

GDP-LINKING FOR A STABLE, RULE BASED MONETARY SYSTEM¹

Jacob Wijngaard²

ABSTRACT

This paper is inspired by the recent attention for the possibility of digital cash issued by the Central Bank. Steps in that direction are very fundamental and far reaching, also because such changes are related to the question of one-tiered versus two-tiered systems. In this paper it is argued that such changes justify to also consider the possibility of GDP-linking of current accounts. GDP-linking of a current account means that the amount of money on the account is adjusted daily to the (nominal) GDP. This idea is most meaningful in case of a one-tiered system where all economic actors have access to base money and where there is a central administrative unit who can take care of the adaptation of the account balances. In such a system it is relatively easy to construct a suitable GDP-proxy that can be monitored continuous time. But by allowing commercial banks to borrow base money, the one-tiered system becomes very flexible and banks play an important role in exercising this flexibility. The advantage of GDP-linked current accounts is stability. The buying power of the accounts can be secured by the application of GDP-linking. It becomes easier to develop general monetary rules. Discretion is not necessary anymore, adding also to more stability. This is explained and explored in this paper.

1 INTRODUCTION

The current monetary system is a two-tiered system. The Central bank (CB) issues *base money*, including cash and bank reserves. That is the first tier. The commercial banks issue claims on base money (e.g demand deposits). That is the second tier. We call that *bank money*. Recently the Bank of England seriously considers the possibility to give more parties access to base money³. They speak of *digital cash*. This would imply a very fundamental change of the monetary system. In its most extreme form it might make bank money superfluous and lead to

¹ This paper is closely related to the white paper by K.M. Van Hee and J. Wijngaard, "A New Monetary System with New Monetary Policy", www.robuustgeld.nl/english/, 2017

² Professor Emeritus University of Groningen

³ B. Broadbent, "Central Banks and Digital Currencies", Speech, Bank of England, 2016

a one-tiered system: all economic actors pay each other with base money. The debate about this change is inspired by two developments⁴, both resulting from the financial crisis.

In the first place the gradual reduction of the rate at which the banks can borrow base money from the CB. Close to zero this major instrument of monetary policy is becoming ineffective. To keep control the CB has to switch to some form of Quantitative Easing (QE). Many monetary economists have more confidence in interest rate oriented rules and explore therefore the possibilities to “break” this Zero Lower Bound (ZLB). Buiter⁵ distinguishes three ways to overcome the ZLB: (1) going cashless, (2) taxing bank notes somehow and (3) introducing an exchange rate between physical cash and euro’s at current accounts. The last possibility is presented as the most realistic. Agarwal and Kimball⁶ elaborate this. Breaking the ZLB is also put forward by Rogoff⁷ in his plea to phase out cash.

In the second place the revival of the Chicago plan, a proposal for full reserve banking, and recent movements in some countries to withdraw the money creating role from the banks. These movements are inspired by the role of the banks in the development of the financial crisis⁸. In full reserve banking, banks are required to have their demand deposits fully backed by base money and government debts. See Benes and Kumhof⁹. It is also possible then to switch to a one-tiered system and require that demand deposits make base money available. Important in this respect is the “Positive Money” (PM) movement in the UK¹⁰. Huber¹¹ gives an overview of this and related proposals and uses the term sovereign money. He articulates the shortcomings of the current system and the principles and advantages of a sovereign money system. The Cambridge Journal of Economics has a special issue on these proposals under the title “Crank and Brave Heretics”¹², showing how difficult it yet is for the official economy to position these developments.

⁴ See also Marilyne Tolle, “Central bank digital currency: the end of monetary policy as we know it”, <https://bankunderground.co.uk/>

⁵ W.H. Buiter, “Negative nominal interest rates; Three ways to overcome the zero lower bound”, *The North American Journal of Economics and Finance*, **20**, 213-238, 2009

⁶ R. Agarwal and M. Kimball, “Breaking Through the Zero Lower Bound”, IMF, WP/15/224, 2015

⁷ K. Rogoff, “Costs and Benefits to Phasing out Paper Currency”, NBER, *Macroeconomics Annual*, 2015

⁸ See N. Roubini and S. Mihm, “Crisis Economics”, Penguin Books, 2010

⁹ J. Benes and M. Kumhof, “The Chicago Plan Revisited”, IMF WP/12/202, 2012

¹⁰ A. Jackson and B. Dyson, “Modernising Money”, Positive Money, 2012

¹¹ J. Huber, “Sovereign Money; Beyond Reserve Banking”, Palgrave, 2017

¹² G. Ingham, K. Coutts and S. Konzelmann, “Introduction: ‘cranks’ and ‘brave heretics’: rethinking money and banking after the Great Financial Crisis”, *Cambridge Journal of Economics*, **40**, 1247-1257, 2016

There is a third development that is relevant here. That is the development of crypto currencies. The most important of these is the Bitcoin¹³. The idea that it is not necessary in such a system to work with a “trusted third” is very appealing. This possibility stems from the block chain basis of the bitcoin. Making use of this block chain principle has been explored in between in many different financial and non-financial applications. In the BoE publications the exploration of the possibility to broaden the access to base money is sometimes combined with the suggestion to try a block chain approach or some other type of distributed ledger approach¹⁴ in realizing this.

The exploration of the possibilities of digital cash is combined with the exploration of these related possibilities: a cashless society or different forms of (physical) cash, a one-tier monetary system instead of a two-tier monetary system, a more standardized payment system that is easier accessible for financial service providers, application of block chain technology or other forms of “distributed ledger”. In exploring all these possibilities the aim is to create a form of money that facilitates a more effective monetary policy, that allows the development of payment systems that are more efficient and more solid and reputable and that also improves the credit provision role of the banks.

It is apparently necessary to consider such fundamental changes. In this paper we contend that given that, it is useful to consider the possibility of *GDP-linking* of base money as well. GDP-linking of bonds is well explored (e.g by Kamstra and Shiller, 2008¹⁵). It implies that the yield of bonds is linked to the GDP, to realize more stability. This idea of GDP-linking can also be applied to (individual) current accounts. GDP-linking of a current account means that the *amount* of money on the account is adjusted daily to the (nominal) GDP. It is straight forward to combine this link with *taxing* the current account, e.g. each day the amount on the current account is reduced with a small fraction. This possibility of GDP-linking is most meaningful in case of a one-tiered system where all economic actors have access to base money and where there is a central administrative unit who can take care of the adaptation of the account balances. In such a system it is also relatively easy to construct a suitable GDP-proxy that can be monitored continuous time. The advantage of GDP-linked current accounts is also stability. The buying power of the accounts can be protected by the application of GDP-linking. Adding an adequate tax helps to create the right incentive to spend and makes the monetary system flexible.

¹³ See e.g. R. Ali, J. Barrdear, R. Clews and J. Southgate, “Innovations in payment technologies and the emergence of digital currencies”, Bank of England Quarterly Bulletin, **54**, 262-275, 2014

¹⁴ See e.g. M. Walport, “Distributed Ledger Technology: beyond block chain”, Government Office for Science, 2016

¹⁵ M.J. Kamstra and R.J. Shiller “The Case for Trills: Giving Canadians and their Pension Funds a Stake in the Wealth of the Nation,” C.D. Howe Institute Commentary, The Pension Papers, 271, 2008

To illustrate the potential of GDP-linking, we develop in the next sections a one-tiered monetary system with GDP-linking. In Section 2 the structure of the system is described. The possibility to develop an adequate GDP-proxy is considered in Section 3. Section 4 describes how to choose the monetary policy. Discretionary actions contribute to instability¹⁶. We aim at a rule based policy therefore. The existence of (physical) cash complicates the GDP-linking, because it is difficult to harmonize the value of cash with the buying power of the current accounts. In Section 5 we will pay attention to this. Application of GDP-linking in a one-tiered system is much more straight forward than in a two-tiered system. But in principle it is also possible in a two-tiered system. That will be explored in Section 5 as well. Section 6 concludes with more general questions: How far away from the current system is it? How to implement it? What alternatives are there? What research is necessary?

2 A MONETARY SYSTEM WITH GDP-LINKED BASE MONEY ACCOUNTS

Base money accounts and CB

First a short description of the one-tiered system that is presupposed in this and the next two sections¹⁷. The CB creates the base money and all economic actors have access to it, through their current accounts (so called *A-accounts*). There is only this *digital cash*, physical cash does *not* exist anymore. The amount of base money on an account is always positive (or zero). You can't pay more than there is available on the account. The government also has its own current accounts and can't spend more than they have on it. Also banks have, for their own business, such current accounts. There is a central administrative unit to process the transactions and monitor the macro-economic variables that are necessary (e.g. a GDP-proxy). Economic actors who have a surplus of money for some time can lend it to a bank. Contracts for such a loan will have a duration and an interest rate. The administration of such contracts will be done by the banks. The base money of a lender is deposited on a so called *B-account* of the bank. The B-account corresponds to the *investment pool* of PM¹⁸. From the B-account base money can be lend to all current accounts (A-accounts).

It may be necessary, however, to create more credit facilities for capital formation for productive investments. This points gets ample attention in the debate in the special issue of

¹⁶ See e.g. Nancy L. Stokey, "'Rules vs Discretion' After Twenty-Five Years", NBER Macroeconomics Annual, 2002

¹⁷ For the specifics see K.M. Van Hee and J. Wijngaard, "A New Monetary System with New Monetary Policy", www.robuustgeld.nl/english/, 2017

¹⁸ A. Jackson and B. Dyson, "Modernising Money", Positive Money, 2012

the Cambridge Journal of Economics. Fontana and Sawyer¹⁹ stress the importance of the role of banks here and judge the PM proposals unsatisfactory in this respect. A possibility to improve that is to give banks the opportunity to borrow base money from the CB. This is also mentioned by the PM people in their reaction on Fontana and Sawyer²⁰. But it is further elaborated and structured here. We introduce the so-called *C-account* of a bank at the CB to administer and register this borrowing. The base money that is borrowed from the CB is transferred from the C-account to the B-account of the bank. The amount of a base money on a C-account is always *negative*. So the total amount of base money on all accounts (A, B and C) together always remains unchanged by transactions. Borrowing from the CB makes the C-account more negative and the B-account more positive.

GDP-linking and taxing the accounts

Now it is explained how to link these accounts (A, B and C) to a continuous time available macro-economic variable. The aim of such linking is to secure the buying power of the accounts. We will discuss what types of variables are suitable and argue that a GDP-proxy is very suitable. It will be shown how application of GDP-linking helps to realize a stable monetary system.

Let $A(t)$ be some macro-economic (aggregate) variable that is continuously available. Linking the current accounts to $A(\cdot)$ means that the balance of each current account is adjusted to $A(\cdot)$ each time a transaction takes place. Suppose the current accounts i and j are involved in a transaction that takes place at time t . Let $D_i(\cdot)$ and $D_j(\cdot)$ be the balances of these accounts. Just before the execution of the transaction, the balances are reset in the following way:

$$D_i(t) := \frac{A(t)}{A(t - \varepsilon_i)} \cdot D_i(t)$$

, with $t - \varepsilon_i$ the time of the previous transaction with respect to account i , and a corresponding reset for account j . The reset is executed by the central administrative unit.

If the variable $A(\cdot)$ represents a stable economic value or reflects, economy broad, price changes, the linking procedure helps to secure the buying power of the current accounts.

Possibilities are:

- 1) Price indices
- 2) GDP-proxy's (nominal GDP)

¹⁹ G. Fontana and M. Sawyer, "Full Reserve banking: more 'cranks' than 'brave heretics'", Cambridge Journal of Economics, **40**, 1333-1350, 2016

²⁰ B. Dyson, G. Hodgson and F. van Lerven, "A Response to critiques of 'full reserve banking'", Cambridge Journal of Economics, **40**, 1351-1361, 2016

- 3) Total consumption
- 4) The total transaction sum for all real transactions
- 5) Estimates of the total market value of all shares

It is important that the variable is stable, not dependent on market fluctuations, that it cannot be manipulated, that it does not lead to speculation and that it can be monitored easily. The variables 2), 3) and 4) seem to be most suitable. They are inclusive and stable. Variable 1) can be made inclusive as well by choosing the right mix of price indices, but it is not easy to monitor it directly. Variable 5) may be too dependent on market fluctuations. Variable 4) is a little easier to monitor than variable 2) and 3), but it is subdue to fragmentation of the economy. More fragmentation leads to a higher transaction sum. The advantage of variable 3) is that it is related to the total VAT and maybe this relationship can be exploited in monitoring the variable. But we choose here for the broader variable 2). The link with the real economy is more complete for a GDP-proxy. In the next section we will define a GDP-proxy that can be monitored sufficiently easy.

With GDP-linking the buying power of a current account follows price increases as well as productivity increases. This may make it attractive to put money on a current account and just leave it there, enjoying the general productivity increases as return on investment in this current account. This necessitates to “tax” the linked account. Instead of the GDP-proxy, $Y(t)$, the taxed GDP-proxy, $e^{-\tau t} \cdot Y(t)$, is used. Adapting the current account balance is then multiplication with $e^{-\tau \varepsilon} \cdot (Y(t)/Y(t - \varepsilon))$. The parameter τ has to be sufficiently large to prevent investing in “money”. It can be used to control the development of the buying power, e.g. inflation control. In Section 4 this is given attention.

The GDP-proxy forms a stable and real basis for the value of the current accounts. There is a time delay however. It is possible that the current prices increase faster than the prices of a year ago and the average price over the last year. In principle it is possible to work with the GDP over a shorter period. But seasonality is so significant that it is difficult then to construct a stable GDP-proxy. So, we have to accept this time delay.

The parameters of the monetary system

So, we assume that all (base money) current accounts are GDP-linked, with a tax on it. There are four monetary parameters in this system:

- 1) The amount of money, $M(t)$ (as fraction of the GDP)
- 2) The tax rate τ ; the tax reduces the amount of money; by adding a corresponding amount to one of the accounts of the government (the tax account) the total amount of money in the system can be kept constant

- 3) A parameter that determines how much extra base money can be borrowed through the C-accounts
- 4) The interest on such loans from the CB

In Section 4 the question of how to derive monetary rules for such a system is treated. We are going to propose a fixed tax rate, τ ; but a market driven way to determine the amount of money (parameter 1)) and the possibility to borrow from the CB (parameters 3) and 4)). Let $M(t)$ be the actual amount of money (as fraction of the GDP). Because of the tax, it is reduced with $\tau \cdot M(t)$ per time unit. If this is added to the government tax account, the total amount of money remains constant. It also possible however to add more money to the government tax account or to add less money. This possibility to correct the total amount of money is going to be based on the (base money) borrowing behavior of the banks. So, the banks are leading here.

Loans in pico instead of in euro

Once we have this GDP-linkage for all current accounts, the financial calculations become easier if the balance of a current account is expressed as a fraction of the GDP. The GDP of the Eurozone is about 10^{13} euro. So, here one could speak of 1 *pico-GDP* instead of 10 euro²¹. If a current account with a balance of 1 pico is not used for transactions, the balance after a year is equal to $e^{-\tau} \cdot 1$ (pico), independent of the development of the (nominal) GDP, while the balance in euro is more complex because it depends also on changes in the (nominal) GDP.

It is straightforward then to have loans also GDP-linked. A loan of 100 pico for 2 year, with an interest of 2% implies that one has to pay each year 1 pico interest and has to pay back 100 pico at the end of the 2 year. Having all loans and bonds in this GDP-linked form leads to a situation where all assets and liabilities are expressed in pico. Where base money is stored or shifted to or from the future, it can be expressed in pico. The GDP-proxy forms a stable and real basis for the financial assets. Transactions with respect to real goods and services remain in euro, however. The continuously available GDP-proxy serves as the exchange rate. Of course it is possible to escape this stability and have assets and liabilities in euro. That may be attractive to risk seeking actors. But it is not necessary and does not contribute to the real economy.

²¹ To keep the paper concrete, we will occasionally write euro instead of something like "unit of currency in use". It is arbitrary. We could have chosen as well for dollar or pound.

In the previous section, we assume to have a GDP-proxy continuously available. Here we consider the construction and monitoring of such a GDP-proxy. To realize a GDP-proxy that is easy to monitor, we use a definition of the GDP that deviates significantly from what is generally used²². It is important that the transactions which contribute to the GDP can be monitored easily. The choices made here are somewhat arbitrary. There are more options. Most important is that it shows that it can be done in a reasonable way. .

A major element in the GDP is the *production of consumer goods and services*. The value added is determined by the total of (final) sales transactions under subtraction of the import. Transactions regarding steps in the chain are a form of investment for the buyer and removes the investment of the supplier. The difference, the added value is the contribution to the GDP. The final step is the consumption. That removes the investment that is built up, but the total consumption value is now added to the GDP. We are going to label only the consumption transactions, the transactions regarding the sales to consumers, mainly the sales of final products. This way of monitoring the GDP is easier than by labeling all transactions in the chain

The supply of *non-life insurance* can be treated as the supply of goods and services. The premium is the service, the reimbursed damage is a form of cost, an input. *Health care* can be modelled accordingly. Buyers are households, insurance companies and the (central) government. The same for *education*. Contributions of the central government are interpreted as consumption. *Local governments* are also interpreted as service organizations, comparable to healthcare and education. A contribution of the central government is a form of consumption.

Next to consumer goods and services, there are *investment goods*. The added value can be derived from the total sum of sales transactions to the users. These transactions are going to be labeled. Just as in case of consumer goods and services, the import has to be subtracted. The precise definition of investment goods is yet open. Most straightforward is to stick to the usual criterion: consumption period longer than a year. To keep the labeling easy, we assume that whether a good is an investment good is independent of the buyer. So, if it is an investment good for a corporation, it is also an investment good for a household. The main form of household investment remains of course residence building.

²² Compare European System of Accounts, ESA 2010, Eurostat

The remaining actors are *financial corporations* (life insurance companies, banks, etc.) and *central government*. Both are modelled as not contributing to the GDP. Comparable to households. The financing costs are redirected through financial corporations to wages and profits and to other expenses (consumption and investment). For these other expenses, financial corporations are modelled as consumers. For the financing costs of corporations this way of modelling financials has no influence on the GDP-proxy, since we are going to label only the consumption transactions. But the financing costs of households are now treated as simple income transfers, instead of as a contribution to the GDP. The reason is that we want to restrict the GDP-proxy as much as possible to real goods and services, and it is not easy to distinguish the payment of interest and of profit on financial products from the payment of the process service.

The *central government* is modeled in the same way as financials. Taxes are redistributed through the central government, to be spent on infrastructure, social security, education, healthcare, local governments and the government organization itself. So, the wages paid by government or financials are not included in the GDP-proxy. Normally these wages, also the wages of the government, are interpreted as contributing to the GDP. We don't do that. That keeps the GDP-proxy closer to the market. We treat the whole central government as a consumer. Instead of that, government services that are partly paid for by users, could be modelled as service organizations, just as the local government organizations. The precise distinction of what is local and what is central government is something to elaborate further.

To monitor this GDP-proxy, we introduce the following labels:

- i. A label for all household accounts (including household serving institutions).
- ii. A label for all salary payments, private withdrawals from privately owned companies, dividend and interest payed directly to households²³, social security payments, etc.
- iii. A label for expenses of all financial corporations.
- iv. A label for all accounts that are used to pay investment goods.
- v. A label for expenses of the central government.
- vi. A label for transactions with respect to import and export of real goods and services.

To facilitate the labeling it may be necessary to have special accounts for certain types of transactions (e.g. ii. and iv.).

These labels can be used to keep track of the expenses that form the GDP(-proxy). See also Figure 1:

²³ If all such transactions go via financial corporations, it is not necessary to include them here.

a) Consumption and investment of households (and household serving institutions). We need all transactions regarding (real) goods and services. That means that transactions with respect to salary etc. have to be excluded. Transactions with financial corporations have to be excluded as well. Such transactions imply the transfer of household income to financial service providers and then to corporations or other households, or the withdrawal of revenues from previously transferred income.

All remaining transactions together form the total of household expenditure for consumption and investment (residences). This includes payments for healthcare, education and local government services (or local taxes). Reimbursements to households (e.g. insurance) can be included and are subtracted in that way from the total of household expenditure. Payments between households have no influence on this total. Export is added, import subtracted.

The expenses are aggregated per day²⁴. The total sum of these expenses over the past year, on day t is called $H(t)$. The labeling of the household accounts may not be expected to be perfect. There are free-lancers who use their business account for household expenses. Direct loans to corporations are wrongly counted as expenses²⁵.

And the labeling of salary accounts and of financial service providers is probably also not flawless. Let $\gamma(t) \cdot H(t)$ be the real expenses for (real) goods and services. The factor $\gamma(t)$ is supposed to be stable. It is sufficient to re-estimate it only once every year or so.

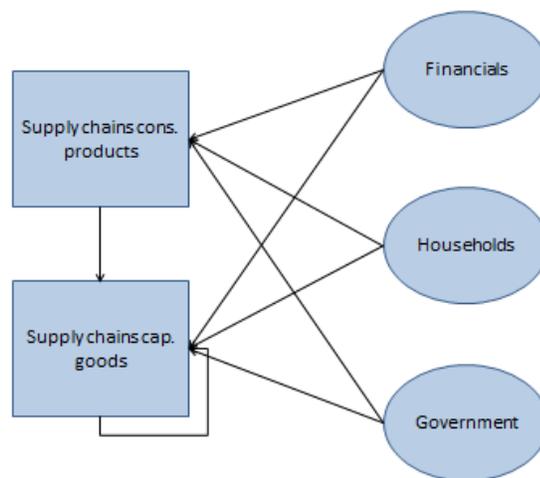


Figure 1: GDP expenses

²⁴ This leads to a GDP-proxy that is updated daily. If necessary it is possible to use a finer time grid.

²⁵ It is possible to prevent this. But that necessitates another label and the effect is relatively small.

- b) Consumption and investment of the central government. This includes all government expenses, except the salary payments and income transfers (also via local governments). The expenses for healthcare and education are included. The total of these expenses over the past year, on day t , is called $G(t)$. Given the role of the government one may expect that this variable measures rather precisely what it should measure.
- c) Consumption and investment of financial corporations. The total of these (labeled) expenses, on day t , is called $F(t)$. Let $\varphi(t) \cdot F(t)$ be the real expenses. The factor $\varphi(t)$ is supposed to be stable.
- d) Expenses for investment goods by corporations (with healthcare organizations, education institutes and local governments included). Here the label for accounts for the payment of capital goods can be used. The total of these expenses during the past year, at day t , is called $I(t)$. It may be expected that corporations collaborate in supporting this label, but perfection is not realizable. Let $\delta(t) \cdot I(t)$ be the real expenses. The factor $\delta(t)$ is supposed to be stable.

The total expenditure is equal to $Y(t) = \gamma(t) \cdot H(t) + G(t) + \varphi(t) \cdot F(t) + \delta(t) \cdot I(t)$. This variable can be used to link the accounts with. In case of a new estimate of $\gamma(t)$ and/or $\delta(t)$ one has to take care of continuity of the estimated total expenditure. Suppose at day t new estimates of $\gamma(t)$ en $\delta(t)$ are determined, $\gamma'(t)$ en $\delta'(t)$. Then a factor μ has to be determined such that $\mu \cdot \gamma'(t) \cdot H(t) + \mu \cdot \varphi'(t) \cdot F(t) + \mu \cdot \delta'(t) \cdot I(t) = \gamma(t) \cdot H(t) + \varphi(t) \cdot F(t) + \delta(t) \cdot I(t)$. Thereafter we continue with $\mu \cdot \gamma'(t)$, $\mu \cdot \varphi'(t)$ and $\mu \cdot \delta'(t)$ as correction factors²⁶.

4 SIMPLE RULES ARE SUFFICIENT FOR A MONETARY POLICY

There is a fundamental debate about rules versus discretion in monetary policy (e.g. Stokey, 2002²⁷). One tends to agree that rules work better if the dynamics of the situation can be modelled well, but that discretion may be necessary because of all unforeseen changes. It is accepted that discretion also adds to the dynamics of the system, because actors anticipate and react. Goodhart stresses the difference between the banking school and the currency

²⁶ There is another discontinuity that requires attention. That is the existence of leap-years. It is important to stick to year totals because of the seasonality of expenses. Normally, to determine a new year total, one new day is added and the oldest day is skipped. On February 29 the new day is added, but the old day is not skipped. Instead of that all day totals are multiplied with a factor 365/366.

²⁷ Nancy L. Stokey, "Rules vs Discretion' After Twenty-Five Years", NBER Macroeconomics Annual, 2002

school of monetary economics (Goodhart, 1998²⁸) and argues that banking school proponents generally accept that discretion is necessary and possible, while currency school proponents are more optimistic about the possibility of rules and more pessimistic about the quality of discretion. (Goodhart & Jensen, 2015²⁹).

In that sense, this approach belongs to the currency school. It is going to be argued that GDP-linking helps to develop a good monetary policy that is completely determined by simple rules. Important here is that the parameter τ can be used to control the buying power, independent of all other choices, even if the amount of money is larger than what is necessary.

Money is a medium of exchange. It is the lubricant of the real economy. There are five “places” where the money has to fulfill this role:

- a) in households for housekeeping,
- b) it is the liquid part in working capital for corporations
- c) or in working capital for government,
- d) it is used in the investment world, e.g. to create flexibility in the investment portfolios; one could call this the working capital in the investment world
- e) and in the last place, it is used for the formation of fixed capital.

In working capital (households, corporations and government) the money is used to buffer temporary discrepancies between the flow of income and the flow of expenditures that are the result of the business. In the investment world it is used to be able to change the composition of the portfolio by selling certain assets and buying other assets. Here the transactions are more independent of each other than in case of working capital.

The last function of money (fixed capital formation) is also performed by households, corporations or government, but is distinguished from the working capital function, because it is accompanied in general by significant discontinuities in the need for money. Large capital investments for production and innovation demand extra liquidity. It is important to check whether the monetary system facilitates this need adequately. Insofar as these capital investments are directly financed, they belong to the investment world and the money required is included in the money required there anyway. But another part of these investments has to be financed or pre-financed through the B-accounts. The money that is not needed as working capital or in the investment world as exchange money, is available for the B-accounts of the

²⁸ C.A.E. Goodhart, “The Two Concepts of Money: Implications for the analysis of optimal currency areas”, *European Journal of Political Economy*, **14**, 407-432, 1998

²⁹ C.A.E. Goodhart and M.A. Jensen, “A Commentary on Patrizio Laina’s ‘Proposals for Full Reserve Banking: A Historical Survey from David Ricardo to Martin Wolf’”, *Economic Thought*, 4, 20-31, 2015

banks. From these B-accounts it can be borrowed back into working capital or investment world and it can also be used for capital formation.

The aim is to develop simple monetary rules. First the choice of the *money tax*. In case of a too high τ the available base money becomes ineffective. The economic actors search for other possibilities to settle their transactions and the base money ends for a large part at the B-accounts of the banks and remains there. The other extreme is a too low τ . For instance $\tau = 0$. In this case, the GDP-linkage implies that just storing base money leads to a result that keeps up with the GDP. Storing base money becomes an attractive “investment”. The base money is meant to be a means of exchange. So, it is important to choose τ sufficiently high to prevent that base money is used by investors as a structural investment possibility. It is sufficient to choose τ equal to or a little higher than the expected increase in the real GDP ($\hat{\pi}$). Recall that 0.02 is the inflation goal of the ECB. With $\tau = \hat{\pi} + 0.02$ the buying power development satisfies that goal. Therefore we choose $\tau = \hat{\pi} + 0.02$ and prevent so that having base money becomes a goal instead of a means.

Next the *amount of money*. To investigate the influence of the amount of money it is useful to explore first how money is used in a situation with plenty of base money. In such a case it easily occurs that there is too much base money for working capital (places a), b) and c)) or exchange money (place d)). Then one has to compare keeping the money, investing it (adding it to some investment portfolio) or making it available to a bank, where it can be put on a B-account. In case of keeping it, the loss in buying power is equal to $\pi - \tau$, which is about equal to 0.02. Investing it leads to a profit that varies around π . The result of making it available to the B-accounts depends on how scarce this money is and on the term that is agreed upon. If there is really plenty of money one may not expect much more than a loss of little less than 0.02. Recall that accepting the money and not using it, leads to a loss in buying power of about 0.02. Let $-0.02 + \varepsilon$ be the interest paid in average by the bank. Then the bank can make it available for investment at an interest equal to $-0.02 + \varepsilon + \rho + \beta$, with ρ the risk assessed and β the banking allowance, necessary to pay the costs for risk assessment and administrative processes and let it contribute to the profit.

The results of all these possibilities vary with $\hat{\pi}$, the expected growth. And this is a rather stable variable in general. But if the return on making superfluous money available to a bank is almost the same as the return of keeping the money, many actors may just keep the money. And all this idle money may at some time lead to sudden runs on the existing resources and sharp inflation. The buying power is compensated for inflation, but only with a delay. It is possible that the current prices increase faster than the average prices over the last year. In principle it is possible to work with the GDP over a shorter period. But seasonality is so significant that it is

difficult then to construct a good GDP-proxy. So, we have to accept this time delay³⁰. That means that even in this GDP-linked system, very high inflation is not attractive.

This implies that the amount of money has to be restricted and the return on money made available to a bank has to be significant. A possibility is to estimate the money that is necessary. This is not easy however and may become rather speculative. In a separate note a possibility is sketched³¹. But instead of using such an estimate to control the amount of money directly, it is also possible to control the amount of money indirectly, by following the market. That option is chosen here. In this option, controlling the amount of money is combined with choosing the other two monetary parameters: the parameter that determines how much *extra base money* can be borrowed through the C-accounts and the *interest on such loans* from the CB (compare Section 2).

We switch to a formulation in pico now instead of in euro (see Section 2). That makes it easier. The following two measures are proposed:

- A. Banks can borrow extra money at an interest of r (yet to determine, the loans are GDP-linked formulated now, see Section 2) The use of this measure is interpreted as a sign that there is too less money in the system. Applying this measure is combined therefore with adding an extra amount of money to the system, by putting more than the money tax on the government tax account (see Section 2). The correction is proportional to the amount of money on loan from the CB, $C(t)$. The correction factor is chosen such that each day 1% of the amount on loan is corrected.
- B. Banks can buy specific GDP-linked government bonds, called *tax bonds*. The term is one year. The buyer pays $1 + s$ (pico) (see Section 2) to receive after a year 1 pico. That means that the yield is negative, about $-s$, with s to be chosen such that that yield is better than the yield of pure base money. The use of this possibility is interpreted as a sign that there is too much money in the system. Using this possibility is combined with withdrawing an extra amount of money from the system, by putting less than the money tax on the government tax account. The correction is proportional to the total value of the active tax bonds, $B(t)$. The correction is chosen such that each day 1% of the total value of the active bonds is corrected.

Banks have to compare borrowing from the CB and borrowing through the B-accounts. Borrowing from the CB goes through the C-accounts. These accounts are also GDP-linked. So, if

³⁰ Another effect of the time delay is that it makes the system somewhat counter cyclical. In case of a speeding up economy, the increase of the amount of money is lagging behind, in case of a slowing down economy, the amount of money decreases slower than the economy. This counter cyclicity helps to keep the system stable.

³¹ Jacob Wijngaard, "Estimating the Amount of Base Money that is Necessary", www.robustgeld.nl/english, 2017

a bank wants to repay the loan after a certain time t , they have to pay $q \cdot e^{-\tau t}$, with q the size of the loan (in pico), while the value of the borrowed money, if it remains idle, is equal to $q \cdot e^{-(\tau+r)t}$. If a bank pays an interest of δ on the base money that is made available to her B-account, the bank has to repay after a certain time t an amount equal to $q \cdot e^{\delta t}$, while the value of the borrowed money, if it remains idle, is equal to $q \cdot e^{-\tau t}$. So, if $r = \tau + \delta$ both options are equally attractive. If $\delta < r - \tau$ using the B-accounts is more attractive.

The yield $-s$ on the tax bonds has to be compared with δ as well. The possibility to buy such tax bonds makes that the interest paid on base money available on B-accounts should not be much smaller than $-s$. So δ remains on the interval $(-s, r - \tau)$. A straightforward possibility is to choose $r = \tau + 0.02$ ($= \hat{\pi}$) and $-s$ just sufficiently far away from $-\tau$ ($> -\tau$) to guarantee that it is more attractive to buy tax bonds than just keeping idle money, e.g. $s = \tau - 0.005$. Such a parameter choice guarantees that the two possibilities (borrowing extra base money and buying tax bonds) are not going to be used simultaneously.

The total monetary policy consists of the rule for the money tax ($\tau = \hat{\pi} + 0.02$), together with measures A and B. Measure A settles the possibility to borrow from the CB (the parameters 3) and 4) in Section 2). Figure 2 gives an overview.

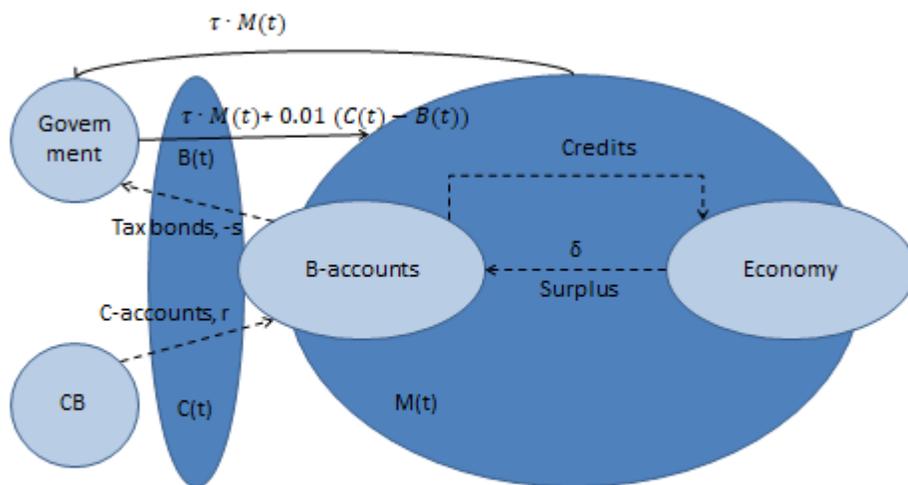


Figure 2: Monetary system

Measure B creates the possibility to get rid of superfluous money (and replaces in fact parameter 1) in Section 2). The parameters r and s and the correction speed are fixed and determined centrally, the decision to activate the measures is made by the banks. The two measures together control the amount of money flexibly. Positive expectations about the economy may create more demand of money and result in borrowing from the CB and a corresponding addition of extra money. Negative expectations may lead to the use of money for tax bonds and a corresponding reduction of money. Such fluctuations in expectations will also lead to price fluctuations. But due to the GDP-linkage the quality of the system is not sensitive to such fluctuations. Notice that the sharpest price increases are due to expected changes in the development of the buying power and such changes are much more modest in a GDP-linked system.

Of course there are many questions about the behavior of the amount of money and of the various interest rates in case of such a policy. First about the influence of the parameters τ, r, s and the correction speed. Thereafter about the possibility of such policies in general, dynamics, credit flexibility, etc. This is just to give an example of a rule based monetary policy or set of policies that could work in such a GDP-linked, one-tiered system.

5 EXTENSIONS

This paper is about the possibilities of GDP-linking of current accounts. The advantage of that is that the buying power of a current account can be secured rather precisely. That leads to stability and is an important step in the direction of a rule based monetary policy. The possibilities are most clear in a one-tiered monetary system without physical cash. That is the system in focus in the previous sections. But it can also be applied in a two-tiered system or in combination with physical cash. That will be sketched here.

Two-tiered system

Notice in the first place that the one-tiered system we propose is not so different from a two-tiered system. Banks are free to borrow base money and to return base money for tax bonds again. A flexibility that is comparable with the flexibility of banks in the current system. It is also possible to give the banks a special role in monitoring and transaction processing. Instead of working with one central administrative unit, it is also possible to distribute this role over the banks, as long as the base money accounts are well distinguished, the transactions are processed properly (including the GDP-linking) and the GDP-proxy is monitored well. This leads

to even more similarities with the current two-tiered system³². But one could go a step further. A possibility that could be combined with the one-tiered system is to accept that banks create a payment account (an A-account) that they use for payments of their customers. The customers develop “drawing rights” by lending base money to the banks, put on the B-account. Depending on these drawing rights, the bank can pay for the customer. The payment is executed from an A-account of the bank, so with base money. To distinguish this A-account from other A-accounts of the bank we call it the P-account. This possibility implies that in principle, it is not necessary anymore for an actor to have an A-account. This is the first step in the direction of a real two-tiered system.

Part of the advantages of the one-tiered system (compare Van Hee & Wijngaard, 2017³³) are lost. But it could be attractive for individual actors. Whether that is the case depends on the conditions offered by the banks. If actors keep their base money, they have a return of $\pi - \tau$ on it. In case of ample availability of base money, it is to expect that making it available to a B-account leads to a return between $\pi - \tau$ and π , depending on the term that is agreed upon. And if that term is short, the return must be close to $\pi - \tau$. In case of ample availability of base money, there is not much room for banks to create business in this way. In case the amount of base money is tight, the banks can make the money that is available more effective and may be able then to create conditions that are attractive for actors. The possibility does not interfere with GDP-linking. GDP-linking remains possible as long as the monitoring of the GDP-proxy can be organized. It makes the collaboration of banks with a P-account necessary. The labels of the actors involved in a transaction have to be also visible if the transaction is executed through the P-account of a bank.

The possibility above is a two-tiered element in a one-tiered system. A complete two-tiered system is created if all actors have to make all their base money available to B-accounts, developing drawing rights that make it possible to let the bank involved take care of their payments. If these drawing rights correspond one-to-one to the amount of base money put on the B-account, the situation is similar to the systems in use (except that the clearing is performed differently). GDP-linking is also possible here, if the banks collaborate in monitoring the GDP-proxy. The tax on the base money (τ) is reflected in the return on the money that is made available. So, the GDP-linking in this two-tiered case leads also to money with a better controlled buying power, even if there is more money than necessary. But it is less direct and

³² It is also possible of course to use a block chain approach instead of having a central administrative unit to deal with the transactions.

³³ K.M. Van Hee and J. Wijngaard, “A New Monetary System with New Monetary Policy”, www.robustgeld.nl/english, 2017

transparent than in a one-tiered system. It is not advised, but it is possible and even in such a system the GDP-linking has a positive effect.

Physical cash

Physical cash does not quite fit in a system with GDP-linking. The value of physical cash cannot be linked to the GDP. The demand for physical cash is rather persevering however. It is clear that it is not easy to abolish cash. Two aspects that play a role here are the anonymity of cash and the perceived convenience of cash. David Wolman³⁴ gives a nice description of the various attitudes towards cash and the possibilities to go cashless. Some people are even religiously involved with the anonymity and “liberty” of (physical) cash³⁵. Other people, just as libertarian, can just as well live without cash, but applaud for crypto currencies, like bitcoin, stressing the same anonymity and independence of government control and hoping to be able to escape in that way a government controlled cashless monetary system³⁶. We are not going to discuss such philosophical issues here, but check the consequences of the existence of such independent currencies and explore the possibilities of also facilitating some form of cash.

The link with the GDP is directed to linking money to the real economy. Part of the real economy is settled with other currencies. The money can only be linked to the real economy as far as it is settled in euro, the euro-economy. People who settle their transactions in dollars or in bitcoins etc.³⁷, participate in fact in another economy. It is not a problem for the concept of GDP-linking as long as these other parts of the economy are relatively small and stable. Bartering affects also the ratio of the size of the economy and the use of money. As long as the development of bartering is smooth, it is no problem. And the insensitivity of the monetary system for too much money, due to GDP-linking, helps here also.

In the present two-tiered system, physical cash is a form of base money and a positive balance on a bank current account is a claim on base money. This implies the ZLB on the rate at which the banks can borrow base money from the CB. To break that bound, Buiter³⁸ mentions three possibilities: going cashless, taxing bank notes somehow and introducing an exchange rate between physical cash and euro’s at current accounts. The last possibility is presented as the most realistic. Buiter suggests the “wim” for a unit of cash. It may be the most realistic, it is

³⁴ David Wolman, “The End of Money”, Da Capo Press, 2012

³⁵ Glenn Guest, “Steps Towards the mark of the Beast”, Essence Publishing, 2007

³⁶ See for instance Kevin V. Tu and Michael W. Meredith, “Rethinking Virtual Currency Regulation in the Bitcoin Age”, *Washington Law Review*, **90**, 217-347, 2015

³⁷ This includes also all kinds of local and network money.

³⁸ W.H. Buiter, “Negative nominal interest rates; Three ways to overcome the zero lower bound”, *The North American Journal of Economics and Finance*, **20**, 213-238, 2009

certainly not very handy in practice. See also Agarwal and Kimball³⁹. But they find the goal, breaking the ZLB, sufficiently important to consider such possibilities. Here we have also two possibilities, cash in euro or cash in pico. Cash in pico would be possible (at least in principle) in case of $\tau = 0$. In case of a positive τ , we have the difficulties of cash taxing that are mentioned by Buiter already. Having cash in the form of euro's is the other, more realistic possibility. People who prefer cash can buy this. The cash is not included in the GDP-linking. So, if they sell it again after a year, they miss possible price increases and productivity increases. On the other hand, they miss also the tax. If the tax is about equal to the productivity increase, switching to cash is not attractive for speculative reasons as long as there is some inflation. The total sum of the transactions settled with cash may be expected to remain small then. Facilitating cash in the form of euro's hardly corrodes the possibilities of GDP-linking.

6 CONCLUSION

This paper is inspired by the current discussion on the possibility to introduce digital cash. That is base money that is made accessible to all economic actors. This possibility suggests to consider monetary systems without physical cash or with physical cash only as a secondary form of cash, a voucher, a termed claim on base money. Such systems make it possible to link current accounts of base money to a GDP-proxy or related macro-economic variables. This leads to completely new possibilities with respect to monetary rules and may be a reason to revisit the acceptance of discretion in monetary policy. This is explored in this paper. It shows that monetary stability and secured buying power can be realized indeed with simple rules.

Sections 2, 3 and 4 show the possibilities of GDP-linking in a one-tiered system. In such a system, GDP-linking is most easy. There is a central administrative unit to keep track of a continuous time available GDP-proxy and to update the current accounts (Section 3). Section 4 describes how a one-tiered monetary system with GDP-linking could work. The banks play an important role in determining the amount of money in the system. Section 5 shows that it is quite possible to combine such a system with some form of physical cash, albeit not the cash people are used to. It is not any longer the basis for the monetary system, the base money, it is only a claim on base money. This section shows also that, given the possibilities of a one-tiered system, there is no rational reason anymore to stick to a two-tiered system. But even if we get stuck with such a system, adding GDP-linking may help in creating control and stability.

³⁹ R. Agarwal and M. Kimball, "Breaking Through the Zero Lower Bound", IMF, WP/15/224, 2015

This conclusion sounds absolute. But it is in fact only tentative. There are many questions to answer before one can speak of a real, complete proposal. I will come back to these. But the first and main question is whether the elements in the proposal are not too different from the actual monetary policy and the existing economic theory to accept it as a serious option. A short summary of these “different” elements is given here.

We are used to money that is hard in the sense that if we have 10 euro in our wallet, it remains 10 euro unless we use it or lose it. We accept that the buying power of this 10 euro changes, but the amount is save. The concept of money explored here implies that *the amount of money may change* (Section 2). The system is directed to securing the buying power instead. We, the people in general, have to get used to this new form of money. And the *anti-hoarding tax* that is added does not make it easier. That Keynes appreciated the idea of such a tax⁴⁰, does not immediately remove the objections against it. An extra complication is that it has to be combined with *a transfer to cashless or at least to another form of cash*. This is in itself already a big issue (Section 5). GDP-linking may be wider applicable, but the monetary system sketched in Section 4 presupposes a *one-tiered system*. The most common proposals of a one-tiered system see no role anymore for commercial banks in determining the amount of money⁴¹. Authors from the banking world protest against this and emphasize the importance of banking know how in this respect⁴². In the proposal developed here (Section 4), banks have a more important role in determining the amount of money, although more restricted than in the actual system. But the *structural use of tax-bonds* is another new element that may be seen as complicating.

All these new elements together make this paper a form of “economic science fiction”, unless there are serious economists who start to elaborate the proposals. There are many reasons not to do that. It endangers your career. The title of the special issue of the Cambridge Journal of Economics on fundamental alternatives for the actual monetary system is meaningful: “... ‘cranks’ and ‘brave heretics’ “. Scientific communities function as tribes. Paul Romer stresses that this is also true for macro economists⁴³, referring to the “mathiness” of macro-economic theory, but suggesting that it is more generally true. Maybe it is worse for macro-economics, because it is difficult to experiment with economies. In macro-economics, it is apparently dangerous to deviate from the tribe. Certainly if it is not possible to hide in the shadow of accepted great scholars like Marx or Keynes or Minsky. In between technological developments continue. Especially the new IT developments enforce paradigm jumps and Marx, Keynes and

⁴⁰ J.M. Keynes, “The General Theory of Employment, Money and Interest”, Book VI, Chapter 23, 1936

⁴¹ See J. Huber, “Sovereign Money; Beyond Reserve Banking”, Palgrave, 2017

⁴² See e.g. W. Boonstra, “Hoe werkt geldschepping?”, Rabo special, 2015

⁴³ P.M. Romer, “Mathiness in the theory of economic growth”, American Economic Review, Papers & Proceedings, vol.105(5): 89-93, 2015

Minsky could not foresee these. New IT possibilities have already lead to crypto currencies like bitcoin, to the application of blockchain principles and the development of all kind of fintech products. Would it not be time, given the new possibilities, to reconsider the structure of the monetary system? Do we have to stick to cash and keep supporting crime and corruption? Is discretion still necessary and do we have to try to interpret the look of the CB president in making her announcements? Do we have to accept the current instability and accept the speculation connected? The size of the financial sector is a measure of its inefficiency. Is this acceptable? This paper is meant to contribute to the exploration of the possibilities of structural monetary innovation. Hopefully it draws the attention of real economists and is sufficiently tempting for them to investigate the proposals in more detail.

Further research is necessary, at least with respect to the following points:

- 1) The effectiveness of GDP-linking with respect to inflation correction. We mentioned already that it is a delayed correction.
- 2) The stability of the GDP-proxy proposed in Section 3. How frequent should the correction factors be determined? Are there alternatives?
- 3) The functioning of the B-accounts.
- 4) The precise choice of the monetary parameters τ , r , s and the feedback parameter (0.01 in Section 4).
- 5) The demand for physical cash and how to organize it.
- 6) The possibility to combine this official money with complementary currencies.
- 7) The advantage of formulating loans in pico instead of in euro.
- 8) The consequences for government finance of the introduction of tax bonds (Section 4).

Hopefully there are sufficient economists who agree that working on a fundamentally different monetary system is not that 'cranky'.

ACKNOWLEDGEMENT

The ideas developed in this paper are rather "different". Therefore I hesitate to thank people. But nevertheless, I trust they don't feel awkward about it. Thanks are due to Dirk Bezemer for introducing me in this field and giving me useful feedback on all kind of wild, early ideas, Wim Westerman for always listening and associating my ideas with already existing concepts, Hans Visser for making me more confident about their quality and Kees van Hee for stimulating me to remain skeptical about the possibilities.

LITERATURE

- R. Agarwal and M. Kimball, "Breaking Through the Zero Lower Bound", IMF, WP/15/224, 2015
- R. Ali, J. Barrdear, R. Clews and J. Southgate, "Innovations in payment technologies and the emergence of digital currencies", Bank of England Quarterly Bulletin, **54**, 262-275, 2014
- J. Benes and M. Kumhof, "The Chicago Plan Revisited", IMF WP/12/202, 2012
- W. Boonstra, "Hoe werkt geldschepping?", Rabo special, 2015
- B. Broadbent, "Central Banks and Digital Currencies", Speech, Bank of England, 2016
- W.H. Buiter, "Negative nominal interest rates; Three ways to overcome the zero lower bound", The North American Journal of Economics and Finance, **20**, 213-238, 2009
- B. Dyson, G. Hodgson and F. van Lerven, "A Response to critiques of 'full reserve banking'", Cambridge Journal of Economics, **40**, 1351-1361, 2016
- European System of Accounts, ESA 2010, Eurostat.
- G. Fontana and M. Sawyer, "Full Reserve banking: more 'cranks' than 'brave heretics'", Cambridge Journal of Economics, **40**, 1333-1350, 2016
- C.A.E. Goodhart, "The Two Concepts of Money: Implications for the analysis of optimal currency areas", European Journal of Political Economy, **14**, 407-432, 1998
- C.A.E. Goodhart and M.A. Jensen, "A Commentary on Patrizio Laina's 'Proposals for Full Reserve Banking: A Historical Survey from David Ricardo to Martin Wolf'", Economic Thought, 4, 20-31, 2015
- Glenn Guest, "Steps Towards the mark of the Beast", Essence Publishing, 2007
- J. Huber, "Sovereign Money; Beyond Reserve Banking", Palgrave, 2017
- K.M. Van Hee and J. Wijngaard, "A New Monetary System with New Monetary Policy", www.robuustgeld.nl/english, 2017
- G. Ingham, K. Coutts and S. Konzelmann, "Introduction: 'cranks' and 'brave heretics': rethinking money and banking after the Great Financial Crisis", Cambridge Journal of Economics, **40**, 1247-1257, 2016

A. Jackson and B. Dyson, "Modernising Money", Positive Money, 2012

M.J. Kamstra and R.J. Shiller "The Case for Trills: Giving Canadians and their Pension Funds a Stake in the Wealth of the Nation," C.D. Howe Institute Commentary, The Pension Papers, 271, 2008

J.M. Keynes, "The General Theory of Employment, Money and Interest", Book VI, Chapter 23, 1936

K. Rogoff, "Costs and Benefits to Phasing out Paper Currency", NBER, Macroeconomics Annual, 2015

P.M. Romer, "Mathiness in the theory of economic growth", American Economic Review, Papers & Proceedings, vol.105(5): 89-93, 2015

N. Roubini and S. Mihm, "Crisis Economics", Penguin Books, 2010

Nancy L. Stokey, "'Rules vs Discretion' After Twenty-Five Years", NBER Macroeconomics Annual, 2002

Marilyne Tolle, "Central bank digital currency: the end of monetary policy as we know it", <https://bankunderground.co.uk/>

Kevin V. Tu and Michael W. Meredith, "Rethinking Virtual Currency Regulation in the Bitcoin Age", Washington Law Review, **90**, 217-347, 2015

See e.g. M. Walport, "Distributed Ledger Technology: beyond block chain", Government Office for Science, 2016

Jacob Wijngaard, "Estimating the Amount of Base Money that is Necessary", www.robustgeld.nl/english, 2017

David Wolman, "The End of Money", Da Capo Press, 2012