SEIGNIORAGE, CENTRAL BANK’S PROFITS, CAPITAL AND CREDIBILITY – Tomáš Holub

I. Introduction

In the previous two essays, I discussed how a lack of anti-inflationary credibility of the central bank can emerge due to its political dependence, and how insufficient credibility can influence the choice of monetary policy regime in favor of introducing a “hard peg”. In this last essay I study the links between the central bank’s credibility (or the country’s credibility in general) and its finance.

The traditional literature has analyzed how a need of monetary policy to generate seigniorage in order to cover fiscal costs may deprive it of its ability to fight inflation, undermine its credibility and in an extreme (but historically quite common) case generate a hyperinflation. The classical contributions in this spirit include Cagan (1956) or Sargent and Wallace (1981). In this paper, I argue in exactly the opposite way, i.e. I show that a low credibility of the country’s authorities may, via a risk premium in the foreign exchange market, reduce the ability of central bank to generate profits and create fiscal resources. This link is probably much less important then the traditional one, but in some special cases it may be non-negligible. I demonstrate that the Czech National Bank belongs to such cases, which puts it under a hard budget constraint and greatly reduces the possibility that it could transfer any profits to the state budget in the foreseeable future. I also argue that this aspect may be important when considering the costs and benefits of the possible dollarization/euroization of some countries.

I also discuss the question whether the central banks need to have their own capital. In other words, I analyze whether they can credibly perform their policy goals with a negative capital or not, and what happens if the trust in sustainability of central bank’s finance is lost even though its financial situation could be sustainable if confidence was preserved. These questions are very interesting for the Czech Republic, too, as the Czech National Bank currently operates with slightly negative net capital.

The paper is organized as follows. In Section I, I discuss the different measures of seigniorage that have been used in the economic literature. I start with the standard concepts of monetary seigniorage and opportunity cost seigniorage. Then I present the broader cash-flow concepts that were introduced during the 1990s by M. Neumann (1992, 1996) and others, i.e. the “fiscal seigniorage“, “total seigniorage“ etc. In contrast to this modern literature, I argue that the broader concepts of seigniorage are not well justified and may be even confusing for economies with developed financial markets and proper institutional setting of their central banks, to which these concepts of seigniorage have been typically applied empirically. As a result, I choose the simple “opportunity cost seigniorage” concept for further analysis in Section II. I study the link between this definition of seigniorage and the central bank’s profits.
This analysis also reveals other factors that influence the central bank’s profits, including the role of the risk premium in foreign exchange markets. Section III applies the previous findings to the profits and loss accounts of the Czech National Bank and shows their strong empirical relevance for our case. Section IV focuses on the question of “capital adequacy” for central banks and the particular situation of the CNB in this respect. Section V summarizes and concludes.

II. What Is Seigniorage?

Let us start with a simplified consolidated balance sheet of a central bank, which is presented in Table 1. On the asset side, there are net foreign assets of the central bank, its net credit to the government and its net claims on the domestic private sector. On the liability side, we have the monetary base, i.e. currency issued by the central bank, and bank reserves (both required and voluntary). Finally, there is net capital of the central bank, by which I here mean the difference between the central bank’s own funds and its fixed assets that the central bank uses in its operation.

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net foreign assets (FA_{CB})</td>
<td>Monetary base (M0)</td>
</tr>
<tr>
<td>Net government debt to c.b. (GD_{CB})</td>
<td>of which: Currency (CU)</td>
</tr>
<tr>
<td>Other net assets (OA_{CB})</td>
<td>Reserves of banks (RE)</td>
</tr>
<tr>
<td></td>
<td>Net capital of c.b. (K)</td>
</tr>
</tbody>
</table>

The monetary seigniorage ($S$) is defined as a change in monetary base during a time period divided by the price level ($P$).\(^1\) The formal definition is

$$ S \equiv \frac{\Delta M}{P} $$

(1).

This notion of seigniorage is closest to the historical one, i.e. the monopoly of mediaeval rulers to issue coins, from which the word seigniorage originated.

An alternative definition of seigniorage is the so called “opportunity cost seigniorage”, defined as

$$ S' \equiv \frac{\mu_{CU}}{P} + \left( \frac{i^r - i}{P} \right) \frac{RE}{P} = \frac{M}{P} - i \frac{RE}{P} $$

(2),

where $i$ denotes the market interest rate and $i^r$ is the interest rate on bank reserves with the central bank. By holding non-interest-bearing currency, or bank reserves that yield no interest or an interest below the market rate, the

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1 It is a question, though, by what price level we should divide the seigniorage to compute its real value. This is important especially in high-inflation countries in which the price level changes fast, and the starting price level thus may differ significantly from the end-period one. In practice, the nominal seigniorage is often related to the yearly nominal GDP, which means that we implicitly use the average yearly price level to compute the relative importance of seigniorage in the economy.
economic agents undergo opportunity costs. And the opportunity costs for private agents are at the same time an opportunity gain for the central bank (assuming that the individuals can invest at the same market interest rate as the central bank does – this is a simplification that I will use throughout this essay).

By investing the monetary base at the market rate \( i \) the central bank can earn a net monetary income equal to the expression in equation (2). I argue below that this notion of seigniorage is closer to the accounting practices of modern central banks, for which an issue of currency does not constitute direct profits (currency is a liability of central bank), but only an opportunity to increase their profits in the future.

As we can see, the opportunity cost seigniorage is equal to monetary seigniorage only in special cases. One of them is the case when the bank reserves do not bear interest and the monetary base grows at a speed equal to the nominal interest rate. This latter condition can be fulfilled for example when both the velocity of broad money and the money multiplier are stable, and the real market interest rate is equal to zero.

If the real interest rate is zero, it is also true that the opportunity cost seigniorage is equal to the „inflation tax“ (see e.g. Friedman, 1971), which is defined as \( p \cdot M_0 \), where \( p \) is the rate of inflation.\(^2\) The inflation tax stems from the fact that currency holders are not protected against inflation, i.e. they give up the opportunity of investing a part of their wealth into assets that provide protection against inflation (From the central bank’s point of view, the inflation erodes the real value of its liabilities, i.e. of the monetary base.). The opportunity cost seigniorage is more general as it adds to the inflation tax also the foregone real interest on money holdings (or gained opportunity to earn real interest from the central bank’s point of view).

We can easily demonstrate the economic relationship between the monetary seigniorage and opportunity cost seigniorage. Let us consider a simple situation: the monetary base increases permanently by \( \Delta M_0 \) in some starting period \( t=0 \), and the central bank uses this opportunity to buy some domestic asset yielding the market interest rate \( i \) (or to repay some of its liabilities bearing the market interest rate). Assuming the increase in monetary base takes place exclusively through an increase in the issued currency, this rises the opportunity cost seigniorage (and, as we will see in Section II, also the central bank’s profits) in each subsequent period by \( i \Delta C U = i \Delta M_0 \). The real present value of this infinite stream of additional opportunity cost seigniorage is

\[
\frac{\text{NPV} (S_{<\infty})}{P} = \frac{1}{P} \left\{ \frac{\Delta C U}{1+i} + \frac{\Delta C U}{(1+i)^2} + \frac{\Delta C U}{(1+i)^3} + \cdots \right\} = \frac{\Delta C U}{P} = \frac{\Delta M_0}{P}
\]  

(3a),

\(^2\) More precisely, the inflation tax is then equal to the nominal value of monetary seigniorage before dividing it by the price level \( P \).
i.e. it is equal to the monetary seigniorage. The current opportunity cost seigniorage can be thus understood as an interest counterpart of the monetary seigniorage accumulated during the whole past.3

On the other hand, if the monetary base increased through a rise in bank reserves only, the opportunity cost seigniorage (and central bank’s profits) would go up just by \((i-ir)\Delta RE\). The real present value of the infinite stream of this additional income is equal to

\[
\frac{NPV (S_{t-n})}{P} = \left(1 - \frac{\hat{i}}{i}\right) \frac{\Delta RE}{P} = \left(1 - \frac{\hat{i}}{i}\right) \frac{\Delta MO}{P} \tag{3b},
\]

i.e. it is smaller than the monetary seigniorage except for the case when the bank reserves bear no interest. On the other hand, when bank reserves bear the market interest rate – which is the other extreme – the real present value of an increase in reserves is zero for the central bank.

The ability to distinguish between the changes in currency and bank reserves in a situation when the reserves bear positive interest is one of important advantages of the opportunity cost seigniorage compared to monetary seigniorage. The comparative disadvantage of monetary seigniorage could be theoretically eliminated, though. Let us look at the general case when the increase in monetary base takes place partly through an increase in currency and partly through a rise in bank reserves. The net present value of additional opportunity cost seigniorage equals

\[
\frac{NPV (S_{t-n})}{P} = \frac{\Delta CU}{P} + \left(1 - \frac{\hat{i}}{i}\right) \frac{\Delta RE}{P} = \frac{\Delta MO}{P} - \frac{\hat{i}}{i} \frac{\Delta RE}{P} \tag{3c}.
\]

The right-hand side of equation (3c) could be labelled as „adjusted monetary seigniorage“, and the standard definition of monetary seigniorage than could be considered as a special case for \(\hat{i}=0\).4

During the 1990s, however, the basic concepts of seigniorage, which I have just presented, became a subject of critique by some economists. Neumann (1992), for example, writes: “the traditional concept of monetary seigniorage does not provide a complete account of the government’s revenue from base money provision. It abstracts from the actual process of base money creation and, therefore, neglects the fact that the total flow of revenue in addition depends on the asset structure of the central bank.” To overcome this alleged shortage, some alternative definitions of seigniorage have been proposed („fiscal

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3 A famous analogy is an example with „cows and milk“. The monetary base is like a herd of cows, the opportunity cost seigniorage is like the milk these cows give. The market value of the cows should be equal to the discounted sum of (net) revenues from all milk that the herd will give in the entire future.

4 But I am personally not a big fan of introducing new definitions of seigniorage. As we will see later on, there already exists a range of alternative definitions, which may result in a big confusion. Moreover, the ratio of interest rate on the bank reserves to the market interest rate may not be stable over time, as was assumed for the easy of computation in equation (3b) and (3c), which would greatly complicate the practical use of such a “adjusted monetary seigniorage” concept.
seigniorage“, “total seigniorage“ etc.). The aim of the following paragraphs, on the contrary, is to show that the economic meaning of these new concepts is doubtful, and that they just bring confusion to the subject of seigniorage.

The broad concepts of seigniorage are essentially cash-flow indicators, which mix together state variables from the central bank’s balance sheet with the flow variables from its income statement, which breaks the clear link of seigniorage to the central bank’s standard accounts. This in itself is a certain disadvantage, but surely not a sufficient one to reject these broad concepts. After all, the cash-flow indicators are economically quite important for private economic agents, in the short-run often more than the standard accounts. Nevertheless, this is due to the existence of liquidity and credit constraints, which most of the private agents have to face. This is not, however, the case of the governments in advanced economies (and also the Czech Republic) to which the cash-flow concepts of seigniorage have been mostly applied empirically. These governments can usually borrow freely in the financial markets at standard market conditions, and this availability of credit is limited only in exceptional situations. This simple consideration suggests that the importance of broad cash-flow concepts of seigniorage could be limited to countries that have underdeveloped financial markets or are undergoing financial crises (but this may arguably be the case of hyperinflationary economies, which the traditional literature on seigniorage has naturally paid most attention to).

Nevertheless, the economic usefulness of cash-flow seigniorage concepts can also be questioned in a more formal and rigorous way. I will start with the government’s budget constraint (for “fiscal seigniorage”), and the consolidated budget constraint of the public sector (for “total seigniorage” etc.). The form of a standard budget constraint is: the primary deficit + costs of servicing debt (i.e. secondary deficit) = change in debt (+ seigniorage, if applicable).

For a non-monetary economy, the government’s (and at the same time public sector’s) budget constraint is

\[(G - T) + iGD^p = \Delta GD^p \]  

(4),

where \(G\) is the government’s spending, \(T\) its current (i.e. tax, fee etc.) income and \(GD^p\) the net government’s debt to private sector.\(^5\) This budget constraint, of course, does not contain any seigniorage. For a monetized economy the government’s budget constraint modifies to

\[(G - T) + iGD^p + iGDCB − TR = \Delta GD^p + \Delta GD^{CB} \]  

(5),

where \(GD^{CB}\) denotes the net government’s debt to the central bank, \(i^c\) is the average interest rate on net government’s debt to the central bank, and \(TR\) is the direct transfer of profit (or its part) from the central bank to government. Equation (5) says that the sum of primary state budget deficit (i.e. \(G-T\)) and the

\(^5\) For simplicity, I do not distinguish here between the government’s external debt and its debt to the domestic private sector.
secondary budget deficit \((iGD^P + iVDCB)\) must be financed either through a transfer of central bank’s profit or an issue of new government’s debt.

The aim of fiscal seigniorage concept is to separate in the government’s budget constraint transactions of the government with private sector from its transactions with the central bank. In other words, we are trying to put aside all the terms in the government’s budget constraint of equation (5) that are missing in equation (4) for a non-monetary economy. This can be achieved by rearranging equation (5) to

\[
\frac{(G-T)}{P} + \frac{iGD^P}{P} = \frac{\Delta GD^P}{P} + \left\{ \frac{\Delta GD_{CB} + TR - i^P GD_{CB}}{P} \right\} \quad (6).
\]

“Fiscal seigniorage” is then the term in braces on the right-hand side of equation (6). This indicator is supposed to capture the total net cash-flow from the central bank to the government. It includes changes in the government’s net debt to the central bank plus the transfer of central bank’s profit to the government, minus the interest paid by the government on its debt to the central bank.

The consolidated public sector’s (by “public sector” I mean here general government plus the central bank) budget constraint in a monetized economy can be written as

\[
\frac{(G-T)}{P} + \frac{iGD^P}{P} + \frac{\Delta GD^P}{P} + \frac{\pi_{CB}}{P} = \left\{ \frac{\Delta GD^P}{P} - \Delta \left( FA_{CB} + OA_{CB} \right) \right\} + \frac{\Delta M_0}{P} \quad (7),
\]

(where \(\pi_{CB}\) denotes profit of the central bank). The left-hand side of equation (7) represents the public budget deficit, i.e. a difference between its total incomes and spending. These incomes include the profit of central bank. The right-hand side shows the way in which the consolidated budget deficit is financed. The term in braces is the change in consolidated public debt, which is equal to the government’s net debt minus the central bank’s net assets. In consolidating, the government’s debt to the central bank naturally drops out. The last term in equation (7) is the classical monetary seigniorage. The public sector’s consolidated budget deficit is thus partly covered by an issue of new consolidated public debt, and partly by monetary seigniorage.

If we rearrange equation (7) to

\[
\frac{(G-T)}{P} + \frac{iGD^P}{P} = \frac{\Delta GD^P}{P} + \left\{ \frac{\Delta M_0}{P} - \Delta \left( FA_{CB} + OA_{CB} \right) + \frac{\pi_{CB} - i^P GD_{CB}}{P} \right\} \quad (8),
\]

6 We can easily obtain this consolidated budget constraint from equation (5) if we realise two basic accounting identities of the central bank: \(TR = \pi_{CB} - \Delta K\) (where \(\pi_{CB}\) denotes profit of the central bank – see Section III) and \(\Delta K = \Delta FA_{CB} + \Delta GD_{CB} + \Delta OA_{CB} - \Delta MO\). The first identity says that the central profit can be either transferred to the state budget or used to increase the bank’s net capital. The second identity originates from the central bank’s balance sheet and says that an increase in its net capital is equal to the increase in its net assets minus the increase of its monetary base (i.e. liabilities).
we get what Herrendorf and Valentinyi (1999) call “seigniorage in the broadest possible sense”. They derived this indicator based on the reasoning that “seigniorage comprises all terms (in the public sector’s budget constraint) that would be absent in a non-monetary barter economy.” In other words, they used the same reasoning that was applied to the government’s budget constraint to derive fiscal seigniorage, except that they applied it to the budget constraint of the whole public sector (and they thus compared equation (7) and (4)). In fact, however, Herrendorf’s and Valentinyi’s (1999) definition represents just another way to write down “fiscal seigniorage“ of equation (6), and we thus can (or must) treat them together.8

Another broad concept of seigniorage is Neumann’s (1992) “extended monetary seigniorage”, or to use a newer term Neumann’s (1996) “total seigniorage”. We can get this from equation (7) by rearranging to

\[
\left( \frac{G-T}{P} + \frac{iGD}{P} - \frac{eFA^{\text{CB}}}{P} + \frac{C^{\text{CB}}}{P} \right) = \left\{ \frac{\Delta GD}{P} - \frac{\Delta (FA^{\text{CB}} + OA^{\text{CB}})}{P} \right\} + \left\{ \frac{\Delta M}{P} + \frac{\pi^{\text{CB}} - eFA^{\text{CB}} - \bar{f}GD^{\text{CB}} + C^{\text{CB}}}{P} \right\}
\]

“Total seigniorage” is the term in the second braces on the right-hand side of equation (9).9 The aim of this indicator is to measure “total flow to the government sector associated with base money creation, (which) results from two sources … (i) resource flow from expanding the base money stock by buying interest-earning assets …; (ii) the flow of interest revenue on the stock of non-government debt that the central bank bought in the past in exchange for non-interest bearing base money” (see Neumann, 1996). The interest payments from the government to central bank are not included, though, as “it is not a revenue flow to the government sector but just an inside transaction between the central government and the central bank.” The exchange rate gains or losses are not included either, for an unexplained reason.10 Neumann (1996) claims that his definition “encompasses all definitions (of seigniorage) in theoretical literature”. It is nevertheless clear that by using more detailed forms of the public sector’s budget constraint and manipulating its terms from here to there we could get a range of other “best and all-encompassing” definitions of

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7 This definition of seigniorage is essentially equivalent to what Neumann (1996) calls “a real resource component of seigniorage”. As Neumann (1996) shows, this is a generalization of Drazen’s (1985) definition of seigniorage for out-of-steady-state situations.

8 This is true only if all central banks profits are always transferred to the state budget, but Herrendorf and Valentinyi (1999) make this assumption in their paper. As a result, they in fact themselves showed in their paper that their seigniorage is equivalent to fiscal seigniorage.

9 To be more precise, Neumann (1996) defines “total seigniorage” as $S^{\text{tot}} = \left\{ \frac{\Delta M}{P} + \frac{iFA^{\text{CB}} + 1O^{\text{A}}}{P} \right\}$. But the expression that I use in equation (9) is equivalent to that.

10 In fact, Neumann (1996) writes that “a book loss does not extinguish collected real seigniorage, but instead this portion of seigniorage is used by the central bank for replacement investment to make up for the exchange rate induced loss of assets.
seigniorage. This approach, of course, would eventually lead to a complete confusion. This fact alone, I believe, gives a good reason to approach the broad concepts of seigniorage with a great deal of caution and try to find some simple criteria that will distinguish reasonable indicators from the misleading ones. I propose two requirements for these criteria:

(i) Any definition of seigniorage should conform with the logic of a standard budget constraint, the form of which I have already described: \( \text{primary deficit} + \text{costs of servicing debt} = \text{change in debt} (+ \text{seigniorage, if applicable}) \);

(ii) The specification of individual items in this budget constraint (i.e. primary deficit, debt and seigniorage) should be economically meaningful.

The first requirement I consider minimalistic. In spite of this, it is not passed by Neumann’s (1992, 1996) total seigniorage. If we look back at the left-hand side of equation (9), we see that the item \( \text{costs of servicing debt} \) relates only to the government’s debt to the private sector \( GD^p \) (plus the exchange rate gains or losses on net foreign exchange assets). On the other hand, the right-hand side implicitly defines \( \text{debt} \) as the consolidated public sector’s debt \( (GD^p - FA^{CB} - OA^{CB}) \). This is a logical inconsistency that, in my opinion, completely disqualifies “total seigniorage” as a useful, intuitive concept.

For the “fiscal seigniorage” or Herrendorf’s and Valentinyi’s “seigniorage in the broadest possible sense” (which are in fact the same – see above), there is not such a clear inconsistency with the standard form of budget constraint. This comes as no surprise, as these concepts of seigniorage are both derived using exactly this standard form of budget constraint (either the government’s one, or the public sector’s one – see above). The \( \text{debt} \) is implicitly defined in equations (6) and (8) as the government’s debt to the private sector \( (GD^p) \) only, both at the left-hand and right-hand sides of these equations.

In spite of this, I think that the equations (6) and (8) are not economically reasonable (i.e. do not fulfil the second requirement). For example it is not

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11 Which is what Herrendorf and Valentinyi (1999) in fact do for Central and Eastern European countries, claiming that the central banks of these countries have some non-standard items in their balance sheets that deserve special treatment.

12 Which is not so much surprising if we realise that in none of his papers, Neumann (1992, 1996) derives his total seigniorage from the consolidated public sector’s budget constraint.

13 The economic meaning of these definitions of seigniorage has been questioned in some earlier papers, too. Kotulan (1995), for example, points to the case in which the central bank purchases government treasury bills from commercial banks in the secondary market, in exchange for a decrease in its net claims on the domestic commercial banks. There is thus a compensating increase in the central bank’s net claims on the government and a fall in its private domestic assets. This transaction represents a pure restructuring of the central bank’s and commercial banks’ balance sheets that does not increase the monetary base or central bank’s profits, does not mean a direct cash-flow between the central bank and government, and does not reduce the government’s cost of servicing its debt. In spite of this, it leads to an increase in “fiscal seigniorage”, as it changes the distribution of the government’s debt between the private sector and central bank. At the same time, this transaction changes Neumann’s (1996) “total seigniorage”, as in this indicator one subtracts the government’s interest payments to the central bank, which increase due to the above transaction (or alternatively, this indicator comprises the interest earnings on private domestic assets – see footnote 9 – that go down in this case).

These critiques of the cash-flow seigniorage concepts on particular examples, however, have never led to their strict rejection, and were rather interpreted as special cases. On the contrary, the aim of this section of my
clear why the debt in equation (6) is defined as \( GD^b \) only, and does not include \( GDP^{CB} \) as well. The standard argument is that the government’s debt to the central bank nets out in the consolidated public sector’s budget constraint. But equation (6) is not public sector’s constraint, it is the government’s budget constraint. If there is (as in most advanced countries) a clear institutional wall between the fiscal and monetary authorities, it is irrelevant from the government’s point of view to distinguish its debt to the private economic agents from its debt to central bank, as the conditions of the debts are identical.\(^{14}\) For the government it pays off to owe money to the central bank only if the central bank provides it with soft credit at an interest rate below the market level. It might thus be more logical to rewrite the government’s budget constraint from equation (5) as

\[
\frac{(G-T)}{P} + \frac{GD^p + GD^{CB}}{P} = \Delta \frac{GD^p + GD^{CB}}{P} + \left\{ \frac{TR}{P} + (1-i^p)GD^{CB} \right\}
\]

(10).

The term in braces represents the total transfer of the opportunity cost seigniorage (or its part) to the government either via a direct transfer of central bank’s profit or via below-the-market interest rate on government’s credit from central bank. An advantage of this expression is a direct link to the central bank’s profits (see Section II). Another advantage consists in the fact that this indicator is not influenced by central bank’s purchases of government bonds in the secondary market, if these have no monetary consequences (see footnote 13). That is why I consider this indicator to be better than the so-called “fiscal seigniorage“.\(^{15}\) I stress, however, that it is not seigniorage in the proper sense of this word, but just an indicator of the part of seigniorage that is distributed to the government.

In a similar manner, we can criticise equation (8), too. In the consolidated public sector’s budget constraint it is of course correct to exclude from the item called debt the government’s liabilities to the central bank. But at the same time it is not correct to exclude the central bank’s net foreign assets and its claims on the domestic private agents (i.e. \( FACB^b + OACB^b \)), which are a natural part of the net consolidated public sector’s debt. It is a bit paradoxical to separate in calculating the consolidated public budget constraint (and public debt) the central bank from the government, which is what equation (8) in fact does.

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\(^{14}\) For example, the status of the ECB bans it from providing direct credit to the public sector. The ECB can only purchase government’s securities in the secondary market. This rule guarantees that the debt relationships between the government and central bank are on standard market terms, and the government’s budget constraint is thus not softened if its debt is held by the central bank rather than the private agents. A similar regulation was introduced in the Czech Republic, too, as a part of EU-harmonisation amendments to the CNB Act.

\(^{15}\) Even this indicator may be not perfect in practice, though. The central bank may de facto transfer resources to the government in other ways than through direct transfers or soft loans. This can be easily demonstrated on the Czech case. The CNB carried out some quasi-fiscal operations amounting to about CZK 65 bn. during 1993-99 (cleaning operations in the banking sector, the loss on the receivable from the National Bans of Slovakia etc.) that the government would have otherwise had to pay for. These quasi-fiscal operations can thus be interpreted as an indirect transfer of financial resources from the CNB to the government – see also footnote 16 below.
We can say the same thing in another way. Equation (8) was derived using the argument that we should include into seigniorage “all terms in the public sector’s budget constraint that would be absent in a non-monetary barter economy” – see above. However, this (otherwise logical) algorithm should not mislead us to include into seigniorage all items the symbols of which would be absent in the public sector’s budget constraint in a barter economy, but rather we should include only those items that would be fundamentally absent in this budget constraint. Even in a non-monetary economy, the public sector can hold net claims on foreign and domestic private agents. Nothing fundamentally changes if the foreign exchange reserves or claims on the domestic private agents are shifted to the central bank as a special public sector institution, and these assets thus continue to be a part of public sector’s assets in the broad sense. Without a central bank, these assets do not just have explicit symbols ($FACB^a$ a $OACB^h$) in the public budget constraint and are instead included in the net government’s debt to the private sector ($GD^B$). The same is true about the earnings on these assets that would be included in the net cost of servicing the government’s net debt.

For all of the above, I do not consider the broader concepts of seigniorage to be a truly beneficial contribution to the theory of seigniorage. I believe we can well make do with the traditional definitions presented in equations (1) and (2), i.e. with the monetary seigniorage and opportunity cost seigniorage. In Appendix I, I show that both these two standard concepts indeed fulfil the two requirements on formal and logical consistency, which I have outlined above.

III. Seigniorage, Risk Premium and Central Bank’s Profits

In the previous section, I tried to explain why I do not consider the broader concepts of seigniorage to be very useful ones, and that the traditional narrow concepts reflect the gains from central bank’s monopoly to issue money quite well. I also showed that the monetary seigniorage and opportunity cost seigniorage are two sides of the same coin (remember the cows and milk analogy). As a result, we can choose for further analysis the one of these concepts that suits our purpose better, which is the opportunity costs seigniorage in this case. In particular, I will analyse in detail its links to the central bank’s profits, together with all other factors that influence these profits.

I have already mentioned in Section I that the opportunity cost of seigniorage for private agents is at the same time an opportunity gain for the central bank (assuming all agents can invest/borrow at the market interest rate). If we look back at the consolidated balance sheet of the central bank in Table 1, we can see that there are income-earning assets. For example the net foreign exchange reserves are typically invested into short-term money market instruments abroad, which yield foreign short-term interest rates. On the liabilities side, however, the situation is completely different. The central bank does not have to pay any interest both on the monetary base (except for the case
when it pays interest on bank reserves) and its net capital. This gives the central bank a potential chance to make profits (if there are no other losses or costs).

We can illustrate the situation in the following simplified income statement of the central bank:\(^\text{16}\):

Table 2: Simplified Income Statement of Central Bank

<table>
<thead>
<tr>
<th>Incomes (net)</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>On net foreign assets = ((i^f + e)(\text{FA}^{\text{CB}}))</td>
<td>On monetary base = (i^f(\text{RE}))</td>
</tr>
<tr>
<td>On government’s debt to c.b. = (i^g(\text{GD}^{\text{CB}}))</td>
<td>On capital = 0</td>
</tr>
<tr>
<td>On net other assets = (i^o(\text{OA}^{\text{CB}}))</td>
<td>Operating costs ((C^{\text{CB}}))</td>
</tr>
</tbody>
</table>

Profits \(\pi = \text{Incomes-Costs}\)

where \(i^f\) is the interest rate on net foreign assets, \(e\) is the percentage rate of exchange rate’s depreciation, \(i^g\) the average interest rate on net government’s debt to the central bank, and \(i^o\) the average interest rate on other central bank’s net assets. \(C^{\text{CB}}\) denotes net other costs of central bank (operating costs, depreciation of capital etc.). The profit is thus given by

\[
\pi^{\text{CB}} = \left(i^f + e\right)\text{FA}^{\text{CB}} + \left(i^g\right)\text{GD}^{\text{CB}} + \left(i^o\right)\text{OA}^{\text{CB}} - \left(f^R\right)\text{RE} - C^{\text{CB}}
\]

which we can rewrite using the domestic market interest rate \(i\) as

\[
\pi^{\text{CB}} = \left(i^f + e\right)\text{FA}^{\text{CB}} + \left(i^g + i^o\right)\text{GD}^{\text{CB}} + \left(i^o\right)\text{OA}^{\text{CB}} - \left(f^R\right)\text{RE} - C^{\text{CB}}
\]

The reason for this rearranging will become clear soon.

I will assume that the uncovered interest rate parity holds, i.e. that the expected income on the domestic assets can differ from the total expected income on foreign assets (including the exchange rate gains or losses) only by a risk premium \(\rho\). Formally,

\[
i = i^f + E(e) + \rho
\]

where \(E(e)\) is the expected percentage depreciation of the domestic currency.\(^\text{17}\)

\(^{16}\) For simplicity I assume that all net assets of the central bank have maturity shorter than one year, and I will thus not consider other capital gains or losses besides the exchange rate ones. This is arguably a big simplification. For example in the CNB’s case, assets with maturity over 1 year represent 33 % of the balance sheet. As a result, the total valuation changes may differ from the exchange rate changes only. For example in 2000, the CNB’s exchange rate loss reached CZK 3.5 bn., while total net valuation losses were CZK 5.1 bn.. Similarly in 1999, the CNB recorded an exchange rate gain of CZK 31.8 bn., but total net valuation gains reached CZK 25.7 bn. only (for more detail see http://www.cnb.cz/_o_cnb/pdf/Ruz2000_cz.pdf).

\(^{17}\) The uncovered interest rate parity is in fact the only economic relationship that I assume here (all other is accounting). Therefore, it is the point that can be perhaps most easily criticised in this essay, especially as the predictions of the uncovered interest rate parity do not perform very well in practice (see e.g. Froot, Thaler, 1990; Lewis, 1994), at least in the short run. For example, there may be expectations errors that do not follow a random walk etc. The profits of the central bank are than influenced not only by the “true” risk premium, but also by these expectations errors – this can be also seen in equations (15) and (16) below. If we want to make inferences about the systematic ability of a central bank to generate profits over the long run, however, we do not need to assume here that these expectations errors follow a random walk. We can make do here with a much weaker assumptions that the errors average to zero (see below), i.e. that the uncovered interest rate parity works at least over the long-run. Mahadeva, L., Sinclair, P., et al. (2001) provide some evidence that this is indeed the case.
And finally, I will denote by $\varepsilon$ the difference between the expected and actual exchange rate depreciation, i.e. an unexpected exchange rate shock

$$\varepsilon = e - E(e)$$

(14).

If we substitute from equations (13) and (14) into equation (12), rearrange the terms on its right-hand side and use the accounting identity $M0 = FA^{CB} + GD^{CB} + OA^{CB} - K$, we get the expression for central bank’s profit:

$$\pi^{CB} = \left\{ \frac{1}{P} \left[ i M0 - \bar{\ell} RE \right] - (\rho - \varepsilon) FA^{CB} - \left( \bar{i} - \bar{\ell} \right) GD^{CB} - \left( \bar{i} - \bar{\ell} \right) OA^{CB} + \bar{i} K - C^{CB} \right\}$$

(15),

which after dividing by the price level gives real profit equal to

$$\frac{\pi^{CB}}{P} = \left\{ \frac{1}{P} \left[ \frac{M0}{P} - \frac{\bar{\ell} RE}{P} \right] - (\rho - \varepsilon) \frac{FA^{CB}}{P} - \left( \frac{\bar{i} - \bar{\ell}}{P} \right) GD^{CB} - \left( \frac{\bar{i} - \bar{\ell}}{P} \right) OA^{CB} + \frac{\bar{i} K}{P} - \frac{C^{CB}}{P} \right\}$$

(16).

The first term in equation (16) is the opportunity cost seigniorage. I have thus demonstrated the link between this concept of seigniorage and central bank’s profit. Equation (16) shows, at the same time, that the central bank’s profit does not depend only on the opportunity cost seigniorage, but is co-determined by a range of other factors. We can summarize that the profit is the higher,

(i) the higher is the opportunity cost seigniorage;
(ii) the smaller is the risk premium on domestic assets (and the smaller are net foreign exchange reserves if the risk premium is positive);
(iii) the bigger is an unexpected exchange rate depreciation in excess to what the uncovered interest rate parity counts on (and the higher are net foreign exchange reserves in this case);
(iv) the less is the average interest rate on the government’s debt to central bank below the market rate (and the smaller is this debt if this applies);
(v) the less is the average interest rate on other net central bank’s assets below the market rate (and the smaller are these assets if this applies)\(^{18}\);
(vi) the higher is the net capital of central bank;
(vii) the smaller are the net operating costs of central bank.

Equation (16) thus allows us to separate the opportunity costs seigniorage – i.e. the implicit (opportunity) gains from central bank’s monopoly to issue narrow money – and the costs or gains from other functions of the central bank, and from the ways in which the opportunity cost seigniorage is used.

Let me first briefly discuss the terms number three to six on the right-hand side of equation (16), and postpone the discussion of the second term, as it is my major focus in this paper, and it thus requires more space. The third and fourth terms show the costs of below-market interest rates on the government’s debt to central bank and on its other net domestic assets. These two terms may be

\(^{18}\)This is true only if the other net central bank’s assets are positive. In the Czech Republic, the opposite is true due to the high volume of reverse repo operations that the CNB uses to withdraw liquidity from the inter-bank market.
interpreted as a way of transferring part of the opportunity cost seigniorage to the government (see the discussion of fiscal seigniorage in Section I) and domestic private agents (for example by financing commercial banks’ bailouts), which are essentially quasi-fiscal operations.  

The fifth term in equation (16) represents the interest earnings of the central bank on its net capital, and the sixth term is the usage of opportunity costs seigniorage to cover the central bank’s net operating costs.

The second term on the right-hand side of (16) captures the costs to central bank due to its responsibility for maintaining foreign exchange convertibility and exchange rate stability, which makes the central bank keep high (net) foreign exchange reserves, or in other words a large open foreign exchange position. This means, first of all, that the central bank is exposed to exchange rate losses/gains due to unexpected exchange rate appreciations/depreciations. This can make the central bank’s profits very volatile (the CNB, for example, experienced an exchange rate gain of CZK 44.7 bn. in 1997 and CZK 31.5 bn. in 1999, and a loss of CZK 35.6 bn. in 1998). However, they should average to zero over the long run. The second kind of cost, though, is a systematic one – it stems from the risk premium on domestic assets. If the risk premium and the central bank’s net foreign assets are both positive, it reduces its profits. This effect is the higher, the higher are central bank’s net foreign assets, and may thus become very important especially if these exceed the monetary base several times, which is also the CNB’s case (its net foreign assets currently reach almost CZK 500 bn., i.e. 220 % of the monetary base).

This risk-premium effect may also mean that there is not a simple relationship between the inflation and the central bank’s profits for the reasonably low levels of inflation. A higher inflation increases the nominal interest rate, and thus raises the opportunity cost seigniorage. But if we assume that the equilibrium risk-premium may be positively related to the level of inflation (or to its variability, which is empirically closely correlated with the average rate of inflation), a higher inflation may at the same time mean a higher “risk-premium cost”. In some special cases (i.e with very high net foreign exchange assets), the latter effect can dominate, meaning that the central bank’s profits can in fact go down with an increase in inflation. This effect may be

19 A classical reference as regards the central banks’ quasi-fiscal operations is Fry (1993). For a discussion of central bank’s quasi-fiscal operations in the particular case of transition economies see Markiewicz (2001). On the issue of soft loans by central banks, she writes: “If the interest rate on such credit (i.e. to financial system) is lower than interest rate prevailing in the market, then the credit may be identified as central bank quasi-fiscal operations. Extension of credit at a preferential interest rate is essentially a subsidy and typically directed at entities with higher credit-risk premia….The subsidy element may also be included in the credit extended by the central bank to the government if the interest rate charged is below market….In any case, when the central bank is obliged to lend below market rates, this constitutes a fiscal subsidy.”

20 Let us assume that over o longer-run the domestic interest rate is equal to $i = r' + p + \rho$, where $r'$ is the world real interest rate and $p$ is domestic inflation. Equation (17) can then be rewritten to $\pi^{cb} = (r' + p)M 0 - \delta RE - \rho (FA^{cb} - M 0) - C^{cb}$, which shows that the risk premium starts to really have a negative impact on the central bank’s profit only when $(FA^{cb} - M 0) > 0$. 

77
important for relatively low-inflation countries, in contrast to the well-known Cagan’s (1956) “Laffer-curve effect” of higher inflation on seigniorage, which is typically thought to dominate for hyperinflationary countries only. Graphically, the classical “Laffer curve” may then modify as illustrated in Figure 1 (see Holub, 2001b). In such a case, instituting credible macroeconomic policies with a credible low inflation target may not necessarily mean giving up a part of the central bank’s profits.21

**Figure 1: The Classical and Modified “Laffer Curve”**

![Graph](image)

This can be, for example, seen if we look at the possibility of introducing a currency board, which I have discussed in the previous essay (see also Rusek, 2000; Čihák, Holub, 2000). If we assume that the whole risk premium on domestic assets stems from the exchange rate risk and low credibility of the domestic monetary policy, than an introduction of a pure currency board should eliminate the second term the on the right-hand side of equation (16).22 At the same time, an orthodox currency board should cover its monetary base completely by foreign exchange reserves and hold no net domestic assets (and should carry out no quasi-fiscal operations). As a result, the third and fourth terms should drop out of equation (16), too. The profit of a currency board is then given by the opportunity cost seigniorage plus the interest earnings on its own net capital, minus its net operating costs, i.e. by

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21 I must stress, though, that the word “credibility” needs to be interpreted in a much broader sense here than in the previous two essays, in which it basically meant “an ability to follow a low inflation target with the trust of the general public”. The risk premium, which reflects credibility in the present essay, embodies a much wider variety of factors, including the inflation risk, exchange rate risk, country default risk (and thus credibility of the fiscal policy), credibility of the country’s institutions, financial sector etc.

22 In practice, though, most currency board countries have not managed to eliminate the risk premium fully. This is partly because their currency boards are not orthodox ones (see e.g. Hanke, Schuler, 1994), and partly because the risk premium reflects not only the exchange-rate and inflation risks, but also other country-specific risks, which are not automatically eliminated by an introduction of a currency board (see the previous footnote).
\[
\left( \frac{\pi}{P} \right)_{\text{currency board}} = \frac{M_0}{P} + iK - C^{CB}
\]  

(17).

Therefore, by introducing a currency board the country does not give up seigniorage. We cannot even say that the profits of a currency board need to be smaller than the profits of the original standard central bank. Currency boards issue non-interest-bearing currency and hold interest-earning foreign exchange reserves, thus receiving seigniorage in exactly the same way as a standard central bank. By establishing a currency board the country just gives up the possibility to influence the magnitude of its seigniorage by "choosing" the domestic inflation and nominal interest rates. This, however, may in itself not mean a reduction in central bank’s profits if the inflation rate is relatively low and the implicit costs associated with the risk premium on domestic assets are important before the currency board is introduced.

The risk-premium factor should be borne in mind also when discussing the possibility of some countries to dollarize or euroize their economies (see the previous essay in this dissertation). The loss of seigniorage is often used as a strong argument against such a step. But I have argued that in a country in which the central bank holds large net foreign exchange assets, the lack of the country’s credibility, which is reflected in a risk-premium in foreign exchange markets, can effectively "eat up" a substantial part of the opportunity cost seigniorage. In such a situation, the central bank is not able to generate large profits, and transfer them to the state budget. This may substantially reduce the financial value of the central bank (i.e. of its monopoly to issue currency) for the state finance. In the end, there may thus not be a big financial difference between having a non-credible central bank with large foreign exchange reserves (and reasonably low inflation) and giving up the monopoly to issue currency altogether. On the other hand, the unilateral dollarization or euroization is clearly dominated in terms of seigniorage and central bank’s profits by a fully credible currency board\(^{23}\) (see above) or joining a currency union that shares the seigniorage among its members. If one of these options is available, a unilateral dollarization or euroization is undoubtedly a bad choice. But if the set of options is restricted, for some reason, to choosing between unilateral euroization, non-credible currency board or non-credible central bank, the first option does not need to be too costly in financial terms, and its macroeconomic advantage can then easily dominate.

Of course, all the above arguments do not apply for the central banks that do not hold high net foreign exchange assets. This means that high foreign exchange reserves can, to some extent, serve as a check against temptations to misuse the central bank for fiscal purposes. This complicates the picture further – high foreign exchange reserve make the risk-premium effect on the central bank more important, but at the same time may make the country’s policies

\(^{23}\) This is true only if we neglect the operating costs of a currency board, but these should be fairly small.
more credible and thus reduce the risk premium itself. But I avoid discussing this effect in more detail here.

**IV. The Czech National Bank’s Case**

I will now discuss the opportunity cost seigniorage for the CNB’s case and demonstrate, that the implicit “risk-premium” costs, which I theoretically discussed above, are indeed important empirically in the Czech case. As a by-product, I will also discuss the extent of quasi-fiscal operations by the CNB in recent past.

Of course, one cannot find such economic indicators as seigniorage, implicit costs of FX reserves or quasi-fiscal operations in the standard accounts of a central bank – these are purely theoretical concepts that have no counterpart in actual accounting practice. We can, however, make rough estimates of these variables. I will proceed in three steps. First, I estimate the opportunity cost seigniorage. Second, I estimate the implicit costs of CNB’s net foreign assets. And third, I compute a proxy for quasi-fiscal operations of the CNB.

The estimate of opportunity cost seigniorage is provided in Table 3 (both in CZKs and as a % of GDP). I computed it as a product of the average monetary base for each year and the average interest rate in that year.24 I used the average level of two-week repo-rate (as most of the CNB’s operations with commercial banks are carried out at this interest rate) for the period of 1996-99, and the two-week PRIBOR for earlier years.25

<table>
<thead>
<tr>
<th>Year</th>
<th>Monetary base (CZK bn.)</th>
<th>Interest rate (in %)</th>
<th>Seigniorage (CZK bn.)</th>
<th>… in % of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>97.2</td>
<td>11.1</td>
<td>10.8</td>
<td>1.1</td>
</tr>
<tr>
<td>1994</td>
<td>132.9</td>
<td>8.6</td>
<td>11.4</td>
<td>1.0</td>
</tr>
<tr>
<td>1995</td>
<td>170.6</td>
<td>10.9</td>
<td>18.6</td>
<td>1.3</td>
</tr>
<tr>
<td>1996</td>
<td>221.5</td>
<td>12.0</td>
<td>26.6</td>
<td>1.7</td>
</tr>
<tr>
<td>1997</td>
<td>242.2</td>
<td>14.0</td>
<td>34.0</td>
<td>2.0</td>
</tr>
<tr>
<td>1998</td>
<td>236.4</td>
<td>13.8</td>
<td>32.5</td>
<td>1.8</td>
</tr>
<tr>
<td>1999</td>
<td>214.5</td>
<td>6.6</td>
<td>14.1</td>
<td>0.8</td>
</tr>
<tr>
<td>2000</td>
<td>213.5</td>
<td>5.3</td>
<td>11.2</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Source: Czech National Bank; own computations

As we can see, the CNB’s opportunity cost seigniorage grew from about 1 % of GDP in 1993-94 to 2 % of GDP in 1997-98 due both to increasing monetary base and rising nominal interest rates (see Appendix II). In 1999-2000, on the contrary, the opportunity cost seigniorage went down to 0.6-0.8 % of GDP as a result of a parallel decrease in the monetary base (due to substantially reduced minimum reserves requirements) and cuts in nominal interest rates (associated with the disinflation process). For the whole period of 1993-2000,

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24 Here I used the fact that the CNB did not pay interest on bank reserves in the past. This system, however, has been changed, and since July 12, 2001 the CNB has been paying the two-week repo-rate on required reserves. The opportunity cost seigniorage since this change thus has to be computed by multiplying the currency in circulation (not the total monetary base) by the market interest rate only, as no seigniorage is now associated with bank reserves any more.

25 In Appendix II, I show that the 2W PRIBOR generally moves very closely with the 2W repo-rate.
the opportunity cost seigniorage reached roughly CZK 160 bn., or 1.3 % of the total GDP in this period.26

In Table 4, I show a simple estimate of the CNB’s implicit costs of holding net foreign exchange assets. I computed its value as the difference between the actual interest income and exchange rate gains of the CNB on its net foreign assets minus the estimated income that the CNB could have hypothetically earned on these assets by investing them in the domestic inter-bank market (or in this specific case by reducing the volume of repo operations used to sterilise foreign capital inflows).27

Table 4: Costs of Holding Net Foreign Assets – an estimate (in CZK bn.)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Net foreign assets</td>
<td>24</td>
<td>112</td>
<td>248</td>
<td>342</td>
<td>359</td>
<td>378</td>
<td>439</td>
<td>488</td>
</tr>
<tr>
<td>Domestic int rate (in %)</td>
<td>11.1</td>
<td>8.6</td>
<td>10.9</td>
<td>12.0</td>
<td>14.0</td>
<td>13.8</td>
<td>6.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Foreign int rate (in %)</td>
<td>5.9</td>
<td>4.9</td>
<td>5.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.1</td>
<td>3.5</td>
<td>5.1</td>
</tr>
<tr>
<td>ER gains/losses</td>
<td>-0.3</td>
<td>0.0</td>
<td>0.2</td>
<td>-8.6</td>
<td>44.7</td>
<td>-35.6</td>
<td>31.8</td>
<td>-3.5</td>
</tr>
<tr>
<td>Estimated costs of NFA</td>
<td>-1.6</td>
<td>-4.1</td>
<td>-14.5</td>
<td>-36.1</td>
<td>8.6</td>
<td>-72.1</td>
<td>18.5</td>
<td>-4.4</td>
</tr>
</tbody>
</table>

Source: Czech National Bank; own computations

As we can see, the estimated implicit costs of net foreign assets were increasing from 1993 to 1996. The central bank accumulated more and more foreign exchange reserves, which were to a large extent being sterilised by issuing the CNB’s treasury bills that had to pay a higher interest rate than the foreign exchange reserves were earning. In 1996, in addition, the costs of foreign exchange reserves were increased by an appreciation of the exchange rate within its widened fluctuation band. Since 1997, i.e. under the floating exchange rate, the estimated costs have been very volatile due to exchange rate changes, but were still negative on average. As a result, the total sum of these costs since 1993 has reached about CZK 105 bn., and thus “consumed” about 2/3 of the total opportunity cost seigniorage in this period. We can thus see that the losses stemming from the existence of a risk premium have indeed had a strong empirical relevance in the Czech Republic (which follows from the fact that the CNB’s net foreign reserves have now reached more than 200 % of the monetary base – see Tables 3 and 4). We can view these costs as a penalty for

26 Hochreiter, et al. (1996) analysed opportunity cost seigniorage in 1993 for three transition economies in comparison with Austria and Germany. They reached the following estimates in ratio to GDPs: Austria 1.02 %, Germany 0.79 %, Czech Republic 1.11 %, Hungary 4.2 %, Romania 29.4 %. These figures, however, are not directly comparable to my own computations, as Hochreiter, et al. (1996) used a broader definition of monetary base than I do in the present paper. Smaghi and Gros (2000) estimated the opportunity cost seigniorage in the EMU at less than 0.3 % of GDP.

27 For the period since 1997, I used the interest earnings and exchange rate gains/losses on the CNB’s foreign exchange reserves that were stated in its annual reports. For the earlier period I approximated these earnings and gains/losses only. I used a weighted average of short-term money market interest rates in Germany (65 %) and the USA (35 %) as a proxy for foreign interest rates, and weighted percentage changes of the CZK’s exchange rate against the DEM (65 %) and USD (35 %) to calculate the exchange rate gains/losses. I used the same domestic interest rates as for calculating seigniorage, i.e. the 2W repo-rate or 2W PRIBOR.
relatively lower credibility of the Czech economy during its transition. But as we can also see in Table 4, the risk premium and its implicit cost for the CNB already became much smaller in 2000, partly reflecting the achievements of recent disinflation, which raises at least some hope for the future (see below).

Finally in Table 5, I subtract from the estimated opportunity cost seigniorage the estimated implicit costs of holding net foreign assets and the CNB’s net operating costs (defined as operating costs minus received net fees etc.). I compare the resulting figure with the CNB’s reported profits/losses. The difference between the two should be – according to equation (15) – a measure of quasi-fiscal operations undertaken by the CNB, apart from the fact that it also includes central bank’s earnings on its net capital. But I ignore these here for the CNB’s case, as its net capital used to be close to zero (and it is even slightly negative at present). More importantly, the figures reported in Table 5 are likely to be only rough approximations of the quasi-fiscal operations in practice for two other reasons: (i) they include any possible errors in estimating the seigniorage and implicit costs of net foreign exchange reserves; (ii) I ignored in this paper any other valuation gains/losses than exchange rate gains/losses, which may be a big simplification – see footnote 16.

Table 5: Costs of Quasi-fiscal Operations – an estimate (in CZK bn.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Seigniorage</th>
<th>Estimated costs of NFA</th>
<th>Operating costs*</th>
<th>Profit/loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>10.8</td>
<td>-1.6</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>1994</td>
<td>11.4</td>
<td>-4.1</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>1995</td>
<td>18.6</td>
<td>-14.5</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>1996</td>
<td>26.6</td>
<td>-36.1</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>1997</td>
<td>34.0</td>
<td>8.6</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>1998</td>
<td>32.5</td>
<td>-72.1</td>
<td>2.1</td>
<td>2.1</td>
</tr>
<tr>
<td>1999</td>
<td>14.1</td>
<td>18.2</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>2000</td>
<td>11.2</td>
<td>-4.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Czech National Bank; own computations
Note: *) General operating costs; depreciation of fixed capital; fees paid - incomes from fees; costs of currency issue – incomes from currency issue etc.

As Table 5 shows, the estimated costs of quasi-fiscal operations were important in 1993-94, and especially in 1997-98. The most important of these quasi-fiscal costs was a creation of reserves and provisions, associated primarily with the CNB’s claim on the National Bank of Slovakia (CZK 25.8 bn.), which was eventually written off in 2000, and with the CNB’s losses from the consolidation of the banking sector (about CZK 60 bn.).

When I tried to take into account the other valuation changes, the overall sum of estimated quasi-fiscal operations for 1993-2000 fell to about CZK 30 bn. from CZK 50 bn. in Table 5, but the time pattern of these operations was largely unaffected.

It is interesting to note that my estimates differ significantly from the estimates of CNB’s quasi-fiscal operations in Markiewicz (2001), both in terms of timing and magnitude. She estimated that the CNB’s quasi-fiscal deficits were positive in 1994-95 and 1998, and negative (i.e. there were quasi-fiscal surpluses) in 1996-97 and 1999. Her figures mean an average quasi-fiscal surplus of the CNB of about 0.9 % of GDP a year for 1994-99. These results, in my opinion, do not reflect the reality of the CNB very well, which casts some doubt on the methodology of measuring quasi-fiscal operations applied by Markiewicz (2001).
The combination of implicit costs of the CNB’s net foreign assets, operating costs and costs of quasi-fiscal operations was a reason why the central bank reached an overall loss of about CZK 10 bn. over the period of 1993-2000. The CNB thus transferred only a negligible sum of money to the state budget during this period, and also for the near future one cannot expect that the transfers of profits from the CNB could become a source of the government’s finance. Moreover, an accumulated loss of CZK 15.9 bn. remains on the CNB’s books at present, which means that its net own capital reaches a slightly negative value. This fact leads us naturally to the question discussed in the next section.

V. Is There a Capital Adequacy for Central Banks?

It is a very interesting question whether the central banks should not be made subject to a capital adequacy requirement in a similar fashion as the commercial banks, and what may happen if a central bank’s own capital becomes negative. As we have just seen, this question is very relevant for the Czech Republic. Unfortunately, the economic literature on this subject is quite scarce (a notable exception is, for example, Stella (1997)). In this section, I thus try to suggest how to deal with this interesting theoretical issue.

The commercial banks have to fulfil capital adequacy requirements basically for two reasons. Firstly, the own capital of banks gives their clients a certain guarantee that the bank is solvent and will be able to repay the money to its depositors in the future. Secondly, and perhaps more importantly, its own capital should prevent the bank from taking on excessive risks, i.e. to reduce the perverse (morale-hazard) incentives in the banks’ behaviour (see Stella, 1997).

In the case of central banks, the first argument clearly does not apply. A central bank is a monopoly issuer of the legal tender, and thus can always repay its debt in national currency by issuing new money. We can thus easily imagine that even a central bank with negative own capital could function without any direct financial problems (Stella, 1997). I argue, though, that this is correct only as long as the ratio of the central bank’s negative own capital to the monetary base is stabilised and does not grow without limits. In view of this, the second argument for a central bank’s capital adequacy, i.e. to prevent it from perverse incentives, may have some appeal – even though it is not a morale-hazard issue in the same sense of this word as for commercial banks. If the financial situation of a central bank becomes unsustainable, it may be forced to subordinate its monetary policy or bank regulation to its financial needs (i.e. to increase the inflation, cut the ratio of foreign exchange reserves to the monetary base, impose high minimum reserve requirements and so on). Alternatively, it may require a subsidy from the state budget. All these solutions undermine the monetary

Stella (1997) writes: “Do central banks need capital? Clearly no, if what is meant is that for all central banks the sum of the government’s capital contribution and retained net earnings must exceed zero. Indeed...the Federal Reserve System, the Bank of Canada, and the Bundesbank could all operate with zero capital without any material impact on their policies or profitability... (But) central banks cannot operate effectively with arbitrarily large negative worth and/or under conflicting constraints.”

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policy independence, i.e. they create incentives for the central bank that damage its ability to perform its major job, which is an independent anti-inflationary monetary policy (and an efficient bank regulation, if applicable). In such a situation, a certain level of own capital that assures positive profits to the central bank may be desirable.  

Formally, I will start with looking for a ratio of central bank’s net capital to its monetary base that is achievable in a steady state, given the parameters of the economy. A steady state can be described as a situation in which for any time periods \( t \) and \( t+1 \), it is true that

\[
\frac{K_z}{M \ 0_z} = \frac{K_{0z1}}{M \ 0_{0z1}} \quad (18),
\]

This can be rewritten as

\[
\frac{K_{0z1}}{M \ 0_{0z1}} = \frac{K_z + \Delta K_{0z1}}{M \ 0_z (\theta + \mu)} \quad (19),
\]

where \( \Delta \) denotes time change and \( \mu \) is a percentage nominal growth rate of the monetary base.

The time change in central bank’s net capital is equal to that part of its profit, which is not transferred to the state budget, i.e.

\[
\Delta K_{0z1} = \pi_{0z}^{CB} - TR_z \quad (20),
\]

The condition for central bank’s financial independence on the government is that the transfer must be non-negative, i.e. the state should not subsidise the central bank. Therefore, it must be true that

\[
\Delta K_{0z1} \leq \pi_{0z}^{CB} \quad (21),
\]

If we combine (19) with (21), we get

\[
\frac{K_{0z1}}{M \ O_{0z1}} \leq \frac{K_z + \pi_{0z}^{CB}}{M \ O_z (\theta + \mu)} \quad (22),
\]

Finally, we can substitute for the central bank’s profit from equation (15) to get

\[
\frac{K_{0z1}}{MO_{0z1}} \leq \frac{1 + i \ K_z + \left[ \left\{ i M O - i \ \rho \ v \right\} - (\rho - \epsilon) FA^{CB} - (i - \delta) GD^{CB} - (i - \delta) OA^{CB} - C^{CB} \right]}{1 + \mu \ M \ 0_z} \quad (23).
\]

Fry (1993), for example, writes: “If central bank losses are not met from government budget appropriations, they must eventually lead to an expansion in central bank money and the abandonment of any monetary policy goal of price stability.” In a similar fashion, Stella (1997) argues: “Seriously deteriorated (central banks’) balance sheets causing chronic losses will eventually interfere with price stability. Facing such a situation, several possibilities exist. One is to abandon price stability as a goal, financing losses by money creation with obvious adverse consequences. A second would be to resort to financial repression with negative repercussions on financial system efficiency and soundness. A third would be to obtain frequent timely transfers from the treasury …(but) it would clearly jeopardise central bank independence to require constant infusions of financing. Consequently, when society places important weight on a sound banking system, price stability and an operationally independent central bank, a recapitalisation becomes necessary when losses turn chronic.”
This relationship can be illustrated in a simple phase diagram, in which the ratio of net capital to the monetary base in time $t$ is put on the horizontal axis and the same ratio in time $t+1$ is shown on the vertical axis. The inequality (23) is a region below the straight line with a slope of $(1+i)/(1+\mu)$ and an intercept given by the last term on the right-hand side of (23). The numerator of this term shows whether the opportunity cost seigniorage exceeds the total central bank’s costs, including operating costs, the implicit costs of holding net foreign exchange reserves and quasi-fiscal operations. If yes, the central bank is able to reach positive profits even with zero net capital, and thus accumulate own resources or transfer profits to the state budget. I should stress here that in order to assess whether the financial position of a central bank is a problem or not, one must evaluate inequality (23) for the nominal interest rate, monetary base growth, minimum reserve ratio, foreign exchange reserves etc. consistent with the central bank’s policy goals.32

Based on (23), we can differentiate among four cases:

1a) The nominal monetary base grows faster than is the nominal interest rate (or equivalently, the real monetary base grows faster than is the real interest rate); the opportunity cost seigniorage exceeds all central bank’s explicit and implicit costs.

1b) The real monetary base grows faster than is the real interest rate; the opportunity cost seigniorage is insufficient to cover all central bank’s explicit and implicit costs.

2a) The real monetary base grows slower than is the real interest rate; the opportunity cost seigniorage exceeds all central bank’s explicit and implicit costs.

2b) The real monetary base grows slower than is the real interest rate; the opportunity cost seigniorage is insufficient to cover all central bank’s explicit and implicit costs.

These cases are illustrated in the corresponding pictures in Figure 2 below, which also include the 45-degree lines representing steady-state points.

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32 It may be oversimplified to assume that the ratio of foreign exchange reserves to the monetary base is a fully autonomous policy decision of the central bank, as I do here. In reality, this ratio may respond endogenously. For example, if the central bank is not able to generate profits and loses credibility, an outflow of foreign capital may take place, which reduces the FX reserves and thus shifts the central bank’s profits up (but at the same time the risk premium is likely to increase, working in the opposite direction). The financial problems may also make the central bank to reconsider some aspects of its foreign exchange policies that are not fully consistent with the economic developments and the low inflation objective (i.e. it may force the central bank to correct some previous policy failures, which is a positive by-product).
The case 1a) is rather problem-free. The central bank’s profits are positive even if its net capital is zero or modestly negative. The monetary base grows relatively fast, and it is thus not possible to sustain the ratio of net capital to the monetary base above \((K/M0)^{1a}\). For example, if the inflation reaches 2 %, the real interest rate is also 2 %, the real monetary base grows at 4 % and the central bank’s costs amount to 1.5 % of monetary base, the maximum steady-state ratio of capital to the monetary base is 125 %. But there is no problem if the capital stands below this sustainable maximum. The central bank can either maintain capital at its present level, or it can gradually accumulate capital until the ratio of \((K/M0)^{1a}\) is reached. This is true even if the capital declines to negative values. The fast growth of monetary base gradually “erodes“ the importance of the negative capital and thus shifts the central bank back to the situation in which it is able to generate sufficient profits in order to repay past losses and accumulate reserves.

Problems would emerge only if the negative central bank’s capital caused distrust in the currency and thus led to a decline in the real growth rate of monetary base, or to an increase in real interest rates due to a risk premium. In such situation, we could jump to the case 2a). If the negative net capital of central bank was below \((K/M0)^{2a}\) at this moment, the capital deficit would start
to grow at an explosive pace, and the central bank would eventually have to resort to a help from the state, or to high inflation, imposing implicit taxes on the banking system through high minimum reserve requirements etc. Otherwise, it would financially collapse (see below). In the case 1a), one can thus consider as a kind of “capital adequacy” maintaining such a ratio of central bank’s net capital to its monetary base that assures that even under the worst negative shocks the capital does not decline below the lower bound of the interval from $(K/M_0)^{2a}$ to $(K/M_0)^{1a}$.33

Moreover, it should be noted that in the very long run, the growth of monetary base can not exceed the growth of GDP, otherwise the monetary base’s ratio to GDP would grow without limit, which is unrealistic (in fact due to the electronic money one might expect right the opposite in the long run). At the same time, if the economy is dynamically efficient, the real interest rate should exceed the economic growth in steady state. This means that the case 1a) is unsustainable in the very long run, and one must always be prepared for its switch to the case 2a). This strengthens the argument of the previous paragraph – we do not need to speculate about the trust in currency to get the same result (which is not a particular advantage for a paper that focuses on credibility issues, but in terms of robustness of the argument it is certainly welcome).

The case 1b) is much more problematic as the central bank does not generate profits but losses with zero net capital. Moreover, the fast growth of monetary base tends to decrease the ratio of capital to monetary base, and thus shift the central bank farther into losses. As a result, the net capital cannot exceed the negative value of $(K/M_0)^{1b}$ in steady state. Even with this negative level of capital the central bank can function in theory, but there is always a danger that it could lead to a self-fulfilling credibility crisis with a switch to the case 2b). A financial collapse of the central bank would eventually follow, which would need to be resolved either by high inflation, financial repression or a massive transfer of resources to the central bank from state budget.34 It is quite difficult to find a remedy in this situation, as it is not enough to endow the central bank with sufficient starting capital.35 The only possibility is to increase its earnings (for example by raising the fees on central bank’s services), or reduce its operating and other costs in ratio to the monetary base so that it is able to generate positive profits even with zero capital, i.e. to shift it to the case 1a).

33 Stella (1997) writes: “In cases where profitability is virtually assured, capital is low. In cases where profitability is subject to wide swings…central banks tend to hold a buffer stock of capital and reserves to absorb the swings.”

34 Moreover, the analogous argument to the previous paragraph implies, that in the very long run, a switch from 2a) to 2b) is almost certain, i.e. it is not just a special case conditioned by a distrust in the currency.

35 In this respect, I differ from Stella (1997) who writes that „recapitalization becomes necessary when losses turn chronic“. In the special case 1b), as I have just shown, a recapitalization is not a permanent solution. It is true, though, that Stella (1997) also adds: “Recapitalization makes sense only when government is committed to adopting other necessary supporting reforms.” If we interpret these “supporting reforms” as changes that shift the central bank to the case 2a) by raising its revenues or cutting its costs (e.g. quasi-fiscal operations), then I can fully agree with Stella (1997).
In the case 2a), central bank can permanently maintain any ratio of net capital to the monetary base above the negative level \((K/M0)^{2a}\). The central bank generates profits even with zero capital. At the same time, the monetary base grows at a slower pace than the real interest rate, and the central bank’s profits are thus more than sufficient to create additional capital to “cover” the newly issued money. A problem arises only if the central bank originally finds itself close to the critical level of \((K/M0)^{2a}\), and a shock shifts it below it. Then the situation becomes unstable (which can be seen from the fact that the thick line in figure 2a) crosses the 45-degree line from below). A financial collapse of the central bank must follow if the central bank does not give up its policy goals. In an economy without shocks, a capital adequacy for the central bank would thus be the negative level of capital \((K/M0)^{2a}\), while in a stochastic economy there must be a sufficient margin above this level to assure that the central bank’s capital never declines below this “point of no return”. In practice, however, this may well mean that a zero capital is sufficient for the central bank (similarly as in case 1a). This corresponds with the arguments of Stella (1997).

In the case 2b) the critical level of capital is positive. The central bank generates losses from its operations, which must be compensated by earnings on its own capital.\(^{36}\) Otherwise, the losses start growing, the capital declines and eventually the central bank financially collapses, or is forced to give up its policy goals. The capital adequacy thus must be sufficiently above \((K/M0)^{2b}\) in this situation to guarantee that even the adverse shocks do not shift the central bank below the critical level of capital. In this situation, a substantial requirement on central bank’s capital may arise – but the bank must be endowed with it in advance, because with a starting capital below \((K/M0)^{2b}\) it can never accumulate it on its own. An alternative, of course, is to reduce the central bank’s costs in order to achieve positive profits and move to situation 2a).

We can sum up our findings as follows:

(i) The key question for central bank’s financial stability is whether it is able – thanks to its monopoly to issue money – to generate positive profits even with zero own capital. If yes, the central bank can exist with a low net capital (in theory even negative), the capital just should not decline below some negative critical level. It thus suffices if the central bank is initially endowed with enough capital (or more precisely, if it does not have too big a capital deficit in the starting period), and it can be financially independent “forever”. If not, the central bank needs to be endowed with high own capital, but even this may not suffice in situation 1b). Then the only option is to raise the central bank’s earnings or to cut its costs, i.e. to reconsider its activities going beyond the scope of monetary policy (such as quasi-fiscal operations or some central bank’s services).

\(^{36}\) In this situation, the central bank in fact functions as a charity foundation that needs enough starting capital to receive interest earnings sufficient to cover its inherently loss-making activities.
(ii) Another important factor is the relationship between the real growth rate of monetary base and the real interest rate. If the former is higher, the ratio of central bank’s capital is bounded from above. In the less optimistic case 1b) it is bounded from above at a negative level, which may give rise to a danger of self-fulfilling confidence crises of the central bank and the currency. Moreover, one cannot expect this situation to last forever even if no confidence crisis takes place, as this would mean the ratio of monetary base ratio to the GDP growing without limit, or a dynamically inefficient economy. Therefore, one must always be prepared for a switch to the other case in which the real growth of monetary base is below the real interest rate. In this situation, the required capital is bounded from below, in the less optimistic case 2b) at a highly positive level.

What does this imply for the CNB? If its earnings on FX reserves were not sufficient in the long run to cover the sterilisation costs and operating costs of the CNB (in other words, if the implicit “risk-premium“ costs of FX reserves consume all the disposable opportunity cost seigniorage), the only plausible cases would be 1b) and 2b). The relationship between the real growth rate of monetary base and the real interest rate is thus a very topical issue for the Czech Republic. The less favourable case 2b) would imply an eventual financial collapse of the CNB (given the fact that its current net capital is slightly negative), a need to get subsidy from the government some time in the future, or a need to compromise on some of the CNB’s policy goals. The more favourable case 1b) would imply a convergence to a steady-state negative capital ratio, but a danger of self-fulfilling confidence crisis would always be there.37 These options show that any steps to assure the CNB is able to make at least slightly positive profits would be strongly welcome. But at the same time it is not easy to find such steps, if the primary problem is the implicit “risk-premium cost“ of CNB’s FX reserves (it is, of course, also necessary to avoid any quasi-fiscal operations – but the CNB has already moved in that direction). In fact the only real remedy is to increase the Czech Republic’s overall credibility, and thus reduce the risk premium below some critical level.

To be more precise, we may ask what maximum level of the risk premium is consistent with the CNB making non-negative profits even with zero own capital. If we assume that the average nominal interest rate will be around 6% in the Czech Republic, and take the current level of issued currency of CZK 190 bn.,38 we can estimate the opportunity cost seigniorage at about CZK 11.5 bn. a year (which is close to my estimate for 2000 in Table 3). From this we must

37 In 2000, the average real growth rate of the monetary base reached roughly 13%, which was clearly above the real interest rate. Also in 1999 the real monetary base grew at a double-digit rate. Based on this recent experience only, the case 1b) thus seems to be more realistic than 2b). This situation, however, may have been a short-term phenomenon only, associated with a decline in nominal interest rates and growing distrust in the banking system in 1999-2000.

38 Note that here I already take into account the fact that the CNB has started to pay interest on bank reserves since 12 July 2001.
deduct the net operating costs of roughly CZK 2.5 bn. (see Table 5). We are thus left with CZK 9 bn. Assuming that there will be no quasi-fiscal operations, this number represents the maximum limit for the implicit costs of net foreign exchange reserves that is consistent with the CNB achieving non-negative profits. It is interesting to note that for 1993-2000, these implicit costs reached more than CZK 13 bn. a year on average, i.e. more than will be available for the future.

Figure 3 plots all the combinations of net foreign exchange reserves and risk premium that just “consume” CZK 9 bn. It shows that with the current level of FX reserves (almost CZK 500 bn.) the risk premium would need to decline below 1.75 % to allow for positive CNB’s profits. Is this realistic to happen? It is hard to say. But fortunately, there is at least a hope (but far from certainty) that we could eventually achieve this, as the recent developments indicate (see the year 2000 in Table 4).

**Figure 3: Financial Trade-off between FX Reserves and the Risk Premium**

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**VI. Summary and Conclusions**

In this essay, I focused on the financial aspects of central banks’ existence and operations, and I tried to discuss how these may relate to the credibility issues. I started with discussing a well-explored issue in the central bank’s finance, the seigniorage. My aim was to show that in spite of the vast literature on this issue (or perhaps because of it?), there has not even been a consensus on the very basic thing: how to define seigniorage? The two traditional concepts of seigniorage, i.e. the monetary seigniorage and the opportunity cost seigniorage, became a subject of critique by some economists (most notably M. Neumann) during the 1990s. To overcome the alleged shortages of the two standard definitions, some alternative “cash-flow” concepts of seigniorage have been proposed (“fiscal seigniorage“, “total seigniorage“ etc.). The aim of my work,
on the contrary, was to show that the economic meaning of these concepts is
doubtful, and that they just bring confusion to the subject of seigniorage. In
particular, I argued that they do not fulfil two elementary criteria that we should
require from any reasonable measure of seigniorage. These proposed criteria
were: (i) Any definition of seigniorage should conform to the logic of a standard
budget constraint in the form: \( \text{the primary deficit} + \text{costs of servicing debt} = \text{change in debt} (+ \text{seigniorage, if applicable}) \); (ii) The specification of individual
items in this budget constraint should be economically meaningful. Therefore, I
propose that the economic literature can – and in fact should – make do with the
two traditional definitions of seigniorage.

In the next section, I analysed theoretically the relationship between
opportunity cost seigniorage and central banks’ profits. I showed that the profit
is the higher, (i) the higher is the opportunity cost seigniorage; (ii) the smaller is
the risk premium on the domestic assets (if the net foreign exchange reserves are
positive); (iii) the bigger is an unexpected exchange rate depreciation in excess
to what the uncovered interest rate parity predicts; (iv) the fewer soft loans the
central bank grants to the government; (v) the smaller are quasi-fiscal operations
of the central bank (subsidies to banks etc.); (vi) the higher is the net capital of
central bank and (vii) the smaller are the net operating costs of central bank.

The factor (ii) was a major focus in this essay, as it relates to the credibility
of central bank and of the country’s authorities in general. If the risk premium
and the central bank’s net foreign assets are both positive, it reduces its profits.
This effect is the higher, the higher are the net foreign exchange reserves, and
may thus become very important especially if they exceed the monetary base
several times. This risk-premium effect may also mean that there is not a simple
relationship between the inflation and central bank’s profits for reasonably low
levels of inflation. A higher inflation increases the nominal interest rate, and
thus raises the opportunity cost seigniorage. But assuming that the equilibrium
risk-premium may be positively related to inflation, a higher inflation may at the
same time mean a higher “risk-premium cost”. In some special cases (high net
foreign exchange assets), the letter effect can dominate, meaning that the central
bank’s profits go down with an increase in inflation.

In such a case, instituting credible macroeconomic policies with a credible
low inflation target may not necessarily mean giving up a part of the central
bank’s profits. Therefore, I argued that the risk-premium factor should be borne
in mind also when discussing the possibility of some countries to dollarize or
euroize their economies. The loss of seigniorage is often used as a strong
argument against such a step. But in a country where the central bank holds
large net foreign exchange assets, the lack of the country’s credibility reflected
in a risk-premium can effectively “eat up” a substantial part of the opportunity
cost seigniorage. In such a situation, the central bank is not able to generate
large profits, and transfer them to the state budget. In the end, there may thus not
be a big financial difference between having a non-credible central bank with
large foreign exchange reserves (and reasonably low inflation) and giving up the monopoly to issue the currency altogether. On the other hand, it is true that a unilateral dollarization or euroization is clearly dominated in terms of seigniorage and central bank’s profits by a fully credible currency board or joining a currency union, if these are viable options.

I analyzed the opportunity cost seigniorage and central bank’s profits for the Czech case between 1993 and 2000. According to my estimates, the CNB’s opportunity cost seigniorage grew from about 1 % of GDP in 1993-94 to 2 % of GDP in 1997-98 due both to increasing monetary base and rising nominal interest rates. In 1999-2000, on the contrary, the opportunity cost seigniorage went down to 0.6-0.8 % of GDP as a result of a parallel reduction in minimum reserves requirements and cuts in nominal interest rates. In 1993-2000 as a whole, the opportunity cost seigniorage reached roughly CZK 160 bn., or 1.3 % of the total GDP in this period. However, about 2/3 of it were effectively “consumed” by the implicit costs of net foreign exchange reserves, which are extremely relevant in the Czech Republic, as the CNB’s foreign exchange reserves currently exceed 200 % of the monetary base. In addition, a substantial part of the opportunity cost seigniorage was spent on quasi-fiscal operations (consolidation of the banking sector, written-off claim on the NBS), and partly (8 % of seigniorage) was used to cover the CNB’s operating costs. As a result, the central bank reached an overall loss of about CZK 10 bn. over the period of 1993-2000. Moreover, an accumulated loss of CZK 15.9 bn. remains on the CNB’s books at present and its net capital reaches a slightly negative value.

This last fact motivated an analysis of the question whether a central bank needs to have positive own capital or not. I argued – in line with the previous literature on this topic – that the central bank can, under some circumstances, operate even with negative own capital without any direct problems. This is correct, though, only as long as the ratio of the central bank’s negative own capital to the monetary base is stabilised and does not grow without limits. Otherwise, the financial situation of the central bank becomes unsustainable, and it may be forced either to subordinate its monetary policy and/or bank regulation goals to its financial needs, or to require a subsidy from the state budget. This would clearly undermine the central bank’s policy independence in the broadest sense. Moreover, if the central bank operates with negative own capital, it may damage its credibility and lead to self-fulfilling crisis. The demand for monetary base may go down due to market distrust, this further worsens the central bank’s losses and a financial crisis of the central bank may eventually take place, even though its position might have been sustainable if the credibility had been maintained.

As a result, I concluded that the key question for central bank’s financial stability is whether it is able to generate positive profits even with zero own capital. If yes, the central bank can exist with a low net capital (in theory even negative), the capital just should not decline below some negative critical level.
If not, the central bank needs to be endowed with high own capital, but even this may not suffice in some situations. Then the only option is to raise the central bank’s earnings or to cut its costs, i.e. to reconsider its activities going beyond the scope of monetary policy (such as quasi-fiscal operations or some central bank’s services). Another important factor is the relationship between the real growth rate of monetary base and the real interest rate. If the former is higher, the ratio of central bank’s capital is bounded from above. In the less optimistic case, it is bounded from above at a negative level, which may give rise to a danger of self-fulfilling confidence crises. If, on the contrary, the real growth of monetary base is below the real interest rate, the sustainable level of capital is bounded from below, in the less optimistic case (inability to generate profits without own capital) at a highly positive level.

Finally, I calculated that for the CNB to be able to make positive profits with the current level of net foreign exchange reserves, the risk premium on Czech assets would need to decline roughly below 1.75 % points (and the CNB would have to avoid any quasi-fiscal operations in the future).
Appendix I: Traditional Concepts of Seigniorage in the Consolidated Public Budget Constraint

In this Appendix, I discuss in more detail the relationship of the two traditional concepts of seigniorage, i.e. of monetary seigniorage and opportunity cost seigniorage, to the consolidated public budget constraint.

If we combine equations (7) and (15) from the main text, we get the consolidated public budget constraint in the form

$$\left(\frac{G-T}{P} + \frac{C^{CB}}{P}\right) + \left\{\frac{1}{\frac{P}{P}} - \left(i - \delta\right) \frac{FA^{CB}}{P} - \frac{OA^{CB}}{P}\right\} + \frac{RE}{P} = \left(\frac{\Delta GD}{P} - \frac{FA^{CB} + OA^{CB}}{P}\right) + \frac{\Delta M 0}{P} \quad (AI-1).$$

The first term on the right-hand side \((GD^{P} - FA^{CB} - OA^{CB})\) represents a definition of the net consolidated debt (denote \(PD\)) of the broadly defined public sector (including the central bank), which is an economically correct counterpart of the term \((GD^{P})\) in the public budget constraint of a non-monetized, barter economy. Apart from the last terms both at the left-hand and right-hand sides of equation (AI-1), this equation says that the sum of the primary budget deficit and the costs of servicing the net consolidated public debt must be covered by an increase in this consolidated debt. This is an exact analogue to the public budget constraint in a barter economy. Thus the only items in which the equation (AI-1) actually differs from the non-monetized economy, are the interest payments on the required minimum reserves and the monetary seigniorage.

This confirms that the classical monetary seigniorage represents an economically logical (and sufficient) concept apart from the fact that it is not able to cope well with interest payments on the required minimum reserves – which is in line with our findings from equations (3a,b,c). Why is this the case? If we define the net consolidated public debt as \((PD=GD^{P} - FA^{CB} - OA^{CB})\), we in fact say that we do not consider the monetary base to be a standard liability of the public sector, but treat it as a special category associated with the central bank’s monopoly to issue currency. It is then not clear, though, why the central bank should pay interest on any part of the monetary base. If it does, it is essentially a voluntary decision of the public sector to transfer automatically a part of the central bank’s revenues from its monopoly to issue money back to commercial banks. The interest paid on minimum required reserves can be then viewed as a kind of automatic subsidy. Consequently, one may find it logical to include this subsidy into the primary deficit of public budgets (i.e. into the first braces on the left-hand side of equation (AI-1)) among other spending of the public sector.\(^{39}\)

\(^{39}\) In theory, we could also reason in another way. In equations (3a,b,c,) I showed that we could define an „adjusted monetary seigniorage“, which would include only a fraction \(\left(1 - \frac{i}{\delta}\right)\frac{\Delta R}{P}\) of the change in minimum...
We could view the whole issue from a slightly different perspective, too. In modern world (unlike in the medieval period which gave rise to the definition of “monetary seigniorage”), the monetary base represents a normal accounting liability of the central bank to other economic agents. As a result, we could in theory define the total consolidated public debt as \((PD'\equiv GD^p-FA^{CB}-OA^{CB}+M0)\). The consolidated public budget constraint then can be read as

\[
\left\{ \frac{(G-T)}{P} + \frac{C^{CB}}{P} \right\} + \left\{ \frac{GD^p}{P} - \left( i^p + \epsilon \right) \frac{FA^{CB}}{P} - \frac{OA^{CB}}{P} + \frac{RE}{p} \right\} + \frac{PD}{P} = \left\{ \frac{\Delta GD^p}{p} - \frac{FA^{CB}}{P} - \frac{OA^{CB}}{P} + M0 \right\}
\]

\((AI-2)\).

Equation \((AI-2)\) says that the sum of primary budget deficit and the costs of servicing the net consolidated public debt (in the alternative, broad definition) must be covered by an increase in this consolidated debt. This is again an exact analogue to the public budget constraint in a barter economy. Compared to the barter economy, the only difference is the implicit interest rate saving on servicing that part of the consolidated debt, which is represented by the monetary base. This saving is equal to \((iM0-iRE)\), and thus corresponds to the opportunity cost seigniorage. As a result, this concept of seigniorage can be also considered economically sensible and sufficiently general – compared to the classical monetary seigniorage it is just based on a slightly different “philosophy” of defining the consolidated public debt.

To see this even more clearly, we can use the broad definition of public debt \((PD'\equiv GD^p-FA^{CB}-OA^{CB}+M0)\) and rewrite equation \((AI-2)\) as

\[
\left\{ \frac{(G-T)}{P} + \frac{C^{CB}}{P} \right\} + \left\{ \frac{GD^p}{P} - \left( i^p + \epsilon \right) \frac{FA^{CB}}{P} - \frac{OA^{CB}}{P} + \frac{RE}{P} \right\} = \frac{PD}{P} = \frac{\Delta PD}{P} + \left\{ \frac{\Delta M0}{P} - \frac{iRE}{P} \right\}
\]

\((AI-3)\)

This form of the budget constraint most closely corresponds to the philosophy of equation \((15)\) – the primary deficit of the public sector contains also the implicit costs of maintaining net foreign exchange reserves, and quasi-fiscal operations of the central bank (i.e. transfers to the domestic private sector via non-market required reserves. The rest of this change, equal to \(\frac{i}{P} \Delta RE\), then must be logically considered to be a change in the net consolidated public debt, and the term \(\frac{i}{P} \Delta RE\) to be the cost of servicing a part of debt. The consolidated public budget constraint can then be read as

\[
\left\{ \frac{(G-T)}{P} + \frac{C^{CB}}{P} \right\} + \left\{ \frac{GD^p}{P} - \left( i^p + \epsilon \right) \frac{FA^{CB}}{P} - \frac{OA^{CB}}{P} + \frac{RE}{P} \right\} = \frac{\Delta GD^p}{P} - \frac{FA^{CB}}{P} - \frac{OA^{CB}}{P} + M0 + \frac{i}{P} \Delta RE + \frac{\Delta M0}{P} - \frac{i}{P} \Delta RE
\]

where the term in the last braces corresponds to the “adjusted monetary seigniorage” of equation \((3c)\). This definition thus fulfills the two criteria that I proposed in the main text as checks of logical and economic consistency of any definition of seigniorage.

\(40\) For those readers that find this definition strange, I note that it is equivalent to \(PD\equiv GD^p+GD^{CB}-K\). In other words, we take total government debt and subtract the central bank’s net capital, as the government is (either directly, or implicitly) a shareholder of the central bank, and its capital is thus a government’s asset that reduces its de facto indebtedness.
interest rates). The implicit cost of servicing the public debt are computed using the market interest rate \( i \). The financing of the overall budget deficit is done partly by increases in the consolidated debt and partly by opportunity cost seigniorage.\(^{41}\)

\[^{41}\text{We could also rearrange the equation (AI-2) in a similar way to get:}\]

\[
\left\{ \frac{(C - T)}{P} + \frac{C^{cn}}{P} + (\rho - \ell) \frac{FA^{cn}}{P} + \left( 1 - \ell \right) \frac{QA^{cn}}{P} + \frac{RE}{P} \right\} + \frac{PD}{P} = \frac{\Delta D}{P} + \frac{\Delta M}{P}.
\]

Here the primary deficit of the public sector also includes the implicit costs of maintaining foreign exchange reserves and quasi-fiscal operations (that here include also “transfers” to commercial banks through interest payments on required reserves). As in the equation (AI-3), the implicit costs of servicing the public debt are computed using the market interest rate \( i \). The financing of the overall budget deficit is done partly by increases in the consolidated debt and partly by monetary seigniorage.
Appendix II: The Determinants of Seigniorage in the Czech Republic

In this Appendix, I show several charts that describe the developments of monetary base and nominal interest rates, i.e. of the two determinants of opportunity cost seigniorage, since 1993.

1. The Monetary Base

Figure AII-1 shows that the monetary base grew fast between 1993 and April 1997, overall by almost 250 % in nominal terms. From April 1997 to April 2001, on the contrary, the monetary base declined by 13 % in nominal terms. The monetary seigniorage was thus positive in the former period (which was pushing up the opportunity cost seigniorage, too), and negative in the latter one (which was pushing down the opportunity cost seigniorage as well). Cumulatively, the monetary seigniorage has exceeded CZK 120 bn. in nominal terms since 1993, which means roughly 1.2 % of the cumulative GDP over that period. The following paragraphs discuss in more detail the factors behind the described developments of the monetary base.

Figure AII-1: Monetary Base

Source: Czech National Bank

If the money multiplier is stable, the growth of the monetary base corresponds to the growth of money supply. In 1993-96, the growth of money supply was very high (ranging from 15 % to 25 % year-on-year) due to an inflow of foreign debt finance that the CNB was not able to fully sterilise. This contributed to the fast growth of monetary base during that period. Since 1997,

---

42 This is higher than e.g. in the USA or EMU. For example if the growth of M3 corresponds to the ECB’s indicative target over a longer run (i.e. to 4.5 % a year), the monetary seigniorage will reach 0.2-0.3 % of GDP in the EMU (see also Smaghi, Gros, 2000). On the other hand, in Poland the monetary seigniorage reached roughly 1.5 % of the nominal GDP in 1993-99. And in the high-inflationary or hyperinflationary countries the monetary seigniorage can be substantially higher, the steady-state maximum being estimated at about 10 % of GDP (see Romer, 1996). For example in some Latin American countries that experienced a 3- or 4-digit inflation rates in the 1980s, the seigniorage reached 4.5 – 7.0 % of GDP (see Dornbusch – Fischer, 1994).
the growth of money supply has declined to 5 – 10 % (see Figure AII-2), partly due to the CNB’s anti-inflationary policy and partly due to the economic recession that reduced the growth of demand for the money balances. This factor could explain a slowdown in the growth of monetary base since 1997.

**Figure AII-2: The Growth of Money Supply M2**

![Graph showing the growth of money supply M2](image)

*Source: Czech National Bank*

However, it is in itself not able to explain its absolute decline. It is thus apparent that the assumption of a stable money multiplier could not hold in this period. Indeed, the CNB experienced substantial changes in the money multiplier (see AII-3).

**Figure AII-3: Money Multiplier**

![Graph showing the money multiplier](image)

*Source: Czech National Bank*

The multiplier first declined in 1993-96, which was pushing the growth rate of monetary base above the growth rate of money supply, i.e. it was pushing on higher monetary seigniorage. On the other hand, the money multiplier increased
again in 1997-99, which contributed to the decline in monetary base and thus to negative monetary seigniorage.

If we take a closer look at the determinants of the money multiplier, we can see that the ratio of currency to deposits was growing between 1993 and 1996 (see Figure AII-4)\(^3\), pushing the money multiplier down. This development was, to a large extent, a correction of a one-off decline of the currency in circulation associated with the currency split-up with Slovakia. In the next period, the ratio of currency to deposits stabilised at 12-14 %, and a further growth in this ratio has then taken place since late-1999 due to the “year-2000“ problem and increasing distrust in the financial sector during early-2000. This was a factor that was pushing up the monetary base (and thus both the monetary seigniorage and opportunity cost seigniorage), but it was outweighed by another factor, in particular by the changes in the minimum reserve requirement.

\[\text{Figure AII-4: Determinants of the Money Multiplier}\]

These changes in the minimum reserve ratio are also illustrated in Figure AII-4. In 1995-96 the CNB raised this ratio substantially in two steps in an effort to slow down the money supply growth associated with foreign capital inflows (see e.g. Čihák, Holub, 1998). That meant a decline in the money multiplier and a growth of the monetary base. Gradually, though, the minimum reserves stopped to play their monetary policy role (personally, I doubt that they had any important monetary effect even in 1995-96). The CNB thus cut them in several steps from their peak of 11.5 % to the current level of 2 %, which is already in line with the ECB’s practice. This caused a decline in the monetary base (and thus negative monetary seigniorage and a decline in the opportunity cost seigniorage).

\[\text{Source: Czech National Bank, own computations}\]

\[^3\] Figure AII-4 shows the development of the total currency issued by the CNB according to the monetary base data. This is different from the currency in circulation that enters the M2 data, as it does not include the currency in the vaults of commercial banks.
2. **Nominal Interest Rates**

Figure AII-5 shows the development of the short-run nominal interest rates (the two-week PRIBOR and two-week repo-rate, which is the main monetary policy rate). It shows that the nominal interest rates were rather high in early-1993 in order to fight against the adverse impacts of the split-up of Czechoslovak federation and the introduction of a new tax system. In late-1993, the money market rates declined again. In 1994-96 the interest rates were growing gradually as the CNB was trying to sterilise the foreign capital inflows and get the domestic demand under control. There was a sharp hike in the interest rates during the currency turmoil of May 1997. The interest rates were later on reduced to about 15 % points and maintained around this level until mid-1998, when a series of rate cuts began that ended in late-1999. Since then the repo-rate was stable at 5.25 % points till February 2001, when another minor cut to 5.00 % was carried out (which was subsequently reversed in July 2001).

**Figure AII-5: Short-Run Nominal Interest Rates**

![Graph showing short-run nominal interest rates from 1993 to 2001](image)

*Source: Czech National Bank*
### Appendix III: A Summary of Symbols Used in the Text

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>S</td>
<td>Monetary seigniorage</td>
</tr>
<tr>
<td>S'</td>
<td>Opportunity cost seigniorage</td>
</tr>
<tr>
<td>S&lt;sub&gt;total&lt;/sub&gt;</td>
<td>Total seigniorage</td>
</tr>
<tr>
<td>P</td>
<td>Price level</td>
</tr>
<tr>
<td>p</td>
<td>Inflation rate</td>
</tr>
<tr>
<td>M0</td>
<td>Monetary base</td>
</tr>
<tr>
<td>μ</td>
<td>Nominal growth rate of monetary base</td>
</tr>
<tr>
<td>CU</td>
<td>Currency in circulation</td>
</tr>
<tr>
<td>RE</td>
<td>Commercial banks’ reserves with the central bank</td>
</tr>
<tr>
<td>K</td>
<td>Net capital of central bank (equity + own funds + reserves – fixed capital)</td>
</tr>
<tr>
<td>FA&lt;sub&gt;CB&lt;/sub&gt;</td>
<td>Net foreign assets of central bank</td>
</tr>
<tr>
<td>GD&lt;sub&gt;CB&lt;/sub&gt;</td>
<td>Net government’s debt to the central bank</td>
</tr>
<tr>
<td>OA&lt;sub&gt;CB&lt;/sub&gt;</td>
<td>Net central bank’s claims on domestic private sector</td>
</tr>
<tr>
<td>GD&lt;sup&gt;p&lt;/sup&gt;</td>
<td>Net government’s debt to the private sector</td>
</tr>
<tr>
<td>G</td>
<td>Government expenditures</td>
</tr>
<tr>
<td>T</td>
<td>Government revenues</td>
</tr>
<tr>
<td>TR</td>
<td>Transfer of profit from central bank to government</td>
</tr>
<tr>
<td>i</td>
<td>Nominal market interest rate</td>
</tr>
<tr>
<td>i&lt;sup&gt;RE&lt;/sup&gt;</td>
<td>Nominal interest rate on commercial banks’ reserves (RE)</td>
</tr>
<tr>
<td>i&lt;sup&gt;g&lt;/sup&gt;</td>
<td>Nominal interest rate on net government’s debt to central bank (GD&lt;sup&gt;CB&lt;/sup&gt;)</td>
</tr>
<tr>
<td>i&lt;sup&gt;p&lt;/sup&gt;</td>
<td>Nominal interest rates on central bank’s net claims on domestic private sector (OA&lt;sup&gt;CB&lt;/sup&gt;)</td>
</tr>
<tr>
<td>i&lt;sup&gt;f&lt;/sup&gt;</td>
<td>Foreign nominal market interest rate (earned on FA&lt;sub&gt;CB&lt;/sub&gt;)</td>
</tr>
<tr>
<td>r&lt;sup&gt;cB&lt;/sup&gt;</td>
<td>Foreign real market interest rate</td>
</tr>
<tr>
<td>π&lt;sup&gt;cB&lt;/sup&gt;</td>
<td>Profit of the central bank</td>
</tr>
<tr>
<td>C&lt;sub&gt;cB&lt;/sub&gt;</td>
<td>Net operating cost of central bank (incomes from fees – fees paid; general operating cost; depreciation of fixed capital; incomes from currency issue – costs of currency issue etc.)</td>
</tr>
<tr>
<td>e</td>
<td>Nominal percentage depreciation of the exchange rate</td>
</tr>
<tr>
<td>ε</td>
<td>Unexpected component of exchange rate depreciation (exchange rate shock)</td>
</tr>
<tr>
<td>ρ</td>
<td>Risk premium on domestic assets</td>
</tr>
<tr>
<td>PD</td>
<td>Consolidated public debt (≡ GD&lt;sup&gt;p&lt;/sup&gt; - FA&lt;sub&gt;CB&lt;/sub&gt; - OA&lt;sub&gt;cB&lt;/sub&gt;)</td>
</tr>
<tr>
<td>PD'</td>
<td>Consolidated public debt (broadest definition; PD'≡GD&lt;sup&gt;p&lt;/sup&gt;-FA&lt;sub&gt;cB&lt;/sub&gt;-OA&lt;sub&gt;cB&lt;/sub&gt;+M0; equivalent to PD'≡GD&lt;sup&gt;p&lt;/sup&gt;+GD&lt;sub&gt;cB&lt;/sub&gt;-K)</td>
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