# Have the Monetary and Fiscal Authorities Run out of Ammunition for dealing with the Crisis?

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# Outline

Monetary policy at the zero lower bound

1. Removing the zero lower bound
2. Quantitave easing and the impossibility of strong liquidity trap equilibria
3. Fiscal aspects of QE and CE
4. The relationship between the central bank and the fiscal authority under QE and CE

# The zero lower bound

- The zero lower bound is based on the *assumption* that the (short, risk-free) nominal interest rate $i_t$ *rate* cannot be negative:
- *i: interest rate on short Treasury Bills (one-period safe rate)*
- $i^M$ *: interest rate on (base) money*
- $i^N$ *: interest rate on currency*
- $i^D$*: interest rate on bank reserves with central bank (Deposits)*
- $i^B$ *: interest rate on collateralised commercial bank borrowing from central bank*
- $i^{CB}$*: official policy rate*
- *k: carry cost on short Treasury Bills*
- $k^M$ *: carry cost on base Money*
- $k^N$ *: carry cost on currency (bank Notes)*
- $k^D$*: carry cost on bank reserves with central bank (Deposits)*

# Some plausible inequalities & some simplifying equalities:

- Assume (plausibly)

$$
\begin{aligned}
i - k &\geq i^{M} - k^{M} \\
i - k &\geq i^{N} - k^{N} \\
i - k &\geq i^{D} - k^{D} \\
i^{D} &\leq i^{CB} \approx i \leq i^{B}
\end{aligned}
\qquad (1)
$$

# Too many short nominal interest rates …

Carry cost: storage & safekeeping, incl. insurance

$$k^N >> k \approx 0,\ k^D \approx 0$$

$$i \geq i^N - k^N \qquad (2)$$

So, even if $i^N = 0$, *lower bound on i is negative*

$i^D$ *and* $i^B$ *can of course be positive or negative*

# Which short interest rate cannot be negative?

$$i^N = o$$

$$i^D \text{ , } i^B \text{ can be positive, zero or negative}$$

***Bearer* instruments/securities vs. *registered* instruments/securities**

- *Bearer instruments: identity of owner not known to issuer (currency)*
- *Registered instruments: identity of owner known to issuer (equity, bank accounts)*
- *Currency is transferable (negotiable) bearer bond, without a requirement for countersignature*
- *How do we determine whether interest (positive or negative) has been paid on a bearer security?*
  - *Since issuer does not know the identity of the owner, the instrument/security must be clearly identifiable, i.e. marked as 'current' on interest;*
  - *This is necessary both to pay a positive interest rate on currency as a negative interest rate.*

# A simple model

Notation: Individual asset stocks are beginning-of-period

Euro currency economy:

$M \geq 0$ : nominal stock of euro base money

$B$ : stock of nominal one-period risk-free euro-denominated debt

$N \geq 0$: nominal stock of euro currency

$D \geq 0$: nominal stock of euro reserves (deposits) with the central bank

$M \equiv N + D$

$c \geq 0$ : private consumption

$e > 0$ : endowment of perishable commodity (leisure time)

$\ell \geq 0$ : consumption of leisure

$\tau$ : real lump-sum taxes paid by households

$g$ : real government consumption spending

$P \geq 0$ : general price level

$m \equiv M / P$

## Notation continued

Nominal stochastic discount factor between period $t_1$ and $t_0$

$$I_{t_1,t_0} \equiv \prod_{k=t_0+1}^{t_1} I_{k,k-1}; \quad t_1 > t_0$$

$$\equiv 1 \qquad\qquad t_1 = t_0.$$

$$\frac{1}{1+i_{t+1,t}} = E_t I_{t+1,t}$$

$$\pi_{t_1,t_0} \equiv P_{t_1} / P_{t_0}$$

Re al stochastic discount factor between period $t_1$ and $t_0$

$$R_{t_1,t_0} \equiv I_{t_1,t_0}\pi_{t_1,t_0}$$

$$\frac{1}{1+r_{t+1,t}} = E_t R_{t+1,t}$$

$W_t$: beginning-of-period financial wealth in period $t$

$A_t$ : gross returns on the non − monetary financial portfolio purchased in period $t$

$F_t$: value of gross non-monetary financial wealth held during period period $t$

$$W_t \equiv A_t + (1+i^M_{t,t-1})M_{t-1}$$

$$F_t = E_t\left(I_{t+1,t}A_{t+1}\right)$$

# A simple model

Notation for wim currency economy:

$M^* \geq 0$: nominal stock of wim base money

$B^*$: stock of nominal one-period risk-free wim-denominated debt

$i^*$: one-period safe nominal rate of interest on wim-denominated bonds

$i^{*M}$: one-period safe nominal rate of interest on wim base money

$P^* \geq 0$: general price level (in wim)

$m^* \equiv M^* / P^*$

$S$: spot exchange rate of the wim & the euro (# of wims per euro)

$F$: one-period forward exchange rate of the wim & the euro

## Notation continued

Nominal stochastic wim discount factor between period $t_1$ and $t_0$

$$I^*_{t_1,t_0} \equiv \prod_{k=t_0+1}^{t_1} I^*_{k,k-1}; \qquad t_1 > t_0$$

$$\equiv 1 \qquad\qquad t_1 = t_0.$$

$$\frac{1}{1+i^*_{t+1,t}} = E_t I^*_{t+1,t}$$

$W^*_t$: beginning-of-period financial wealth in period $t$

$A^*_t$ : gross returns on the non − monetary financial portfolio purchased in period $t$

$F^*_t$: value of gross non-monetary financial wealth held during period period $t$

$$W^*_t \equiv A^*_t + (1+i^{*M}_{t,t-1})M^*_{t-1}$$

$$F^*_t = E_t\left(I^*_{t+1,t} A^*_{t+1}\right)$$

# A simple model

- For simplicity (to get rid of a few interest rates):

$$i^D = i^{CB} = i = i^B$$

# A simple model

- A simple monetary model of a closed endowment economy
  - The benchmark euro currency model
    - Households-producers

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \left[ \ln c_t + \phi \ln \ell_t + \eta \ln m_t \right] \tag{3}$$

$$0 < \beta < 1, \ \phi > 0; \ \eta > 0$$

$$E_t \left( I_{t+1,t} W_{t+1} \right) \equiv W_t + P_t (y_t - c_t - \tau_t) - \left( \frac{i_{t+1,t} - i^M_{t+1,t}}{1 + i_{t+1,t}} \right) M_t \tag{4}$$

or

$$B_t + \left( \frac{1 + i^M_{t+1,t}}{1 + i_{t+1,t}} \right) M_t \equiv (1 + i_{t,t-1}) B_{t-1} + (1 + i^M_{t,t-1}) M_{t-1} + P_t (y_t - c_t - \tau_t) - \left( \frac{i_{t+1,t} - i^M_{t+1,t}}{1 + i_{t+1,t}} \right) M_t$$

$$\lim_{k \to \infty} E_t I_{k+1,t} W_k = \lim_{k \to \infty} E_t I_{k+1,t} \left( (1 + i_{k+1,k}) B_k + (1 + i^M_{k+1,k}) M_k \right) \geq 0. \tag{5}$$

# A simple model

$$e_t \geq \ell_t + y_t \tag{6}$$

$$\begin{aligned} M_{-1} &= \bar{M}_{-1} > 0 \\ B_{-1} &= \bar{B}_{-1} \end{aligned} \tag{7}$$

The household's intertemporal budget constraint can be written as:

$$\begin{aligned} W_t = {} & P_t(c_t + \tau_t - y_t) + \left( \frac{i_{t+1,t} - i^M_{t+1,t}}{1 + i_{t+1,t}} \right) M_t \\ & + E_t \sum_{j=1}^{\infty} I_{t+j,t} \left( P_{t+j}(c_{t+j} + \tau_{t+j} - y_{t+j}) + \left( \frac{i_{t+j+1,t+j} - i^M_{t+j+1,t+j}}{1 + i_{t+j+1,t+j}} \right) M_{t+j} \right) \\ & + E_t \lim_{T \to \infty} I_{t+T,t} W_{t+T} \end{aligned} \tag{8}$$

# A simple model

From the household FOCs (all inequality constraints bind)

$$c_t^{-1} = \beta\left(1+r_{t+1,t}\right)E_t c_{t+1}^{-1}, \tag{9}$$

$$= \beta\left(1+i_{t+1,t}\right)E_t\left(\pi_{t,t+1}c_{t+1}^{-1}\right)$$

$$\ell_t = \phi c_t \tag{10}$$

$$\frac{M_t}{P_t} = \eta\left(\frac{1+i_{t+1,t}}{i_{t+1,t}-i_{t+1,t}^M}\right)c_t. \tag{11}$$

$$1+r_{t+1,t} = \left(1+i_{t+1,t}\right)\left(E_t\pi_{t,t+1}+\frac{Cov_t(\pi_{t,t+1},c_{t+1}^{-1})}{E_t c_{t+1}^{-1}}\right) \tag{12}$$

# A simple model:

- There also is the transversality condition (see Buiter and Sibert (2007)):

$$\lim_{T \to \infty} E_t \left( \frac{\beta^T}{c_{t+T}} \frac{M_{t+T}}{P_{t+T}} \right) = 0 \qquad (13)$$

# A simple model

- Price behaviour

$$\pi_{t,t-1} - \omega_{t,t-1} = \alpha\left(y_t - \bar{y}_t\right) + \lambda E_t\left(\pi_{t+1,t} - \omega_{t+1,t}\right). \quad (14)$$

$$0 \le g < \bar{y};\ 1 \ge \lambda \ge 0;\ \alpha \ge 0$$

$\omega_{t,t-1} = 0$ (Calvo (1983))

$= \pi_{t-1,t-2}$ (New-Keynesian accelerationist) (15)

= whatever

$$P_0 = \bar{P}_0$$

# A simple model

- The government

$$M_t + B_t \equiv (1+i^M_{t,t-1})M_{t-1} + (1+i_{t,t-1})B_{t-1} + P_t(g_t - \tau_t)$$

or

$$(1+i^M_{t,t-1})M_{t-1} + (1+i_{t,t-1})B_{t-1} = P_t(\tau_t - g_t) + \left(\frac{i_{t+1,t} - i^M_{t+1,t}}{1+i_{t+1,t}}\right)M_t + E_t I_{t+1,t}\left((1+i^M_{t+1,t})M_t + (1+i_{t+1,t})B_t\right) \quad (16)$$

$$E_t \lim_{k\to\infty} I_{k+1,t}(1+i_{k+1,k})B_k \le 0 \quad (17)$$

Note difference between (5) and (16): fiat base money is irredeemable, an asset to the holder but not a liability to the issuer

# A simple model:

- The government's intertemporal budget constraint can be written as:

$$(1+i^{M}_{t,t-1})M_{t-1}+(1+i_{t,t-1})B_{t-1} \equiv P_t(\tau_t - g_t)+\left(\frac{i_{t+1,t}-i^{M}_{t+1,t}}{1+i_{t+1,t}}\right)M_t$$
$$+E_t\sum_{j=1}^{\infty} I_{t+j,t}\left(P_{t+j}(\tau_{t+j}-g_{t+j})+\left(\frac{i_{t+j+1,t+j}-i^{M}_{t+j+1,t+j}}{1+i_{t+j+1,t+j}}\right)M_{t+j}\right)$$
$$+E_t\lim_{T\to\infty} I_{t+T+1,t}\left((1+i^{M}_{t+T+1,t+T})M_{t+T}+(1+i_{t+T+1,t+T}B_{t+T})\right)$$

or, equivalently, as:

$$(1+i_{t,t-1})B_{t-1} \equiv P_t(\tau_t - g_t)+M_t-(1+i^{M}_{t,t-1})M_{t-1}$$
$$+E_t\sum_{j=1}^{\infty} I_{t+j,t}\left(P_{t+j}(\tau_{t+j}-g_{t+j})+M_{t+j}-(1+i^{M}_{t+j,t+j-1})M_{t+j-1}\right)$$
$$+E_t\lim_{T\to\infty} I_{t+T+1,t}(1+i_{t+T+1,t+T})B_{t+T}$$

# A simple model

Taylor rule with lower bound constraint on short nominal interest rate

$$1+i_{t+1,t} = \beta^{-1}\hat{\pi} + \zeta(E_t\pi_{t+1,t} - \hat{\pi}), \text{ if } \beta^{-1}\hat{\pi} + \zeta(E_t\pi_{t+1,t} - \hat{\pi}) \geq 1 + i^M_{t+1,t}$$
$$= 1 + i^M_{t+1,t} \text{ if } \beta^{-1}\hat{\pi} + \zeta(E_t\pi_{t+1,t} - \hat{\pi}) < 1 + i^M_{t+1,t};\ \zeta > 1 \qquad (18)$$

$$\text{If } i_{t+1,t} = i^M_{t+1,t} \text{ then } M_{t+1} = (1+\mu_{t+1,t})M_t \quad \text{(QE)} \qquad (19)$$

Equilibrium

$$y_t = c_t + g_t \text{ or } e_t = (1+\phi)c_t + g_t$$
$$A_t = (1+i_{t,t-1})B_{t-1} \qquad (20)$$

# A simple model

- In the euro currency model, the lower bound constraint can become binding (take deterministic steady state, chose $\hat{\pi}$ such that stead-state $\pi\beta^{-1} = 1 + i^{M}$.

  Then have an unexpected temporary negative shock to g

# If currency creates the zero lower bound, what can be done about it?

1. Abolish currency (first-best solution!)
   - Currency is a redundant medium of exchange/means of payment, except possibly for the smallest denomination (€ 5, say)
   - Main reasons for currency's popularity are
     - Source of seigniorage for central banks
     - Anonymity/privacy it provides (bearer instrument)
       - Encourages tax evasion
       - Encourages money laundering
       - Encourages criminality
       - Social costs especially associated with large denominations (€500 and €200)
   - Replace currency with universal accounts with the central bank, possibly administered through commercial banks, post offices etc. Could pay positive or negative interest

# Abolish currency

- Formally $M \equiv N + D$

$N, D \geq 0$

$i^N = 0$

$i^D <> 0$

$\text{Set } N \equiv 0$

Works painlessly if *N* & *D* are perfect substitutes:

# If currency creates the zero lower bound, what can be done about it?

2. Tax currency and mark (stamp) it (Gesell, Irving Fisher). Like clipping coupons
   - Requires monitoring and enforcement
   - Administrative costs and intrusive policing
   - Does permit negative (and positive) interest rates on bearer instruments. Still don't know the identity of the owner, but we can verify from an inspection of the instrument whether it is 'current' on interest, so

$$i^N < o \text{ is possible}$$

# Goodhart's method for paying negative interest on currency

- All currency notes have serial number ending in integer from 0 to 9. All currency notes also should have a year printed on them.
- Once a year, on a fixed date, central bank randomly selects integer from 0 to 9.
- All currency notes ending in that integer, printed in that year or earlier, lose their legal tender status and are no longer redeemable/exchangeable at central bank for anything else
- Expected nominal interest rate on currency is therefore -10%
- Negative interest rate version of British Premium Bond, a government bond that bears no interest or capital gains but enters the holder into lotteries.
- Similar to putting an expiration date on currency
- Problem: value of fiat money is what people think it is. Legal tender status not necessary. Threat of confiscation may still be necessary

# If currency creates the zero lower bound, what can be done about it?

- *Spurious arguments against negative nominal interest rates:*
  - *My model doesn't solve when $i \leq 0$ (my programs cannot take the logarithm of a non-positive number)*
  - *How would people living off their savings survive?*
    - *Confusion between real & nominal rates*
    - *Confusion between removing zero lower bound (removing an asymmetry) and having rates negative forever*
    - *How about consuming capital?*
    - *Monetary policy is not social policy*

# Spurious arguments against negative nominal interest rates:

- Everyone would rush into: equity, gold etc.
- Let d be the euro dividend and q the euro price of a share of equity. Interior F.O.C.s are:

$$u'(c_t) = (1 + i^M_{t+1,t}) E_t \left( \frac{P_t}{P_{t+1}} u'(c_{t+1}) \right)$$

$$u'(c_t) = \frac{d_t}{q_t} E_t \left( \frac{P_t}{P_{t+1}} u'(c_{t+1}) \right) + E_t \left( \frac{P_t q_{t+1}}{P_{t+1} q_t} u'(c_{t+1}) \right)$$

so

$$1 + i^M_{t+1,t} = \frac{d_t}{q_t} + E_t \frac{q_{t+1}}{q_t} + \frac{Cov_t \left( \frac{P_t}{P_{t+1}} u'(c_{t+1}), \frac{q_{t+1}}{q_t} \right)}{E_t \left( \frac{P_t}{P_{t+1}} u'(c_{t+1}) \right)} \qquad (21)$$

# Spurious arguments against negative nominal interest rates

- Even with $d_t \geq o$, $i^M < o$ presents no special problems; either $q$ is expected to fall or the risk premium can do the job.
- Works for gold also; $c$ is non-gold consumption, f(z) is the marginal utility of gold, and q is the price of gold. Then. In (19)

$$d_t = \frac{p_t f(z_t)}{E_t\left(\frac{P_t}{P_{t+1}} u'(c_{t+1})\right)}$$

# If currency creates the zero lower bound, what can be done about it?

3. **Eisler's** solution: decouple the numéraire and means of payment/medium of exchange roles of currency

E.g.

- Abolish the euro as currency
- Introduce a new currency, the wim (Duisenberg)
- Keep the euro as numéraire (bank accounts, government contracts, bank reserves with central bank, government debt).
- There no longer is a zero lower bound on euro interest rates as there is no euro currency.
- There is a zero lower bound on wim interest rates
- There are both euro-denominated and wim-denominated one-period safe bonds
- Government sets the exchange rate over time (or spot and forward exchange rate) between euro instrument and wim instruments to ensure absence of arbitrage

# A simple model

- The wim currency model
  - Households:

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \left[ \ln c_t + \phi \ln \ell + \eta \ln \left( \frac{M_t^*}{S_t P_t} \right) \right], \; M_t^* \geq 0 \tag{22}$$

$$E_t I_{t+1,t}^* W_{t+1}^* \equiv W_t^* + S_t P_t (y_t - \tau_t - c_t) - \left( \frac{i_{t+1,t}^* - i_{t+1,t}^{*M}}{1 + i_{t+1,t}^*} \right) M_t^* \tag{23}$$

or

$$\frac{M_t^*}{S_t} + B_t + \frac{B_t^*}{S_t} \equiv (1 + i_{t,t-1}^{*M}) \frac{M_{t-1}^*}{S_t} + (1 + i_{t,t-1}) B_{t-1} + (1 + i_{t,t-1}^*) \frac{B_{t-1}^*}{S_t} + P_t (y_t - \tau_t - c_t) \tag{24}$$

# A simple model

$$E_0 \lim_{t\to\infty} I_{t+1,0} W_t^* \geq 0$$

or

$$E_0 \lim_{t\to\infty} I_{t+1,0} \left[ (1+i_{t+1,t}^{*M}) \frac{M_t^*}{S_t} + (1+i_{t+1,t}) B_t + (1+i_{t+1,t}^*) \frac{B_t^*}{S_t} \right] \geq 0. \tag{25}$$

$$\begin{aligned} M_{-1}^* &= \bar{M}_{-1}^* > 0 \\ B_{-1} &= \bar{B}_{-1} \\ B_{-1}^* &= \bar{B}_{-1}^* \end{aligned} \tag{26}$$

# A simple model

- Asset menu changes: no euro currency. Wim currency, euro and wim bonds
- Government:

$$A_t^* = (1$$

$$\frac{M_t^*}{S_t} + B_t + \frac{B_t^*}{S_t} \equiv (1+i_{t,t-1}^{*M})\frac{M_{t-1}^*}{S_t} + (1+i_{t,t-1})B_{t-1} + (1+i_{t,t-1}^*)\frac{B_{t-1}^*}{S_t} + P_t(g_t - \tau_t) \qquad (27)$$

$$E_0 \lim_{t\to\infty} I_{t+1,0}\left[(1+i_{t+1,t})B_t + (1+i_{t+1,t}^*)\frac{B_t^*}{S_t}\right] \le 0. \qquad (28)$$

- The price setting equations are the same
- The Taylor rule for the euro interest rate becomes (note contrast with (17)):

$$1 + i_{t+1,t} = \beta^{-1}\widehat{\pi} + \zeta(E_t\pi_{t+1,t} - \widehat{\pi}) \qquad (29)$$

  - Contrast (26) with (17)
- Asset market equilibrium:

$$A_t^* = (1+i_{t,t-1})S_t B_{t-1} + (1+i_{t,t-1}^*)B_{t-1}^* \qquad (30)$$

# A simple model

- *$S_t$ : spot exchange rate of the euro and the wim (# of wims per euro)*
- *$F_{t+1,t}$ : forward exchange rate of the euro and the wim (# of wims per euro)*

$$1 + i_{t+1,t} = \frac{S_t}{F_{t+1,t}}(1 + i^*_{t+1,t})$$ CIP

$$\sigma_{t_1,t_0} \equiv S_{t_1}/S_{t_0}$$

$$\frac{1+i_{t+1,t}}{1+i^*_{t+1,t}} = E_t\left(\frac{1}{\sigma_{t+1,t}}\right) + \frac{Cov_t\left(c^{-1}_{t+1}\pi_{t,t+1}, \sigma^{-1}_{t+1,t}\right)}{E_t\left(c^{-1}_{t+1}\pi_{t,t+1}\right)}.$$

Recognises the non-negativity of *i**

# A simple model

$$\frac{S_t M_t^*}{P_t} = \eta \left( \frac{1 + i^*_{t+1,t}}{i^*_{t+1,t} - i^{*M}_{t+1,t}} \right) C_t .$$

Note that it is possible, by decoupling the numéraire and the currency, to achieve Friedman's OQM rule: $i^* = i^{*M}$ even when $i^{*M}$ *is exogenous, including* $i^{*M} = o$ while still achieving any rate of inflation!

The reason is that OQM involves wim rate of interest, while inflation rate is in terms of the euro price level.

All other equilibrium relations are the same as in the euro currency model.

# A simple model

- Monetary authority can choose 3 out of the following four variables as instruments has three instruments (assuming $i^{*M} = o$)
  1. $i$
  2. $i^*$
  3. $S$
  4. $F$

  *Say it picks i, S and F. These three determine $i^*$ endogenously, subject to*

  $i^* \geq o$

# A simple model

If the path of the euro-wim exchange rate (which is a policy instrument) is deterministic, then:

$$\frac{1+i_{t+1,t}}{1+i^{*}_{t+1,t}} = \frac{S_t}{S_{t+1}}$$

The path of the exchange rate is irrelevant as long as $i^* \geq o$ *is not a binding constraint .*

If $i^* = o$ *, the authorities can still achieve* $i < o$ *by setting* $S_t / S_{t+1} < 1$.

So by appreciating the euro vis-a-vis the wim, the authorities can achieve an negative euro interest rate, even though the wim interest rate is constrained to be non-negative.

# Comments and Reflections

- You can determine a wim price level, $P^*$ , in the wim economy, because the law of one price would imply that

$$PS = P*$$

- Real interest rates on euro and wim bonds are the same in the wim currency economy (because of Covered Interest Parity, Law of One Price & the same set of exogenous variables.
- Real interest rates on euro and wim bonds in wim currency economy different from real interest rates on euro bonds in euro currency economy, even for identical processes for the exogenous variables, if there is any probability that the lower bound constraint becomes binding in the euro currency economy.

# Comments and reflections

- You don't have to abolish the euro (your existing currency). All the monetary authorities have to do is not exchange at par a euro bank note for bank reserves with the central bank (X euro bank note exchanges for X euro worth of reserves). Instead, X euro bank note exchanges for SX euro worth of reserves.

# Comments and Reflections

- Would the numéraire not 'follow the currency'? (this would cause the Phillips curve to be 'endogenously' re-specified in terms of wim prices)
- Governments and central bank can do much to avoid this:
  - All government/ECB/Eurosystem contracts denominated in euro
  - All taxes invoiced in euro
  - Prohibit bank accounts denominated in wim

- Having thus demonstrated 3 ways to overcome the zero lower bound, let's assume central banks continue to ignore these solutions. What else can be done, if we choose not to break through the zero lower bound?

# From zero lower bound to liquidity trap

- Make sure that you are not just at the zero lower bound for short rates, but in a proper liquidity trap:
  1. **Weak**: risk-free nominal interest rates at all maturities are at their lower bound
     - Use purchases of government assets of all maturities (QUANTITATIVE EASING)
     - Use credible announcements of future short rates
  2. **Strong:** yields on private assets at all maturities have no liquidity risk premium in them;
     - Use lender of last resort actions for funding liquidity
     - Use market maker of last resort actions for market (instrument) liquidity
       - Accepting a wider range of private sector collateral
       - Outright purchases of private securities
       - Unsecured lending to the banks or other private agents

# Once you are in a strong liquidity trap:

- Use helicopter drops of money (money-financed tax cuts or transfer payment increases)
- This means the central bank either acting as a fiscal principal in its own right, or acting as a fiscal agent for the government
- Will work only if increases in the monetary base are expected never to be reversed in the future

# There exists no strong liquidity trap equilibrium unless the monetary & fiscal authorities want it and demonetise the economy (Buiter (2003))

Household solvency constraint (binding):

$$\lim_{k\to\infty} E_t I_{k+1,t} W_k = \lim_{k\to\infty} E_t I_{k+1,t} \left( (1+i_{k+1,k}) B_k + (1+i^M_{k+1,k}) M_k \right) = 0 \qquad (31)$$

Assume government solvency constraint binds (this is a policy choice of the government):

$$\lim_{k\to\infty} E_t I_{k+1,t} (1+i_{k+1,k}) B_k = 0 \qquad (32)$$

Therefore:

$$\lim_{k\to\infty} E_t I_{k+1,t} (1+i^M_{k+1,k}) M_k = 0 \qquad (33)$$

In a strong liquidity trap,

$$i^M_{t+1,t} = i_{t+1,t} \text{ for all } t \qquad (34)$$

So as long as the growth rate of base money exceeds the nominal interest rate on base money, we'll have

$$\lim_{k\to\infty} E_t I_{k+1,t} (1+i^M_{k+1,k}) M_k = \lim_{k\to\infty} E_t I_{k,t} M_k > 0 \qquad (35)$$

*So,* with (32) & (33) holding with equality we have a contradiction with (35).

# There exists no strong liquidity trap equilibrium unless monetary authority wants it (Buiter (2003))

- In the case of zero nominal interest rate on base money, if both the private and public sectors satisfy their solvency constraints with equality, a strong liquidity gap cannot be an equilibrium unless the stock of base money goes to zero (the OQM equilibrium is an example).

# Consolidating household & government intertemporal budget constraints:

- The consolidated private and public sector intertemporal budget constraints imply:

$$0 \equiv P_t(c_t + g_t - y_t) + E_t \sum_{j=1}^{\infty} I_{t+j,t} P_{t+j}(c_{t+j} + g_{t+j} - y_{t+j}) \qquad (36)$$

- So there is both debt neutrality (Ricardian equivalence) and absence of any "pure wealth effect from fiat base money issuance".
- Impossibility of strong liquidity traps (if private & public IBCs bind and $M_t > o$ always) due to transversality condition (13) and/or asymmetric solvency constraints between private & public sectors.

# Problems of QE

- **Ideology;** (ECB)
- **Reversibility**; depends on fiscal credibility & future fiscal capacity
- **Default risk** for some Euro Area Sovereigns
  - Who recapitalises/bails out the ECB/Eurosystem?
  - Absence of a 'fiscal Europe'
  - Threat to ECB independence without fiscal indemnity for losses incurred due to default in monetary policy operations, liquidity enhancing and credit enhancing operations.

# Problems of CE

- Operational problems:
  - What private securities to accept as collateral
  - What private securities to buy outright
  - Which private counterparties to lend to unsecured
- (Credit risk problems of QE)$^2$
- Note change of  notation in what follows.

# Conventional Balance Sheet of Central Bank

<table>
<tr><th>Assets</th><th colspan="2">Liabilities</th></tr>
<tr><td>T: Treasury securities (bought outright)</td><td rowspan="2">M<sub>0</sub>: Monetary base</td><td>C: Currency</td></tr>
<tr><td>L(T): Loans to the private sector (including repos) secured against Treasury securities</td><td>BR: Bank reserves with central bank</td></tr>
<tr><td>L(P): Loans to the private sector (including repos) secured against private securities.</td><td rowspan="4">L: Non-monetary liabilities of the central bank</td><td>TD: Treasury deposits with the central bank</td></tr>
<tr><td>P: Private securities (bought outright)</td><td rowspan="3">CBB: Central banks bills and bonds</td></tr>
<tr><td>L: Unsecured loans to the private sector</td></tr>
<tr><td rowspan="2">X: Central bank foreign exchange reserves</td></tr>
<tr><td colspan="2">W: Conventional Net Worth or Equity</td></tr>
</table>

# Comprehensive Balance Sheet of Central Bank
## (intertemporal budget constraint (Buiter (2007))

<table>
<tr><th>Assets</th><th colspan="2">Liabilities</th></tr>
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<tr><td>P: Private securities (bought outright)</td><td rowspan="2">CBB: Central banks bills and bonds</td></tr>
<tr><td>L: Unsecured loans to the private sector</td></tr>
<tr><td>S: Present value of future seigniorage (interest saved by issuing monetary base liabilities)</td><td colspan="2">E: present value of future cost of running the central bank</td></tr>
<tr><td rowspan="2">X: Central bank foreign exchange reserves</td><td colspan="2">T: present value of future net payments to the Treasury</td></tr>
<tr><td colspan="2">V: Comprehensive Net Worth or Equity</td></tr>
</table>

# Can central banks go broke?

- Central bank's conventional equity, *W*, need not be positive, but its comprehensive net worth, $V=W+S-E-T$ , must be positive, lest it either is at risk of failing to meet its financial obligations, or will have to raise *S* and thus future inflation to restore solvency.
- Restoring solvency even through seigniorage may be impossible if the exposure of the central bank is to foreign currency assets or index-linked assets.
- In that case only a low or negative realisation of *T* (recapitalisation by the Treasury) can restore central bank solvency

# Conventional and comprehensive balance sheets of the ECB/Eurosystem look

- ECB itself small and irrelevant
- Eurosystem (ECB + 16 Euro Area NCBs) large and relevant, but not fully integrated
- NCBs share losses incurred as a result of Eurosystem monetary operations, liquidity operations and credit-enhancing operations
- NCBs do not share losses incurred by NCB acting as quasi-fiscal agent for national Treasury
- NCBs do no pool capital.

# ECB conventional balance sheet; (year-end)

| Assets (€ bn) | | | Liabilities (€ bn) | | |
|---|---|---|---|---|---|
| | 2008 | 2007 | | 2008 | 2007 |
| Gold & Gold Receivables | 10.7 | 10.3 | Bank notes in circulation | 61 | 54.1 |
| Claims on non-euro area residents in foreign currency | 41.6 | 29.2 | Liabilities to euro area residents in euro | 1 | 1.1 |
| Claims on euro area residents in foreign currency | 22.2 | 3.9 | Liabilities to non-euro area residents in euro | 253.9 | 14.5 |
| Other assets | 14.3 | 11.3 | Liabilities to euro area residents in foreign currency | 0.3 | 0 |
| Intra-Eurosystem claims | 295.1 | 71.3 | Liabilities to non-euro area residents in foreign currency | 1.4 | 0.7 |
| | | | Other liabilities | 20.5 | 9.4 |
| | | | Intra-Eurosystem liabilities | 40.1 | 4 |
| | | | Capital & reserves | 4.1 | 4.1 |
| | | | Profit for the year | 1.3 | 0 |
| Total | 383.9 | 126 | Total | 383.9 | 126 |

# Eurosystem Assets, 08/-5/2009

| Assets (EUR millions) | | |
|---|---|---|
| 1 | Gold and gold receivables | 240,817 |
| 2 | Claims on non-euro area residents denominated in foreign currency | 159,299 |
| 3 | Claims on euro area residents denominated in foreign currency | 123,101 |
| 4 | Claims on non-euro area residents denominated in euro | 21,359 |
| 5 | Lending to euro area credit institutions related to monetary policy operations denominated in euro | 653,352 |
| 6 | Other claims on euro area credit institutions denominated in euro | 26,453 |
| 7 | Securities of euro area residents denominated in euro | 292,405 |
| 8 | General government debt denominated in euro | 36,790 |
| 9 | Other assets | 241,523 |
| | Total assets | 1,795,099 |

# Eurosystem Liabilities, 08-05-2009

| Liabilities (EUR millions) | | | |
|---|---|---|---|
| 1 | Banknotes in circulation | | 759,502 |
| 2 | Liabilities to euro area credit institutions related to monetary policy operations denominated in euro | | 264,137 |
| 3 | Other liabilities to euro area credit institutions denominated in euro | | 436 |
| 4 | Debt certificates issued | | 0 |
| 5 | Liabilities to other euro area residents denominated in euro | | 139,090 |
| | 5.1 | of which General government | 130,717 |
| 6 | Liabilities to non-euro area residents denominated in euro | | 177,993 |
| 7 | Liabilities to euro area residents denominated in foreign currency | | 1,548 |
| 8 | Liabilities to non-euro area residents denominated in foreign currency | | 11,407 |
| 9 | Counterpart of special drawing rights allocated by the IMF | | 5,551 |
| 10 | Other liabilities | | 159,644 |
| 11 | Revaluation accounts | | 202,952 |
| 12 | Capital and reserves | | 72,840 |
| Total liabilities | | | 1,795,099 |

# Can the Eurosystem go broke?

- Consolidated financial statement of the Eurosystem as at 8 May 2009:
  - **Bad news: Eurosystem has only €74 bn of capital and reserves & €1,795 bn worth of assets, i.e. 24.6 times leverage**
  - **Good news: Eurosystem's balance sheet is 20% of Euro Area annual GDP & monetary base (€1 trillion, 75% currency) is about 11% of GDP (€9.2 trillion)**

# Can the Eurosystem go broke?

- With 4 % trend nominal GDP growth a reasonable seigniorage benchmark is 0.33% of GDP each year (currently €30bn).
- If long-term safe interest rate exceeds long-term growth rate of GDP by one percent, capitalised value of seigniorage is 33% of GDP, more than 1.5 times the size of the balance sheet of the Eurosystem.
- Safe but beware:
  - growth of balance sheet of Eurosystem
  - Financial development and crime-fighting could reduce seigniorage revenue

# Conclusions

1. There is no zero lower bound, or rather, there need not be a zero lower bound on nominal rates of interest. There are 3 ways of eliminating the zero lower bound
   - Abolish currency
   - Tax currency
   - Decouple the currency from the numéraire. Use the spot and forward exchange rates between numéraire-denominated assets and the currency to drive the interest rate on numéraire-denominated assets below zero even when the interest rate on currency-denominated assets is at the zero lower bound.

# Conclusions

2. Central banks engaged in QE may need long-term credible fiscal backup to pursue both CE/QE and price stability
3. Central banks engaged in CE/QE may need a fiscal indemnity for capital losses due to defaults on risky assets (private and/or public) the central bank becomes exposed to through repos or outright purchases of securities and unsecured lending

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