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A THEORY OF CURRENT ACCOUNT AND EXCHANGE RATE DETERMINATIONS

Joshua Aizenman

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ABSTRACT

The purpose of this paper is to construct a two-period, two-country model that derives the current account, the exchange rate, the terms of trade, and real interest rates from optimal behavior principles. This is done by constructing a model that uses money mainly as a means of exchange, where the technology of exchange is flexible due to potential substitutability of time and real balances as a means of coordinating transactions. The discussion results in a framework that integrates elements of net saving theories and the monetary approach into a unified structure, in which the two approaches are complementary viewpoints.

Joshua Aizenman
Department of Economics
University of Pennsylvania
3718 Locust Walk CR
Philadelphia, PA 19104
(215) 898-7409

I. Introduction

The adoption of floating exchange rates in the seventies was coupled with massive real shocks and consequently with current account imbalances. These phenomena have renewed interest in theories of exchange rate and current account determinations. Both the exchange rate, and the current account can be viewed as windows that provide links between different economies. Their role is to help to accommodate adjustment to various shocks. Their behavior can be understood better if the underlying internal forces affecting each economy are traced out. Those forces are like an iceberg, whose observable tip is the current account and the exchange rate. Such a structure can be summarized in reduced form equations that describe the dependence of prices and current account on various parameters. The equations are derived from a number of theories that explore various approaches explaining the behavior of the exchange rate and the accumulation of foreign assets via the current account. However, since the various reduced form equations are not always derived explicitly from a unified framework, the connections between the different approaches deserve further exploration. The purpose of this paper is to derive the reduced form equations from a detailed structure of the economy, a procedure that will give us a better understanding of the interaction among different theories. This is done in a perfect foresight, optimal behavior model, where the role of money is introduced by describing the technology of exchange. Despite the natural limitations of this simplified model, it enables us to trace out the various channels that are summarized by the reduced forms, explaining them in a general equilibrium fashion.

A necessary step in any theory of exchange rate is modeling and understanding the role of money. This has been the topic of intensive research that has yielded various possible frameworks. Among them, we find the Clower liquidity-type and the Sidrauski utility type as possible alternatives.[1] The liquidity-type models concentrate mainly on the role of money as a means of exchange, assuming that money is a necessary means of payment in any transaction. Helpman and Razin recently used this approach in a theory of exchange rates. Although the approach proved to be a useful tool, its usefulness is limited when it comes to explaining the dependence of the velocity of circulation on expected inflation. This dependence might be crucial in any intertemporal model, and might provide a possible link between future expected policies and current prices. The utility approach (adopted by Sidrauski) includes real balances as a component of the utility function in addition to the physical consumption of each good. It provides a useful framework in analyzing inflationary effects; however, critics of this approach have found it unsatisfactory because of the lack of economic motivation for treating real balances in a fashion similar to consumer goods.

The purpose of this study is to employ a modified approach to modeling the use of money that takes advantage of the insights of the above two approaches. Instead of using real balances as a component of the utility function, this approach uses a utility function that depends on leisure and consumption of consumer goods. The primary role of real balances is to enable more efficient exchange and trade and in so doing to save costly resources. Those resources might include time and capital, which would be used to coordinate various transactions. To simplify exposition, the paper studies the case where the exchange is time intensive.[2] A possible way of capturing this notion is by assuming that leisure is a decreasing function of the velocity of circulation, that is, a function whose nature depends on the technology of exchange. The paper demonstrates the potential usefulness of this approach by employing it to analyze the determinations of exchange rate, current account, terms of trade and real interest rate. The model is developed in Section II; Section III analyzes prices and current account determinations, and Section IV closes the paper with concluding remarks.

II. The Model

Assume a two country world, where each country specializes in production of one good. To simplify exposition, the analysis concentrates on the case of two periods, where the case of n periods could be analyzed in a similar fashion without changing the main results. To facilitate the discussion, the analysis is conducted in terms of a representative consumer. Consumers share the same tastes. They might differ, however, in their endowment. A typical consumer in the home country lives two periods. His utility depends on consumption of goods X and Y, as well as on leisure:

$$U(X_0, Y_0, L_0) + \rho U(X_1, Y_1, L_1) \tag{1}$$

where X_i, Y_i, L_i are consumption of goods X, Y, and leisure in period i (i=0, 1) and ρ is the rate of time preference. A typical consumer in the home country is endowed in the beginning of period i with $\bar{X}_i$ units of good X, where good X is the home-produced good. At the beginning of period i, our consumer is also provided with $\bar{M}_i$ extra money balances, via a transfer mechanism. This mechanism is analogous to printing money, and is exogenously given. Within each period exchange occurs and allows the home consumers to trade the domestic product (X) with the foreign good (Y). The two goods are nonstorable, and the consumer can carry wealth from period 0 to 1 only by bonds (domestic and/or foreign) and money balances. Those bonds are issued in period 0, where debt repayment occurs in period 1. The exchange of goods is facilitated by the use of money or by time to coordinate transactions: the consumer can save on the use of real balances by spending more time on coordinating various transactions. This trade-off is assumed to be described by:

$$L_i = L(v_i) \qquad (i=0,1), \text{ where} \tag{2}$$

$$v_i = (X_i \cdot P_{x,i} + Y_i \cdot P_{y,i})/M_i \ ; \qquad \frac{\partial L}{\partial v_i} < 0 \ .$$

$P_{x,i}$ and $P_{y,i}$ are the prices of goods x and y in period i, and X_i and Y_i correspond to the consumption of the various goods by the consumer in period i. v_i is the value of the velocity of money in period i. It describes the intensity of the use of money (M) relative to expenditure. Eq. 2 states that higher intensity of using money balances enables one to save resources and reduce the time needed to co-ordinate various transactions.[3] During the analysis it is assumed that foreign exchange is not used in circulation. Our economy is characterized by consumers who are distributed in various locations, and face the problem of coordinating their transactions. The underlying structure of the economy is that of markets centralized only for financial transactions (bonds) and for the exchange of goods and bonds across borders. There is no centralized exchange of goods among consumers. Such an exchange is facilitated by shopping time and the use of money balances. Eq. 2 provides the reduced form for such a system. The asymmetry between financial transactions and the exchange of goods among consumers is reflected in the specification of the velocity of money, which is defined only for transactions that involve consumption. The approach described in the paper can also be adapted for the case where money is needed to coordinate bond transactions. The assumption that foreign exchange is not circulated can be relaxed, to allow for simultaneous demand for both currencies. One way to proceed is to consider a more symmetrical framework, in which foreign money is needed to facilitate transactions involving foreign goods.[4] Another asymmetry in the model is the assumption that a change in velocity affects leisure, the latter does not affect output. Those assumptions are made in order to simplify exposition. The appendix describes the case in which the level of production depends inversely on the amount of leisure. This allows us to analyze endogenous output fluctuations within an intertemporal open economy model.[5] It is shown that the determinants of the current account are also the determinants of the intertemporal allocation of leisure. The problem facing a typical home consumer is described by:

choose $\{X_i, Y_i, M_i\}_{i=0}^{1}$ to

$$\text{Max } U(X_0, Y_0, L(v_o)) + \rho U(X_1, Y_1, L(v_1)) \tag{3}$$

subject to:

$$P_{x,0} \cdot \bar{X}_0 + \bar{M}_0 = P_{x,0} \cdot X_0 + P_{y,o} \cdot Y_0 + B_0 + e_0 \cdot B_0^* + M_0 \tag{3a}$$

$$P_{x,1} \cdot \bar{X}_1 + \bar{M}_1 + M_0 + B_0(1+R) + e_1 \cdot B_0^*(1+R^*) = P_{x,1} \cdot X_1 + P_{y,1} \cdot Y_1 + M_1 \tag{3.b}$$

Eq. 3a and 3b provide the budget constraints for the first and the second period. e_i corresponds to the exchange rate in period i (price of foreign currency in terms of home currency), where B_0 and e_0. B_0^* are the purchases of domestic and foreign bonds in period 0 by our consumer. Negative values of B correspond to borrowing position. The initial endowment in period 0 $(P_{x,0} \cdot \bar{X}_0 + \bar{M}_0)$ is given by the market value of the endowment of the domestic good, plus the money balances $(\bar{M}_0)$ that are transferred to the consumer at the beginning of the period. This endowment is used to finance the consumption in period 0, the purchase of domestic and foreign bonds, and the hoarding of money (M_0) used to facilitate transactions. The initial money balances in the next period are given by $M_0 + \bar{M}_1$, where $\bar{M}_1$ is the exogenous transfer that has taken place at period 1.

Debt repayment takes place at the beginning of period 1, providing our consumer with $B_0\,(1+R) + B_0^*\,(1+R^*)\,e_1$, where R and R^* are the domestic and foreign interest rates.[6] The left-hand side in eq. 3b is the budget constraint in period 1, and it is composed of the initial money balances, the value of the bonds, and the market value of the endowment of the domestic good. This budget is used to finance consumption and the hoarding of money balances (M_1). It is assumed that transaction costs are nil, thus arbitrage ensures that:

$$e_o(1+R) = e_1(1+R^*) \tag{4}$$

Using this condition, eq. 3a and 3b could be integrated into a unique budget constraint facing our consumer:

$$P_{x,1} \cdot\bar{X}_1 + P_{x,o} \cdot\bar{X}_o(1+R) + \bar{M}_1 + \bar{M}_o(1+R) - M_o \cdot R - M_1 = \tag{5}$$

$$P_{x,1} \cdot X_1 + P_{y,1} \cdot Y_1 + (1+R)\,(P_{x,o} \cdot X_o + P_{y,o} \cdot Y_o)$$

The foreign country is populated by consumers whose tastes are identical to those of the home country's consumers, however they produce only good Y. Thus, the motivation for international trade comes from differences in production basket and from a potential difference in the intertemporal distribution of income across countries. The first gives rise to trade in goods, the second to trade in securities. The problem of a typical consumer in both the foreign country and the home country can be described symmetrically: Choose for the foreign country consumer

$$\{X_i^*, Y_i^*, M_i^*\}_{i=0}^{1} \qquad \text{to}$$

$$\text{Max } U(X_0^*, Y_0^*, L(v_0^*)) + \rho\, U(X_1^*, Y_1^*, L(v_1^*)) \tag{6}$$

Subject to

$$P_{y,1}^* \cdot \bar{Y}_1^* + P_{y,o}^* \cdot \bar{Y}_o^* (1+R^*) + \bar{M}_1^* + \bar{M}_o^* (1+R^*) - M_o^* . R^* - M_1^*$$

$$= P_{x,1}^* . X_1^* + P_{y,1}^* . Y_1^* + (1+R^*)(P_{x,o}^* . X_o^* + P_{y,o}^* . Y_o^*).$$

The notation here is symmetric to the home country case, taking into account the fact that the foreign consumer is endowed with good Y, and using $*$ to denote foreign values. The next section specializes this model, and provides a complete characterization of the equilibrium values of prices, consumption and saving paths.[7]

III. Prices and Current Account Determination

To gain further insight into the determinations of prices and current account, let us specialize the model by assuming the following log additively separable utility function:

$$
\begin{aligned}
&\ln\left[\frac{(X_0)^{1-\gamma}}{1-\gamma} + \frac{(Y_0)^{1-\gamma}}{1-\gamma}\right] + \delta\cdot\ln(L_0) \\
&+ \rho\left(\ln\left[\frac{(X_1)^{1-\gamma}}{1-\gamma} + \frac{(Y_1)^{1-\gamma}}{1-\gamma}\right] + \delta\cdot\ln(L_1)\right)
\end{aligned}
\qquad (7)
$$

where $\gamma < 1$, and ρ is the rate of time preferences.

The choice of the utility function is motivated by its ability to provide an interesting and traceable explanation for current account and money market behavior.[8]

The problem facing each consumer is to maximize utility subject to the given technology of exchange ($L(v)$). The result of this process enables us, using world budget constraints, to determine all prices and the current account.

The next step is to solve the consumer problem (eq. 3 and 6) for the utility function given by eq. 7. It is clear that the solution for our consumer of this problem depends on the realized values of variables specific to him (like $\bar{X}_i$, $\bar{M}_i$). To gain further insight, let us present the solution as a function of aggregate values. This is done by aggregating the first order conditions across all the consumers of each country. Due to the nature of our framework, the only effect of this aggregation is that the sum of M_i across all the consumers can be identified with the supply of money in period i, which is given by $\bar{M}_o$ and $\bar{M}_o + \bar{M}_1$ in period zero and one, respectively. From this point on, all variables stand for the aggregate consumers in each country. To simplify, let us use the following notation:

$Q_i = P_{y,i}/P_{x,i}$ = the terms of trade in period i.

$I_i = X_i \cdot P_{x,i} + Y_i \cdot P_{y,i}$ = money expenditure in period i (in the home country).

$$\frac{\bar{M}_o + \bar{M}_1}{\bar{M}_o} = \mu = \text{ the ratio of money supply in the two periods.}$$

$W_1 = P_{x,1} \cdot \bar{X}_1 + P_{x,o} \cdot \bar{X}_o (1+R)$ = the net present value of the home country output (in terms of period 1). Similar notation applies for the foreign country. Notice that the aggregation across all the consumers yields that:

$$W_1 = I_o(1+R) + I_1 \; . \tag{8}$$

Thus, W_1 corresponds to the wealth of the home country, defined in money terms prevailing in the second period. Using this notation, the first order conditions for each country provide us with the following information:

$$\text{(a)} \quad \frac{I_o}{\bar{M}_o} = \frac{1-\gamma-\beta_o}{\beta_o} \cdot \frac{R}{1+R} \; ; \quad \frac{I_o^*}{\bar{M}_o^*} = \frac{1-\gamma-\beta_o^*}{\beta_o^*} \cdot \frac{R^*}{1+R^*} \tag{9}$$

$$\text{(b)} \quad \frac{I_1}{\bar{M}_o+\bar{M}_1} = \frac{1-\gamma-\beta_1}{\beta_1} \; ; \quad \frac{I_1^*}{\bar{M}_o^* + \bar{M}_1^*} = \frac{1-\gamma-\beta_1^*}{\beta_1^*}$$

$$\text{(c)} \quad \frac{\mu \cdot \beta_o}{\beta_1} = \rho R \; ; \quad \frac{\mu^* \cdot \beta_o^*}{\beta_1^*} = \rho \cdot R^*$$

(d) $Y_i = I_i/[P_{y,i}(Q_i^{(1/\gamma)-1} + 1)]$; $Y_i^* = I_i^*/[P_{y,i}^*(Q_i^{(1/\gamma)-1} + 1)]$

(e) $X_i = I_i/[P_{x,i}(Q_i^{1-(1/\gamma)} + 1)]$; $X_i^* = I_i^*/[P_{x,i}^*(Q_i^{1-(1/\gamma)} + 1)]$

(f) $\frac{I_1}{I_o} = \rho(1+R)q$; $\frac{I_1^*}{I_o^*} = \rho(1+R^*)\ q^*$

(g) $I_1 = \frac{W_1}{(1/\rho q) + 1}$; $I_1^* = \frac{W_1^*}{(1/\rho q^*) + 1}$ for $W_1^* = P_{y,1}^* \cdot \bar{Y}_1^* + P_{y,o}^* \cdot \bar{Y}_o^*(1+R^*)$;

where $\beta_i = \delta \cdot \eta_{L_i,v_i}$, $\eta_{L,v_i} = \left|\frac{dL_i}{dv_i} \cdot \frac{v_i}{L_i}\right|$, and

$q = (1-\gamma-\beta_1)/(1-\gamma-\beta_o)$, similar notation applies for the foreign country.

Eq. 9a describes the velocity of money in period o. It depends on three considerations: the interest rate, the technology of exchange and the relative importance of leisure versus consumption in the utility function. The higher the interest rate the higher the opportunity cost of money, motivating the substitution of real balances with time. The greater the technological substitutability between time and real balances (β_i) , the greater the use of real balance and the lower the velocity. The greater the importance of leisure relative to consumption ($\frac{\delta}{1-\gamma}$) , the smaller the velocity, because it increases the weight that the consumer gives to the gain in time induced by higher real balances.[9] Eq. 9c describes the equilibrium money interest rate. It corresponds positively to the rate of printing money (μ), and negatively to the rate of time preference. Eq. 9 d-e give the demand for the goods, and eq. 9 f-g describe the dependence of nominal expenditure on the time preference rate, the interest rate, and wealth. Notice that condition 9a implies that to avoid a corner solution the substitutability between time and real balances (β_i) should be less than $1-\gamma$. During the course of the analysis we assume a non-corner solution. Notice that the terms β and q depend on the elasticity of leisure with respect to the velocity of money. To simplify exposition, we take the case in which those elasticities are assumed to be time-invariant and equal for both countries. Thus $\beta_o = \beta_1 = \beta$, $\beta_o^* = \beta_1^* = \beta$, and $q = q^* = 1$.[10] The contemporary world supply constraint implies that,

$$\bar{X}_i = X_i + X_i^* \; ; \; \bar{Y}_i^* = Y_i + Y_i^* \quad \text{for } i=o,1. \tag{10}$$

These constraints, together with the equilibrium conditions (9) and the law of one price yield the solution for relative prices (terms of trade):

$$\left(\frac{\bar{Y}_i^*}{\bar{X}_i}\right)^{-\gamma} = Q_i \qquad i=o,1 \tag{11}$$

Let us denote by ℓ_i the relative world supply of the two goods in period i, $(\bar{Y}_i^*/\bar{X}_i)$. Using the demand for good X (9e), and the solution to the relative prices (11) we get:

$$\bar{X}_i \cdot P_{x,i} \, [\ell_i^{1-\gamma} + 1] = I_i^* \cdot e_i + I_i \qquad i=o,1. \tag{12}$$

Taking the ratio of the two equations in 12, using Eq. 9 f-g gives the solution for the evolution of absolute prices over time:

$$\frac{P_{x,1}}{P_{x,o}} = \frac{\bar{X}_o}{\bar{X}_1}(\rho + \mu) \, . \, S, \qquad \text{where } S = \frac{\ell_o^{1-\gamma} + 1}{\ell_1^{1-\gamma} + 1} \tag{13}$$

In the same way we get

$$\frac{P^*_{y,1}}{P^*_{y,o}} = \frac{\bar{Y}^*_o}{\bar{Y}^*_1} \cdot (\rho + \mu^*)\, S^*; \text{ where } S^* = \frac{\ell_o^{\gamma-1} + 1}{\ell_1^{\gamma-1} + 1} \qquad (13')$$

The evolution of the price of X over time depends upon the relative supply of X$\left(\frac{\bar{X}_o}{\bar{X}_1}\right)$, the rate of time preference (ρ) and printing money (μ), and a measure of the relative intertemporal distribution of output across countries (S). To understand the role of S, suppose that we start with S=1, which implies that $\frac{\bar{X}_o}{\bar{X}_1} = \frac{\bar{Y}^*_o}{\bar{Y}^*_1}$, or that the relative distribution of output across time is the same for both countries. Suppose now that S goes up, holding $\frac{\bar{X}_o}{\bar{X}_1}$ given. This occurs if there is transitory output shock in the foreign country in period $0(d\bar{Y}^*_o > 0)$. In such a case the world output distribution becomes more biased to the present (in relative terms), making future consumption more scarce and causing an increase in the relative intertemporal price of X and Y $\left(\frac{P_{x,1}}{P_{x,o}}, \frac{P_{y,1}}{P_{y,o}}\right)$ 11.

Using equilibrium condition 9, we can derive from eq. 13 that:

$$W_1 = \bar{X}_o \cdot P_{x,o} \cdot (1+R) \cdot (1+\rho S)$$

$$P_{x,o} = \frac{\bar{M}_o}{(\rho/\mu)+1} \cdot \frac{(1+\rho) \cdot (1-\gamma-\beta)/\beta}{(1+\rho S) \cdot \bar{X}_o} ; \quad P^*_{y,o} = \frac{\bar{M}^*_o}{(\rho/\mu^*)+1} \frac{(1+\rho)(1-\gamma-\beta)/\beta}{(1+\rho S^*)\, \bar{Y}^*_o} \qquad (14)$$

$$P_{x,1} = \mu\bar{M}_o \cdot \frac{S(1+\rho)(1-\gamma-\beta)/\beta}{(1+\rho S) \cdot \bar{X}_1} ; \quad P^*_{y,1} = \mu^*\bar{M}^*_o \cdot \frac{S^*(1+\rho)(1-\gamma-\beta)/\beta}{(1+\rho S^*) \cdot \bar{Y}^*_1}$$

The price of X depends upon monetary considerations (summarized by the first term) as well as real factors (summarized by the second term). Notice that higher initial money supply $(\bar{M}_o)$ increases prices in both periods at the same rate (for a given μ). A higher rate of printing money in period 1 (higher μ) is going to increase prices in both periods. The reason is that higher μ is associated with higher cost of using money balances in period o, resulting in lower demand for real balances. For given initial nominal balances (M_o), prices should go up to equate the demand to the supply of real balances. The actual increase in nominal balances in period 1 is responsible for higher prices in that period. Higher output tends to reduce money prices because it implies higher demand for real balances (higher output increases wealth, inducing higher consumption and higher demand for real balances due to more transactions). This analysis could be conducted using the wealth of each nation as the explanatory variable, where wealth itself is endogenously determined by the output stream. Combining eq. 11 and 14 gives us that:

$$P^*_{x,o} = \frac{M^*_o}{((\rho/\mu^*)+1)} \cdot \frac{(1+\rho)(1-\gamma-\beta)/\beta}{(1+\rho S^*)\cdot\bar{Y}^*_o} \cdot \left(\frac{\bar{Y}^*_o}{\bar{X}_o}\right)^{\gamma} \tag{15}$$

and

$$e_o = \frac{P_{x,o}}{P^*_{x,o}} = \frac{\bar{M}_o((\rho/\mu^*)+1)}{\bar{M}^*_o\,((\rho/\mu)+1)} \cdot \left(\frac{\bar{Y}^*_o}{\bar{X}_o}\right)^{1-\gamma} \cdot \frac{1+\rho S^*}{1+\rho S}\,, \tag{16}$$

which, after some manipulations, gives:

$$e_o = \frac{\bar{M}_o((\rho/\mu^*)+1)}{\bar{M}^*_o((\rho/\mu)+1)} \cdot \left[\theta_o\left(\frac{\bar{Y}^*_o}{\bar{X}_o}\right)^{1-\gamma} + \theta_1\left(\frac{\bar{Y}^*_1}{\bar{X}_1}\right)^{1-\gamma}\right], \text{ where} \tag{16'}$$

$$\theta_o + \theta_1 = 1, \qquad \theta_o = \frac{1}{1+\rho S}$$

Thus, the exchange rate depends upon monetary considerations, summarized by the first component, and real considerations, summarized by the second component. An increase in the relative home/foreign money supply $(\bar{M}_o/\bar{M}_o^*)$ induces a depreciation at the same rate. Increase in the rate of future growth of the money supply anticipated today (μ) results in a current depreciation. The above results emphasize the dependence of current prices on expectations of future policies, a point that is highlighted by the various assets approaches to exchange rate determination. Although the above results are derived from a detailed structure of the model under discussion in this paper, they can also be derived from a variety of models of exchange rate determination that are likely to share a similar reduced form.[12] A possible channel by which anticipation of future policies could affect current exchange rate can be described in the following way: an increase in the rate of future growth of the money supply, anticipated today, induces a higher domestic interest rate and a lower demand for real balances. For given nominal balances it induces current depreciation and higher domestic prices. In a similar way, an increase in present or future output (anticipated today) induces appreciation.

Notice that for a given rate of future money supply growth (μ), higher M_o is equivalent to a "permanent" increase in money supply. To study the effects of a "transitory" increase in the money supply we should impose the condition that $d\bar{M}_o > 0$ comes with $d(\bar{M}_o \cdot \mu) = 0$, implying that the transitory increase comes with a lower interest rate. The first effect $(d\bar{M}_o > 0)$ induces current depreciation; the second effect $(d\mu < 0)$ implies current appreciation. With the help of eq. 16 we see that for the case studied in this paper the net effect of a transitory increase in the money supply is a lower interest rate and depreciation. Recall that the effect of a higher rate of future increase in the money supply (μ) implies a higher interest rate and depreciation. Thus, we can conclude that the sign of the correlation between movements of interest rates and exchange rates is ambiguous, depending on the nature and the permanence of the monetary shocks.

An alternative presentation of the exchange rate can highlight the role of wealth in exchange rate determination. Defining real wealth by

$w_o = \bar{X}_o + \frac{\bar{X}_1 \cdot P_{x,1}}{(1+R)P_{x,o}}$ $\quad w_o^* = \bar{Y}_o^* + \frac{\bar{Y}_1^* \cdot P_{y,1}^*}{(1+R^*)P_{y,o}^*}$ enables us to present the exchange rate by [13]

$$e_o = \frac{M_o((\rho/\mu^*)+1)}{\bar{M}_o^*((\rho/\mu)+1)} \cdot \frac{w_o^*}{w_o} \cdot \ell_o^{-\gamma} \tag{16"}$$

An increase in real wealth in the home country induces appreciation. Higher real wealth is associated with higher consumption and more transactions. This implies higher demand for domestic real balances, inducing appreciation. This result conforms with the predictions of the asset approach presented by Branson et al., Kouri, and other writers.

The current account in period o corresponds to the excess of current income over the current absorption. Using the previous results we get that the real current account surplus (in terms of output price) is given by:

$$CU_o = \frac{P_{x,o} \cdot \bar{X}_o - I_o}{P_{x,o}} = \frac{\bar{X}_o \cdot \rho \cdot (1-S)}{1+\rho} \tag{17}$$

$$CU_o^* = \frac{P_{y,o}^* \cdot \bar{Y}_o^* - I_o^*}{P_{y,o}^*} = \frac{\bar{Y}_o^* \cdot \rho \cdot (1-S^*)}{1+\rho}$$

and that

$$\text{sign } CU_o = \text{sign } \left[\frac{\bar{X}_o}{\bar{X}_1} - \frac{\bar{Y}^*_o}{\bar{Y}^*_1}\right]$$

The current account behavior depends on the relative intertemporal distribution of output (and income) across countries.[14] If the relative distribution of output is the same in both countries $\left[\frac{\bar{X}_o}{\bar{X}_1} = \frac{\bar{Y}^*_o}{\bar{Y}^*_1}\right]$, the current account is 0. $\frac{\bar{X}_o}{\bar{X}_1} > \frac{\bar{Y}^*_o}{\bar{Y}^*_1}$ implies that the home country's output (and income) is more biased to the present relative to the foreign country. In such a case, the current account is the channel which enables intertemporal shifting of resources across countries in order to provide a more desirable distribution of consumption. A current account surplus in period 0 enables the home country to shift resources to the future, that is, to the less favorable period (in relative terms). Notice that starting with a balanced current account, a "permanent" increase in output ($\bar{X}_o$ and $\bar{X}_1$ going up at the same rate) has no effect, whereas a transitory output shock (increase only in $\bar{X}_o$ or in $\bar{X}_1$), will induce a shift in resources via the current account (and the world capital market) to the less favorable period (in relative terms).[15]

Using eq. 16", we can conclude that output expansion (in the present or the future) implies appreciation in both periods due to higher real wealth. This appreciation, however, is associated with current account surplus in period o only to the extent that the output expansion is biased to the present. This result diverges from the predictions of the framework used by Branson et al., which assumed that an increase in wealth should be accompanied by present accumulation of foreign assets.

Notice that real shocks might result in correlated changes between exchange rate, current account and terms of trade.[16] This result is in agreement with Mussa and Stockman's findings. The nature of this correlation depends, however, on the timing, location, and permanency of these shocks. Moreover, there is no clear-cut sign for these correlations. For example, present domestic output expansion induces negative correlation between the present exchange rate and current account (current account surplus + appreciation); whereas future domestic output expansion (anticipated today) results in positive correlation today (current account deficit + appreciation). In the first case we get appreciation and deterioration in the terms of trade, while in the second case the appreciation comes with no change in the terms of trade.

A two-country model also enables us to analyze the determinations of real interest rates and how they affect the current account. Define the real interst rate in terms of good $Z(Z = X,Y)$ by

$$1 + r_z = \frac{1+R}{P_{z,1}/P_{z,o}} \tag{18}$$

From eq. 13 we derive that

$$\frac{\bar{X}_1}{\bar{X}_o \cdot \rho \cdot S} = 1+r_x \tag{19}$$

$$\frac{\bar{Y}^*_1}{\bar{Y}^*_o \cdot \rho \cdot S^*} = 1+r_y$$

$$\frac{1+r_x}{1+r_y} = \left(\frac{\bar{Y}^*_o \,/\, \bar{Y}^*_1}{\bar{X}_o/\bar{X}_1}\right)^{\gamma} \tag{20}$$

Most of the previous discussion can be stated in terms of real interest rates. For example, consumption in period 0 can be rewritten as:

$$\frac{I_o}{P_{x,o}} = \frac{1}{1+\rho} [\frac{\bar{X}_1}{1+r_x} + \bar{X}_o] \tag{21}$$

Since consumption at time zero corresponds to a fraction $1/(1+\rho)$ of real wealth, defined by the term in the bracket, it will adjust to transitory income to the degree that transitory income affects wealth (and permanent income). This outcome is the familiar proposition of the permanent income hypothesis. The role of the current account is to bridge the gap between current income and consumption. It can be presented by

$$CU_o = \frac{\bar{X}_o \cdot \rho}{1+\rho} [1 - \frac{\bar{X}_1}{\bar{X}_o \cdot \rho(1+r_x)}] \tag{22}$$

The real interest rates are set by the market such as to meet a current account surplus in one country with an equal deficit in the other country. Notice that

$$\text{sign } CU_o = \text{sign } [\rho(1+r_x) - \frac{\bar{X}_1}{\bar{X}_o}]: \tag{23}$$

$\rho(1+r_x)$ represents the present value of the real return in terms of the domestic good, discounted by the subjective rate of time preference. If the discounted real return exceeds the growth rate of output $(\frac{\bar{X}_1}{\bar{X}_o})$, a current account surplus emerges. The higher the descrepancy between the two, the greater the real saving in period 0 in the home country.

Consider the case where the home country experiences a transitory rise in its current output $(d\bar{X}_o > 0)$. At a given real interest rate this rise results in an increase in consumption in the home country that falls short of the increase in output, resulting in increased saving at home. This outcome will depress both real rates of return $(\frac{d\bar{X}_o S}{d\bar{X}_o} > 0 , \frac{dS^*}{d\bar{X}_o} > 0$ in eq. 19). As can be seen from eq. 20 the effect of the shock is stronger in the market in which it occurs $(dr_x < dr_y < 0)$. The relative real returns $\frac{1+r_x}{1+r_y}$ depend on the relative intertemporal distribution of the output of the two goods $(\frac{\bar{Y}^*_o / \bar{Y}^*_1}{\bar{X}_o/\bar{X}_1})$. $d\bar{X}_o > 0$ causes X to be scarcer relative to y in the future resulting in a higher expected price inflation in terms of X, which in turn tends to depress r_x. The same argument works in the opposite direction for Y, mitigating the reduction in r_y that is induced by $d\bar{X}_o > 0$. As can be seen from eq. 22, the increase in saving at home results in an increase in the current account surplus of the home country. This is because the direct income effect of $d\bar{X}_o > 0$ dominates the substitution effect of lower r_x. The first effect favors increase in net savings; the second favors lower savings. For the foreign country, the output stays the same and, therefore, the substitution effect has the dominant influence resulting in a higher dissaving. Thus, the adjustment of real interest rates ensures that the current account improvement in the home country is matched by an equal deterioration of the current account in the foreign country.

IV. Concluding Remarks

The above analysis constructed a two-period, two-country model that derives the current account, the exchange rate, the terms of trade, and real interst rates from optimal behavior principles. The model uses money mainly as a means of exchange, where the technology of exchange is flexible due to potential substitutability of time and real balances as means of coordinating transactions. This framework is helpful in deriving the reduced forms of prices and current account which result from the optimizing behavior of economic agents in each economy.

The analysis demonstrates that a useful way of understanding the current account is by concentrating on net saving decisions. The current account function is to enable more desirable intertemporal allocation of resources across countries. Thus, it depends on the (relative) difference of the intertemporal distribution of output and income across countries. The effect of various real shocks on the current account depends on the timing and permanence of these shocks. The study of the exchange rate determinations demonstrates that a useful way of analyzing the exchange rate is by considering the effects of various policies on the excess demand for money in each country. The results of this analysis are in agreement with the monetary approach.

The nature of general equilibrium analysis enables us to specify the exchange rate also as a function of wealth, in a way that is consistent with the contributions of Branson and others. Studying the interaction between prices and current account emphasizes that real shocks might induce a correlated change in the exchange rate, current account, and terms of trade. The nature of this correlation depends, however, on the timing, permanency, and geographical origin of those shocks. The above discussion results in a framework that integrates elements of net saving theories and the monetary approach into a unified structure in which the different approaches are complementary viewpoints.

APPENDIX

The purpose of this appendix is to generalize the paper's framework in two dimensions. First, we consider the case of endogenous labor supply determinations. This will allow us to trace the interaction between financial considerations and the production decision in the context of an open economy. Next, the last section of the appendix presents the general case to which the main results derived in the paper apply.

Let us make two assumptions: first let us take the case of a small country and second, let us assume the country has a Ricardian production technology. Both assumptions are made in order to allow of a simple reduced from solution. The approach considered can, however, be extended to the case of a large country with diminishing marginal productivity technology. Suppose that the small country specializes in producing X, with an output given by:

$$\bar{X}_t = a_t \cdot L_{x,t} (t = 0,1); \qquad \text{(A1)}$$

where a_t summarizes the input-output coefficient at time t. The time spent on exchange activities at time t is given by:

$$f(v_t) \ , \ f' > 0 \ . \qquad \text{(A2)}$$

Thus, leisure is given by

$$L_t = \bar{L} - f(v_t) - \frac{\bar{X}_t}{a_t} \ . \qquad \text{(A3)}$$

The problem facing our consumer is to choose $\{X_i \ , \ Y_i \ , \ M_i \ , \ \bar{X}_i\}_{i=o}^{1}$ in such a way as to maximize his utility function subject to the budget constraint given by eq. 3 , where leisure is given by A3. Let us assume that the utility function is the same as that used in the paper. Thus, the problem facing our consumer differs from the one analyzed in the paper in two dimensions: First, the endowment is solved endogenously, due to the trade-off between output and leisure. Next, the leisure is now a function of both the velocity and the output level. Thus, eq. A3 replaces eq. 2. The first order conditions for the small country provide us with the information summarized by eq. 9 (applied only for the home country). The endogenous choice of $\bar{X}_o$, $\bar{X}_1$ gives us two extra conditions:

$$\frac{L_1}{L_o} = \frac{(1+r_x)\ \rho}{1+\hat{a}}\ , \text{ where } \hat{a} = (a_1 - a_o)/a_o \tag{A4}$$

$$\frac{L_{x,o}}{L_o} + \frac{L_{x,1}}{L_1} = \eta \cdot \chi\ (1+\rho) \tag{A5}$$

where $\chi = \frac{1-\gamma-\delta\eta}{\delta\eta}$ and η is the leisure-velocity elasticity. As in the paper, we assume for notational simplicity that η is time invariant.

Notice that interest rate parity and the law of one price imply that:

$$1 + r_x = \frac{1+R^*}{1+\pi_x^*} = 1 + r_x^* \tag{A6}$$

$$\text{where } \pi_x^* = (P_{x,1}^*/P_{x,o}^*) - 1. \tag{A7}$$

Thus, the small country is faced with exogenously given rates of return in terms of each good. From A6 and eq. 9 we get:

$$1 + \pi_x = \frac{\mu + \rho}{(1+r_x)\rho}\ . \tag{A8}$$

Inflation, as measured in output terms, goes up with the rate of monetary expansion. Eq. A8 implies also the existence of a negative correlation between inflation and real interest rates (all in terms of a given good). This reflects the fact that the money interest rate (R) depends only on μ and ρ.

$\hat{a}$ in eq. A4 corresponds to the rate of technology improvement. This equation states that if the discounted real interest rate (in product terms) exceeds the rate of technology improvement, we will favor future leisure (L_1) over the leisure in period zero (L_o). Comparing eq. A4 to eq. 22 reveals that the determinants of intertemporal distribution of leisure are also the determinants of the current account in the previous framework (notice that the intertemporal technology ratio (a_1/a_o) replaces the intertemporal output ratio $(\bar{X}_1/\bar{X}_o)$). That is because both the current account and the intertemporal leisure decisions serve the same end:intertemporal re-distribution of utility. From eq. (A4) - (A5) we get the reduced form solution for the supply of labor:

$$L_{x,o} = \frac{[\bar{L} - f(v_o)][\eta\chi(1+\rho)+1] - [\bar{L} - f(v_1)] \cdot \frac{1+\hat{a}}{\rho(1+r_x)}}{2 + \eta\chi(1+\rho)} \tag{A9}$$

$$L_{x,1} = \frac{[\bar{L} - f(v_1)][\eta\chi(1+\rho)+1] - [\bar{L} - f(v_o)] \cdot \frac{\rho(1+r_x)}{1+\hat{a}}}{2 + \eta\chi(1+\rho)} .$$

Using the solution for the velocity (eq. 9a, b), we can represent the reduced form solution by:

$$L_{x,o} = L_{x,o}[\overset{-}{\mu}, \overset{-}{a_1/a_o}, \overset{+}{r_x}] \tag{A11}$$

$$L_{x,1} = L_{x,1}[\overset{+}{\mu}, \overset{+}{a_1/a_o}, \overset{-}{r_x}] \tag{A12}$$

and relative output, denoted by S', as:

$$S' = \frac{\bar{X}_1}{\bar{X}_o} = S'(\overset{+}{\mu}, \overset{+}{a_1/a_o}, \overset{-}{r_x}) . \tag{A13}$$

A higher real interest rate (in output terms), a lower rate of technology improvement, and lower inflation anticipated in period zero favor inter-temporal substitution towards increasing future leisure and current work. The rate of inflation affects $L_{x,i}$ via its leisure - velocity trade-off effect. A higher inflation anticipated today for one period[17] will reduce current output, increasing future output. Using eq. A9, A10 we get that

$$\frac{\partial w_o}{\partial \mu} < 0 \qquad \text{(where } w_o = \bar{X}_o + \frac{\bar{X}_1}{1+r_x}\text{).} \tag{A14}$$

Finally, using the previous results we get:

$$CU_o = \frac{\bar{X}_o \cdot \rho}{1+\rho}[1 - \frac{S'}{\rho(1+r_x)}] \tag{A15}$$

$$P_{x,o} = M_o \cdot \chi \cdot \frac{\mu}{\rho+\mu}(\frac{1+\rho}{w_o}) \tag{A16}$$

$$e_o = \frac{M_o}{P^*_{x,o}} \cdot \chi \cdot \frac{\mu}{\rho+\mu} \cdot (\frac{1+\rho}{w_o}) . \tag{A17}$$

The underlying forces shaping the current account and prices are similar to the ones shaping them in the paper. The new aspect of endogenous production decisions is in allowing us to trace the allocative effects of inflation on the supply of output. Inspection of eq. A15 reveals that a higher inflation (due to $d\mu > 0$) anticipated today will deteriorate the current account, because of the intertemporal re-distribution of output. A higher anticipated inflation will cause a depreciation and a current price increase because of both interest rate and wealth effects. The resultant higher money interest rate will create a drop in the demand for money, causing depreciation and a current price increase. This adjustment is further strengthened by the drop in real wealth, $(dw_o/d\mu < 0)$, which further reduces the demand for real money balances.

The case studied in the paper corresponds to a specific utility function. The purpose of this section is to present the general case to which the main results derived in the paper apply. This is the case where the nominal expenditure in each period depends only on nominal wealth, money interest rate, and the time preference rate. The demand for money is described by a functional dependence of the velocity on the interest rate. The composition of expenditure on different goods in each period depends only on the prices of the different goods in the given period.

Using the notation of the paper, such a system is described by:

$$I_o = \frac{W_1 \cdot \alpha}{1+R}, \qquad I_1 = W_1(1-\alpha) \tag{A18}$$

$$\frac{M_o}{I_o} = f(R); \quad \frac{M_1}{I_1} = f_o \tag{A19}$$

$$X_1 = \frac{I_i}{P_{x,i}} \cdot g(Q_i); \; Y_i = \frac{I_i}{P_{y,i}}(1-g(Q_i)) \tag{A20}$$

The foreign country has the same demand structure. The endowment of the home country is $(\bar{X}_o, \bar{X}_1)$, whereas of the foreign country $(\bar{Y}^*_o, \bar{Y}^*_1)$.

A special case of such a system is the one analyzed in the paper. Using the notation $\ell_i = \bar{Y}^*_i/\bar{X}_i$, $Q_i = P_{y,i}/P_{x,i}$ we get that in such an economy

$$Q_i = Q(\ell_i), \text{ where } |\eta_{Q,\ell}| < 1. \tag{A21}$$

Using the procedure employed in the paper we get that:

$$CU_o = \bar{X}_o(1-\alpha)(1-S) \tag{A22}$$

$$e_o = \frac{M_o}{M^*_o} \frac{f(R^*)}{f(R)} \cdot \ell_o \cdot Q(\ell_o) \cdot \frac{1+\alpha' \cdot S^*}{1+\alpha' \cdot S} \tag{A23}$$

where $S = g(Q(\ell_1))/g(Q(\ell_o))$,

$S^* = [1-g(Q(\ell_1))]/[1-g(Q(\ell_o))]$, $\alpha' = \frac{1-\alpha}{\alpha}$.

With the help of eq. A21 - A23, it can be shown that the main results of the paper hold for this system as well.

Footnotes

1. This list is far from being exhaustive. Among several other approaches we find the overlapping generation approach and transaction demand.

2. For a related study see Dornbusch and Frenkel. They model the exchange activity to highlight the issue of inflation and growth, where the exchange of goods is facilitated by money balances, labors and capital.

3. This approach can be viewed as an example of modeling the use of money as a means of saving transaction costs, where those costs are time spent in coordinating transactions. For a related study see Karni. A crude example of a system that will result in a functional form described in eq. 2 is the case where each consumer is facing a uniform flow of receipts, which are accumulated in his bank account. Let us assume that he also faces a uniform flow of expenditure, which can be financed only by cash balances. If each bank transaction consumes C_F time, he will spend at least $C_F \cdot v$ time (per period) in coordinating transactions.

4. This strategy is used by Helpman and Razin for the case of a rigid velocity. For a discussion of currency substitution in a Sidrauski type model see Liviatan (1981). For simplicity of exposition the current paper proceeds by neglecting the possibility of currency substitution. Thus, the exchange rate is set indirectly according to implicit goods arbitrage conditions. Extending the framework for the case of currency substitution will modify the analysis in two ways. First, the velocity of each currency will depend also on contemporaneous relative prices of goods, whereas in our case the velocity of money will be shown to be

independent of them. Next, under currency substitution the relative demand for each good at a given period will depend also on the velocity of the various monies, whereas in our case the relative demand for the goods will depend only on the goods' relative price.

5. The current paper's framework can be extended to allow also for investment and for a production process that uses other inputs (like oil and capital). Such an extension will cause the production path, prices, and the current account to depend also on the price path of those inputs. For an analysis of those topics in the context of a real model see Sach. On the output effects of money, introduced through changes in leisure, see Claassen.

6. The assumption of no initial indebtedness in period 0 could be generalized without changing the main results.

7. The assumption of identical rates of time preference for both countries can be relaxed, allowing the current account ot depend also on differences in taste. This was done in the context of rigid velocity by Helpman and Razin.

8. Analysis of a two-period current account behavior in a real model of a small economy based upon additively separable utility can be found in Sachs. Another related study is Helpman and Razin. They use a Cobb Douglas version of the utility function in a Clower type model. The approach adapted in this paper could be applied for their analysis as well. The utility function in eq. 7 is preferred because it provides a more interesting theory of the current account than the Cobb Douglas case.

9. Notice that because the analysis is conducted in two periods there is no "future" in period 1. Thus, the velocity in period 1 (eq. 9) lacks a measure of future inflation. It could be shown that in a model with n periods, $n \geq 2$, in period $k(k < n)$ exists $I_k/M_k = \frac{1-\gamma-\beta}{\beta} \cdot \frac{R_k}{1+R_k}$ and $\frac{M_{k+1}}{M_k} = \frac{R_k}{R_{k+1}}(1+R_{k+1})$. Thus 9a represents the more general expression for the velocity (for $k < n$). The main results of the paper could be generalized for the case of $n \geq 2$ periods.

10. The main results of the current paper are not affected by this assumption. The condition needed to generate the paper's results can be expressed as:

$$0 < \rho \cdot \eta_{L_1,v_1} + \mu \cdot \eta_{L_o,v_o} + \frac{\partial \eta_{L_o,v_o}}{\partial v_o} \cdot \mu(v_o - 1)$$

This condition ensures that $\frac{\partial v_o}{\partial \mu} > 0$.

11. Notice that this exercise does not change the interest rate, which depends only on the time preference rate and monetary considerations. Another way to increase S (for given $\frac{\bar{X}_o}{\bar{X}_1}$) is by $d\bar{Y}_1^* < 0$ (for a given $\bar{Y}_o^*$). The above analysis applies for this case as well.

12. For further discussion of these points, and detailed references, see Frenkel (1981). For discussions of related reduced form see Bilson, Dornbusch (1978), Mussa, Sachs, and the studies in Frenkel and Johnson.

13. Notice that $w_o = \frac{W_1}{(1+R)\, P_{x,o}}$, $w_o^* = \frac{W_1^*}{(1+R^*)P_{y,o}^*}$. Using previous results, $w_o = \bar{X}_o(1+\rho S)$ and $w_o^* = \bar{Y}_o^* (1+\rho S^*)$.

14. Notice that the assumption of price flexibility implies that the real current account is free from monetary considerations. Equivalent definition of the current account is as the net export of goods and services plus transfers and net factor payments from abroad. Our assumption of no initial indebtness implies that net interest payments in period zero are nil.

15. This result is in accord with Sachs and the predictions of the permanent income and life cycle hypothesis.

16. The above results and the model presented in this paper should be viewed as intermediate-run. This is the run over which prices are flexible and aggregate demand effects on output may be ignored. In the short run, price inflexibility and demand effects on output can induce a different structure of correlations between prices and current account. The analysis of the current account behavior is in accord with Svensson and Razin's contribution, which provides a general analysis of the Laursen Metzler effect in a real model.

17. In the context of n periods, $n \geq 2$, $d\,\mu > 0$ is equivalent to an increase in the rate of monetary expansion for one period.

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