"Dollarization," Seignorage, and the Demand for Money*

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*A comment on "Seignorage and the Case for a National Money," by Stanley Fischer, and "Dollarization in Mexico: Causes and Consequences," by Guillermo Ortiz. This comment in large part reflects opinions about monetary economics that I have absorbed from my colleagues John Kareken and Neil Wallace.

The subjects of "dollarization" and seignorage involve fundamental and still controversial aspects of monetary economics. Views on these subjects stem directly from judgments about the theoretical models appropriate to explain why inconvertible (or "fiat") currencies command value. Currently, a variety of theories about the "demand for money" have adherents. These theories differ in terms of the economic forces that they adduce to assign a currency value, the relevance that they attach to distinctions between "inside" and "outside" money, and whether they give rise to well-defined and stable demand functions for national monies in a world of flexible exchange rates.

Theories of money begin from the observation that there is no role for unbacked fiat currency in the standard general equilibrium model of Arrow and Debreu, with its complete array of frictionless state contingent futures markets. To provide room for an inconvertible currency, it is necessary to deviate from the Arrow-Debreu assumptions and to posit some source of friction that inhibits at least some of the trades envisaged by Arrow and Debreu. Theories of money differ in the ways that they introduce these frictions and the explicitness with which the theorizing is done.

One popular way of motivating a demand for money in a general equilibrium model is to resort to Sidrauski's [14] device of adding real balances to the instantaneous utility function of a model that is otherwise isomorphic to a version of a Cass-Koopmans [6] optimum growth model. The representative individuals in such a model are posted to maximize a criterion such as

$$(1) \qquad \sum_{0}^{\infty} u(c_t, \frac{m_t}{p_t}) e^{-\delta t}, \ u_1 > 0, \ u_2 > 0$$

where $\delta > 0$ is an instantaneous rate of time preference, c_t is per capita consumption of a single good, m_t is "nominal balances," and p_t is the nominal price level. Such a model is capable of generating a well-behaved, smooth demand function for the aggregate of assets included in nominal balances, m_t. This demand schedule permits the assets m_t to be dominated in rate of return by the alternative assets (corporate and government bonds, equities, or physical capital) that households have access to. Real balances are dominated in rate of return by those other assets to the extent that they provide utility directly, i.e., to the extent that $u_2 > 0$. An important aspect of this theory is that very different principles are used to assign value to real balances, on the one hand, and all other assets, on the other. All other assets are valued according to the utility value of the streams of consumption that they support in equilibrium. There is an asymmetry here, in that all assets except real balances are valued according to the principle of modern finance theory, which prices assets in such a way that no asset's return is dominated in equilibrium by the return on any other collection of assets.

In a theory of this kind, the analyst in effect decides a variety of important issues when he defines precisely what collection of assets enter the category of "real balances," or m_t/p_t. Is m_t/p_t high-powered money, as in the formal models of Sidrauski [14], Brock [2], and Fischer, thereby excluding "inside money" or that portion of demand deposits and time deposits that is not fully backed by high-powered money? The verbal arguments that are used to justify including m_t/p_t in the utility function are widely interpreted as arguing for a broader aggregate including some components of inside debt, such as demand deposits, bank notes, and bills of exchange.[1/] A closely related question is the following one: for residents of a given country, are real balances denominated in foreign currencies included in m_t/p_t in (1)? It certainly seems plausible to posit, for example, that, for a two-country world, agents in country j maximize

$$(2) \qquad \sum_0^\infty u\left(c_{jt}, \frac{m_{1t}^j}{p_{1t}} + \frac{m_{2t}^j}{p_{2t}}\right)e^{-\delta t}$$

where c_{jt} is consumption in country j, m_{it}^{j} is nominal balances of country i held by residents of country j, and p_{it} is the price level in terms of country i currency. At this level of theorizing, positing (2) seems as plausible as positing that agents in country 1 maximize

$$(3) \qquad \sum_{j=0}^{\infty} u(c_{1t}, m_{1t}^{1}/p_{1t})$$

while agents in country 2 maximize

$$(4) \qquad \sum_{j=0}^{\infty} u(c_{2t}, m_{2t}^{2}/p_{2t}).$$

Equations (3) and (4) assert that country 1 residents just happen to have "dollars" in their utility function, but not "pounds," while country 2 residents just happen to have "pounds" and not "dollars." While these assumptions give rise to smooth and well-behaved demands for national currencies and a determinate theory of exchange rates, they are not useful for addressing the dollarization phenomenon described by Mr. Ortiz. However, using the criterion function (2) in a two-country Sidrauski model can readily be shown to imply a severe "dollarization" problem under a regime of flexible exchange rates and no capital controls. In particular, the resulting model has the properties that there are not smooth, well-defined demand schedules for particular national currencies, and that there is not even a unique equilibrium exchange rate. Thus, the predictions of the model depend very sensitively on the particular aggregate that the analyst chooses for "real balances." No first principles seem available to guide that choice for an analysis conducted at this level.

The same set of questions arises in models with "cash in advance" constraints, of the kind analyzed by Clower and Lucas [7]. Here the idea is to have individuals maximize a Cass-Koopmans utility functional involving only consumption

(5) $$\sum_{t=0}^{\infty} u(c_t)e^{-\delta t}$$

but to add the "cash in advance" constraint

(6) $$p_t c_t \geq m_{t-1}$$

to the other intertemporal constraints of a version of a Cass-Koopmans model. A smooth, well-behaved demand schedule for real balances is obtained by forcing individuals to transact in the particular set of assets included in m_{t-1} in the Clower constraint (6). This constraint permits the assets included in m_{t-1} to be dominated in return by the other assets in the model. As in the Sidrauski model, the choice of assets to include in m_{t-1} sensitively conditions the conclusions of the analysis, especially from the point of view of the issues raised by the two papers of this session.

It seems to me that the same questions again arise if one attempts to use the reasoning underlying the Baumol-Tobin transactions costs models [1,16] to generate a demand for a particular class of assets called "money" that are dominated in terms of rate of return because it is less costly to transact with them. For example, it is hard to imagine a reasonable specification of a physical transaction cost technology that would naturally give rise to a situation in which in equilibrium each country turns out to have its own national money. Again, the Baumol-Tobin setup is silent on the question of the particular class of assets that are to be called money, and in which it is less costly to transact.

The final brand of monetary theory that I will mention is based on the insight of Paul Samuelson [12] that if sufficient "missing links" are introduced into a general equilibrium model, via spatial or temporal separation of agents, then a role for a properly managed inconvertible currency can emerge. Such models obtain a valued fiat currency by restrictions directly on the endowment patterns, locations in time and space, and technological possibilities for transforming goods over time and space. One popular example of this class of models is Samuelson's model of overlapping generations of two-period-lived agents, which has been used by Cass-Yaari [3], Lucas [8], Wallace [19], and others to examine outstanding questions in macroeconomics. However, other models with agents who live more than two periods, such as those analyzed by Townsend [18] and Tesfatsion [15], embody the same general kind of missing links friction that characterizes Samuelson's model. As in the previous kinds of models, issues of inside and outside money and of international currency substitution also arise in the context of these "missing links" models. However, in these models the analysis is conducted at a more primitive level that naturally directs the analyst's attention toward the forces that make inside money displace (and devalue) outside money, and that make foreign currency compete with domestic currency.

Kareken and Wallace [4,5] have used a version of Samuelson's model to analyze currency substitution, while Wallace [19] and Sargent and Wallace [13] have used such a model to analyze inside-outside money issues. To illustrate the issues raised by this brand of monetary theory for the subject of this session, I shall briefly consider the following parametric, nonstochastic, two-country, pure exchange overlapping generations model.

At each date $t \geq 1$, there are born in country j N_j two-period-lived agents. Within each country, the agents are identically endowed both within and across time periods. There is a single, nonstorable consumption good. Let $w_s^j(t)$ be the endowment of t period goods of an agent in country j who is born at time s. Let $c_s^j(t)$ be the consumption of t period goods of an agent in country j who is born at time s. I assume the stationary endowment pattern

$$w_t^1(t),\ w_t^1(t+1) = (\beta_1,\beta_2) \tag{7}$$
$$w_t^2(t),\ w_t^2(t+1) = (\alpha_1,\alpha_2).$$

The young of each generation in each country are assumed to maximize the logarithmic utility function

$$\ln c_t^h(t) + \ln c_t^h(t+1). \tag{8}$$

This utility function implies the saving function

(Saving of an agent in country j who is young at t) =

$$w_t^j(t) - c_t^j(t) = \left[\frac{w_t^j(t)}{2} - \frac{w_t^j(t+1)}{2R(t)}\right] \tag{9}$$

where $R(t)$ is the real gross rate of return on saving between times t and t+1, denominated in time (t+1) goods per unit of time t goods.

At time t=1, there are N_j old people in country j. The old in country 1 are in the aggregate endowed with $H_1(0)$ units of government-supplied inconvertible paper currency, denominated in "dollars." The old in country 2 are in the aggregate endowed with $H_2(0)$ units of government-supplied inconvertible paper currency, denominated in "pesos." The government of country j has a <u>policy</u> of financing a real deficit of $G_t^j \geq 0$, t=1, 2, ... by creating additional fiat money. The government budget constraints are

$$G_t^j = \frac{H_j(t)-H_j(t-1)}{p_j(t)},\ j=1,\ 2 \tag{10}$$

where $p_j(t)$ is the price of time t goods, measured in units of j country currency per unit of time t good. Below I shall characterize policy by $H_j(t)$ paths, and <u>not</u> G_t^j paths. The G_t^j path will be endogenous.

Consider a free-trade, flexible exchange rate regime in which agents in the two countries are permitted freely to borrow and lend to each other, and to hold each other's national currencies. Since there is no uncertainty, if the fiat currencies are to be valued (i.e., if $p_j(t) < \infty$), they must bear the same real rates of return with each other, and with consumption loans (or "inside debt").[2/] The real gross rate of return on currency j is $p_j(t)/p_j(t+1)$ at time t. Thus, we have the requirement that

$$\frac{p_1(t)}{p_1(t+1)} = \frac{p_2(t)}{p_2(t+1)}.$$

This implies

$$\frac{p_1(t)}{p_2(t)} = \frac{p_1(t+1)}{p_2(t+1)}. \tag{11}$$

The ratio $p_1(t)/p_2(t) = e(t)$ is the exchange rate, measured in dollars per peso. Equation (11) states that the exchange rate e(t) must be constant over time if the currencies are to bear the same gross real rates of return. So we have $e(t) = e$ for all $t \geq 1$.

The sequence of equilibrium conditions for this two-country, world economy can be written, for $t \geq 1$, as

(net saving of young of country 1) +
(net saving of young of country 2) =
(net dissaving of old of countries 1 and 2) +
(net dissaving of government of country 1) +
(net dissaving of government of country 2).

Net dissaving of the old at t is given by $H_1(t-1)/p_1(t) + H_2(t-1)/p_2(t)$, while net dissaving of government j is G_t^j. Substituting from (9) and (10), and using $p_1(t)/p_1(t+1) = p_2(t)/p_2(t+1) = R(t)$, these equilibrium conditions can be written

$$N_1[\frac{\beta_1}{2} - \frac{\beta_2}{2}\frac{p_1(t+1)}{p_1(t)}] + N_2[\frac{\alpha_1}{2} - \frac{\alpha_2}{2}\frac{p_1(t+1)}{p_1(t)}]$$

$$= (\frac{H_1(t-1)}{p_1(t)} + \frac{H_2(t-1)}{p_2(t)}) + \frac{H_1(t)-H_1(t-1)}{p_1(t)} + \frac{H_2(t)-H_2(t-1)}{p_2(t)}.$$

This equation can be rewritten, using $p_2(t) = p_1(t)/e$, as

$$(12) \qquad (N_1 \frac{\beta_1}{2} + N_2 \frac{\alpha_1}{2}) - (N_1 \frac{\beta_2}{2} + N_2 \frac{\alpha_2}{2})\frac{p_1(t+1)}{p_1(t)} = \frac{H_1(t)+eH_2(t)}{p_1(t)}.$$

Multiplying by $p_1(t)$ and rearranging, we have the difference equation in $p_1(t)$

$$(13) \qquad p_1(t) = \lambda p_1(t+1) + \phi[H_1(t)+eH_2(t)], \ t\geq 1$$

where

$$\lambda = (\frac{\beta_2 N_1+\alpha_2 N_2}{\beta_1 N_1+\alpha_1 N_2}), \ \phi = \frac{2}{N_1\beta_1+N_2\alpha_1}.$$

If possible, the difference equation (13) is to be solved for a sequence of price levels $\{p_1(t), t=1,2,\ldots\}$ and an exchange rate $e \geq 0$. It happens, however, that the difference equation (13) cannot determine all of these endogenous variables. Kareken and Wallace describe this fact by stating that the equilibrium exchange rate is indeterminate or underdetermined. So long as all the price level $p_1(t)$ for all dates $t \geq 1$ is regarded as endogenous, Kareken and Wallace's characterization must be accepted.

We say that there exists a fiat money equilibrium if the difference equation (13) has a solution with $p_1(t)\varepsilon(0,\infty)$ for $t \geq 1$. The general solution of the difference equation (13) is

$$(14) \qquad p_1(t) = \phi\sum_{i=0}^{\infty}\lambda^i H_1(t+i) + e\phi\sum_{i=0}^{\infty}\lambda^i H_2(t+i) + c(\frac{1}{\lambda})^t, \ t\geq 1$$

where c is any arbitrary constant. So long as $G_t^j \geq 0$, $t \geq 1$, in (10), a necessary condition for the difference equation (13) to have a solution with $\infty > p_1(t) > 0$ is $\lambda < 1$. The parameter $\lambda = (\beta_2 N_1+\alpha_2 N_2)/(\beta_1 N_1+\alpha_1 N_2)$ is the real gross rate on consumption loans in the pure consumption loans (or pure "inside debt") economy.[3/] This is a version of Samuelson's result that for there to be a role for the "social contrivance" of inconvertible currency, an economy with inside debt alone must not provide a real gross rate of return in excess of the gross rate of growth of the economy.

If $\lambda < 1$, the existence of a fiat money equilibrium depends on the paths of $H_1(t)$ and $H_2(t)$ for $t \geq 1$. To take a concrete case, suppose that

$$H_1(t) = z_1 H_1(t-1), \quad t \geq 1$$

$$H_2(t) = z_2 H_2(t-1), \quad t \geq 1.$$

We assume that $1 < z_1 < z_2$. Then we have the following situation. If $\lambda \cdot z_1 < 1$ and $\lambda \cdot z_2 < 1$, a continuum of fiat money equilibrium solutions of (13) is given by

$$(15) \qquad p_1(t) = \frac{\phi}{1-\lambda z_1} H_1(t) + e \frac{\phi}{1-\lambda z_2} H_2(t) + c \cdot \left(\frac{1}{\lambda}\right)^t$$

for any $\infty \geq e \geq 0$, and any $c \geq 0$. If $\lambda \cdot z_1 < 1$, $\lambda z_2 > 1$, then a continuum of fiat money equilibrium solutions of (13) is given by

$$(16) \qquad p_1(t) = \frac{\phi}{1-\lambda z_1} H_1(t) + c\left(\frac{1}{\lambda}\right)^t$$

with $e \equiv 0$, and any $c \geq 0$. If $\lambda \cdot z_1 > 1$, the solution of (13) is $p_1(t) = +\infty$, so that neither fiat currency is valued.

The nature of these solutions reveals that the valuation of national currencies is <u>tenuous</u> for several reasons.[4/] First, when $\lambda z_2 < 1$, so that the solution (14) is pertinent, then the equilibrium exchange rate is underdetermined, with any constant e in the closed interval $[0,\infty]$ being an equilibrium exchange rate. This is Kareken and Wallace's celebrated result about the indeterminacy of equilibrium exchange rates under laissez faire. Second, so long as $\lambda < 1$ and $\lambda z_1 < 1$, there exists a continuum of equilibria (indexed by the parameter $c \geq 0$). All of these equilibria, except the stationary equilibrium with $c = 0$, have $p_1(t)$ following an explosive, self-fulfilling speculative bubble in which the real value of currency asymptotically goes to zero. Third, confining oneself to the stationary ($c=0$) equilibrium, the more inside debt there is, or equivalently, the more private borrowers there are relative to private lenders, the higher is the equilibrium price level. Thus, equation (12) can be rewritten

$$\underbrace{(N_1 \frac{\beta_1}{2} + N_2 \frac{\alpha_1}{2})p_1(t)}_{\text{total nominal debt}} = \underbrace{(N_1 \frac{\beta_2}{2} + N_2 \frac{\alpha_2}{2})p_1(t+1)}_{\text{"inside" nominal indebtedness}} + \underbrace{(H_1(t)+eH_2(t))}_{\text{nominal value of world currency supply}}$$

where nominal values are measured in dollars. Notice that in a fiat money equilibrium the ratio of inside nominal debt to the total nominal debt is given by[5/]

$$\left(\frac{N_1\beta_2+N_2\alpha_2}{N_1\beta_1+N_2\alpha_1}\right)\frac{p_1(t+1)}{p_1(t)} = \lambda\cdot\frac{p_1(t+1)}{p_1(t)}.$$

The larger is the value of λ, the smaller is the base of the inflation tax and the smaller is the maximal sustained amount of real revenue that can be raised jointly by the two governments. Further, if $\lambda > 1$, we have seen that no fiat money equilibrium exists. Thus, private indebtedness competes with public indebtedness and limits the ability of the government to collect revenues through an inflation tax. Fourth, the valuation of national currencies is tenuous because it depends on the government not running deficits that are too large far into the future, that is, it depends on the government's repeated fiscal <u>policies</u>, as is exhibited directly by (14), or by the restrictions on z_1 and z_2 in the special versions of the solutions (15) and (16).[6/]

Although the equilibrium value of the exchange rate is indeterminate, its value is important to the two governments, since it helps to determine the real value of the inflation tax revenues collected by each government (see (10) and (14)).7/ The scope of trade in inside debt is also significant from the viewpoint of the real amount of inflation tax that each government can potentially collect.8/

This model thus implies, under a regime of flexible exchange rates and no capital controls, that "dollarization" will be a very important problem. This is particularly true if the economy with the larger deficits follows so expansionary a fiscal policy (e.g., $\lambda z_2 > 1$) that its currency is predicted to be valueless. The model indicates that a government intent on extracting an inflation tax from its own residents, or intent on preventing other countries from imposing such a tax on its residents, has substantial incentives to deviate from a regime of flexible exchange rates and capital mobility. That is, it has an incentive to impose currency and capital controls. The model also implies that such a government has a strong incentive to restrict and to regulate the scope of both domestic and international financial intermediaries that issue currency-like (i.e., small-denomination, low-risk) assets that compete with domestic currency in the portfolios of private agents.9/

There is a variety of possible forms that the exchange interventions and regulations of intermediaries can take that are sufficient to render the equilibrium exchange rate determinate and the demand for domestic high-powered money well defined. Kareken and Wallace [4] and Nickelsburg [11] have studied several such intervention schemes. Here it should simply be mentioned that various kinds of implicit and state contingent threats, which perhaps need actually never be executed, are sufficient to render the exchange rate determinate. In interpreting time series data, in principle, it may be difficult to determine whether a system is truly operating under a laissez faire regime "now and forever," or whether demands for inconvertible currencies are being influenced by some such implicit threats.

As do the other models of money that we have discussed, the Kareken-Wallace model has serious deficiencies. In order to get at the issues at an explicit and deep level, while maintaining analytical tractability, the model oversimplifies by severely restricting the technology, the life cycle, and the temporal distribution of agents. In fact, the physical and economic setup is so restricted that no one would seriously entertain econometrically estimating the free parameters of such a model by the appropriate econometric techniques of the post-Lucas critique [9] era.10/ In interpreting the time series data, Kareken and Wallace do not seem to intend that their model be taken literally. In this sense, the model of Kareken and Wallace cannot yet serve as an entirely rigorous guide in formulating time series econometric specifications. However, it is possible to imagine generalizations of Kareken and Wallace's model along the lines of Townsend's [18]. Such a model would retain the missing links features and isolate forces such as exchange rate indeterminacy and the tenuous character of fiat money equilibria. At the same time, it could accommodate more realistic and econometrically plausible infinite-period utility functions for households, so that one could think more seriously about formally using the model to interpret time series data. The problem is that such models quickly became analytically difficult to handle. In contrast, the Baumol-Tobin and real balances in the utility function models have more readily suggested econometric specifications.

Despite its abstractness and its remoteness from econometric applicability, the Kareken-Wallace model has the virtue of pointing toward forces that have seemed to operate in international currency markets and that other models have to some extent ignored. The history of exchange controls in England since World War II, for example, can be understood, at least partly, as a response to the forces pinpointed by their model.[11/] So can the concern that monetary authorities in the United States and Europe have exhibited about the implications of Euro-currency markets for monetary management. There is also Mr. Ortiz's observation that it was only with considerable difficulty that the Mexican authorities were able to induce Mexican citizens to hold domestically issued currency.

Footnotes

1/ By introducing some heterogeneity of endowments and/or preferences across agents in a Sidrauski-like model, markets for consumption and production loans can be included, so that inside debt can be incorporated into the model. The properties of such a model would depend sensitively on what fraction of inside debt one included in the concept of real balances that enters the utility function.

2/ Tobin's [17] theory of the demand for money also requires that the return on money not be dominated by the return on any possible portfolio of assets.

3/ Notice that where there is no fiat currency, the equilibrium condition for the world economy is

(net saving of young of country 1) +
(net saving of young of country 2) = 0

or

$$N_1\left(\frac{\beta_1}{2} - \frac{\beta_2}{2}\frac{1}{R(t)}\right) + N_2\left(\frac{\alpha_1}{2} - \frac{\alpha_1}{2}\frac{1}{R(t)}\right) = 0.$$

The solution for the gross real rate of return of consumption loans is $R(t) = (\beta_2 N_2 + \alpha_2 N_2)/(\beta_1 N_1 + \alpha_1 N_1)$.

4/ Neil Wallace [19] has emphasized this feature of inconvertible currencies.

5/ Equation (14) and (15) implies that $p_1(t+1)/p_1(t) > 1$.

6/ It is interesting to pose the following "optimal stationary seignorage" question for this model. Given the exchange rate e, the real rate at which both governments together collect revenues through the inflation tax is $G = H(t) - H(t-1)/p_1(t)$ where $H(t) = H_1(t) + eH_2(t)$. Let the "world money supply" follow the law $H(t) = zH(t-1)$. Then what value of z maximizes the sustainable value of G in stationary equilibrium? If the real gross rate of return on consumption loans in the nonfiat money equilibrium λ is greater than unity, no real revenues can be raised through the inflation tax. If $\lambda < 1$, the revenue-maximizing value of z turns out to be $\sqrt{1/\lambda}$.

7/ Notice that in this economy there are not well-defined demand functions for the individual countries' currency stocks, or for inside debt. Because all of these assets are perfect substitutes in lenders' portfolios, only a demand function for the total indebtedness, which can be thought of as the "total world money supply," is well defined. The real demand for this aggregate is equal to $(N_1\beta_1+N_2\alpha_1)/2$.

8/ The model is silent on the question of what currency inside debts are denominated in terms of.

9/ I have set up the model so that residents within each country are identically endowed and have identical preferences. This means that all "inside debt" occurs in the form of international private loans. From the point of view of the points made here, it would have made no substantial difference if I had introduced heterogeneity of agents' preferences and/or endowments within each country in order to open up the possibility of within-country inside debt.

10/ These techniques are described in various papers in Lucas and Sargent [10].

11/ See Leland Yeager [20, Chapter 22] for a history of British exchange controls.

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