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The Effective Rate of Interest on Target Balances

Abstract

While the formal decision of the ECB Council to impose interest on Target claims and liabilities is meaningless, this paper shows that the pooling of primary interest income among national central banks in the Eurozone implies that Target and cash balances do, in fact, bear an effective rate of interest. The magnitude of this effective rate of interest is given by a weighted average of the ECB's policy interest rates where (i) the relative country sizes and (ii) the uses of alternative sources and sinks of international liquidity flows determine the weights. Without countervailing transactions, which would effectively service the Target claims and liabilities, Target balances grow with compound interest. The payment of interest on Target balances internalizes the competitive externality that otherwise could induce excessive money supply in a decentralized monetary system of the kind characterizing the Eurozone. It also implies that the recording of Target balances in the balance sheets of national central banks is compatible with fair value accounting.

Highlights

- The Eurozone's Target and cash balances carry an effective rate of interest.
- The effective rate of interest is a weighted average of the ECB's policy rates.
- Target balances grow with compound interest.
- Aizenman's competitive seignorage externality is absent in the Eurozone.
- Target balances are recorded in line with fair value accounting.

JEL-Codes: E400, F410, F450, H600.

Keywords: Target2, ECB, interest, competitive seignorage externality.

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1. Introduction

China's huge foreign reserve position, 25% of GDP in 2018,[1] mostly vis-à-vis the US has been widely discussed.[2] In Europe, Germany's equally large net position of about 28.5% of GDP or 966 billion euros in the Target clearing system (also 2018) has still received surprisingly little attention in the general debate although their potentially "explosive" character has been documented.[3]

A key question to assess whether the risks are comparable is whether these net-claims are akin to interest bearing assets, like US government bonds for instance. This paper argues that the Target claims are in a number of respects indeed similar. While the Target claims cannot be called due, they are open positions among national central banks (NCBs) that qualify as credits. Moreover, the paper will show that they bear an effective rate of interest, and even compound interest, implied by the ECB's policy rates and the respective economies' payment habits. This result is not trivial as Target balances formally imply interest payments among the NCBs during a year which is then nullified by the pooling and redistribution of all NCB interest income by the end of the year.

This result is also relevant for the question of whether a loss of Target balances after an exit from the Eurozone or after the collapse of a national financial system might involve real resource losses for the Target creditor countries. After all, Target claims result from a net transfer of goods and assets to other countries, and the stream of interest income they generate would be part of a return whose present value is equivalent to the value of goods and assets transferred.

Finally, the interest on Target balances works against the sort of competitive externalities analyzed by Aizenman (1992). Aizenman analyzed a currency union with decentralized provision of central bank money by local central banks, which arguably have some similarities with the powerful national central banks (NCBs) of the Eurosystem. He showed that such a decentralized union may suffer from an incentive to oversupply money balances relative to the optimal inflation tax as specified by Phelps (1973), because agents do not take into account that the increase of inflation that they cause reduces the demand for money created by other local central banks, thus shifting the economy to the wrong (elastic) side of the Laffer curve. If seignorage does not come from the inflation tax but from interest income the local central banks earn by lending out central bank money to commercial banks or by buying interest bearing assets, basically the same distorted incentive structure due to a

[1] See International Monetary Fund (2019a, 2019b).
[2] Cf. e.g. Shi and Nie (2012), Neely (2017) and Reuters (2019).
[3] See Potrafke and Reischmann (2014). Cf. Deutsche Bundesbank (2019a).

negative competitive externality would result, provided the local central banks could keep the extra primary interest income they collect from their monetary policy operations and distribute it to local governments. However, as I will show, the interest on Target balances means that this extra primary interest income cannot be be kept by the respective NCB but must be transferred to other NCBs to compensate them for the reduced scope for also lending out money balances. Thus, the intra-Eurosystem interest payments on Target balances help reduce, if not eliminate, the competitive externality Aizenman described.

My result complements previous studies by Sinn and Wollmershäuser (2012), Steinkamp und Westermann (2014) and Tornell (2018), who called Target claims "loans" or "automatic loans". It also supports Reinhart (2018) who argued that Target debt should be added to normal public debt to assess a country's financial sustainability and Aizenman, Cheung and Quian (2019) who speak of "swap line arrangements" and "credit lines". Finally, the ECB's view that Target claims are valuable titles that need to be booked in the balance sheets of NCBs and would have to be redeemed in full, should a country wish to leave the Eurosystem (Draghi 2017), also finds support in this paper.

2. The Construction Principles of the Eurozone and the Credit Question

The Eurosystem is organized in a decentralized manner. It consists of a set of NCBs which carry out most of the monetary policy operations coordinated by the European Central Bank (ECB). The NCBs are owned by the respective nation states and distribute their profits to them. The NCBs sustain an international public payment system named Target.[4] Net payment orders between the countries of the Eurozone which are made to buy goods and assets and to repay foreign debt may lead to non-zero Target balances. The NCB of a country making net payment orders incurs a Target liability, and other NCBs that carry out net payment orders acquire Target claims. Both claims and liabilities relate to the entire system and are reported in the annual balance sheets of the respective NCBs. The balances are part of a country's net foreign asset position as published by Eurostat.

The positive and negative balances were about zero at the time of the Lehman crash, but have grown to sizeable numbers during recent years, way beyond 1000 billion euros in absolute terms. They are the largest single items in some of the NCB balance sheets. ECB President Draghi said he observes the Target balances "Every day actually, not almost every

[4] Target is an acronym standing for "Trans-European Automated Real-time Gross Settlement Express Transfer System". Sometimes the term Target2 is used, but as there is no relevant difference between the original Target system and Target2 as introduced in 2007, the number behind the term is omitted here.

day!" and warned that countries exiting the Eurozone would have to redeem their Target debt in full.[5]

To understand the role of Target balances, it is useful to reconsider the choice European policy makers and central bankers faced when they wanted to fulfil the task the ECB had been given by the Maastricht Treaty, namely "to promote the smooth operation of payment systems".[6] There were at least four kinds of payment systems that would have satisfied this task:

A) Private:
International payments are made between private banks or private clearing institutions (with a possibility of mutually lending out bank notes).

B) European public, with ECB accounts:
NCBs are branches owned by the ECB. All assets purchased with central bank money are properties of the ECB which itself is owned by the EU. Commercial banks have accounts with the ECB and are able to make payment orders among one another by transferring central bank deposits.

C) National public, with a potential transfer of assets to the ECB to build up ECB accounts:
The assets that an NCB acquires with central bank money are owned by this NCB. However, the NCB can transfer these assets to the ECB to build up an ECB account. If it wants to make an international payment order, it transfers the money on its account to another NCB's account. Alternatively, it transfers a corresponding part of its assets to the ECB or other NCBs if it wants to make an international payment order.

D) National public, without a transfer of assets:
An NCB that makes a payment order to another jurisdiction remains proprietor of the assets it acquired by issuing central bank money. The NCBs mutually provide unsecured credit when they make international payment orders.

In the Eurosystem, variant D was chosen as the states wanted to remain proprietors of their respective NCBs and the NCBs did not want to mutualize asset ownership. Thus, the Target balances recorded in the NCBs' balance sheets can indeed be seen as a sort of credit.

The question however is whether the credit interpretation is really appropriate as Target claims cannot be called due by the creditor NCBs and as it is unclear whether they bear interest. If they bear no interest, the NCBs' booking of Target balances as claims and liabilities would not be compatible with fair value accounting, and the Eurosystem could be accused of booking irrelevant items. Moreover, there would be the described incentive to oversupply local money balances due to a competitive externality resulting from the

[5] Draghi (2012, 2017).
[6] Article 127.2 TFEU.

possibility to "steal" seignorage income from other NCBs along the lines analyzed by Aizenman (1992).

The question of whether or not interest on Target balances is paid is institutionally tricky, as the answer depends on partially conflicting and complicated statutory rules of the Eurosystem. While central banks have agreed to mutually service their Target balances with interest equal to the ECB's main refinancing rate during a calendar year, they also agreed to pool their annual interest income resulting from monetary policy operations and redistribute this income according to country size.[7] As pooling eliminates the prior interest payments, it at first glance might seem to imply that there is no interest on Target balances. However, this appearance is deceptive. As I will prove in this paper, pooling implies that interest is effectively paid and accumulated with compound interest in the balance sheets of national central banks.

My proof extends and generalizes an analysis of Fuest and Sinn (2018), which referred to an example in which Target balances result from an international shift in refinancing operations that would keep the national stocks of central bank money constant despite the liquidity shift as measured by the Target balances. The generalization is relevant insofar as the international liquidity shift may involve various sources and sinks of liquidity, may change the local stocks of central bank money and may take place with given stocks of monetary assets issued by local NCBs. Sources and sinks of liquidity flows in this paper are meant to be deposits at NCBs and/or liquidity producing and liquidity absorbing operations by the local NCBs, respectively.

While my analysis focuses on Target balances, it also includes the so-called cash balances resulting from physical cross-border movements of cash for which the NCBs record claims and liabilities very similar to the Target balances.

3. *Some Basic Eurosystem Accounting Identities*

To prepare the analysis, a look at the basics of the Eurosystem's accounting system is necessary. Let i denote a particular NCB, country or state of the Eurozone, respectively, where $i = 1, ..., n$. The amount of central bank money that NCB i has issued consists of cash B_i and demand deposits that commercial banks hold with the ECB which themselves can be

[7] Cf. ECB (2001), preamble, sections 2, 7 and 8, and Article 2.2 of the (unpublished) ECB Council decision ECB/ 2007 / NP10.

split into minimum reserves M_i und excess liquidity U_i. The central bank money issued by NCB *i* originated either from international payment orders on behalf of other NCBs, which resulted in a Target balance T_i, or from an accumulation of "monetary assets" A_i (refinancing credit and open market purchases of all kinds, evaluated at historical purchasing volumes) net of term deposits L_i, which in the Eurosystem are not counted as part of the monetary base:

(1) $$T_i + A_i - L_i \equiv B_i + M_i + U_i \ .$$

The amount of cash issued by NCB *i* may be larger or smaller than the amount of currency circulating in country *i* , as some international transactions are carried out with cash rather than Target payment orders. Given that these transactions cannot directly be observed, it is assumed in the Eurosystem that a given "statutory" amount of cash $\overline{B}_i$ is circulating in country *i* which is proportional to country size[8] while cash of size S_i , I name it the "cash balance",

(2) $$S_i \equiv \overline{B}_i - B_i \ ,$$

is assumed to having flown in from abroad in net terms. Both $\overline{B}_i$ and S_i are official categories booked as separate items in the NCBs' balance sheets.[9]

Using (2), equation (1) can be transformed to

(3) $$G_i = \underbrace{T_i + S_i}_{\text{external money}} + \underbrace{A_i - L_i}_{\text{internal money}} \ .$$

where

(4) $$G_i \equiv \overline{B}_i + M_i + U_i$$

is the monetary base circulating within country *i*. Equation (3) separates country *i*'s base money into external money and internal money. External money in my terminology is that part of the local monetary base that entered the economy via international payment orders and physical cash transports as is officially calculated. Internal money is the remainder, which

[8] According to the calculation method specified in Article 29.1 of the Protocol on the Statute of the European System of Central Banks and of the European Central Bank, $\overline{B}_i$ is proportional to the aggregate stock of cash where the share of paid-in capital is the proportionality factor. The latter in turn is a parameter that is adjusted every five years to match the average of a country's population and GDP shares. In this note I treat $\overline{B}_i$ as an exogenous variable. In addition to the NCBs, the ECB itself is allocated a share of 8% in the total amount of cash. I abstract here from the details concerning the special role of the ECB itself. I also abstract from coins as they are issued by the states rather than central banks. In 2018 coins accounted for only 2.3% of the total amount of cash in Germany, for example. See Deutsche Bundesbank (2019b), p. 77.

[9] In the balance sheets, $\overline{B}_i$ is called "bank notes in circulation" and S_i "claims related to the allocation of euro banknotes within the Eurosystem".

came into existence via credit operations in the sense of acquiring monetary assets (refinancing credit and open market purchases) net of liquidity absorbing flows into term deposits.

4. *Interest on Minimum Reserves, Excess Liquidity and Term Deposits*

International liquidity flows as measured by the Target and cash balances result in changes in local monetary aggregates that have direct implications for the primary interest income Y_i that NCB *i* earns from its contacts with the rest of the economy other than other central banks. This primary interest income will directly or indirectly flow to a common pool from which all NCBs receive a proportional refund. I will show that Target and cash balances directly affect this primary income and that the pooling mechanism will therefore result in secondary interest flows between the NCBs, which are directly related to, and caused by, these balances. The secondary interest flow caused by a marginal change in the sum of a country's Target and cash balance I call the "marginal effective rate of interest" on these balances.

I assume that the primary interest income subject to pooling of an NCB is given by

$$Y_i = rA_i - r^L L_i - rM_i - r^U U_i \tag{5}$$

where *r* is the main refinancing rate, r^L the term deposit rate and r^U the deposit facility rate. This formula is a simplification, as some of the assets captured by A_i earn a rate of interest different from *r*. However, the main refinancing rate is the most important rate insofar, as in the statutory standard case without risk sharing it applies to most assets.[10]

Excess liquidity is the excess of the demand deposits commercial banks hold with the local NCBs over the required minimum reserves. It can be split into what the ECB calls excess reserves and deposit facility. A distinction between excess reserves and deposit facility is irrelevant for this paper, however, as banks used to shift their liquidity from the formally interest-free excess reserve to the deposit facility, when the latter was bearing interest, and the ECB Council decided on 5 June 2014 to impose the deposit facility rate also on excess reserves, to avoid evasion reactions upon shifting the deposit facility rate into negative

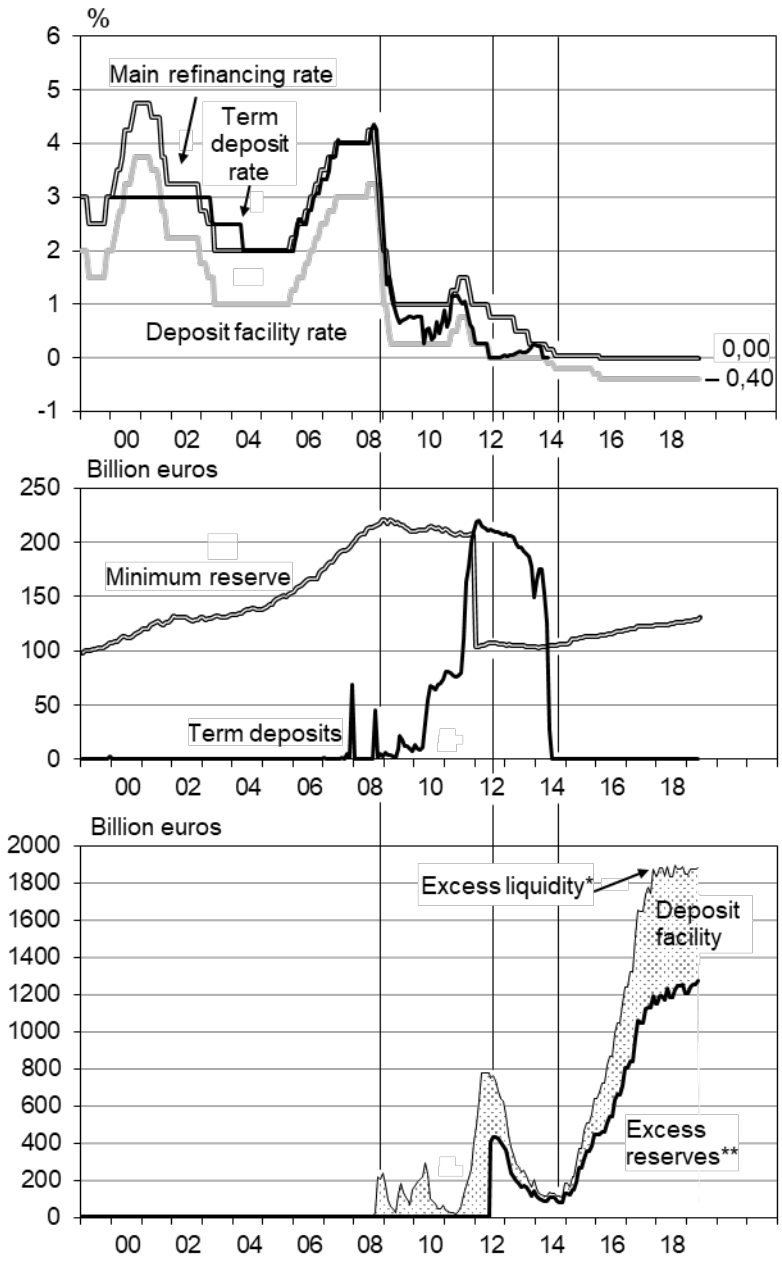
[10] According to the statutes of the ECB, in the standard case, all money creating operations of the national central banks, including ELA credit, ANFA and PSPP asset purchases as well as ordinary refinancing operations require paying interest equal to the main refinancing rate, *r*, times the historical purchasing value of the respective assets to the pool regardless of what the true rates of return of these assets turn out to be. Thus, in this standard case there is no risk sharing. Exceptions that do involve risk sharing need to be decided by the council one by one. At this writing, the exceptions are way less than 50% given that PSPP purchases by NCBs alone already cover 60% of the ECB's monetary base. Moreover, longer term refinancing operations (LTROs) carry a spectrum of interest rates that differ from *r*. Explicitly including the exceptions would not significantly change, but complicate the analysis of this paper. See Fuest and Sinn (2018) for a detailed discussion of the statutory rules concerning risk sharing and the treatment of ELA, ANFA and PSPP assets.

territory where it has been up to this writing.[11] Thus, we can assume without any loss of generality that all kinds of demand deposits of banks with their NCBs do indeed bear interest.

The following triple diagram, Figure 1, illustrates the development of the named interest rates (upper diagram) and the corresponding stocks of deposits in the Eurosystem since the introduction of the euro. The diagram shows that the relevant interest rates have now become zero or negative, and that term deposits are currently no longer available. It also shows that (lowest diagram) excess reserves were quantitatively negligible when the deposit rate was positive and rose sharply when the deposit rate left positive territory and was applied to excess reserves.[12]

[11] See European Central Bank (2014).
[12] In addition, there is a separate interest rate on LTROs and the marginal lending facility.

Figure 1: Interest rates and deposits in the Eurosystem



* Excess liquidity = excess reserves + deposit facility.

** Excess reserves = demand deposits – minimum reserves

Remark: Minimum reserves were reduced from 2% to 1% of deposits on 18 January 2012. All data refer to end-of-month data. Before summer 2012, when the deposit rate was positive, excess reserves were approximately zero. The deviations from zero were too small to be visible in the diagram.

Sources: European Central Bank, Statistical Data Warehouse, *Eurosystem Policy and Exchange Rates*, Official interest rates, Key ECB interest rates, http://sdw.ecb.europa.eu/browse.do?node=9691107; Minimum reserves and liquidity, http://sdw.ecb.europa.eu/browse.do?node=9691109; Eurosystem balance sheet, Eurosystem consolidated statement, http://sdw.ecb.europa.eu/browse.do?node=9691294-; Deutsche Bundesbank, *Geldpolitische Geschäfte des Eurosystems (Tenderverfahren)*, https://www.bundesbank.de/resource/blob/607812/56b28363cb29bd223e1cd202f62e4bfb/mL/refd-data.pdf.

5. Interest Pooling and the Effective Rate of Interest on Target and Cash Balances

In the Eurosystem, all primary interest income of NCBs is pooled and redistributed according to the "paid-in capital key" α_i which is proportional to the average of a country's population and country shares. However, according to a decision of the ECB council, during a calendar year, debtor central banks have to pay interest equal to the main refinancing rate on their Target liabilities to the Eurosystem while creditor NCBs receive a corresponding amount of interest on their claims. These sub-year interest payments obviously do not affect the amount of interest income an NCB ultimately receives and may distribute to its state, as the recipient NCBs must also send the prior interest payments they received from other NCBs to the pool while the paying NCBs can subtract their payments from their contributions to the pool.[13] One can therefore see the prior interest payments as part of the pooling system itself. Without the pooling and the prior interest payments among NCBs, NCB *i* could distribute its entire primary interest income Y_i to its owner, the local state. With the pooling, it instead is able to distribute the refund X_i from the pool. Thus, NCB i, and hence state *i*, receives an algebraic redistribution gain Z_i, or net payment from other central banks, given by

(6) $$Z_i = X_i - Y_i \quad .$$

The refund from the pool is given by

(7) $$X_i = \alpha_i (Y_i + Y_{i*}) \quad ,$$

where *i** denotes the set of all NCBs except i, and Y_{i*} correspondingly is the sum of all injections of primary interest revenue of all NCBs except *i*:

(8) $$Y_{i*} \equiv \sum\nolimits_{j=1,\, j\neq i}^{n} Y_j \quad .$$

Y_j, and implicitly also Y_{i*}, is defined by equation (5). It follows from (6) and (7) that:

(9) $$Z_i = \alpha_i Y_{i*} - (1-\alpha_i) Y_i \quad .$$

According to (5), the contributions of an NCB to the pool depend among other things on the deposit structure of its banking system. If all items on the right-hand side of (5), i.e. A_i, L_i, U_i and M_i, were proportional to α_i and $1-\alpha_i$, respectively, for country *i* and the remainder *i** it would follow that $Z_i = 0$. If the proportionality condition is not satisfied, because country *i*'s payment habits differ from the average, it is obviously possible that there

[13] See Sinn (2014), p. 148.

is a "basic" redistribution of primary interest income even if there are no international transactions and country *i*'s sum of Target and cash balances is zero.

However, if there are non-zero Target and cash balances, there is an additional redistribution which directly depends on the balances, because they measure a net inflow of liquidity that has to come from somewhere and flow somewhere and will therefore directly affect the primary interest revenues Y_{i*} and Y_i that the NCBs have to transfer to the pool. This implies that interest on Target and cash balances is effectively paid.

Rewriting equation (3), while using the definition of the monetary base G_i as given in (4), shows the possibilities for potential sources and sinks of international liquidity flows:

(10) $$T_k + S_k = G_k + L_k - A_k \ , \qquad G_k \equiv \bar{B}_k + M_k + U_k \ \text{ for all } k = i,\, i^*,\, i = 1,...,n.$$

Obviously, the inflow of liquidity as measured by $T_k + S_k$ can affect country *i*'s monetary base G_k only via M_k and U_k, and must otherwise accumulate as term deposits L_k or be used to reduce the NCB's monetary assets A_k. The analogue is true for a liquidity outflow which can be treated as a negative inflow and is therefore captured by the same algebraic equations. Note that the statutory stock of cash $\bar{B}_k$ is an exogenous variable which can neither be source nor sink of liquidity flows. A change in the stock of cash issued by an NCB implies, as is shown by equation (2), a change in the cash balance S_k itself.

Let $d(T_k + S_k)$ be some exogenous flow of liquidity to a country or set of countries k. Assume that the share γ_k of this flow results in an increase in the monetary base,

(11) $$dG_k = \gamma_k \ d(T_k + S_k) \ ,$$

while the remainder, $1-\gamma_k$, will flow into term deposits to the share λ_k and be used for a reduction of monetary assets to the share $1-\lambda_k$:

(12) $$dL_k = \lambda_k \ (1-\gamma_k) \ d(T_k + S_k), \quad dA_k = -\,(1-\lambda_k)(1-\gamma_k) \ d(T_k + S_k) \ .$$

Assume moreover that the share μ_k of the increase in the monetary base will be flowing into minimum reserves, while $1-\mu_k$ will be accumulated as excess liquidity:

(13) $$dM_k = \mu_k \ dG_k, \quad dU_k = (1-\mu_k) \ dG_k \ .$$

All the shares mentioned are bounded by the unit interval. If we take account of the fact that all Target and cash balances add up to zero in the entire Eurozone,

(14) $$d(T_{i*} + S_{i*}) = -d(T_i + S_i) \, ,$$

differentiation of (9), using the definition of Y_i and, accordingly, Y_{i*}, as given by (5), as well as (10) to (14), yields

(15) $$dZ_i = \rho_i \, d(T_i + S_i) \ .$$

Here ρ_i is the marginal effective rate of interest on NCB *i*'s Target and cash balances in the Eurozone as given by

(16) $$\rho_i = \alpha_i \tilde{\rho}_{i*} + (1-\alpha_i)\tilde{\rho}_i$$

where

(17) $$\tilde{\rho}_k = \gamma_k \left(\mu_k \, r + (1-\mu_k) \, r^U \right) + (1-\gamma_k)\left(\lambda_k \, r^L + (1-\lambda_k)\, r \right), \ k = i, \, i* .$$

To interpret the RHS terms, suppose a unit of liquidity is transferred from the rest of the Eurozone, *i**, to country *i*. The variable $\tilde{\rho}_{i*}$ is the subsequent annual marginal transfer of primary interest income to the pool from the rest of the Eurozone and $\tilde{\rho}_i$ is the corresponding marginal reduction of the primary income that NCB *i* transfers to the pool. They both determine the marginal effective interest rate on the Target and cash balances according to (16). The following proposition summarizes this result.

Proposition 1: *The marginal effective rate of interest on Eurozone Target and cash balances is a weighted average of (1) the main refinancing rate (with the qualifications of Footnote 8), (2) the term deposit rate and (3) the deposit facility rate, where the weights depend on the magnitudes of the countries involved as given by the paid-in capital keys as well as on the extents to which the international liquidity shifts as measured by the Target and cash balances involve changes in the stocks of monetary assets and/or minimum reserve requirements (1), changes in the amount of term deposits (2) and changes in excess liquidity (3).*

The distinction between $\tilde{\rho}_{i*}$ and $\tilde{\rho}_i$ in equations (16) and (17) is obviously irrelevant if country *i* is relatively small such that $\alpha_i \approx 0$ or if country *i* is an "average" type in the sense that the structure of its marginal liquidity sinks is the same as the structure of the other countries' marginal liquidity sources $(\tilde{\rho}_i = \tilde{\rho}_{i*})$. Let us assume the latter to interpret (16) and (17) for some special cases.

Suppose first all NCBs accommodate the liquidity transfers measured by the Target and cash balances by compensating changes in their respective stocks of monetary assets $(\lambda = \gamma = 0)$. In this case (16) and (17) simplify to $\rho = r$; the relevant interest on the balances is now the main refinancing rate.

This is the special case already dealt with in Fuest and Sinn (2018). It shows that an NCB cannot in fact exploit its power to determine the local money supply within the rather

loose constraints set by the ECB Council to generate extra seignorage income for its respective state.[14] Any extra local money supply inducing and enabling international payment orders as measured by the Target balances would necessitate a transfer of the surplus interest revenue thereby generated to other NCBs.

Suppose alternatively that the international shift of liquidity goes along with compensating changes in term deposits ($\lambda = 1,\ \gamma = 0$). Now the effective rate on the balances is the term deposit rate, $\rho = r^L$. This case currently is not relevant as term deposits are presently not available in the Eurozone.

More relevant are the cases where the international liquidity shifts involve only minimum reserves M_i or only excess liquidity U_i . If the former absorb the entire liquidity shifts $(\gamma = \mu = 1)$, we have $\rho = r$. Again, the main refinancing rate is the relevant effective interest rate on Target and cash balances. If by contrast excess liquidity is the only buffer $(\gamma = 1,\ \mu = 0)$, (17) reduces to $\rho = r^U$; i.e. the effective rate of interest on the Target and cash balances now equals the deposit facility rate. As Figure 1 revealed, this rate has been –0.4% up to this writing, but it used to be much higher when the refinancing rate was in normal territory.

Note that according to (16) and (17) the fact that the main refinancing rate is currently zero and term deposits are not available (see Figure 1), makes ρ_i negative regardless of the special assumptions about the weights of the liquidity channels and country sizes, provided that at least some of the international liquidity flows involve changes in the banks' demand deposits, i.e. $\gamma_i(1-\mu_i) > 0$ and/or $\gamma_{i*}(1-\mu_{i*}) > 0$ while $0 < \alpha_i < 1$. Conversely, for a similar reason $\rho_i > 0$ if the deposit facility rate is positive, provided that the ECB sticks to its rule of setting all other policy interest rates at higher levels.

6. Compound Interest on Target and Cash Balances

As was shown, a positive Target and cash balance of NCB *i*, which mirrors a negative balance of the other NCBs *i**, causes intra-Eurosystem interest flows from countries *i** to country *i* by way of the pooling mechanism. These flows are accounting items rather than payments in the usual sense of the word. Payments in the sense of settling the interest claims require reverse

[14] This power is, in fact, substantial for three reasons: i) Local NCBs are, within limits, able to define their own criteria for collateral that they accept from banks when providing refinancing credit. See e.g. Drechsler et al. (2016). ii) Local NCBs may unilaterally decide on Emergency Liquidity Assistance, which gives them the right to unlimited local money printing and lending provided two thirds or more of the ECB Council do not object. iii) Local NCBs have the right to buy assets at their own choice within the limits of the ANFA agreement.

transactions via the Target system from the recipient country *i* to the rest of the Eurozone *i**. Such transactions could take the form of sending more private credit from *i* to *i** or sending goods in the opposite direction, from *i** to *i*, because both would involve payment orders from *i* to *i**. If there are no such countervailing transactions, the interest is simply booked in the accounts of the NCBs involved as additional Target balances, which then, however, trigger additional intra-Eurosystem interest payments and international liquidity transfers by way of the pooling process as can easily be explained.

In a first round, the intra-Eurosystem transfer of interest between the NCBs implies more Target balances that come on top of the original Target and cash balances. In proportion to these new Target balances, NCBs *i** extract from their economies more primary interest income and liquidity which has to go to the pool, while NCB *i* extracts less from its economy and sends less to the pool. As governments in both countries receive the same profit distributions as before, the intra-Eurosystem transfer of interest on the original Target and cash balances implies both new Target balances and a corresponding liquidity shift from countries *i** to country *i*.

If there were no pooling and hence no interest transfers between NCBs, the deficit NCBs *i** would be able to distribute the extra primary interest income resulting from their original negative Target and cash balances to their respective states and hence re-channel the liquidity back to the domestic economies. Conversely, the surplus NCB i which collects less primary interest would distribute less profit to the local state. In both countries the liquidity would be unchanged. With pooling, however, NCB *i** is forced to transfer its primary interest and the liquidity coming in with it to the surplus country *i*, which needs it as a compensation for its own primary interest and liquidity loss due to the original Target and cash balances. This liquidity shift requires additional reactions of the kind, shown in the previous section; i.e. even more asset purchases, lower term deposits, lower minimum reserves or less excess liquidity in *i**, and reversely in *i* , than was necessary because of the original Target and cash balances themselves.

The interest-induced liquidity shift will, however, in a further round, trigger additional interest-induced liquidity shifts, as the above-described reactions at the respective sources and sinks of international liquidity flows will again take place. There will be again additional liquidity transfers because of the interest pooling and even higher Target balances. In short, there is a compound interest chain.

Let $d\left(T_i(0)+S_i(0)\right)$ be an exogenously caused additional Target and cash balance of NCB *i*, which is booked by the end of year 0 because of a liquidity inflow due to payment

orders from abroad. As was shown, this additional sum of balances causes intra-Eurosystem interest transfers to NCB *i* and a corresponding liquidity shift to country *i*. If not compensated by countervailing transactions, the sum of the balances in year 1 will increase by the relevant interest rate of that year, $\rho(1)$, such that $d\left(T_i(1)+S_i(1)\right)=d\left(T_i(0)+S_i(0)\right)\left(1+\rho(1)\right)$. The shifting of liquidity due to the intra-Eurosystem interest payments which leads to the increase in the balances will now again force the foreign NCBs *i** to acquire more monetary assets or to reduce the various kinds of deposits, while the opposite is true in country *i*. Thus, additional interest is booked on the Target account in year 2 with corresponding new liquidity shifts implying that $d\left(T_i(2)+S_i(2)\right)=d\left(T_i(0)+S_i(0)\right)\left(1+\rho(1)\right)\left(1+\rho(2)\right)$ and so on. The original, exogenous increase in the Target and cash balances obviously transmits to the consecutive years with a volume that grows at the respective effective rate of interest on the balances. By the end of year t, $t>0$, the sum of the balances is

$$d\left(T_i(t)+S_i(t)\right)=\left(d\,T_i(0)+d\,S_i(0)\right)\prod_{j=1}^{t}\left(1+\rho(j)\right) \tag{18}$$

unless countervailing transactions of the real economy take place which would actually "pay" for the interest on the balances and perhaps even redeem the original Target debt.

Proposition 2: *If the Target and cash balances are not serviced at the effective rate of interest implied by the ECB's policy interest rates (on refinancing credit, excess reserves, minimum reserves and term deposits) by way of international transactions of those sectors that do not belong to the system of central banks, the balances grow with compound interest at this effective rate.*

Again, however, the reader should be aware, as explained above, that the current interest policy of the ECB makes the effective rate of interest negative provided at least some of the change in Target balances comes along with mere deposit shifts. Thus, currently, the compound interest effect implies that the Target balances decline year by year unless new payment orders between the sectors outside the central bank system create new ones.

7. Conclusion

This paper has shown that the pooling of primary interest income in the Eurozone implies that Target and cash balances as recorded in the NCB balance sheets bear an effective rate of interest which is a weighted average of the ECB's main policy rates, where the weights depend on the importance of the various channels linking liquidity sources and sinks in the deficit and surplus countries. Thus, Target credit does resemble other types of interest-bearing

credit. If the debt is not serviced with countervailing transactions between the economies involved, the Target and cash balance grows with compound interest. If countervailing transactions just compensate for the interest, the balance stays constant. If the countervailing transactions are larger than the interest that is due on the Target and cash balances, the credit volume, i.e. the sum of Target and cash balances, will decline. The booking of Target claims and liabilities in the balance sheets of NCBs is therefore basically in line with fair value accounting.

This reduces or eliminates the negative competitive externality of local money creation that otherwise would have to be feared in a decentralized monetary system such as the Eurozone. NCBs that print more than their fair share of the aggregate money balances may be incentivized by seemingly positive effects this may have on local economic activity, but they would not profit from being able to increase their seignorage income at the expense of other NCBs. The intra-Eurosystem interest on Target balances thus protects the Eurozone at least partly against the problems Aizenman (1992) once described.

The result also has implications for the question of whether or not a default of a national financial system involving the government and the banking system will impede the other euro countries via the Eurosystem. In fact, Target and cash claims might be able to default in the sense that deficit NCBs are unable to extract the liquidity from their economies that is needed to allow other NCBs to continue distributing profits to their respective states without injecting more liquidity into the Eurozone economy as a whole than would have been compatible with any given monetary policy goal of the ECB.

Finally, the above findings are also relevant for the question of whether Target and cash balances are valuable and booked appropriately in national and international accounts. The current practice of including the balances as an element of a country's net foreign asset position and their annual increases in international current account statistics finds support in the considerations laid out in this paper.

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