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WHY IS 100% RESERVE BANKING INEFFICIENT?

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Why is100% Reserve Banking Inefficient?

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Abstract:
Financial crises are an important concern today. One part of the problem is banking crises, at the root of which is the bank run problem. One solution is *100% reserve banking*. But this is inefficient. The reasons are, however, not obvious.

The literature on bank runs following Diamond and Dybvig (1983) is based on banks' role in consumption smoothing. However, the earlier (rich) literature is based on banks' role in issuing deposits, which are a component of money and are a source of credit. In this context, a high reserve ratio for commercial banks obviously decreases *commercial bank credit*. However, in general, it does not decrease *total credit*. Despite this, 100% reserve banking is inefficient if competitive banks have a comparative advantage over the central bank in providing credit.
The paper ends by examining the implications of a decrease in gold reserves held by the central banks.

Key words: 100% reserve banking, commercial bank credit, total credit, nominal credit, real credit, gold reserves.
JEL Classification: E5, G2

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Financial crises are an important concern today in the developed countries (For more details on the current crisis (in 2007-08), see the exclusive issue on this crisis in Financial Stability Review, February, 2008, Banque de France.) So far, the Indian economy has not faced any such difficulties on a large scale (though some commercial banks in India have provided for losses in their exposure to derivatives). However, there is a lesson for the policy makers in India too. Parts of the financial sector in India have been liberalized considerably. It is possible that that some other parts of the financial system will be liberalized in the future (see Rajan 2008). While this liberalization is expected to improve efficiency, there is a possibility of Indian financial system becoming more vulnerable to instability than it has been in the past. In this context, it is important that we understand financial crises.

One form that a financial crisis takes is a banking crisis. A specific and recent example of this is the failure of Northern Rock Bank in UK in 2008. Northern Rock is not an isolated case of a banking crisis in the world economy in recent times. The last few decades have witnessed several cases of banking crises almost all over the world. These have imposed a high cost to the economy. The cost of rescuing banks in several countries has been high - as high as 55% of GDP in Argentina (41% in Chile, 27% in S. Korea, and so on) (Klinebel and Laewen 2002). Banking sector problems have independent negative real effects (Ariccia, et al. 2008).

What is a banking crisis? The problems of large non-performing assets on banks' balance sheets, difficulties in meeting banks' capital requirements, cost of recapitalization of

banks imposed on the governments, loss of confidence in some banks in minds of the people, considerable flight to quality from some or all banks, and so on are clubbed under the heading of the banking crises problem these days. For analytical purposes, we need to be careful. There can be two problems. One is the root problem of a banking crisis. The other is the side-effects of policies to deal with the root problem. Often these two problems are clubbed together. There is a need to separate these two.

In many countries, the governments provided deposit insurance and lender of last resort facilities. These policies were meant to protect depositors and ensure macroeconomic stability, which they did. However, they also had side-effects. They encouraged moral hazard in banks. Many banks accumulated large non-performing assets (NPAs). So in many cases NPAs are not the root problem though they attract a lot of attention in the media and even in policy making circles. They are simply the side-effect of a policy that is used to deal with the root problem. This paper is motivated by the root problem, and the root problem in many cases is one of bank runs.

The literature on bank runs following Diamond and Dybvig (1983) has focused on inter-temporal consumption smoothing. Much of this literature does not incorporate money[i]. However, the earlier literature including classic works such as Thornton (1802), Bagehot (1873) and Friedman (1964) had a different framework and focus. The context was monetary stability - ensuring that amount of money in the economy is stable. This framework is still useful. This paper will follow this older tradition and focus on money and credit in the context of the bank run problem.

A bank is vulnerable to a run because it has fractional reserves whereas its deposits can be withdrawn any time. One simple solution in this context is that banks adopt 100% reserve banking, or, sometimes also referred to as, unitary banking. This is inefficient. However, the reasons are not very obvious.

The central bank in many countries imposes a cash reserve ratio (CRR) on a commercial bank. The more the CRR, the smaller is the credit that can be made available by the commercial banks in the economy. The extreme case is where CRR is 1 and commercial bank lending is zero. However, commercial banks are not the only source of credit creation. The central bank, too, creates credit in the process of issuing, what is usually referred to as, high-powered money or base money. For many purposes, we are interested in total credit creation rather than simply the credit created by commercial banks alone. So we may ask the question – Does a change in CRR have an effect on *total credit*? If yes, then does this effect hold in general? Or, are there conditions under which this is true?

It may be argued that central bank credit should not be included in total credit. Usually the central bank provides funds to the government and the commercial banks lend to the private sector. However, this is not always true. The central bank may lend to the private sector (for example to private banks) and the commercial banks may lend to the government (or invest in government securities). The Statutory Liquidity Ratio (SLR) in India is very important. In any case, the central bank is also a bank, albeit a special bank.

So we consider credit creation by both the commercial banks and the central bank. It is true that apart from commercial banks and the central bank, there are various other financial institutions. But our interest lies in commercial banks and the central bank because other financial institutions are not usually involved in the payments system.

In this paper, we will use an extended but simple version of the standard model of credit creation and money multiplier. For simplicity, we will assume full employment level of output. We will use the Quantity Theory of Money for determination of the price level. Again for simplicity, we consider demand for money as a function of previous period output, which is pre-determined. Current period output in our model is endogenous. It is a function of the total real credit creation in the economy.

The standard model of credit creation and money multiplier incorporates reserves of the commercial banks. But the central bank also keeps reserves. It is interesting that some central banks have reduced their gold reserves in recent times. The official stock of gold with central banks has declined by about 10% between 1980 and 1999. Sellers included Canada, Belgium, the Netherlands, Switzerland, Australia, the United Kingdom, Portugal, and some Latin American countries (World Gold Council 2003). The sale of gold by central banks may continue in the future. What are the implications of this reduction in gold reserves of a central bank?

This paper will show that the total real credit by the banking system (the central bank plus the commercial banks) is invariant to cash reserve ratio of commercial banks, if the

central bank keeps zero gold reserves. It follows immediately that total real credit creation under fractional reserve commercial banking is the same as that under unitary banking. However, if the central bank keeps positive gold reserves, then total real credit does vary with the cash reserve ratio maintained by commercial banks. Further, the magnitude of this effect of a change in cash reserve ratio on total real credit falls as the central bank decreases its gold reserves.

Unitary banking received considerable attention after the banking crises in 1930s. It was advocated because it was run-proof (see Simons 1948; Bryan 1988). However, it was not adopted because it was considered obviously inefficient. We will see that the reasons are not very obvious.

The standard model of credit creation and money multiplier deals with credit creation by commercial banks only. It does not include credit creation by the central bank (see, for example, Papademos and Modigliani 1990). What are the implications of including credit creation by the central bank?

Foreign exchange reserves are held in many countries in the form of bonds and treasury bills of reputed foreign governments. So foreign exchange reserves may be viewed as 'credit given to foreign governments'. So the total of government bonds and foreign exchange reserves may be viewed as the total credit given to governments (domestic and foreign). For simplicity, we will focus on credit given by the central bank to domestic government only. So we will abstract from foreign exchange reserves.

The plan of the paper is as follows. The standard model of credit creation by commercial banks is set out in section I. Output in section I is pre-determined. Section II includes the central bank in the model. Output in section II is endogenous. In section III we conclude.

I THE MODEL

For simplicity, consider a closed economy. We will use an extended version of the standard model of supply of money supply (M). The economy consists of commercial banks, the central bank, the government and the public. The central bank issues irredeemable high-powered money (H), which is demanded by public in the form of currency (C), and by commercial banks in the form of reserves (R). The commercial banks issue deposits (D) and give out loans (L^b) after keeping a proportion (r) of deposits as reserves. We assume that $0 < r \leq 1$. If $r < 1$, we have fractional reserve commercial banking. If $r = 1$, we have unitary commercial banking. Currency and deposits are held in a fixed ratio (c). Assume that $c > 0$.

Assume that high-powered money is exogenously given ($\overline{H}$). Since high-powered money consists of currency and reserves, it follows that

$$\overline{H} = C + R. \tag{1}$$

It follows from the above discussion that in equilibrium,

$$C = cD, \tag{2}$$

$$R = rD, \text{ and} \tag{3}$$

$$L^b = (1-r)D. \quad (4)$$

By the definition of money, we have

$$M = C + D. \quad (5)$$

This is where the usual model of credit creation and money multiplier ends. Since our interest lies in real credit, we need to consider the price level (P) as well. We will use a simple version of the Quantity Theory of Money for this purpose. Money illusion is absent, by assumption. The demand for real money is a function of output. However, for simplicity, we consider a one period lag. We assume that the demand for money in the current period is a function of output in the previous period. Let Y_{-1} be the output in the economy in the previous period. Since Y_{-1} is pre-determined, the model remains simple. In equilibrium,

$$M = kPY_{-1}, \quad (6)$$

where k is a behavioral parameter. We will later treat the current period output (Y) as an endogenous variable. But to keep the model simple, in (6), we have used Y_{-1} instead of Y. At this stage, let us consider a well known and very straightforward result in the literature:

C*redit created by commercial banks decreases with cash reserve ratio.*

Though the proof is well known and straightforward, we restate it here for later reference and comparison. We will first consider nominal credit and thereafter consider real credit. It follows from (1) to (4) that, in equilibrium,

$$L^b = \frac{1-r}{c+r}\overline{H} \,. \tag{7}$$

It is easy to check that $(\partial L^b / \partial r) < 0$. Similarly solving for C and D from (1) to (4), and using (5) and (6), we get

$$P = \frac{(1+c)\overline{H}}{(c+r)kY_{-1}} \,. \tag{8}$$

From (7) and (8), we have

$$\frac{L^b}{P} = \frac{1-r}{1+c}kY_{-1} \,. \tag{9}$$

This implies that $\partial[L^b / P]/\partial r < 0$. This completes the proof of the proposition that (nominal as well as real) credit creation by the commercial banks falls with cash reserve ratio. This proposition has an obvious corollary:

C*redit created by the commercial banks under fractional reserve banking is greater than that under unitary banking.*

We will need this for later reference. In this section, we have reconsidered the standard model and restated the well known effect of a change in cash reserve ratio on credit creation by commercial banks. In this section, output was treated as a pre-determined variable. In the next section, we will consider the banking system that includes not only the commercial banks but also the central bank. We will also treat output as an endogenous variable in the next section.

II REAL CREDIT CREATION BY THE BANKING SYSTEM

This section will include the central bank in the model. Assume that the central bank has only two assets viz. loans (L^c) and gold reserves. Let g be the proportion of the central bank assets held in the form of gold reserves. The central bank, it is assumed, has only one liability viz. central bank money, which is sometimes referred to as base money or high-powered money. Recall that we have assumed that the high-powered money is exogenously given. So the nominal credit creation by the central bank is given by

$$L^c = (1-g)\overline{H} . \tag{10}$$

Next, let us consider output. Recall that in the previous section, we considered output with one period lag. This was pre-determined. Let us now consider the current period output (Y) in the economy. The current period output is an endogenous variable. The current period output in the economy is a function of current period real credit creation by the commercial banks and by the central bank. Let

$$Y = f(a^b(L^b / P) + a^c(L^c / P)), \tag{11}$$

where a^b and a^c are the respective proportions of commercial bank credit and of central bank credit that are used for productive purposes. If $a^b > a^c$, it means that relatively more commercial bank loans are used for productive purposes than in the case of central bank loans, and vice-versa. If $a^b = a^c$, it means that the effect of commercial bank loans on output is the same as that of central bank loans on output. We may interpret a^b and a^c as measures of efficiency with which commercial bank funds and central bank funds are utilized respectively.

In this model, Y_{-1} is pre-determined. So there are eight variables in the model viz. C, D, R, M, L^b, L^c, P and Y . We have eight equations from (1) to (6) and from (10) to (11). We can now state our first result formally.

Proposition 1 *Total real credit decreases with cash reserve ratio if the central bank keeps positive gold reserves. Total real credit is invariant to a change in cash reserve ratio if the central bank keeps zero gold reserves.*

Proof: From (8) and (10), we have

$$\frac{L^c}{P} = \frac{(1-g)(c+r)}{1+c} kY_{-1} \tag{12}$$

From (9) and (12), total real credit is given by

$$\frac{L^b + L^c}{P} = \frac{(1-r)+(1-g)(c+r)}{1+c} kY_{-1} \tag{13}$$

$$\Rightarrow \frac{\partial[(L^b + L^c)/P]}{\partial r} = \frac{-gkY_{-1}}{(1+c)} \tag{14}$$

This implies that

$$\frac{\partial[(L^b + L^c)/P]}{\partial r} < 0, g > 0$$

and

$$\frac{\partial[(L^b + L^c)/P]}{\partial r} = 0, g = 0 .$$

This completes the proof.

We have shown that total real credit varies with the cash reserve ratio if the central bank keeps gold reserves. So far we have considered reserve ratios (r and g) as determinants of credit. Another determinant of nominal credit is high-powered money. How does real credit vary with respect to high-powered money? Observe from (9) and (12) that real credit created is invariant to high-powered money. This is not surprising, given our model. But for comparison of the effect of a change in high-powered money on total real credit with the effect of a change in cash reserve ratio on total real credit, observe from (9) and (12) that $\frac{\partial(L^b / P)}{\partial H} = \frac{\partial(L^c / P)}{\partial H} = 0, g \geq 0$. So it does not matter whether g is greater than or equal to zero as far as the impact of a change in high-powered money on real credit is concerned. But it does matter whether g is positive or zero as far as the impact of a change in cash reserve ratio on total real credit is concerned (Proposition 1).

Let us now see the implications of Proposition 1 for the debate on fractional reserve banking $(r < 1)$ vis-à-vis unitary banking $(r = 1)$.

Corollary 1: *If $g = 0$, total real credit created by the banking system under fractional reserve banking is the same as that under unitary banking.*

Proof: From proof of Proposition 1, we have $\frac{\partial[(L^b + L^c) / P]}{\partial r} = 0$ if $g = 0$. Corollary 1 follows immediately. *This completes the proof*.

Let us now compare Corollary 1 with the corollary in section I. The latter stated that commercial bank credit creation is greater under fractional reserve banking than under unitary banking. But if we consider the banking system as a whole, then it is no longer true in general that the credit creation decreases with cash reserve ratio. Real credit creation by the banking system decreases with cash reserve ratio if and only if $g > 0$. If $g = 0$, real credit creation by the banking system is the same, whether there is fractional reserve banking or unitary banking (Corollary 1).

In Corollary 1, we have compared credit creation under the regime of fractional reserve banking and under unitary banking. Let us next consider the welfare implications. For simplicity, let us consider output as a measure of welfare.

Corollary 2: *If* $g = 0$ *and* $a^b = a^c$*, then output under unitary banking is the same as output under fractional reserve banking.*

Proof: Substituting $a^b = a^c$ in (11), we get

$Y = f(a^b([L^b + L^c]/P)$, if $a^b = a^c$.

Using (13), we get

$Y = f(a^b kY_{-1})$, if $a^b = a^c$ and $g = 0$.

Observe that Y is invariant to r if $a^b = a^c$ and $g = 0$. *This completes the proof.*

In Corollary 1 and in Corollary 2, we have seen the implication of $g = 0$ for credit and for output respectively. Let us now consider the case $g > 0$. What is the effect of a change in the reserve ratio of the central bank (g) on the impact of the change in cash reserve ratio (r) on total real credit creation? Formally, how does $\frac{\partial[(L^b + L^c)/P]}{\partial r}$ change with respect to g ?

Proposition 2 *Assume that* $g > 0$. *The absolute impact of a change in commercial banks' cash reserve ratio on total real credit is a monotonically increasing function of the central bank's gold reserve ratio.*

Proof: From (14), it immediately follows that $\left[-\frac{\partial^2[(L^b + L^c)/P]}{\partial g \partial r}\right] = \frac{kY_{-1}}{(1+c)} > 0$. *This completes the proof*.

We have thus shown that the impact of a change in cash reserve ratio of commercial banks on total real credit depends on the gold reserves that the central bank maintains. The more the gold reserves of the central bank, the greater is the impact of a change in cash reserve ratio of commercial banks on total real credit. As mentioned already, in recent times, some central banks have reduced their gold reserves. This implies that in any of these countries, the central bank cannot use the instrument of cash reserve ratio as effectively as it did in the past. So the policy of a fall in gold reserves has implications for the effectiveness of a given change in cash reserve ratio.

Let us make a few observations. First, if $g = 1$ and $r = 1$, then total real credit creation is zero (see (13)). The intuition is straightforward. In this case, effectively, gold is the medium of exchange since all money is directly or indirectly fully backed by gold. Currency is directly backed by gold. But observe that indirectly bank deposits are also backed by gold. The reason is that since $r = 1$, it follows that deposits are 100% backed by reserves held by commercial banks in the form of (central bank) money, which is in turn 100% backed by gold. On the other hand, if $g = 0$, then the total credit creation is $(L^b + L^c)/P = kY_{-1}$ (see (13)). Observe that $M / P = kY_{-1}$ (see (6)). Since total real credit creation against real money issued by the banking system cannot exceed the amount of real money, it follows that total real credit creation is maximum when $g = 0$. Observe that this is true regardless of the value that r takes. Again the intuition is straightforward. Money takes two forms viz. currency and deposits. If $g = 0$, there is no gold backing for currency issued by the central bank so this gives scope for credit creation by the central bank to the extent that currency is issued. The remaining money is commercial bank deposits. Against these deposits, commercial banks hold loans and reserves. So there is scope for credit creation by commercial banks to the extent that the commercial banks do not hold reserves. But observe that that the reserves held by the commercial banks are in the form of (central bank) money, which is not backed by gold at all if $g = 0$. The central bank holds loans entirely instead of holding any gold. So the central bank creates credit instead of the commercial banks against the reserves held by the commercial banks. Therefore, the reserve ratio observed by the commercial banks affects the composition of loans instead of the amount of loans, if $g = 0$. The higher the reserve ratio maintained by

the commercial banks, the less the credit creation by the commercial banks *but the more the credit creation by the central bank*. So the total real credit creation is constant if $g = 0$.

Figure 1 about here

Figure 1 shows the effect of reserve ratio (r) on total real credit creation ($(L^b + L^c)/P$). On x-axis and y-axis, we have r and $(L^b + L^c)/P$ respectively. Line segments AB, CD and EF represent the cases $g = 0$, $0 < g < 1$ and $g = 1$ respectively. AB is horizontal since the total real credit is invariant to the cash reserve ratio of commercial banks. The height of AB represents the maximum credit creation that is possible. CD lies below AB because g is no longer zero so that the central bank cannot create credit fully against the money that it issues. CD is downward sloping because with $g > 0$, a higher r permits a lower total real credit creation. Finally, EF represents the case of least credit creation. Observe that EF intersects the x-axis at $r = 1$. So total real credit creation is zero if $r = g = 1$. Observe that in general $r = 1$ does not imply that $(L^b + L^c)/P = 0$ (see the case of AB and CD). Further, observe that the position of CD depends on the value of g. The lower the g, the higher is the position of CD. Moreover, the lower the g, the flatter is the segment CD. This is the graphical representation of Proposition 2 that the absolute impact of a change in cash reserve ratio on total real credit falls as g falls. As $g \to 0$, the line segment CD tends to become horizontal.

Much of the literature has focused on nominal credit created by commercial banks. Though there is a fairly long history of the ideas of credit creation, Phillips (1921) was a pioneering attempt at a somewhat formal model of credit creation. But there is hardly any discussion of the credit created by the central bank or of the effect of commercial bank credit creation on the price level. There is a similar omission of total real credit creation in Gurley and Shaw (1960), Towey (1974), Wilson (1992), and Humphrey (1992). This omission is also witnessed in many textbooks (for example, Mankiw 1997). On the other hand, Fama (1980) and Fama (1983) bring central bank money, commercial banks' deposits and the price level together but their focus is different. These two papers do not discuss credit creation. King and Plosser (1984) consider money, credit and prices but their analysis is in the context of a real business cycle. There is no central bank credit in their model. Kennedy (2000) is a useful reading on distinction between nominal and real magnitudes. However, Kennedy does not consider this distinction in the context of credit creation. In this paper, both the price level and the central bank credit have been included in the analysis.

III CONCLUSION

It is widely believed that credit created under fractional reserve banking is greater than that under unitary banking. It is usually not made clear whether we are considering nominal credit or real credit. It is also not clear if we are considering commercial bank credit alone or total credit. We have examined these issues in this paper. Our result is as follows. If the central bank holds positive gold reserves, then the total real credit creation under fractional reserve banking is indeed more than that under unitary banking.

However, if the central bank holds zero gold reserves, then the total real credit creation under fractional reserve banking is no different from that under unitary banking. Furthermore, if the credit created by the central bank is used as productively as the credit created by the commercial banks, then the output in the economy under fractional reserve banking is the same as that under unitary banking, if the central bank keeps zero gold reserves.

One result on comparative statics is as follows. The lower the gold reserves of the central bank, the less is the impact of a given change in commercial banks' cash reserve ratio on total real credit created by the banking system. In the extreme case where the central bank does not keep any gold reserves, the impact of a change in cash reserve ratio on total real credit is zero. So cash reserve ratio could cease to be a tool of credit policy if the central bank switches to a regime of zero gold reserves. It is important to keep in mind that at present, cash reserve ratio is a useful tool because the central bank keeps gold reserves. So any change in the policy of the central bank to reduce gold reserves has important implications. Many European countries have reduced their gold reserves.

In this paper, we have used comparative statics to arrive at our results. We have also assumed flexible prices. Some of our results are strong for these reasons. It is possible that our results will get somewhat diluted if we relax these assumptions.

Fractional reserve banking developed at a time when gold standard prevailed and central banking had not come into being in many countries. In those days, reserves of

commercial banks took the form of gold. The higher the reserve ratio maintained by commercial banks, the less the credit that banks could give out. So in such a monetary and banking system, 100% reserve banking was indeed *obviously* inefficient. However, at present, reserves of commercial banks are not kept in the form of gold. Instead, these are held in the form of central bank money. The latter is backed primarily by government bonds and foreign exchange reserves in many countries. Gold reserves with central banks are very small these days. Government bonds and foreign exchange reserves may be viewed as 'credit given to the government - domestic and foreign'.

Reserves of commercial banks do decrease credit given by commercial banks but these reserves are used to finance credit given by the central bank. So the central bank credit creation goes up with an increase of cash reserve ratio of commercial banks. So there is little or no overall decrease in total credit given by the banking system (the commercial banks plus the central bank) if the cash reserve ratio of commercial banks is varied. However, the quality of lending by the commercial banks may be different from that by the central bank. If so, then positive reserves with commercial banks in general and 100% reserves in particular will have efficiency implications. Observe that this argument is very different from the simple (or even naïve) argument that 100% reserve banking is inefficient because it allows less credit than fractional reserve banking.

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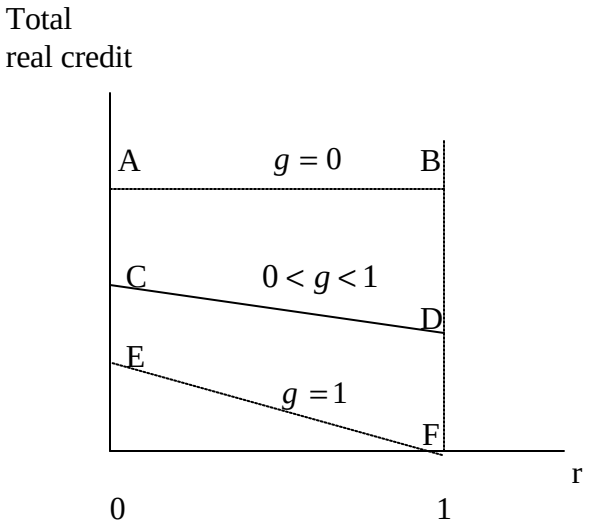

Figure 1

[i] Some recent papers have included money in this framework, but it still does not occupy centre-stage (see Diamond and Rajan 2003).