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CENTRAL BANK BALANCE SHEETS UNDER FOREIGN EXCHANGE ACCUMULATION: INSIGHTS FROM ENDOGENOUS MONEY THEORY AND MONETARY POLICY IMPLEMENTATION

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ABSTRACT

The present article proposes to draw on the recent experiences of many central banks of advanced economies and the evolution of their operational frameworks in the new context of increased domestic liquidity, when analysing the operations of central banks that engage in exchange rate management and increase their official foreign reserves as a result. It argues that the theoretical literature on endogenous money set within the context of an open economy with an exchange rate objective needs to be amended to account for such developments, as it would be entirely possible for a central bank that accumulates substantial foreign reserves to adopt a floor system and thus maintain a near-perfect control over its policy interest rate without the need for any compensating measure. On the grounds of the reverse causation argument, establishing a direct link between the foreign reserves and the monetary base should not entail any quantitative effect on other economic variables.

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Central bank balance sheets under foreign exchange accumulation: insights from endogenous money theory and monetary policy implementation

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Abstract

The present article proposes to draw on the recent experiences of many central banks of advanced economies and the evolution of their operational frameworks in the new context of increased domestic liquidity, when analysing the operations of central banks that engage in exchange rate management and increase their official foreign reserves as a result. It argues that the theoretical literature on endogenous money set within the context of an open economy with an exchange rate objective needs to be amended to account for such developments, as it would be entirely possible for a central bank that accumulates substantial foreign reserves to adopt a floor system and thus maintain a near-perfect control over its policy interest rate without the need for any compensating measure. On the grounds of the reverse causation argument, establishing a direct link between the foreign reserves and the monetary base should not entail any quantitative effect on other economic variables.

Keywords: central bank balance sheets, endogenous money theory, foreign exchange accumulation, monetary policy implementation

JEL codes: E58, E42, E50

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INTRODUCTION

The open economy element of demand-led endogenous money theory embodied in the dedicated theoretical literature, arises from the possible presence of the monetary authorities on the foreign exchange market. Brought forward by Lavoie (2001, 2014, p.462-477, 2019, 2021) and referred to in the literature as the compensation thesis, these contributions analyse the nature of money and interest rate setting in a particular context, that of modern central banks having a share of their operations directed at managing the exchange rate parity. Its main theoretical arguments are often presented as opposed to any previously established notion of an automatic influence through quantities of the balance of payments position of the country on the domestic money creation. The compensation approach posits that the domestic liquidity effect of foreign exchange accumulation on the monetary base is inevitably compensated by the remaining components of the central bank balance sheet, either through reimbursement of previously acquired debt or as part of the daily interest rate targeting operations of central banks (Lavoie, 2001, 2014).

One of the arguments that back the claim of an automatic compensation of foreign currency receipts of the private sector arises from the workings of the reflux mechanism (Lavoie, 1999), which ensures that the supply of money adjusts to demand through the reimbursement of previously incurred debt, thus ruling out the possibility of a direct external influence over the domestic money supply. As pointed out by Arestis and Eichner (1988) and Lavoie (2001), the private sector would use the proceeds from its foreign currency receipts from abroad to reimburse its previously acquired debt with commercial banks. Consequently, these foreign receipts do not have an expansionary effect on domestic money supply despite modifying the aggregate liquidity position of the system, as commercial banks end up holding more central bank reserves than before. In case banks had previously been reliant on the central bank for the provision of reserves, the additional reserves would be used to reduce their indebtedness or continue to borrow in lesser amounts. Furthermore, any excess supply of central bank reserves following the workings of the reflux mechanism would be expected to be further absorbed by the central bank as a means to ensure its daily interest rate target, eventually creating the expected compensating effect on the central bank balance sheet.

The above interpretation remains in agreement with the proposition that the central bank accommodates the demand for reserves and offsets changes in autonomous factors, which had been the guiding principle for of the analyses of the nature of central bank operations from an endogenous money perspective and

it applied to the functioning of the major central banks under their pre-crisis operational frameworks (Lavoie, 2005; Fullwiler, 2013; Lavoie, 2014; Fullwiler, 2017, p.60-2). However, as their sustained recourse to unconventional monetary policies oversupplied their systems with domestic liquidity, many of these central banks put into force major changes in their operational frameworks as a means to maintain control over short-term interest rates by adopting versions of the floor system (Ihrig et al., 2020; Grossmann-Wirth, 2019; Åberg et al., 2021). In view of these developments from monetary policy implementation, endogenous money theory has been revisited to allow for an expansion the quantity of central bank reserves under such an operational framework (Lavoie, 2010). Nonetheless, the theoretical implications of the adoption of a floor system by central banks that accumulate foreign reserves, in particular with regards to the composition of their balance sheets, have not yet been put clearly forward in the literature. The present article argues that an endogenous money interpretation of central bank operations under foreign exchange accumulation does not need to rely on the existence of compensating balance sheet movements; and that in the absence of a conclusive relationship between foreign reserves and the monetary base, drawing on insights from monetary policy implementation could provide further support to the endogenous money interpretation of the movements on the central bank balance sheet.

The remainder of the article is structured as follows. Section 1 reviews the strands of empirical literature that analyse the balance sheet composition of central banks with an exchange rate objective; in particular, it underlines their shared observation of high and persistent levels of neutralization of the domestic liquidity effect of foreign exchange accumulation, despite stark differences in the interpretation of this phenomenon. Section 2 draws on insights from the evolutions in the operating procedures of a number of central banks recently confronted with an abundant supply of domestic liquidity, which resulted in a complete separation of the quantity of central bank reserves in the system from their short-term interest rate targets; it further argues that a similar course of action would be possible for central banks that expand their levels of official foreign reserves. Section 3 emphasizes the importance of paying close attention to the method of interest rate maintenance put in place by the central bank, when analysing the composition of its balance sheet. The last section contains the concluding remarks.

1 EMPIRICAL ANALYSES ON THE LINK BETWEEN FOREIGN RESERVES AND THE MONETARY BASE

The question of a possible existence or a mere absence of a causal relationship between foreign reserve accumulation and the process of domestic money creation, eventually brought forth a number of empirical studies that concentrate on evaluating the movements in central bank balance sheets in countries that engage in foreign exchange intervention. One particular strand of literature typically includes estimations of the degree to which the remaining components of the central bank sheet in aggregate responded to changes in foreign reserve accumulation, by that shielding the monetary base from its supposed influence. Despite the use of a wide range of empirical methods as well as countries under consideration, what these studies have in common, among other elements, are the estimations of various versions of the so-called sterilization coefficients (Cavoli and Rajan, 2006; Lavigne, 2008; Ouyang, Rajan and Willett, 2008; Aizenman and Glick, 2009; Cardarelli et al., 2009; Ouyang, Rajan and Willett, 2010; Ouyang and Rajan, 2011; Cavoli, 2017). The demand-led endogenous money interpretation of the operations of the central bank in an open economy, namely the compensation thesis, brought about a few empirical papers inspired by this approach (Lavoie and Wang, 2012; Angrick, 2018; Gerioni et al., 2022). These studies approach the issue by estimating the neutralizing effect of each relevant balance sheet component in response to movements in foreign reserves, instead of taking the remainder of the central bank balance as a distinct and separate variable, while leaving out the monetary base.

In the sterilization coefficients literature, the extent of these measures is different countries gets tested empirically on the basis of two variables derived from the basic central bank accounting identity. The first, net foreign assets, is a rather standard one. The second, the previously mentioned aggregate variable called net domestic assets (or alternatively, domestic credit), can be obtained as the difference between the monetary base and net foreign assets. This implies an intrinsically negative relationship between these two variables, as net domestic assets in aggregate would need to decrease so as to neutralize the implied effect of an increase in foreign reserves on the monetary base. On that account, the estimated sterilization coefficients for the analysed countries are supposed to represent the extent to which the changes in aggregate domestic assets on the central bank balance sheet neutralize the impact of the movements in foreign reserves on the

monetary base¹. The results of these empirical studies predominately disclose a partial, yet often very strong neutralizing effect of net domestic assets when responding to changes in foreign assets, while a number of studies also report an even stronger opposite effect on the monetary base compared to the change in foreign reserve accumulation. Therefore, the results derived from this strand of empirical literature seem to suggest that a directly proportional effect of an increase in foreign exchange reserves on the monetary base had been usually absent in the analysed countries during the observed periods. Consequently, these findings imply that the rest of the central bank balance sheet constituted a counterweight for the movements in foreign reserves in the majority of observed cases of central bank intervention. In a sense, these studies apply more advanced econometric techniques to test the relationship between the variables previously analysed by Nurkse (1944, ch.4) and Bloomfield (1959, p.47-51), where predominantly opposite movements in foreign assets and domestic assets were observed on a year-to-year basis on the balance sheets of a number of central banks under study, during the inter-war period and the pre-1914 gold standard years, respectively.

The empirical studies that build upon the insights of the compensation thesis approached the issue instead by estimating the relationship between foreign reserves and the monetary base, as well as between foreign reserves and a number of separate balance sheet components that could play a role in neutralizing the effect of foreign exchange intervention on domestic liquidity. Therefore, these studies do not take the overall central bank balance sheet into consideration, but rather only the components through which the central bank can further influence domestic liquidity conditions. Notably, the central bank components taken into account include narrower balance sheet categories, such as net domestic credit of the commercial banks vis-a-vis the central bank, the purchase and sale of government bonds from and to banks, the issuance of central bank bonds and moving government deposits between the accounts of the central banks and the commercial banking sector, following the discussion on balance sheet representation outlined in Lavoie (2001). For example, in line with the previous theoretical discussion and through the workings of the reflux mechanism, commercial banks that end up holding central bank reserves in excess of their payment and reserve requirements needs are expected to reduce their previously incurred debt reserve balances towards the

¹ The sterilization coefficient could therefore take values between 0 and -1, where 0 implies the absence of a neutralizing effect and consequently a direct one-to-one effect of foreign reserve accumulation on the monetary base, while -1 implies no change whatsoever. A coefficient lower than -1 would represent an even stronger response of the domestic asset variable to the observed change in foreign reserves.

central bank, thus reducing their claims on the asset side of the central bank balance sheet. Additionally, the issuance of central bank bills is supposed to represent this commonly used instrument for liquidity absorption, where central banks offer this safe and liquid asset in exchange for central bank liquidity, at a rate higher than the rate of remuneration of excess reserves. Both the studies of Lavoie and Wang (2012) and Angrick (2018) disclose an absence of a long-term relationship and between foreign reserves and the monetary base, while they report a significant and sustained relationship between foreign reserves and the other relevant balance sheet components.

While the empirical studies inspired by the compensation thesis have the apparent advantage of paying closer attention to actual central bank practices, the possible central bank instruments that could be responsible for the observed neutralization effect have not been completely overlooked by the sterilization coefficients literature. However, despite being generally absent from the empirical estimations, a mention of current monetary policy implementation practices appear in a number of these studies and usually involve a wider range of instruments that modern central banks have at their disposal beyond the commonly acknowledged open market operations. These would include the majority of instruments pointed out by Lavoie (2001) that could be employed by monetary authorities, including the issuance of central bank securities, transfer of government deposits with the accounts held at commercial banks, repurchase agreements and reverse repurchase agreements, but also foreign exchange swaps (Ouyang, Rajan and Willett, 2008, p.178; Aizenman and Glick, 2009, p.779-80; Cardarelli et al., 2010, p.341).

In addition, recent sterilization coefficient studies take a step further by incorporating some of these instruments in the empirical estimations. Analysing the case of China in the empirical analysis conducted by Yang (2016), the emissions of central bank bills are analysed separately from the broader category of net domestic credit in order to estimate the extent of their role in the neutralisation of foreign reserve accumulation. Furthermore, recognising the possible compensating role of reserve requirements employed by the People's Bank of China, Wang et al. (2019) modify the standard sterilization coefficient framework by separating the changes in these reserve requirements from the monetary base and including them together with the remaining components of the central bank balance sheet, as they find that the failure of accounting for these changes in the reserve ratios in the case of China would lead to an underestimation of the degree of sterilization. The compensating effect of these two instruments on the balance sheet of the Chinese central bank has been equally observed in the empirical studies of the compensation thesis (Lavoie

and Wang, 2012; Angrick, 2018). Moreover, while Li et al. (2021) do not take these requirements as a separate instrument, they report a significant relationship between foreign reserves and the monetary base for the case of China for the years during which the central bank relied more extensively on changes in the reserve ratios, an effect which was later subdued by a more intensive liquidity absorption through the use of central bank bills.

Therefore, it appears that the results of both strands of empirical literature amount to one general observation, that substantial and sustained foreign exchange intervention failed to provoke a prolonged expansion of reserve money. Recent experiences in the countries covered by these studies, predominantly Asian economies that engaged in exchange rate management policies over the last two decades, seems to have left little room to continue to assume a straightforward and inevitable influence of foreign exchange accumulation on reserve money. An important question that could thus arise are the broader consequences of these developments, including the changes in the central bank balance sheet composition that ensue, for the way in which the question of money creation gets approached in a context of an open economy. Considering that these two strands of empirical literature build on different theoretical approaches, significant differences in the interpretation of the observed phenomenon exist and seem rather substantial.

The studies dedicated to estimating sterilization coefficients suppose an inevitable monetary impact of reserve accumulation that the sterilization policy is meant to counteract. Moreover, as already pointed out by Disyatat (2008), this strand of literature seems to consider the observed degree of sterilization as a matter of policy choice for the central bank through which it can further influence macroeconomic conditions, an approach which ‘can potentially lead to inappropriate interpretations of central bank actions’ (*ibid.*, p.18). In contrast, the compensation thesis literature considers the neutralization of domestic liquidity stemming from foreign exchange intervention as either a result of the commercial banks reimbursing previously acquired reserve balances from the central bank through the reflux mechanism, or as part of the defensive liquidity management operations that the central bank undertakes so as to achieve the targeted level of the base interest rate (Lavoie, 2001, 2014). Even in a liquidity context dictated by substantial increases in the aggregate supply of central bank reserves stemming from the presence of the monetary authorities on the foreign exchange market, the compensating effect on the central bank balance sheet in managed exchange rate regimes could nevertheless be interpreted as a by-product of the attempts of the central bank to keep its interest rate at its target level.

These supposed monetary implications of reserve accumulation are outlined, for example, in Aizenman and Glick (2009), where it is assumed that a central bank which accumulates foreign reserves ‘must decide whether to fund it by increasing the reserve money base, which is potentially inflationary, or by reducing its net domestic assets, which sterilizes the impact on the domestic reserve money base’ (*ibid.*, p.779). In a rather similar way, by assuming an influence of foreign reserve accumulation on money supply, Cavoli (2017) carries on to consider the degree of sterilization as an instrument of monetary policy *per se*, estimating the factors that determine the extent to which central banks might engage in sterilization. However, such assertions would seem to attribute a much larger function of the degree to which foreign reserves get compensated on the central bank balance sheet, compared to approaching the issue through the lens of post-Keynesian endogenous money theory. As previously mentioned, since the ultimate operational tool of central banks could be nothing else but a short-term rate on its liabilities, the extent of neutralization of the autonomous factors could be considered a by-product of the defensive operations of the central bank, rather than a separate tool at its disposal. In addition, as the size of the monetary base is considered to be of no consequence for the money creation process, using the reverse causation argument, the extent to which these movements get compensated on the central bank balance sheet in itself should not have a direct influence through quantities on broader macroeconomic conditions.

While sceptical of the usefulness of analysing quantities when empirically testing the degree of sterilization, notably through estimating sterilization coefficients, Disyatat (2008, p.17) points out that the liquidity effect of foreign exchange intervention could be considered fully sterilized even if it does not entail a liquidity-absorbing operation of the same amount, due to a possibly changing demand for reserve balances in the system. Such statement could be considered rather in line with the claims of the compensation thesis literature, where it is implied that for the central bank to be able to achieve its interest rate target, it would need to ensure that the supply of reserve balances in the system corresponds to the demand for reserves at the targeted level of interest. This would mean that as the accumulation of foreign exchange reserves and the monetary base are assumed to have different determinants, the compensation on the central bank balance sheet would need to happen to the extent which could prevent large swings in interest rates and make sure that the target for the base interest rate gets attained. In addition, consistent with the claim that compensation is inherently a result of interest rate targeting operations, Disyatat (*ibid.*, p.17) acknowledges that ‘the liquidity impact

of foreign exchange intervention is much the same as that of changes in one of the autonomous factors and as such, must be offset in order to maintain aggregate reserve balances in line with demand'. In other words, the central bank would need to engage in defensive operations so as to maintain the targeted level of its base interest rate no matter what the source of the increase in reserve balances, one of which could be foreign exchange accumulation.

2 INSIGHTS FROM MONETARY POLICY IMPLEMENTATION AND POST-CRISIS OPERATIONAL FRAMEWORKS

While in the years preceding the global financial crisis the expansion of central bank balance sheets had been largely attributable to foreign exchange intervention of a number of countries that engaged in exchange rate management, the so-called unconventional monetary policies of the last decade were the main contributing factor for the substantial increase in the size of the central bank balance sheet of several advanced economies (BIS, 2019). The sustained recourse to these policies had generated a turnabout in the aggregate liquidity positions of their respective banking systems, which were previously reliant on their central banks for the provision of reserve balances. As reserves were now abundant, the central banks of these countries adopted major changes in their operational frameworks in an effort to regain control over their base interest rates, thus establishing versions of the so-called floor system (Ihrig et al., 2020; Grossmann-Wirth, 2019; Åberg et al., 2021).

Under this operational framework, the targeted rate of interest being set at the rate at which these reserves get remunerated, the central bank could allow for substantial increases of the supply for central bank reserves while retaining near-perfect or perfect control over the interest rate being targeted. Therefore, the central banks that adopted the floor system could achieve their main policy rate independently of the level of central bank reserves, as under this operational framework there is a complete decoupling of these two variables (Borio and Disyatat, 2010, p.56). Such changes in the operational procedures therefore resulted in sizeable expansion of the monetary base in these countries, as with a floor system there is no need for central banks to engage in extensive liquidity-absorbing operations for the purposes of interest rate targeting. As noted by Lavoie (2010, 2014, p.224-5), the recent experiences in the countries that adopted this operational framework challenge any notion of a causal relationship between reserves, money and prices. Moreover, the actual outcomes of the quantitative easing policies

implemented during this time leave little space to ascertain the existence of a direct effect through quantities, from reserves to broader economic activity (Lavoie and Fiebiger, 2018). However, these insights from monetary policy implementation remain consistent with demand-led endogenous money as they give support to the reverse causation argument, even though the determination of the monetary base could not be considered endogenous under a floor system. The characteristics of these operational frameworks and the experiences of the central banks that have implemented them have been analysed in great detail by a number of post-Keynesian authors (Lavoie, 2010; Fullwiler, 2013; Bouguelli, 2022).

In the dedicated theoretical literature, the essential characteristic of the compensation thesis as an approach to money creation in an open economy continues to be exemplified by the existence of compensating movements to foreign reserves on the central bank balance sheet. In a recent definition, Lavoie (2021) points out that ‘the claim of the compensation thesis is that purchases of foreign currency by the central bank, so as to avoid the appreciation of the domestic currency, do not lead to an increase in the monetary base despite the increase in foreign exchange reserves on the asset side of the central bank balance sheet, and vice versa when the central bank sells foreign currency’ (p.14). Furthermore, the compensation thesis gets equally defined as ‘the belief that foreign reserves can be systemically sterilized’ (*ibid.*, p.15). Such emphasis on the systemic and the inevitable nature of the compensation of foreign reserves in the theoretical literature would be rather unsurprising since, as seen previously, it appears to closely correspond to the actual experiences of a large number of countries that engaged in foreign exchange accumulation. In addition, the introduction of demand-led endogenous money analysis in an open economy had been put forward to challenge any previously established notion of an automatic influence through quantities of the external position of a country on its domestic money supply. Accordingly, breaking the link between foreign reserves and the monetary base on the central bank balance sheet means disproving the existence of the first level of functioning of this mechanism.

However, it would be important to note that the interpretation of the compensation process relies on the idea of an endogenously determined monetary base, where the central bank ensures that the supply of reserve balances in the system corresponds to the demanded amounts at the targeted level of interest. The compensating effect on the central bank balance sheet could thus be considered inevitable and systematic, only if both the money supply and the monetary base are considered to be determined by demand. This widely acknowledged proposition by post-Keynesian authors, that the central bank accommodates the demand for

reserves and offsets changes in autonomous factors, had been the guiding principle of the analyses of the nature of central bank operations from an endogenous money perspective and it applied to the functioning of the major central banks under their pre-crisis operational frameworks (Lavoie, 2005; Fullwiler, 2013; Lavoie, 2014; Fullwiler, 2017, p.60-2). Therefore, the amount of reserves cannot be considered completely decoupled from the targeted interest rate, regardless of the aggregate liquidity position of the system. Before the outburst of the global financial crisis, many central banks of the major advanced economies have been conducting their operations in a context of structural indebtedness of their banking sectors vis-à-vis the central bank, therefore making sure to provide sufficient liquidity at the targeted interest rate. For countries accumulating foreign exchange reserves, the operations of the central bank should be expected to be primarily liquidity-absorbing, so as to neutralize the increases of domestic liquidity created by these interventions to the demanded levels at the targeted interest rate. Whichever the case, attaining this target would require central bank operations that counter the movements in the autonomous factors, creating thus a compensating effect on its balance sheet.

Nevertheless, the liquidity effects of the various lending and asset-purchase programs conducted at a massive scale in the aftermath of the crisis by several major central banks, imposed changes in the operational frameworks with meaningful implications for monetary theory. By adopting the so-called floor system, these central banks allowed for their monetary bases to expand substantially, while simultaneously maintaining perfect control over their respective base rates of interest. These recent insights from the actual monetary policy implementation procedures of central banks remain consistent with the notion of endogenous money supply, even though the monetary base under a floor system could no longer be considered demand-led. As pointed out by Lavoie (2010, 2014, p.225), under this operational framework there would thus be neither the need for the central bank to engage in liquidity management operations in order to maintain control over its base rate of interest, nor would the supply of reserves automatically adjust to demand through a reflux mechanism as there would be no previously incurred debt to the central bank for the banking sector to reimburse with reserve balances, which would happen if the increases in the supply of liquidity are large enough. Consequently, the defensive operations in response to the movements of autonomous factors would be needed under the so-called corridor and no-interest-on-reserves systems, yet in the special case of a floor system, the central bank could attain its base interest rate even if the monetary base expands to levels substantially surpassing the demanded amounts.

While endogenous money theory has been revised in light of these insights from monetary policy implementation, the implications of the adoption of this particular operational framework have not yet been put clearly forward in the literature on the compensation thesis. From a monetary policy implementation perspective, as indicated by Bindseil (2004, p.46), the autonomous factor items on the central bank balance sheet are those that represent transactions that ‘are not controlled by the monetary policy function of the central bank, while at the same time all in principle include a leg in domestic currency, such as that they affect the scarcity of reserves of banks with the central bank’ (ibid., p.46). This means that while their movements could not be considered completely outside of the sphere of influence of the monetary authorities, they rather reflect the functions of the central bank that go beyond targeting the base interest rate level. In addition, not every balance sheet item other than central bank reserves and monetary policy instruments could count as an autonomous factor, as only those that generate inflows or outflows of domestic reserve liquidity in the payment and settlement system would possibly require a compensating measure. The various lending and asset-purchase programmes as part of the so-called unconventional measures could be thus considered as autonomous factors, since they are put in place by the monetary authorities, could not be counted as operations directly aimed at targeting the base rate and have significant aggregate liquidity effect on the system. However, such is the case for foreign exchange intervention, as these policies have a different intended aim, but ultimately influence domestic liquidity conditions. Therefore, there would be no compelling reason to assume that a central bank could not adopt a floor system while engaging in foreign exchange intervention. Accordingly, an inevitable compensating response to movements in foreign reserves on the central bank balance sheet would thus be applicable only if the central bank under analysis implements monetary policy within a framework other than a floor system.

As a case in point, Borio and Disyatat (2010) place together the exchange rate policies, as well as the lending and asset-purchase programs into one broader group of balance sheet policies, through which the central bank can ‘affect directly market prices and conditions beyond a short-term, typically overnight, interest rate’ (ibid., p.53). They further assert that as long as central banks have the means to decouple these two policies, notably through the adoption of a floor system, balance sheet policy can be pursued independently of the interest rate policy. Lavoie (2010, p.15), however, questions the usefulness of an independent reserve supply policy, with reference to the reverse causation argument. Alternatively, it could be argued that

one common trait of central banks that accumulate foreign exchange reserves and those that undertake some kind of asset-purchase programmes, is that both types of central banks attempt to maintain control over their main policy rate, while at the same time seeking to influence economic conditions through variables other than the base rate of interest, that is through the exchange rate or longer-term asset yields, respectively. On that account, the resulting increases in central bank liquidity could thus be considered instead as a by-product of these policies, without a further supposed quantitative effect on other economic variables. This should be the case regardless of the autonomous factors that acts as a source of increased domestic liquidity in the system.

Long time reserved for countries that pursued exchange rate policies, these recent changes in the operational procedures of central banks help throw some additional light on the question of liquidity management and interest rate targeting in a situation of surplus liquidity. As part of its interest rate targeting operations when the banking system gets oversupplied with liquidity, the central bank would need to either undertake compensating measures to the movements of these autonomous factors in the case of a corridor or no-interest-on-reserves system, or decouple the level of reserves from the base interest rate and allow for the monetary base to rise, through a floor system. Therefore, it could be claimed that compensation of foreign reserve inflows could be observed only in the cases where the monetary authorities chose an operational framework other than the floor system for their interest rate targeting operations. By emphasizing the importance of the operational framework in place with regards to the size of reserves on the central bank balance sheet, it becomes even more evident that sterilization cannot be considered a separate policy, neither something reserved only for countries that intervene on the foreign exchange market. Revisiting the question of the extent of sterilization and its supposed relevance, Disyatat (2008, p.17) called into question the usefulness of measuring the degree of sterilization through quantities based on the argument of a shifting demand for reserves, somewhat compliant with the assertion of Lavoie (2014, p.474) that in a growing economy, a positive correlation between foreign and domestic assets does not disprove the operation of a compensation mechanism. The introduction of the possibility of a floor system would add one more element to the argument, as the extent to which the movements in foreign reserves get compensated could not be considered attributable only to changes in the demand for high-powered money, but also to the type of framework through which the central bank implements monetary policy. Decoupling the amount of reserves from the targeted interest rate, could therefore greatly reduce the extent of sterilization

of foreign exchange reserve inflows on the monetary base. However, because of reverse causation, there should be no reason to believe that a partial or incomplete sterilization on a central bank balance sheet could be intended as an accompanying policy measure, or be used by monetary authorities as such.

Provided that the supply of central bank liquidity is large enough, under a floor system, it could be that the central bank perfectly achieves its base interest rate target, without the need to engage in any monetary policy operations whatsoever. As an example, the situation of a central bank targeting interest rates in a system with ample reserves have been thoroughly explored by Ihrig et al. (2020) and Bouguelli (2022) in the case of the Fed. Similarly, as long as the resulting liquidity from the foreign exchange accumulation is substantial, it should be entirely possible for a central bank that intervenes on the foreign exchange market to be able to have a perfect control over its base interest rate without a further use of the possible compensating instruments at its disposal. In this case, adopting a floor system would make foreign reserves and the monetary base move together on the central bank balance sheet. However, here the reverse causation argument becomes crucial. Establishing a direct and proportionate link between foreign reserves and the monetary base could not bring back any automatic adjustment mechanism through quantities. As long as it is assumed that the quantity of central bank reserves does not influence money creation and broader monetary conditions, the demand-led theory of endogenous money set within the context of an open economy with central bank purchases of foreign currency continues to be valid, even with an absence of compensation on the central bank balance sheet.

3 APPROACHING THE ISSUE OF COMPENSATION ON A CASE-BY-CASE BASIS

Taking all of these arguments into account, the absence of a conclusive relationship between foreign reserve and the monetary base could therefore by no means prevent an endogenous money analysis of the operations of central banks. Instead, the insights from monetary policy implementation could be useful in interpreting the overall composition of the central bank balance sheet as well as the movements in its components. The monetary base thus far figured in the analysis in its entirety, consistent with the theoretical debates on the subject. As a result, all non-interest-bearing liabilities issued by the central bank were treated as one, joining together central bank balances held by the commercial banks with currency in circulation. However, there seems to be little doubt in the monetary implementation literature

about the demand-led nature of the amount of banknotes held by the general public and commercial banks, considering them instead an autonomous factor of domestic liquidity, as exemplified in Bindseil et al. (2004, p.49) and Rule (2015, p.8). These claims are consistent with endogenous money theory, as post-Keynesian authors have long asserted that in case more banknotes are in circulation compared to demand, the exceeding supplied amounts would adjust to demand through a reflux mechanism (Lavoie, 1999), as economic agents would exchange these banknotes for deposits to further use these proceeds for the reimbursement of previously incurred debt; moreover, that any transactions that involve banknotes between the the private sector and the central bank via commercial banks would modify the aggregate liquidity position of the system (Lavoie, 2014, ch.4). By issuing banknotes, the central bank does nothing more than accommodate the demand by commercial banks and the general public, such that ‘rather than being a source of bank deposit creation - an increase in currency of circulation is, if anything, a response to bank deposits creation.’ (Fullwiler, 2017, p.58). The monetary authorities would continue to provide banknotes on demand in order to ensure the smooth functioning of the system. Therefore, since being the provider of cash balances to the economy constitutes a function of the central bank that remains outside of its monetary policy function, the inclusion of this balance sheet component in the list of autonomous factors becomes even more apparent. As a direct consequence, when looking through the lens of the workings of the payment and settlement system, the existence of currency in circulation on the central bank balance sheet not only serves a completely different purpose than the remaining component of the monetary base i.e. central bank reserves, but also the variations in the amount of banknotes held by the general public ultimately result in corresponding changes in the aggregate reserve liquidity of the system.

It would be thus important to note that unlike central bank reserves, the assumption of the endogeneity of currency in circulation should apply regardless of the operational framework of the central bank in question. While the possibility for shifting demand for banknotes remains - as related to, for example, seasonal factors, changing payment methods or ultimately by the growth rate of the economy - as long as there is a demand for cash balances the central bank would have no choice but to accommodate it. As a result, relaxing the assumption of an endogenous monetary base in the case of a central bank that implements a floor system, would apply primarily to the central bank reserve portion of the monetary base. For a central bank with an exchange rate objective, the aggregate liquidity position of its banking sector would not depend exclusively on the extent of the official foreign

exchange accumulation, but also on the position of every other autonomous factor. The balance sheet representation put forward by Bindseil (2004, p.48) and presented in table 1, could be used in support of the following argument. As previously noted, if the central bank enacts an operational framework other than a floor system, upholding the interest rate target would require a recourse to its monetary policy instruments as a means to adjust reserve supply to the corresponding demand. With a floor system in a context of substantial reserves, the actual position of the autonomous factors would directly determine the prevailing level of reserves in the system. Whichever the case, the residual variable linked to the interest rate targeting efforts of central banks are the reserve balances held by commercial banks, not the monetary base.

Autonomous factors	
Assets	Liabilities
Foreign currency incl. gold	Banknotes in circulation
Investment assets	Government deposits
Other assets	Capital and reserves
	Other liabilities
Monetary policy operations	
OMO I (e.g. reverse operations)	Liquidity-absorbing OMO I (e.g. reverse operations)
OMO II (e.g. outright holdings of securities)	Liquidity-absorbing OMO II (e.g. issuing debt certificates)
Liquidity-injecting standing facility	Liquidity-absorbing standing facility
Reserves of banks (including those to fulfil required reserves)	

Table 1: Central bank balance sheet representation from Bindseil (2004, p.48)

This balance sheet representation is rather consistent with the one provided in Lavoie (2001) as it contains the same components, with table 1 further separating them in two categories: those connected to the supporting functions of the central bank, exemplified by the autonomous factors; along with those stemming from the monetary policy function, such as the monetary policy operations. Apart from any exceptional measures such as extensive asset-purchase programmes, the foreign reserve accumulations stands as the main autonomous factor that contributes to increased liquidity, as banknotes and government deposits have a negative effect on the aggregate liquidity position of the banking sector. The analysis of the compensation process provided in Lavoie (*ibid.*) somewhat applies to the cases where the effect of foreign exchange accumulation has not yet greatly surpassed that of the remaining autonomous factors, so that compensation could still be

partly achieved through the reimbursement of previous recourse to the liquidity-providing standing facilities or acquiring government bills held by the monetary authorities, thus making the distinction between overdraft and asset-based system, respectively. However, in the special case of ample reserves, either from foreign exchange accumulation or special asset-purchase programmes, such distinction would no longer be visible at the junction between commercial banks and the central bank, as banks would now dispose of substantial reserve liquidity, with no previous debt to reimburse in aggregate thus removing the need for monetary policy operations on the asset side of the central bank balance sheet. In a reversed liquidity position from the example presented in Lavoie (1992, p.165-7) due to substantial expansion of domestic liquidity incurred in the past, commercial banks could exchange these reserve balances for banknotes with the central bank should the demand for holding cash by private agents increase. Consequently, the composition of central bank liabilities on its balance sheet would be modified, with the amount of reserves acting as the residual variable.

In the wake of the above arguments, the size of the reserves held by the commercial banks on the balance sheet of the central bank could be said to reflect not only their demand, stemming from their payment and settlement needs as well as their obligation to fulfil reserve requirements where applicable, but also on the operational framework put in place by the central bank. For that reason, it could be ultimately argued, as pointed out by Fullwiler (2017, p.70-73), that the quantity of reserve balances held by the commercial banking sector on the central bank balance sheet gets principally determined by the method of interest rate maintenance employed by the monetary authorities at a given point in time. As a direct consequence, the reasons for the movements of this residual variable on the central bank balance sheet could not be fully grasped if analysed separately from the operating procedures put in place by the monetary authorities at the given moment. Correspondingly, valuable insights for the interpretation of central bank operations could be drawn by focusing on the evolution of the operational frameworks in separate countries, as well as taking into consideration the institutional particularities that surround them.

Two observations that have their origins in actual operational practices of central banks would need to be pointed out, which can serve as an additional guideline to any balance sheet analysis. First, while these entries outline the broad balance sheet categories, possibility of a change in the function of the balance sheet components or their constituent elements exists, depending on the institutional structure of each country under study. Moreover, the interpretation of the compensating movements

as being domestic liquidity management operations aimed at maintaining control over the target for the base interest rate, relies on the assumption that all foreign currency inflows get transferred into domestic currency. Nevertheless, in practice, it is possible that foreign currency elements exist as part of these broad balance sheet components, which could be subject to a rather different interpretation.

Accordingly, while keeping government deposits on the balance sheet of the central bank could be considered as an autonomous factor for it arises from a supporting function of the central bank, the transfer of deposits between the accounts of the government with commercial banks and with the central bank could also have a monetary policy function in some cases, if the intention behind its day-to-day use is maintaining control over the base rate target. Such measure has been in force, notably in Canada (Lavoie, 2005), but also in the US before the advent of quantitative easing, with the use of the Treasury tax and loans accounts at commercial banks. In the case of central banks that enforce mandatory reserve requirements on domestic currency deposits with averaging provisions, the reserves held for the purposes of fulfilling this obligation could not be separated from the overall level of central bank reserves held by the commercial banking sector. Under this arrangement, banks are allowed to use the reserve balances for their payment and settlement needs in the course of the maintenance period, as such the excess of reserves held above these requirements by banks could be calculated only in relation to the imposed amounts. Both the monetary policy literature and endogenous money theory assign the desire to even out demand for reserves through the maintenance period for the ultimate purpose of stabilization of short-term interest rates, as the principal motivation behind the use of requirements with averaging provisions of more than one day (Bindseil, 2004, p.197-201; Fullwiler, 2017, p.63-4), rather than absorbing central bank reserves from the system. However, should the central bank impose reserve requirements on a fixed basis without the possibility of averaging, in addition to remunerating these required amounts, such measure could be considered closer in function to a liquidity-absorbing monetary policy instrument. These type of requirements have notably been employed in China (Ma et al., 2011).

Finally, apart from their exclusion from the monetary policy function of the central bank, the second part of the definition of autonomous factors by Bindseil (2004, p.46) requires that these components ultimately have an influence on the quantity of central bank reserves in the system. Comparably, following the theoretical interpretation of the compensation thesis, central banks engage in compensatory measures in order to offset the domestic liquidity effect and attain their short-term

interest rate target. As such, only foreign currency inflows that ultimately get transferred in domestic currency could be subject to compensating measures, depending on the operational framework in place. Components or sub-components of the broad categories of the central bank balance sheet could be denominated in foreign currency, modifying thus its composition, sometimes contributing to its expansion without an accompanying increase in domestic liquidity. The reasons behind their existence could be many: a result of attempts by the monetary authorities to impede a further spread of the use of foreign currency in the context of a partial dollarization of the country in question; or an outcome of efforts to maintain a backing of the domestic currency with foreign reserves in an a situation of an unfavourable balance of payments under a currency board regime (De Lucchi, 2013).

CONCLUSION

Foreign exchange accumulation of central banks has for a long time been the most common source of sustained domestic liquidity expansion, until the monetary authorities of a number of advanced economies instigated monetary policy responses that were previously deemed unconventional, oversupplying their systems with domestic liquidity at an unprecedented scale. The present article argues that regardless of the source of domestic liquidity expansion, modern central banks on a daily basis continue to enforce their monetary policy objective by means of controlling a short-term interest rate target. On that account, when confronted with domestic liquidity expansion brought on by foreign exchange accumulation, central banks should be able to adopt a floor system, upholding their daily interest rate targets without the need for a recourse to the monetary policy instruments at their disposal. While the implementation of a floor system in such situations would fail to produce the effect on the central bank balance sheet put forward by the literature on the compensation thesis (Lavoie, 2001, 2014, 2019, 2021), the present article argues that these developments remain consistent with endogenous money theory, thanks to the reverse causation argument. In the special case of the floor system, central banks do not need to engage themselves into compensating measures when they intervene on foreign exchange markets. The adoption of this interest rate targeting method in the midst of persistent foreign exchange accumulation would inevitably modify the relationship between official foreign reserves and the monetary base on the central bank balance sheet. Through the prism of endogenous money theory, these developments could be above all regarded as an outcome of the

change in the operational framework rather than an adjustment of the monetary policy stance, since the resulting expansion of central bank reserves could not be expected to exert a direct influence on broader economic conditions, or be used by the monetary authorities for that distinct purpose.

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