehow induce people to spend more: a reformed financial sector might be able to lend to people and firms that are credit-constrained (Demand-side). Deregulation might create new investment opportunities, raising investment demand. And conceivably reform might raise expectations of future income, encouraging higher spending now.

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap: policy response

2) Fiscal expansion

1. Government purchases of goods and services in the first period, while they would be partly offset by a reduction in private consumption expenditures, could indeed increase demand and output.
2. Fiscal constraint might limit this tool.
3. Debate on the size of fiscal multiplier when you are at the zero lower bound.

Lecture 4: Liquidity Trap and Policy Response

An intertemporal perspective on the liquidity trap: policy response

3) Monetary Policy:

1. In the flexible-price version of the model, even when money and bonds turn out to be perfect substitutes in period 1, money is still neutral - that is, an equiproportional increase in the money supply in all periods will still raise prices in the same proportion.
2. Consider a permanent increase in the money supply when prices are predetermined in period 1. Then monetary expansion would raise the expected future price level P*, and hence reduce the real interest rate.
3. A permanent as opposed to temporary monetary expansion would, in other words, be effective - because it would cause expectations of inflation.

The way to make monetary policy effective, then, is for the central bank to *credibly promise to be irresponsible* - to make a persuasive case that it will permit inflation to occur, thereby producing the negative real interest rates the economy needs.

Policy Options in a Liquidity Trap

- Two key messages from Krugman (1999)
  - liquidity trap is a symptom of a demand problem
  - role of monetary policy in a liquidity trap should not be dismissed: transmission channel through Euler equation and real interest rate.
- Policy debate: avoid deflation, and keep interest rate low at different maturities.

Policy Options in a Liquidity Trap

- Policy tools from monetary policy perspective: (rationale from a monetary policy perspective is to achieve inflation target)
  - Quantitative easing; (adopted by several major central banks during GFC and Covid-19 crisis)
  - Yield control; (adopted by Japan in 2016)
  - Negative interest rates; (Sweden, Denmark, ECB)
  - Forward Guidance; (adopted by major advanced Central Banks)
  - Helicopter money;

Lecture 4: Unconventional Monetary Policy

Quantitative Easing

- Quantitative Easing: The policy of expanding the central bank's balance sheet through asset purchases, financed by central bank money is widely referred to as quantitative easing (QE)
- Different from buying and selling of bonds (typically short term) to keep interest rate at a specified target value.
- Possibility of affecting the long-term interest rate by purchasing assets of longer maturity than only short term government.

Lecture 4: Unconventional Monetary Policy

Qualitative Easing

- W. Buiter has proposed a terminology to distinguish *quantitative* easing, or an expansion of a central bank's balance sheet, from what he terms *qualitative* easing, or the process of a central bank adding riskier assets onto its balance sheet:
- Quantitative easing is an increase in the size of the balance sheet of the central bank through an increase [in its] monetary liabilities (base money), holding constant the composition of its assets. Asset composition can be defined as the proportional shares of the different financial instruments held by the central bank in the total value of its assets. An almost equivalent definition would be that quantitative easing is an increase in the size of the balance sheet of the central bank through an increase in its monetary liabilities that holds constant the (average) liquidity and riskiness of its asset portfolio.
- Qualitative easing is a shift in the composition of the assets of the central bank towards less liquid and riskier assets, holding constant the size of the balance sheet (and the official policy rate and the rest of the list of usual suspects). The less liquid and more risky assets can be private securities as well as sovereign or sovereign-guaranteed instruments. All forms of risk, including credit risk (default risk) are included.

Lecture 4: Unconventional Monetary Policy

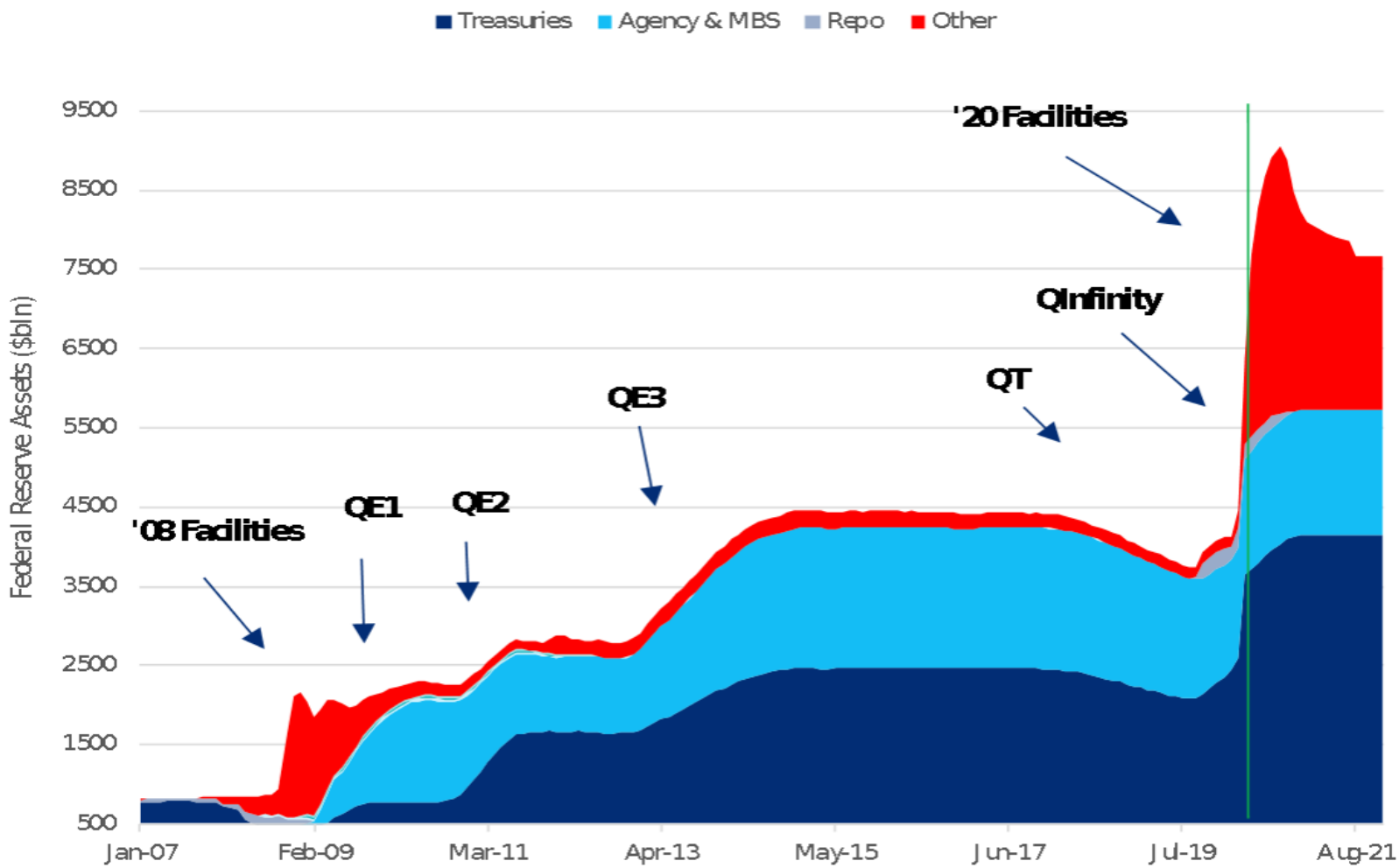
Credit Easing

- In introducing the Federal Reserve's response to the 2008–9 financial crisis, Fed Chairman Ben Bernanke distinguished the new programme, which he termed "credit easing" from Japanese-style quantitative easing. In his speech, he announced:

  Our approach—which could be described as "credit easing"—resembles quantitative easing in one respect: It involves an expansion of the central bank's balance sheet. However, in a pure QE regime, the focus of policy is the quantity of bank reserves, which are liabilities of the central bank; the composition of loans and securities on the asset side of the central bank's balance sheet is incidental. Indeed, although the Bank of Japan's policy approach during the QE period was quite multifaceted, the overall stance of its policy was gauged primarily in terms of its target for bank reserves. In contrast, the Federal Reserve's credit easing approach focuses on the mix of loans and securities that it holds and on how this composition of assets affects credit conditions for households and businesses.

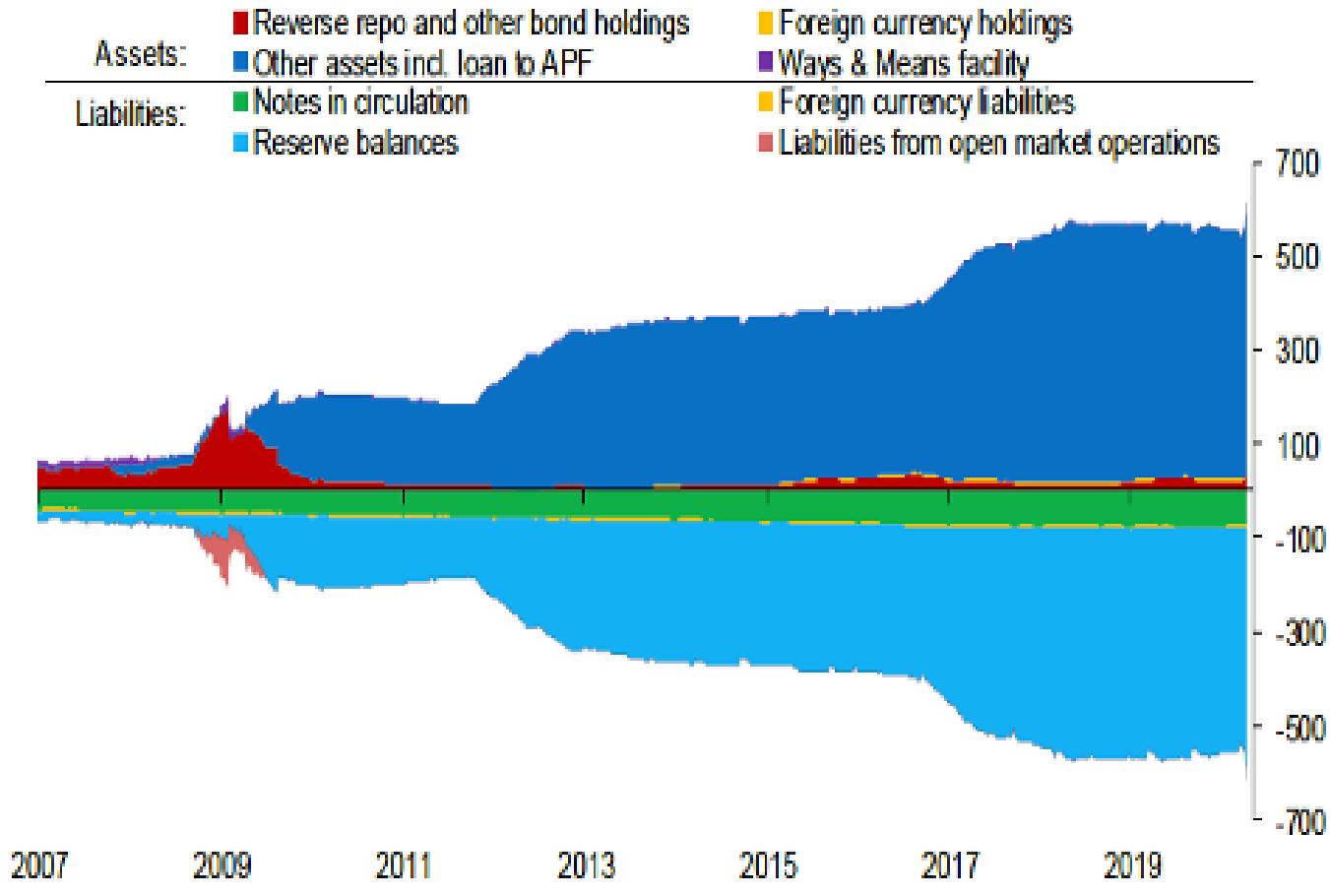
Lecture 4: Unconventional Monetary Policy

Federal Reserve Balance Sheet (Assets)



Lecture 4: Unconventional Monetary Policy

Federal Reserve Balance Sheet (Assets)



Source: Bank of England Weekly Report. Latest observation: 14 April 2020.

Lecture 4: Unconventional Monetary Policy

Central Bank Balance Sheet

Diagram 1: Stylised central bank balance sheet after conventional interest rate policy

<table>
<tr><th>Assets</th><th>Liabilities</th></tr>
<tr><td rowspan="2">Public sector securities (+)</td><td>Reserve balances (+)</td></tr>
<tr><td>Notes in circulation (+)</td></tr>
<tr><td>Private sector loans/securities</td><td rowspan="2">Capital and other liabilities</td></tr>
<tr><td>Net foreign assets</td></tr>
</table>

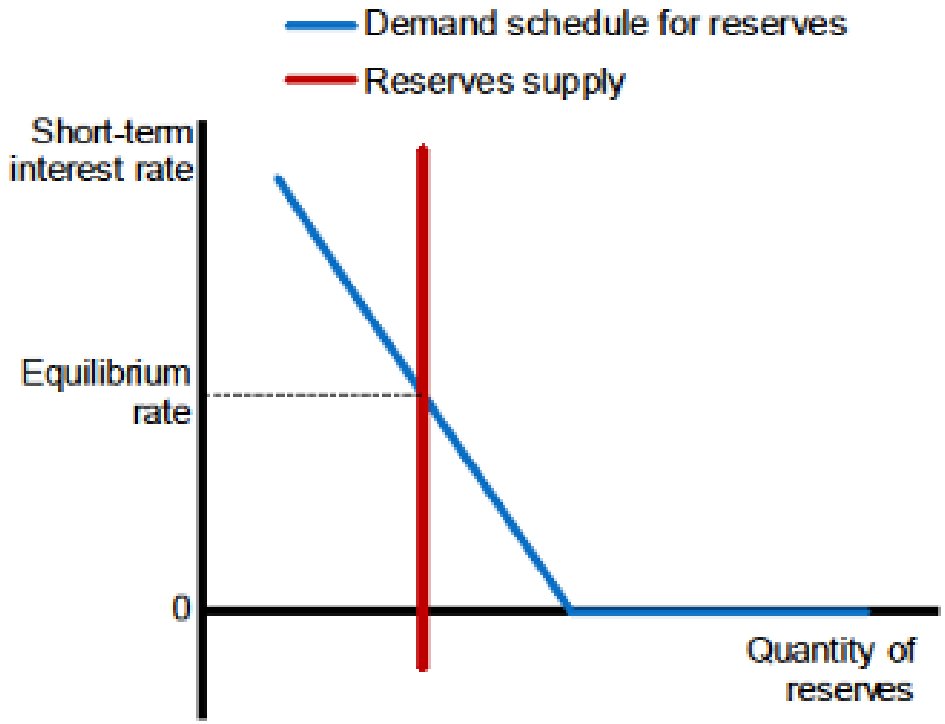
Lecture 4: Unconventional Monetary Policy

Central Bank Balance Sheet

- Reserves are simply deposit balances held at the central bank. Reserves are created through open market operations.
- In general, open market operations are a mix of outright purchases of government bonds by the central bank, or temporary purchases with an agreement to sell back later (repos).
- In the case of outright purchases, the central bank is selling reserves in exchange for government bonds. Or purchasing government bonds financed by issuing reserves. Or purchasing government bonds financed by "printing" reserves.

Lecture 4: Unconventional Monetary Policy

Central Bank Reserve Management



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Lecture 4: Unconventional Monetary Policy

Central Bank Reserve Management

- The fact that banks have some demand for reserves allows the central bank to affect the short-term interest rate.
- In particular, the short-term interest rates that a central bank affects most directly are the rates at which financial institutions borrow and lend reserves to each other.
- By controlling the level of reserves and/or the terms on which it is prepared to supply them, the central bank is able to set the level of short-term interest rates in the economy required to meet the inflation target.

Lecture 4: Unconventional Monetary Policy

Quantitative Easing

- Assets purchases, or QE, are typically carried out when the short-term rate cannot be lowered further and the central bank judges that additional stimulus is required to hit the inflation target. QE aims to stimulate spending by influencing longer-term interest rates.
- In the process of buying government bonds, the central bank creates additional reserves.
- The central bank is no longer trying to balance reserve supply with the reserve demand from the banks.
- The scale of QE operations that primarily drives the quantity of reserves.

Lecture 4: Unconventional Monetary Policy

Quantitative Easing

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Lecture 4: Unconventional Monetary Policy

Quantitative Easing: Interest Rate on Reserves (IOR)

- If reserves did not earn interest, then the supply by central banks of ample reserves beyond what banks need at any given level of interest rates, would push the short-term interest rate to zero (i.e. QE operations would lead to a loss of central bank control over short term interest rates).
- Central banks would only be able to raise interest rates by unwinding the QE operations first, in order to remove the "ample" portion of the reserves.
- To prevent this loss of control over short-term interest rates, all central banks that engage in QE have switched to paying interest on reserves,

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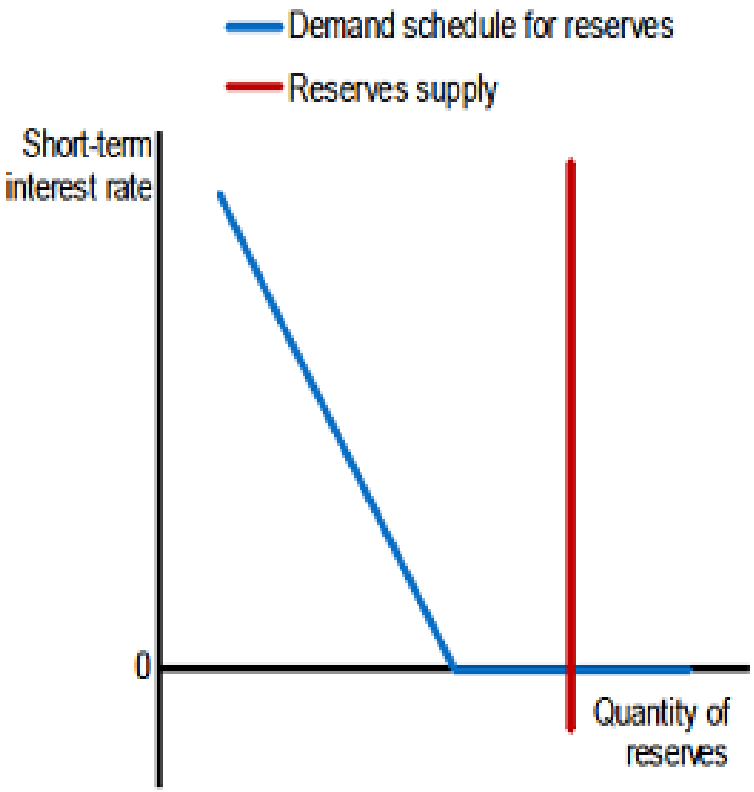
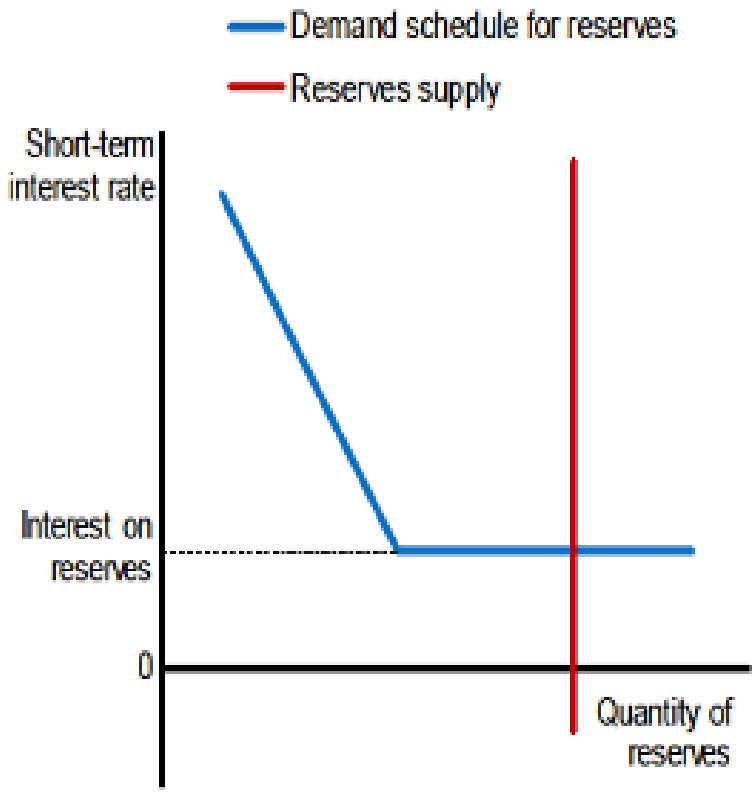
Interest Rate on Reserves (IOR)





Lecture 4: Unconventional Monetary Policy

QE: transmission mechanism
How do asset purchases affect spending and inflation?

- Policy signalling effects: This channel includes anything economic agents learn about the likely path of future monetary policy from asset purchases. For example, asset purchases may have led market participants to expect policy rates to remain low for longer than otherwise by signalling the Central Bank's determination to meet the inflation target.

  - Work by affecting expected policy rates;
  - Anchoring inflation expectation to the target.

Lecture 4: Unconventional Monetary Policy

QE: transmission mechanism
How do asset purchases affect spending and inflation?

- Portfolio balance effects: Central bank asset purchases, through this channel, push up the prices of the assets bought and also the prices of other assets. When the central bank purchases assets, the money holdings of the sellers are increased. Unless money is a perfect substitute for the assets sold, the sellers may attempt to rebalance their portfolios by buying other assets that are better substitutes.
- Higher asset prices mean lower yields, and lower borrowing costs for firms and households, which acts to stimulate spending. In addition,higher asset prices stimulate spending by increasing the net wealth of asset holders.

  - Work by reducing risk premia
  - Require imperfect asset substitutability

Lecture 4: Unconventional Monetary Policy

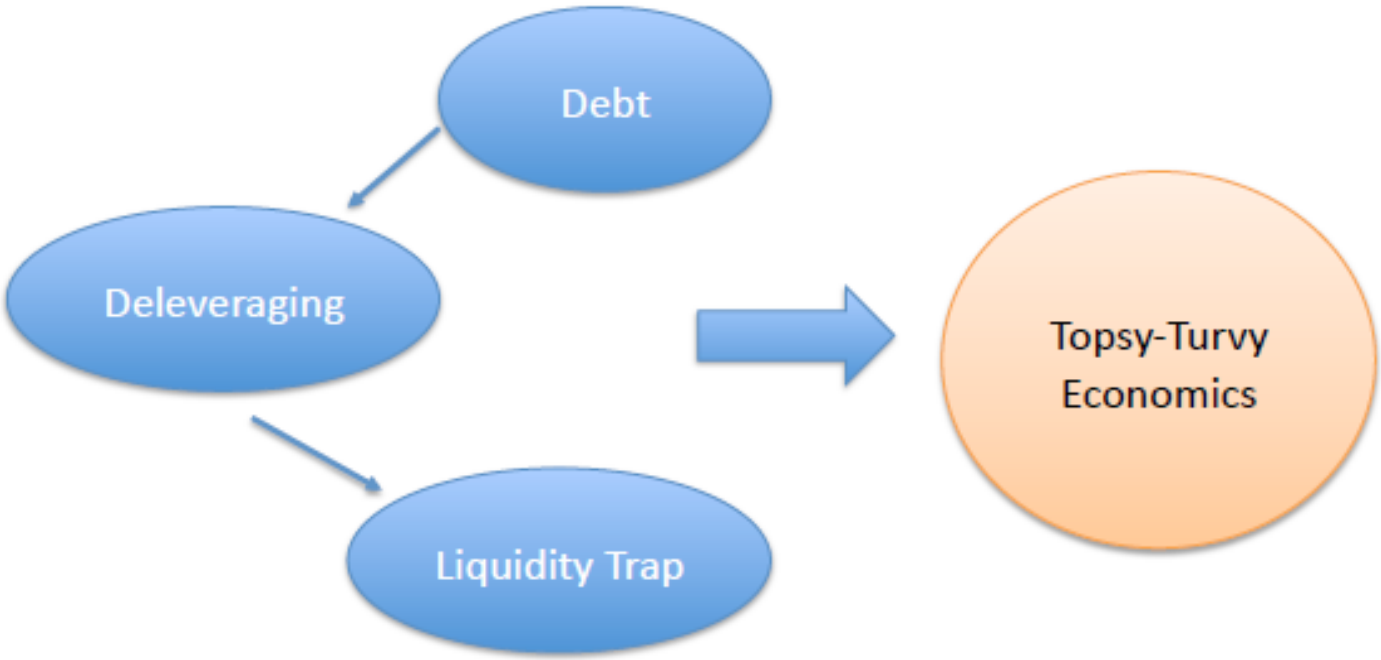
QE: transmission mechanism
How do asset purchases affect spending and inflation?

- Liquidity premia effects: When financial markets are dysfunctional, central bank asset purchases can improve market functioning by increasing liquidity through actively encouraging trading. Asset prices may therefore increase through lower premia for illiquidity.
  - Effects of this channel may only persist while the monetary authority is conducting asset purchases.
- Confidence effects: Asset purchases may have broader confidence effects beyond any effects generated through the effect of higher asset prices. For example, to the extent that the policy leads to an improved economic outlook, it might directly boost consumer confidence and thus people's willingness to spend.
- Bank lending effects: When assets are purchased from non-banks (either directly or indirectly via intermediate transactions), the banking sector gains both new reserves at the Central Bank and a corresponding increase in customer deposits. A higher level of liquid assets could then encourage banks to extend more new loans than they otherwise would have done.

The Global Financial Crisis: deleveraging

- Debt, deleveraging and liquidity trap.(Eggertsson and Krugman, 2012)

Perspective



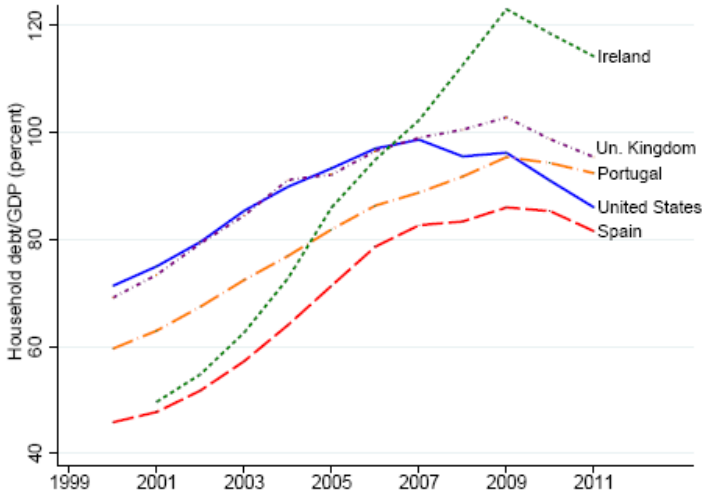
Lecture 4: Debt and Deleveraging

- In the Great Depression of the 1930s, the world entered a period of global debt reduction and experienced the most severe recession in modern history. (Fisher, 1933, Debt deflation spiral)
- Almost 80 years later, history seemed to be repeating itself. Following the 2007-2008 turmoil in financial markets several advanced economies started a process of private debt deleveraging accompanied by a deep economic downturn, the Great Recession.

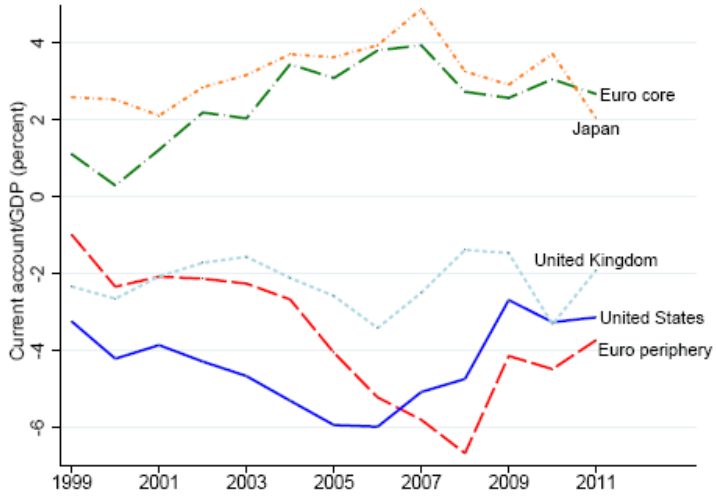
Lecture 4: Debt and Deleveraging

- Examine now a model in which we study the role of alternative policy in a deleveraging environment.
- Analysis will examine the interaction of borrowers and lenders and how credit shock might lead to liquidity trap.
- Role of debt and its implication has a long tradition in economic analysis (Fisher (1933), Minsky (1986) and Koo (2008))
- Analysis is related to model of sudden stop.

Lecture 4: Debt and Deleveraging



(a) Household debt in percent of GDP



(b) Current account in percent of GDP

Lecture 4: Debt and Deleveraging

- Simple case of endowment economy with no aggregate savings.
- Endowment good is perishable and there is no investment. (total endowment for the whole economy is Y)
- We consider an economy populated by two types of agents.
- Patient agents (lenders), Impatient agents (borrowers).

Lecture 4: Debt and Deleveraging

- Infinite horizon structure. Patient agent preference:

$$\sum_{t=0}^{\infty} \beta^t(s) \log C_t(s)$$

- Impatient agent preference:

$$\sum_{t=0}^{\infty} \beta^t(b) \log C_t(b)$$

  where $\beta(b) < \beta(s)$.

- b refers to borrower (impatient), while s refers to savers (patient).

Lecture 4: Debt and Deleveraging

- Borrowing occurs among agents and only asset exchanged is risk-free bond in units of consumption good.
- Agents receive the same share of endowment every period (no idiosyncratic risk). Total endowment is Y so individual endowment is $\frac{1}{2}Y$.

$$B_t(s) = (1 + r_{t-1})B_{t-1}(s) + \frac{1}{2}Y - C_t(s)$$

$$B_t(b) = (1 + r_{t-1})B_{t-1}(b) + \frac{1}{2}Y - C_t(b)$$

where $B > 0$ denotes credit position and $B < 0$ denotes debit position.

Lecture 4: Debt and Deleveraging

Borrowing limit:

- Agents cannot borrow more than given amount (exogenous debt limit):

$$0 > B_t(1 + r_t) > B^{high}$$

- Note here that there is a natural debt limit (at a given point in time agents cannot borrow more than the present discounted value of his resources).
- The limit that we impose here is more restrictive than the natural debt limit.

Lecture 4: Debt and Deleveraging

We start by considering steady state solution (in which variable do not change over time, $(B_t = B_{t-1})$

- Because agents (b) are more impatient than (s) then b-agents borrow as much as they could, we can determine the consumption function of impatient agents in steady state. From the budget constraint we have

$$B(b) = (1+r)B(b) + \frac{1}{2}Y - C(b)$$

$$C(b) = \frac{1}{2}Y + \frac{r}{1+r}B^{high}$$

where $B(1+r) = B^{high}$

- Since goods market equilibrium condition implies:

$$Y = C(s) + C(b)$$

- Agents (s) consumption in steady state is:

$$C(s) = \frac{1}{2}Y - \frac{r}{1+r}B^{high}$$

Lecture 4: Debt and Deleveraging

Interest rate determination

- Since patient agents are not constrained their consumption profile satisfies the Euler equation

$$\frac{1}{C_t(s)} = (1 + r_t)\beta(s)\frac{1}{C_{t+1}(s)}$$

- In steady state, $C_t = C_{t+1}$

$$r = \frac{1 - \beta(s)}{\beta(s)}$$

- In steady state equilibrium real interest rate is pinned down by savers' discount factor.

Lecture 4: Debt and Deleveraging

The effect of a deleveraging shock (dynamic equilibrium)

1. Consider now the situation in which the debt limit falls unexpectedly from B^{high} to B^{low}.

- Suppose that borrower need to bring debt within the new debt limit and as such he must deleverage (reduce amount of debt)
- Consider short and long run equilibrium (new steady state)
- Long run (new steady-state)

$$C_L(b) = \frac{1}{2}Y + \frac{r}{1+r}B^{low}$$

Since goods market equilibrium condition implies:

$$Y = C(s) + C(b)$$

Agents (s) consumption in steady state is:

$$C_L(s) = \frac{1}{2}Y - \frac{r}{1+r}B^{low}$$

Lecture 4: Debt and Deleveraging

Short run equilibrium

- From budget constraint of the impatient agent (borrower) we have

$$B_S(b) = B_{t-1}^{High}(b) + \frac{1}{2}Y - C_S(b)$$

where $B_{t-1}^{High}(b) = (1 + r_{t-1})B_{t-1}$

- If we assume that deleveraging occurs within a period then $B_S = \frac{B^{low}}{1+r_S}$

$$\frac{1}{1+r_S}B^{low}(b) = B_{t-1}^{High}(b) + \frac{1}{2}Y - C_S(b)$$

and the short-run consumption of the borrower is given by:

$$C_S(b) = \frac{1}{2}Y - \frac{1}{1+r_S}B^{low} + B^{high}$$

Lecture 4: Debt and Deleveraging

Savers behavior:

- Keeping into account the goods market equilibrium conditions we can find the long and short run consumption of the savers as

$$C_S(s) = \frac{1}{2}Y + \frac{1}{1+r_S}B^{low} - B^{high}$$

$$C_L(s) = \frac{1}{2}Y - \frac{r}{1+r}B^{low}$$

- Since savers behavior satisfies the Euler equation

$$C_L(s) = (1+r_S)\beta(s)C_S(s)$$

we obtain the short run interest rate as

$$1 + r_S = \frac{\frac{1}{2}Y - B^{low}}{\beta\left(\frac{1}{2}Y - B^{high}\right)}$$

Lecture 4: Debt and Deleveraging

Liquidity trap

- Deleveraging shock will produce a liquidity trap when

$$1 + r_S = \frac{\frac{1}{2}Y - B^{low}}{\beta\left(\frac{1}{2}Y - B^{high}\right)} < 1$$

  The condition becomes:

$$\beta B^{high} - B^{low} < \frac{1}{2}Y\left(\beta - 1\right)$$

- Intuition: following a deleveraging shock, the consumption of borrowers drop and the savers need to increase their consumption. This happens when the real interest rate falls. For big shock this will imply that the real interest rate becomes negative.

Lecture 4: Debt and Deleveraging

Nominal side

- Suppose there is a nominal government debt traded in zero net supply. So there is arbitrage conditions for savers:

$$\frac{1}{C_t(s)} = (1+i_t)\beta(s)\frac{1}{C_{t+1}(s)}\frac{P_t}{P_{t+1}}$$

- We impose that $i_t \geq 0$ and assume that in the long run prices reflect an environment in which zero bound is not binding and price level will be stable: $P_L = P^*$.
- In the short run we have:

$$1 + r_S = (1+i_S)\frac{P_S}{P^*}$$

and the right policy would imply $P_S = P^*$ if the nominal interest rate did not have a lower bound.

- If $i_t = 0$ then

$$(1+i_S)\frac{P_S}{P^*} = \frac{P_S}{P^*} = \frac{\frac{1}{2}Y - B^{low}}{\beta\left(\frac{1}{2}Y - B^{high}\right)} < 1$$

- Price level must drop now so that it can raise in the future creating the necessary inflation (Krugman, 1999)

Lecture 4: Debt and Deleveraging

Nominal side with non-indexed bonds (Fisher debt-deflation)

- Consider now the situation in which debt is denominated in nominal terms but the debt limit is defined in real terms

$$\frac{B_t^{nom}}{P_t}(1+r_t) > B^{Low}$$

- In this case there is a debt-deflation spiral with natural interest rate becoming more negative as the nominal price level drops. (natural interest rate becomes endogenous).

$$1+r_S = \frac{\frac{1}{2}Y - B^{low}}{\beta\left(\frac{1}{2}Y - \frac{B^{high}}{P_S}\right)}$$

- When the price level drops, the natural interest rate becomes more negative, making the price level dropping even more.

Lecture 4: Debt and Deleveraging

Endogenous output: illustrative analysis

- We now consider the sticky price case in which there is a fraction of firms λ that keeps prices fixed while a fraction $1-\lambda$ can change prices all the time.
- Firms produce with a simple linear technology in labor $(y(i) = Ah(i))$
- Agents now choose consumption and the amount that they work: they can deleverage by consuming less or working more.
- Monetary policy is expressed in terms of a rule on the nominal interest rate.

Lecture 4: Debt and Deleveraging

Equilibrium conditions (first order approximation)

- Model is approximated up to first order around steady state in which borrowing constraint is binding and then solved for short and long run equilibrium.
- Aggregate supply curve (New classical Phillips curve)

$$\pi_t = k\hat{Y}_t + E_{t-1}\pi_t$$

- Taylor Rule:

$$i_t = \max(0, r_t^n + \phi_\pi \pi_t)$$

- Consumption function by borrower and savers will determine output demand.

Lecture 4: Debt and Deleveraging

Equilibrium conditions (first order approximation)

- Model is approximated up to first order around steady state in which borrowing constraint is binding and then solved for short and long run equilibrium.
- Goods market equilibrium condition

$$\hat{Y}_t = \chi \hat{C}_t(s) + (1-\chi)\hat{C}_t(b)$$

- Euler equation by the savers:

$$\hat{C}_t(s) = E_t \hat{C}_{t+1}(s) - \sigma(i_t - E_t \pi_{t+1} - \bar{r})$$

- Long-run equilibrium: like flex price equilibrium described above..

Lecture 4: Debt and Deleveraging

Endogenous output

- In the short run we have upward sloping aggregate supply.
- In the short run we have goods market equilibrium condition (similar to IS curve) in which we derive a link between interest rate and total demand for goods.
- Aggregate demand: if short run interest rate falls, other things being equal, savers are induced to consume more. Higher consumption will lead to higher income for both borrowers and savers. Since borrowers are liquidity constrained they spend their additional income and further income expansion will follow.

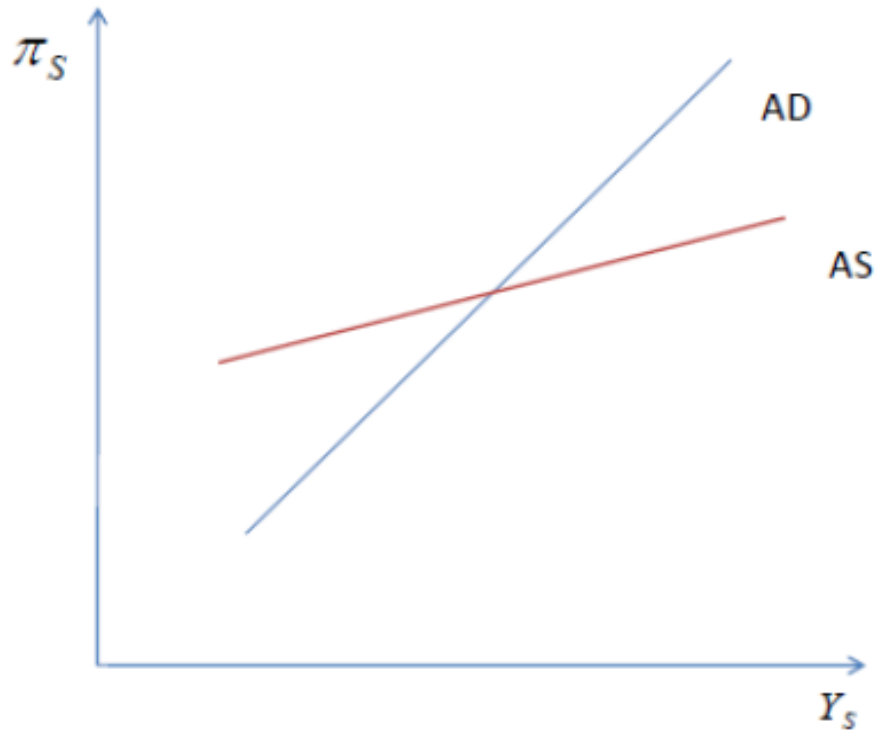
Lecture 4: Debt and Deleveraging

Endogenous output and deleveraging shock:

- Suppose now that a deleveraging shock hits the economy.
- Taylor rule will imply that as long as real natural rate is positive the actual interest rate will fall to offset the impact on output. If the shock is large, zero lower bound will be binding and output will fall below potential.
- From aggregate supply fall in output is associated with fall in the price level.
- Large deleveraging shock which puts the economy against the zero lower bound, makes aggregate demand curve upward sloping: indeed the fall in the price level increases the real value of debt forcing borrowers to consume less and since nominal interest rates are at the lower bound savers will not have any incentive to consume more.

Lecture 4: Debt and Deleveraging

Endogenous output and deleveraging shock:



Lecture 4: Debt and Deleveraging

Endogenous output and deleveraging shock:

- The paradox of thrift: if interest rate reaches the zero lower bound, a collective attempt to save more will simply depress the economy leading to lower investment and from accounting identity to lower savings.
- The paradox of toil: suppose aggregate supply shift out (agents prefer to supply more labor) that usually imply higher output. But the rise in aggregate supply leads to a fall in prices and the price decline is contractionay throught the Fisher effect. (consume less, less income).
- The paradox of flexibility: it is commonly argued that price and wage flexibility minimize losses from adverse demand shock. but here falling prices don't help raising the demand they simply magnify the Fisher effect raising the real value of debt and depressing spending by borrowers.

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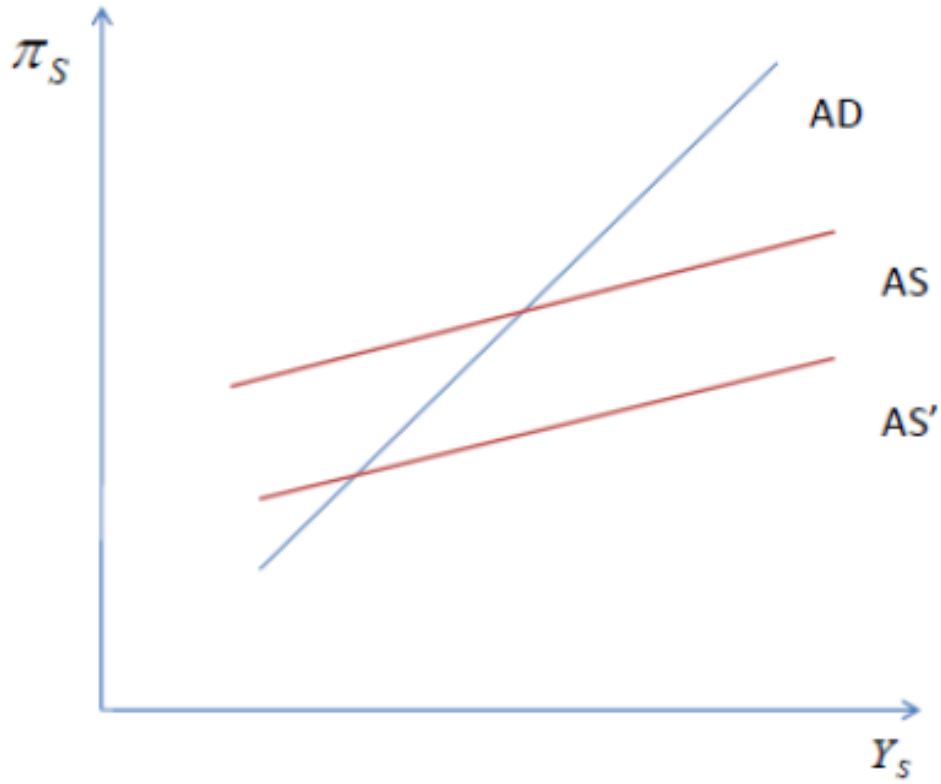
Endogenous output and deleveraging shock:



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Endogenous output and deleveraging shock: