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ABSTRACT

In monetary economies, international differences in rates of time preference do not in general lead to long run trade imbalances -- in sharp contrast with Buiter's [1981] results on non-monetary overlapping generation economies. This claim is documented within the context of a simple two-country framework in which new immortal families enter each economy over time, with the two countries differing only in their subjective discount rates. Even if consumers are more "impatient" at home than abroad, trade is balanced in the long run in the presence of valued fiat currencies in constant supply, and the current account is indeterminate.

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The existence of differences in subjective time preference and thriftiness is often invoked to account for the pattern of international capital movements. Countries, Buiter [1981] has argued, whose residents are, *ceteris paribus*, more impatient to consume than their international trading partners will experience a long run current account deficit — thus confirming, in a nonmonetary, two-country overlapping generation model, the presumption that "a nation consisting of people with a high rate of time preference will tend to be net foreign borrower" [*ibid.*, p. 782].

In this paper, I argue that the common sense results of Buiter do not carry over to *monetary* economies — i.e., to economies in which the menu of assets is enlarged to allow for the possibility that intrinsically useless assets, such as fiat money, bubbles, or old paintings, are held, for purely speculative purposes, by consumers. The reason is that the presence of "unbacked" financial assets enables economies to reach the golden rule, and thus breaks the link, crucial to Buiter's conclusions, between time preference, autarkic interest rates, and trade patterns. As a consequence, trade is shown to be balanced, and the current account indeterminate, in a long run monetary equilibrium.

To formally establish these results, I consider a simple continuous-time economy in which new infinitely-lived dynasties, which are defined to be families *not* linked to their ascendants through operative bequest or gift motives, enter the economy over time. As I have shown elsewhere,[1] this model possesses, despite the infinite horizon of every agent alive at any date, all the features of a standard two-period overlapping generation model — and in particular the feature, important for this analysis, that all wealth is not held, in the long run, by the most patient consumer. Because every agent alive has the same (infinite) remaining lifespan, age-effects are however eliminated from individual optimal consumption programs — so that the linear consumption functions of agents with isoelastic preferences can be very easily aggregated.[2]

[1] See Weil [1987a, 1987b]

[2] This solution to the aggregation problem is essentially the same as Blanchard's [1985], who assumes that conditional death probabilities are independent of age. By setting those probabilities equal to zero, one can abstract from issues related to the compulsory annuitization of wealth; by letting new infinitely-lived cohorts enter the economy, one introduces the intergenerational effects at the core of standard overlapping generation models.

The analysis proceeds as follows. Section 1 derives individual and aggregate consumption functions. Section 2 characterizes autarkic and trade equilibria. Section 3 studies equilibrium trade and current account patterns. The conclusion summarizes the results.

1. Consumption

I characterize optimal consumption at the individual level, and then turn to the derivation of the aggregate consumption function.

1.1. Individual consumption

Consider the problem faced at time $t > 0$ by an infinitely-lived dynasty "born" at time s, $t \geq s \geq 0$, and living in country i, $i = 1, 2$. Assume, for simplicity,[3] that the family's utility over future consumption is

$$U^i(s,t) = \int_t^{\infty} e^{-\delta^i \tau} \ln c^i(s,\tau)\, d\tau, \tag{1}$$

where $\delta^i > 0$ denotes the country-specific pure rate of time preference, and $c^i(s,t)$ represents the consumption at time t of a family born at time s in country i.

Residents of country i can freely trade claims on output among themselves and with foreigners — which leads to the equalization, in equilibrium, of real interest rates. It is assumed that legal restrictions prevent residents of any one country to hold foreign currency. Since each currency can individually be traded against international mobile financial claims, these legal restriction in fact do not matter in equilibrium, as triangular arbitrage ensures that real rates of return on money, i.e, deflation rates, are equalized across countries, and equal to the real interest rate. Formally, letting $r^i(t)$ denote the real instantaneous real rate of return on loans in country i, and $\pi^i(t)$ the instantaneous inflation rate in country i, it must be the case, if all currencies are traded and there are international capital

[3]This analysis can be easily extended to the more general class of HARA utility functions, which delivers consumption functions which are linear in wealth.

flows[4] that

$$r^1(t) = r^2(t) = -\pi^1(t) = -\pi^2(t) \quad \forall t \geq 0, \tag{2}$$

an arbitrage condition henceforth assumed to be satisfied.[5]

Letting e(t) denote the exchange rate between home and foreign currencies, an important implication of (2) is that

$$\dot{e}(t) = \pi^2(t) - \pi^1(t) = 0, \tag{3}$$

where a dot represents a derivative with respect to time. Equation (3) simply indicates that the exchange rate between the two (indirectly) traded useless fiat currencies must be constant. This is, of course, one of the striking conclusions of Kareken and Wallace [1981].

The instantaneous budget constraint faced at t by a family born at s is then simply

$$\dot{w}^i(s,t) + \dot{m}^i(s,t) = r^i(t)w^i(s,t) - \pi^i(t)m^i(s,t) + y - c^i(s,t), \tag{4}$$

where $w^i(s,t)$ denotes the non-human, non-monetary wealth at t of a family born at s in country i, and $m^i(s,t)$ the (real) monetary wealth at t of that family. Each family, independently of the date, its age, or the country it lives in, receives a constant endowment $y > 0$ of the *perishable* consumption good. It is moreover assumed that the initial non-human wealth of any family, born in any country, at any date $s > 0$, is zero, i.e, that $w^i(s,s) = m^i(s,s) = 0$.[6]

Letting

$$a^i(s,t) = w^i(s,t) + m^i(s,t) \tag{5}$$

denote total non-human wealth at t, and using (2), the budget constraint (4) can be rewritten more compactly as

$$\dot{a}^i(s,t) = r^i(t)a^i(s,t) + y - c^i(s,t). \tag{6}$$

Maximization of (1) subject to (6) and a transversality condition designed to rule out private Ponzi schemes[7] leads to the following

[4]This will in general be the case in a monetary equilibrium.

[5]Note that (2) implies that the nominal interest rate is zero in this economy: "money" is not a dominated asset.

[6]What original families find in the Garden of Eden, namely $w^i(0,0)$, and the initial nominal stocks of currency are, however, given and non-zero.

[7]One must impose $\lim_{t\to\infty} e^{-\int_s^t r(\tau)\, d\tau} a^i(s,t) \geq 0$.

well-known individual consumption function and law of motion:

$$c^i(s,t) = \delta^i[a^i(s,t) + H^i(t)], \tag{7}$$

$$\dot{c}^i(s,t) = [r^i(t) - \delta^i]c^i(s,t), \tag{8}$$

where

$$H^i(t) \equiv y \int_t^\infty e^{-\int_t^s r^i(\tau)\, d\tau}\, ds \tag{9}$$

denotes the (age-independent) human wealth at time t of a country-i family. Notice, from (9), that human wealth satisfies

$$\dot{H}^i(t) = r^i(t)H^i(t) - y, \tag{10}$$

an expression which will be used below.

1.2. Aggregate consumption

Suppose that, in each country, *new* dynasties, which are not by definition linked to pre-existing ones through operative intergenerational altruistic bequest or gift motives, continuously enter the economy at the constant and country-independent exponential rate $n > 0$. Letting superscripted uppercase letters denote the aggregate per capita counterpart of the lowercase superscripted concepts defined above,[8] *consumption per head* in country i is simply, from (7),

$$C^i = \delta^i[A^i + H^i], \tag{11}$$

with time arguments dropped for simplicity.

Since the newly born families have, by assumption, zero non-human wealth (but the same human wealth as older dynasties), it is easy to show that non-human wealth per head only grows at rate $r^i - n$ [instead of r^i for human wealth, as shown in (10)]. More precisely:

$$\dot{A}^i = (r^i - n)A^i + y - C^i. \tag{12}$$

Combining equations (10), (11) and (12), one obtains the law of motion of consumption per head in country i:

$$\dot{C}^i = (r^i - \delta^i)C^i - n\delta^i A^i. \tag{13}$$

[8]Notice that this definition unfortunately implies that M^i denotes per capita *real* money balances in country i.

Because the newly born have no non-human wealth, "each" of them consumes $\delta^i A^i$ per unit of time less than the average, and the arrival of new dynasties at rate $n > 0$ depresses aggregate consumption per head by $n\delta^i A^i$ per unit of time.

2. Equilibria

I first consider, for the sake of reference, autarkic equilibria, and then characterize the pattern of international capital movements once trade is opened.

2.1. Autarky

Given that the (non-produced) consumption good is perishable by assumption, goods market clearing in country i requires, in autarky, that per capita consumption be equal to the endowment at every instant. In other terms:

$$C^i(t) = y \quad \forall t. \tag{14}$$

Moreover, since all agents at home are identical and there is no foreign trade, all non-human wealth must be held in monetary form, so that

$$A^i = M^i \quad (\Leftrightarrow W^i = 0). \tag{15}$$

Inserting these market clearing conditions into (13), one finds that in an autarkic equilibrium it must be the case that

$$0 = [r^i(t) - \delta^i]y - n\delta^i M^i(t) \quad \forall t. \tag{16}$$

Moreover, we also have

$$\dot{M}^i(t) = [r^i(t) - n]M^i(t), \tag{17}$$

because M^i represents per capita real balances, population grows at rate n, inflation rate is the negative of the rate of return on (inside) loans, and the nominal money supply is assumed to be constant.

Equations (16) and (17) fully characterize the equilibrium autarkic dynamics of interest rates and real balances. It is easy to show that there always exists a *non-monetary* equilibrium ($M^i = 0$)

in which the interest rate is equal to the rate of time preference δ^i. Non-monetary autarkic interest rates reflect, as in Buiter [1981], differences in time-preference. Provided, however, that non-monetary autarkic allocations be dynamically inefficient, in the sense that

$$\delta^i < n \quad i = 1,2, \tag{18}$$

there also exists a stationary, *golden rule* monetary equilibrium in which

$$r^i(t) = n \quad \text{and} \quad M^i(t) = \frac{(n - \delta^i)y}{n\delta^i} > 0 \tag{19}$$

for all t.[9]

Autarkic interest rates are hence equalized, in a long-run monetary equilibrium, to the common rate of population growth — a property which severs the links between time preference and autarkic interest rates.[10]

2.2. World equilibrium

Assume that the two countries have the same size (as measured by population). In a world equilibrium in which there is trade between the two countries, world consumption per number of inhabitants in one country ("average" world consumption) must be equal to the average world endowment:

$$C^1 + C^2 = 2y. \tag{20}$$

Non-human wealth can be held either in claims against foreigners or in home real balances,[11] and the market for foreign claims must clear:

$$A^1 = W^1 + M^1 \tag{21}$$

$$A^2 = W^2 + M^2 \tag{22}$$

$$W^1 = -W^2 \equiv W. \tag{23}$$

[9] As I show in Weil [1987a], there also exists non-stationary equilibria which, although monetary in the short run, are asymptotically non-monetary.

[10] If nominal money grows at rate σ^i in country i, equation (17) becomes $\dot{M}^i(t) = [r^i(t) - n + \sigma^i]M^i(t)$, and the steady state interest rate is $r^i = n - \sigma^i$ in a monetary equilibrium. Autarkic interest rates then reflect population growth and monetary policies, but *not* time preference.

[11] No claim can be held in equilibrium against one's fellow countrymen.

Assume that the dynamic inefficiency condition (18) holds. It is then easy to show that there exists a unique equilibrium in which both currencies are valued in the long run.[12] It is a *golden rule*,[13] stationary[14] equilibrium which has, from (2), (9), (11), (13), (17), (20) and (23), the following features:

$$r^1 = r^2 = -\pi^1 = -\pi^2 = n, \tag{24}$$

$$C^1 = C^2 = y, \tag{25}$$

$$(n - \delta^1)y = n\delta^1[M^1 + W], \tag{26}$$

$$(n - \delta^2)y = n\delta^2[M^2 - W]. \tag{27}$$

The implications of this (monetary) equilibrium allocation for international trade patterns are examined in the next section.

3. International capital movements

I first characterize the trade balance, and then study the behavior of the current account.

3.1. Trade balance

From equation (25), consumption per head is equal, in each country, to endowment per head. The trade balance of each country is thus, in this golden rule monetary equilibrium, zero.

To understand this result, it suffices to remember that trade imbalances, can arise, in our model, only from differences in domestic consumption — since output is exogenous, equal in each country, and perishable. But it is a very general property that, at the golden rule, aggregate per capita consumption is equal to the per capita endowment, which is the same by construction in every country. Aggregate per capita consumption being the same in both countries, trade must be balanced.

[12] Long-run non-monetary equilibria are not studied here due to space limitations. They would confirm, of course, Buiter's conclusions.

[13] If nominal money supplies are *not* constant, the world interest rate differs, however, from the growth rate, and reflects monetary policies. See footnote 10.

[14] The long-run is reached immediately in this exchange economy. Transitional dynamics would arise in the presence of a state variable like, say, capital.

Differences in pure rates of time preference have, therefore, no influence whatsoever on the pattern of real trade flows in an economy in which the asset menu is enlarged to include fiat currencies and other like assets.

3.2. Current account

The instantaneous current account of country i, CA^i, is by definition equal to the change in the country's indebtedness per unit of time. Given that W^i denotes the country's *per capita* claim on foreigners, the current account of country i is simply

$$CA^i = \dot{W}^i + nW^i. \tag{28}$$

In a long-run monetary equilibrium, the current account balances of the two countries are then, using (23):

$$CA^1 = nW \quad \text{and} \quad CA^2 = -nW. \tag{29}$$

Unfortunately, there are only two equations, (26) and (27), to determine the three equilibrium values of M^1, M^2 and W, and thus of the current accounts. This feature of the model is not coincidental; it is instead a reflection of the fundamental indeterminacy of the exchange rate between the home and foreign currencies. Both are, in our setup, essentially identical (they are intrinsically useless and are held only for speculative purposes). The only constraint imposed by equilibrium considerations is that, as emphasized by equations (2) and (3), the two currencies offer the same rate of return and, as a consequence, the exchange rate be constant. But there is nothing, as first noted by Kareken and Wallace [1981], to pin down the value of that exchange rate in equilibrium. It is, as the exchange rate between nickels and dimes, purely conventional.

To say that the exchange rate is indeterminate or conventional does not, of course, entail that it is irrelevant. On the contrary, it determines, in this economy, the current account pattern. Suppose, by choice of units, that the *nominal* money stocks are equal in both countries. Then, since population is the same in both countries, the ratio of home to foreign per capita *real* balances is simply the exchange rate:

$$e = M^1/M^2. \tag{30}$$

Fix, by convention, the exchange rate. From (26) and (27), the current account of, say, country 1 is then:

$$CA^1 = \frac{\frac{n-\delta^1}{\delta^1} - e\frac{n-\delta^2}{\delta^2}}{1+e} y. \tag{31}$$

It is clear that the exchange rate, because it allocates world *real* balances (and thus initial wealth) between the home and foreign countries, determines which country is a net borrower or lender.

In general, equation (31) establishes that there is no presumption that the impatient (high δ) country should run a current account deficit, in sharp contrast with Buiter's [1981] results. Note, however, that Buiter's conclusions carry over to this monetary economy in the special case — without much economic content — in which $e = 1$, and that the current account of country 1 does deteriorate if, *ceteris paribus*, it is more impatient (δ^1 large).

Conclusion

This paper has demonstrated that international differences in rates of time preference need not lead, in monetary economies, to long run trade imbalances — in contrast with Buiter's [1981] non-monetary conclusions.

This result was established within the context of a simple two-country framework in which *new* immortal families enter each economy over time, with the two countries differing only in their subjective discount rates. Even if consumers are more "impatient" at home than abroad, trade is balanced in the long run in the presence of valued fiat currencies in constant supply are valued, and the current account is indeterminate.

These conclusions easily generalize to the case in which nominal money supplies are growing, and remain valid when the useless fiat currencies analyzed here are reinterpreted as public debt. Autarkic long run interest rates reflect, in equilibria in which money (debt) is held, biological factors and monetary (fiscal) policies, but not time preference; when trade is opened, the pattern of international capital movements depends in a complex fashion on tastes, technology, demography, *and* monetary (fiscal) policies — so that no straightforward inference can be made about trade patterns from differences in time preference .

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