Sovereign Money Reforms and Welfare*

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Abstract

A monetary reform is submitted for vote to the Swiss people in 2018. The Sovereign Money Initiative proposes that all sight deposits should be controlled by the Swiss National Bank (SNB) and that the SNB could distribute its additional resources. While a sovereign money reform would clearly affect the structure of the banking sector, it would also have macroeconomic implications, in particular because it transfers resources from banks to the central bank. The objective of this paper is to analyze these macroeconomic implications using a simple infinite-horizon open-economy model calibrated to the Swiss economy. While we consider several policy experiments, we find that there is a key trade-off between a reduction in distortionary labor taxes and an increase in the opportunity cost of holding money. However, in the proposed Swiss reform it is this latter cost that dominates and we find that the reform unambiguously lowers welfare.

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1 Introduction

The recent financial crisis generated renewed interest in reforming the financial or the monetary system. A bold proposal of monetary reform has been presented in Switzerland in the form of a political initiative to be voted at the Federal level. The Swiss people are voting on this initiative, often called the Vollgeld initiative, in June 2018. The proposal is to have *sovereign money*, where all bank notes and scriptural money included in M1 would be issued by the Swiss National Bank (SNB). This implies that all sight deposits of commercial banks should be removed from their balance sheets and be directly invested at the central bank. The initiative also modifies the law governing the central bank, by allowing it to distribute the increase in its balance sheet to the public or to the government.[1] While the sovereign money reform clearly affects the structure of the banking sector, it also has macroeconomic implications, in particular because it transfers resources from banks to the central bank. The objective of this paper is to analyze these macroeconomic implications.

The sovereign money reform is related to proposals of full reserve requirements or of "narrow banking", where banks are only allowed to invest in very safe and liquid assets, while the function of originating loans would be performed by institutions financed by long-term debt or equity. Among these proposals, one specific brand is the "Chicago Plan", originally initiated by Irvin Fisher and other Chicago economists in 1933, and recently revived by Benes and Kumhof (2012) (hereafter BK). In addition to avoiding runs on deposits, advocates of these reforms see another benefit which would be to cut banks' ability to collect rents from deposits, and give back the full benefits of money creation (seigniorage) where they belong, i.e., to the central bank.[2]

The objective of this paper paper is to analyze the costs and benefits of the proposed reform by taking a macroeconomic perspective and by using a very simple framework. So far, the type of monetary reform considered in Switzerland has not been formally analyzed in the literature. Advocates of the reform often refer to the BK paper, who show that a Chicago plan could significantly increase the economy's output. However,

[1] For further details on this initiative see the SNB webpage or Bacchetta (2018).

[2] Another purported benefit is to better control economic fluctuations – the view being that the banks' ability to create money, i.e., to create their own funding, allows them to excessively expand credit during booms and contract it during contractions.

BK's analysis is not adequate for the Swiss monetary reform, because the experiment is different and their closed-economy model introduces mechanisms that are not present in an open-economy like Switzerland. Our analysis focuses on the main features of the reform proposed for Switzerland and calibrates the model on the Swiss economy.

A major issue is to understand the implications of resource allocation implied by the reform. BK shows that one of the benefits of narrow banking is to enable the government to reduce distortionary labor taxation, which increases output and should increase welfare. However, the increase in government resources is significant only if interest rates on deposits at the central bank are low. In the Swiss initiative they would be zero. But lower interest rates on deposits increase the opportunity cost of holding money. Consequently, the monetary reform might imply a trade-off between lower distortionary labor taxes and a higher opportunity cost of money.[3] We analyze the outcome of this trade-off by carefully calibrating labor elasticity and the interest elasticity of money demand. In this context, we find that a sovereign monetary reform as proposed in Switzerland unambiguously decreases welfare.

We develop a deterministic infinite-horizon model with households, firms, banks and the government/central bank. Households work in firms, consume and save in two different instruments: an international asset in perfectly elastic supply yielding a real interest rate r^*, or domestic bank deposits, giving an interest rate r^d typically lower than r^* due to banks' market power. The reason why households save a positive amount in the form of bank deposits is that the latter have money properties: deposit (money) holdings reduce the transaction cost from consumption. We model the transaction cost following Schmitt-Grohe and Uribe (2004).

For exogenous reasons, which have been identified in the literature as informational frictions, a fraction of firms' capital needs to be financed by bank loans. Banks collect deposits from households and grant loans to firms. Although deposits are a source of financing for bank loans, bank's marginal financing cost is r^*, as banks need to borrow at rate r^* to finance loans in excess of the deposit supply, or lend at rate r^* to invest deposits in excess of the loan demand. This is in contrast with the approach of BK, who model all bank liabilities as a single asset yielding an interest rate lower than the policy

[3]Another way to look at it is that "seigniorage" is essentially a tax on deposits. Since deposits are in the model proportional to consumption, a tax on deposits is a progressive tax, which is also distortionary.

rate. Moreover, BK consider a closed economy model with an endogenous equilibrium interest rate. The government finances an exogenous and fixed consumption g through a tax proportional to labor income and a tax on dividends.

In the baseline model we assume that there is a continuum of banks in monopolistic competition and that all bank profits are distributed to domestic households. Monopolistic competition requires some degree of differentiation between the services sold by different banks. With respect to deposits, in the presence of transportation costs, differentiation could be provided by bank location, as in the model of Salop (1979). With respect to loans, differentiation could arise from the fact that different banks specialize in monitoring different types of firms, and from the fact that banks accumulate informational capital with respect to the firms with which they already have a relationship, so that switching bank would entail a cost for a firm.

With monopolistic competition there is no interplay between the deposit and lending functions of the bank: the banks' optimization problem yields two independent equations for the deposit rate $r^d(i)$ and the loan rate $r^l(i)$ offered by bank i. Separating the two functions in two entities, a "narrow bank" managing deposits and the payment system and a lending institution, would therefore have no effect on the decisions of the two entities. In particular, it would have no effect on the volume of lending. We also consider a model with N banks in Cournot competition, and in this case we do find a degree of interplay between the two functions of the banks. However, we find that the impact is only significant with a very small number banks. With a realistic number of banks the effects of the reform are almost identical whether we model banks as being in monopolistic competition or Cournot competition. Thus the only effect of the reform would stem from the fact that the central bank may have a different objective function from commercial banks and might use the profits to offset other (distortionary) taxes, as discussed below.

Besides analyzing the case proposed by the Swiss initiative, we will also consider alternative scenarios. We consider three different policies. "Policy 1" is the policy which is the closest to the proposal of the Vollgeld initiative.[4] In this case deposits would yield zero interest and the government/central bank would collect the entire

[4]Notice that the text of the initiative is not very precise and people also rely on the arguments made by the initiative committee.

rebate the additional seigniorage to the public in lump-sum fashion. Our "Policy 2" assumes that additional seigniorage is used to lower the (distortionary) labor income tax. This is one of the channels through which the switch to sovereign money would benefit the economy according to BK. Finally our "Policy 3" is the case in which the central bank chooses r^d after the reform with the objective of maximizing welfare, and adjusts the labor income tax in order to be able to finance its consumption.

If "Policy 1" is adopted after the reform, welfare decreases regardless of the parameter choice, and the welfare loss is increasing in the elasticity of labor supply and in the interest semi-elasticity of money demand. If "Policy 2" is adopted, we find that the reform is essentially welfare-neutral. If "Policy 3" is adopted, we find that the central bank, in order not to increase the opportunity cost of holding money, optimally chooses an interest rate on deposits close to the risk-free rate (around 3.5% for a risk-fre rate of 4%), and in this case welfare increases between 20 and 40 bps, depending on the elasticity of labor supply. We only find a higher welfare increase if we assume that banks are owned by foreigners. In this case the reform would also have the effect of redistributing the portion of bank dividends coming from deposits from bank owners to domestic households. In this case welfare could increase by around 1.2% if "Policy 2" is adopted and by around 1.7% if "Policy 3" is adopted. If the Vollgeld policy is adopted, welfare would decrease despite the redistribution.

The paper is structured as follows. Section 2 presents the basic model and the objective of its agents: households, firms and banks. Section 3 analyzes the impact of the reform. Section 4 consider several extension of the baseline analysis. Section 5 concludes.

2 Model

We consider a small open economy model with households, firms, and banks. The world price level is assumed constant and equal to one and purchasing power parity is assumed to hold. Therefore the price level is equal to the nominal exchange rate: $P_t = S_t$. The world real interest rate is also constant at r^* and uncovered interest rate parity holds. Thus we have $(1 + i_{t+1}) = (1 + r^*)(1 + \pi^e_{t+1})$, where i_{t+1} is the nominal interest rate on the domestic safe asset and π^e_{t+1} is the expected inflation rate.

Since the objective of our analysis is to examine the impact of sovereign money reforms in the long run, we focus on deterministic steady states; hence $\pi^e_{t+1} = \pi_{t+1}$. We will assume that the central bank can set inflation at its target level $\overline{\pi} \geq 0$.[5] We will describe the model in real terms.

2.1 Households

Households work in firms, consume and save, either in a safe asset A giving nominal interest rate i_t or in bank deposits. Due to the costs of managing deposits and to banks' market power, discussed in section 2.3, bank deposits give a lower interest rate $i^d_t < i_t$, but households still hold them because they reduce the transaction costs from consumption.[6] The real interest rate on deposits is r^d_t. The safe asset can be either in domestic or in foreign currency as both are perfect substitutes.

The representative household derives utility from consumption and disutility from working. We assume separable CRRA preferences so that the household's periodic flow utility is given by

$$u(c,h) = log(c) - \frac{h^{1+\gamma}}{1+\gamma} \qquad\qquad \gamma > 1$$

where c is consumption and h denotes labor supply. The household's expected lifetime utility is:

$$U = \sum_{t=0}^{\infty} \beta^t u(c_t, h_t) \tag{1}$$

where we assume $\beta(1+r^*) = 1$ for stationarity. Expressed in real terms, the households budget constraint is

$$\begin{aligned} & (1-\tau_h) w_t h_t + (1+r^*) a_{t-1} + (1+r^d_t) d_{t-1} + (1-\tau^d)\Pi^b_t \\ = \;& c_t(1+s_t) + d_t + a_t + t_t \end{aligned} \tag{2}$$

where w_t is the real wage, a_t are real holdings of the safe asset, d_t are real deposits, Π^b_t are real bank dividends, t_t is a lump-sum tax, and τ^h and τ^b are labor income and

[5] The objective of our analysis is to determine the impact sovereign monetary reform for a given monetary policy. It would be of interest to examine how such a reform could affect optimal fiscal and monetary policies, but this goes beyond the scope of this paper.

[6] We do not introduce bank notes, as they would play a minor role in the analysis.

dividend tax rates. In our benchmark case, we assume that households own the banks and receive all bank profits, but we will also consider the case where banks are not held by households. To consume c_t, households incur transactions costs $c_t s_t$, that can be reduced by holding deposits.[7]

Households maximize their utility subject to (2). First-order conditions are standard and are described in the Appendix. Below we will assume a specific form for the transactions cost, similar to Schmitt-Grohé and Uribe (2004). Denoting money velocity as $x_t \equiv c_t/d_t$, we assume that transactions costs function is:

$$s(x) = Ax_t + \frac{B}{x_t} - 2\sqrt{AB} \tag{3}$$

where A and B are constant. As can be easily obtained from the Euler equations shown in Appendix, this specification implies that the demand for deposits is

$$d_t = c_t \sqrt{\frac{A(1+r^*)}{B(1+r^*) + r^* - r_t^d}} \tag{4}$$

In the benchmark model, we assume monopolistic competition in the deposits market, so that deposits are distributed across banks. We assume that deposits from different banks provide slightly different liquidity services. In this case, $s(x)$ depends a bundle of deposits from different institutions:

$$d_t \equiv \left(\int (d_t(j))^{1-\frac{1}{\epsilon^d}} dj \right)^{\frac{\epsilon^d}{\epsilon^d - 1}} \tag{5}$$

where ϵ^d is the elasticity of substitution between deposits at different banks. Notice that in principle every deposit institution j offers a different interest rate $i_t^d(j)$, corresponding to a real rate $r_t^d(j)$. We can obtain the demand equation

$$d_t(j) = \left(\frac{r^* - r_{t+1}^d(j)}{r^* - r_{t+1}^d} \right)^{-\epsilon^d} d_t \tag{6}$$

where

$$r^* - r_t^d \equiv \left(\int (r^* - r_t^d(j))^{1-\epsilon^d} dj \right)^{\frac{1}{1-\epsilon^d}} \tag{7}$$

[7]Modeling money demand by the reduction in transaction or liquidity costs can be found for example in Feenstra (1986), Rebelo and Vegh (1996) or Schmitt-Grohe and Uribe (2004)

2.2 Firms

There is a representative firm with Cobb-Douglas production function

$$y_t = z k_t^{\alpha} h_t^{1-\alpha} \tag{8}$$

where k_t is capital. Firms are not constrained, but a fraction φ of capital can only be financed by banks (e.g., for the financing of working capital), so that $\varphi k_t = l_t$, where l_t are the real loans that the firm obtains from the bank in period t. The remaining fraction $1 - \varphi$ is financed by issuing bonds at interest rate r^*.

In the benchmark model, we assume monopolistic competition in the loan market, so that, similarly to deposits, loans are a bundle of loans from different banks

$$l_t \equiv \left(\int di (l_t(i))^{1-\frac{1}{\epsilon^l}} \right)^{\frac{\epsilon^l}{\epsilon^l - 1}} \tag{9}$$

where ϵ^l is the elasticity of substitution for loans from different banks and the index i denotes a bank. We obtain that loan demand is

$$l_t(i) = \left(\frac{r^l_{t+1}(i)}{r^l_{t+1}} \right)^{-\epsilon^l} \tag{10}$$

where $r^l_t(i)$ is the loan interest rate charged by bank i and

$$r^l_t = \left(\int di (r^l_t(i))^{1-\epsilon^l} \right)^{\frac{1}{1-\epsilon^l}} \tag{11}$$

In equilibrium all banks choose the same rate r^l_t. Given the constraint $\varphi k_t = l_t$, the real cost of a unit of capital is $r^K_t = \varphi r^l_t + (1 - \varphi) r^*$. From the first order conditions of the firm we easily obtain

$$k_t = \left(\frac{z\alpha}{r^K_t} \right)^{\frac{1}{1-\alpha}} h_t \tag{12}$$

and (with competitive labor markets)

$$w_t = (1 - \alpha) z \left(\frac{z\alpha}{r^K_t} \right)^{\frac{\alpha}{1-\alpha}} \tag{13}$$

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2.3 Banks

In our benchmark specification, we assume that there is is a continuum of banks with monopolistic competition in the deposit market and in the loans market. We will examine other market structures in Section 5. The aggregate banks balance sheet is $l_t + b_t^b + m_t = d_t + a_t^b$, where b_t^b are bonds held by the banks, m_t are required reserves held at the central bank and a_t^b are other bank liabilities. b_t^b and a_t^b yield an interest rate r^*, whereas reserves yield an interest rate r_t^r determined by the central bank. Banks hold reserves in proportion ϕ_t of deposits: $m_t = \phi_t d_t$. The reform sets $\phi_t = 1$ and $i_t^r = 0$.

Loans are provided with cost c^l at interest rate $r_t^l(j)$ for bank j. Deposits are provided with cost c^d at interest rate $i_t^d(j)$. Profits of bank j are

$$\Pi_t^b(j) = (1+r_t^l(j)-c^l)l_{t-1}(j)+(1+r^*)(b_{t-1}^b(j)-a_{t-1}^b(j))+(1+r^*)m_{t-1}(j)-(1+r_t^d(j)+c^d)d_{t-1}(j) \tag{14}$$

Using the bank balance sheet and the reserve ratio, this can be rewritten as:

$$\Pi_t^b(j) = [(1-\phi)r^* + \phi r_t^r - (r_t^d(j) + c^d)]d_{t-1}(j) + [r_t^l(j) - c^l - r^*]l_{t-1}(j) \tag{15}$$

In equilibrium all profit-maximizing banks choose the same deposit rate

$$r_t^d(j) = r_t^d = r^* - (c^d + \phi(r^* - r_t^r))\frac{\epsilon^d}{\epsilon^d - 1} \tag{16}$$

and loan rate

$$r_t^l(j) = \frac{\epsilon^l}{\epsilon^l - 1}(r^* + c^l) \tag{17}$$

2.4 Central bank

The central bank issues the monetary base m_t and holds assets b_t^c. Assets bear an interest rate r^* and it does not matter if they are domestic or foreing assets as they are assumed to be perfect subsitutes. Central bank profits are $(r^* - r_t^r)m_{t-1}$ and are distributed each period to the government. The growth in monetary base is determined by the inflation target and money market equilibrium is simply given by $m_t = \phi_t d_t$.

2.5 Government

The government needs to fund a constant exogenous real expenditure g. The government receives central bank profits, levies taxes on labor income at rate τ^h and on bank profits at rate τ^b (firm profits are 0), and possibly imposes a lump sum tax or transfer t_t. It pays interest r^* on its debt b_t^g. The government budget constraint is:

$$\tau^h w_t h_t + \tau^b \Pi_t^b + t_t + (r^* - r_t^r)\phi_{t-1} d_{t-1} + b_t^g = g + (1 + r^*) b_{t-1}^g \tag{18}$$

We assume that the government keeps its real debt b^g constant, so that (18) becomes

$$\tau^h w_t h_t + \tau^b \Pi_t^b + t_t + (r^* - r_t^r)\phi_{t-1} d_{t-1} = g + r^* b^g \tag{19}$$

2.6 Steady State

In this section we summarize the equations that determine the more relevant steady state variables. Household steady state consumption c and labor supply h are given in the Appendix. Given the exogenous real government debt b^g, the expenditure g and the reserve rate r^r (chosen by the central bank), the government chooses the tax rates τ^h and τ^b and the transfers T to satisfy

$$\tau^h wh + \tau^b \Pi^b + t + (r^* - r^r)\phi d = g + r^* b^g \tag{20}$$

Banks all choose the deposit rate and the loan rate

$$r^d = r^* - (c^d + \phi(r^* - r^r))\frac{\epsilon^d}{\epsilon^d - 1} \tag{21}$$

$$r^l + \delta = \frac{\epsilon^l}{\epsilon^l - 1}(r^* + \delta + c^l) \tag{22}$$

Bank profits are

$$\Pi^b = ((1 - \phi)r^* + \phi r_t^r - (r^d + c^d))d + (r^l - c^l - r^*)l \tag{23}$$

Loans are $l = \varphi k$ and k is given by (12).

2.7 Calibration

The model needs to be calibrated for the numerical analysis in the next section. Using Swiss data from 1980 to 2013, we estimate the A and B in the transaction cost (3),

following the the same approach as Schmitt-Grohé and Uribe (2004), and the reserve ratio ϕ. For the parameters of the transaction cost we obtain $A = 0.0279$, $B = 0.0241$. With a spread $r^* - r^d = 2\%$, the implied elasticity of money demand is -0.114, in line with the elasticity estimated by Bacchetta (2018) and Benati (2016). For the reserve ratio, estimated as the average value over time of $(Monetary\ Base - Bank\ Notes)/(M1 - Bank\ Notes)$, we obtain ϕ=0.08. For the other parameters, we use the following benchmark values: $r^* = 4\%$; $r^d = 2\%$ and $c^d = 0.25\%$; $r^l = 5\%$ and $c^l = 0.25\%$; inverse elasticity of labor supply: $\gamma = 1$; $\tau^h = \tau^b = 25\%$.

3 Sovereign Money Reforms

3.1 Policy Scenarios

The reforms we consider have two dimensions. The first dimension is the transfer of bank deposits to the central bank, which in the model is equivalent to full reserve requirement. Thus, we set $\phi = 1$. We also set nominal interest is paid on reserves, i^r. In the the Vollgeld policy case, we assume that $i^r = 0$, but we also look at a policy with positive i^r. When $i^r = 0$ we also assume that inflation is low enough so that $i^d = 0$ and $r^d = -\pi$. The reasoning is the following. First, we assume a zero lower bound on the deposit rate, i.e., $i^d = min(r^d + \pi, 0)$. Second, from (21) we see that $\phi = 1$ and $i^r = 0$ implies $r^d < 0$. When π is low, we naturally have $i^d = 0$.

The second dimension is the fiscal implication of the reform. Overall, a sovereign money reform increases seignoriage and thus government income. Since we assume a constant debt level, the government can then satisfy its budget constraint (20) either by increasing transfers T, or by decreasing the tax rates τ^h and/or τ^b.

We consider three variants of sovereing money reforms.

- *Policy 1: Vollgeld*: The extra seigniorage goes directly to increase transfers. This is the policy envisioned by the Vollgeld reform, and can be thought as a form of helicopter drop. In that case the tax rates τ^h and τ^b actually have to increase as a result of this policy: since bank profits and hence $\tau^b \Pi^b$ decrease after the reform, if tax rates are not increased the government does not have sufficient resources to fund its expenditure and debt service. We assume that the government decides

to increase τ^h and leaves τ^b unchanged.

- *Policy 2: Lower taxes*: The increased seigniorage is offset by lower tax rates. We assume that the government decides to decrease τ^h (the most distortionary tax) while leaving τ^b unchanged.
- *Policy 3: Lower taxes and positive interest on reserves*: The government/central bank is allowed to set an interest rate for deposits different from zero after the reform, and uses the seigniorage revenues to lower τ^h.

Below we compute the welfare impact of these three policies. We consider our benchmark model, but we also examine where households do not receive bank profits.

3.2 Numerical results

For each policy after the reform, we show the changes in consumption, labor and welfare (in consumption terms) relative to their pre-reform values. We also show the labor income tax rate (25% before the reform) and the deposit rate (2% before the reform). We first compute the results for zero steady state inflation, $\overline{\pi} = 0$. In this case the nominal and real interest rates coincide.

Table 1: Benchmark

	Policy 1	Policy 2	Policy 3
Consumption	-1.41%	+0.52%	+0.65%
Labor	-0.99%	+0.81%	+0.45%
Welfare (in c terms)	-0.67%	-0.11%	+0.30%
τ^h	25.74%	22.91%	25.13%
r^d	0	0	3.46%

Policy 1 (*Vollgeld*) is unambiguously bad for the economy. Labor taxes need to increase because, with lower bank profits, revenues from profit taxes are lower. So the distortion from labor taxation increases. At the same time, with $r^d = 0$, money holdings decrease and the transaction cost of consumption increases. In conclusion Policy 1 exacerbates both economic distortions: the labor wedge and the suboptimal money holdings associated with low interest on deposits.

Policy 2 (*Lower Taxes*) entails a consumption increase but a welfare decrease of 11 bps in consumption terms. Higher seigniorage revenues allow the government to decrease labor income taxes, which makes people work more. However, for the same reasons as for Policy 1, the transaction cost of consumption increases. In conclusion, one distorsion in the economy, the labor wedge, is reduced, but the one associated with money is exacerbated.

Policy 3, in which the government optimizes the composition of the revenues between labor taxes and seigniorage, allows for a modest reduction of labor income taxes and an increase of the interest rate on deposits (from 2% to 3.46%). This policy entails a welfare increase of 30 bps.

The following table presents the results where bank profits are distributed to foreign rather than domestic households.

Table 2: Banks owned by foreigners

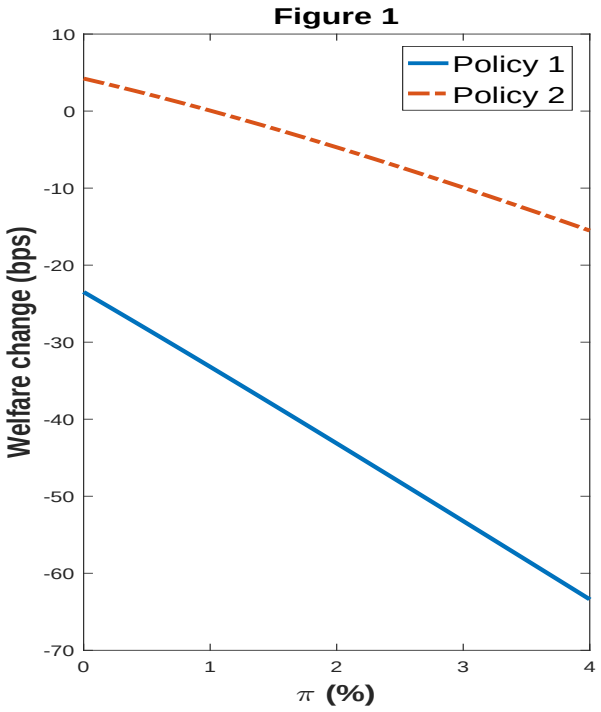
	Policy 1	Policy 2	Policy 3
Consumption	-1.33%	+1.53%	+1.72%
Labor	-1.48%	+0.35%	0.05%
Welfare (in c terms)	-0.16%	+1.23%	+1.67%
τ^h	26.05%	22.49%	24.69%
r^d	0	0	3.53%

With all 3 policies the reform looks better than in the benchmark case, when domesting households share the dividends. The difference lies essentially in the redistribution from foreigners, who lose the profits from deposits, to households, who receive extra transfers from the government, or whose labor taxes are reduced. With the Vollgeld policy, however, due to the fact that both distortions in the economy are exacerbated, welfare still decreases.

3.3 The Impact of Inflation

With steady state inflation $\overline{\pi}$, the reform sets $r^d = -\overline{\pi}$. With positive inflation, the welfare consequences of the reform with Policy 1 and 2 are worse than with zero inflation, since the opportunity cost of holding money increases. The results for Policy

3 show that the optimal real interest on deposits is positive, hence the more negative the real interest the farther we are from optimality. Figure 1 plots the welfare effects of the reform with Policy 1 and 2 as a function of $\overline{\pi}$.



4 Robustness and Extensions

It is interesting to see how results change when we deviate from our benchmark analysis. In this section, we examine the impact of another utility function frequently used in the literature, GHH (see Greenwood, Hercowitz and Huffman (1988)), of a different banking market structure, and different parameter choices, affecting the labor supply elasticity and the interest semi-elasticity of money demand.

4.1 GHH utility Function

The household flow utility is

$$u(c,h) = \frac{1}{1-\sigma}(c - \theta h^{\nu})^{1-\sigma} \tag{24}$$

While most papers[8] calibrate the parameters, in particular the parameter ν, to the Frisch elasticity, the most relevant quantity for our experiment is the uncompensated elasticity of labor supply

$$\epsilon^{unc} \equiv \frac{w}{h}\frac{\partial h}{\partial w} \tag{25}$$

Indeed, as seen in the previous sections, after the reform we have a permanent change in the labor tax rate, the sign and magnitude of which depend on the policy choice. For the utility (24), with the transaction cost specification (3), the labor supply is

$$h^{ghh} = \left(\frac{W(1-\tau^l)}{\theta\nu(1+2Av-2\sqrt{AB})}\right)^{\frac{1}{\nu-1}} \tag{26}$$

hence

$$\epsilon^{unc} = \frac{1}{\nu-1} \tag{27}$$

We pick $\nu = 5$ which implies $\epsilon^{unc} = -0.25$.[9] . We further pick $\sigma = 5$ and calibrate $\theta = 118$ (the latter value is chosen so that the pre-reform average working time is 1/5 of total time, as in Hnatkovska, Lahiri and Vegh (2016)). The results are qualitatively similar to those obtained with the separable utility function (2.1).

Table 3: GHH preferences

	Policy 1	Policy 2	Policy 3
Consumption	-1.14%	+0.02%	+0.67%
Labor	-0.52%	+0.25%	+0.35%
Welfare (in c terms)	-0.82%	-0.26%	+0.43%
τ^h	25.50%	23.16%	25.03%
r^d	0	0	3.61%

[8] see for example Hnatkovska, Lahiri and Vegh (2016), Neumeyer and Perri (2005) or Mendoza (1991)

[9] For example the review paper by Evers, De Mooji and van Vuuren (2008) find an uncompensated elasticity of 0.1 for men and 0.5 for women. This is consistent with the numbers reported by E. Saez on his lectures in Public Economics, which can be found at
https : *//eml.berkeley.edu/ saez/course/Labortaxes/laborsupply/laborsupply_slides.pdf*.

4.2 Different Banking Market Structure: Cournot Competition

Before the reform

N banks choose deposit and loan quantities L^i, with $i = 1, ..., N$, and deposit quantities D_i to maximize profits, which, in real terms, are

$$\Pi_t^b(j) = ((1-\phi)r^* + \phi r_t^r - (r_t^d + c^d))d_{t-1}(j) + (r_t^l - c^l - r^*)l_{t-1}(j) \tag{28}$$

The only difference relative to (15) is that the deposit and loan rate are the same for every bank. Deposits D appearing in the transaction cost are the sum of deposits from individual banks $d_t = \Sigma_{j=1}^N d_t^j$. Similarly, for loans $l_t = \Sigma_{l=1}^N l_t^j$. The deposit rate is determined by the aggregate deposit quantity: using the deposit demand (4) we obtain

$$r_t^d = B(1+r^*) + r^* - A(1+r^*)\left(\frac{c}{\Sigma_{j=1}^N d_t(j)}\right)^2 \tag{29}$$

The aggregate loan supply $l_t = \Sigma_{j=1}^N l_t(j)$ determines capital $k_t = \frac{l_t}{\varphi}$ which in turn determines r_t^K(see (12)).

The novelty in the case of Cournot competition is that an individual bank has an impact on aggregate quantities. In particular, an individual bank's decision to increase its loan quantity $l_t(j)$ has the effect of lowering r_t^K, which has a positive effect on wages (see (13)) and consumption. With higher consumption, the demand for deposits is higher, or, given an aggregate deposit supply $d_t = \Sigma d_t(j)$, the deposit rate r_t^d is lower, which increases bank profits. In sum, an individual bank has an incentive to increase its loan supply (or lower the loan rate) in order to increase its profits from deposits. Clearly, the higher the number of banks, the less an individual bank internalizes this effect.

After the reform After the reform bank profits come only from loans:

$$\Pi_t^b(j) = (r_t^l - c^l - r^*)l_{t-1}(j) \tag{30}$$

Banks lose the incentive to give more loans in order to increase the profits from deposits. hence we can expect the loan rate to be higher after the reform than before the reform, and we expect the difference between the pre-reform and the after-reform loan rate to be stronger for lower$N$.

Appendix C shows how the loan rate (before and after the reform) and the deposit rate (before the reform) depend on the number of banks N. Our results indicate that a deposit rate of 2% before the reform (given $r^* = 4\%$) is consistent with $N = 10$. With $N = 10$, however, the difference between the pre-reform and the after-reform loan rate is only 7 bps, and the effects of the reform on labor, consumption, welfare, the tax rate and the deposit rate in the case with Cournot competition are almost indistinguishable from those with monopolistic competition.

4.3 Other parameter choices

The parameters that have a sizeable impact on the results are those that affect the elasticity of labor supply and the interest semi-elasticity of money demand.

In this section we first look at the results obtained with different values of γ (inverse elasticity of labor supply): results for $\gamma = 0.5$ are shown in Table 4 and those for $\gamma = 2$ are shown in Table 5. In Table 6 we look at the results obtained with the parameters A and B of the transaction cost used by Schmitt-Grohé and Uribe (2004), calibrated to US data. The latter parameters imply a much lower semi-elasticity of money demand (-0.05, compared to -0.11 in our benchmark case, for $r^* - r^d = 2\%$).

When the elasticity of labor supply is higher, labor taxes are more distortionary. Hence Policy 2, which leads to lower taxes, has a better potential to improve welfare, and the opposite for the Vollgeld policy, which leads to a tax increase.

When the semi-elasticity of money demand is lower, as in the US case, the friction associated with money is less important, so both Policy 1 and Policy 2, which lower the interest on deposit, have lower welfare costs.

Table 4: $\gamma = 0.5$

	Policy 1	Policy 2	Policy 3
Consumption	-2.11%	+0.87%	+0.88%
Labor	-1.44%	+1.15%	+0.68%
Welfare (in c terms)	-1.13%	+0.06%	+0.40%
τ^h	26.07%	22.82%	24.88%
r^d	0	0	3.24%

Table 5: $\gamma = 2$			
	Policy 1	Policy 2	Policy 3
Consumption	-1.26%	+0.20%	+0.46%
Labor	-0.65%	+0.51%	+0.27%
Welfare (in c terms)	-0.72%	-0.24%	+0.23%
τ^h	25.85%	22.99%	25.32%
r^d	0	0	3.61%

Table 6: $A = 0.0111$, $B = 0.07524$			
	Policy 1	Policy 2	Policy 3
Consumption	-0.60%	+0.31%	+0.26%
Labor	-0.49%	+0.37%	+0.23%
Welfare (in c terms)	-0.23%	+0.03%	+0.09%
τ^h	25.33%	23.99%	24.87%
r^d	0	0	3.62%

5 Conclusion

This paper has proposed a simple framework to analyze sovereign money proposals. We find that a reform along the lines of the Vollgeld proposal would entail welfare losses. In order for a sovereign money reform to generate even modest welfare gains, as obtained with our "Policy 3", the central bank should essentially reward deposits with an interest close to the risk-free rate, rather than setting the interest on deposits to 0, as advocated by the Vollgeld reform.

It is obvious that some of the issues in the debate surrounding this proposed reform cannot be addressed by the current simple model and that richer extensions would be required. For example, in our model there are no shocks, hence there is no need for liquidity insurance and maturity transformation, the traditional rationales for the coexistence of deposits and lending. We implicitly take the view expressed by Cochrane (2014) that, with modern financial technology, this is not a function that banks are uniquely able to fulfill.

Also, we disregard the possibility of bank runs, one of the arguments in favor of

the reform. As discussed by Bacchetta (2018), although the financial crisis can be viewed in the perspective of runs, there was no run on deposits. Even in the case of Northern Rock, the run was on short-run liabilities not included in M1, which would not be touched by the proposed reforms. The possibility of a run on deposits is greatly limited by the existence of deposit insurance. If we view runs as a self-fulfilling "bad equilibrium", deposit insurance rules them out altogether.

Finally, we point out that in this model there is no mechanism by which the co-existence of the deposit and loan functions within banks amplifies economic fluctuations. On the other hand, such mechanism is not clearly identified in the existing literature either, not even by BK, who seem to take for granted the connection between banks' money creating ability and economic fluctuations. Bacchetta (2018) documents that in Switzerland the correlation between credit and M1 is insignificant, whereas it should be strongly positive if the above intuition reflected economic reality.

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Appendix

A. Household FOCs

FOC with respect to consumption

$$\frac{1}{c_t} = \lambda_t(1 + s(x_t) + x_t s'(x_t)) \tag{31}$$

Specialized to the case of the transaction cost in the form (3), (31) becomes

$$\frac{1}{c_t} = \lambda_t(1 + 2Ax_t - 2\sqrt{AB}) \tag{32}$$

FOC with respect to hours worked

$$h_t^{\gamma} = \lambda_t W_t(1 - \tau^h) \tag{33}$$

FOC with respect to d_{t+1}

$$\lambda_t(1 - Ax_t^2 + B) = \lambda_{t+1}\frac{1 + i_t^d}{1 + \pi_{t+1}} \tag{34}$$

FOC with respect to a_{t+1}

$$\lambda_t = \lambda_{t+1}\frac{1 + i_t}{1 + \pi_{t+1}} \tag{35}$$

(32), (33), (34)and (35) imply the two Euler equations

$$\frac{1}{c_t(1 - Ax_t^2 + B)}1 + 2Ax_t - 2\sqrt{AB} = \beta(1 + r^d)\frac{1}{c_{t+1}(1 + 2Ax_{t+1} - 2\sqrt{AB})} \tag{36}$$

$$\frac{1}{c_t(1 + 2Ax_t - 2\sqrt{AB})} = \beta(1 + r)\frac{1}{c_{t+1}(1 + 2Ax_{t+1} - 2\sqrt{AB})} \tag{37}$$

and the labor/leisure tradeoff condition

$$h_t^{\gamma} = \frac{W_t(1-\tau^l)}{c_t(1+2Ax_t-2\sqrt{AB})} \tag{38}$$

B. Steady state; consumption and labor

Using (2), (4) and (33) we obtain that c solves

$$c^{1+\frac{1}{\gamma}}(1+2\sqrt{A(B+r-r^d)}-2\sqrt{AB})-c^{\frac{1}{\gamma}}\mathcal{R} = \frac{w^{1+\frac{1}{\gamma}}(1-\tau^l)^{1+\frac{1}{\gamma}}}{(1+2\sqrt{A(B+r-r^d)}-2\sqrt{AB})^{\frac{1}{\gamma}}} \tag{39}$$

with $\mathcal{R} = (a_{TOT}r+\zeta(1-\tau^d)\mathcal{B}-T)$ and a_{TOT} are the total household savings, $a_{TOT} \equiv a+d$. Labor supply is

$$h = \left(\frac{w(1-\tau^l)}{c(1+2\sqrt{A(B+r-r^d)}-2\sqrt{AB})}\right)^{\frac{1}{\gamma}} \tag{40}$$

C. Deposit and loan rates with Cournot competition

In the table below, r^l "before" is the loan rate chosen by the banks before reform, when banks perform both the deposit and the loan functions, and r^l "after" is the loan rate chosen after the reform, when banks do not manage deposits. Clearly r^d refers to the deposit rate choosen by the banks before the reform, since after the reform the deposit rate is set to 0 by the central bank. As in the monopolistic competition case, we assume that the cost of managing loans and deposits, c^l and c^d respectively, are equal to 0.25%.

Table 7: Cournot Competition			
N	r^l Before	r^l After	r^d
1	18.72%	19.17%	0%
2	8.43%	8.55%	0%
3	6.66%	6.76%	0%
4	5.94%	5.02%	0%
5	5.54%	5.62%	0%
6	5.29%	5.39%	0.22%
7	5.13%	5.22%	0.89%
8	5.02%	5.11%	1.35%
9	4.93%	5.01%	1.79%
10	4.85%	4.92%	1.99%
15	4.65%	4.67%	2.66%
20	4.55%	4.57%	2.94%