The Debt of Nations Revisited Lecture 2

The Central Bank as a quasi-fiscal player: theory and applications

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Central banks as a branch of government

- Even operationally independent (and target independent) central banks are state agencies, although they may not be part of the executive, legislative or judiciary branches of government.
- The financial resources of the central bank are “tax payers’ money”
  - In a standard ‘one central bank – one Treasury’ configuration, the Treasury is the proximate beneficial owner of the central bank (whatever the legal technicalities) and the tax payers/beneficiaries of public spending are the ultimate beneficial owners of the central bank’s resources.
  - In the Euro Area (EA), the NCBs are the shareholders of the ECB, but the national Treasuries are the beneficial owners of their NCBs, so ultimately EA tax payers/beneficiaries of public spending are the ultimate beneficial owners of the ECB’s resources.
  - The non-inflationary loss-absorption capacity (NILAC) of the leading central banks is huge. We expect the ECB’s NILAC to be used on a cumulatively significant scale, but never in an overwhelming, pre-emptive manner.

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The ‘Game of Chicken’ between the central bank and the Treasury

Central banks and Treasuries often clash over the who takes on the direct burden for financial rescues – the Treasury usually wins

- Central banks are the natural lender of last resort (LLR) for the sovereign
- TFEU Article 123 makes it awkward but not impossible for the ECB/Eurosystem to act as LLR for the sovereign
- Central banks fight for dominance with fiscal authorities over unsustainable government deficits.
  - This is conveniently modeled as a *game of chicken*
  - *Fiscal dominance* is generally the outcome of this game of chicken: the central bank gives in
  - The EA could be different because there are 17 national Treasuries facing a single central bank; ECB trying to establish *monetary dominance*
  - Despite this, fiscal dominance has steadily been asserted. We can expect this to continue.
- The ECB/Eurosystem has already acted not only as LLR for solvent but illiquid sovereigns, it has provided funding for manifestly insolvent sovereigns (Greece, Portugal, Ireland), using the fig-leaf of market maker of last resort/orderly transmission mechanism for monetary policy

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The period budget identity of the Central Bank

$$M_t - D_t - L_t - e_t R_t^f$$
$$\equiv C_t^b + T_t^b + H_t + (1+i_t^M)M_{t-1} - (1+i_t)D_{t-1} - (1+i_t^L)L_{t-1} - (1+i_t^f)e_t R_{t-1}^f \quad \textbf{(1)}$$

Where:

- M = Monetary base
- R^f = Foreign Exchange Reserves
- e = Nominal Exchange Rate
- D = Treasury Bills
- L = Claims on the Private Sector
- T^b = Taxes paid by the Central Bank
- H = Transfer Payments to the Private Sector ("helicopter drops")
- C^b = Central Bank Spending on Goods and Services
- i, i^f, i^M, i^L : one period nominal interest rates on domestic T-bills, foreign exchange reserves, the monetary base and central bank lending to the private sector

The intertemporal budget constraint of the Central Bank

$$(1+i_t^M)M_{t-1}-(1+i_t)(D_{t-1}+L_{t-1}+e_{t-1}R_{t-1}^f)\le E_t\sum_{j=t}^{\infty}I_{j,t}\left[-\left(C_j^b+T_j^b+H_j+Q_j\right)+\left(\frac{i_{j+1}-i_{j+1}^M}{1+i_{j+1}}\right)M_j\right] \quad \textbf{(2a)}$$

or

$$-(1+i_t)\left(D_{t-1}+L_{t-1}+e_{t-1}R_{t-1}^f\right)\le E_t\sum_{j=t}^{\infty}I_{j,t}\left[-\left(C_j^b+T_j^b+H_j+Q_j\right)+\left(M_j-(1+i_j^M)M_{j-1}\right)\right] \quad \textbf{(2b)}$$

where

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

$$=1 \quad \text{for} \quad t_1=t_0$$

is the nominal discount factor

$$\frac{1}{1+i_t}=E_tI_{t+1,t}$$

E_t is the expectation operator conditional on information at time t

and $Q_j=(i_j-i_j^L)L_{j-1}+\left(1+i_j-(1+i_j^f)\frac{e_j}{e_{j-1}}\right)e_{j-1}R_{j-1}^f$ are the implicit (quasi-fiscal) subsidies paid by the central bank

In practice, Helicopter drops of money cannot be implemented by the central bank alone, but requires combined central bank-Treasury actions. So set $H_j = 0$ in what follows.

The many faces of seigniorage and the inflation tax

- **Seigniorage**: the profits earned from the new issuance of base money in a period

$$S_{1,t} = M_t - (1+i_t^M)M_{t-1}$$
$$= \Delta M_t \quad \text{if} \quad i^M = 0$$

- **Central Bank Interest Saved**: interest earned by investing the resources obtained though the past issuance of base money in interest-bearing assets

$$S_{2,t} = \left(i_t - i_t^M\right)M_{t-1}$$
$$= i_t M_{t-1} \quad \text{if} \quad i^M = 0$$

- **Anticipated Inflation Tax**: the reduction in the real value of the stock of base money caused by inflation

$$S_{3,t} = \pi_t M_{t-1} \qquad \text{where} \quad \pi_t = \frac{P_t}{P_{t-1}} - 1$$

Anticipated inflation tax can be effective in reducing the real NPV of debt service for interest-bearing instruments when there is financial repression

- **Unanticipated Inflation Tax:** reduction in the real NPV of current and future debt service on fixed rate, nominally denominated (sovereign) debt due to unanticipated inflation.

Relating the PV of Seigniorage, CB Revenue and the Inflation tax

- NPV of seigniorage (S_1) is given by:

$$NPV_t(S_1) \equiv E_t \sum_{j=t}^{\infty} I_{j,t} \left(M_j - (1+i_j^M) M_{j-1} \right)$$

- NPV of Central Bank Interest Saved (S_2) is given by:

$$NPV_t(S_2) \equiv E_t \sum_{j=t}^{\infty} I_{j,t} \left(\frac{i_{j+1} - i_{j+1}^M}{1+i_{j+1}} \right) M_j$$

- The intertemporal seigniorage identity (Buiter 1983, 2007)

$$E_t \sum_{j=t}^{\infty} I_{j,t} \left(M_j - (1+i_j^M) M_{j-1} \right) \equiv E_t \sum_{j=t}^{\infty} I_{j,t} \left(\frac{i_{j+1} - i_{j+1}^M}{1+i_{j+1}} \right) M_j - \left(1+i_t^M \right) M_{t-1}$$

$$NPV_t(S_1) \equiv NPV_t(S_2) - (i+i_t^M) M_{t-1}$$

→ Maximizing the NPV of S_1 is equivalent to maximizing the NPV of S_2

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Conventional financial balance sheet of the central bank

Table 1 Central Bank Conventional Financial Balance Sheet	
Assets	**Liabilities**
D	M
L	
eR^f	
	W^b

W^b : conventional net worth, capital or equity of the central bank (with $i^M = 0$)

$$W^b = D + L + eR^f - M \qquad (3)$$

Do central banks need positive (conventional) equity?

- For central banks there is no close relationship between conventional regulatory notions of capital/equity, W^b, and economic capital, that is, unconditional loss-absorbing capacity, $\overline{W}^b$.

Comprehensive balance sheet/intertemporal budget constraint of central bank	
Assets	**Liabilities**
D	M
L	
eR^f	
$NPV(S_2)$	$NPV(\text{Costs of running central bank})$
	$NPV(\text{Quasi-fiscal subsidies})$
	$NPV(\text{Payments to Treasury})$
	$\overline{W}^b$

Equivalent comprehensive balance sheet of central bank

Comprehensive balance sheet/ intertemporal budget constraint of central bank	
Assets	**Liabilities**
D	
L	
eR^f	
$NPV(S_1)$	NPV(Costs of running central bank)
	NPV(Quasi-fiscal subsidies)
	NPV(Payments to Treasury)
	$\bar{W}^b$

$\bar{W}^b \geq 0$ requires

$$W^b + NPV(S_2) \geq NPV(\text{Payments to Treasury}) + NPV(\text{Costs of running central bank}) + NPV(\text{Quasi-fiscal subsidies})$$

where

$$W^b = D + L + eR - M$$

$$NILAC \triangleq W^b + NPV(S_2)$$

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The non-inflationary loss-absorption capacity of the central bank

- A central bank that suffers a capital loss can, assuming *NPV*(Costs of running central bank) and *NPV*(Quasi-fiscal subsidies) are given, either increase *NPV(S2)* or reduce *NPV (Payments to Treasury).*
- As long as we are on the correct side of the seigniorage Laffer curve, increasing *NPV(S2)* means higher inflation.
- Setting the *NPV(Payments to Treasury)* to zero gives the maximum non-inflationary loss-absorption capacity of the central bank (unless the Treasury is willing to contribute to the central bank's capital – *NPV(Payments to Treasury)* could be negative).
- Calculate *NPV(S2)* at the target rate of inflation of the monetary authorities as the unrecorded non-inflationary loss absorption capacity of the central bank. This can be added to the conventional loss absorption capacity of the central bank.

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Estimating NPV of Narrow Seigniorage

- Notation: $M = C + R$

  $R = R^r + R^e$

  C : currency

  R: bank reserves held with the central bank

  R^r : required reserves

  R^e : excess reserves

- Narrow seigniorage in a point in time: $\Delta C_t = C_t - C_{t-1} = S_t$
- Net Present Discounted Value of current and future narrow seigniorage:

$$NPV_t\{\Delta C\} = \sum_{j=0}^{\infty} I_{t+j}\Delta C_{t+j}$$

$$NPV_t\{\Delta C\} = C_{t-1}\left(\frac{1+i}{i-\mu}\right)\mu \qquad \textbf{(4)}$$

Where:

- $I_{t+j} = \frac{1}{(1+i)^j}$ = Discount factor
- μ = Growth rate stock of currency
- *t-1* = initial period

Estimating NPV of Narrow Seigniorage

- 3 Steps
  - 1) Specify currency demand function
  - 2) Estimate parameters of currency demand function
  - 3) use formula for PDV of seigniorage, together with assumptions on the growth rates of currency that are consistent with price stability (target inflation) and on nominal interest rates.

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Currency Demand Function

Currency demand depends positively on the amount of transactions in the economy and negatively on the opportunity cost of holding money (the interest rate)

- A typical long-run currency demand function takes the following form:

$$\frac{C}{P} = kY^{\alpha}e^{-\beta\left(i-i^{C}\right)} \qquad \textbf{(5)}$$

Where:

- α = the output (scale) elasticity of the demand for currency
- β = the semi-elasticity of currency demand with respect to the opportunity cost of holding currency
- k, α, β >0

Cagan, Philip (1956), "Monetary Dynamics of Hyperinflation", in Milton Friedman, Editor, *Studies en the Quantity Theory of Money*, University of Chicago Press, Chicago, Illinois.

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The NILAC formula

- From equation (5), when real GDP grows at a constant rate γ, inflation is constant at π, it follows that

$$1+\mu=(1+\pi)(1+\gamma)^{\alpha}$$

- Plugging this into the NPV(ΔC) formula (4) gives:

$$NPV(\Delta C)=\left(\frac{1+i}{1+i-(1+\pi)(1+\gamma)^{\alpha}}\right)\left((1+\pi)(1+\gamma)^{\alpha}-1\right)C_0 \qquad \textbf{(6)}$$

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Currency Demand Function for the EA: Data

We have estimated money demand functions for the EA, using Johansen (1991)'s cointegration approach

- Sample period: 1977Q1 – 2011Q2
- Variables:
  - Real currency demand:
    - proxy aggregate for the Euro Area based on data from Germany, France, Italy, Spain and Netherlands. Aggregation by summing countries nominal currencies (all in millions of Euros, end of period, and provided by the IMF), and deflated by an aggregated CPI
  - Real GDP
    - proxy aggregate by summing real GDP for the above countries (in millions of chained 2000 Euros, provided by the OECD)
  - Interest Rate
    - proxy aggregate by a weighted average (by GDP share) of the short term interest rates across countries (3 month Treasury bills, quarterly average from monthly data, and provided by the OECD).

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Currency Demand Function for the EA: Methodology

We have estimated money demand functions for the EA, using cointegration's techniques in the Johansen's (1991) test approach

- Methodology: Cointegration
- Test: Johansen (1991)
- Procedure:
  - Testing for unit roots (Augmented Dickey-Fuller)
  - Estimating a VAR (Schwarz criterion for lag length)
  - Testing for the presence of cointegration vectors (Maximum eigenvalue test)
  - Estimating the VEC

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Currency Demand Function for the EA: Results

We have estimated money demand functions for the EA, using cointegration's techniques in the Johansen's (1991) test approach

- Coefficient for output elasticity of currency demand: around 0.85
  - very robust estimate
    - Using GDP deflator rather than CPI
    - Using policy rates or 10-year bond rates instead of 3-month Treasury bill rate
    - Using Engle & Granger cointegration methodology
    - Using different samples
- Coefficient for interest rate (semi) elasticity around 3
  - Robustness much less robust, with values often ranging from 2 to 4 and sometimes much wider
  - But it turns out that quantitative significance of this estimate is rather small for our purposes….

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Currency Demand Function for the EA: Results

	Benchmark	GDP Deflator	Sample Period 2001q1 - 2011q2	Sample Period 1977q1 - 2000q4
Log(GDP)	0.849**	0.851**	0.899**	0.856**
(s.d.)	(0.004)	(0.004)	(0.013)	(0.005)
Int	-2.923**	-3.122**	-16.416**	-3.431**
(s.d.)	(0.651)	(0.654)	(5.358)	(0.707)
dummy_1992	0.008*	0.013**		0.015*
(s.d.)	(0.009)	(0.009)		(0.015)
dummy_2001	-0.051**	-0.052**		
(s.d.)	(0.011)	(0.010)		
dummy_2001q4	-0.234**	-0.240**		
(s.d.)	(0.021)	(0.021)		
dummy_2002q4	0.256**	0.258**		
(s.d.)	(0.022)	(0.022)		
dummy_2003	-0.019*	-0.017**		
(s.d.)	(0.011)	(0.011)		
dummy_2008	0.019**	0.021**		
(s.d.)	(0.009)	(0.009)		
No. Observations	132	132	42	93
R2	0.821	0.837	0.044	0.293

Source: Citi Investment Research and Analysis

Estimates of the PDV of narrow seigniorage for the euro area

The PDV of narrow seigniorage for the ECB is very large

- Plugging in our estimates for α and β into:

$$NPV(\Delta C) = \left(\frac{1+i}{1+i-(1+\pi)(1+\gamma)^{\alpha}} \right) \left((1+\pi)(1+\gamma)^{\alpha} - 1 \right) C_0$$

and combining with assumptions on g, i, and π gives

Present Discounted Value of future seigniorage in the Euro Area (α= 0.8; β=2.9)

EUR (bn)	Interest/ Discount Rate (i)				
Real Growth Rate (g)	3.5%	4.0%	4.5%	5.0%	5.5%
0.5%	€1,886	€1,273	€956	€763	€632
1.0%	€3,717	€2,065	€1,421	€1,078	€865
1.5%	€13,090	€3,817	€2,216	€1,553	€1,189
2.0%	Infinite	€10,966	€3,888	€2,345	€1,670

Note: α represents the long run income elasticity of the money demand function, and β the corresponding interest rate semi-elasticity

Source: Citi Investment Research and Analysis

The same approach applied to the case of the US…

Present Discounted Value of future seigniorage in the United States (α= 0.8; β=7.2)

USD (bn)	Interest/ Discount Rate (i)				
Real Growth Rate (g)	3.5%	4.0%	4.5%	5.0%	5.5%
0.5%	$1,727	$1,150	$849	$664	$540
1.0%	$3,186	$1,795	$1,226	$918	$724
1.5%	$8,669	$3,096	$1,839	$1,285	$974
2.0%	Infinite	$7,077	$3,005	$1,864	$1,329

Note: α represents the long run income elasticity of the money demand function, and β the corresponding interest rate semi-elasticity

Source: Citi Investment Research and Analysis

the UK, …

Present Discounted Value of future seigniorage in the United Kingdom (α= 0.8; β=1.7)

GBP (bn)	Interest/ Discount Rate (i)				
Real Growth Rate (g)	3.5%	4.0%	4.5%	5.0%	5.5%
0.5%	£98	£67	£51	£41	£34
1.0%	£182	£105	£74	£56	£46
1.5%	£514	£183	£111	£79	£62
2.0%	Infinite	£432	£183	£116	£85

Note: α represents the long run income elasticity of the money demand function, and β the corresponding interest rate semi-elasticity

Source: Citi Investment Research and Analysis

and Japan

Present Discounted Value of future seigniorage in Japan (α= 0.7; β=12.1)

Yen (trn)	Interest/ Discount Rate (i)				
Real Growth Rate (g)	3.5%	4.0%	4.5%	5.0%	5.5%
0.5%	¥136	¥90	¥65	¥50	¥40
1.0%	¥225	¥131	¥89	¥66	¥51
1.5%	¥457	¥203	¥125	¥88	¥66
2.0%	¥2,438	¥360	¥185	¥120	¥86

Note: α represents the long run income elasticity of the money demand function, and β the corresponding interest rate semi-elasticity

Source: Citi Investment Research and Analysis

The non-inflationary NPV of seigniorage numbers underestimate true *NILAC*

- Currency only
  - Ignores required reserves or assumes they are paid market opportunity cost
    - Reserve requirements can be raised (they were just lowered from 2% of eligibible deposits to 1% in EA)
  - Ignores excess reserves or assumes they are paid market opportunity cost
    - Remuneration rate of both required and excess reserves are instruments of central bank
- Need to add about €400bn of conventional loss-absorbing capacity for Eurosystem (€81bn capital plus reserves and around €320bn worth of gold & forex reserve revaluations)
- $NPV(S_2) = NPV(S_1)+M_0$, where M_0 for EA ≈ €875bn

NILAC estimate for EA with γ = 1% and i =4%: €3.2 trillion.

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The Conventional Balance Sheet of the Central Bank

Why does using NILAC not imply present or future base money creation?

Assets	Liabilities	
– Loans to the private sector (including repos) secured against treasury securities	– Currency	Monetary Base
– Loans to the private sector (including repos) secured against private securities.	– Bank overnight deposits/reserves with central bank	Monetary Base
– Treasury securities (bought outright)	– Bank term deposits with central bank	Non-monetary Liabilities
– Private securities (bought outright)	– Treasury deposits with the central bank	Non-monetary Liabilities
– Unsecured loans to the private sector	– Central banks bills and bonds	Non-monetary Liabilities
– Central bank foreign exchange reserves	– Conventional Net Worth or Equity	

Sources: Citi Investment Research and Analysis

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The Comprehensive Balance Sheet of the Central Bank

Assets	Liabilities	
– Loans to the private sector (including repos) secured against treasury securities	– Currency	Monetary Base
– Loans to the private sector (including repos) secured against private securities.	– Bank overnight deposits/reserves with central bank	Monetary Base
– Treasury securities (bought outright)	– Bank term deposits with central bank	Non-monetary Liabilities
– Private securities (bought outright)	– Treasury deposits with the central bank	Non-monetary Liabilities
– Unsecured loans to the private sector	– Central banks bills and bonds	Non-monetary Liabilities
– Central bank foreign exchange reserves	– Present value of future cost of running the central bank	
– NPV of future interest saved through the central bank's monopoly of base money	– Present value of future net payments to the Treasury	
	– Comprehensive Net Worth or Equity	

Sources: Citi Investment Research and Analysis

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The Conventional Balance Sheet of the Eurosystem

Assets (Mil EUR)		
	02-Dec-11	03-Dec-10
Gold & forex reserves	712,321	597,912
Collateralised loans to banks	748,473	558,771
Debt held outright	639,664	485,626
Other assets	353,230	281,821
Total assets	2,435,688	1,924,130

Liabilities (Mil EUR)		
	02-Dec-11	03-Dec-10
Banknotes in circulation	873,981	824,523
Bank reserves	707,956	337,919
Non-monetary liabilities	388,995	386,761
Financial net worth	81,481	78,187
Revaluation accounts	383,276	296,740
Total liabilities	2,435,688	1,924,130

Note: “Debt held outright” includes public and private debt securities held for monetary policy purposes, including those resulting from the Covered Bonds scheme and the government debt purchases of the Securities Markets Programme announced on May 10, 2010. It also includes a small amount of sovereign debt securities held not for monetary policy purposes. Totals/sub-totals may not add up, due to rounding.

Sources: ECB and Citi Investment Research and Analysis

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Does the vast increase in the monetary base spell future inflation?

Consider data since the start of the crisis (2007) for the size of the balance sheet (currency units and share of GDP), for the monetary base, currency, required reserves and excess reserves, Eurosystem, Federal Reserve System, BoE, BoJ

Ways to neutralise potentially inflationary consequences of central bank balance sheet increase:

1) Shrinking the size of the balance sheet by selling assets & running down loans
2) Sterilising the monetary liabilities
3) Raising reserve requirements (turning excess reserves into required reserves)
4) Raising the remuneration rate on excess reserves to induce banks to hold them idle

(3) And (4) reduce the size of the base money – broad money or base money – bank credit multiplier.

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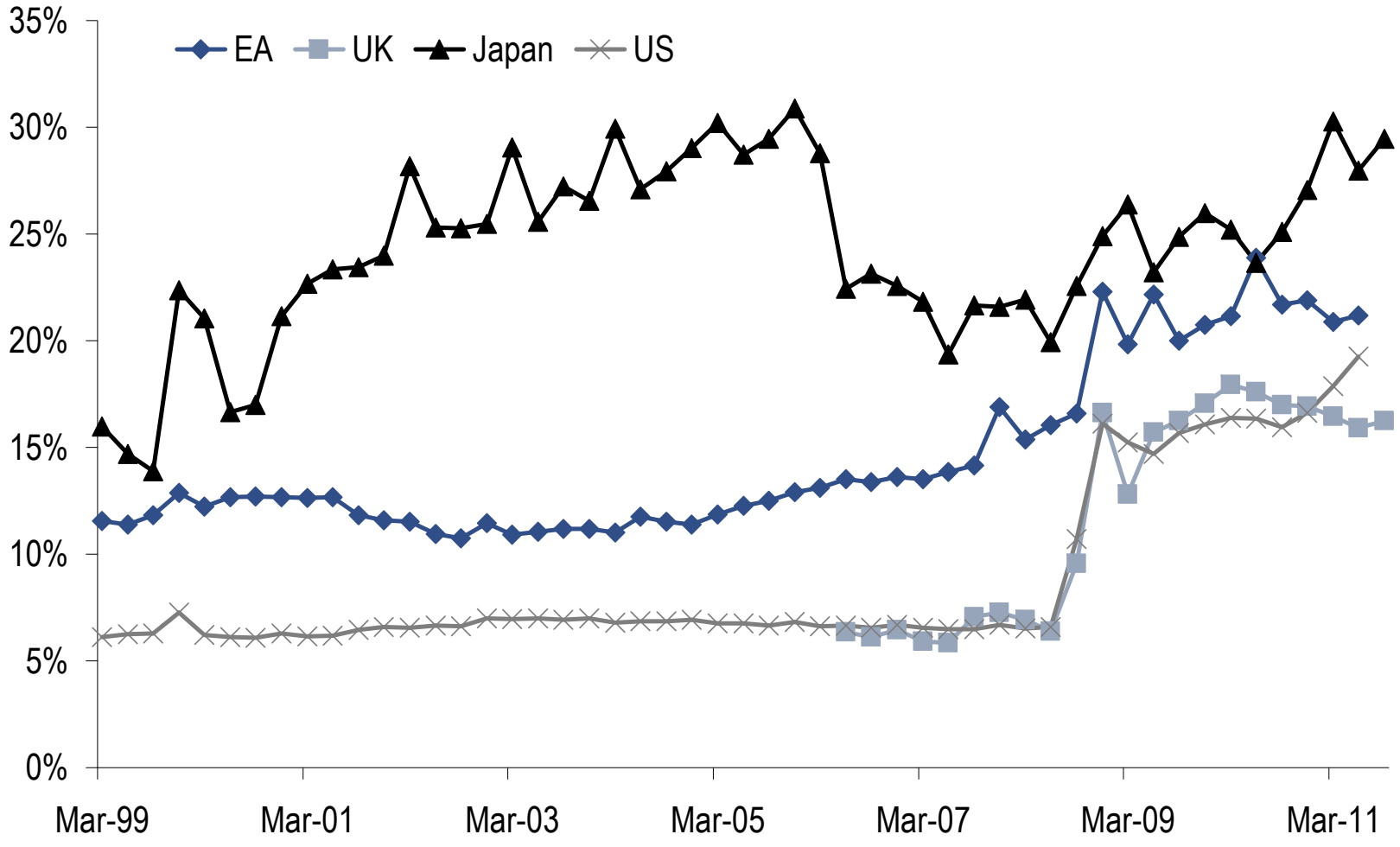
Size of Central Bank Balance Sheets

The ECB's and BoJ's balance sheet remain larger, but the BoE and the Fed have been catching up quickly

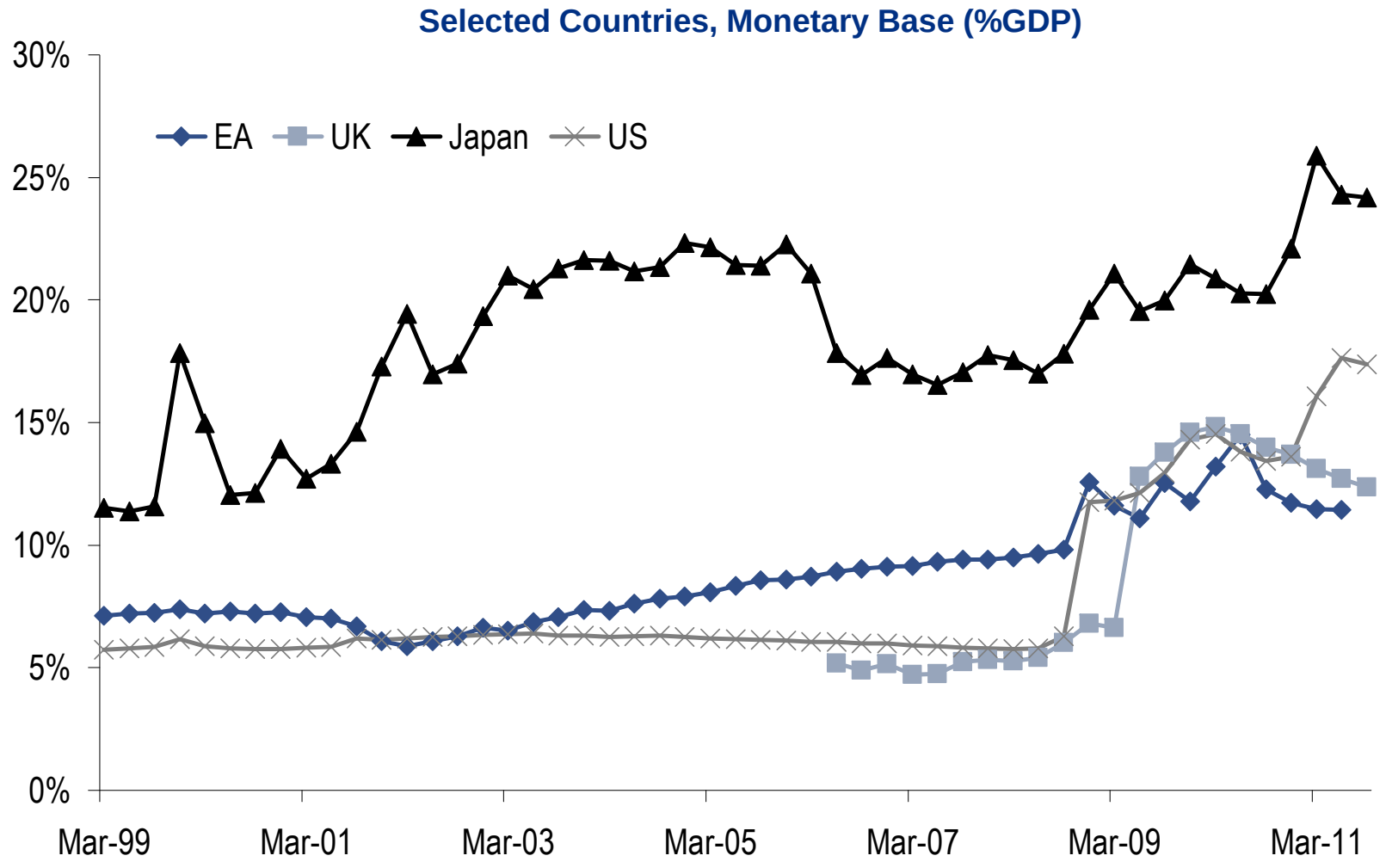
Selected Countries, size of balance sheet of Central Bank (%GDP)



Source: Bureau of Economic Research, ECB, Eurostat, National Central Banks, National Statistic Offices, and Citi Investment Research and Analysis

Monetary Base in the EA, Japan, UK, and US

And the monetary base is already larger (in proportion) in the US and UK than in the euro area

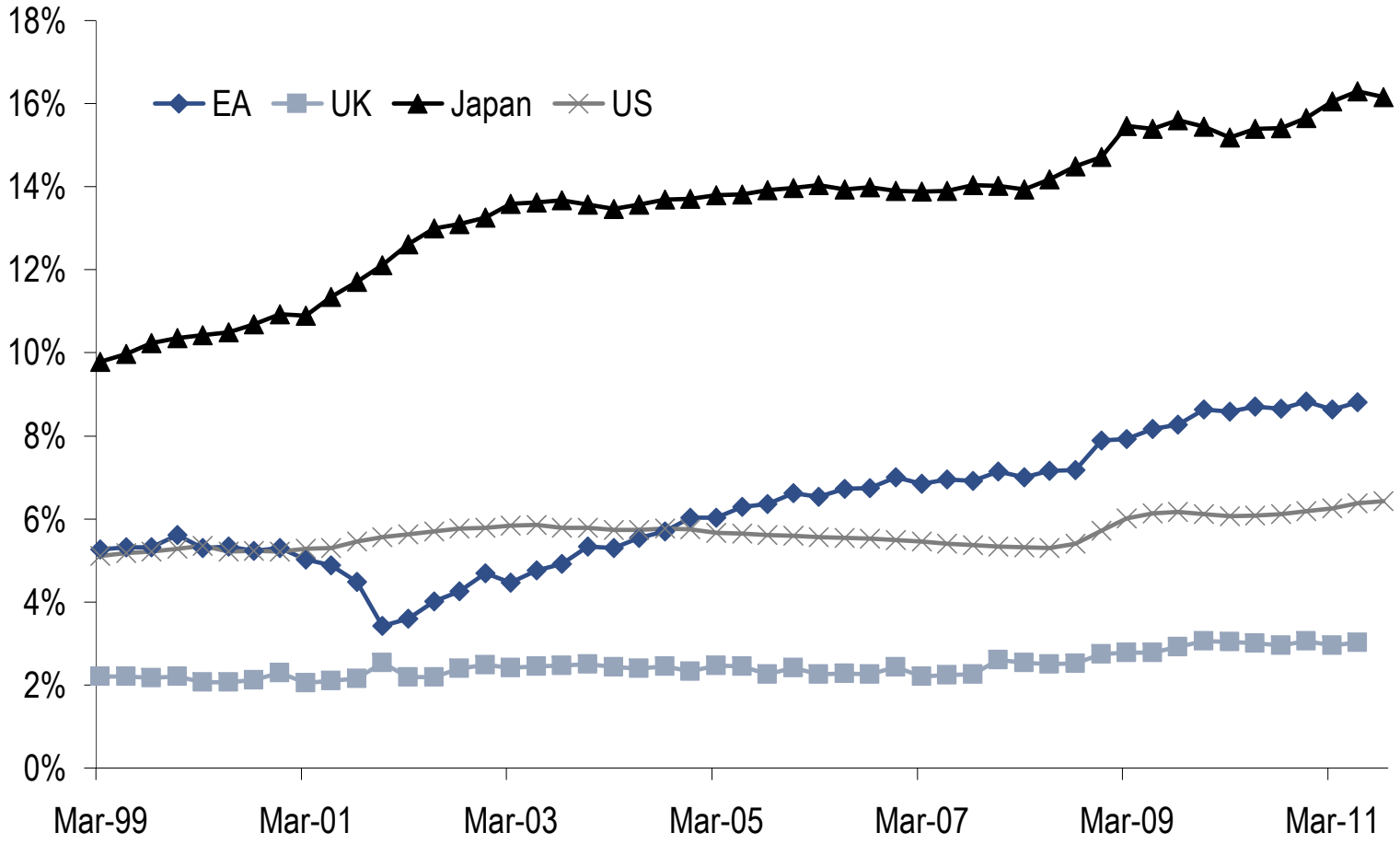


Source: Bureau of Economic Research, ECB, Eurostat, National Central Banks, National Statistic Offices, and Citi Investment Research and Analysis

Currency in circulation in the EA, Japan, UK, and US

Currency in circulation is much less volatile and remains much higher in Japan and EA than in the US and UK

Selected Countries, Currency in Circulation (%GDP)



Source: Bureau of Economic Research, ECB, Eurostat, National Central Banks, National Statistic Offices, and Citi Investment Research and Analysis

The Central Bank as Lender of last Resort for the Sovereign

- Sovereigns are like banks: even when sound, they are at risk of illiquidity
  - Long-maturity illiquid assets
    - NPV of future tax revenues
    - NPV of future public spending cuts
  - Recurrent funding needs
- Therefore always risk of self-validating, insolvency fear driven denial of market access for banks and sovereigns & disorderly, fundamentally unwarranted sovereign default
  - Bank deposit run or wholesale funding run
  - Sovereign debt run/sudden stop
- Sovereign needs LLR
  - Stock of liquid financial assets (EFSF/EFSM, ESM)
  - External source of liquid funds (IMF)
  - Central bank (for domestic currency liquidity only)
- How relevant is classic Bagehot LLR model
  - Lend to solvent parties only?
  - Against good collateral?
  - At a penalty rate?

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Article 123 TFEU and the LLR role of the ECB

- ECB can operate directly only in the secondary sovereign debt markets (SMP)
- ECB can by-pass sovereign debt markets and fund sovereigns indirectly by funding entities that lend to sovereigns (loans by ECB or NCBs to IMF)
- ECB can intervene indirectly (through agents) in primary sovereign debt markets
  - EIB is eligible counterparty of Eurosystem for repo
  - EFSF/ESM could be given bank status
  - EFSF already can repo with private banks

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Problem: Moral Hazard, Fiscal Austerity and Structural Reform

- Game of chicken (1): ECB v. fiscal authorities of donor/creditor countries about who takes credit risk of EA periphery sovereigns (quasi-fiscal (Eurosystem) vs. fiscal (EFSF/EFSM, ESM))
- Game of chicken (2): ECB plus fiscal authorities of donor/creditor countries vs. fiscal authorities of fiscally and competitively weak countries about fiscal austerity and structural reform
- Game of chicken (3): fiscal authorities of all EA countries vs. private creditors of EA periphery sovereigns and unsecured private creditors of insolvent EA banks (PSI for sovereign and bank creditors)
  - ECB concerned about financial stability implications of PSI (and talking its book – see Game of Chicken (1))
- ECB is losing Game of chicken (1), but slowly and one skirmish at a time: crisis is moving from acute to chronic
- Game of chicken (2) being resolved so far in favour of more austerity and structural reform, except in Greece, where sovereign debt restructuring is a fact
  - Expect future sovereign debt restructuring also for Portugal and Ireland
  - All of periphery and 'soft core' at risk of sovereign restructuring
- Game of chicken (3) ongoing.
  - Likely OSI (except for IMF) and well as PSI
  - Many more EA banks to be majority state-owned before crisis is over
  - More restructuring of unsecured senior bank creditors (haircuts and conversion into equity).
- All this is likely to take years, leading to recession due to fiscal austerity and credit crunch conditions
- Deleveraging could be expedited by (a) financial repression and (b) inflation. We are likely to get (a) in most advanced countries, but (b) is unlikely everywhere, most unlikely in EA and Japan, least unlikely in UK.

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- Buiter, Willem H. (2007), "Seigniorage," *Economics*, the Open-Access, Open-Assessment E-Journal, 2007-10.

Appendix

Central Bank Unconventional Balance Sheet Policies

	Financial stability	
Liquidity provision to funding and credit markets	Fed	Active use of repo operations, TAF, TSLF, CPFF, AMLF, and TALF
	ECB	Fixed-rate full allotment refinancing operations, Covered bonds purchases, Security Market Program
	BoE	Active use of LTRO, Purchase of corporate bonds and CPs by Asset Purchase Facility
	BoJ	Active use of term operations, Special Funds-Supplying Operations to Facilitate Corporate Financing, Outright purchase of corporate bonds and CPs
	BoC	Term PRA, Term PRA for Private Sector Instruments
	RBA	Active use of term operations, Active use of repo operations against private debts
Foreign exchange liquidity provision to local markets	USD operations by many central banks Euro operations by Sweden, Denmark, Poland and Hungary CHF operations by ECB, Poland and Hungary	
	Macroeconomic stability	
Purchase of long-term public securities	Fed	Large-scale purchase of Agency MBS,[1/] Agency debt and US Treasury
	BoE	Gilt purchase by Asset Purchase Facility
	BoJ	Purchase of JGB under Asset Purchase Program
Large-scale foreign exchange intervention	BoI	FX purchases
	SNB	FX purchases
Central bank involvement in credit provision	BoJ	Purchase of commercial paper, corporate bonds, ETF and REIT under Asset Purchase Program, Fund-Provisioning Measure to Support Strengthening the Foundations for Economic Growth[1/]

1/ These measures have some elements of central bank credit provision to the private sector as defined here.

Source: Central bank websites and press reports, Stone et al. (2011), "Should Unconventional Balance Sheet Policies be Added to the Central Bank Toolkit? A Review of the Experience so Far", IMF working paper 11/145

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Appendix: PDV Seigniorage Estimates: Robustness

Present Discounted Value of future seigniorage in the Euro Area (α= 0.5; β=2.9)

EUR (bn)	Interest/ Discount Rate (i)				
Real Growth Rate (g)	3.5%	4.0%	4.5%	5.0%	5.5%
0.5%	€1,502	€1,062	€817	€662	€555
1.0%	€2,100	€1,382	€1,025	€812	€669
1.5%	€3,106	€1,834	€1,294	€995	€805
2.0%	€5,158	€2,515	€1,652	€1,224	€968

Note: From equation (3) α represents the long run income elasticity of the money demand function, and β the corresponding interest rate semi-elasticity

Source: Citi Investment Research and Analysis

Present Discounted Value of future seigniorage in the Euro Area (α= 1; β=2.9)

EUR (bn)	Interest/ Discount Rate (i)				
Real Growth Rate (g)	3.5%	4.0%	4.5%	5.0%	5.5%
0.5%	€2,104	€1,384	€1,027	€812	€670
1.0%	€5,221	€2,532	€1,661	€1,229	€972
1.5%	Infinite	€6,172	€2,962	€1,935	€1,430
2.0%	Infinite	Infinite	€7,148	€3,392	€2,209

Note: From equation (3) α represents the long run income elasticity of the money demand function, and β the corresponding interest rate semi-elasticity

Source: Citi Investment Research and Analysis

Present Discounted Value of future seigniorage in the Euro Area (α= 0.8; β=2)

EUR (bn)	Interest/ Discount Rate (i)				
Real Growth Rate (g)	3.5%	4.0%	4.5%	5.0%	5.5%
0.5%	€1,929	€1,308	€987	€790	€658
1.0%	€3,801	€2,121	€1,466	€1,118	€901
1.5%	€13,388	€3,921	€2,287	€1,609	€1,239
2.0%	Infinite	€11,266	€4,013	€2,431	€1,739

Note: From equation (3) α represents the long run income elasticity of the money demand function, and β the corresponding interest rate semi-elasticity

Source: Citi Investment Research and Analysis

Present Discounted Value of future seigniorage in the Euro Area (α= 0.8; β=4)

EUR (bn)	Interest/ Discount Rate (i)				
Real Growth Rate (g)	3.5%	4.0%	4.5%	5.0%	5.5%
0.5%	€1,835	€1,232	€920	€730	€602
1.0%	€3,616	€1,998	€1,367	€1,032	€824
1.5%	€12,735	€3,693	€2,133	€1,486	€1,132
2.0%	Infinite	€10,610	€3,741	€2,244	€1,589

Note: From equation (3) α represents the long run income elasticity of the money demand function, and β the corresponding interest rate semi-elasticity

Source: Citi Investment Research and Analysis

The Conventional Balance Sheet of the ECB

As 31 December, 2010

Assets (Mil EUR)		Liabilities (Mil EUR)	
Gold & forex reserves	62,856	Banknotes in circulation	67,176
Claims on EA credit institutions	33	Liabilities to EA credit institutions	33
Debt held outright	17,926	Non-monetary liabilities	4,735
Intra-Eurosystem claims	67,176	Intra-Eurosystem liabilities	61,430
Other assets	15,532	Provisions	5,217
		Revaluation accounts	19,627
		Financial net worth	5,306
Total assets	163,523	Total liabilities	163,523

Note: “Debt held outright” includes public and private debt securities held for monetary policy purposes, including those resulting from the Covered Bonds scheme and the government debt purchases of the Securities Markets Programme announced on May 10, 2010. It also includes a small amount of sovereign debt securities held not for monetary policy purposes. Totals/sub-totals may not add up, due to rounding.

Sources: ECB and Citi Investment Research and Analysis

The Conventional Balance Sheet of the Federal Reserve

As 30 November, 2011

Assets (Mil US$)		Liabilities (Mil US$)	
Treasury Debt	2,604,999	Base Money	2,651,357
Private Debt	53,218	Non Monetary Liabilities	110,362
Gold & forex reserves	18,484	Financial Net Worth	53,962
Other Assets	142,396		
Total Assets	2,816,851	Total Liabilities	2,816,851

Note: “Private debt” also includes net portfolio holding of Maiden Lane I, II, and III, and those for TALF. Totals/sub-totals may not add up, due to rounding.

Sources: Federal Reserve and Citi Investment Research and Analysis

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The Conventional Balance Sheet of the Bank of England

As 30 November, 2011

Assets (Mil GBP)		Liabilities (Mil GBP)	
Advances to HM Government	370	Notes in Circulation	55,754
Securities acquired via market transactions	14,146	Reserve Balance	159,879
Short-term market operations & reverse repos with BoE Counterparties	12,602	Other	63,822
Other Assets	254,741	Equity	2,404
Total Assets	281,859	Total Liabilities	281,859

Note: Totals/sub-totals may not add up, due to rounding.

Sources: Bank of England and Citi Investment Research and Analysis

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The Conventional Balance Sheet of the Bank of Japan

As 30 November, 2011

Assets (Yen Billions)		Liabilities (Yen Billions)	
Gold & forex reserves	5,783	Currency in circulation	79,461
Treassury securities	91,527	Bank reserves	32,077
Private sector assets	43,950	Non-monetary liabilties	25,745
Other assets	544	Financial net worth	5,923
Total Assets	143,206	Total Liabilties	143,206

Note: Totals/sub-totals may not add up, due to rounding.

Sources: Bank of Japan and Citi Investment Research and Analysis