Seigniorage in the 21st Century

A Study of the Profits from Money Creation in the United Kingdom and Denmark

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Abstract:

This paper develops a new theory of seigniorage suited to modern economies where the majority of money is created not by the state or central bank but by commercial banks and other monetary financial institutions via their lending activity. We identify four different forms of seigniorage that take account of the modern institutional separation between the state, the central bank, commercial banks and the non-bank private sector in terms of their identities as 'money creators' and 'money users'. The new typology differentiates between seigniorage profits arising from interest rate spreads on stocks of created money and profits arising from flows of interest payments on newly created assets. We illustrate our theoretical framework with empirical data on commercial bank seigniorage and related variables in the United Kingdom and the Denmark over the past quarter century.

Keywords: Seigniorage, money creation, central banks, banks, financial intermediation, interest rates, financialization.

JEL classification: E40, E41, E42, E51, E58, G21

Contents

Introduction

> *Seigniorage is the revenue earned from the issue of money. Historically, this revenue accrued to the "seigneur" or ruler.* (Bank of Canada 2013)

> *Historically, issuing money has been a royal prerogative, one of the reasons being that it generates considerable revenue, called seigniorage. From the sovereign's point of view this could be seen as equivalent to tax revenue. Today the Danmarks Nationalbank Act states that the Nationalbank is responsible for issuing banknotes, while minting is the prerogative of the Treasury under the Coinage Act. Since 1975, the Nationalbank has been in charge of the production and administrative aspects of minting. After allocations, the seigniorage falls to the Treasury via the National bank's allocation of profits.* (Pedersen and Wagener 2000, 19)

In modern economies the majority of money is created by private commercial banks rather than central banks or any other state body (see for instance Ryan-Collins et al. 2011; Jackson and Dyson 2013; Werner 2014a; McLeay, Radia, and Thomas 2014; Jakab and Kumhof 2015). A survey into the history of economic ideas reveals that this is anything but a new insight. The process by which commercial banks create money when they issue new credit was central to thinking of prominent figures of the discipline such as Knut Wicksell, Friedrich Hayek, Irving Fischer, John Maynard Keynes and Joseph Schumpeter and was an integral aspect of theories on banking and money at the beginning of the 20th century (Turner 2013; Werner 2014a).

As the 20th Century wore on, however, banks' main role was viewed as intermediating between savers and borrowers and they were not granted any privileged position in mainstream theories and models of the economy (Ingham 2004, chap. 1). The financial crisis of 2007-08, however, made clear that bank credit and money creation was of fundamental significance to the macroeconomy. The recognition of the capacity of private commercial banks to

create money has profound implications for our understanding of many other concepts and phenomenon in the economy (Turner 2015). This includes the concept of seigniorage.

The quote from the Bank of Canada above illustrates how seigniorage is generally understood as the revenue derived from the creation of new money and the introduction of this money into the economy. And the subsequent quote from the Danish Nationalbank illustrates how money creation and thus also seigniorage is typically attributed to the sovereign ruler in the economy, whether it be the monarch or the government represented by the central bank and the Treasury. The ambition of the current paper is to rethink the concept of seigniorage in light of the fact that today neither monarchs nor central banks but rather commercial banks play the primary role in the creation of money, a point brought home by the Bank of England's recent Quarterly Bulletin Article on the subject (McLeay, Radia, and Thomas 2014).

This paper has two objectives. Firstly, since seigniorage has historically been a source of considerable income for monarchs and governments, the shift towards commercial banks creating money has implications for public finances and the macroeconomy. This is one of the points that we wish to highlight with the current paper. A second objective is to inform and qualify on-going public and political debates about money and monetary reform. If we understand how commercial banks derive profits from seigniorage we are in a better position to discuss and evaluate proposals for changes to the monetary system, including potentially shifting the prerogative to create money back to governments and central banks (see e.g. Benes and Kumhof 2012; Dyson and Jackson 2013). We illustrate our examples of modern seigniorage by drawing on data for the UK and Denmark, both countries where lively discussion around monetary reform are occurring. While the paper does not directly address questions of seigniorage in terms of monetary reform, it does prepare a conceptual framework for such a discussion.

The paper is structured as follows: Section 1 sets out a conceptual framework for understanding four different concepts of seigniorage and how this relates to epistemological considerations around the nature of money. This framework informs the following sections. Section 2 reviews different concepts and measurements of state or central bank seigniorage. This in-

cludes particularly the distinction between monetary seigniorage and opportunity cost seigniorage. Section 3 extends the logic of these concepts by applying them to the contemporary economy, where seigniorage is accrued by commercial banks. The section presents a definition and a formula for the measurement of commercial bank opportunity cost seigniorage. Section 4 applies the definition and measurement of commercial bank opportunity cost seigniorage in an empirical analysis of seigniorage profits in United Kingdom and Denmark. Section 5 returns to the theoretical discussion by exploring the concept of commercial bank monetary seigniorage and which is the also applied in a brief analysis of 'excess financialization' in United Kingdom and Denmark. The final section summarizes the findings of the paper.

1. Seigniorage and Money

Like money itself, seigniorage is a concept that appears straightforward at first glance but upon closer inspection turns out to be highly complex. In the literature, we find competing definitions and the field is 'marred by a certain confusion about the appropriate way to measure seigniorage' (Baltensperger and Jordan 1997a, 133). This confusion is not merely due to superficial differences in the definitions of technical concepts. Any concept or calculation of seigniorage invariably implies a number of important assumptions about the nature of money and money creation. The lack of consensus on the definition of seigniorage is thus a symptom of the lack of consensus over the definition of money itself (Bjerg 2014, 148–52). As we review different definitions of seigniorage in the next section, we shall see how each of them corresponds to different theories about the nature of money. The discussion serves to set up a theoretical framework for the subsequent empirical analysis of our two cases, UK and Denmark.

We propose to map the assumptions behind the definition of seigniorage according to four questions, laid out below:

A) What is money?

If seigniorage is revenue accrued through the creation of money, any concept of seigniorage necessarily has to make an assumption about what money is. Which kinds of assets and/or liabilities do we include in our measurement of money? The vast majority of the literature on seigniorage takes for granted that the state has a monopoly on the creation of money and thus only include bank notes, coins and in some cases central bank reserves as the basis for seigniorage (see for instance Gros 1989; Klein and Neumann 1990; Rovelli 1994; Pedersen and Wagener 2000). However, the more recent literature on commercial bank money creation recognizes that the majority of money in modern economies is electronic deposits created by commercial banks in the act of lending (McLeay, Radia, and Thomas 2014).

B) Who issues money?

Since seigniorage is accrued by the creator of money any concept of seigniorage also has to make an assumption about who issues money. The question here is not simply whether the state or commercial banks should be included as creators of money. Even within the literature on central bank seigniorage there are differences in the way that the state as the creator of money is conceived. While some authors treat the state as one coherent issuer of money (see for instance Friedman 1971; Drazen 1985) others take into account the institutional separation between the central bank and the government (see for instance Rovelli 1994; Pedersen and Wagener 2000). We concur with Klein and Neumann (1990) that definitions of seigniorage should pay close attention to particular institutional circumstances in different countries as these may have profound implications for the way that money creation is turned into seigniorage. This includes not only the relation between the central bank and the government but also the relations between commercial banks, the central bank and the government.

C) How is money introduced into the economy?

The way money is created and introduced in to the economy has profound implications for the definition and measurement of seigniorage. If we think of new money as being *spent* directly into the economy, seigniorage profits are accrued as the difference between the cost of producing money and its purchasing power. If, however, we think of money as an interest-free *credit* that is *lent* in to the economy and circulates, seigniorage is accrued in the form of interests foregone by the users of money. In the literature, the former kind of seigniorage is referred to as 'monetary seigniorage' and the latter as 'opportunity cost seigniorage' (Gros 1989; Klein and Neumann 1990; Neumann 1992; Baltensperger and Jordan 1997a). This distinction is not only relevant in terms of the introduction of central bank money into the economy. It is also useful in terms of discussing how commercial banks introduce new money into the economy.

D) From whom is seigniorage revenue accrued?

While definitions of seigniorage are usually quite explicit about who receives the revenue from money creation, their assumptions about where this revenue ultimately comes from tend to be more implicit. The underlying economic model in most studies of central bank seigniorage assumes that there is only one possible source of new money- the state (or its monetary authority). Furthermore, it is also implied that there is only one class of money users. This means that money creation is typically conceived as a trade-off between the state, who appropriates purchasing power through an expansion of the money supply, and private money users (everyone else), who experience a deflation in the purchasing power of the existing money supply in circulation (see for instance Bruno and Fischer 1987). This trade-off may be partially offset by growth in the productive output of the economy, which increases the demand for money and thus curbs inflation. Another version of the trade-off is that the state finances deficit spending through the issuance of new money, which then circulates as an interest free loan to the government. But in both cases, seigniorage is ultimately paid by private users and holders of money in the form of either lost purchasing power or foregone interests.

The inclusion of commercial banks as creators of money complicates the conception of seigniorage. With multiple money creators in the model, seigniorage is not just simply paid by private money users. Rather, we may also consider seigniorage as revenue foregone by an original monopolistic money creator by relinquishing its monopoly and allowing other institutions to also create money. The model with only one kind of money creator and one class of money users is a one-dimensional model, where the only question is: what is the optimum amount of money the money creator should issue? In a model with two money creators, the question is not only *how much* but also *who* should issue money to achieve the most desirable economic impacts. This introduces a second kind of trade-off, which is not between money creator and money user but between two different money creators. Obviously, the trade-off between different money creators is crucial when trying to understand and evaluate the changing relations between the central bank and commercial banks.

The four questions above constitute the parameters framing any particular definition of seigniorage. Table 1 combines these parameters to provide a mapping of different definitions of seigniorage in terms of their underlying assumptions. The rows define who issues money and thus accrues seigniorage. The columns define how new money is introduced into the economy and thus the kind of seigniorage that is derived. Inside each cell is a simple mathematical definition of the particular notion of seigniorage, the implied definition of money, and a description of the way that new money is introduced into the economy. The definitions listed in the table are not assumed to be self-explanatory. In the following sections we thus provide further elaboration and explanation for each of the four combinations. The table serves first and foremost to provide an initial overview and guide to the structure of our argument.

Table 1: Definitions of Seigniorage

	Monetary	Opportunity Cost
Central Bank	$S = \Delta M$ Money is notes and coins New money is *spent* into economy	$S = Mi_b$ Money is base money New money is *lent* to commercial banks
Commercial Bank	$S = \Delta L - \Delta gL_{-1}$ Money is current account deposits New money is *spent* on interest bearing financial assets	$S = M(i_{mb} - i_d)$ Money is current account deposits New money is *lent* to private borrowers

Where:

S = seigniorage

M = money supply

L = non-bank liabilities held by commercial banks

g = GDP growth rate

i_b = interest on government bonds

i_{mb} = market benchmark interest

i_d = interest on commercial bank deposits

2. State and Central Bank Seigniorage

2.1 Monetary Seigniorage

> *The use of metals in this rude state was attended with two very considerable inconveniencies; first with the trouble of weighing; and, secondly, with that of assaying them. ... Before the institution of coined money, however, unless they went through this tedious and difficult operation, people must always have been liable to the grossest frauds and impositions, ... To prevent such abuses, to facilitate exchanges, and thereby to encourage all sorts of industry and commerce, it has been found necessary, in all countries that have made any considerable advances towards improvement, to affix a public stamp upon certain quantities of such particular metals, as were in those countries commonly made use of to purchase goods. Hence the origin of coined money, and of those public offices called mints.* (Smith 1776, 27)

In Adam Smith's classic account money emerges as a convenient solution to the problem of exchange in a barter economy. We find this in his famous story of the butcher, the brewer, and the baker, who make the transition into a money economy by employing metals as a medium of exchange in their mutual transaction. Along similar lines Smith explains how the institution of minting also emerges as a practical solution to certain inconveniences. In the account, quoted above, seigniorage is the value added to gold or silver bullion as it is stamped and minted into standardized coins. It is, in other words, the value incurred as a commodity is transformed into money. This account fits into the notion of money found in the so-called commodity or metallist theory of money (Menger 1892; Goodhart 1998, 2)

Even if we no longer make money out of precious metal, which carry a commodity value parallel to their value as money, the commodity theory of money is still pervasive among many economists. Much of contemporary orthodox economics relies on an idea that '*money's historical origins and logical conditions of existence are explained as the outcome of economic exchange in the market that evolves as a result of individual utility maximization*' (Ingham 2004, 19). This means that the existence of money in the market is taken for granted and it may be treated as nothing but a 'veil' over an economy, that essentially functions as if it

were based on pure barter (Schumpeter 1954, 277). As stated by one of the key proponents of neo-classical economics, Nobel memorial laureate Paul Samuelson

> [E]ven in the most advanced industrial economies, if we strip exchange down to its barest essential and peel off the obscuring layer of money, we find that trade between individuals or nations largely boils down to barter. (Samuelson 1973, 55)

Even if money is not actually a commodity but paper printed by the central bank or just records on an electronic ledger, we can still treat it intellectually *as if* it were a commodity. This view is illustrated by the following comment from Paul Krugman:

> *Here's my current thought: in some sense money is a really weird thing, which can look to individuals like a real asset — cold, hard, cash — but is ultimately, as Paul Samuelson put it, a "social contrivance" whose value is more or less conjured out of thin air. Mainstream macroeconomics acknowledges the weirdness — in particular, makes heavy reliance on the ability of central banks to create more fiat money at will — but otherwise treats money a lot like ordinary goods.* (Krugman 2015)

The monetarism of Milton Friedman is a classic reference point in the literature on seigniorage, which is based on the commodity theory of money. In a seminal paper on the issue, Friedman begins with the following statement:

> *It has become common to regard inflation produced by the issue of fiat money as a tax on cash balances.* (Friedman 1971, 846)

Money may be a useful technology to facilitate the exchange of goods and services in the market but the creation of fiat money by the government also has the potential to disturb the inherent mechanisms in the economy that push the market towards equilibrium. Friedman builds on Fischer's classic equation of exchange:

$$MV = PT \tag{1}$$

where:

M = stock of circulating money

V = velocity of money

P = general price level

T = volume of transactions.

V is presumed to be constant in the long-run meaning that the amount of money changing hands to pay for transactions is equal to the value of these transactions. Adjustments to the money supply, which is assumed to be exogenous, should thus feed directly through to prices and income. Thus M is the independent variable in the equation above which the government or central bank controls.

Friedman argued that any issuance of government money in excess of economic growth leads to inflation, which devalues the purchasing power of existing money balances. Seigniorage is thus conceived as an alternative form of taxation. It is an 'inflation tax' through which the government may finance investments or fiscal deficits. Rather than imposing conventional forms of taxation, which appropriates a portion of the existing money in circulation, the government finances itself by permitting its monetary authority (in most cases the central bank) to issue new money. Besides Friedman himself we find this view in a series of other works (Fischer 1982; Buiter 1985; Mankiw 1987a; Calvo and Leiderman 1992; Roubini and Sala-i-Martin 1992)

A simple mathematical definition of this kind of seigniorage, which is discussed in Groeneveld and Visser (1997, 72) is:

$$S = \Delta M \tag{2}$$

where:

ΔM = change in the supply of central bank money.

This definition may be refined to take into account the actual costs of producing money and the impact of inflation on the purchasing power of the new money issued by the central

bank. In some versions, M measures only central bank notes and coins and in other versions it also includes central bank reserves.

The crucial issue raised by the strand of literature viewing seigniorage as a form of inflation tax is the question of identifying the optimal point in the trade-off between inflation, growth and seigniorage (Mankiw 1987b). How much (or perhaps rather: how little) money should the central bank issue in order to balance its interests in supporting the government on the one hand and ensuring economic stability and growth on the other.

In the underlying model of the economy we find two classes of agents: the money creator and the money users. On the creator side, no distinction is made between the government and the central bank, and on the user side, no distinction is made between firms, banks and private individuals. Just like Marx would conceive of profits as part of a class struggle between capitalists and workers, the concept of inflation tax conceives of seigniorage as part of a class struggle between government and the market as constituted by the collective of private money users.

This notion carries with it an undertone of seigniorage as an illegitimate and potentially abusive form of exploitation of money users, which can be found not only in much of the orthodox literature on seigniorage but also in policy making in terms of the institutional structures and operations of contemporary central banks. Indeed the institutionalisation of central banks that are fully independent of governments and focussed primarily on inflation targeting above and beyond other objectives and the prohibition of monetary financing of governments by central banks in most advanced economies can be seen as an outcome of this conception of seigniorage as a primarily negative inflation tax. In his paper on seigniorage, Friedman is remarkable clear on his position on the issue:

> *My own personal view is that inflation is neither desirable nor necessary, that the most effective road to development is through free enterprise and private investment, and that the government can serve best by limiting itself to essential government functions, keeping taxes of all kinds low, refraining from intervention into the economy, and providing a stable monetary framework.* (Friedman 1971, 847)

2.2 Opportunity Cost Seigniorage

> [S]*eigniorage* [is] *the 'interest-bearing debt' which the government does not have to issue due to the operation of monetary policy.* (Rovelli 1994, 13)

A common critique of the above approach of monetary seigniorage is that it does not take into account the institutional division between the central bank and the government treasury (Pedersen and Wagener 2000). If we accept the arguments that central banks can be and are independent, then the government is not at liberty to just 'print new money' at will in order to finance deficit spending. In most cases today, central banks are operationally independent from governments, with a specific mandate to secure specific monetary policy goals such as financial stability and steady low inflation. Financing the government, in particular long-term financing or financing at rates superior to market rates, is typically prohibited. In addition, the creation and the spending of money is institutionally separated between the central bank and the ministry of finance (Ryan-Collins et al. 2011, 77–92)

When taking this separation fully into account, money is no longer conceived in terms of the commodity theory but rather in terms of the so-called state theory of money. This theory conceives of money as ultimately a creation of the sovereign state through its legal powers to institute and enforce legal tender laws as well as taxation (Knapp 1905; Bjerg 2014, 100–104). According to this theory, money is a special form of credit with the state or debt owed by the state, depending on the perspective from which it is perceived. This debt is special because it is not redeemable in other forms of money. It can also be used for payment of taxes or other forms of debt to the state. Furthermore, the state may require banks by law to hold a certain quantity of monetary units as reserves. All of these features place central bank base money at the top of a hierarchy of credits and makes it the most liquid means of exchange in the economy (Bell 2001). Due to this special character of central bank base money, people and banks either voluntarily or for legal reasons hold this credit with the state at no or at least at below market rates of interest.

Thinking in terms of monetary seigniorage and the commodity theory, seigniorage is the difference between the commodity price of money and the nominal price of money that is

between the production cost and the face value of money. Thinking in terms of opportunity cost seigniorage and the state theory of money, *seigniorage is the difference between the market interest rates on debt and the interest on the special kind of debt owed by the state, which is also money.* Under this conception money is central bank base money consisting of a combination of physical notes and coins as well as commercial bank deposits with the central bank. While notes and coins are available private money users, deposits with the central bank can only be used in transactions between commercial banks or between commercial banks and the central bank.

The simplest mathematical definition of central bank opportunity cost seigniorage is derived from Groeneveld and Visser (1997, 73):

$$S = {}_{i}M \tag{3}$$

where:

${}_{i}M$ = interest foregone by the holders of money.

This definition assumes that no interests are paid on commercial bank deposits with the central bank and that physical cash is produced at no cost. Taking these two features into account, central bank opportunity cost may be defined as in (4). This definition is derived from Groeneveld and Visser (1997, 73) although it has been slightly changed to take into account the cost of producing physical currency:

$$S = iBN - C + (i - i_{br})BR \tag{4}$$

where:

BN = notes and coins

C = costs of producing physical cash.

BR= central bank reserves

i = interest foregone by commercial banks holding reserves

i_{br} = interests paid on reserves to commercial banks.

Perhaps the most elaborate definition of central bank opportunity cost seigniorage is provided by Rovelli in his investigation of the relation between seigniorage and reserve require-

ments in the European Union. While the definition above takes the perspective of money users, Rovelli (1994, 22) takes the perspective of the central bank:

$$S = i'_{\varphi}\Phi_{-1} + i_c B^C_{-1} + i_L L^C_{-1} - i_R R_{-1} - C^S \qquad (5)$$

where:

$i'_{\varphi}\Phi_{-1}$ = interests earned on foreign assets

$i_c B^C_{-1}$ = interests earned on claims to the government

$i_L L^C_{-1}$ = interests earned on loans to banks and other institutions

$i_R R_{-1}$ = interests paid on commercial bank reserves with the central bank

C^S = costs attributable to the issue department of the central bank.

Rather than viewing seigniorage as revenue forgone by holders of cash and central bank deposits, Rovelli calculates the revenue actually earned by the central bank through the issuance of money. In the former definition, seigniorage is measured as a discount on the financing of the liability side of the central bank balance sheet. In Rovelli's definition, seigniorage is derived from the holding of assets on the central bank balance sheet enabled by the creation of money. As mentioned, the purpose of the current paper is not the settlement of divergent definitions of central bank seigniorage. The point here is thus merely to show how seigniorage may be conceived in terms of the issuance of non- or low-interest bearing debt by the state in the form of the central bank.

As implied by Rovelli's definition, the central bank introduces new money into the economy as it increases its holdings of assets in the form of government bonds, loans to banks and other institutions or foreign assets. These assets are typically purchased from commercial banks in return for a credit on their deposit accounts with the central bank or a transfer of physical currency. It is important to note how the central bank depends on the commercial banks to translate an increase in central bank deposits into an increase in commercial bank deposits, which may be used by private money users. Even in the case of physical currency, the central bank has no outlet to distribute these directly to private money users but have to rely on the ATM's of commercial banks.

A curious exception to this rule is the fact that employees with the central bank (at least in the case of Denmark and the UK) have private accounts with corresponding payment cards directly in the central bank. The Bank of England even features an ATM in its lobby exclusively for employees. As the central bank pays salaries directly into these accounts it does in fact spend money directly into the economy thus realizing a kind of monetary seigniorage.

2.3 Central Bank Independence

Besides the commercial banks, the treasury constitutes another interface between the central bank and private money users. The treasury and the central bank interacts through two main channels: direct transfer of seigniorage and purchase of government bonds. The ownership structure of central banks vary between countries with different compositions of government ownership, ownership by banks, and private shareholder ownership (Rossouw 2014). But part of the institution of a central bank is typically some kind of obligation to transfer seigniorage to the treasury. This money is credited to the treasury's deposit account with the central bank. As new money is now available for government spending, we may think of this as a form of monetary seigniorage (For empirical studies of this kind of seigniorage see Gros 1989; Hochreiter, Rovelli, and Winckler 1996; Hochreiter and Rovelli 1999)

A significant portion of the central bank's portfolio of assets is constituted by government bonds. If the central bank purchases these bonds directly from the government, it also pays by crediting the treasury's deposit account in the central bank, thus making new money available for public spending. This is the second main channel for the interaction between the central bank and the treasury. Since the central bank lends this money to the government, we can argue that this is merely a form of opportunity cost seigniorage. If, however, we regard the central bank as a public institution that is an integrated part of the state, we may think of the debts and credits between the treasury and the central bank as merely a matter of internal book-keeping, whereby money accrued through the selling of government bonds to the central bank could be counted as monetary seigniorage.

The role of the central bank as a public institution and the institutional separation between government and central bank is a delicate issue. While this has probably always been the case as long as central banks have existed, it has become especially pronounced with the establishment of the EMU and subsequently the Euro. Article 123 of the Lisbon Treaty inscribes the separation between the central bank and government into the constitution of the EU:

> *Overdraft facilities or any other type of credit facility with the European Central Bank or with the central banks of the Member States (hereinafter referred to as 'national central banks') in favour of Union institutions, bodies, offices or agencies, central governments, regional, local or other public authorities, other bodies governed by public law, or public undertakings of Member States shall be prohibited, as shall the purchase directly from them by the European Central Bank or national central banks of debt instruments.* (European Union 2007, para. 123)

This article from the Lisbon Treaty means that states cannot circumvent the separation between government and central bank by letting the central bank purchase government bonds directly from the government with newly created money. Any purchase of government bonds must be done indirectly, that is on secondary bond markets, and it should be governed by general monetary policies such as financial stability or hitting an inflation target rather than a fiscal policy concern for the financing of government spending. The Treaty thus implies a consolidation of the separation between fiscal and monetary policy within the EU. Fiscal policy is the responsibility of government while monetary policy is the responsibility of the ECB as well as national central banks in the EU.

Article 123 thus creates a separation between the powers to create money and the powers to spend money. National governments may spend money into the economy by purchasing labour power and commodities or simply give the money into the economy through various kinds of social benefits to citizens. They can, however, only finance themselves through taxation or borrowing of money already in existence. The power to create new money lies with the central bank and the national governments have no access to this power. They may receive transfers of money as dividends of the seigniorage revenues of the central bank but this should be regarded as a 'convenient fringe benefit' (Rovelli 1994, 15) of the core operations of

the central bank, which are spelled out in the monetary policy targets of low inflation and financial stability.

The institutional relationship between the central bank and the government is also important to consider when we review central bank opportunity cost seigniorage in terms of the fourth in our list of questions: From whom is seigniorage revenue accrued? As we have seen, Friedman's notion of inflation tax suggests that seigniorage revenue is ultimately accrued from the holders and users of money, whose purchasing power is deflated as new money is created. Rovelli's definition of seigniorage as 'the 'interest-bearing debt' which the government does not have to issue due to the operation of monetary policy' seems to have similar implications. The interests saved by the government through the issuance of money is paid by money users, as they are forced to hold this debt of the government without getting paid any interests.

As already indicated in the theoretical discussion, the conception of seigniorage may branch off into two directions at this point. The notion that seigniorage as interest forgone by money users assumes that if the government cannot finance itself through the central bank, it will have to borrow existing money at interest from money users instead. This model, however, abstracts from the role of commercial banks in the economy. The crucial question is this: When governments are barred from utilizing the money creating powers of the central bank, does this mean that less seigniorage is accrued from the money users, or does it mean that other institutions will *de facto* take over and meet the public as well as private demand for additional money and thus also take over the power to accrue seigniorage? In the following, we argue that the latter, rather than the former, seems to be the case.

3. Commercial Bank Opportunity Cost Seigniorage

3.1 Money as Commercial Bank Credit

> *Total seigniorage is the sum of bank seigniorage and central bank seigniorage. Central bank seigniorage consists of the revenue due to the currency demand and the revenue due to the possibility to force the banking sector to hold reserves. Bank seigniorage is the net revenue due to the desire of the private sector to hold deposits which pay less interest than bonds.* (Baltensperger and Jordan 1997b, 786)

If we look at financial transactions in volume terms, electronic commercial bank credit money would appear much more economically significant than physical notes and coins printed and minted by the central bank. This is corroborated by statistical measures, which show that in Denmark only 5 percent of the money supply is constituted by notes and coins whereas 95 percent is commercial bank current account deposits. The equivalent figures for the United Kingdom are 3 percent and 97 percent (Ryan-Collins et al. 2011).

These proportional relations between central bank cash money and commercial bank credit money are also reflected in contemporary debates around the theoretical conception of money. Arguing against conventional textbook economics, which suggest that banks are merely financial intermediaries, several authors have suggested that commercial banks play a much more prominent role in modern economies as they are the primary creators of money. These authors include post-Keynesian endogenous money theorists (see for instance Moore 1983; Lavoie 1984; Cottrell 1994) as well as a new wave of authors showing this conception of money to be not only theoretically (Werner 2005; Ryan-Collins et al. 2011; Jackson and Dyson 2013; Huber 2014) but also empirically (Werner 2014a; McLeay, Radia, and Thomas 2014) inaccurate and misleading.

The conception of money applied by these authors is derived from the so-called credit theory of money (Innes 1914; Bjerg 2014, 115–31). Money is debt issued by individuals or

institutions, which enjoy general credibility or creditworthiness in the economy. Given this general creditworthiness their debt circulates as a general means of payment and settlement throughout the economy. In our contemporary economy, the primary creators of money are thus commercial banks, who administer the deposit accounts that are used to pay and receive money, when money users make electronic transfers. Even the government accepts this kind of money in payment of taxes thus supporting its general acceptance among money users. The role of commercial banks in the creation of money obviously has profound implications for the appropriation and distribution of seigniorage in the economy. If commercial banks are the main suppliers of money they should also be the main recipients of seigniorage.

3.2 Commercial Bank Seigniorage

In the quote at the beginning of the section, Baltensperger and Jordan conceive of seigniorage as consisting of two components: central bank seigniorage and commercial bank seigniorage. Building on the work of VanHoose (Vanhoose 1985; VanHoose 1988), Baltensperger and Jordan break down the private sector's demand for money into two components: the demand for central bank currency and the demand for commercial bank deposits. The trade-off between the two forms of seigniorage is determined by the relation between the two forms of demand that are inversely correlated. The distribution between the two forms of demand is dependent on the degree of competition in the banking industry and the state of the payment transaction technology.

If there is an increase in competition in the banking system, banks may have to pay more interest to attract sufficient deposits to maintain adequate liquidity and/or offer loans at lower rates of interest. In both cases, commercial bank opportunity cost seigniorage will be less. On the other hand, if there is an improvement in payments transaction technology, for example a more efficient interbank settlement system or more efficient systems for digital payments, this is likely to mean banks will need to hold less reserves to settle their payments without running into liquidity problems, meaning they can enhance their opportunity cost seigniorage by paying less interest to the central bank (Ryan-Collins et al. 2011, chap. 4).

Furthermore, some or all of the seigniorage accrued by the commercial banking industry may be reclaimed by the central bank through the imposition of legal reserve requirements that go beyond what commercial banks actually require to participate in the payments system. Thus, Baltensperger and Jordan define commercial bank seigniorage as opportunity cost seigniorage determined by the trade-off between the central bank and commercial banks:

> *The banking industry can extract a larger share of total seigniorage, the lower competition and reserve requirements and the better the payment transaction technology. As long as some seigniorage is going to the banking sector, the central bank can increase its seigniorage revenue without increasing the welfare loss or letting the economy drift further away from the optimal quantity of money. /.../ Since bank seigniorage has, from a public finance point of view, no direct utility for the public, it is optimal for the central bank to reduce bank seigniorage as much as possible. We therefore conclude that bank seigniorage should be completely eliminated in order to reduce welfare losses and to get closer to the optimal quantity of money.* (Baltensperger and Jordan 1997b, 793)

The creation of money by commercial banks of course involves two parties. In order to create new money the bank must interact with a money user, who is willing to accept the debt of the bank in return for taking out a loan with the bank. Since the bank runs a risk by issuing a new loan, the depositor/borrower must be perceived as creditworthy for the transaction to be sensible from a business perspective. Typically, a bank will charge interest on the loan to cover this risk and often also ask for collateral for instance in the form of real estate.

At the same time, a bank must also attract deposits in order to manage the liability side of its balance sheet and its liquidity, since there is a high chance that borrowers will spend their newly acquired deposits at a different bank. It is for this reason that banks frequently also offer a rate of interest on deposits held with them. At the heart of the traditional commercial banks' business model is the interest differential between the rate on loans issued and the rate paid on deposits.

This profit margin between loans and deposits is derived from two elements, which constitute the two fundamental functions of commercial banks today: financial intermediation

and money creation. On the one hand, banks make profits by evaluating prospective borrowers and by taking on the risk of providing them with a loan. In the classical model of banks as financial intermediaries, the loan is funded by persuading savers to lend their money to the bank at an interest rate that is lower than that which the bank charges borrowers. This is the interest rate spread. On the other hand, the banking sector as a whole has a near monopoly on the store of value function of money as well as on the medium of exchange value through the processing of payments.

In our contemporary banking and money system the boundaries between lenders and money users has become blurred. If money users want to store their value in money or make electronic payments they are compelled to essentially lend their money to the bank. The same blurriness thus also applies to the boundaries between financial intermediation and money creation. The conceptual challenge in calculating commercial bank seigniorage lies in separating these two functions.

A basic mathematical definition of commercial bank opportunity cost seigniorage may be expressed as follows:

$$S = M\left(i_{mb} - i_{d}\right) \tag{6}$$

where:

M = Commercial bank deposits

i_d = interests paid on deposits

i_{mb} =market benchmark interest.

The reasoning behind the definition is that since deposits function as money, money users are prepared to accept a relatively lower interest on them. Keynes (2007) refers to this as a 'liquidity premium'. The logic of the definition is similar to the one found in discussions on conventional central bank seigniorage, where people are prepared to hold physical currency even though they do not receive any interest on this money. Commercial bank opportunity cost seigniorage is the difference between this interest (if any) actually paid on deposits and a market benchmark interest, which is the interest that the bank *would have had to* pay if de-

posits were not simultaneously liquid money. The crude definition raises a number of issues, which need to be considered before it is applicable to empirical measurement.

The most elaborate empirical study of commercial bank seigniorage has been done by Huber and Robertson. Huber and Robertson estimated commercial bank seigniorage in 1998/99 to be $37.3bn in the USA, €57.9bn in the Euro Area, £21.4bn in the UK, DM29.7bn in Germany and ¥1,846bn in Japan (Huber and Robertson 2000, 89). These calculations are based on a variety of the formula in equation (6). As their benchmark interest rate, Huber and Robertson use the base rate offered by the central bank in each of the currency zones in question. Furthermore, the interests foregone by having to hold some non-interest bearing central bank money is subtracted from the commercial bank seigniorage. In a more recent study, Huber estimates the commercial bank seigniorage in Germany to be €23bn in 2007 and €17bn in 2011 (Huber 2014, 90–91). These estimates use a similar methodology although they are based on money market interest rates as benchmark.

3.3 Benchmark interest rates

The first issue to merit discussion is the choice of an interest rate to serve as the market benchmark interest rate. This choice partially depends on our theoretical perspective. As we have seen in the discussion on central bank seigniorage, there are differences in the literature in terms of whether we conceive of seigniorage as actual profits accrued through a bank's holding of assets funded by its creation of liabilities that function as money, or whether we conceive of seigniorage as potential revenues foregone by money users by holding the liabilities of banks at no or low interest.

In the context of central banks, definition (4) derived from Visser and Groeneveld represents the latter perspective, while definition (5) from Rovelli represents the former. The problem with using Rovelli's approach to commercial banks is that it would not distinguish between profits earned by financial intermediation and profits earned by money creation. This is why we decide to take the more conservative approach of only looking at the liability side of the commercial banks' balance sheets.

In the approach by Huber and Robertson (2000) and Huber (2014) referenced above, the central bank base rate and the money market interest rate are used as the benchmark against which actual interests paid on deposits is compared. We believe, however, that this benchmark is too conservative. This is especially the case in the current situation, where central bank base rates are close to, and occasionally even below, the zero lower bound. First, the commercial bank's access to the central bank discount window is part of their special privilege as money creators. Using the central bank base rate as benchmark is to make the following implicit assumption: If commercial banks were not able to fund their liabilities through deposits they would have to borrow reserves from the central bank instead. But the reason why commercial banks have access to the central bank discount window in the first place, is because they administer the payment system and the creation of money. This argument also applies to money market interest rates. The price of money in interbank money markets is dependent on fact that commercial banks have access to the central bank discount window.
Second, we should also consider the causal relation between central bank interest rates and the money supply. Conventional theory would suggest that the money supply is a function of central bank interest rates. If the central bank lowers interest rates, more investments become profitable, more money is borrowed, and the supply of money expands.

If we adopt the idea that commercial banks create money more or less independently of the supply of central bank reserves (a development that certainly seems to characterise this relationship in the post-financial crisis period), however, we might consider whether causality runs in the other direction. If bank balance sheets expand at a faster rate than economic growth and incomes, growing volumes of debt may eventually begin to dampen consumption spending, profits and demand and inflation and make households and firms vulnerable to moderate increases in interest rates – a so called 'debt-deflation' (Fisher 1933). In order to fulfil their mandate of maintaining nominal demand and prices and securing financial stability, central banks may have to lower interest rates and keep them low. This may especially be the case of bank lending mainly flows in to existing real estate assets rather than to businesses, as the former form of credit appears weakly or negatively related to economic growth

(Bezemer, Zhang, and Grydaki 2016). This is of course a very big question that is beyond the scope of this paper. The only conclusion, which we need to draw here, is that central bank base rates or even money market interest rates are not a useful benchmark for seigniorage. Instead we turn to the bond markets.

If commercial banks were not able to fund themselves through the creation of deposit money, they would be in a position similar to regular non-banking corporations with regards to funding (Werner 2014b; Hodgson unpublished). If deposits did not circulate as money they would be comparable to a kind of corporate bonds. As a market benchmark interest rate we thus use some kind of bond rate. But which kind of bonds should we use? Government bonds are backed by the government's prerogative to tax. Corporate bonds are backed by the machinery, buildings, goodwill and other forms of productive capital of the corporation. Real estate bonds are backed by real estate. Bonds issued by a bank, however, are ultimately backed by the loans that the bank holds as assets. Some of these loans will be lent against collateral, while others are non-secured. In addition, banks hold a number of other assets such as shares and government bonds on their balance sheet. This suggests that we should use some kind of average bond rate as the benchmark against which we measure the interests foregone by users and holders of deposit money.

This interest rate may, however, be too conservative as it fails to take into account the full benefit of being a bank with the capacity to create money. Paradoxically, the main asset of banks is on the liability side of their balance sheet, since this is where we find their capacity to create money. This poses an additional challenge to our measurement of seigniorage. Not only should we compare the interests actually paid on deposits with the interests that would have to be paid if the bank were to finance its lending through the issuance of bonds. We should even imagine that these bonds were issued by a bank, which did not have the capacity to create money.

A bank without the capacity to create deposit money is essentially the same as a peer-to-peer lending company (Hodgson unpublished). It receives funding from savers and investors, who commit a certain amount of money for a certain amount of time for a certain rate of

interest, and it lends this money to entrepreneurs, companies and other agents in need of funding. The difference between the peer-to-peer lending company and the bank is that the lending company cannot expand its balance sheet at will in order to accommodate potential borrowers. It needs to find savers, who are willing to relinquish disposal of their money for a period of time, before it is able to make new loans. The issuance of a loan is thus two separate transactions. Only the commitment of funds by savers expands the balance sheet of the lending company. When funds are lent out it is merely a transformation of one form of asset, money, to another form of asset, the loan. Depending on the business model of the peer-to-peer lending company, lenders bear all or some of the risk of loans defaulting.

Since the bank, stripped of its privilege to create money, is similar to a peer-to-peer lending company, we might use the lending rates offered by such companies as market benchmark rates. This rate, however, might be too high as actually existing peer-to-peer lending companies today operate in a lending market, where they compete with banks. It may thus be argued that at least part of their portfolio of borrowers have been through a selection process, where they have been found unqualified for a loan with a conventional bank. Indeed, UK banks have been obliged by regulation to pass on risky borrowers to peer-to-peer lenders. Part of the difference between the interest rate on deposits with a commercial bank and the interest rate on savings with a peer-to-peer lending company may thus be due to a difference in the risk profile of their lending portfolio.

Our definition of commercial bank seigniorage is formalized as following:

$$\begin{aligned} S_{lb} &= D(i_{ab} - i_d) \\ S_{ub} &= D(i_{ppl} - i_d) \end{aligned} \tag{7}$$

where:

S_{lb} = Commercial bank opportunity cost seigniorage lower bound

S_{ub} = Commercial bank opportunity cost seigniorage upper bound

D = Commercial bank deposits

i_d = interests paid on deposits

i_{ab} =average bond interest rate

i_{ppl} =peer-to-peer lending rate.

3.4 Competition and Deposit Rates

It is in fact a simplification to say that the conventional literature on central bank seigniorage does not take into account the creation of money by commercial banks. In Friedman's seminal paper on inflation tax, the creation of deposit money is taken into consideration but immediately discarded on the assumption that competition between banks eliminates seigniorage profits due to low or no interests on deposits (1971, 846n) As noted by Baltensperger and Jordan (1997b, 782) subsequent authors such as Romer (1985), Brock (1989), and Daniels and VanHoose (1996) adopt this assumption and thus ignore commercial bank seigniorage on the basis that it is eliminated by competition in the banking sector. Baltensperger and Jordan themselves are in disagreement with these authors and thus proceed on the assumption of imperfect competition in the banking sector.

Whether or not there is perfect competition in the commercial banking sector is beyond the scope of this paper to determine. Our focus, in turn, is on another dimension of the question of competition: On the one hand, money users have to decide if they want to hold their deposits with commercial bank A or commercial bank B. It is this kind of competition between the two banks that Friedman is talking about. On the other hand, money users have to decide whether they want to hold their money as deposits with a commercial bank or as physical cash issued by a central bank. In this sense, there is competition between the commercial bank money and central bank money. It is this form of competition, which is the main focus of the current paper.

If we look at the empirical constitution of our current money and payment system, it seems fair to suggest that there is little and perhaps declining competition between commercial bank money and central bank money. Whilst certain categories of money users, such as small businesses, who cannot afford card payments, or more illicit trades, may wish to avoid electronic money, for the majority of money users electronic money is much more convenient. Thus although usage of cash is not declining per se, it has declined significantly as a proportion of the total money supply. As central banks do not, currently, offer money users the opportunity to keep deposits with the central bank they are effectively giving commercial

banks the monopoly to create and offer electronic money. In the near future, we might indeed see central banks offering digital cash to ordinary money users, which would change the dynamics of the way that seigniorage is accrued (Barrdear and Kumhof 2016; Buiter 2016; Skingsley 2016; Tolle 2016).

In our calculation of commercial bank opportunity cost seigniorage, we shall be using actual deposit rates paid on the bank's outstanding account money without making any assumptions about whether these are the result of perfect or imperfect competition in the banking sector. The reasoning is that even if these rates were the subject of perfect competition, the difference between deposit rates and benchmark market interest rates still constitutes seigniorage earned through the commercial bank's privilege to create electronic money. Whether this seigniorage revenue simply represents the bank's costs of administering the payment system plus a 'fair' profit determined by the competition in the sector, is also beyond the scope of this paper.

3.5 Reserve Requirements

The fact that commercial banks are in a position to create new deposit account money as they issue new loans does not mean that they operate completely independently from the creation of central bank money. Commercial banks need to hold a certain amount of central bank money in the form of central bank reserves as well as physical cash money. Commercial bank's demand for central bank money is a function of several factors. They need physical cash to service customers demanding deposits paid out in notes and coins. They need central bank reserves to clear balances with other banks, which cannot be cleared through the interbank money market. And they may also need a certain amount of central bank reserves to meet legal reserve requirements.

As noted by Rovelli (1994), Baltensperger and Jordan (1997b), Huber (2014, 90) and several other authors, the amount of central bank money required for commercial banks to operate smoothly constitute a means for the central bank to reclaim some of the seigniorage accrued by commercial banks through the issuance of deposit account money. This is related

to the fourth question posed in our introduction. Seen from the perspective of commercial banks, central bank seigniorage derived from central bank money held by commercial banks in the form or reserves or cash constitutes seigniorage forgone by the commercial bank. When commercial bank's demand for central bank money is lowered, for instance by the implementation of electronic payment infrastructure or by relaxation of legal reserve requirements, the commercial bank's share of total seigniorage revenue is increased. In other words, the trade-off between the two creators of money is shifted to the benefit of the commercial banks.

In order to account for this trade-off, we include the commercial bank's holding of central bank money in the definition of commercial bank opportunity cost seigniorage. If the bank did not have to tie up a portion of its assets in central bank money, it could have invested it in interest bearing assets such as bonds. We thus subtract the interest foregone by commercial banks as they hold an amount of central bank money on their balance sheets.

But just like commercial banks sometimes pay interests on customer deposits, commercial bank's may also sometimes receive interests on their reserves held with the central bank. The policies of central banks in different countries differ on this issue, with some central banks paying interest on all or a portion of commercial bank deposits with the bank and other paying no interest on this money (Goodfriend 2005; Bowman, Gagnon, and Leahy 2010). In some countries this rate is currently even negative.

In fact the financial crisis led to a change in policy in several central banks most notably the US Federal Reserve, which introduced for the first time interest payments on commercial bank reserves in 2008 (Board of Governors of the Federal Reserve System 2008). Such interest payments mean that the opportunity cost of holding central bank money instead of other interest bearing assets is decreased and seigniorage is again shifted back to the commercial bank. Including the net opportunity costs of holding central bank money we thus arrive at the following definition:

$$S_{lb} = D(i_{ab} - i_d) - (BR + BN)\, i_{ab} + BRi_{br}$$
$$S_{ub} = D(i_{ppl} - i_d) - (BR + BN)\, i_{ppl} + BRi_{br} \quad (8)$$

where:

S_{lb} = Commercial bank opportunity cost seigniorage lower bound

S_{ub} = Commercial bank opportunity cost seigniorage upper bound

D = Commercial bank deposits

BR= central bank reserves

BN = notes and coins held by commercial banks

i_d = interests paid on deposits

i_{ab} =average bond interest rate

i_{ppl} =peer-to-peer lending rate

i_{br} = interests received on central bank reserves.

The first term on the right hand side of the equation is the original opportunity costs of holding commercial bank deposit money for money users, the second term represents the opportunity costs for commercial banks of holding central bank reserves and cash, and the final term are the interests received on central bank reserves.

3.6 Compound Interest

As we have discussed extensively in the previous sections, seigniorage is revenues accrued through the creation of new money. We should, however, also turn this question around and ask: Is new money created, when seigniorage is accrued? Seigniorage constitutes a form of profit to the central bank, the commercial bank or whatever institution creates new money. But what kind of money does this profit constitute. This question is relevant to consider as we want to calculate how seigniorage revenues are carried over from one time period to the next. Let's say a bank makes DKK100m in seigniorage in a year. Does this mean that DKK100m new money is created? If this is the case, we need to include this new money into the subsequent supply of money from which subsequent seigniorage revenues are derived. We may refer to this as a form of 'compound seigniorage', which is not accrued on the basis of newly created money but rather on the basis of previously accrued seigniorage. In order to

take this element of seigniorage into account we would need to include compound interests in our calculation of seigniorage.

As we have seen, the nature of seigniorage not only depends on who creates new money but also how this new money is introduced into the economy. A similar issue arises with regards to seigniorage from seigniorage. When commercial banks create new deposit money in the process of issuing new loans, they accrue opportunity cost seigniorage. This form of seigniorage constitutes a discount on the interest that the bank has to pay to depositors. Over time the bank thus saves money that it would have otherwise had to pay to depositors in interest. Now the curious question arises: What happens to the money that is *not* paid out to depositors? This question may also be posed from the perspective of the money users, who are the ones paying for seigniorage: If depositors were paid the full market interest rate on deposits, what would they have done with the money?

There are principally two different options depending on the way that interests on credits and debts between banks and money users are recorded. If we assume that money users would have used the interests now forgone through seigniorage to pay down their debt to the bank, commercial bank opportunity cost functions to *create new debt*. In other words, seigniorage revenue is retained on the asset side of the bank balance sheet, and banks earn interests on it in subsequent years. If, on the other hand, we assume that money users would have kept the interests now forgone through seigniorage on their deposit accounts, commercial bank opportunity cost functions to *destroy money*. In other words, seigniorage revenue is retained on the liability side of the bank balance sheet, where it functions to lower the amount owed by the bank to its depositors and thus also lower the amount of interests that the bank has to pay to depositors over time. In either case, seigniorage earned in one year continues to either earn interests on the asset side or save interests on the liability side in subsequent years.

In equation (8), we use current deposit account liabilities as the basis for the calculation of seigniorage. Since seigniorage earnings from previous years are either recorded on the asset side of the bank balance sheet or result in a relative reduction of the liabilities of the bank,

this definition does not include compound seigniorage, that is current seigniorage earned on the basis of previous seigniorage. In order to take compound seigniorage into account we revise the definition to take into account current interests saved due to interests saved in previous years. For simplicity we assume that all previous seigniorage revenues are retained as reductions in bank liabilities rather than increases in bank assets. This revision amounts to the following definition:

$$\begin{aligned} S_{lb} &= D(i_{ab} - i_d) + S_{T-1}(i_{ab} - i_d) - (BR + BN)i_{ab} + BRi_{br} \\ S_{ub} &= D(i_{ppl} - i_d) + S_{T-1}(i_{ppl} - i_d) - (BR + BN)i_{ppl} + BRi_{br} \end{aligned} \qquad (9)$$

where:

S_{T-1} = Corresponding seigniorage earned in the previous year

When applying this definition in empirical estimates it is of course necessary to choose a base year, where the calculation begins. In our examples, this is simply driven by data availability, being 1990 in the UK and 1991 in Denmark.

The conceptual as well as the mathematical definition of derivative seigniorage makes a number of assumptions, which are not entirely in line with the actual functioning of banks. Most importantly it assumes that all seigniorage revenues are retained on a bank's balance sheet in the form of reduced deposits corresponding to an increase in equity. In practice, however, banks are likely to use these earnings in a number of other ways. They may be used to increase salaries or bonuses to bank employees and managers. They may be used to purchase non-interest earning assets such as buildings and inventory. Or they may be paid out as dividends to shareholders.

On the one hand, we may say that such uses remove money from the banks' balance sheet so that they no longer continue to earn compound interest. But on the other hand, we may claim that even when seigniorage revenue is used in any of these three ways, they still remain on the balance sheets of the banking sector in aggregate in so far as bank employees, bank managers, property developers, office supply companies, and bank shareholders all hold accounts with commercial banks. This means that when seigniorage revenue is recirculated back into the economy of money users, it becomes the source of new money creation. This

creation of money is not based on the issuance of new loans and thus the creation of new interest bearing assets but rather on the liquidation of bank equity. When a bank, for instance, pays out dividends to a shareholder, who holds a deposit account with the bank, it simply increases this deposit account and decreases its equity with an equivalent amount. In brief, equity is liquidated into money. The question is if we are justified in maintaining that even when new money is created through the payment of wages, expenditure on buildings and inventory, or the payment of dividends, it is still the source of compound interest earning opportunity cost seigniorage. Another option would be to say that it constitutes an immediate valorisation in the form of monetary seigniorage, which is not carried over into the future (see Huber 2014, 89 for a discussion on this issue).

As the discussion reveals, the concept of retained seigniorage earning compound interest is not unproblematic. In our calculations, we therefore only include this calculation as a supplement to the more conservative estimate of simple opportunity cost seigniorage. At the same time, the issue of compound interest and seigniorage is still important to include in our conceptual thinking about the way that seigniorage works over time.

In order to complete the explanation of all four concepts presented in table 1 in the introduction, we still need to account for the concept of commercial bank monetary seigniorage. As we shall see, this concept is a little more speculative than the other three concepts. Therefore, we have moved the discussion of this concept to section 6. Instead, we now move to the empirical estimates of commercial bank opportunity cost seigniorage.

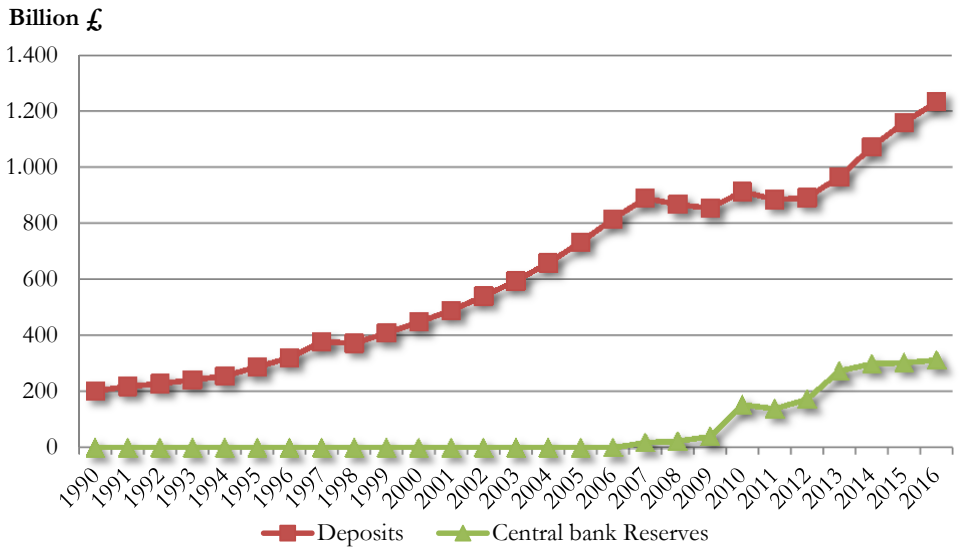
4. Commercial Bank Opportunity Cost Seigniorage in the UK and Denmark

In this section we apply our theoretical model of commercial bank opportunity cost seigniorage – as laid out in the previous equations- to two countries: the United Kingdom and Denmark. We begin by examining the variables used for the calculation.

4.1 Measures of money

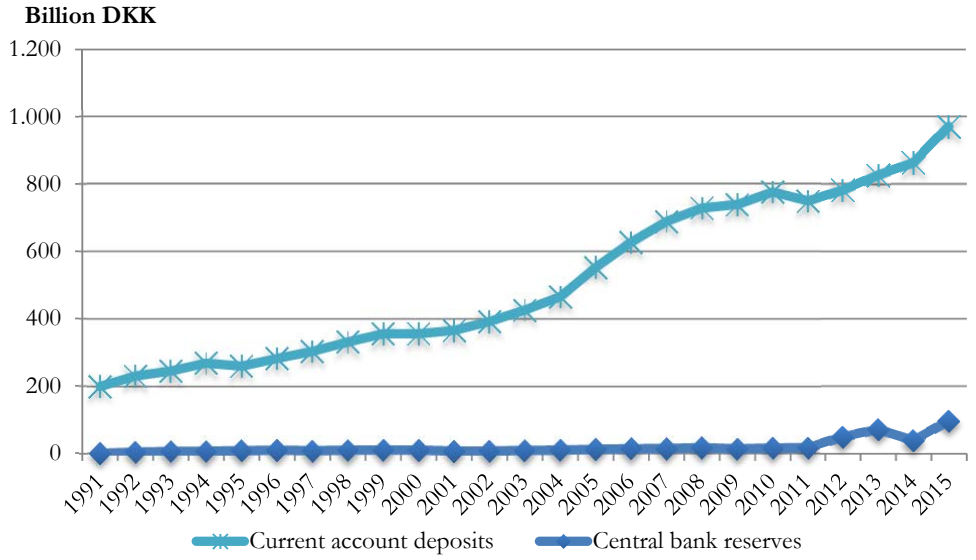
We choose to examine current account sight deposits as our measure of commercial bank money for the UK and Denmark. An alternative would have been to use a broader measure that might include some kinds of liquid time deposits. There is, however, no clear monetary aggregate appropriate for both countries for any extended amount of time that is suitable. Figures 1 and 2 present the development in current account sight deposits held at private banks as well as Central Bank reserves for the UK and Denmark.

Figure 1: UK: Current account sight deposits held at private banks and central bank reserves



Source: Bank of England codes LPQVWYE (levels) and LPQVWXS (changes): "Quarterly levels/changes of monetary financial institutions' sterling and all foreign currency M1 (UK estimate of EMU aggregate) liabilities to private and public sectors (in sterling millions) not seasonally adjusted." Levels were break adjusted back from 2016 using the using the changes measure. Quarterly data was aggregated by taking average across the four quarters.

Figure 2: Denmark: Current account Deposits held at private banks and Central Bank Reserves



Source: Danish Statistics database www.statistikbanken.dk, table DNM1KOR, DNMNOGL and DNSNB1. Current account deposits are measured as M1 minus cash in circulation.

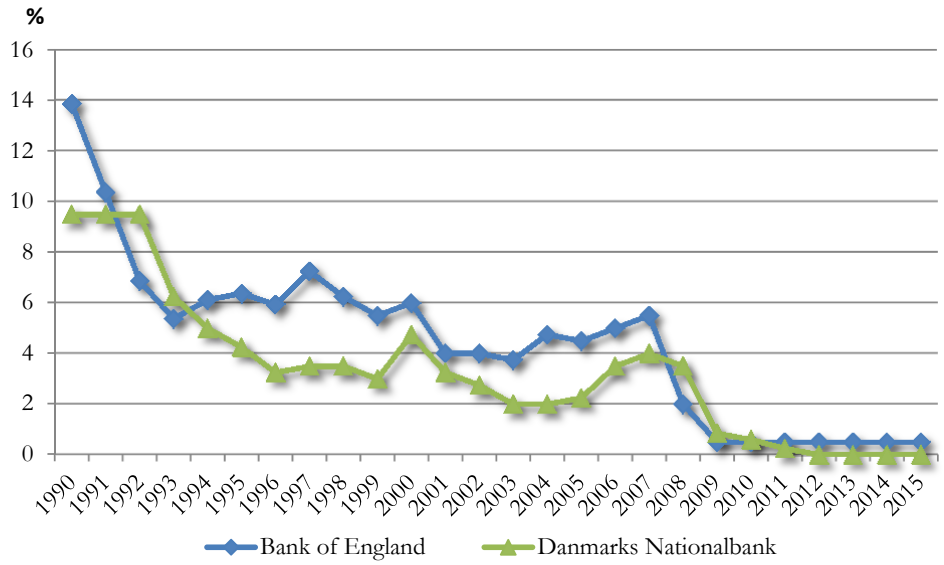
For both countries we see little evidence of a relationship between central bank reserves and commercial bank deposits. This supports the existing critique of the 'money multiplier' model, which says that the model is wrong in assuming the supply of commercial bank deposits to be a function of the supply of central bank reserves (Werner 2005).

For both countries there was also a steady growth in current account deposits before the onset of the financial crisis in 2007. The growth was particularly dramatic during the years immediately preceding the crisis. While the growth in current account deposits continued in Denmark, interrupted only by a single year fall in 2011, it stagnated in the UK after the crisis, as can be seen in the period between 2007 and 2010. Since 2012 there has been a 38% increase in current account deposits in the UK compared with a 24% increase in Denmark.
The large rise in central bank reserves in the UK post-crisis is mainly explained by the Bank of England's Quantitative Easing program (QE). The rise in the amount of Central Bank reserves in Denmark might be explained by imported effects of the QE/Asset Purchasing Program (APP) by the ECB, due to the currency peg of the Danish Krone.

4.2 Interest rates

Figure 3 below shows that the central bank overnight rates for the UK and Denmark follows a similar path and that both are now at an all-time historically low level. The Danish rate has been at a lower level than the UK rate since 1993, except during the financial crisis in 2008 and 2009. The Bank of England base rate has persisted at 0.5% for 8 years, which is significantly below the long term average rate of 7%. Before 2008 the Bank of England base rate had never been below 3.5%.

Figure 3: Central bank overnight rates in the UK and Denmark (end of year rate)

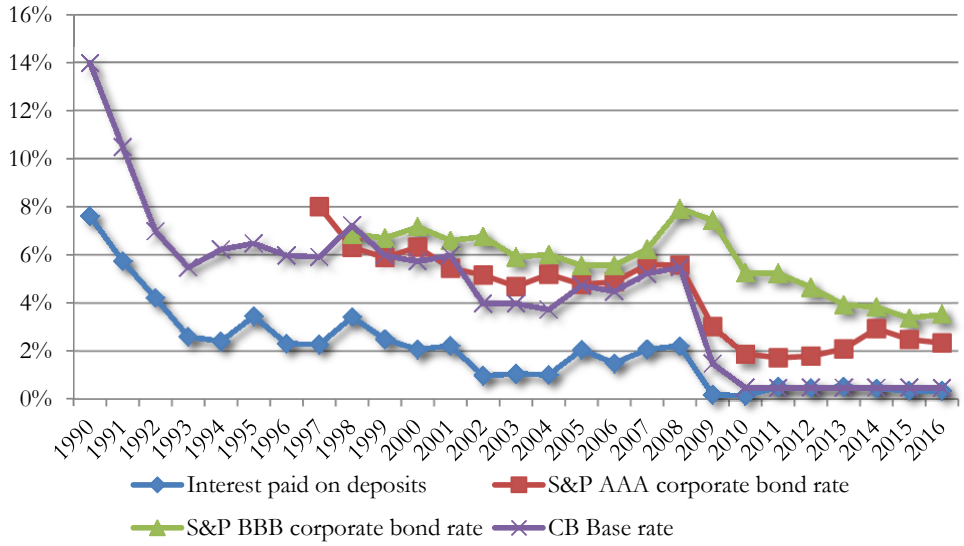


Source: Danish Statistics database www.statistikbanken.dk, table MPK3.

Figures 4 and 5 below show the key interest rates used in our seigniorage calculations for the two countries on separate graphs over the last quarter decade. We compare central bank rates with interest rates on commercial bank sight deposits and our chosen lower and upper bound benchmark interest rates.

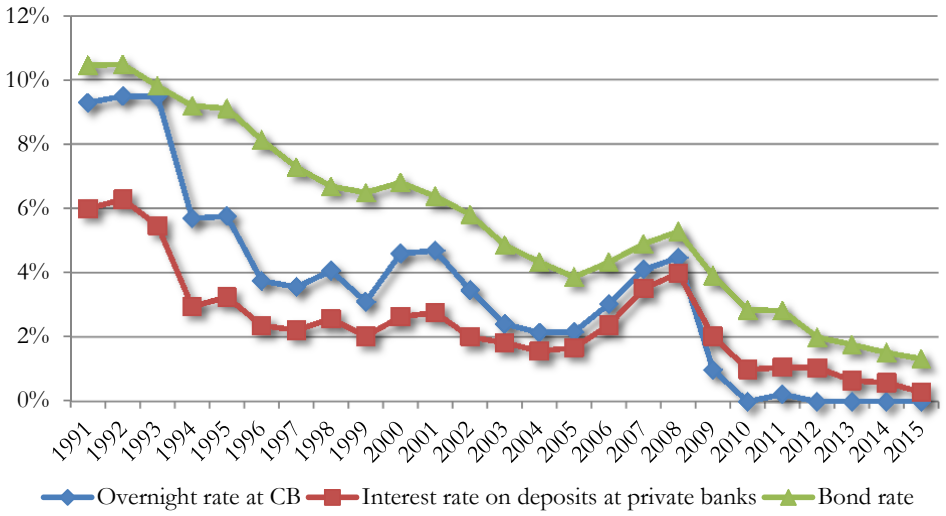
We see how the spread between deposits held with commercial banks and the central bank is larger (2% as compared to 2.5-3%) in the UK than Denmark on average up to the financial crisis but then narrows sharply in both countries. With regard to Denmark, it is worth noting that the central bank now has moved its deposit rate below zero with commercial banks now having to pay to keep money on deposit with the central bank.

Figure 4: UK key interest rates (annual averages)



Source: Bank of England, Standard and Poor's Corporate Bond Indexes

Figure 5: Denmark key interest rates (annual averages)



Source: Danish statistics database, table MPK3

For the UK (figure 4) Standard & Poor's Corporate Bond Indexes AAA corporate bond rate are chosen as the lower bound, reflecting the fact that if the banks did not have the ability to create money, they would need to fund themselves on the bond market like a normal company. For the upper bound we use S&P's BBB corporate bond rate index, since this is the worst investment grade rating and a bank would struggle to operate at a credit rating below that.

Although rates on these bonds have reduced since the crisis, the reduction has not been anywhere near as dramatic as the base rate or the deposit rate. During the last twenty years the top rates for AAA and BBB corporate bonds have been 6% and 8% respectively with the financial crisis leading to a reduction in the rate to 2.3% and 3.5% respectively in 2016.

For the lower and upper bound calculations in Denmark (figure 5) we have chosen to use the average mortgage bond rate for calculating the lower bound opportunity-cost seigniorage. This is sourced from the Danish Statistics database and is the rate on 'Unit mortgage bonds' that consists of a weighted average of Danish mortgage bonds. Both the corporate bond market and the peer-to-peer lending market are undeveloped in Denmark, so the upper bound is more difficult to estimate. Hence we only calculate the upper bound for the latest year using a peer-to-peer lending rate.

In Denmark the mortgage bond rate fell more or less consistently until 2006 where they climbed until 2009. Since then they have been falling all the way towards zero. The spreads between the different rates are generally lower than in the UK.

4.3 Results

The estimates of commercial bank opportunity cost seigniorage for the UK and Denmark are presented in figures 6 and 7. For the UK, the calculations go back to 1998 as the S&P index was only available from this year. For Denmark, only the more conservative lower bound estimate is available given the lack of an equivalent data set to the S&P index.

For the UK the average lower bound seigniorage for the period 1997–2016 was £17.6bn, peaking in 2007 at £30.6bn. The average upper bound seigniorage for the same period was £29bn peaking in 2009 at £65.2bn.

For Denmark we see that the lower bound opportunity cost seigniorage averages DKK 11.7bn per year during the period from 1991 to 2015. It peaked at DKK 16.2bn in 1994 and has been steadily declining since then. In 2015 the opportunity-cost seigniorage is estimated at DKK 8.0bn

Figure 6: Commercial bank opportunity cost seigniorage in the UK, 1997-2016

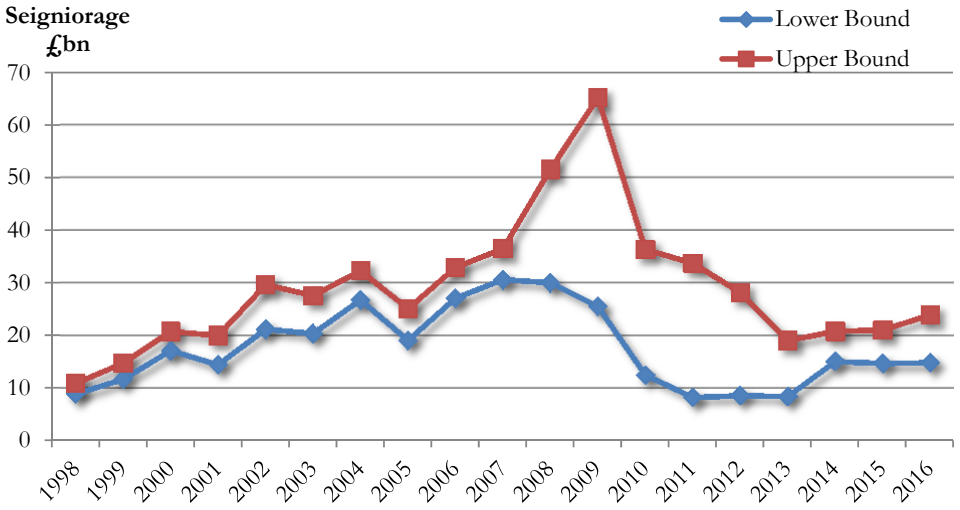
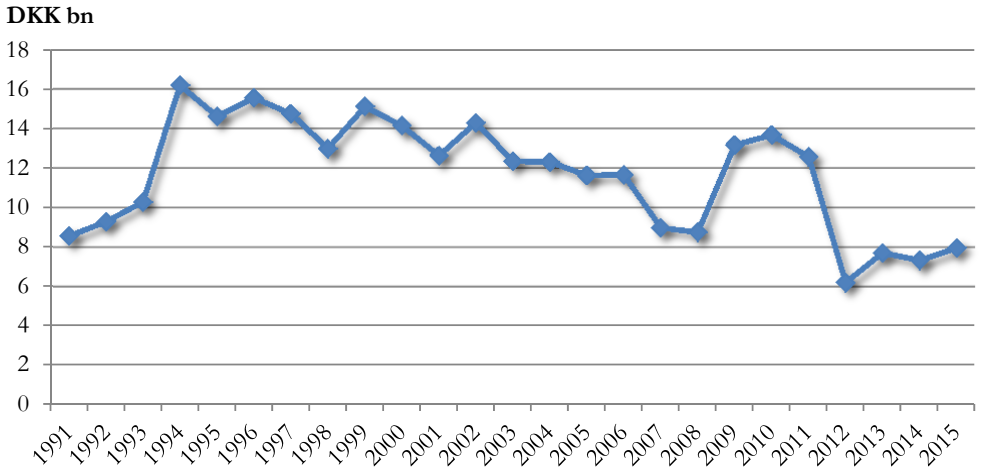


Figure 7: Commercial bank lower bound opportunity cost seigniorage in Denmark, 1991-2015



Due to the lack of available data it is only possible to calculate the upper bound seigniorage for the current year for Denmark. Using a peer-to-peer lending interest rate from the biggest peer-to-peer lending company, Lendino, at 7.7% we estimate the upper bound opportunity cost seigniorage at DKK 49.5bn in 2016. Even though this might be an overestimation, it provides a clear picture of the competitive advantage that banks hold compared to peer-to-peer lenders under the current monetary framework in Denmark.

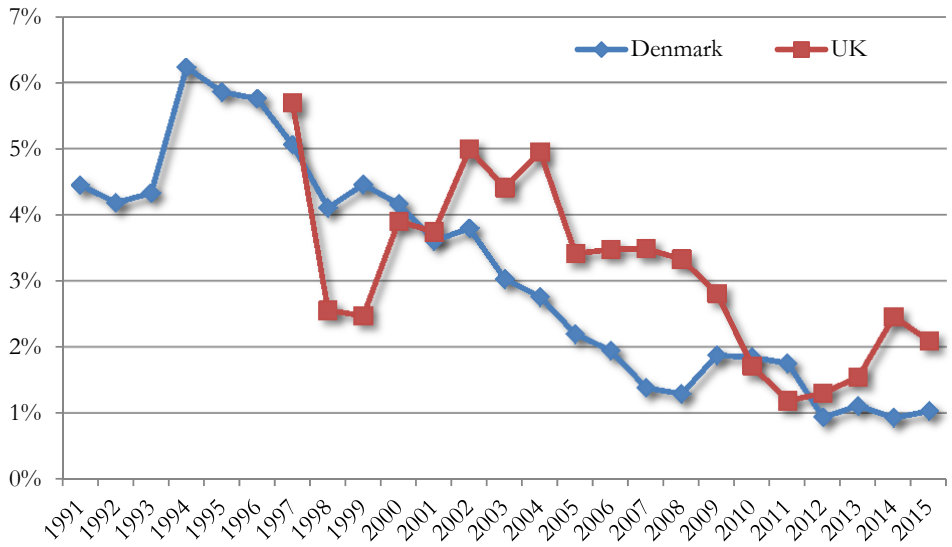
Table 2: Overview

	Average	1998	2003	2008	2013	Peak	Low
UK (Low est.)	£17.6bn (1997-2016)	£9bn	£19,7bn	£26,2bn	£9,3bn	£30.6bn (2007)	£7.9bn (2011)
UK (High est.)	£29bn (1997-2016)	£11bn	£26,7bn	£45bn	£21bn	£65.2bn (2009)	£11bn (1998)
Denmark (Low est.)	DKK11.7bn (1991-2015)	DKK 13bn	DKK 2.4bn	DKK 8.8bn	DKK 7.8bn	DKK 16.2bn (1994)	DKK 6.2bn (2012)

4.4 Discussion of results

Commercial bank opportunity-cost seigniorage is a product of interest spreads between the benchmark rate and the rate on current account deposits (shown in figure 8) as well as the development in the amount of current account deposits. All else being equal lower spreads between the current account deposit rate and the benchmark rate leads to less benefit being derived from opportunity-cost seigniorage. A higher volume of current account deposits, an increase in the central bank base rate and a large change in central bank deposits, on the other hand, lead to more revenue from opportunity-cost seigniorage.

Figure 8: Spread between lower bound benchmark rates and current account deposit rates in Denmark and the UK



Source: Danish statistics database, table MPK3 and Bank of England

For both of our case study countries the effect on the total opportunity cost seigniorage of the increase in the amount of current account deposits over time (figures 1 & 2) can be seen to have been counter-balanced by the fall in interest rate spreads (figure 8). In comparison to Denmark where interest spreads have been falling during the whole period, they remained fairly stable until 2008 in the UK when there was a precipitous crash followed by a slow recovery. This can explain why we see some stability in the value of opportunity-cost seigniorage to the banking sector in the UK before the crisis in 2008 and a fall in Denmark during the same time period.

Opportunity cost seigniorage can be viewed through different lenses. Relative to GDP opportunity-cost seigniorage for Denmark was 0.2% in 2015 and 0.7 % on average during the period 1991-2015. Similar figures for the UK are higher as they constitute 1% of GDP (taking an average of the upper and lower bound results) across the period but going as high as 3% of GDP in 2007 and 2008.

But we can also conceive of seigniorage relative to the earnings of the banking sector itself. Seigniorage constitutes a component of the total profits of commercial banks although the distinction between profits from seigniorage and profits from other banking activities is theoretical and not specified in commercial banks' financial statements.

Examining the average costs and profits of banks in both countries we find that opportunity cost seigniorage constitutes 84% of the average profits of the Danish banks (Danish Statistics, Table MPK39) that is 11bn of 13,3 bn DDK between 1991-2014. The relationship to bank profitability is also striking for the UK where the average opportunity cost seigniorage between 2004-14 represents 167% of post-tax banking sector profits (Table B3.2 from Bank of England). Clearly the banking sector business models of both countries are heavily dependent on opportunity cost seigniorage profits.

Seignorage is generally lower when interest rates are lower, when interest spreads are low, and when the gain for the banks of holding reserves at the central bank is low or even negative. In this regard it is important to note how the estimate of opportunity cost seigniorage is based on the conventional idea that the central bank controls monetary policy via the setting of interest rates. This implies that interest rates are exogenous to the private banks' business model.

As discussed in earlier sections, this assumption can be criticized since commercial banks do not immediately need central bank money in order to create new deposits. They require liquidity. But this does not necessarily mean a requirement to secure additional central bank reserves from the central bank or customer deposits, since liquidity can also be created by interbank loans that is by the private banks themselves.

It has been argued that central bank interest rates are the effects rather than the cause of commercial bank credit creation (Werner 2005; Wray 2012). If we accept this argument, it seems that commercial bank credit creation has pushed the economy to the limit thus exhausting the potential for opportunity cost seigniorage. When market interest rates are close to zero, the opportunity costs paid by money users, as they accept deposits at a low interest rate, also become very low. At the same time, the creation of credit and money by commer-

cial banks has been feeding a large increase in the level of private money user's indebtedness. This makes it difficult for central banks to raise interest rates without endangering financial stability as well as the prospects for growth.

The falling rates of opportunity cost seigniorage thus seem to signify an erosion of the classic business model of commercial banking, where profits are earned on the spread between deposits and loans. In a sense, this constitutes a financial version of Marx's old prediction of 'the tendency of the rate of profit to fall'. This pushes banks to look for other ways to profit on their power to create credit and money for example through fees from securitization activities or currency and bond market trading (Bindseil, Domnick, and Zeuner 2015; Krall 2015). While these are ultimately derived from the power to create money, such profits are not captured by our calculation of opportunity cost seigniorage. In the following section, we shall turn to the final concept of seigniorage, which is an attempt to capture more unconventional ways of profiting from the power to create money.

5. Commercial Bank Monetary Seigniorage and Excess Financialization

> *Financialization is the major dynamic polarizing today's economies. Its aim is to appropriate the means of production and rent-extracting privileges for a creditor class to load labor, industry, agriculture and governments down with debt. Employment, wages and capital investment cannot recover as long as the resulting debt overhead is left in place.* (Hudson 2015, 275)

As we have seen, the nature of central bank seigniorage depends on the institutional relation between the central bank and the government. The concept of monetary seigniorage assumes that the government has the power to spend newly created central bank money into the economy. The concept of opportunity cost seigniorage, however, assumes an institutional separation between the central bank and the government, which means that newly created central bank money are lent rather than spent into the economy. In more general terms, the concept of monetary seigniorage assumes an identity between money creator and money user whereas the concept of opportunity cost seigniorage assumes a division between money creator and money user.

A similar kind of reasoning seems to apply to commercial bank seigniorage. The commercial bank typically creates new money by lending them into the economy, where they are then made available for spending by private money users. The money creator is not a money user and we thus conceive of commercial bank seigniorage in terms of opportunity cost seigniorage. The question is now whether the roles of money creator and money user are necessarily divided in the case of commercial bank seigniorage? In terms of the conceptual framework set-up in table 1, this issue boils down to the following: How is monetary commercial bank seigniorage possible?

5.1 Excess Monetization

Again it is useful to take our starting point in the existing literature on central bank seigniorage. Gros provides an elaborate account of the difference between opportunity cost seigniorage and monetary seigniorage in terms of a stock and a flow concept of money:

> *Seigniorage* [opportunity cost] *is the revenue the government obtains because the public holds zero interest-bearing debt in the form of cash and because the government can force commercial banks to hold reserves at zero interest or below market interest rates. The savings in interest payments on the stock of currency in circulation and required reserves can, from an economic point of view, be considered the implicit revenue from seigniorage. Another way to look at seigniorage* [monetary] *is to consider the command over real resources the government obtains by issuing additional currency or by being able to impose higher reserve requirements. According to this flow concept, the revenue from seigniorage is equal to the change in the monetary base (non-interest-bearing component).* (Gros 1989, iii our additions in squared brackets)

If a government is in a position to dispose over the money creating capacities of a central bank, it has the opportunity to expand its 'command over real resources' by simply purchasing them with newly created money. As long as we think of commercial bank seigniorage in terms of the creation of new credit money, which is lent into the economy, they do not seem to have the same opportunity. It is, however, possible to deconstruct the distinction between spending and lending by thinking of the interaction between commercial banks and borrowers in terms of a process, where the bank purchases debt in exchange for newly created credit money. From this perspective, the commercial bank does in fact spend new money into the economy by purchasing assets in the form of interest bearing debt. But how does this translate into a flow concept of seigniorage? The money used to purchase the debt is still a liability on the balance sheet of the commercial bank, which may even incur some kind of interest itself.

The usual concern with governments and central banks creating too much money, which is reflected in Friedman's concept of inflation tax as well as Article 123 of the Lisbon Treaty, is that an increase in the supply of money will ultimately lead to inflation and thus a dimin-

ishing purchasing power of the existing money in circulation. In order to conceptualize this concern within the framework of the contemporary institutional separation of the government from the central bank, Rovelli coins the phrase 'excess monetization', which is defined as an:

> [i]*ncrease of the net liabilities of the government with the central bank, in excess of the amount which is required to keep the ratio of those liabilities to GDP constant.* (Rovelli 1994, 39)

This concept accepts the premise that central banks must hold government bonds as part of their portfolio of assets required to conduct monetary policy. Still, Rovelli argues, any increase of the amount of government bonds on the central bank balance sheet in excess of the demands for an expansion of the money supply, which is in turn assumed to be a linear function of GDP, constitutes a transfer of seigniorage to the government. Excess monetization thus constitutes one of the components of total central bank seigniorage and it is mathematically defined as a proportion of GDP as (Rovelli 1994, 31):

$$S = \frac{\Delta B^C - (n+\pi) B^C_{-1}}{Y} \qquad (10)$$

where:

B^C = government liabilities held by the central bank

n = real GDP growth

π = inflation

Y = nominal GDP

The definition basically says that we would normally expect the central bank to monetize government debt at the same rate as nominal GDP growth. Any surplus monetization above this rate is considered to be excessive.

5.2 Excess Financialization

As the power to create new money has now largely been transferred to private commercial banks, we find some commentators expressing a similar concern that these institutions will use this power to expand their 'command over real resources' at the expense of ordinary

money users. One of the most vocal expressions of this concern is found in Hudson's notion of financialization, which was quoted at the beginning of the section (see also Epstein 2001). The debt overhead created by the commercial banking system means that funds that could be used for producing investment and consumption are appropriated in the form of interest payments to the financial sector.

In Friedman, Rovelli, the Lisbon Treaty and much of the conventional literature on seigniorage, all money users in the economy are treated equally as it is assumed that any inflation caused by excessive money creation hits all sectors of the economy in the same way. This is in line with the way that central banks use an average CPI as the target of their monetary policy. The only money user that stands out is the government in so far as it is being privileged by the central bank. However, as we have seen, an empirically realistic model of the economy would separate out money users (non-bank private sector and government) and money creators (banks).

We can operationalize this alternative division following Rovelli's notion of excess monetization. Rovelli makes the assumption that under normal circumstances the central bank's holdings of government liabilities should increase only at the rate of nominal GDP growth. A similar assumption could be made with regards to the banking sectors holdings of the debt of all other sectors of the economy. Under normal circumstances this debt should increase only at the rate of nominal GDP growth. Paraphrasing Rovelli, we may thus define a concept of 'excess financialization' as an:

> *increase of the net liabilities of the non-banking sector with the banking sector, in excess of the amount which is required to keep the ratio of those liabilities to GDP constant.*

The corresponding mathematical definition of excess financialization is thus:

$$S = \frac{\Delta L^{Co} - (n+\pi) L_{-1}^{Co}}{Y} \tag{11}$$

where:

L^{Co}= government and non-bank liabilities held by commercial banks.

Of course the number derived from such a calculation does not constitute a net seigniorage *profit* for the banking sector. It is an expression of the expansion or contraction of the asset base from which the banking sector is able to derive profits. And seen from the perspective of money users it is an expression of the overall indebtedness of the non-banking sectors of the economy. Commercial bank monetary seigniorage is thus a function of this number.

In contrast to the calculation of opportunity cost seigniorage, we have now shifted our focus to the asset side of the commercial bank balance sheet. As we make this shift it does indeed become more difficult to distinguish unequivocally between commercial bank profits derived from money creation and commercial bank profits derived from financial intermediation.

The extent to which banks are able to convert expanding balance sheets into a flow of profits depends on multiple other factors such as interest rates, asset price inflation or deflation, defaults, government subsidies, their ability to charge fees for creating and selling financial assets, the role of securitisation etc. It is outside the scope of this paper to attempt to analyse this data but this should not distract us from the basic point. The extent to which commercial banks are able to expand the asset side of their balance sheet through the creation of credit money beyond the growth of the economy can be considered a measure of excess monetization and a measure of their capacity to extract resources from the real economy. We summarize the continuity between our concept of commercial bank monetary seigniorage and the discussion on seigniorage by paraphrasing the previous quote from Gros:

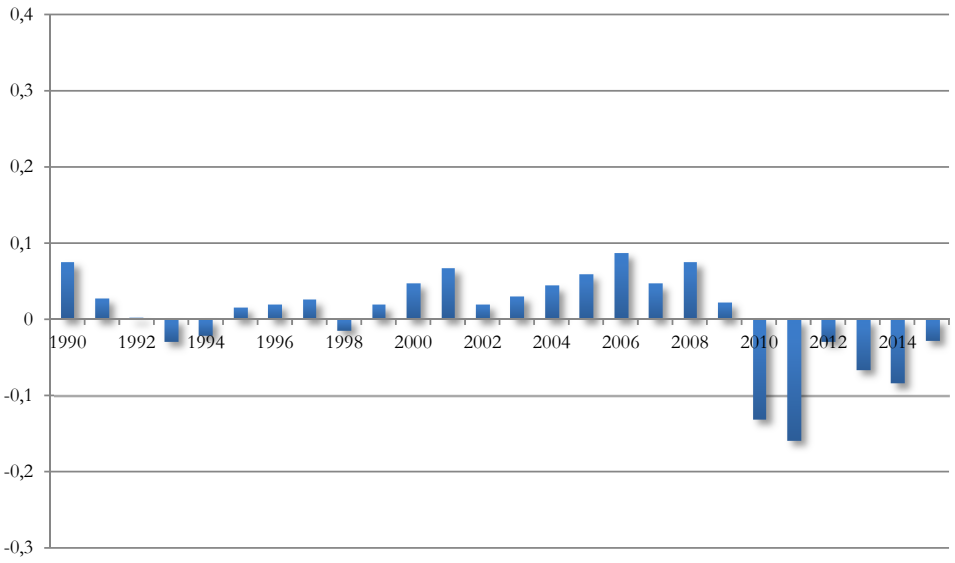
> *Another way to look at seigniorage is to consider the command over real resources the financial sector obtains by issuing additional credit or by being able to impose higher rates of rent and collateral. According to this flow concept, the revenue from seigniorage depends on the change in the total debt* (interest-bearing and collateralized).

5.3 Estimating Excess Financialization

Figures 10 and 11 show the excess financialization estimated from equation (11) for Denmark and the UK. The figures show how much the money supply increased in excess of nominal GDP growth during particular years. We see that especially during the years imme-

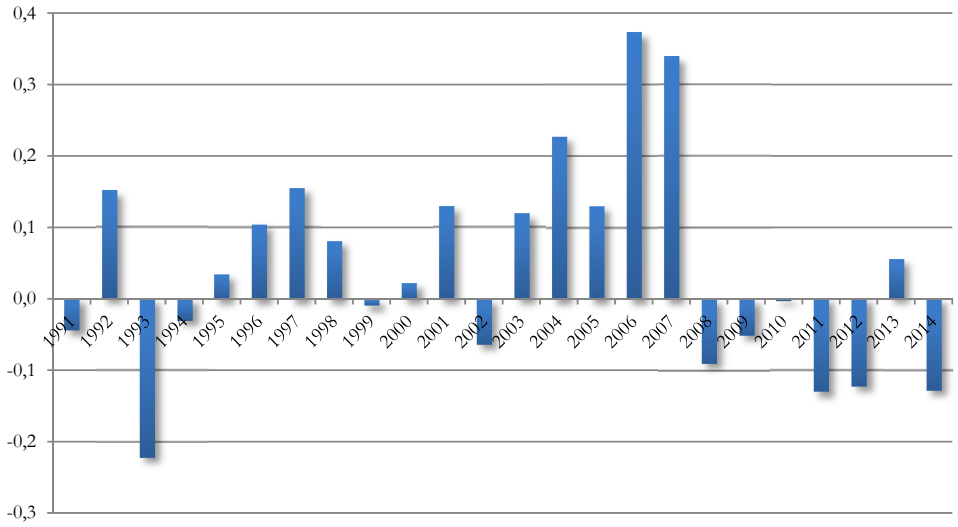
diately leading up to the financial crisis, the banks created money in excess of GDPgrowth. In 2007 and 2008 the excess monetization in Denmark amounted to 0.36 % of GDP and during the whole period 2001 – 2008 there was a total excess monetization of 0.12 % of GDP. This excess monetization mainly reflects a very large mortgage credit to GDP ratio. It constitutes a significant potential for accruing seigniorage for the private banks if interest rates were to rise, depending on the proportion of mortgage holders with fixed or variable rate mortgages.

Figure 10: UK excess monetization by commercial banks (% in excess of nominal GDP)



Source: Bank of England M4 Lending (until 1998) and M4LxOFC post 1998 and ONS code YBHA

Figure 11: Denmark - excess monetization by commercial banks (% in excess of nominal GDP)



Source: Danish statistics, table Tabel: DNBAL4

In the UK, excess monetization is smaller, averaging around 0.05% since 1990, although again increasing in the run up to the financial crisis. Post-crisis there was a large deleveraging in 2010 and 2011 and on-going negative excess monetization, potentially acting as a drag on the economy. Although there is an argument to saying that a significant deleveraging was required in the financial and mortgage lending sectors, non-financial business lending also contracted for most of the post-crisis period, only recovering in 2015.

Conclusion

In this paper we have set out a new conceptual framework for understanding seigniorage in modern economies, where commercial banks are the primary creators of money. We have established four different forms of seigniorage:

1) Monetary central bank seigniorage, whereby the state and central bank are subsumed together and are able to spend newly created money directly into the economy, resulting in profits deriving from the direct new purchasing power gained and potential 'inflation tax' for all other money users. Such a concept of seigniorage, with its roots in the commodity theory of money, has less relevance today given the separation of the state from the central bank and prohibition on monetary financing by the central bank in the EU and other advanced economies.

2) Opportunity cost central bank seigniorage, which recognises the independence of the central bank from the state and Treasury and represents the profits the central bank generates from the fact that commercial banks and non-bank money users must hold a proportion of low or zero interest central bank assets as opposed to assets yielding income at market interest rates.

3) Commercial bank opportunity cost seigniorage, which recognises that in modern economies the vast majority of money is created as the liabilities of commercial banks as they create credit for the non-bank private sector as well as the government. Commercial bank opportunity cost seigniorage can be calculated as the difference between the interest money users pay on their deposits and a market benchmark interest rate that is a proxy of the interest the bank would have had to pay, if deposits were not simultaneously liquid money.

4) Commercial bank monetary seigniorage, which recognises that the power of commercial banks to expand the asset side of their balance sheets, beyond that required to maintain a constant ratio to GDP, may lead to the appropriation of resources from the real economy.

Commercial bank opportunity cost seigniorage for two countries with sovereign currencies and central banks, Denmark and the UK, was calculated. We found that in the UK commercial bank seigniorage made up between 1% and 3% of GDP over the last quarter decade, whilst in Denmark the figure was lower, varying between 0.2% and 1%. We found that seigniorage profits make up a significant element of banks' profits during the period under investigation, suggesting such profits are integral to commercial banks business models. We noted that such seigniorage profits have been falling as interest rates have been lowered post-the financial crisis. In an era of low or negative interest rates and high public and private sector to GDP debt levels, we hope the evidence presented in this paper may help inform policy makers as they consider how best to design and implement monetary policy and financial sector regulation.

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