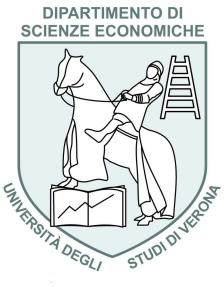

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An Asymmetric Model on Seigniorage and the Dynamics of Net Foreign Assets

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Abstract

The emergence of international current account imbalances has dominated the economic debate for several years and has been considered one of the main reasons for the turbulences in the world economy since 2007. Economic theory suggests that an economy cannot run persistent current account deficits without depleting its net foreign assets. Nevertheless, for most of the 2000s the US net foreign liabilities grew at a rate below the one of the cumulative current account deficit. To investigate on the mechanisms that allow the US to do so, this paper sets up a two country DGE model with asymmetric liquidity constraints. The model will show that there is a permanent wealth transfer from the world to the US. The unique position of the US not only allows them to run persistent current account deficits, but also imposes a permanent decay on the American current account. As the issuer of the world key currency in an asymmetric world monetary system, the US can make use of Seigniorage and valuation effects to be able to run a continuous current account deficit. These mechanisms work in favour of their net foreign bond holdings, but let their CA further deteriorate. The corresponding one-way capital flows were part of the distortions that laid the ground for the world financial crisis 2007-2009. Future will show if a multi polar world with several (regional) reserve currencies emerges.

JEL-Classification: E41, E42, E47, E51, F31, F32, F47, G12, G15

Keywords: Seigniorage, NFA Positions, Current Account, DGE, Two Country Model, Borrowing Constraints, International Monetary Theory

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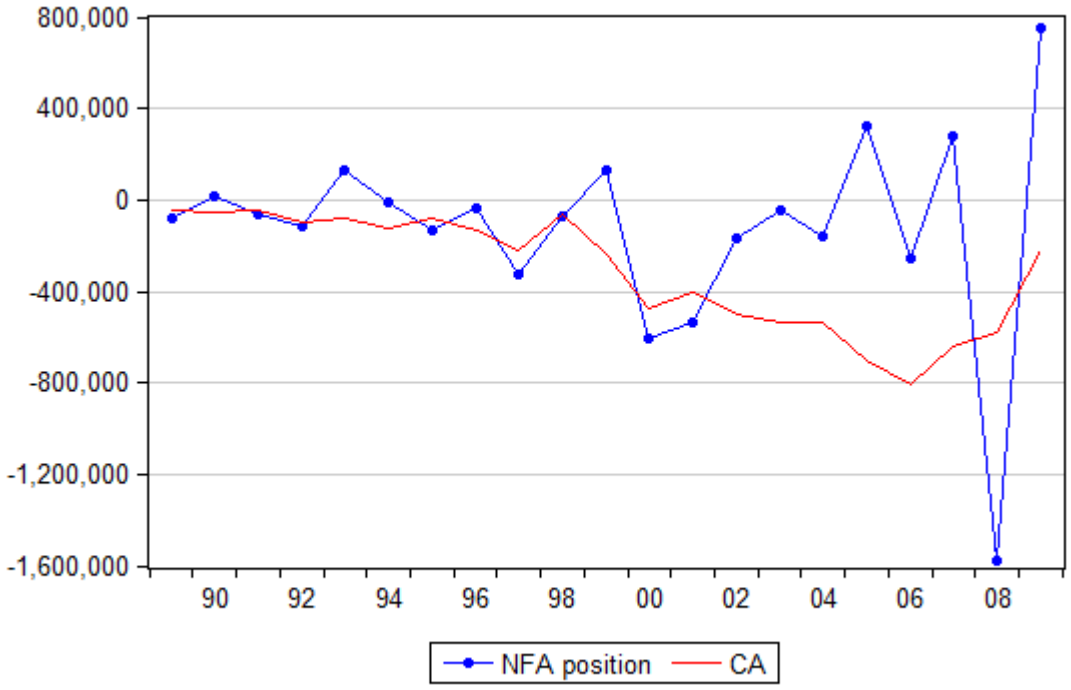
1 Introduction

Global imbalances, the divergence of international current account (CA) positions, has been considered one of the main drivers behind the events that led to the world financial crisis from 2007 to 2009. Standard intertemporal international macroeconomics suggests that every current account deficit has to be mirrored by future surpluses. No country can run persistent current account deficits, without depleting its net foreign assets (nfa)[1]. Nevertheless, for most of the 2000s (the time of the widening US current account deficit), the US net foreign liabilities grew at a rate below the one of the cumulative current account deficit[2]. This paper will show how the unique position of the US in the world monetary system allowed them to do so. Figure 1 displays the change in the nfa position and the CA positions between 1989 and 2009. The dotted line being above the solid line indicates the US net foreign liabilities were growing at a rate smaller than the American CA deficit in most years. Triffin describes how the "disastrous result" of the use of a reserve currency as the sole instrument of international monetary reserves is that "the deficits of a reserve-centre country may be financed [...] with little or no decline of gross reserves for that reserve-centre country and, therefore no imperative pressure for the readjustment of inflationary policies"[3].
According to Triffin, the discrepancy between the two figures is explained by the use of Seigniorage. This has also been mentioned by other authors[4]. In that scenario, there is an unaccounted value in the form of liquidity services that the US provide to the world (Seigniorage). The US earn a significant premium on the provision of liquidity[5]. The Americans use the proceeds from printing money as an interest free loan to buy assets that generate returns[6]. The US also benefit from exchange rate effects through the valuation channel. When the value of the US-dollar (USD) decreases, the value of the US liabilities in USD remains the same, whilst the value of US assets in foreign currencies increases (measured in USD) [7]. Thus, in both cases, there is a wealth transfer towards the US. The fact that the dotted line is below the solid one in 1997 (Asia crisis), and the early 2000s, when the USD reached its 15 year peak, demonstrates that the valuation effect can also be negative for the US, in times of peaks in the value of the USD[8].

[1] See Obstfeld et al. [1996]
[2] See Dettmann [2011]
[3] See Triffin [1992]
[4] See Fiorentini and Montani [2010]
[5] See Hausmann and Sturzenegger [2005]
[6] See Buiter [2006]
[7] See Gourinchas and Rey [2007]
[8] The extreme deterioration of the nfa position in 2008 derives from negative price effects, due to a slump in the world's equity markets in the context of the world financial crisis.

Figure 1: Development US CA deficit and NFA position in million USD



Data: U.S. Department of Commerce, BEA

The idea of this paper is to set up a deterministic two country dynamic general equilibrium model for an asymmetric world, where only one country can issue the world reserve currency and use it to purchase its imports, whilst the other country will have to collect foreign currency to pay for its imports. We will analyse how the use of Seigniorage in one country leads to current account deficits and a deteriorating net foreign asset position. The paper is based on earlier models with asymmetric liquidity constraints that cover current account deficits and Seigniorage[9], but will extend them by the holdings of domestic and foreign bonds. Thus, we will be able to examine the development of the respective net foreign asset positions. We will establish that the fact that the US is the sole issuer of the world key currency not only helps them to run persistent CA deficits, but lets their CA deteriorate even further. The paper will be structured as follows: The next section will set up the model and solve it analytically, whilst section 3 will run a numeric simulation and section 4 will conclude.

[9]Such as Fiorentini [2002]

2 A two country pure endowment model with bond holdings and cash-in-advance constraints

A model of a world will be set up that contains only two economies: Europe (EU) and America (US). These two economies will only differ in the form of their cash-in-advance constraint.

2.1 Europe

The utility for the representative European consumer is a functional of the following form:

$$U_t^{EU} = \Sigma_{s=0}^{\infty}(\frac{1}{1+\beta})^s(lnC_{t+(s)}^{EU} + lnC_{t+(s)}^{*EU}),\ \beta \in [0,1] \tag{1}$$

C_t^{EU} stands for European consumption of domestic goods in period t, whilst C_t^{*EU} stands for European consumption of American goods in period t, both goods are normal goods.

Agents can acquire interest yielding one-period bonds or non interest yielding currency. They need to acquire cash in period t-1 for all goods they plan to purchase in period t. Consumption at each date is bounded by stock of money carried from previous period. Goods cannot be stored, so they must be entirely consumed in each period.

Cash-in-advance constraints:

$$M_{t-1}^{EU} \geq P_t C_t^{EU} \tag{2}$$

$$M_{t-1}^{*EU} \geq P_t^* C_t^{*EU} \tag{3}$$

The European consumers need to hold sufficient cash of each currency to purchase their goods from that economy.
The consumer's budget constraint has the following form:

$$\begin{aligned} PY_t + M_{t-1}^{EU} + S_t M_{t-1}^{*EU} + B_{t-1}^{EU}(1+r_t) + S_t B_{t-1}^{*EU}(1+x_t) = \\ P_t C_t^{EU} + S_t P_t^* C^{*EU} + T_t + S_t M_t^{*EU} + M_t^{EU} + B_t^{EU} + S_t B_t^{*EU} \end{aligned} \tag{4}$$

The left-hand-side represents the total wealth of the European consumers. The nominal value of endowment $P_t Y_t$, the amounts of euros and dollars M_{t-1}^{EU} *and* M_{t-1}^{*EU}, where S_t is the dollar-euro exchange rate in period t, and the European holdings of domestic and foreign bonds carried forward from the former period B_{t-1} and B_{t-1}^*, with the interest payment r_t for European bonds and x_t on American bonds. These bonds are purchased at the end of period t-1 and carried into period t where they yield an income $r_t B_{t-1}^{EU}$ or $x_t B_{t-1}^{*EU}$.
The right-hand-side contains the expenditure for consumption of both goods, the amount of taxes the representative consumer faces (T_t) and the amount of money and bonds that

are acquired in this period.
Since money neither yields any interest, nor enters the utility function directly, the rational consumer will strictly demand the quantity of money necessary for the expected consumption of the desired domestic and foreign goods, so that the cash-in-advance constraint will always be binding [10]:

$$M_{t-1}^{EU} = P_t C_t^{EU}, M_{t-1}^{*EU} = P_t^* C_t^{*EU} \tag{5}$$

If money supply is determined exogenously and consumers demand exactly the quantity of money necessary for their desired consumption, the prices will have to adjust so that all the money markets clear.
Plugging (5) into the budget constraint and some simplifications lead to:

$$P_{t+1}C_{t+1}^{EU} + S_t P_{t+1}^* C_{t+1}^{*EU} = PY_t - T_t - B_t^{EU} - S_t B_t^{*EU} + B_{t-1}^{EU}(1+r_t) + S_t B_{t-1}^{*EU}(1+x_t) \tag{6}$$

To determine the optimal level of bond holdings we maximise the utility function with respect to holdings of foreign and domestic bonds:

$$\frac{dU_t}{dB_t^{EU}} : P_{t+2}C_{t+2}^{EU} + S_{t+1}P_{t+2}^* C_{t+2}^{*EU} = \frac{(1+r_{t+1})}{(1+\beta)}[P_{t+1}C_{t+1}^{EU} + S_t P_{t+1}^* C_{t+1}^{*EU}] \tag{7}$$

and

$$\frac{dU_t}{dB_t^{*EU}} : P_{t+2}C_{t+2}^{EU} + S_{t+1}P_{t+2}^* C_{t+2}^{*EU} = \frac{S_{t+1}(1+x_{t+1})}{S_t(1+\beta)}[P_{t+1}C_{t+1}^{EU} + S_t P_{t+1}^* C_{t+1}^{*EU}] \tag{8}$$

From (7) and (8) we get the uncovered interest rate parity equation which states that the expected change in the exchange rate is determined by the interest rate differential between the two countries

$$\Rightarrow S_{t+1} = S_t \frac{(1+r_{t+1})}{(1+x_{t+1})} \tag{9}$$

Maximising the utility with respect to consumption of domestic and foreign goods gives:

$$P_{t+1}C_{t+1}^{EU} = P_{t+1}^* C_{t+1}^{*EU} S_t \tag{10}$$

Given the log utility function, it is not surprising that the agents want to consume the same nominal value on both goods. Because European consumers have to buy USD for their desired level of consumption of foreign goods before the beginning of the period, the exchange rate of the former period applies for their current consumption.
The amount of money spent on both goods will be the same

$$M_t^{EU} = S_t M_t^{*EU} \Rightarrow S_t = \frac{M_t^{EU}}{M_t^{*EU}} \tag{11}$$

[10] See Obstfeld et al. [1996]

Equation 11 is a monetary model of the exchange rate[11]. It says that the exchange rate is determined by relative money spent on domestic and foreign goods by the Europeans. We can use it and the cash-in-advance constraints to simplify (7) to:

$$P_{t+1}C_{t+1}^{EU} = \frac{(1+r_t)}{(1+\beta)}[(P_tC_t^{EU})] \tag{12}$$

Equation 12 is the Euler equation which says that in each period we expect tomorrow's consumption to equal today's consumption times the differential of the interest rate and the discount factor. A similar identity will apply for our consumption of foreign goods.

2.2 The US economy

The utility function of the representative consumer in the US takes a similar form as the European one,

$$U_t^{US} = \Sigma_{s=0}^{\infty}(\frac{1}{1+\beta})^s(lnC_{t+(s)}^{US} + lnC_{t+(s)}^{*US}) \tag{13}$$

whilst there is only a single cash in advance constraint. American consumers can pay for their consumption of domestic goods C_t^{*US} and foreign goods C_t^{US} in USD and thus do not need to accumulate foreign currency reserves.

$$M_{t-1}^{*US} \geq \frac{P_t}{S_t}C_t^{US} + P_t^*C_t^{*US} \tag{14}$$

Thus, the consumer's budget constraint takes the following form:

$$\begin{aligned} P_t^*Y_t^* + M_{t-1}^{*US} + B_{t-1}^{*US}(1+x_t) + (1+r_t)\frac{B_{t-1}^{US}}{S_t} \\ = P_t^*C_t^{*US} + \frac{P_tC_t^{US}}{S_t} + T_t^{US} + M_t^{*US} + B_t^{*US} + \frac{B_t^{US}}{S_t} \end{aligned} \tag{15}$$

$$\Rightarrow \frac{P_{t+1}}{S_{t+1}}C_{t+1}^{US} + P_{t+1}^*C_{t+1}^{*US} = [P_t^*Y_t^* - T_t^{US} - \frac{B_t^{US}}{S_t} + B_{t-1}^{*US}(1+x_t) + (1+r_t)\frac{B_{t-1}^{US}}{S_t} - B_t^{*US}] \tag{16}$$

Maximising utility w.r.t. foreign and domestic bonds:

$$\Rightarrow \frac{dU_t^{US}}{dB_t^{US}} : [\frac{C_{t+2}^{US}P_{t+2}}{S_{t+2}} + C_{t+2}^{*US}P_{t+2}^*] = \frac{S_t(1+r_{t+1})}{S_{t+1}(1+\beta)}[\frac{C_{t+1}^{US}P_{t+1}}{S_{t+1}} + C_{t+1}^{*US}P_{t+1}^*] \tag{17}$$

$$\Rightarrow \frac{dU_t^{US}}{dB_t^{*US}} : [\frac{C_{t+2}^{US}P_{t+2}}{S_{t+2}} + C_{t+2}^{*US}P_{t+2}^*] = \frac{(1+x_{t+1})}{(1+\beta)}[\frac{C_{t+1}^{US}P_{t+1}}{S_{t+1}} + C_{t+1}^{*US}P_{t+1}^*] \tag{18}$$

[11] See Bilson [1978] or Mussa [1976]

The expected exchange rate is as before:

$$S_{t+1} = S_t \frac{(1 + r_{t+1})}{(1 + x_{t+1})} \tag{19}$$

Maximising for consumption of foreign and domestic goods:

$$\frac{C_{t+1}^{US} P_{t+1}}{S_{t+1}} = C_{t+1}^{*US} P_{t+1}^{*} \tag{20}$$

$$\Rightarrow P_t^* C_t^{*US} = \frac{1}{2} M_{t-1}^{*US} = \frac{P_t C_t^{US}}{S_t} \tag{21}$$

The main difference to the European case is that American consumers do not have to change their money for their desired consumption before the period, thus the value of foreign consumption translates into domestic consumption using the current exchange rate, whilst the Europeans have to purchase foreign currency before the beginning of the period and thus the former exchange rate applies (10).
The Euler equation for the US consumer takes a similar form as the European one:

$$C_{t+1}^{*US} P_{t+1}^{*} = \frac{(1 + x_t)}{(1 + \beta)} C_t^{*US} P_t^{*} \tag{22}$$

American consumers will spend half their USD on each good. The nominal value of consumption in foreign and domestic goods will be the same.

2.3 Aggregate level

After deriving the individual consumption levels for both economies, we will now turn to the aggregate levels. On the aggregate level, taxes cannot be considered exogenous. The government budget constraint will enter the consumer's budget constraint in the aggregate. It will take the following form in the case of Europe:

$$G_t^{EU} + B_{t-1}(1 + r_t) = T_t + M_t - M_{t-1} + B_t \tag{23}$$

Taxes, the newly issued money and issued bonds will have to finance the government's expenditure and the repayment of last period's bonds plus interest.
Rearranging (23) and Substituting T_t in the consumer's budget constraint yields to:

$$\begin{aligned} \Rightarrow P_t C_t^{EU} + S_t P_t^* C_t^{EU} =& (PY_t + M_{t-1}^{EU} + S_t M_{t-1}^{*EU} + B_{t-1}^{EU}(1 + r_t) + \\ & S_t B_{t-1}^{*EU}(1 + x_t) - G_t^{EU} - B_{t-1}(1 + r_t) + M_t - M_{t-1} \\ & + B_t - S_t M_t^{*EU} - M_t^{EU} - B_t^{EU} - S_t B_t^{*EU}) \end{aligned} \tag{24}$$

Since only European consumers demand European currency, whilst European bonds are held in both countries, the following identities apply: $M_{t-1} = M_{t-1}^{EU}, M_t = M_t^{EU}, B_{t-1} = B_{t-1}^{EU} + B_{t-1}^{US}, B_t = B_t^{EU} + B_t^{US}$

Substituting into the consumer's budget constraint:

$$P_t C_t^{EU} + S_t P_t^* C_t^{*EU} = P_t Y_t + S_t M_{t-1}^{*EU} + S_t B_{t-1}^{*EU}(1+x_t) - G_t^{EU} \\ -B_{t-1}^{US}(1+r_t) + B_t^{US} - S_t M_t^{*EU} - S_t B_t^{*EU} \tag{25}$$

Note that on the aggregate level, domestic bonds are not part of the consumer's budget constraint, since the government will tax away all interest gains on domestic bonds in the next period (Ricardian equivalence).

$$P_t C_t^{EU} + S_t P_t^* C_t^{*EU} = (PY_t + S_t P_t^* C_t^{*EU} + S_t B_{t-1}^{*EU}(1+x_t) - G_t^{EU} \\ - B_{t-1}^{US}(1+r_t) + B_t^{US} - S_t P_{t+1}^* C_{t+1}^{*EU} - S_t B_t^{*EU}) \tag{26}$$

Applying (10):

$$P_t C_t^{EU} + P_{t+1} C_{t+1}^{EU} = (PY_t + SB_{t-1}^{*EU}(1+x_t) - G_t^{EU} - B_{t-1}^{US}(1+r_t) + B_t^{US} - S_t B_t^{*EU}) \tag{27}$$

$$\Leftrightarrow P_t C_t^{EU} \frac{(1+r_t)}{(1+\beta)} + P_t C_t^{EU} = (PY_t + S_t B_{t-1}^{*EU}(1+x_t) - G_t^{EU} \\ - B_{t-1}^{US}(1+r_t) + B_t^{US} - S_t B_t^{*EU}) \tag{28}$$

For the US, the government budget constraint takes a similar form:

$$G_t^{US} + B_{t-1}^*(1+x_t) = T_t^{US} + M_t^* - M_{t-1}^* + B_t^* \tag{29}$$

Since European consumers need to acquire USD for their imports, the demand for American assets is defined as:

$$M_{t-1}^* = M_{t-1}^{*US} + M_{t-1}^{*EU}, B_{t-1}^* = B_{t-1}^{*US} + B_{t-1}^{*EU} \tag{30}$$

$$and\ M_t^* = M_t^{*US} + M_t^{*EU}, B_t^* = B_t^{*US} + B_t^{*EU} \tag{31}$$

Substituting T_t^{US} by the government budget constraint:

$$\Rightarrow P^* C_t^{*US} + \frac{P_t}{S_t} C_t^{US} = P^* Y_t^* - G_t^{US} - \frac{B_t^{US}}{S_t} + \frac{B_{t-1}^{US}}{S_t}(1+r_t) \\ + B_t^{*EU} - B_{t-1}^{*EU}(1+x_t) + M_t^{*EU} - M_{t-1}^{*EU} \tag{32}$$

Note that the level of American consumption rises with the amount of Seigniorage used $(M_t^{*EU} - M_{t-1}^{*EU})$[12] which equals the European consumption of American goods (remember: The nominal value of consumption of domestic goods equals the nominal value of consumption of foreign goods).

[12]Following Obstfeld et al. [1996], we define Seigniorage as the increase in the stock of USD held outside the US.

$$\Rightarrow 2P_t^* C_t^{*US} = [P^* Y_t^* - G_t^{US} - \frac{B_t^{US}}{S_t} + \frac{B_{t-1}^{US}}{S_t}(1+r_t) \tag{33}$$
$$+B_t^{*EU} - B_{t-1}^{*EU}(1+x_t) + \frac{P_{t+1} C_{t+1}^{EU}}{S_t} - \frac{P_t C_t^{EU}}{S_{t-1}}]$$

Given the fact that goods cannot be stored, the good markets have to clear in every period. Total consumption of each good will equal total endowment for each country in each period. Thus, the resource constraints are given by:

$$Y_t^{EU} = C_t^{EU} + C_t^{US} + \frac{G_t}{P_t} \tag{34}$$

$$Y_t^{US} = C_t^{*US} + C_t^{*EU} + \frac{G_t^*}{P_t^*} \tag{35}$$

2.4 Solving the System

From equations 28 and 33 we get for holdings of foreign bonds in period t:

$$B_t^{US} = S_t * [P_t^* Y_t^* - G_t^{US} + \frac{B_{t-1}^{US}}{S_t}(1+r_t) + B_t^{*EU} - B_{t-1}^{*EU}(1+x_t)$$
$$+\frac{(1+r)}{S_t(1+\beta)} P_t C_t^{EU} - \frac{P_t C_t^{EU}}{S_{t-1}} - 2C_t^{*US} P_t^*] \tag{36}$$

$$B_t^{*EU} = \frac{P_t Y_t + S_t B_{t-1}^{*EU}(1+x_t) - G_t^{EU} - B_{t-1}^{US}(1+r_t) + B_t^{US} - P_t C_t^{EU} \frac{(1+r_t)}{(1+\beta)} + P_t C_t^{EU})}{S_t} \tag{37}$$

Since equations 36 and 37 both contain the holdings of foreign bonds and domestic bonds held by foreigners, they show the same position from different sides. We can summarise them in one equation:

$$\frac{1}{S_t}[B_t^{US} - B_{t-1}^{US}(1+r_t)] - [B_t^{*EU} - B_{t-1}^{*EU}(1+x_t)] = [P_t^* Y_t^* - G_t^{US} - 2C_t^{*US} P_t^*] \tag{38}$$
$$+ (P_{t+1}^* C_{t+1}^{*EU} - P_t^* C_t^{*EU})$$

The left-hand-side of this equation just describes the change in American bond holdings abroad over two periods minus the change in foreign holdings of American bonds over two periods and thus can be expressed as:

$$\Leftrightarrow \frac{\Delta B_t^{US}}{S_t} - \Delta B_t^{*EU} = [P_t^* Y_t^* - G_t^{US} - (\frac{P_t}{S_t} C_t^{US} + P_t^* C_t^{*US})] \tag{39}$$
$$+ (M_t^{*EU} - M_{t-1}^{*EU})$$

The first term on the right-hand-side describes the American CA whilst the second term describes the American use of Seigniorage.

$$\Leftrightarrow \frac{\Delta Total\ foreign\ bond\ holdings}{S_t} - \Delta Total\ foreign\ bond\ liabilities = CA + (M_t^{*EU} - M_{t-1}^{*EU}) \tag{40}$$

And thus, the change in the net foreign bond position.

$$\Rightarrow \Delta\ NFB^{US} = CA^{US} + Seigniorage^{US} \tag{41}$$

Similar for the European case:

$$S_t \Delta B_t^{*EU} - \Delta B_t^{US} = (P_t Y_t - G_t^{EU} - P_t C_t^{EU} - S_t P_t^* C_t^{*EU}) + S_t P_t^* C_t^{*EU} - P_{t+1} C_{t+1}^{EU} \tag{42}$$

$$\Leftrightarrow \Delta NFB^{EU} = CA^{EU} - Seigniorage^{US} \tag{43}$$

$$\Rightarrow \frac{CA_t^{EU}}{S_t} = -CA_t^{US} \tag{44}$$

Equations 41 and 43 show that the use of Seigniorage is mitigating the deterioration of the American NFB position in case of a CA deficit, whilst it represents an additional burden on the European NFB position. Via the use of Seigniorage, the US can just swap interest free currency holdings for interest bearing bonds within their liabilities. Thus, the use of Seigniorage equals a net wealth transfer from the rest of the world towards the US.
Equation 44 shows that on a global level the sum of all current accounts has to be zero. The same result could be derived from dividing the European resource constraint (34) by the exchange rate S_t and adding it to American resource constraint (35).

To solve the system, we use equation 39, the two resource constraints (34,35), the exchange rate (9) or (19) and the cash in advance constraints:

$$M_{t-1}^{EU} = C_t^{EU} P_t \tag{45}$$

$$M_{t-1}^{*EU} = \frac{M_{t-1}^{EU}}{S_{t-1}} \tag{46}$$

$$M_{t-1}^{*US} = 2C_t^{*US} P_t^* \tag{47}$$

The amount of Seigniorage used by the US is defined by:

$$Seigniorage(SE_t) = \frac{P_{t+1} C_{t+1}^{EU}}{S_t} - \frac{P_t C_t^{EU}}{S_{t-1}} \tag{48}$$

The two current accounts are given by:

$$CA_t^{EU} = P_t Y_t - G_t^{EU} - P_t C_t^{EU} - S_t P_t^* C_t^{*EU} \tag{49}$$

$$CA_t^{US} = P_t^* Y_t^* - G_t^{US} - (\frac{P_t}{S_t} C_t^{US} + P_t^* C_t^{*US}) \tag{50}$$

And for the separate consumption levels we get:

$$C_{t+1}^{EU} = \frac{C_t^{EU} P_t(1+r_t)}{(1+\beta)P_{t+1}}, C_t^{*EU} = \frac{P_t C_t^{EU}}{P_t^* S_{t-1}} \tag{51}$$

$$C_{t+1}^{*US} = C_t^{*US} P_t^* \frac{(1+x_t)}{P_{t+1}^*(1+\beta)}, C_t^{US} = \frac{P_t^* S_t C_t^{*US}}{P_t^{US}} \tag{52}$$

Note once again that the Americans will face todays exchange rate when switching between domestic and foreign consumption whilst the Europeans face last period's rate. The interest rates will be defined by the Euler equations as the growth of the monetary base:

$$r_t = \frac{(1+\beta)M_t^{EU} - M_{t-1}^{EU}}{M_{t-1}^{EU}}, x_t = \frac{(1+\beta)M_t^{*US} - M_{t-1}^{*US}}{M_{t-1}^{*US}} \tag{53}$$

The interest rate on European bonds only depends on money needed for domestic consumption, while the interest rate on US bonds rises with the American demand for domestic and imported goods.
The price level of European goods is given by:

$$P_{t+1} = \frac{G_{t+1}^{EU} + M_t^{EU}}{Y_{t+1}^{EU}} + \frac{\frac{1}{2}M_{t-1}^{*US} M_t^{EU}}{M_{t-1}^{EU} Y_{t+1}^{EU}} \tag{54}$$

$$\Rightarrow P_{t+1} = \frac{G_{t+1}^{EU} + M_t^{EU} + \frac{1}{2}M_{t-1}^{*US}(1+g_t^{EU})}{Y_{t+1}^{EU}} \tag{55}$$

for $g_t^{*US} = (\frac{M_t^{*US}}{M_{t-1}^{*US}} - 1)$, g_t^{*US} being the growth rate of money held in the US.
The price level of US goods is:

$$P_{t+1}^* = \frac{G_{t+1}^{US} + M_t^{*EU} + \frac{1}{2}M_t^{*US}}{Y_{t+1}^{EU}} \tag{56}$$

The level of Seigniorage for t+1 of:

$$SE_{t+1} = \frac{M_t^{*EU} M_t^{*US}}{M_{t-1}^{*US}} - M_t^{*EU} \tag{57}$$

$$\Rightarrow SE_{t+1} = M_t^{*EU}(g_t^{*US}) \tag{58}$$

For the change in the American net foreign bond position:

$$\Delta NFB_{t+1}^{US} = \frac{M_t^{*EU} M_t^{*US}}{M_{t-1}^{*US}} - \frac{M_t^{*US}}{2} \tag{59}$$

$$\Leftrightarrow \Delta NFB_{t+1}^{US} = SE_{t+1} + M_t^{*EU} - \frac{M_t^{*US}}{2} \tag{60}$$

Thus, the American CA in period t+1 can also be expressed as:

$$CA_{t+1}^{US} = M_t^{*EU} - \frac{1}{2}M_t^{*US} \tag{61}$$

If the Europeans demand more money to be spent on American goods than the Americans themselves, the US will run a CA surplus in the following period. Consequently the European CA in period t+1:

$$CA_{t+1}^{EU} = S_{t+1}(\frac{1}{2}M_t^{*US} - M_t^{*EU}) \tag{62}$$

3 Numerical example

So far, we considered economies without economic growth. In a world without economic growth, there cannot be Seigniorage in the steady state. Since all variables are stable in the steady state, the amount of nominal consumption will remain unchanged, thus the European demand for USD will remain unchanged. Since we defined Seigniorage as the change in the amount of USD held in Europe $M_t^{*EU} - M_{t-1}^{*EU}$(p. 8), this difference will be zero.
To find a steady state, we ran a numerical simulation of the model. To determine the initial values, we assume that both economies are equal in GDP Y_t (5 units) and government spending G_t (1 unit) and have a similar discount factor $\beta = 0.02$. Further we assume that domestic money supply is exogenous, whilst the (European) holdings of foreign currency will be determined endogenously. Both economies will start with 1 monetary unit for consumption of domestic goods and 1 unit for consumption of foreign goods. Given the asymmetric structure of the model, the US receive 2 units of USD each period, which they will spend half on domestic, half on foreign goods. The Europeans instead receive 1 unit of domestic currency and 1 unit of USD. In the following periods, they will receive 1 unit of EUR and will have to collect foreign currency to purchase imported goods. The initial exchange rate S_t will be equal to one.

The two economies will find a steady state for the following values,
Europe:

$$P_t = 0.61, C_t^{EU} = 1.65, C_t^{*EU} = 1.64, r = 0.02 \tag{63}$$

$$and\ a\ CA\ of\ +0.0262 \tag{64}$$

America:

$$P_t^* = 0.59, C_t^{US} = 1.70, C_t^{*US} = 1.68, x = 0.02 \tag{65}$$

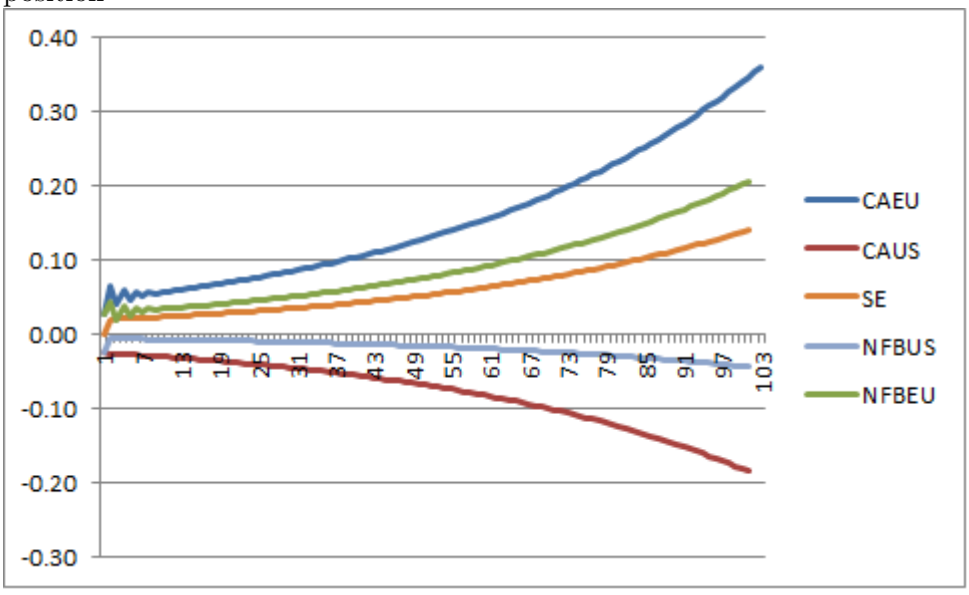
$$and\ a\ CA\ of\ -0.0256 \tag{66}$$

The CA equals in both cases the change in the NFB position and the American use of Seigniorage is zero. The exchange rate is S_t=1.03. It is interesting to see that the monetary asymmetry leads to an American CA deficit even in the absence of Seigniorage.

According to equations 41 and 43, the US would permanently deplete their net foreign bond position, whilst Europe would permanently increase its position. The economy remains in its steady state, because the exchange rate compensates for these changes. The Americans can run a permanent CA deficit if the exchange rate works in their favour (in this model that is the case whenever $S \geq 1$). This supports the idea of a permanent wealth transfer to the US through the exchange rate channel (valuation effect).

If we now add growth to the model, there can be an additional wealth transfer via Seigniorage. We let both economies grow at a rate of 2 per cent, in line with government expenditure. The money supply will grow at the same rate, so there will not be inflation. Starting from our steady state values, figure 2 shows the simulated values for 100 periods. It demonstrates how the use of Seigniorage (SE) lets the American CA (CAUS) further deteriorate but mitigates the depleting of the American international bond position (NFBUS). The interest rates jump to a higher level and remain there, which causes the little jump in the first period of our graphs.
The possibility of Seigniorage has further worsened the American CA, but their NFB position did not deteriorate by the same amount. In Europe, on the contrary, the CA (CAEU) has further improved but the NFB position (NFBEU) did not improve by the same amount. In both cases, American Seigniorage accounts for the difference. The exchange rate additionally works in favour of the American NFA position. It further enhances the European demand for USD, for a given level of nominal consumption. Considering the international investment position, the US profit whilst it is an additional burden for Europe. The figure shows how the change in the NFB position now diverges from the CA, in both cases.

Figure 2: Development of the CAs, Seigniorage and the American net foreign bond position



4 Conclusion

In this paper we described a world with monetary asymmetry. By using a simple two country model, we could show that the fact that the US issues the world's reserve currency facilitates the running of CA deficits for them. The use of valuation effects and Seigniorage lets the American CA further deteriorate. Nevertheless, the deterioration of the NFA position is mitigated by the possibility to swap cash against interest bearing assets, or for interest bearing liabilities and through the exchange rate channel. The reserve currency issuing country is able to obtain real foreign resources for its currency. It can maintain a CA deficit, without having to fear a balance of payment crisis or quickly running down its foreign assets. This is not possible in that way for any other country. Our results may contribute to the understanding of the state of the world economy. If one country is in the unique position to run continuous deficits and the rest of the world has to (partially) finance that, imbalances will be caused by these one-way capital flows. The capital flows into the US and the excessive use of their Seigniorage privilege laid the ground for the financial crisis 2007-2009. The events that happened in and after that crisis have shown that the provision of liquidity to the world by only one country is not a benign situation. Future will show if a multi polar world with several (regional) reserve currencies will emerge.

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