WORKING PAPER 2111

Bank Seigniorage in a Monetary Production Economy

Biagio Bossone

August 2021

POST-KEYNESIAN ECONOMICS SOCIETY

BANK SEIGNIORAGE IN A MONETARY PRODUCTION ECONOMY

BIAGIO BOSSONE

E-mail: BBossone@WorldBank.org and Biagio.Bossone@Gmail.com

ABSTRACT

This article speaks to post-Keynesian economists and their fundamental vision of monetary production economies. It focuses on the role of commercial banks as creators of money in monetary production economies and studies the rent-extraction power of banks in the form of "seigniorage." The article examines how the relative size of banks in the payment system combines with their capacity to determine quantities and prices in the market for demand deposits and gives them the power to extract seigniorage from the economy; it clarifies the distinction between seigniorage originating from commercial bank money creation and profits derived from pure financial intermediation; and analyzes how seigniorage affects the economy's price level and resource distribution. The article draws political-economy and economic-policy implications.

JEL Codes: E19, E20, E31, E40, E52, E58, E62, G21.

Key Words: Commercial banks; Interest rate; Money creation; Prices; Resource distribution; Seigniorage.

Rome, 16 July 2021

BANK SEIGNIORAGE IN A MONETARY PRODUCTION ECONOMY[1]

1. INTRODUCTION

Drawing on my recent work on commercial bank money creation,[2] this article speaks to Post-Keynesian economists and their fundamental vision of monetary production economies. In such economies, commercial banks create and advance money to firms, which use it to pay money wages to workers, who supply labor services to produce commodities for market sales.[3] As firms sell the produced commodities in the markets, they recover the money needed to repay their debt to the banks.

Now, when money is created by fiat – as commercial banks do[4] – at a cost that is lower than its value and when is lent out or sold in exchange for real resources, a special type of rent – seigniorage – is extracted from the economy by the money creators. This is the unique power that money creators hold and exercise, in that they can generate exchange value through which they can exert a degree of command over real resources beyond what they have contributed to produce. This degree of command consists of claims on goods, services, or assets (if the money is sold) or claims on future streams of interest income (if the money is lent), which do not reward any abstention from present consumption or sacrifice of liquidity by the money creators.

[1] I am grateful to the several readers of the previous versions of this article, too many to mention. I wish in particular to thank those who offered more extensive and critical comments, including Massimo Costa, Stefano Caringi, and the anonymous reviewers of the *International Review of Financial Analysis*, whose tough criticism and constructive suggestions have helped me significantly to improve the contents developed in the article first published there, and which constitute the basis for this new one. I am also grateful to the anonymous referee of the PKES Working Papers for the suggestions on the post-Keynesian literature relevant to this article. Finally, my most heartfelt gratitude goes to my wife Ornella for her unremitting support. Obviously, I am the only responsible for the opinions expressed in the article and for any remaining errors.

[2] See Bossone (2020, 2021).

[3] See Graziani (2003) but also references in Section 2).

[4] *Commercial* banks (henceforth also referred to simply as "banks") are here and throughout the text defined as institutions that accept demand deposits from the public *and* lend money to borrowers by issuing demand deposit claims to them, that is, claims that give their owners the right to convert them in cash or to transfer them to third parties either for settling payment obligations or for value transferring purposes.

Etymologically understood as the "right of the lord to mint money,"[5] *seigniorage* has historically been related to governments (the *sovereigns*), which over the ages have appropriated real resources through the monopoly of coinage (Buiter, 2007). Seigniorage is, thus, a form of tax that governments extract from the economy by virtue of their power to issue money and implies a net transfer of resources from the real economy (firms and households) to government.

In contemporary (monetary production) economies, the monopoly of the issue of legal tender is typically assigned to an agency – the central bank – which may operate under varying degrees of independence or autonomy from government. More specifically, the legal tender issued by central bank usually consists of banknotes and excludes the coins, which continue to be issued by the government's treasury. The seigniorage extracted from the creation of such money, thus, accrues to the money issuing central bank, which returns it to government after recovering its own operating costs and assuring itself a profit.

Seigniorage, therefore, is inherently associated with the power to create money, quite irrespective of whoever exercises it. In fact, the central bank may even be a private-sector institution entrusted by law with the pursuance of specific public interests. The transfer of money creation power (by explicit legal provisions or tacitly as a by-product of specific regulations) is of critical importance, as it is today recognized that the largest fraction of the money used in transactions is created by commercial banks. Shouldn't this imply that commercial banks, as money creators, extract seigniorage from the economy? How does that seigniorage originate, and how is it extracted? Does seigniorage affect the economy's price level and resource distribution? And what are the related economic policy implications?

[5] According to the Oxford Dictionary, the word is a late middle English one deriving from old French "seigneur," a feudal lord (the lord of a manor).

This article is about the role of commercial banks as money creators, and specifically about their rent extraction power in the form of seigniorage (Box 1).

BOX 1. SEIGNIORAGE: DOES IT APPLY TO BANKS?

As seigniorage has always been discussed in the context of governments and central banks, some reviewers of previous versions of this article have found somewhat disconcerting the use of this concept in association with private-sector entities such as commercial banks. This is because – I presume – money creation has always been thought of as a state prerogative and because banks have always mostly been considered as pure intermediaries of existing resources, especially by mainstream economics theory (see Section 2). While this understanding is finally changing across the economics community, including mainstream, which now growingly recognizes the money creation power of banks, legacy still creates reservations to the idea of associating seigniorage to commercial banks.

Such reservations should be resolved by considering that seigniorage relates to a function (money creation) rather than the legal nature of the entity carrying it out: it is inherently associated to the power to create money, not to the identify of whom exercises the power do so. True, commercial banks are not entirely autonomous in creating money: their deposit liabilities, once created, need to be backed by the liabilities of another entity (the central bank, or any similarly dedicated stage agency, or one or more of their peers in their absence), as discussed at length in Section 4, which allow them both to settle their mutual payment obligations through a mutually acceptable asset and to honor cash-out demands from deposit holders. Yet, this backing function needs to be only partial (in fractional reserve regimes), and this is precisely where commercial bank seigniorage originates from, as analytically explained below. In fact, in the (hypothetical) limiting case of only one bank in a cash-less economy, no third-party liabilities would be necessary for the above purposes and the bank would extract seigniorage from its money creation functions no more nor less than a central bank does. True: no economy features a single bank, and not all banks in an economy share an equal money creation power, since the latter is a function of each bank's relative payments market share (see Section 3), and obviously any use of reserves would diminish seigniorage; but none of this would eliminate it, in so far money is created that is not fully backed with reserves.

It also argued that no seigniorage occurs, because the bank money creation process is different from the process of money issuance by the "Lord" (the seigneur engaging in minting money), as banks do not mint money and also do not print money. Well, in fact, today banks (as well a growing range of nonbank entities) "print" or "mint" money electronically much the same way as any central bank does. It is not just that the Lord extracts seigniorage because he has the power to create money; whoever is given or acquires and holds the power to create money (that is accepted in the economy) extracts seigniorage from the economy: he so then acts like a Lord, or becomes a Lord, or is perceived to be a Lord…

Another argument against seigniorage in banking is that the banks' power to extract it is limited compared to governments, since banks do not share a similar capacity to expand their balance sheet. While this may be true for individual banks, one should only notice that US banks held more reserve balances at the Fed in 1951 than at the end of June 2008, and yet, payments executed by banks have since gone up 10,000 times! Thus, while there is no correlation whatsoever (in fact, there has even been a negative correlation throughout the period observed) between changes in central bank reserves and the economy's nominal variables (e.g., GDP or the value of transactions), the correlation is very strong between commercial bank money creation and the associated transactions (payments) funded with commercial bank money. Is it thus really true that commercial banks (at least taken as an aggregate) cannot grow their balance sheet and have such a limited seigniorage power vis-a-vis governments?

As Box 1 submits, there seem to be good reasons to argue that talking about "seigniorage" in association with commercial banks' money creation is justifiable. Against this background, this

article explores the theory behind commercial bank seigniorage in a monetary production economy and evaluates its implications.

The article is organized as follows: Section 2 reviews the existing literature on the subject; Section 3 discusses how commercial banks extract seigniorage from the economy through money creation; Section 4 analyzes the economics of commercial bank seigniorage: it identifies the determinants of seigniorage, it shows how seigniorage from money creation differs from the profit derived from pure financial intermediation, and it analyzes the relationship between commercial bank seigniorage and payment settlement rules. Section 5 shows how the equilibrium price level is determined in a three-sector economy (with banks, firms, and workers) when commercial banks extract seigniorage and studies the impact of seigniorage on resource distribution across the three sectors; the section also draws preliminary political-economy implication; and Section 7 discusses policies to eliminate or redistribute seigniorage. Section 8 closes the article.

2. REVIEW OF THE LITERATURE

Thus far, the power of commercial banks to extract seigniorage from the economy, and the impact of seigniorage extraction on the economy's price level and resource distribution, have not received attention from research, although the power of banks to create money has long been recognized by important scholars (and has today been almost widely accepted even by mainstream economists). The history of banks and money creation is reconstructed by Werner (2014, 2016) and Morelli (2018), and is reported in my recent work on the topic, where a new understanding of the banks' money creation process is developed, which integrates the role that payment and settlement systems play in shaping the process (Bossone, 2020). This new understanding is explored in Section 3.

Commercial bank money creation is a tenet of the post-Keynesian school since at least the 1970s (e.g., Moore 1979, 1983), and is one of the founding elements of the circuit theory of money, which studies the role of money in monetary production economies with historical time (Realfonzo, 2012). The literature on the circuit theory of money is too vast for trying to provide here a list of references

that would do justice to the many contributors to this brand of non-mainstream monetary economics. One contribution that offers a good illustration of the theory's fundamentals is by Augusto Graziani (cit.), one of the theory originators and most inspiring "circuitist." Another excellent reference is Rossi and Rochon (2003).

The links between bank credit creation, the macroeconomy and asset prices have been analyzed by Werner (1997) under the Quantity Theory of Credit. Today, the view is acknowledged even in the mainstream camp, as evidenced by the contributions of the Bank of England's McLeay et al. (2014a, b) and Jakab and Kumhof (2015). In fact, the practice with money may have induced central bankers to gain an earlier and better appreciation than many academics of the role of commercial banks in the money creation process of contemporary economies.[6]

Yet, none of the contributions that support the role of banks as money creators consider the seigniorage associated with it. Early references on the origin of commercial bank seigniorage are in Baltensperger and Jordan (1997) and Bossone (2000, 2001a[7]), and empirical work on commercial bank seigniorage was done by Cardoso (2003), Arby (2006), Soldatos and Varelas (2015), and recently Bjerg et al. (2017) and Macfarlane et al. (2017). A conceptual and applied analysis of seigniorage from the issuance of various forms of money (cash and banknotes, central bank reserves, and commercial bank money) is provided under the newly proposed "Accounting View of Money" recently contributed by Bossone et al. (2018) and further developed in Bossone and Costa (2021).

This article's emphasis on commercial bank seigniorage as a cost element for the economy bears resemblances with the literature on the "cost channel" of monetary policy initiated by Barth and Ramey (2001), and further explored by Ravenna and Walsh (2006), Christiano et al. (2005), and

[6] In a post titled *Central Bankers: 'We're all Post-Keynesians now'*, Jesse Frederik suggests that central bankers may have grasped the reality of commercial bank money creation somewhat earlier than academics. See also the related post *Who is right? Krugman or Keen or / and 9 Central Bank economists?*.

[7] Also reprinted in Rossi and Rochon (2017).

Gaiotti and Secchi (2006), on the impact of nominal interest rates on the firms' marginal cost of production and the related implications for optimal monetary policy. Similarly, this article's predicted effect of seigniorage on inflation through the interest rate echoes the recent Neo-Fisherian proposition by, most prominent among others, Bullard (2015), Cochrane (2015), and Williamson (2016). However, neither strand of research investigates any rent component of the interest rate associated with commercial bank money creation. In fact, no other research contributions were found to have considered the impact of commercial bank seigniorage on the economy's price level and resource distribution, except for Bjerg et al. (cit.) and Bossone et al. (2018) which estimate the relative size of seigniorage in select economies. Finally, using a neoclassical production function under different assumptions on price and wage behavior, Bossone (2021) is the first to analyze the impact of commercial bank seigniorage on aggregate output.

As regards post-Keynesian contributions to the issues analyzed in this article, the following deserve mentioning. Onaran et al. (2011) and Kohler et al. (2019) have investigate the adverse effects of the increasing power of banks on economic performance and the distribution of income analyzed in Section 5, and Dallery and Van Treeck (2011 as well as Rochon and Setterfield (2012) have used a conflicting claims approach to inflation, which is similar to the model developed in the same section but (unlike the latter) does not recognize the equilibrating role that prices play to redistribute output to banks as seigniorage. Moreover, Lima and Setterfield (2010), Argitis and Dafermos (2013), and more recently Gouzoulis (2021) have analyzed the positive effects of interest rates on price and wage inflation along similar lines with the cost channel of monetary policy discussed in Section 6, and Kregel (2012) and Fontana and Sawyer (2016) have critically evaluated the proposals for narrow banking discussed in the same section.

3. COMMERCIAL BANK MONEY AND SEIGNIORAGE

A. Commercial Bank Money Creation

Commercial banks create the money they lend in the form of newly issued demand deposit claims.[8] They create such claims by crediting borrowers' accounts with balances loaned to them; by such an act of creation, new liabilities and assets are simultaneously recorded on the bank's balance sheet. More generally, banks create money not only when they lend but also when they sell deposits, for instance, in securities (re-)purchasing operations or against the purchase of obligations or foreign currencies. Money creation via lending is unique to commercial banking, in as much as commercial banks only are allowed by regulation to i) hold customers' demand deposits *and* issue loans to customers in the form of demand deposits and ii) carry both operations through customer accounts held in their own books. On the other hand, these features are not shared by pure financial intermediaries, which may a) intermediate only pre-existing funds and b) perform lending functions only by ordering fund transfers to take place across accounts held with commercial banks (Box 2).

BOX 2. LENDING OPERATIONS: BANKS VS. NONBANK FINANCIAL INTERMEDIARIES

When a nonbank financial intermediary intermediates funds, say, by accepting funds from savers against the issuance of term deposits or securities and by on-lending such funds as, say, mortgages to homebuyers, the intermediary typically receives the funds in an account that it holds with a bank and transfers those funds from that account to the bank accounts of the homebuyers.

In such a case of pure financial intermediation, there is no money creation and the funds on-lent to the homebuyers are the same funds that were originally saved by the intermediary's customers. As said, both the intermediary and its borrowers hold deposit accounts with banks and all fund transfers in the example (i.e., from the savers to the intermediary, and from the intermediary to the homebuyers) take place across deposit accounts held with banks.

The crucial difference between banks and pure financial intermediaries, as explained by Werner (2014) and as discussed above, is that only banks (not the intermediaries) may – by regulation – credit their borrowers' bank deposit accounts with newly issued deposit claims. It is this special account structure, permitted by regulation, that confers on the banks the power to "create" money by allowing them to originate new assets (loans) and equivalent new liabilities (deposits).

Thus, money creation by lending is unique to banking, in as much as banks only are allowed by regulation to i) hold customers' demand deposit liabilities and issue loans to customers in the form of demand deposit claims and ii) carry both operations through customer accounts held in their own books. On the other hand, these features are not shared by pure financial intermediaries, which may a) intermediate only pre-existing

[8] Werner (cit.) offers a very detailed reconstruction of the accounting process underpinning commercial bank money creation.

funds and b) perform lending functions only by ordering fund transfers to take place across accounts held with banks. Unlike banks, pure intermediaries may not, and cannot, create money by issuing new deposit liabilities and originating corresponding loan assets. The implications of all this for rent extraction (seigniorage) by banks are analyzed in the following section.

As noted and empirically tested by Werner in several contributions,[9] and as emphasized by Borio and Disyatat (2011), the distinction between lending claims on pre-existing real resources (savings) by financial intermediaries, on one side, and lending claims on not yet created real resources, on the other, is possible only when *monetary* factors are considered. In *non-monetary* (real) models, investments can only be carried out by transferring pre-existing real resources from saving units to investment units: pre-existing savings (or endowments) are necessary to carry out investment and when financial intermediaries are present, they perform no other functions than allocating purchasing power that already exists in the economy and is backed by output already produced. In a monetary economy, on the other hand, some special intermediaries – commercial banks – do create additional purchasing power in the form of deposit claims issued through the act of extending credit to facilitate production of output yet to come.

Thus, while savings set a limit on lending when this is done by pure financial intermediaries, commercial bank lending is not constrained by savings (although it is constrained by other critical factors, as discussed below), since banks create the claims to be loaned. This is where seigniorage originates from, as for any money creation process, in a way that is equivalent or very similar to the seigniorage extracted by the sovereign when issuing sovereign fiat money.

B. Commercial Bank Seigniorage

Seigniorage is, by definition, a rent. As bank money creation by lending requires the use of inputs, seigniorage is any revenue accruing to the money creator in excess of the competitive remuneration

[9] See Werner (1997, 2005, 2011, 2012, and 2013).

of the inputs used, including the money creator's "normal" profit, or broadly speaking the minimum amount of earnings needed to justify the money creation business.

Now, since this article does not attempt to estimate commercial bank seigniorage in real-world economies, it does not make any attempt to empirically determine what normal profits should be for banks in any given economy. It only juxtaposes the concept of normal profit to seigniorage to signal that not all bank profits should be understood as seigniorage. As banks add value to the economy by creating money, the normal (i.e., zero excess) profit they earn on their loans remunerates the value added they contribute to the economy and, thus, no seigniorage is involved.

Banks do add value to the economy by creating and allocating money, through lending, as a "public good" that is needed to finance economic activities. Much as issuing fiat money (instead of commodity money) affords greater elasticity to the economy, adopting a decentralized (versus centralized) money supply system based on commercial bank lending affords even greater elasticity to the economy. In both cases, the greater elasticity translates into a more flexible and convenient accommodation of the money supply to its dispersed demand than if the money supply were determined exogenously and centrally managed. Yet, one could conceive of decentralized money supply regimes where the provision of money is separated from lending and seigniorage is thereby socialized, that is, redistributed to society (Bossone and Sarr, 2002 and 2003).

As regards the determination of "normal" profit in an economy, one could neoclassically expect that, in the absence of frictions and as competition increases in the banking sector, bank profits (net of risk reward) tend to gravitate around zero-excess profits.; or one could take a Sraffian perspective and consider that a uniform (net of risk) rate of profit attains across all sectors as an inherent technical feature of the economy, assuming the latter is unperturbed by exogenous impositions on prices (Sinha and Dupertuis, 2009).

As shown below, while competition in the banking sector reduces seigniorage, the latter does not strictly depend on banks exercising monopolistic power in the loan market and/or monopsonistic

power in the deposits market, but on the efficiencies that banks attain in funding their payments activity. Seigniorage from money creation differs from rents extracted through the intermediation of pre-existing resources, and while seigniorage (as any forms of rent) relates to the existence of (quasi) monopolistic power, it is not the same as rent from monopoly: the latter derives from the exclusive control that a monopolist exercises over the selling price of a scarce or irreproducible resource (or a monopsonist exercises over the purchasing price of a production factor). Seigniorage, on the other hand, derives from the money creator's power to generate exchange value in excess of the cost to produce and distribute it, where such cost declines (all else being equal) with its share of the payments market (Section 3.C).

This power does require exclusivity, as (quasi) monopoly or monopsony does; but it is the exclusivity of generating *new* exchange value, not of controlling the supply of, or access to, a *pre-existing* resource. In the case of commercial banks, exclusivity refers to a class of legal entities and to each of these entities vis-à-vis other intermediaries, which are granted regulatory permission to issue demand deposit claims that are accepted as money by the public, provided they fulfill certain regulatory requirements.[10] It will be discussed later how the power of extracting seigniorage varies across individual banks. Obviously, a bank may exploit its monopolistic/monopsonistic position to expand seigniorage, and the two effects would compound each other (see Section 4).

C. Commercial Bank Money, Seigniorage, and Payments

When banks create money by lending, they neither need deposits or central bank reserves to do so.[11] By crediting borrowers' accounts with new deposit claims, they simultaneously create new liabilities and new assets on their balance sheet and need nothing else do so. However, once money has been created, banks need to avail themselves of the resources required (either by interbank conventions,

[10] Werner (2014) identifies the accounting contrivance that allows banks to create money, unlike other financial intermediaries (see Box 2).

[11] See Bossone (2000, 2001a) and the empirical work by Werner (2014).

payment system rules, or central bank regulation) to settle the obligations that originate when the loans are mobilized by borrowers to make payments. Lacking such resources, and being unable to raise them through appropriate channels, causes banks to default on their obligations and to incur related costs and penalties. The ability to raise resources implies costs that banks need to consider when determining the financial viability of their lending activity.

Indeed, contemporary large-value payment systems in most jurisdictions across the world require that settlement takes place in central bank money, since this is the safest and most liquid asset that an economy can use to settle transactions (CPSS-IOSCO, 2012). [12] The other key reason for so requiring is that, as long as banks must use reserve balances to pay each other, the central bank can set the marginal price of reserves, thus determining the opportunity cost for banks to lend funds to each other and thereby influencing interest rates in the money markets and further on across all assets markets.

Notice that if the central bank requires payments to be settled with reserves, and if deposit liabilities are not required to be fully backed with reserves, commercial banks always hold only a *fractional* amount of reserve balances for settlement purposes vis-à-vis their deposit liabilities (since reserves are costly). This occurs even if no specific reserve ratio is legally imposed on the banks and if the latter are thus free to determine the fraction of liabilities to be backed with reserves. In this sense, even for systems where banks are not required to hold specific reserve ratios (e.g., New Zealand, United Kingdom), or where banks are required to hold zero reserves at the end of the operating day

[12] Notice that the principle of settling obligations using a liquid and safe asset has been adopted by payment systems even before central banks were created and is adopted today in payment systems where the use of central bank reserves is not a feasible option. Where this is the case, settlement happens using the liability issued by one of the participating banks, typically the one bank that is most highly reputed, financially solid, and sufficiently large, which acts as a central institution providing clearinghouse and settlement services to all other banks participating in the system. All these other banks must hold enough balances of such liability for them to be able to fulfill their settlement obligations in due time. Loans may be extended by the central institution to participants that need liquidity to complete settlement, but eventually all such loans must be retired and settled in the liability issued by the central institution and which no other bank can issue (as it would not be acceptable to the others as settlement asset). This solution was the norm in the clearinghouse arrangements adopted in the US and UK in the past centuries (Norman et al. 2011), and it is still the case today for a number of payment systems especially for cross-border transactions (CPSS, 2013).

(e.g., Canada), one can talk of "fractional" reserve regimes, where the optimal fraction of reserves held voluntarily by banks against their deposit liabilities is greater than zero and less than 100%. Terminology aside, this is how banks operate in most jurisdictions worldwide: for settlement purposes, they all express a positive net demand for central bank reserves, as a ratio of their deposit liabilities. Their demand for reserves consists of:

i. Cash reserves and reserves deposited with the central bank (held in response to regulatory requirements, for payment and cash-out purposes, or as part of general pool of liquid resources)
ii. Reserves from settlement of incoming payments or transfers from other banks
iii. Borrowings from the interbank market
iv. Borrowings from the central bank
v. Unencumbered assets in the balance sheet that can be liquidated immediately, and
vi. New deposits of cash from (old and new) customers (new noncash deposits may consist only of deposits transferred from other banks, which as such fall under item ii).

Thus, while banks may in principle create all the money the economy is willing to absorb, and extract the associated seigniorage, in practice their money creation power is constrained by their ability to raise the required funding and the cost of doing so (or, said differently, their ability to support the payments activity associated with their money creation). True, reserves are not a binding constraint on lending in so far as central banks do not choose to determine a specific level of reserves and set, instead, a policy interest rate at which they stand ready to supply all the reserves that banks demand (Box 3). However, the interest rate is a cost factor that banks need to consider when determining the viability of their lending activity. In addition, banks do not have an infinitely elastic capacity to acquire reserves at a given rate, even if lending were profitable at that rate.

BOX 3. BANK MONEY, CENTRAL BANK RESERVES AND SEIGNIORAGE

Banks always need to hold adequate reserves to settle payments (BIS, 2013), and if they don't have enough of them (since reserves may be inadequate in the aggregate, or they may be adequate in the aggregate but inadequately distributed across banks), they have to borrow them. Banks normally attract reserves every day by receiving payments from other banks, which they need in order to settle their own payments in turn. Should they (hypothetically) not receive incoming payments, they would run out of reserve balances very soon, given the huge disproportion of reserve holdings vs. the value of payment settlements.

True, surplus banks may lend their reserve surpluses to deficit banks and thus allow them to settle. Yet, the latter will have to come up with extra reserves so as to pay their debts to the surplus banks and continue to operate. And if surplus banks were unwilling to lend, or if the total stock of reserves were inadequate vis-à-

vis the extant settlement obligations, the central bank must be there to provide the extra reserves needed. Finally, if the central bank were (hypothetically) to deny the supply of extra reserves, the payments system would come to a gridlock, with potentially systemic consequences. As explained in this article, since banks are in the business of extending loans, they must always pay attention to the availability and cost of reserves, if they want to keep their business sustainable.

Yet, for the banks operating in many advanced economies the world of reserves management has changed since the global financial crisis, as central banks have responded to the crisis with ultra-accommodative monetary policy programs. The increase in the supply of reserves that followed those programs has confronted the same central banks with a new sensitive issue: how to compensate banks for the loss of seigniorage deriving from both the larger reserve holdings to which they would be forced under the programs, on one side, and the low demand for loans from the economy due to the crisis, on the other.

In the U.S., the Federal Reserve (FED) started paying interest on reserves (IOR). As the FED explained, the purpose was to inject more money into the economy without lowering the federal funds rate below target (Sumner, 2019). But behind the scenes the seigniorage story is evident, and the IOR has since been fiscal policy in disguise: an outright subsidy to the banks whereby the FED transfers part of its own seigniorage to the banks in order to support their balance sheet. This is eventually at the expense of the U.S. Treasury, which is the ultimate beneficiary of the FED's seigniorage revenue (Haslag, 1998).

The same was not done in Europe and Japan, where even negative interest rates (NIR) were applied on bank reserves, under the expectation that the contraction of seigniorage would push banks to recover it by increasing lending to the economy. In fact, NIR acted as an extra tax on the European banks and two-tier systems for reserve remuneration were eventually introduced to reduce the NIR impact on their seigniorage (Tötterman, 2019).

The capacity of each bank to raise funding (reserves) is constrained by two scale factors: i) the size of the bank itself, as proxied by its share of the payment market(s) where it operates, and ii) the bank's level of capital (i.e., equity plus accumulated reserves). The share of the payment market(s) reflects the bank's capacity to receive funding though incoming payments from other banks, which should on balance be adequate for settling outgoing payments. The level of capital, on the other hand, reflects (all else being equal) the bank's capacity to access (borrow) external funding to ensure settlement of its obligations under adverse contingencies, such as temporary liquidity shortages.

On the other hand, four factors allow banks to economize on the use (and cost) of reserves (funding):

a. ***The economy's desire to hold commercial bank deposits that pay less interest than bonds.*** Such preference, noted by Baltensperger and Jordan (1997), is due to the "moneyness" of demand deposits, as supported by the whole complex of institutional, technical and policy solutions that support public trust in their use as money (which includes inter alia payment infrastructures, banking supervision, central bank liquidity support, deposit insurance, etc.). This factor allows banks to save on the cost of funding relative to non-bank financial intermediaries.
b. ***The payments market share of each individual banks.*** In a fractional reserve regime banks hold only a fraction of reserves against their total deposit liabilities out of which payments take place.

Similarly, the volume of reserves they use for settling interbank obligations and for cash withdrawal from customers are only a fraction of the total transactions settled. Economies of scale related to the share of the payments market captured by a bank allows the bank to economize on the use of reserves. Such economies specifically relate to i) the share of total payment transactions that a bank intermediates: the larger the share of incoming payments (and, hence, of settlement reserves received) the bank receives from the others, the less it needs to raise and hold reserves to settle outgoing payments, and ii) the number of depositors: this allows the bank to settle a larger share of payments in its own books ("on us" payments), to expand its sources of reserves through incoming transfers and payment, and to benefit from asynchronous withdrawals of deposits from depositors. Consolidation generates increasing returns for banks, enabling them to create liabilities (by lending or selling deposits) with decreasing reserve margins needed for coverage. Thus, the larger the payments market share of a bank, the higher the seigniorage the bank can extract from deposit creation. More broadly, all else being equal, the larger the economies of scale a bank exploits in the use of settlement money, the higher its seigniorage power. Economies of scale in the use of reserves combine with scale economies in bank production, which empirical research show to be significant.[13]

c. ***The market power of each bank*.** If free entry were allowed into commercial banking, seigniorage would be reduced accordingly, as banks would compete on the asset and liability side of their balance sheet until their extra profits would vanish. In fact, policy regulations restrict the number of bank entries into the market, with a view to ensuring their soundness and preserving their franchise.[14] Commercial banks do extract seigniorage because of such regulatory restrictions. All else equal, seigniorage is higher in more consolidated banking systems where banks exercise their quasi-monopolistic and monopsonistic power and extract larger rents through higher interest rate margins. Also, while public regulations limit market entry, they also usually seek to promote competition within the banking sector and to prevent, where feasible, their domestic banking market from becoming dominated by a single or few entities.As Section 4.B shows, for any given degree of monopolistic/monopsonistic power, commercial banks can extract extra profits (seigniorage) owing to the exclusive power they have (vis-à-vis any other financial

[13] See Anolli et al. (2015) and Wheelock and Wilson (2015), and the ample literature therein referred, which show that banks (especially large ones) operate under increasing returns to scale in production. Also, value-maximizing financial intermediaries benefit from "systemic scale economies" effects, whereby intermediaries operating in large systems are expected to have lower costs of production, risk absorption, and reputation signaling than intermediaries operating in small systems (Bossone and Lee, 2004).

[14] Hellmann et al. (2000) argue that regulation must ensure the rent-extraction capacity of commercial banks.

intermediaries) to create money by fiat. One way of setting apart the effects of a bank's economies of scale and market power over seigniorage is to consider that the former affect quantities (i.e., by expanding the bank's power to create money while economizing on reserves) while the latter works through prices (by enabling the bank to increase the loan-deposit interest rate spread). The two effects are necessarily intertwined, however, and seigniorage is whatever extra rents are associated with the money creation function.

d. ***Rules and technologies for payment settlement.*** While the payments market share of individual banks affects, as discussed above, each bank's optimal demand for reserves at the margin, the rules and technologies for settling payments determine the structural demand for reserves of the whole system. Payment system rules determine such demand via two channels: the settlement modality (typically netting or gross) and the technology adopted for transferring value at settlement. As shown in Section 4.A, each of the two modalities has a drastically different effect on the system's demand for reserves, with netting requiring much less reserves than the gross modality (at the cost of higher settlement risk). Similarly, by re-introducing elements of netting into the gross modality, modern technologies (such as liquidity-saving mechanisms in hybrid real-time gross settlement systems) do increase the velocity of reserves circulation in the payments system and allow banks to economize on the use of reserves for any given volume and value of payments to be settled. Both factors interact with payment system scale economies,[15] and affect the overall level of seigniorage that commercial banks extracts from the economy.

As an exemplification of the above factors (summarized in Chart 1), take the hypothetical case of a cashless economy with a fully consolidated banking system where all agents hold accounts with only one bank. In this case, all payments and money transfers would be "on us" for the single bank. The bank would need no reserves for settling transactions, it would be under no debt obligation towards its customers, and it might in fact create all the money the economy would be willing to absorb at a given interest rate without having to hold (costly) reserves. The single bank's deposit liabilities would become the accepted instrument to settle debts within the economy and would de facto be irredeemable, much as legal tender is in any economy. On the contrary, in the opposite extreme case of an atomistic banking sector (with zero-dimensional banks) every single bank could still issue new deposits as loans to borrowers; yet, they would have to cover all new deposits with central bank reserves and their profits from lending would be normal. With atomistic banks, the fractional reserve

[15] Significant scale economies in payment systems are found by Beijnen and Bolt (2007) and Humphrey (2009).

regime would de facto be equivalent to a regime where the fraction is 100% and every deposit unit must be backed by a unit of central bank reserves.

CHART 1. DETERMINANTS OF COMMERCIAL BANK SEIGNIORAGE

Determining Factors	Effects	Impact on Seigniorage
Agents' preference for using demand deposits as money	Stronger preference lowers cost of issuing deposit liabilities	Seigniorage increases due to • higher profit margin
Payments market share of each bank	A larger share: • increases the bank's balance sheet • increases the share of payments settled on the bank's books ("on us")	Seigniorage increases due to • bank's higher profit base (Section 4.A & 4.B) • bank's lower optimal reserves for payments settlement Section 4.C)
Market power of each bank	Stronger market power increases the loan interest rate and decreases the deposit interest rate	Seigniorage increases due to • higher interest rate margin
Settlement rules and technologies	Use of deferred net settlement (DNS) or adoption of liquidity-saving mechanisms in real-time gross settlement (RTGS) decreases banks' demand for settlement reserves	Seigniorage increases due to • lower cost of liabilities management (Section 4.C)

Obviously, in the real world, systems are populated by a plurality of banks. Yet, in a highly consolidated system, the largest banks (and the system as a whole) feature significant economies of scale in reserves use and can thus extract the extra seigniorage that such economies make possible vis-à-vis less consolidated systems. Consolidation increases seigniorage not (only) because it grants the consolidated banking institutions higher quasi-monopolistic and monopsonistic powers – over loans, deposits, and their prices (interest rates) – but because it enhances their power to expand their balance sheet by deposit creation while economizing on the resources (reserves) needed to back the deposits and to support the interbank payments activity associated with the deposits created.

As a result of the above arguments, the seigniorage power of banks varies according to their different funding capacity, which in turn depends on structural characteristics of the system (e.g., competition, settlement rules, liquidity management and provision mechanisms), liquidity requirements by regulatory authorities, and banks' own characteristics (e.g., size and capital) as well as liquidity preferences and risk management policies.

It should be noted that some types of banks (e.g., not-for-profit community banks, such as local savings banks and mutual co-operative banks) either do not extract seigniorage since they lend at rates consistent with zero-excess profits or they return seigniorage to the economy by reinvesting their profits or redistributing them to the local communities. The former case (i.e., no seigniorage) would be consistent with the above analysis of the effects of size and competition on seigniorage. In the latter case, banks would indeed extract seigniorage, but this would be returned to the economy (a point that will be discussed at the conclusion of the article).

D. Optimal Bank Money Creation

The limited capacity of a bank to satisfy its funding needs acts as a constraint on the bank's power to create money by lending deposit claims, and thus to extract seigniorage. At the margin, the cost of funding for each bank may be higher than the expected return from creating money, or it may even become prohibitive. A bank's idiosyncratic decision to, say, double at once its total lending by issuing new deposit claims would run against the bank's capacity to support the new lending with adequate funding. The bank would always be able – in principle – to create money by signing off new loans with a stroke of a pen (or, in our times, with a click of a mouse). Yet, the new money created would not be sustainable under the bank's normal funding structure. As most of the payments generated by the new loans would go to payees holding accounts with other banks, the bank would not be in a position to settle its obligations since it would not be able to raise the needed funds, even if reserves in the system were not in shortage. The bank would not be able to expand at once its deposit base as needed or to capture a larger payments market share overnight; it would not have all the collateral needed to borrow from the central bank; moreover, borrowing so much extra funds from the market might be perceived as too risky by investors and bank creditors, with borrowing becoming too expensive or even being rationed and the bank's market valuation and rating being penalized as a result. Even a deep money market and a fully accommodating central bank's monetary policy stance

would not help, if the bank's funding structure and capital were unchanged: the marginal cost of the extra funding could actually become infinite for the bank.

The conclusion is that a bank can create money by lending deposits only within an overall resource envelope that is determined by the bank's capacity to raise funds (reserves) at costs that are consistent with the sustainability of its business. Banks do create money, but they can do so within the limits of their funding plan, which must consider their incoming and outgoing payments (as adjusted for growth and risk factors), their borrowing capacity (which is also a function of their size and risk profile), and the cost of raising and holding funds (reserves) vis-à-vis the prospective return from lending. It doesn't matter whether the funding is in place prior or after the act of money creation; as said, creating deposit claims, per se, does not require any funding, and central bank reserves (and even less deposits) are not what banks lend out when they extend credit to their clients. What matters is that funding i) is in place when the bank's new financial obligations to other banks (or other payment system participants) fall due and are to be settled, and ii) can be obtained when needed without impairing the bank's financial viability.

Every bank, thus, plans its lending activity taking into consideration its own funding capacity and its expected flow of incoming and outgoing funds (reserves). The flow of funds will also include the expected time profile of loan use by the borrowers, which generates a stream of future payment and transfer obligations that the bank will have to honor. Within its overall planned liquidity envelope, the bank then extends new loans until the marginal return from lending (net of risk) exceeds its marginal cost (Tobin, 1963), which also incorporates the cost of raising and holding reserves.

Since the net-of-risk marginal return depends on the demand for loans by borrowers and their debt repayment capacity, the money creation capacity of each bank may be limited by loan supply and demand factors, even before the overall resource envelope becomes binding. Moreover, lending may be limited by the bank's decision to ration it or by regulatory (administrative) restrictions that limit its supply.

Central banks may affect the resource envelope by changing the policy interest rates. These influence the banks' current and expected cost of funding, and hence their risk-return prospects, their money creation decisions, and ultimately their seigniorage. Other regulatory instruments (such as capital, liquidity, and leverage ratios, as well as macroprudential tools) may constrain the overall power of banks to create money.

All the above factors being considered, by operating under fractional reserves and being able to economize on the use of (costly) resources (funding) needed to support the payments activity that derives from the use of deposit claims as money, any income beyond normal profits, which accrue to banks from their lending activity, amounts to pure rent extraction from the economy. This is seigniorage.

4. THE ECONOMICS OF COMMERCIAL BANK SEIGNIORAGE

A. Conditions for Commercial Bank Seigniorage

This section shows the conditions under which commercial banks extract seigniorage from the economy through money creation. Bank *B* operates as a profit-maximizing firm in a fractional reserve regime. It is authorized both to offer its customers demand deposit (DD_B) accounts earning interest i_{DD} and to lend money to borrowers by crediting their accounts with funds L_B (and by issuing to them equivalent deposit claims) at interest i_L, where for simplicity, the bank faces no costs other than deposit remuneration and the cost of raising central bank reserves *RES* needed to back its deposits liabilities.

Bank *B*'s payments market share is proxied by $\sigma_B = \frac{DD_B}{DD}$, the ratio of the bank's demand deposit liabilities over total demand deposits outstanding in the system, *DD*.[16] Scale effects are such that at zero-dimensional share, $\sigma_B = 0$, bank *B* operates in a perfectly competitive environment and enjoys

[16] The payments market share could obviously be proxied by alternative and more accurate indicators; however, this issue does not need to detain us here.

no economies of scale in liabilities management, whereas at maximum share, $\sigma_B = 1$, the bank enjoys the largest economies of scale in liabilities management possible, is a monopolist in the lending market and a monopsonist in the deposit market.

Bank *B*'s cost structure, thus, is given by

$$[(1 - \mu_B)i_{DD} + \mu_B i_{RES}]DD_B = \phi_{DD} DD_B,$$

where $\mu_B = \frac{RES_B}{DD_B}$, with $0 \leq \mu_B \leq 1$, where i_{RES} is the interest rate at which the central bank lends reserves and is a policy instrument controlled by the central bank, and where $\mu_B = 0$ for $\sigma_B = 1$ and $\mu_B = 1$ for $\sigma_B = 0$, for the reasons discussed in Section 4.C, that is, in principle, parameter μ_B may vary from 0 to 1, taking the extreme value of zero in the (hypothetical) case a cashless economy with only one banks, where all payments are all "on us" and their settlement does not require central reserves, and taking the extreme value of 1 in a perfectly competitive economy with atomistic banks. Parameter $\mu_B$could also be set by central bank regulation or else it could be set by each bank as part of its liquidity management policy. In this last case, and assuming a fractional reserve regime, the parament would also be a function of the structure, rules, and procedures of the payment system(s) where each bank operates (see Section 4.C).

Note that $\phi_{DD} = \phi_{DD}(i_{DD}, \mu_B, i_{RES})$ is the cost of raising and holding reserves *RES* as a fraction of demand deposit liabilities and includes both the remuneration of bank *B*'s demand deposit liabilities and the cost of accessing reserves through alternative sources. At i_{RES}, the central bank supplies all the reserves that banks demand.

One may therefore posit:

(i) $i_L = i_L(\sigma_B)$, with $\frac{\partial i_L}{\partial \sigma_B} > 0$ and $i_L = i_L^*$ for $\sigma_B = 0$,

where i_L^* is the equilibrium loan interest rate under perfect competition,

(ii) $i_{DD} = i_{DD}(\sigma_B)$, with $\frac{\partial i_{DD}}{\partial \sigma_B} < 0$ and $i_{DD} = i_{DD}^*$ for $\sigma_B = 0$,

where i_{DD}^{*} is the equilibrium deposit interest rate under perfect competition, and

(iii) $\mu_B = \mu(\sigma_B)$, with $\mu' > 0$ and $\begin{cases} \lim_{\sigma \to 0} \mu_B = 1 \\ \lim_{\sigma \to 1} \mu_B = 0 \end{cases}$

Item (iii) implies that, as the bank's payments market share grows, the bank economizes on the reserves held at the central bank.

Bank B's loan supply function is

$$L_B^S = L_B^S(i_L - \phi_{DD}) = L_B^S\left(i_L, \phi_{DD}(i_{DD})\right) \leq L_B^S(\rho) \quad \text{for given } \mu_B \text{ and } i_{RES},$$

$$\text{with } i_L > \phi_{DD} \text{ and } \begin{cases} L_B^{S\prime} > 0 \text{ for } i_L \leq \rho \\ L_B^{S\prime} = 0 \text{ for } i_L > \rho \end{cases},$$

where ρ is the critical credit risk threshold, beyond which bank *B* no longer lends (i.e., the bank rations the supply of loans), and where the demand functions for bank *B*'s loans is

$$L_B^D = L_B^D(i_L) \qquad \text{with } L_B^{D\prime} < 0,$$

On the deposits market side, while the supply is determined by the supply of loans, the demand for bank B' deposits is

$$DD_B^D = DD_B^D(i_{DD}) \qquad \text{with } DD_B^{D\prime} > 0$$

Under the above conditions, at zero-dimensional market share ($\sigma_B = 0$), that is, with perfect competition, equilibrium attains at

$$L_B^* = \min_L [\, L_B^*(i_L^*, i_{DD}^*), L_B^S(\rho)]$$

where bank *B*'s maximum profit is normal profit

(A1) $Max\ \Pi_B|_{\sigma_B=0} = i_L^* L_B^*(i_L^*, i_{DD}^*) - \phi_{DD}(i_{DD}^*) DD_B^*(i_{DD}^*)$

for given μ_B and i_{RES} and $i_L^* \leq \rho$. Call π_B^* the unit normal profit rate, at which bank *B* extracts no seigniorage. As the market share of bank *B*'s increases, the bank enjoys larger scale economies and

greater monopolistic/monopsonistic powers; as a result, its profit grows above normal (that is, zero extra profit),

$$Max\ \Pi_B|_{\sigma_B=1} > \text{Max}\ \Pi_B|_{1>\sigma_B>0} > Max\ \Pi_B|_{\sigma_B=0},$$

and its unit seigniorage rent increases $s_B \equiv \pi_B - \pi_B^* > 0$. Notice that s does not reflect any value added created for the economy by bank *B*; it amounts to pure extraction of net resources from the economy by the bank and, unlike the seigniorage earned by the central bank (which is partly returned to the state budget after covering for the central bank's expenses and profit), commercial bank seigniorage is owned by the bank (net of any tax imposed by the state on the banks' income).

Notice that, in the real world, commercial banks provide various types of services in addition to lending (e.g., for account management and for payments), typically against the charge of fees and commissions from customers. In the article, for reasons of simplicity, but without loss of generality for the results derived in it, it is assumed that banks only accept deposits from customers and lend money to borrowers in the form of newly issued deposits.

B. Seigniorage from Money Creation and Profit from Pure Financial Intermediation

This section clarifies the distinction between seigniorage from commercial bank money creation and profit from pure financial intermediation. A stripped-down-to-the-bone model is used that builds on two financial intermediaries, a commercial bank, and a pure intermediary. The two differ from each other precisely, and only, for the money-creation power that characterizes the bank only and are identical in all other respects.

Call the two financial intermediaries bank *B* and pure intermediary *I*. Bank *B* is the same as in Section 4.A. Pure intermediary I is authorized to offer its customers (non-demand) term deposit (TD_I) accounts bearing interest i_{TD} and to lend long-term funds L_I at interest i_I. Both intermediaries operate in identical quasi-monopolistic market environments and at the same scale, $1 > \sigma_B = \sigma_I > 0$.

For purposes of comparison, the following additional assumptions apply. The two entities feature identical administrative and operational cost structures (including, inter alia, such items as the costs for screening, selecting, and monitoring borrowers, and those to enforce contract terms), which for simplicity are here set to zero. They charge on loans the same net-of-risk interest rate ($i_L = i_I$). Credit rationing is assumed away.

As in Section 4.A, bank *B* maximizes profits

$$\Pi_B|_{1\geq\sigma_B\geq 0} = i_L L_B(i_L, i_{DD}) - \phi_{DD}(i_{DD})DD_B(i_{DD}),$$

And, similarly, pure intermediary *I* maximizes profits

$$\Pi_I|_{1\geq\sigma_I\geq 0} = i_{TD} L_I(i_I, i_{TD}) - i_{TD} TD_I(i_{TD})$$

where $\Pi_{B,I}|_{\sigma_I=0}$ sets the normal (zero excess) profit of the two intermediaries under perfect competition.

Now, looking at bank *B*'s cost structure, notice that the variable *RES* consists of reserves from incoming payments (*RINP*) and borrowed reserves (*BR*), which include reserves borrowed (wholesale) from other banks (*RW*) and those borrowed from the central bank (*RCB*), which also reflects the cost of holding collateral (safe and liquid) assets against potential cash borrowing needs. Knowing that $i_{DD} < i_{TD}$, and noting that

$$i_{RES} = \frac{i_{RINP}RINP + i_{BR}BR}{RES}$$

where $i_{RINP} = 0 < i_{TD}$, and $i_{BR} = \frac{i_{RW}RW + i_{CB}RCB}{BR} < i_{TD}$, since the cost of borrowing reserves from the interbank market or from the central bank is lower than the interest rate on term deposits, the following strict inequality holds:

$$\phi_{DD} \equiv (1 - \mu_B)i_{DD} + \mu_B i_{RES} \ll i_{TD},$$

that is, all else equal, bank *B*'s cost of liabilities management is lower than for pure intermediary *I*. Moreover, since both are profit maximizers and the marginal cost of lending is lower for bank *B* than

for pure intermediary *I*, the former will always be able to create money and expand equilibrium lending beyond what is feasible for the pure intermediary, that is, $L_B^* \gg L_I^*$, where L_B^* is the volume of loans that the economy is willing to borrow at i_L^*, where $i_L^* < i_I^*$ are equilibrium values. Thus, it will always be the case that

$$\Pi_B|_{1>\sigma_B=\sigma_I>0} - \Pi_I|_{1>\sigma_I=\sigma_B>0} \gg 0.$$

It follows that, all else equal, money creation allows commercial banks to extract from the economy larger rents than is possible for pure financial intermediaries, under (hypothetically) identical market (and price) conditions. Importantly, in the above hypothetical case, monopolistic/monopsonistic powers affect both intermediaries identically; thus, the extra-profit extracted by the bank (which goes into seigniorage) is due exclusively to its money creation power, which by construction is precluded to the pure financial intermediary. This would be apparent considering, for instance, the effect of an increase in scale σ_B on bank B's cost structure ϕ_{DD} through parameter μ_B (all else being equal), and hence on interest margin $i_L - \phi_{DD}$, given prices i_L and i_{DD}, and thus ruling our monopolistic and/or monopsonistic effects.

One way of setting apart the effects of a bank's economies of scale and market power over seigniorage is to consider that the former affect quantities (i.e., by expanding the bank's power to create money while economizing on reserves), and the latter works through prices (as it enables the bank to increase the loan-deposit interest rate spread). The two effects are necessarily intertwined, however, and seigniorage is whatever extra rents are associated with the money creation function.

C. Commercial Bank Seigniorage and Payment Settlement Systems

It is important to understand commercial bank seigniorage in the context of different types of payment settlement systems. In this section, following current practice worldwide, it is assumed that settlement of interbank payments takes place in central bank money (reserves). Since holding reserves carries an opportunity cost for banks (unless such reserves are remunerated at the same level as their best

possible alternative investment option), the cost from holding reserves detracts from commercial bank seigniorage (while strengthening their liquidity position). As different payment settlement systems require banks (all else being equal) to mobilize different volumes of reserves, each type of system has a different impact on commercial bank seigniorage.

A simple numerical example makes the point. Take an economy with a central bank (CB), two banks (A, B), and four customers (a1, a2, b1, b2), where a1 and a2 are customers of bank A and b1 and b2 are customers of bank B. Banks A and B hold no reserves with CB initially. The case is analyzed where the same transactions are executed and settled in two different systems, respectively: i) a real-time gross settlement (RTGS) system and ii) a deferred netting settlement (DNS) system.

RTGS and DNS systems

In RTGS systems transfer of money or securities takes place from one bank to another on a "real time" and on a "gross" basis. Settlement in "real time" means payment transaction is not subject to any waiting period: the transactions are settled as soon as they are received, accepted and processed. Transactions are executed only if they are covered by sufficient liquidity. "Gross" settlement means that transactions are settled on a one-to-one basis, without bundling or netting them against any other transactions. Once executed, payments are settled with "finality" (funds transfers are irrevocable and unconditional). In DNS systems, credit and debit transactions are recorded on the clearinghouse books throughout the business day, and at the end of the operating day (in case of one netting cycle) or at the end of each netting cycle (in case of multiple cycles a day), the clearinghouse calculates the total "net" multilateral balances of all transactions and determines what each bank owes to/is due from all others. Settlement of such balances then takes place with finality.

Reserve management in RTGS systems

The following sequence takes place:

1. A lends $100 to a1 (and creates an equal amount of deposits)

2. a1 pays $100 to b1
3. A borrows $100 from CB and transfers $100 to B: interbank settlement is done
4. B lends $150 to b2 (and creates an equal amount of deposits)
5. b2 pays $150 to a2
6. B receives $100 from A (item 3 above) and borrows $50 from CB
7. B pays $150 to A: interbank settlement is done
8. A repays $100 to CB
9. B borrows $50 from A and repays $50 to CB, or
10. B renews its loan from CB

At the end of the sequence, CB has issued $150 intraday.

Under item 9 all $150 reserves go to zero by end-of-day as A and B repay their loans to CB: no net central bank money (reserves) creation. Yet $250 commercial bank money (demand deposits) were created, which supported $250 worth of transactions.

Under alternative item 10, the $50 intraday loan converts into an overnight loan and becomes money supply: $50 net reserves creation. But, as above, $250 demand deposits were created by banks, which supported $250 worth of transactions.

Reserve management in DNS systems

Assuming the same transactions take place in a NSS, it can be immediately seen here that the end-of-day balance to be settled between A and B is $50, which B borrows from CB. Although this resembles item 10 above, netting in fact saves borrowing costs overall, since under RTGS total borrowing from CB is $150 while under netting it is only $50. Deposit creation and transactions are as above.

In both cases, commercial bank money has been created in excess of central bank money and has supported a correspondingly larger volume of (real and financial) transactions. As the demands for

converting deposits into cash are limited, the greatest share of deposits created in excess of reserves remain in the system as such: this large mass of deposits outstanding (net of all conversions, destructions and new deposit creations) earn an ongoing flow of net revenues. These net revenues originate from the banks' exclusive power to create money (in excess of central bank money) and represent commercial bank seigniorage.

Seigniorage and reserve requirements

All else being equal, and for banking market configurations other than perfect competition, commercial bank seigniorage varies inversely with the demand for reserves that banks determine or are required to hold. In the limiting case of money issuance being subject to full reserves requirements (e.g., currency board, 100% reserve or narrow banking), no seigniorage would be extracted even by a single bank exercising full monopoly in the market, while seigniorage would increase with the decline of the fraction of (costly) reserves held against the deposit liabilities. However, consistent with the definition of seigniorage used throughout this article as "excess profits due to the power to create money by banks," no bank seigniorage would be extracted if banks were hypothetically to operate under perfect competition, even in a fractional reserve regime, since profits would then be just enough to remunerate banks for the valued added they generate in the economy by creating money.

5. COMMERCIAL BANK SEIGNIORAGE, PRICES, AND RESOURCE DISTRIBUTION

Consider an economy with three sectors (firms, households, and banks) and define commercial bank seigniorage as $s_B \equiv \pi_B - \pi_B^* > 0$, that is, a form of unearned income (rent) that originated from profits beyond normal rate.

How does seigniorage affect this economy's price level and resource distribution?

In the case of no-seigniorage, where the banking sector is perfectly competitive (that is, $\sigma_B = 0$ and $s_B = 0$, from Section 4.A), the economy's real output is distributed across the three sectors of the economy as

(1) $$Y^* = \frac{w^* N^*}{P^*} + \frac{\pi_E^* K^*}{P^*} + \frac{\pi_B^* L_B^*}{P^*},$$

where for π_E is the firms' unit profit rate the aster refers to perfectly competitive equilibrium values. On the other hand, where the banking sector exploits larger than atomistic shares of the payments market ($0 < \sigma_B < 1$), commercial bank seigniorage is positive, $s_B = \pi_B - \pi_B^* > 0$.[17] In this case, the given aggregate output produced is not enough to satisfy all sector claims that materialize at the original equilibrium price level; nor can additional output can be produced if and as the factors employed are unchanged; thus,

(2) $$Y^* < \frac{w^* N^*}{P^*} + \frac{\pi_E^* K^*}{P^*} + \frac{\pi_B L_B^*}{P^*},$$

where $\pi_B > \pi_B^*$. To restore balance, and to accommodate the higher claims (rents) from the banks, the price level must adjust upward in order both to increase output and to re-distribute it across the three sectors. While various possible price adjustment dynamics could be set in motion depending on the relative price flexibility, all dynamics bear distributional implications. Thus, in the real-world, the emerging adjustment process would be determined by the bargaining power of each affected sector.

Abstracting momentarily from how the distributional tensions would be resolved between the firm and household sectors (to be discussed later), the aggregate real resource balance under seigniorage requires using some share of the output produced to pay for the higher claims (rents) extracted by the

[17] For the reasons discussed earlier, this is not the result of banks exploiting their market power and applying a higher interest rate on their loans, but on banks exploiting scale or technology to save on the reserves used to back up their loans (or, more precisely, the payments activity deriving from their lending). At given interest rates, this would generate higher (beyond-normal) profits; that is, rent; that, is seigniorage.

banks from the economy. One way to achieve this new balance is through a higher general price level that transfers resources across sectors, such that:

$$(3) \qquad Y^* = \left[\frac{w^*N^*}{P^*} + \frac{\pi_E^*K^*}{P^*} + \frac{\pi_B L_B^*}{P^*}\right](1+p')^{-1},$$

yielding

$$(4) \qquad Y^* = \left[\frac{w^*N^*}{P'} + \frac{\pi_E^*K^*}{P'} + \frac{\pi_B L_B^*}{P'}\right],$$

where $P' = (1+p')P^*$ is the new price level required to restore real resource balance, and p' is the implicit rate of price adjustment. Recall from Section 4 that any interest rate differential applied by the banks above the normal profit rate constitutes unearned income. Thus, banks draw from the economy a share of output in excess of what they contribute for the production of that output. As reflected in Eq. (4), the rebalancing process causes an erosion of the real value of money through the increase in the general price level, which acts as a rationing device that neutralizes the excess (aggregate) claims on the economy's output at the original equilibrium price level. Notice that the real value erosion partly hits the banks as well, since the higher general price level eats into their normal real profits; however, the erosion is not enough to offset the rent that they extract from money creation via lending.

An alternative path to restoring real resource balance would be for the adjustment to be born entirely by the firm and/or household sectors in the form of lower nominal profits and/or wages, respectively, at the given general price level. Whether this option would be feasible in practice is an open question – one that would involve also political-economy considerations such as the relative bargaining power of the two sectors and their respective tolerance to unfavorable relative prices. Here, it is worth noticing that any incomplete price adjustment causing the imbalance in inequality (2) to persist would either require firms to agree with the banks on re-financing the original loans that they are unable to

repay, or it would force firms into defaulting on their obligations to the banks (with their assets being eventually seized by the banks).

To analyze the distributional implications of commercial bank seigniorage in greater detail, divide Eq. (4) by Y^* to get

$$(5)\quad 1 = \frac{w^*N^*}{Y^*P'} + \frac{\pi_E^*K^*}{Y^*P'} + \frac{\pi_B L_B^*}{Y^*P'} = \phi_N + \phi_E + \phi_B,$$

where the ϕ's are the shares of total real income accruing to labor, firms, and banks, respectively. Assume, then, that the price level adjusts fully, and divide the terms in the last expression of the RHS of Eq. (4) by the total of labor services employed *N*. Recalling that $wN = L_B$ and that $\pi_B = s_B + \pi_B^*$, any level of aggregate output per unit of labor can be decomposed as

$$(6)\qquad \frac{Y}{N} = \frac{w}{P} + \frac{\pi_E K}{PN} + \frac{\pi_B L_B}{PN} = \frac{w}{P}(1 + \pi_B) + \frac{\pi_E K}{PN} = \frac{w}{P}(1 + \pi_B^* + s_B) + \frac{\pi_E K}{PN}.$$

Using natural log transformations, applying Taylor's expansion to derive the equality $\ln(1 + \mathrm{s_B}) \approx \mathrm{s_B}$, for small $\mathrm{s_B}$,[18] taking income from Eq. (5))shares into account, and solving Eq. (6) for the change in real seigniorage $\mathrm{s_B}$ yield

$$(7)\ \mathrm{s_B} - \mathrm{p} \approx \frac{\lambda}{\phi_B} - \left\{\frac{\phi_N}{\phi_B}(\mathrm{w} - \mathrm{p}) + (\pi_\mathrm{B}^* - \mathrm{p} + \mathrm{l_B} - \mathrm{n}) + \frac{\phi_E}{\phi_B}(\pi_\mathrm{E} - \mathrm{p} + \mathrm{k} - \mathrm{n})\right\},$$

where $\lambda \equiv \mathrm{y} - \mathrm{n}$ is labor productivity growth and normal rate of profit π_B^* is constant. Treating expression (7) as an equation expresses commercial bank seigniorage as the share of productivity growth that is extracted by the banking sector from the household and firm sectors (the real economy), and its underlying algebra makes explicit the growth accounting relationships between the different

[18] From Taylor's expansion, and dropping subscript B, $\ln(1 + \mathrm{s}) = \mathrm{s} - \frac{\mathrm{s}^2}{2} + \frac{\mathrm{s}^3}{3} - \frac{\mathrm{s}^4}{4} + \frac{\mathrm{s}^5}{5} - \cdots = \sum_{n=1}^{\infty}(-1)^{n+1}\frac{s^n}{n}$, $\forall \mathrm{s} \in (-1, 1]$, and $\lim_{n\to\infty}(R_n) = -\frac{\mathrm{s}^2}{2} + \frac{\mathrm{s}^3}{3} - \frac{\mathrm{s}^4}{4} + \frac{\mathrm{s}^5}{5} - \cdots = \frac{(-1)^\mathrm{n}}{(1+\xi)^{\mathrm{n}+1}}\frac{(\mathrm{s})^{\mathrm{n}+1}}{(\mathrm{n}+1)!} = 0$, $\forall\, \xi \in (0, \mathrm{s})$, and $\forall \mathrm{s} \in (-1, 1]$. Thus, $\ln(1 + s) \approx s$.

economic sectors that are considered in the model and are implicit in the expression. Eq. (7) allows to highlight the relationships between changes in bank seigniorage and changes in labor productivity, inflation, wages and profits, capital endowment and bank lending.[19]

These relationships should be understood in the context of the distributional dynamics characterizing any given economy. Eq. (7) identifies the constituent elements of commercial bank seigniorage (in real terms). It indicates that such form of seigniorage depends on the political-economy context in which banks and the other economic agents operate, including their power to affect the economy's resource distribution process. For instance, all else equal, more consolidate is the banking sector, the higher is the banks' capacity to extract rents from the economy, and the higher is the growth of labor productivity required for the firms to be able to repay their bank debt. In point of political-economy considerations, most notable is the indication from Eq. (7) of a strongly negative relationship between the seigniorage power of banks and the share of national output going to workers.

A. Three Relevant Cases

Three cases are of interest from the resource distribution standpoint and deserve consideration:

a) The case where firms protect the value of their capital

b) The (neoclassical) case where the rate of change of marginal productivity of labor equals real wage growth, and

c) The case where nominal wage growth lags inflation.

Case A: Protecting the real value of capital

The real value of the firms' capital is protected when $\pi_E \geq \mathrm{p}$, For this to be possible under positive bank seigniorage in real terms, $\mathrm{s_B} - \mathrm{p} > 0$, and assuming stationarity of the capital endowment per

[19] In Bossone (2021), where I developed this analysis, I omitted by mistake to consider the sector income shares, thereby deriving unweighted growth rate components. However, while the omission is an error, it does not alter the qualitative nature of the relationships therein analyzed and here replicated.

worker, $k - n = 0$, it follows from Eq. (15) that inequality $\lambda/\phi_B - \phi_N/\phi_B(w - p) > (\pi_B^* - p + l_B - n)$ must hold whereby the output that firms extract from labor must be greater than the output absorbed by banks. This requires that firms can engineer an increase in labor productivity for given real wage dynamics or manage to compress real wage growth through internal devaluation and/or higher price growth. Call "labor appropriation" the resources that accrues to the firms in excess of those that the firms transfer back to the banks, $\lambda/\phi_B - \phi_N/\phi_B(w - p) - [(\pi_B^* - p + l_B - n)] > 0$. Clearly, all else being equal, the larger the seigniorage (in real terms) extracted by the banks, $s_B - p$, the larger the labor appropriation needed by firms; moreover, with a growing stock of capital per worker, $k - n > 0$, labor appropriation would have to be even larger.

Case B: The neoclassical case

In this case, the economy follows the neoclassical rule whereby labor productivity and real wages grow at the same rate, $\lambda = w - p = 0$. Positive seigniorage in real terms, $s_B - p > 0$, requires that $(\pi_B^* - p + l_B - n) > \phi_E/\phi_B(\pi_E - p)$, meaning that the resources needed to ensure extra profits to the banks can only come from the firms and exceed firms' profits. This implies that firms' capital must progressively shift to the banking sector for the firms to be able to repay their debt obligations to the banks. Call "capital expropriation" the net resources $(\pi_B^* - p + l_B - n) - \phi_E/\phi_B(\pi_E - p) > 0$ that accrue to the banks in excess of firms' profits, reflecting banks' seigniorage power. Notice that, all else being equal, capital expropriation grows with the capital-to-labor ratio. Consequently, commercial bank seigniorage disincentivizes capital accumulation since any resource newly accumulated is eventually appropriated by the banks. With a growing stock of capital per worker, $k - n > 0$, capital expropriation would have to grow even more.

Case C: Wages lag inflation

Finally, the case when $w < p$, that is, real wages decline, which materializes when nominal wages lag price growth. According to Eq. (7), positive (real) commercial bank seigniorage $(s_B - p > 0)$ requires $\lambda/\phi_B - [\phi_N/\phi_B(w - p) + \phi_E/\phi_B(\pi_E - p + k - n) + (\pi_B^* - p + l_B - n)] > 0$. Assuming

no productivity growth and stationary capital endowment per worker (that is, $\lambda = 0$ and $k - n = 0$), the condition can be re-written as $\phi_B(\pi_B^* - p + l_B - n) > \phi_N w - \phi_E \pi_E$, implying that firms enjoy some flexibility, in that they can service their bank debt even if wages grew faster than profits, at least up to a limit. This flexibility would be heightened by positive productivity growth, $\lambda > 0$, while it would be eroded by a positive growth of the capital stock per worker, $k - n > 0$: productivity growth would generate extra resources that could be transferred to the banks at no cost to the firms (in terms of profit loss); a growing capital stock per worker would increase the firms' claims on any given level of the economy's output and thus require lower nominal wages and/or higher nominal profits for them to be able to satisfy their higher claims to themselves and those of the banks, i.e., the banks' normal plus excess profits (seigniorage).

Under the three cases evaluated, the very existence of commercial bank seigniorage affects resource distribution between firms and labor. Moreover, given the sanctity of debt, seigniorage raises tensions between the two classes of agents and determines a zero-sum game type of situation where one class may gain only at the expense of the other, and where the firms' inability to protect the real value of their capital would cause part of their capital to be appropriated by banks.

6. POLICY IMPLICATIONS

The above results show that commercial bank seigniorage raises the general (equilibrium) price level of the economy and commercial banks play a key role in determining the distribution of resources across the economy.

In the analysis above, higher prices are the firms' response to commercial bank seigniorage, through which firms seek to recover the resources they need to service their bank debt. As discussed, such debt does not originate from the financial intermediation of previously saved resources; they originate from the claims on real resources (i.e., the exchange value) that banks create *ex nihilo* for themselves beyond what they contribute to the economy by providing money to it (see Section 3). These claims determine net positive transfers of real output from the economy to the banks in the form of a special

type of rent, i.e., seigniorage. If firms are unable to recover the needed resources (by reducing their own profits and/or by compressing real worker wages), they must resort to new bank lending. If the banks are willing to evergreening existing debts, then new loans will accumulate over time until the firms succeed in raising the resources needed to settle their obligations. On the other hand, if banks are not willing to lend additional money, firms will be forced into default (with their capital being eventually seized by the creditor banks). Commercial bank seigniorage *diverts* resources from the real economy to the banking sector and generates distributional tensions between capital and labor. The relevance of seigniorage ultimately depends on the bank shares of the payments market power and scale.

The above results bear policy implications that are worth considering.

A. Monetary Policy

The model above abstracts from the cost to commercial banks from having to hold or to attract central banks reserves (discussed in Section 3). Introducing this cost factor reduces commercial bank seigniorage. Extending the model to include commercial banks' demand for central bank reserves creates space for monetary policy. The central bank's policy interest rate(s) would be a cost to commercial banks and influence their decisions on lending and loan interest charges.

Under a Taylor monetary policy rule, the central bank would increase the policy interest rates if inflation were above target. To a point, based on the model above, an increase in the policy interest rates would induce commercial banks to raise their rates and firms to increase prices accordingly – a result that is analyzed by the monetary policy "cost channel" literature and is in line with Neo-Fisherian predictions.[20] However, as the above analysis indicates, if nominal wages and/or firm profits did not keep pace with inflation, there might be a critical threshold beyond which further price adjustments would no longer be sustainable, either because additional value extraction from labor

[20] See references in Section 2.

and/or capital would not be tolerated by workers and firms or because the compression of the real remunerations of labor and capital would cause output to drop. Price dynamics would be brought under control but, if commercial bank seigniorage kept increasing, further price adjustments would be inhibited and would eventually cause firms to default on their debt obligations.

Despite central bank action on policy rates, the outcome just described that would bring a stop to inflation might be superseded if commercial banks were willing to renew old loans or to extend new ones to firms, and if firms were willing to take one or a combination of the following actions: borrow from the banks; increase sale prices; and accommodate worker demands for higher nominal wages. Money in circulation and/or money velocity would grow (followed by increased borrowing of central bank reserves at higher rates by banks) and accommodate the acceleration of price and wage inflation and possibly setting off spiraling interest-price-wage dynamics. Effective monetary restraint would require the central bank to abandon the interest rate policy in favor of quantity targeting and to ration the supply of reserves to commercial banks, with disruptive consequences for debt repayments and the payments activity across the economy. An example of this is the US Fed's anti-inflationary monetary policy of the early 1980s.

B. Eliminating Seigniorage?

As commercial bank seigniorage imposes an undue cost – or dead-weight loss – on society, the question then is what kind of policies could be adopted to reduce or remove it, or to re-distribute it across the economy. Taxation comes naturally to mind as one possible solution: it would actually be a way to reintegrate into the economy (through the fiscal budget) the rents that have been extracted from it. Yet, aside from the challenges of estimating seigniorage correctly (see Bossone et al., cit.), also including the estimate of the "normal" profit rate beyond which earnings become rents, the risk of taxation is that banks could pass on the cost of higher taxes on their borrowers and depositors, with negative repercussions on lending, and hence output, and resource distribution. Other remedies would involve financial policies aimed to remove the formation of seigniorage. One type of policy is to raise

competition within the banking market and to de-consolidate the banking sector, thus shrinking the average size of banks, reducing their payments market share, and diminishing their market power, all factors that determine bank seigniorage. However, the benefits associated with this policy should be contrasted against the risk of inducing higher risk taking from banks, due to the lower earnings, possibly resulting in greater financial instability overall. Another type of policy is to remove altogether the fractional reserve regime that underpins contemporary commercial banking and move to a so-called "narrow banking" system, whereby banks are required to fully back their demand deposit liabilities with reserves held at the central bank or with safe and liquid assets such as high-quality government bonds: no money creation would be possible, all lending would be through pure intermediation, and seigniorage would disappear consequently. In this case, the benefits would have to be measured against the costs to society from depriving the economy of the money supply elasticity that the fractional reserve regime makes possible, as opposed to a narrow banking or 100% reserve regime, which would likely raise the cost of credit to the economy (Bossone, 2001b).

Thus, great caution should be exerted when thinking about policies to reduce or eliminate seigniorage from banking. An alternative way to address the issue would be to incentivize forms of bank ownership, such as not-for-profit community banks, which reduce the extraction of seigniorage by providing credit at low rates or support the re-injection of seigniorage back into the economy through the re-investment of profits in the local economy or their distribution to users.[21] These are typically local savings and mutual cooperative banks, which are already present in large numbers in many countries but are far from dominating their domestic banking sector in terms of market share.

[21] Werner (2013) points to the not-for-profit community banks accounting for 70% of all deposits in Germany as being a preferable model of banking.

7. CONCLUDING REMARKS

A few considerations before concluding. First, a counterargument to commercial bank seigniorage is that the income that commercial banks extract is not a rent but rather a share in the newly created output corresponding to the resource allocation services that they provide to society by applying their specialized screening and monitoring technologies to lending. In response, it should be said that while these specialized services do represent a contribution to output (and should therefore be compensated at a normal profit rate), they are not inherently associated with the banks' money creation process. These services can be provided through pure intermediation of existing resources, and do not require or necessarily involve any creation of money.

A second counterargument is that the rents from commercial bank seigniorage are ultimately transferred to bank shareholders as dividends, much as central bank profits are (partly) given back to taxpayers through the government budget. Yet, there are two substantial differences between the two cases. First, in the central bank case, resources are extracted from the economy and (in large part) returned to the public through the fiscal budget. In the case of commercial banks, on the other hand, resources are extracted from the economy and appropriated by the bank owners. To be sure, the owners may re-inject these resources in the economy (using them to finance their own consumption and/or investment activities), but this would not compensate those who initially had to pay for the seigniorage. (Different would be the noted case of cooperative banks where seigniorage, if extracted, is paid back to the same loan users.) Second, the central bank is not in the business of "making money:" it creates and manages money supply for the purpose of pursuing public policy objectives, and the value it adds to the economy is compensated at the cost rate of the factors of production employed. Again, any extra revenue (seigniorage) is returned to the economy.

In conclusion. Speaking to post-Keynesian economists, this article has focused on the essential role of commercial banks as creators of money in a monetary production economy, in particular their rent-extraction power in the form of *seigniorage*. The article has examined how the relative size of banks

in the payment system combines with their capacity to determine quantities and prices in the market for demand deposits, giving them the power extract rents – seigniorage – from the economy, and has clarified the distinction between seigniorage from commercial bank money creation and profits from pure financial intermediation. The article has then studied how seigniorage affects the economy's equilibrium price level and resource distribution by raising tensions between labor and capital. Finally, the article has drawn economic-policy implications on how conflicts around resource distribution raised by seigniorage may affect the conduct of monetary policy and has discussed policies to remove or reduce seigniorage.

REFERENCES

Anolli, M., E. Beccalli, and G. Borello (2015), Are European banks too big? Evidence on economies of scale, *Journal of Banking & Finance*, 58, pp. 232-246.

Arby, M. F. (2006), Seigniorage Earnings of Commercial Banks and State Bank of Pakistan, *Munich Personal RePEc Archive*.

Argitis, G., and Y. Dafermos (2013), Finance, monetary policy and the institutional foundations of the Phillips curve. Review of Political Economy, 25(4), 607-623.

Baltensperger, E., and T. J. Jordan (1997), Seigniorage, Banking, and the Optimal Quantity of Money, *Journal of Banking & Finance*, 21 (6): 781–96.

Barth, M.J.III., and V. A. Ramey (2001), The cost channel of monetary transmission, in *NBER Macroeconomic Annual 2001*, MIT Press, Cambridge, MA, 199–239.

BIS (2013), Monitoring tools for intraday liquidity management, Basel Committee on Banking Supervision (in consultation with the Committee on Payment and Settlement Systems), Bank for International Settlement, Basel, April 2013.

Bjerg, O., D. McCann, L. Macfarlane, R. H. Nielsen, and J. Ryan-Collins (2017), Seigniorage in the 21st Century: A study of the profits from money creation in the United Kingdom and Denmark, *CBS Working Paper*, January.

Beijnen, C., and W. Bolt (2007), Size matters: economies of scale in European payments processing, *DNB Working Paper*, No. 155, November.

Borio, C., and P. Disyatat (2011), Global imbalances and the financial crisis: Link or no link?, BIS Working Papers, No 346, May.

Bossone, B. (2000), What Makes Banks Special? A study on banking, finance, and economic development, *Policy Research Working Paper*, WPS2408, The World Bank.

Bossone, B (2001a), Circuit theory of banking and finance, *Journal of Banking and Finance*, Vol. 25, Issue 5, vol. 25, issue 5, 857-890.

Bossone, B. (2001b), Should Banks be Narrowed?, IMF Working Paper, WP/01/159.

Bossone, B. (2020), Banks create money (but only to a point): The 'payments perspective,' *Journal of Payments Strategy & Systems*, Volume 14 Number 3, 286-304.

Bossone, B. (2021), Commercial bank seigniorage and the macroeconomy, International Review of Financial Analysis 76: 101775

Bossone, B, and A. Sarr, (2002), A new financial system for poverty reduction and growth, IMF Working Paper, WP/02/178.

Bossone, B, and A. Sarr (2003), Thinking the economy as a circuit, in S. Rossi and L. P. Rochon (ed. by) *Modern Theories of Money. The Nature and Role of Money in Capitalist Economies*, Edgar, Edward Publishing, Inc.

Bossone, B., and J. K. Lee (2004), In Finance, Size Matters, *IMF Staff Papers*, Volume 51, Number 1, April.

Bossone, B., and M. Costa (2021), Money as Equity, *Economics*, forthcoming.

Bossone, B., M. Costa, A. Cuccia, and G. Valenza (2018), Accounting meets economics: towards an `'Accounting View' of money, *ISSN* 2611-0172, volume II.

Buiter, W. H. (2007), Seigniorage, Discussion Paper, *Economics*, No. 2007-8, 1 March.

Bullard, J. (2015), Neo-Fisherianism, Presentation at the University of Oregon's conference, *Expectations in Dynamic Macroeconomic Models*, Eugene, Oregon, 13 August.

Cardoso, E. (2003), Seignorage, Reserve Requirements, and Spreads in Brazil, in P. Honohan (ed.), Taxation of Financial Intermediation: Theory and Practice for Emerging Economies, a co-publication of the World Bank and Oxford University Press, 241-267.

Christiano, L. J., M. Eichenbaum, and C. L. Evans (2005), Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy, *Journal of Political Economy*, University of Chicago Press, vol. 113(1), 1-45, February.

Cochrane, J. (2016), Do Higher Interest Rates Raise or Lower Inflation?, mimeo (available at http://faculty.chicagobooth.edu/john.cochrane/research/papers/fisher.pdf)

CPSS (2013), The role of central bank money in payment systems, report by the Committee on Payment and Settlement Systems, Basel: Bank for International Settlements, August.

CPSS-IOSCO (2012), Principles for financial market infrastructures, report by the Committee on Payment and Settlement Systems Technical Committee of the International Organization of Securities Commissions, Basel: Bank for International Settlements, April.

Dallery, T., and T. Van Treeck, (2011). Conflicting claims and equilibrium adjustment processes in a stock-flow consistent macroeconomic model. Review of Political Economy, 23(2), 189-211.

Fontana, G. and M. Sawyer (2016), Full reserve banking: more 'cranks' than 'brave heretics'. Cambridge Journal of Economics, 40(5), 1333-1350.

Gaiotti, E., and A. Secchi (2006), Is There a Cost Channel of Monetary Policy Transmission? An Investigation into the Pricing Behavior of 2,000 Firms, *Journal of Money, Credit and Banking*, Vol. 38, No. 8, 2013-2037, December.

Gouzoulis, G. (2021), Finance, Discipline and the Labour Share in the Long-Run: France (1911‑2010) and Sweden (1891‑2000), British Journal of Industrial Relations, 59(2), 568-594

Graziani, A. (2003), The Monetary Theory of Production, Cambridge University Press, Cambridge UK.

Haslag, J. H. (1998), Seigniorage Revenue and Monetary Policy, *Economic Review*, Third Quarter, Federal reserve Bank of Dallas

Hellmann, T. F., K. C. Murdock, and J. E. Stiglitz (2000), Liberalization, Moral Hazard in Banking, and Prudential Regulation: Are Capital Requirements Enough?, *American Economic Review*, Vol. 90, No. 1, March, 147-165.

Humphrey, D. B. (2009), Retail Payments: Integration and Innovation Payment Scale Economies, Competition, and Pricing, *ECB Working Paper Series*, No. 1136, December.

Kohler, K., A. Guschanski, and E. Stockhammer (2019), The impact of financialisation on the wage share: a theoretical clarification and empirical test. Cambridge Journal of Economics, 43(4), 937-974.

Kregel, J. (2012), Minsky and the narrow banking proposal: No solution for financial reform (No. 125), Public Policy Brief.

Lee, K. S. and R. A. Werner (2018), Reconsidering monetary policy: An empirical examination of the relationship between interest rates and nominal GDP growth in the U.S., U.K., Germany and Japan, *Ecological Economics*, 146, April, 26-34.

Lima, G.T., and M. Setterfield (2010), Pricing behaviour and the cost-push channel of monetary policy. Review of Political Economy, 22(1), 19-40.

Macfarlane, L., Ryan-Collins, J., Bjerg, O., Nielsen, R., and McCann, D. (2017), *Making Money from Making Money. Seigniorage in the Modern Economy*, New Economics Foundation, Copenhagen Business School.

McLeay, M., Radia, A. and Thomas, R. (2014a), Money in the Modern Economy: An Introduction, *Bank of England Quarterly Bulletin*, 54(1), 4-13.

McLeay, M., Radia, A. and Thomas, R. (2014b), Money Creation in the Modern, Quarterly Bulletin 2014 Q1, Bank of England, 14 March.

Morelli, M. (2018), Signoraggio Secondario, Banche e Creazione di Moneta: Un Sistema Insostenibile?, Università degli Studi di Macerata.

Norman, B., R. Shaw, and G. Speight (2011), The history of interbank settlement arrangements: exploring central banks' role in the payment system, Working Paper No. 412, Bank of England, June.

Moore, B. (1979), The Endogenous Money Stock, *Journal of Post Keynesian Economics*, 2(1), 49-70.

Moore, B. (1983), Unpacking the Post Keynesian Black Box: Bank Lending and the Money Supply, *Journal of Post Keynesian Economics*, 5(4), 537-556.

Onaran, Ö., E. Stockhammer, and L. Grafl (2011), Financialisation, income distribution and aggregate demand in the USA. Cambridge Journal of Economics, 35(4), 637-661.

Ravenna, F., and C. E. Walsh (2006), Optimal monetary policy with the cost channel, *Journal of Monetary Economics*, Vol. 53, Issue 2, March, 199-216.

Realfonzo, R. (2012), Circuit Theory, in J. E. King, The Elgar Companion to Post Keynesian Economics, Edward Elgar, 87-92.

Rochon, L.P., and M. Setterfield (2012). A Kaleckian model of growth and distribution with conflict-inflation and Post Keynesian nominal interest rate rules. Journal of Post Keynesian Economics, 34(3), 497-520.

Rossi, S, and L. P. Rochon (ed. by) (2003) Modern Theories of Money. The Nature and Role of Money in Capitalist Economies, Edgar, Edward Publishing, Inc.

Rossi, R., and L. P. Rochon (eds.) (2017), Post-Keynesian Economics, The International Library of Critical Writings in Economics series, Edward Elgar Publishing, Cheltenham, UK.

Soldatos, G. T., and E. Varelas (2015), On the Quantity Theory of Money, Credit, and Seigniorage, *The International Journal of Business and Finance Research*, Vol. 9 (5), 93-102.

Sinha, A., M. S. Dupertuis (2009), Sraffa's System: Equal Rate of Profits and the Notion of Centre of Gravitation, *Journal of Economic Behavior and Organization*, Elsevier, 71 (2), 495-501.

Sumner, S. (2019), Should the Fed Pay Interest on Bank Reserves?, *Monetary Policy Policy Briefs*, September 12.

Tobin, J. (1963), Commercial Banks as Creators of 'Money, Cowles Foundation Discussion Papers 159, *Cowles Foundation for Research in Economics*, Yale University.

Tötterman, K. (2019), The Eurosystem's two-tier system for remunerating excess liquidity holdings, *Bank of Finland Bulletin* 4/2019 – *Monetary policy*, 12 November.

Werner, R. A. (1997), Towards a New Monetary Paradigm: A Quantity Theorem of Disaggregated Credit, with Evidence from Japan, *Kredit und Kapital*, vol. 30, no. 2, July 1997, pp. 276-309.

Werner, Richard A. (2005), New Paradigm in Macroeconomics: Solving the Riddle of Japanese Macroeconomic Performance, Basingstoke: Palgrave Macmillan.

Werner, R. A. (2011), Economics as if Banks Mattered - A Contribution Based on the Inductive Methodology, Manchester School, 79, September, 25-35.

Werner, R. A. (2012), Towards a New Research Programme on 'Banking and the Economy' – Implications of the Quantity Theory of Credit for the Prevention and Resolution of Banking and Debt Crises, *International Review of Financial Analysis*, 25, 94-105.

Werner, R. A. (2013), Towards a More Stable and Sustainable Financial Architecture – A Discussion and Application of the Quantity Theory of Credit. *Kredit und Kapital*, 46 (3), 353-389.

Werner, R. A. (2014), How do banks create money, and why can other firms not do the same? An explanation for the coexistence of lending and deposit-taking, *International Review of Financial Analysis*, 36, 71–77.

Werner, R. A. (2016), A lost century in economics: three theories of banking and the conclusive evidence', *International Review of Financial Analysis*, Vol. 46, July, pp. 361–379.

Wheelock, D. C., and P. W. Wilson (2015), The Evolution of Scale Economies in U.S. Banking, *Economic Research*, Federal Reserve Bank of Saint Louis, Working Paper 2015-021C.

Williamson, S. D., (2016), Neo-Fisherism: A Radical Idea, or the Most Obvious Solution to the Low-Inflation Problem?, *Regional Economist*, Federal Reserve Bank of Saint Louis, July.

Wolfson, M.H. (1996). A Post Keynesian theory of credit rationing, *Journal of Post Keynesian Economics*, 18, 443–470.