

# Can Central Banks Go Broke?

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## Introduction

The Federal Reserve System has recently accepted exposure to a considerable amount of private sector credit risk, partly on its balance sheet, through the riskier collateral it now accepts at its discount window and in open market operations, and partly off-balance sheet, through its \$29 billion exposure to the special purpose vehicle (SPV) created to warehouse \$30bn of Bear Stearns most toxic assets. It is possible that the new reality, prompted by the financial crisis, of larger-scale open market and discount window operations, less demanding collateral requirements and a wider set of counterparties will cause the Fed to take on exposure to considerably more private sector default risk in the future.

The Bank of England also took on additional credit risk when it created the Liquidity Support Facility for Northern Rock in September 2007 and accepted mortgages and mortgage-backed securities as collateral for its loans. The widening of the eligible collateral in some of its liquidity-oriented open market operations at one and three month maturities has further increased the Bank's exposure to private sector credit risk, as has the creation of the £50 billion Special Liquidity Scheme in April 2008, through which the Bank of England lends Treasury bills to banks, secured against illiquid mortgage-backed securities, covered bonds and asset-backed securities backed by credit card receivables. There could be a significant further exposure if the Bank were to engage in outright purchases of illiquid and possibly impaired private securities, as has been proposed by some.

There is little doubt that the Eurosystem – the European Central Bank (ECB) and the 15 national central banks (NCBs) of the euro area – have also relaxed the creditworthiness standards for the assets they accept as collateral in liquidity-oriented repos and at their discount windows.

Before the current crisis becomes history, the Fed, the ECB and the Bank of England are likely to hold significant amounts of illiquid and possibly dodgy assets on

their balance sheets. Even if this increased credit risk had been priced properly *ex ante* (when it was incurred) – through the *penalty rate* over the official policy rate applied to discount window borrowing, through the *valuation of the collateral* offered at the discount window or in repos and other collateralised lending, and through liquidity *haircuts* (discounts) applied to these valuations – there is little doubt that, should the credit risk attached to these assets materialise *ex post*, the balance sheet of the central banks involved would show a large hole. Their capital could easily be wiped out.

**Before the current crisis becomes history, the Fed, the ECB and the Bank of England are likely to hold significant amounts of illiquid and possibly dodgy assets on their balance sheets.**

This raises the following questions:

1. Does it matter if the central bank suffers a large capital loss?
2. Can the central bank become insolvent?
3. How and by whom should the central bank be recapitalised, should its capital be deemed insufficient?

Before turning to the practical capital adequacy and solvency challenges facing central banks like the Fed, the Bank of England and the ECB, it will help to look at a couple of stylised balance sheets for a central bank.

## 1. The balance sheet of the central bank

The stylised conventional balance sheet of a central bank can be represented as in Table 1 below. For the US we should think of this as the consolidated balance sheet of the Federal Reserve Board and the 12 regional Feds. For the euro area, it is the consolidated balance sheet of the ECB and the 15 NCBs of the euro area.

On the right-hand-side of the T-account are the liabilities and shareholder equity of the central bank. First, there are its monetary liabilities, *M*, sometimes called base money or high-powered money. It is the sum of currency in circulation and balances or reserves held

with the central bank by commercial banks.

For simplicity, I shall treat the whole of the base money stock as non-interest-bearing. This is certainly the case for currency, but interest is sometimes paid on commercial bank reserves held with the central bank. The central bank also has non-monetary liabilities,  $O$ . This can be debt to the government, to the domestic private sector, to international organisations like the IMF, or to the rest of the world. It can be denominated in domestic currency or in foreign currency.

As assets the central bank has Treasury debt,  $D$ , that is, sovereign bonds (Treasury bills and bonds), sovereign-guaranteed debt and, in federal systems, sometimes the debt of lower-tier governments (state, provincial, municipal); private debt,  $L$ , that is, outright or collateralised loans to the private sector and other private securities and instruments of all kinds (domestic or foreign); and official foreign exchange reserves,  $R$ . The currency denomination of assets other than foreign exchange reserves can be either domestic or foreign.

For simplicity, think of all asset and liabilities –  $M$ ,  $O$ ,  $D$ ,  $L$  and  $R$  – as marked-to-market. Where there is no market, fair value valuation is applied. The financial net worth or (conventional) equity of the central bank,  $W$ , is residually determined as the excess of the value of the assets over the value of the other liabilities:

$$W = D + L + R - M - O \quad (1)$$

### Some interesting central bank balance sheets

How does this conventional balance sheet look in the case of the Fed, the Bank of England, the ECB, the Bank of Japan and the Central Bank of Iceland?

The data for the Fed are summarised in Table 2, those for the Bank of England in Table 3, for the ECB in Table 4, for the Eurosystem in Table 5, for the Bank of Japan in Table 6 and for the Central Bank of Iceland in Table 7.

The data for the Fed are updated weekly in the Consolidated Statement of Condition of All Federal Reserve Banks. In Table 2, I have for simplicity lumped \$2.1bn worth of buildings and \$40bn worth of other assets together with claims on the private sector,  $L$ . The Federal Reserve System holds but small amounts of assets in the gold certificate account and SDR account as Foreign exchange reserves,  $R$ . The foreign exchange reserves of the US are on the balance sheet of the Treasury rather than the Fed. As of February 2008, US Official Reserve Assets stood at \$73.5bn.<sup>1</sup> US gold reserves (8133.8 tonnes) were valued at around \$261.5bn in March 2008.

Table 2 shows that, as regards the size of its balance sheet, the Fed would be a medium-sized bank in the universe of internationally active US commercial banks, with assets of around \$900bn and capital (which corresponds to financial net worth or conventional equity in Table 1) of about \$40bn. By comparison, at the time of the run on the investment bank Bear Stearns earlier

this month (March 2008), that bank's assets were around \$340bn. Citigroup's assets as of 31 December 2007 were just under \$2,188bn (Citigroup is a universal bank, combining commercial banking and investment banking activities). With 2007 US GDP at around \$14 trillion, the assets of the Fed are about 6.4% of annual US GDP.

**We may well have arrived at the point where any highly leveraged financial institution above a certain size is a candidate for direct or indirect Fed financial support, should it, for whatever reason, be at risk of failing.**

At the end of January 2008, seasonally adjusted assets of domestically chartered commercial banks in the US stood at \$9.6 trillion (more than ten times the assets of the Fed). Of that total, credit market assets were around \$7.5 trillion. What in this paper is called equity (assets minus all other liabilities) was reported as \$1.1 trillion.<sup>2</sup> Commercial banks exclude investment banks and other non-deposit taking banking institutions. The example of Bear Stearns has demonstrated that the primary dealers in the US are now all considered to be too big, too systemically important and/or too interconnected to fail by the Fed. The 1998 rescue of LTCM – admittedly without the use of any Fed financial resources or indeed of any public financial resources, but with the active 'good offices' of the Fed – suggests that large hedge funds too may fall in the 'too big or too interconnected to fail' category. We may well have arrived at the point where any highly leveraged financial institution above a certain size is a candidate for direct or indirect Fed financial support, should it, for whatever reason, be at risk of failing.

Like its private sector fellow-banks, the Fed is quite highly leveraged, with assets just under 22 times capital. The vast majority of its liabilities are currency in circulation (\$781bn out of a total monetary base of \$812bn). Currency is not just non-interest-bearing but also *irredeemable*: having a \$10 Federal Reserve note gives me a claim on the Fed for \$10 worth of Federal Reserve notes, possibly in different denominations, but nothing else. Leverage is therefore not an issue for this highly unusual inherently liquid domestic-currency borrower.

The Bank of England, whose balance sheet is shown in Table 3, also has negligible foreign exchange reserves of its own. The bulk of the UK's foreign exchange reserves are owned directly by the Treasury. The shareholders' equity in the Bank of England is puny, just

<sup>1</sup> Source: IMF <http://www.imf.org/external/np/sta/ir/8802.pdf>

<sup>2</sup> A footnote in the Federal Reserve Bulletin (2008) informs us that 'This balancing item is not intended as a measure of equity capital for use in capital adequacy analysis. On a seasonally adjusted basis, this item reflects any differences in the seasonal patterns estimated for total assets and total liabilities.' That is correct as regards the use of this measure in regulatory capital adequacy analysis. For economic analysis purposes it is, however, as close to  $W$  as we can get without a lot of detailed further work.

**Table 1** Central Bank Conventional Financial Balance Sheet

Assets	Liabilities
D: Treasury debt	M: Base money
L: Private sector debt	N: Other (non-monetary) liabilities
R: Foreign exchange reserves	W: Financial net worth or conventional equity

**Table 2** Conventional Financial Balance Sheet of the Federal Reserve System (US\$ bn), 12 March 2008

Assets	Liabilities
D: 703.4	M: 811.9
L: 182.2	O: 47.4
R: 13.0	W: 39.7

**Table 3** Conventional Balance Sheet of the Bank of England (£ bn)

	1-Jun-06	24-Dec-07	12-Mar-08
<b>Liabilities</b>	82	102	97
M: Notes in circulation	38	45	41
Reserves balances	22	26	21
O: Other	20	30	33
W: Equity	2	2	2
<b>Assets</b>	82	102	97
D: Advances to HM Government	13	13	7
L&D: Securities acquired via market transactions	8	7	9
L: Short-term market operations & reverse repos with BoE	12	44	43
Counterparties			
Other assets	33	38	38

Source: *Financial Statistics*.**Table 4** Conventional Balance Sheet of the European Central Bank (€ bn)

	31-Dec-06	31-Dec-07
<b>Liabilities</b>	106	126
M: Notes in circulation	50	54
O: Other	56	72
W: Equity	4	4
<b>Assets</b>	106	126
D:	54	71
L: Other assets	10	11
Claims on euro area residents in forex	3	4
R: Gold and forex reserves	40	39

Source: European Central Bank (2008a).

**Table 5** Conventional Balance Sheet of the Eurosystem (€ bn)

	22-Dec-06	29-Feb-08
<b>Liabilities</b>	1142	1379
M:	805	887
O: Other	273	421
W: Equity	64	71
<b>Assets</b>	1142	1379
D: Euro-denominated government debt	40	39
L: Euro-denominated claims on euro area credit institutions	452	519
Other assets	330	480
R: Gold and forex reserves	321	340

Source: European Central Bank (2008b).

**Table 6** Conventional Balance Sheet of the Bank of Japan (yen trn)

	31-Mar-06	31-Mar-07
<b>Liabilities</b>	145	142
M:	106	88
O:	36	21
W:	3	3
<b>Assets</b>	145	113
D:	93	76
L:	52	37

Source: Bank of Japan (2008).

**Table 7** Conventional Balance Sheet of the Central Bank of Iceland (ISK bn)

	31-Dec-06	31-Mar-08
<b>Liabilities</b>	476.9	575.1
M:	167.8	163.8
O: Other	218.1	320.3
W: Equity	91.0	91.0
<b>Assets</b>	476.9	575.1
D:	0.0	0.0
L:	308.3	349.8
Other assets	5.9	5.4
R: Gold and forex reserves	162.7	220.0
	\$2.6bn	\$2.8bn

Source: European Central Bank (2008b).

under £2bn. The size of its balance sheet has grown a lot since early 2007, reflecting the loans made to Northern Rock as part of the government's rescue programme for that bank. The size of the balance sheet is around £100 bn, about 20 percent smaller than Northern Rock at its *acme*. Leverage is just under 50, which would be impressive even for a hedge fund.

The size of the equity and the size of the balance sheet appear small in comparison to the possible exposure of the Bank of England to credit risk through its lender-of-last resort and market-maker-of-last resort operations. Its total exposure to Northern Rock was, at its peak, around £25bn. This exposure was, of course, secured against Northern Rock's prime mortgage assets. More important for the solvency of the Bank of England than this credit risk mitigation through collateral is the fact that the central bank's monopoly of the issuance of irredeemable, non-interest-bearing legal tender means that leverage is not a constraint on solvency as long as most of the rest of the liabilities on its balance sheet are denominated in sterling and consists of nominal, that is, non-index-linked, securities, as is indeed the case for the Bank of England.

**The Central Bank of Iceland's balance sheet is unique in two respects. First, it appears to hold effectively no securities issued by the government of Iceland. Second, the country's foreign exchange reserves are tiny in comparison to the foreign currency exposure of the private sector.**

The balance sheet of the ECB for end-year 2006 and 2007 is given in Table 4, that for the consolidated Eurosystem (the ECB and the 15 NBCs of the Eurosystem) as of 29 February 2008 in Table 5. The consolidated balance sheet of the Eurosystem is about 10 times the size of the balance sheet of the ECB, but the equity of the Eurosystem is about 17 times that of the ECB. Gearing of the Eurosystem is therefore quite low by central bank standards, with total assets just over 19 times capital.

Between the end of 2006 and end-February 2008, the Eurosystem expanded its balance sheet by €237bn. On the asset side, most of this increase was accounted for by a €67bn increase in claims on the euro area banking sector and a €150bn increase in other assets. Both items no doubt reflect the actions taken by the Eurosystem to relieve financial stress in the interbank markets and elsewhere in the euro area banking sector.

The Bank of Japan, whose balance sheet is shown in Table 6, does not hold the country's gold and foreign exchange reserves, which are on the balance sheet of the Treasury.<sup>3</sup> The size of the balance sheet of the Bank

of Japan is very large relative to the size of the Japanese economy. At the end of 2006, Bank of Japan assets were 28.4 percent of annual GDP. By the end of 2007, this figure had declined to 21.5 percent. At the end of 2006, Bank of Japan holdings of Japanese government debt amounted to 18.1 percent of annual GDP. The 2007 figure was 14.6 percent, still a large number. The large holdings of public and private domestic debt by the Bank of Japan are a reflection of more than a decade of easy money, following the crash of Japanese asset prices in the beginning of the 1990s. This culminated in a policy of quantitative easing, which involved the Bank of Japan acquiring government and private securities in exchange for base money.

The Central Bank of Iceland's balance sheet, shown in Table 7, is unique in two respects. First, it appears to hold effectively no securities issued by the government of Iceland. Outright open market operations therefore take the form of the sale or purchase of domestic private securities (mainly claims on the domestic banking sector and on other domestic financial institutions) and of foreign exchange. Second, the country's foreign exchange reserves (which are held by the central bank) while large by international standards in relation to GDP (14 percent at the end of 2007), are tiny (at around \$2.8 billion on 31/03/2008) in comparison to the foreign currency exposure of the private sector. The Icelandic central bank holds foreign assets equal to only about five percent of the foreign liabilities of Iceland's money deposit banks.<sup>4</sup>

The country as a whole is a net external debtor, with a net international investment position of minus 119 percent of annual GDP at the end of Q3/2007, if FDI is measured at book value. When marked-to market, Iceland's net international investment position is minus 27 percent of annual GDP. The difference is accounted for mainly by capital gains on FDI: Iceland's holdings of foreign direct investment are significantly larger than foreign ownership of direct investment in Iceland. Except for the FDI liabilities, the external liabilities are overwhelmingly foreign-currency-denominated.

The banking sector of Iceland (consisting of three internationally active banks) is also very large relative to the size of the economy. Although the banking sector is a significant net foreign currency creditor, it has a large excess of short-term foreign currency liabilities over short-term foreign currency assets. When there is an international wholesale financial 'strike', as there has been since August 2007, the problems faced by banks with large amounts of maturing short-term foreign-currency-denominated debt and a portfolio consisting mainly of illiquid long-term assets, could spell disaster even for institutions whose assets are sound, or would be sound if held to maturity.

With limited foreign exchange reserves and, so far, limited access to other foreign exchange resources (swaps, credit lines, etc.), the Central Bank of Iceland

<sup>3</sup> I had to do a fair amount of guesswork to come up with a figure for the equity of the Bank of Japan. It is possible that the figures for 2006 and 2007 ought to be yen 5 trillion and yen 6 trillion respectively, with offsetting changes in other liabilities, 0.

<sup>4</sup> Foreign liabilities are liabilities to non-residents, rather than foreign-currency liabilities. However, foreign-currency liabilities to domestic residents are a small fraction of foreign liabilities and krónur -denominated liabilities to foreigners are small as well.

cannot act as an effective lender of last resort or market maker of last resort for a domestic banking system whose lending, borrowing and investment activities are mainly in foreign currencies and whose balance sheet is largely foreign-currency-denominated. This massive mismatch between the currency of the lender of last resort/market maker of last resort and the foreign currency exposure of the banking sector (euro, sterling, Norwegian, Danish and Swedish kroner and US dollar) is unique among developed countries, as far as I know.

## 2. Does the balance sheet of the central bank constrain its ability to act in a crisis?

As pointed out by Ed McKelvey (2008), the size of a central bank's existing stock of assets says little about its capacity to increase its assets in a hurry. Consider the case of the Fed. Normally, increased holdings of assets (typically US Treasury securities), are funded by increasing the stock of base money. Technically, this means that the increase in Fed assets is financed by borrowing, that is, through higher Fed leverage. Since the borrowing is through the issuance of non-interest-bearing, non-redeemable debt instruments (base money), there is, in principle, no limit to the amount of monetary borrowing the Fed can engage in, and therefore also no limit to the domestic currency value of the assets it can hold on its balance sheet. The Fed's \$900bn balance sheet can therefore, should the need arise, be doubled or increased tenfold overnight, should there be a compelling financial stability or economic stability case for it.

...of the two common concepts of insolvency – *equitable insolvency* (that is, failure to pay obligations as they fall due) and *balance sheet insolvency* (the condition that liabilities exceed assets) – *equitable insolvency* is the relevant one.

It is not hard to envisage a situation where the Fed would suffer a capital loss on its private assets larger than \$40bn. Some of the asset-backed securities the Fed is now taking as collateral for loans at the discount window, the Prime Dealer Credit Facility (PDCF) or the Term Securities Lending Facility could turn out to be worthless. For instance, the \$29 bn non-recourse loan extended by the Fed to JP Morgan to help JP Morgan fund Bear Stearns least liquid assets must be subject to non-negligible default risk.

### From the conventional to the comprehensive balance sheet of the central bank

Any loss greater than \$40bn would wipe out the Fed's capital and could indeed give it negative capital or equity. Would and should this be a cause for concern?

The good news is that the conventional balance sheet of the Fed or of any other central bank is a completely unreliable guide to and indicator of the financial health

and strength of that central bank. The reason is that it excludes the valuation of its most important source of future revenue – the present discounted value of the future profits the Fed will earn from its ability to issue non-interest-bearing debt. The conventional balance sheet also excludes two implicit liabilities of the Fed. The first is the present value of the cost of running the Fed (salaries, depreciation of the Fed's real estate, salaries, costs of IT, communications equipments, paper clips and pencils, etc.). The second is the present value of the net payments made by the Fed to the Treasury.

This means that as regards the central bank, of the two common concepts of insolvency – *equitable insolvency* (that is, failure to pay obligations as they fall due) and *balance sheet insolvency* (the condition that liabilities exceed assets) – *equitable insolvency* is the relevant one.<sup>5</sup>

In most countries the central banks transfers a share of its operating profits (net interest income minus the cost of running the central bank) to the Treasury. In addition, the Treasury is often the only or the main shareholder of the central bank. In the UK, for instance, the Bank of England is a joint stock company whose shares are all held by the Treasury.<sup>6</sup>

The Federal Reserve System is an independent entity within the US Federal government. The stock of the twelve regional Federal Reserve Banks is owned by (private) member banks. Ownership of a certain amount of stock is, by law, a condition of membership in the System. The stock may not be sold or traded or pledged as security for a loan; dividends are, by law, 6 percent per year.

The ECB is owned by the 27 national central banks (NCBs) that make up the EU's European System of Central Banks (ESCB).<sup>7</sup> Note that it is the NCBs of all EU members (currently 27) that constitute the shareholders of the ECB, not just those who are part of the Eurosystem and have adopted the euro (currently 15). The NCBs themselves have a variety of formal ownership structures.

The Bank of Japan's capital is one hundred million yen, subscribed by both the government and non-gov-

<sup>5</sup> See Lastra (2007).

<sup>6</sup> The Bank of England is a body corporate incorporated by Royal Charter pursuant to the 1694 Act. The Bank was nationalised by the 1946 Act and its capital stock transferred to the Treasury.

<sup>7</sup> The capital of the ECB is ECU 5 000 million. The capital may be increased by such amounts as may be decided by the Governing Council acting by the qualified majority provided for in Article 10.3, within the limits and under the conditions set by the Council under the procedure laid down in Article 42. The national central banks shall be the sole subscribers to and holders of the capital of the ECB. The subscription of capital shall be according to the key established in accordance with Article 29. Article 29 states that 'Each national central bank shall be assigned a weighting in this key which shall be equal to the sum of: - 50% of the share of its respective Member State in the population of the Community in the penultimate year preceding the establishment of the ESCB; - 50% of the share of its respective Member State in the gross domestic product at market prices of the Community as recorded in the last five years preceding the penultimate year before the establishment of the ESCB. ... The weightings assigned to the national central banks shall be adjusted every five years after the establishment of the ESCB by analogy with the provisions laid down in Article 29.1.'

**Table 8** Central Bank Comprehensive Balance Sheet or Intertemporal Budget Constraint

Assets	Liabilities
<i>D</i> : Treasury debt	<i>M</i> : Base money
<i>L</i> : Private debt	<i>O</i> : Other financial liabilities
<i>R</i> : Foreign exchange reserves	
<i>S</i> : Present discounted value of seigniorage profits (interest saved on current and future stocks of non-interest-bearing base money liabilities)	<i>E</i> : Present discounted value of cost of running central bank
	<i>T</i> : Present discounted value of payments to Treasury
	<i>W*</i> : Comprehensive net worth or comprehensive equity

ernmental legal persons, in exchange for subscription certifications (shares), with the government providing no less than 55 million yen.

However, the fact that the central bank is, from a financial point of view, an integral part of the state, does not depend on the formal legal niceties of stock ownership. Even if the central bank has formal or *de facto* operational independence, it is an integral part of a sovereign state. Their balance sheets and profit and loss accounts should be included in the consolidated financial accounts of the nation state to which they belong. The special issues this creates for a supranational central bank like the ECB will be discussed below. The common practice of analyzing public sector debt and deficits using the general government measure of the public sector, which includes Federal/central, state/provincial and local/municipal governments but excludes the central bank, is an unfortunate one.

The current and future payments the central bank makes to the Treasury should be viewed, from a functional economic perspective, as a tax on the central bank. For our purposes it is important to note that these taxes paid by the central bank to the Treasury could be negative – at the discretion of the Treasury. Such transfer payments from the Treasury to the central bank can be viewed as the mechanism through which the Treasury can inject capital into the central bank, that is, transfer resources to the central bank to recapitalise it. The distinction between (re)current transfers and a one-off capital transfers need not detain us here.

When we allow for these key implicit assets and implicit liabilities of the central bank, we obtain the comprehensive balance sheet of the central bank, also called the intertemporal budget constraint of the central bank, shown in Table 8.<sup>8</sup>

So

$$W^* = W + S - E - T \quad (2)$$

If comprehensive net worth,  $W^*$ , were to be zero or negative, the central bank would be insolvent. But it is clearly possible for the central bank's financial net worth,  $W$ , to be negative without this implying a negative comprehensive net worth. This would require that the present discounted value of current and future seigniorage,  $S$ , exceed the present discounted value of

future non-interest costs of running the central bank,  $E$ , plus the present discounted value of future net payments by the central bank to the Treasury,  $T$ , by more than the negative value of the conventional financial net worth. The solvency constraint for the central bank can therefore be written as:

$$\begin{aligned} W^* &\geq 0 \\ \text{or, equivalently} & \\ W + S &\geq E + T \end{aligned} \quad (3)$$

The central bank's comprehensive balance sheet or intertemporal budget constraint is complemented by its one-period budget constraint, which in words can be stated as follows:

*The value of the net acquisitions of financial assets minus the value of the net issues of financial liabilities equals the central bank's net interest income minus its running costs minus the net payment it makes to the Treasury.*

Finally, the change in the value of the central bank's conventional financial net worth,  $\Delta W$ , is by definition equal to the value of the net acquisitions of financial assets minus the value of the net issues of financial liabilities plus capital gains on the outstanding stocks of financial assets and liabilities.

Consider the case where the conventional net worth of the central bank takes a beating, say, because a number of private securities backed by subprime mortgages it holds on its balance sheet suffer a loss in value. What can the central bank do to ensure that equation (3), its solvency condition, is satisfied? The Fed itself can do just two things: tighten its belt (reduce  $E$ ) and increase the present value of current and future seigniorage,  $S$ . The future payments it makes to the Treasury or the future transfers it receives from the Treasury,  $T$ , are not under its control, but are determined by the Treasury.

The running costs of the central bank cannot become negative. Even if the entire FOMC and staff were to work *pro bono*, there is some positive irreducible minimum value for  $E$ . This means that, without Treasury support, the central bank can only ensure its solvency, if its financial net worth,  $W$ , takes a sufficiently large hit, by boosting seigniorage,  $S$ .

The nominal value of seigniorage is the present discounted value of the sequence of current and future interest costs saved through the central bank's ability to

<sup>8</sup> For a detailed and formal analysis see Buiter (2004, 2005 and 2007), Sims (2004, 2005) and Ize (2005).

issue non-interest-bearing liabilities. Let  $i_t$  be the short nominal interest rate that represents the opportunity cost of being able to issue non-interest-bearing liabilities in period  $t$ . We can think of this as the 3-month Treasury Bill rate or some other short-term default-risk-free rate. Let  $M_t$  be the nominal stock of base money at time  $t$ . Then the nominal value of seigniorage in period  $t$  is  $i_t M_t$ .

**While the Fed can always recapitalise itself through the issuance of base money if its liabilities are denominated in domestic currency and not index-linked, doing so may not be optimal or even acceptable, even though it is feasible.**

It should be obvious that the central bank can make the nominal present discounted value of current and future seigniorage pretty much anything it wants it to be. For instance, the Fed could buy up today, the entire outstanding stock of privately held US Federal debt ('monetise the public debt'), around \$4.5 trillion in March 2008<sup>9</sup>. If the Fed could act as a fiscal agent, making transfer payments to the private sector, it could engage in 'helicopter drops of money' of any magnitude.<sup>10</sup>

**3. Constraints on what the central bank can achieve through monetary issuance: inflation and the inflation tax Laffer curve**

What this means is that the central bank can always bail out any entity – including itself – through the issuance of base money – if the entity's liabilities are denominated in domestic current and nominally denominated (that is, not index-linked). If the liabilities of the entity in question are foreign-currency-denominated or index-linked, a bail-out by the central bank may not be possible.

While the Fed can always recapitalise itself through the issuance of base money if its liabilities are denominated in domestic currency and not index-linked, doing so may not be optimal or even acceptable, even though it is feasible: self-recapitalisation through seigniorage may generate undesirably high rates of inflation.

The reason for this is pretty intuitive. The real value of the seigniorage earned in period  $t$  by the central bank is  $i_t \frac{M_t}{P_t}$  where  $P_t$  is the general price level in period  $t$  and  $M_t/P_t$  is the stock of real (base) money balances in period  $t$ , that is, the purchasing power over real goods and services of the stock of nominal base money balances. It is often informative to relate the seigniorage earned

by the central bank to the size of the economy; the share of seigniorage in GDP, let's call it  $s_t$ , is given by  $s_t = i_t m_t = i_t \frac{M_t}{PY_t}$  where  $m_t$  is the period- $t$  ratio of base money to GDP and  $Y$  is real GDP.

The nominal interest rate,  $i$ , equals the real interest rate,  $r$ , plus the (expected) rate of inflation  $\pi$ , so seigniorage as a share of GDP in period  $t$  can be written as  $(r_t + \pi_t)m_t$ . The demand for base money (relative to GDP) decreases with the financial opportunity cost of holding base money, which is the short nominal interest rate,  $i$ . An empirically successful example of a base money demand function (going back to Philip Cagan's (1956) study of hyperinflations) is the semi-logarithmic one, which states that, in the long-run, the logarithm of the demand for base money as a share of GDP decreases linearly with the nominal interest rate, that is,

$$\ln m = a - bi \quad (4)$$

$a, b > 0$

It follows that in any given period seigniorage is given by

$$s = ie^{a-bi}$$

Consider, for simplicity, the case where the economy is in a steady-state, that is, in a state of long-run equilibrium. Although the argument that follows does not depend on this assumption, it significantly simplifies the argument and exposition and makes the intuition behind it obvious.

The present discounted value of current and future seigniorage, as a share of GDP, is given by

$$S = \frac{s}{r-g} = \frac{im}{r-g} = \frac{ie^{a-bi}}{r-g} = \frac{(r+\pi)(e^{a-b(r+\pi)})}{r-g} \quad (5)$$

where  $g$  is the steady-state growth rate of real GDP, and all other variables are assumed to represent steady state or long-run average values. So the present value of seigniorage, as a share of GDP,  $S$ , is the average future value of seigniorage as a share of GDP,  $s$ , capitalised using a discount rate equal to the excess of the long-run real interest rate,  $r$ , over the long-run growth rate of real GDP,  $g$ .

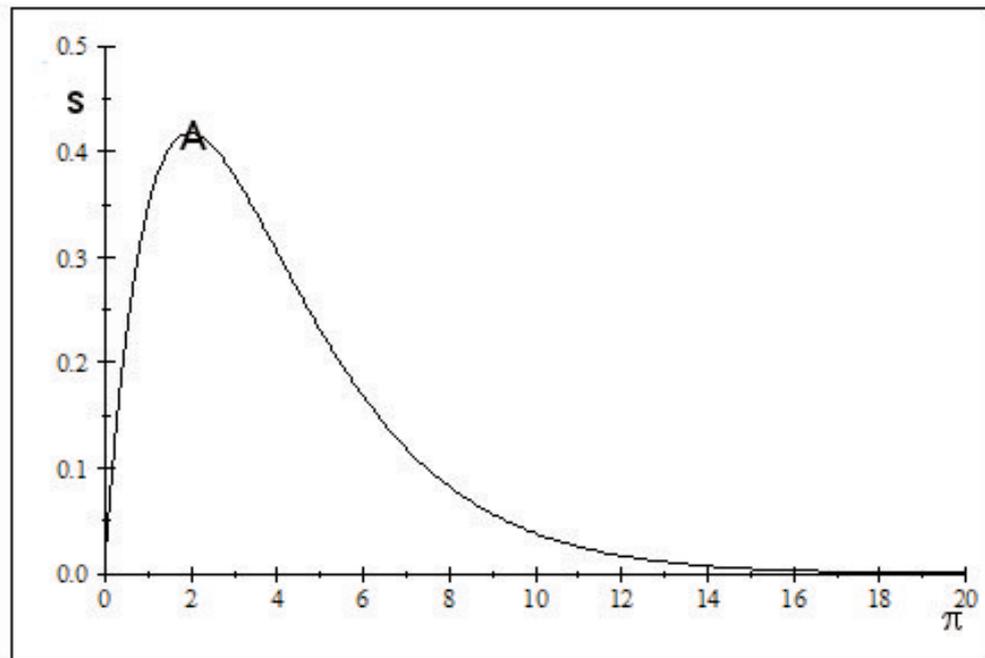
When the central bank increases the growth rate of the nominal base money stock, it raises the rate of inflation, at the very least in the medium and long term. To a reasonable first approximation, the long-run real interest rate,  $r$ , and the long-run growth rate of real GDP,  $g$ , are independent of the rate of growth of the stock of base money, and thus of the rate of inflation. If the long-run real interest rate exceeds the growth rate of real GDP (as seems reasonable both empirically and because it would be a funny old world if this were not the case – with Ponzi finance a viable option for the state), then the direction of the effect of higher inflation on the present discounted value of current and future seigniorage,  $S$ , is the same as the effect of higher inflation on long-run seigniorage,  $s$ .

The effect of higher (expected) inflation (and of a higher nominal interest rate) on seigniorage is given by

<sup>9</sup> Source: *Economic Report of the President 2008*, Table B.89.

<sup>10</sup> In that case the Comprehensive Balance Sheet of the central bank in Table 3 would have to include, on the liability side, the present discounted value of current and future net transfer payments of the central bank to the private sector, and its single period budget constraint would have net transfer payments to the private sector as a current outlay.

Figure 1 The Long-Run Seigniorage Laffer Curve



the product of two effects that go in opposite directions. Higher inflation raises the *inflation tax rate*,  $\pi$ , in equation (5). Given the inflation tax base,  $m$ , this will raise seigniorage (inflation tax revenue). However, because of the negative incentive effect of higher expected inflation on the demand for real money balances,  $m$  falls when  $\pi$  increases. Thus, as the *inflation tax rate* rises, the *inflation tax base* falls.

The effect of a higher rate of inflation on long-run inflation tax revenue or seigniorage depends on the responsiveness of the long-run demand for real base money to changes in the expected rate of inflation. If the negative effect of higher expected inflation on the inflation tax base is strong enough, higher inflation could reduce inflation tax revenue. Technically, higher inflation increases (lowers) long-run inflation tax revenue if the elasticity of base money demand with respect to the rate of inflation is less than (greater than) unity in absolute value.

In the case of the semi-logarithmic money demand function shown in equation (4), the (absolute value of the) inflation elasticity of the demand for base money starts at a value well below unity when inflation is very low. As inflation rises the inflation elasticity of money demand rises (in absolute value) and eventually becomes larger than unity, at A in Figure 1. This means that the economy exhibits a long-run inflation tax or seigniorage Laffer curve. In this case considered in Figure 1, the nominal interest rate that maximizes long-run seigniorage is given by  $\frac{1}{b}$ .<sup>11</sup>

<sup>11</sup> We assume the long-run real interest rate is 2.5 percent per annum ( $r = 0.025$ ), that the semi-elasticity of money demand with respect to the nominal interest rate,  $b$ , is 0.5 and that the constant term in the long-run money demand function is  $-0.58065$ . These numbers are not unreasonable for long-run base money demand functions in advanced industrial countries, but the qualitative shape of the long-run Seigniorage Laffer curve does not depend on the precise numbers.

This means that, if we start from low rates of inflation, the central bank can, if it suffers a capital loss, boost its solvency by increasing the growth rate of the nominal base money stock and the rate of inflation. For a while, such increases in the growth rate of base money and the rate of inflation will boost the real resources the central bank can extract from the economy through the issuance of base money. When inflation gets too high, however, the disincentive effects on desired holdings of real money balances associated with higher expected inflation will reduce the desired money-income ratio to such an extent, that higher inflation reduces the value of the real resources the central bank can appropriate by issuing base money.

Thus, even if the resources needed to recapitalise the central bank are less than the maximum amount that can be appropriated through seigniorage (given by the peak of the seigniorage Laffer curve at A in Figure 1), the extraction of these resources may involve an unacceptably high rate of inflation.

Worse than that, even the maximum amount of real resources the central bank can extract through seigniorage may not be enough to close the central bank insolvency gap. This could happen if the central bank had a large stock of foreign-currency denominated or index-linked liabilities. In that case, without a capital injection from outside the central bank, the central bank cannot meet its funding needs from its own resources. The result would be hyperinflation and/or central bank insolvency.

The recapitalisation of the central bank could be undertaken by the national Treasury or by a foreign agency (e.g. one or more foreign central banks, national Treasuries or international organisations like the IMF, the World Bank and the regional development banks).

In the current financial crisis, the currency denomination of the assets and liabilities of the key central banks (the Fed, the ECB and the Bank of England) and of the

private financial entities with which they interact through open market operations and lender of last resort operations) has not been a key issue. For some of the smaller countries (Iceland comes to mind) access to foreign currency liquidity is the defining issue.

In what follows I shall concentrate on the case where the Treasury, in order to recapitalise the central bank (or in order to recapitalise some other part of the financial sector directly), has to be able to engineer just an *internal fiscal transfer*, rather than both an internal fiscal transfer and an *external transfer of resources*, as would be required if an injection of foreign currency-denominated assets were needed to ensure central bank solvency.

#### 4. Which fiscal authority stands behind and backs up the central bank in the euro area?

In the usual nation state setting, a single national Treasury or national fiscal authority stands behind a single national central bank. The combined fiscal-financial-monetary resources of the fiscal authority and the central bank must be sufficient to provide the central bank with the resources it requires to fulfil its role as lender of last resort and market maker of last resort and to meet its macroeconomic stability objectives (price stability in the euro area and the UK, or both price stability and full employment in the US). If this is not the case, either the central bank will not be able to meet both its financial stability and price stability objectives, or the fiscal authority will have to raise taxes or cut spending elsewhere.

There can be no doubt that in all large and medium-sized advanced countries where a single fiscal authority stands behind the central bank, the fiscal authorities are, from a technical, administrative and economic management point of view, capable of extracting and transferring to the central bank the resources required to ensure capital adequacy of the central bank should the central bank suffer a severe depletion of capital in the performance of its lender of last resort and market maker of last resort functions. For the smaller countries, especially those like Iceland where the banking sector has significant exposure to foreign-currency-denominated financial instruments and high-frequency requirements for foreign currency liquidity, even the combined monetary and fiscal authorities may not be able to access enough foreign currency liquidity to forestall a foreign exchange liquidity crisis and possible insolvency of financial institutions whose assets would be sound if held to maturity. Even if a fiscal bail-out of the central bank is technically feasible, however, it is not necessarily the case that the political consensus to implement these technically feasible policies exists everywhere.

Unique complications arise in the euro area, where each national fiscal authority stands financially behind its own NCB, but no fiscal authority stands directly behind the ECB. The lender of last resort function in the EMU is assigned to the NCB members of the ESCB

(see Padoa-Schioppa (1999), Goodhart (1999) and Lastra (2000)). This will work fine when a troubled or failing bank or other financial institution deemed to be of systemic importance has a clear 'nationality', legally and politically, as most euro area-domiciled and registered banks and other financial institutions do today.

Banks domiciled in a euro area member state that are

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subsidiaries of institutions domiciled either in another euro area member state or in a country outside the euro area (in the EU or outside the EU), will, as regards supervision and regulation (capital adequacy, all other liquidity and solvency issues, market conduct etc.) be the responsibility of the national regulator(s)/supervisor(s) of the country where the subsidiary is registered – not of the regulator(s)/supervisors of the country where the parent bank is located. Branches in a euro area member state of parents domiciled and registered outside that member state remain the responsibility of the national regulator(s)/supervisors of the parent's country of registration and domicile.

For lender of last resort access to the central bank's discount window or other special liquidity facilities, and as regards the right to act as a counterparty to the central bank in its open market operations, the rules are much less clear. Indeed, the very words 'lender of last resort' tend to be scarce or completely absent in most central bank legislation. This is probably out of deference to the fear of many central bankers that moral hazard would be encouraged even by merely officially recognising the rights and duties of the central bank and the private banks in situations of systemic financial instability.

Despite this, there is a presumption that the central bank of the host country will perform the lender of last resort role vis-à-vis the subsidiary of a foreign bank, while a branch of a foreign bank can make no such claim and has to rely on support, through its parent, from the central bank in the country of registration and domicile of the parent. Therefore, if a euro area NCB – say the Nederlandsche Bank (central bank of the Netherlands) – acts as lender of last resort for a bank (ABN-AMRO, say), that is a subsidiary of one or more foreign banks whose parents are registered in different countries (Belgium, Spain and the UK), and if as a result of that lender of last resort action the NCB suffers a balance sheet loss, there is a presumption that the Dutch Treasury is the national fiscal authority that would stand behind the Nederlandsche Bank. There is no legal obligation to do so, but there would be a strong presumption and a lot of political pressure to do so.

Whether the foreign ownership of the bank would influence the decision of the NCB to act as lender of

last resort (and whether the national Treasury could influence the lender of last resort decision of the NCB, say by threatening not to support the NCB if the NCB were to suffer a significant capital loss as a result of its lender of last resort or market maker of last resort operations) is an interesting and open question. What if ABN-AMRO were in turn to be the owner of a subsidiary in Italy – as is indeed the case (Banca Antonveneta)? Would the Italian Treasury pick up the bill for bailing out (directly or indirectly through the Banca d'Italia) the Italian subsidiary?

### If it is to be the Euro Area national Treasuries that will provide fiscal back-up for the ECB, in what proportions will they share the fiscal burden of recapitalising the ECB, should the need arise?

Ownership of many internationally active private financial institutions has by now become quite dispersed globally. The foreign parent bank may in turn have a significant share of its equity owned by institutions or individuals in the country where its subsidiary is domiciled. These are uncharted waters.

Greater complications arise when euro area-domiciled and registered banks emerge that do not have a clear national identity, even from a purely legal perspective. The clearest example would be a bank incorporated solely under European Law.<sup>12</sup> Such banks don't exist as yet, but I have no doubt that they will.<sup>13</sup> Indeed, many experts on regulation are of the opinion that because of the unique insolvency issues associated with banks and other highly leveraged financial institutions, and given the vast differences in national bankruptcy laws across the EU member states, large banking institutions and financial conglomerates should be incorporated as European companies and a specific EU-wide insolvency regime should apply to them (see e.g. Lastra (2007)). If and when we get EU-banks – banks incorporated solely under European Law, and registered in one or more euro area member states – which NCB will provide lender of last resort facilities for them and which national Treasury or Treasuries will pick up the tab for a bail-out either of the EU-banks themselves or of one or more NCBs that have suffered losses as a result of lender-of-last-resort actions in support of these EU-banks?

It would seem natural that the ECB itself rather than one of the euro area NCBs would provide lender of last resort facilities for EU-banks. But who stands behind the ECB as recapitaliser of last resort? Not the European Community, which has a tiny budget, (just over 1 percent of EU GDP), no discretionary taxation

powers and no borrowing powers. Also, even if the European Community were to evolve into a serious supranational budgetary entity, with independent powers to tax and to borrow, it would not be the appropriate fiscal back-up for the ECB, unless all EU members were also members of the euro area. As of today, there are still 12 EU members that are not part of the euro area.

If it is to be the euro area national Treasuries that will provide fiscal back-up for the ECB, in what proportions will they share the fiscal burden of recapitalising the ECB, should the need arise?

There is one readily available key for distributing the fiscal burden of recapitalising the ECB if in the future its balance sheet is impaired as a result of lender of last resort operations or market maker of last resort actions vis-à-vis EU-banks. This would be for each euro area Member State national Treasury to pay a share of the bail-out costs equal to the share of its NCB in the total share capital of the ECB, divided by the sum of the shares of all euro area NCBs in the total share capital of the ECB. Other formulae can be thought of, but it would be wise to have something agreed before the first EU Bank incorporated under EU statute law pops up and goes belly-up.

### Conclusion

Central banks can go broke and have done so historically, albeit mainly in developing countries. Two recent examples are the Reserve Bank of Zimbabwe (the current inflation rate in Zimbabwe is over 100,000 percent year-on-year) and the National Bank of Tajikistan. Late in 2007, the National Bank of Tajikistan admitted deliberately misleading the IMF on seven separate occasions on the nature of its external debt. In addition, senior National Bank figures were involved in a conflict of interest, which led the President of Tajikistan to sack the Chairman of the National Bank and all his deputies. The IMF has ordered the Tajik authorities to repay five IMF disbursements that were obtained on the basis of false information – instead of the claimed \$500m in reserves, the National Bank only had \$115m. Apart from the allegations of corruption and conflict of interest, the National Bank had played an active role guaranteeing loans to domestic cotton producers. It is only the expectation/hope of a further multilateral bail-out that has saved the National Bank of Tajikistan from formally defaulting on its obligations.

Central bank insolvency may become an issue again even in advanced industrial countries, if central banks were to assume too many foreign-currency denominated liabilities in an attempt to support or bail out private banks and other financial institutions deemed to be too large or too interconnected to fail.

The conventional balance sheet of the central bank is quite uninformative about the financial resources it has at its disposal and about its ability to act as an effective lender of last resort and market maker of last resort. Insolvency for central banks therefore would mean failure to pay obligations as they fall due (equitable insolvency) rather than liabilities exceeding assets (balance

<sup>12</sup> The legal form of the European Company, or Societas Europaea (SE), was created by the European Council on the 8 October 2001. It became subject to Community law in all EU member states on the 8 October 2004, over 30 years after negotiations for the creation of a European company were initiated.

<sup>13</sup> The German insurance, asset management and banking company Allianz AG became an SE in 2006.

sheet insolvency).

As long as central banks don't have significant foreign exchange-denominated liabilities or index-linked liabilities, it will always be possible for the central bank to ensure its solvency through monetary issuance (seigniorage).

**In the absence of foreign assistance, the Treasury and the taxpayer are the ultimate and only guarantor of central bank solvency and of its ability to pursue its price stability mandate despite its financial stability responsibilities.**

However, the scale of the recourse to seigniorage required to safeguard central bank solvency may undermine price stability. In addition, there are limits to the amount of real resources the central bank can appropriate by increasing the issuance of nominal base money. For both these reasons, it may be desirable for the Treasury to recapitalise the central bank should the central bank suffer a major capital loss as a result of its lender of last resort and market maker of last resort activities.

All the leading central banks, except the Bank of Japan, are small, as regards their capital and the size of their balance sheets, relative to the possible/likely exposure to credit risk and market risk they may incur as a result of their crisis-mitigating efforts. National fiscal authorities therefore play a key role in supporting the credibility of the central banks as lenders of last resort and market makers of last resort. They must let it be known that they will underwrite the balance sheet exposure of the central banks to the illiquid and impaired assets that are the most visible manifestation of the current crisis. In the absence of foreign assistance, the Treasury and the taxpayer are the ultimate and only guarantor of central bank solvency and of its ability to pursue its price stability mandate despite its financial stability responsibilities.

The central bank-Treasury team is naturally, indeed umbilically, linked in conventional nation states with a single national central bank and a single national Treasury. The euro area has a single central bank, the ECB, which works through an operationally decentralised system of national central banks, the Eurosystem, but works alongside (and at times at cross-purposes with) 15 national fiscal authorities. As long as the nationality of a bank is clear (legally through clear rules of domicile, registration and incorporation and politically through the importance of the bank in the national financial system or as an employer) the appropriate NCB and national Treasury can handle the necessary lender of last resort and recapitalisation responsibilities. Even today, the growing complexity of cross-border banking activities in the euro area may be creating ambiguities and doubt as to who are the lender of last resort and recapitaliser of last resort for specific banks with a range of border-crossing activities, branches and subsidiaries.

This situation will become vastly more complex when there will be banks incorporated as *Societas Europaea* (SE). Regardless of whether the NCBs continue to implement the lender of last resort role for banks incorporated as SE or the ECB assumes that function, the fiscal authorities of the euro area should as a matter of urgency agree on a formula for dividing the fiscal burden of recapitalising the European Central Bank, should the need ever arise.

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