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TRADE IN NOMINAL ASSETS: MONETARY POLICY, AND PRICE LEVEL AND EXCHANGE RATE RISK

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ABSTRACT

In a previous paper, "Trade in Risky Assets," I have analyzed the pattern of international trade in risky real assets between barter economies, relying on the Law of Comparative Advantage and using autarky asset price differences to predict the pattern of asset trade. In this paper the analysis is extended to international trade in nominal assets (assets with returns paid in currencies) between monetary economies. The risk characteristics of real returns on nominal assets depend on price level and exchange rate risk, and therefore on monetary policy. It is examined how different combinations of monetary policies and exchange rate regimes affect nominal assets' return risk characteristics, their autarky prices, and hence their trade pattern, when countries differ with respect to their outputs or their attitudes towards risk. When when world asset markets are incomplete, different monetary policies and exchange rate regimes have dramatic effects on risk characteristics of home and foreign currency bonds and on the trade pattern in these assets, as well as on aggregate capital and current accounts.

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I. Introduction

In practice all internationally traded assets are risky. That is, their real returns are risky and depend, among other things, on risk characteristics of price levels, exchange rates and terms of trade. With increased liberalization and integration of international capital markets, the importance of international trade in risky assets can hardly be disputed. There has been considerable work on the determinants of aggregate capital movements, for instance in the literature that regards capital movements as intertemporal trade.[1] However, there seems to be relatively little research done on the determinants of the disaggregate pattern of trade in distinct risky assets, definitely much less than on the determinants of the pattern of trade in goods.

A previous paper of mine, Svensson (1987), discusses the trade pattern in risky assets between barter economies, by combining the general Law of Comparative Advantage from the literature on international trade in goods with the literature on international asset pricing.[2] As developed by Deardorff (1980) and Dixit and Norman (1980) for trade in goods, the Law of Comparative Advantage states that there is a correlation between autarky price differences and the trade pattern such that a country tends to import goods for which the country's autarky price is high relative to the world market price, or relative to autarky prices in the rest of the world. When adapted to asset trade, the law states that there is a tendency for a country to import assets for which the autarky price is relatively high. Differences in countries'

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1 See Persson and Stockman (1987) for a presentation of this approach.

2 See Svensson (1987) for references to the relevant literature on international asset pricing, and for references to the existing (but relatively small) literature on the trade pattern in risky assets in barter economies.

autarky prices depend on underlying differences between countries. Svensson (1987) explains how international differences with respect to the stochastic properties of outputs, rates of time preference, attitudes towards risk, and subjective beliefs determine autarky price differences, and how autarky price differences then determine the pattern of trade in arbitrarily specified assets, as well as in specific assets like indexed bonds, claims to countries' output (stocks, equity), and Arrow-Debreu securities.

The analysis in Svensson (1987) applies only to real assets in barter economies. Most international assets are nominal assets, in the sense that their return is paid in some international currency. Then, the real returns depend on risk characteristics of price levels and exchange rates, which in turn depend on, among other things, the risk characteristics of countries' money supplies.[3]

This paper extends the analysis to include trade in risky nominal assets between monetary economies. The new element is to study the effect of monetary policies and price level and exchange rate risk on the real returns on specified nominal assets in a general-equilibrium setting. The focus is on how different combinations of monetary policies and exchange rate regimes determine the pattern of trade in nominal assets by affecting the risk

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3 See Fama and Farber (1979), Grauer, Litzenberger and Stehle (1976), and Kouri (1977). These papers take, as is common in the finance literature, the stochastic processes for price levels as exogenous, and the dependence on money supply in general equilibrium is not integrated into the analysis. Such an integration is undertaken in the general-equilibrium international asset pricing models of Lucas (1982), Stulz (1984) and Svensson (1985). The focus in these papers is on prices and exchange rates and not on the trade pattern; since a perfectly pooled equilibrium is assumed, the trade pattern is trivial. That is, relative to autarky each country (in a two-country world) exports half of its assets and imports half of the other country's assets. Still, capital movements and correlations between key macro variables like investment, the current account, output, etc., can be studied, as in Stockman and Svensson (1987), but any current and capital account movements are due exclusively to revaluation of domestically based assets relative to foreign based assets, not to changes in the ownership of assets.

characteristics of these assets.

The outline of the paper is as follows. Section II lays out a two-period model of a two-country world, where home and foreign currencies are introduced via cash-in-advance constraints. The international asset market is characterized by the assets' real return risk characteristics, summarized as a real return matrix. Sections II and III exploit that, for a given real return matrix, the monetary world equilibrium is equivalent to an equilibrium in a world barter economy without money and liquidity constraints. The Law of Comparative Advantage, relating trade in assets to autarky asset price differences, can then be applied as in Svensson (1987). Section IV discusses how different monetary polices determine risk characteristics of real returns of nominal assets, the real return matrix. These building blocks are combined in Section V, which examines the determinants of autarky asset prices for the case when countries differ only with respect to the stochastic properties of their outputs. It presents a simple condition, in terms of the covariances between output and real asset returns, for the direction of trade in a given asset with given real return characteristics. Four distinct monetary policies are specified: the passive (nominal GDP) and the price-level (inflation rate) stabilizing policies, and the fixed exchange rate regimes with either a one-sided or a two-sided peg. In section VI these elements are combined to examine how different combinations of monetary policies and exchange rate regimes determine the trade pattern in home and foreign currency bonds, when countries differ with respect to the risk characteristics of their outputs. Section VII examines the case when the countries differ with respect to their attitudes towards risk. Section VIII includes a summary, some conclusions, and a discussion of limitations and possible extensions of the analysis. An appendix includes a detailed description of the cash-in-advance transactions structure.

II. Markets and Assets

We consider a world with two countries, home and foreign. Each country consists of a representative consumer and a government. There are two periods, 1 and 2, and there is one good and two currencies, home and foreign, in each period. Period 1 outputs in the home and foreign country, y^1 and y^{*1}, are exogenous and certain. Period 2 outputs in the two countries, y^2 and y^{*2}, are also exogenous but uncertain. We call the vector $s = (y^2, y^{*2})$ the state of the world in period 2. The state of the world is distributed accordingly to the distribution function F(s). Goods are perishable and there is no storage or other investment technology.

Stochastic outputs is the only source of uncertainty in the model. The monetary policies to be specified in section V will be conditional upon the stochastic outputs. The model can easily be expanded to consider monetary policy as an independent source of uncertainty.

The home and foreign countries have access to a world asset market in the beginning of period 1. On this asset market home and foreign currencies and assets can be traded. Let us now describe this asset market.

There is a given set J of J different assets (in addition to home and foreign currency), which can be traded on the world asset market in period 1, before the uncertainty about the state of the world in period 2 has been resolved. (We let J denote both the set and the number of elements of the set.) The assets pay a state-dependent return in the beginning of period 2. All assets are nominal assets. More precisely, they are either home currency or foreign currency assets, in the sense that they returns are paid in either home or foreign currency.[4] If a particular asset $j \in J$ is a home currency

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[4] The demand for money will be introduced via liquidity (cash-in-advance) constraints. Assets who pay returns physically in goods can then not be allowed, since they would provide a way to avoid the liquidity constraints, and remove any demand for money.

asset, it is characterized by a (gross) home currency return function $R_j(s)$ giving the amount of home currency it pays in the beginning of period 2 as a function of the state. If instead a particular asset $j \in J$ is a foreign currency asset, it has a (gross) foreign currency return function $R_j^*(s)$ giving the amount of foreign currency it pays in the beginning of period 2 as a function of the state. The most important characteristic of an asset will be its real return measured in the one good, however. Let the home and foreign currency price of goods in state s in period 2 be denoted by $P^2(s)$ and $P^{*2}(s)$, respectively. Then, the (gross) (real) return function $r_j(s)$ for a given asset $j \in J$ is a function given by

(2.1) $\quad r_j(s) = R_j(s)/P^2(s)$ or $r_j(s) = R_j^*(s)/P^{*2}(s)$, for all s,

depending upon whether the asset is a home or foreign currency asset. We see that the real return on a home currency asset in general depends on the home price level, and that the real return on a foreign currency asset in general depends on the foreign price level. Hence, in general the real returns will be endogenously determined in equilibrium.

Let us consider some special assets. A home currency bond (more precisely a home currency discount bond) pays one unit of home currency in all states in period 2. It will be denoted by $j = m$ and has the home currency return function $R_m(s) = 1$ for all s. Hence, its real return function $r_m(s)$ is given by

(2.2a) $\quad r_m(s) = 1/P^2(s)$, for all s.

That is, its real return is the reciprocal of the home price level. This implies that the risk characteristics of home currency bonds depends directly on the risk characteristics of the home price level, which in turn depend on the supply and demand of home currency.[5]

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[5] Let Q_m^1 be the home currency price on the asset market in period 1 of a home currency bond. Then the nominal interest rate i_m on a home currency bond

Similarly, a foreign currency bond, denoted $j = n$, has the foreign currency return function $R_n^*(s) = 1$ for all s, and the real return function $r_n(s)$ given by

(2.2b) $\quad r_n(s) = 1/P^{*2}(s)$, for all s.

The risk characteristics of the foreign currency bond depend directly on the risk characteristics of the foreign price level and hence on the demand and supply for foreign currency.[6]

Let us also consider some real assets, assets that although they pay in home or foreign currency have real returns that are independent of the countries' price levels. That is, their currency returns are, directly or indirectly, indexed. The indexed bond (denoted $j = 0$) has the home currency return function $R_0(s) = P^2(s)$ or the foreign currency return function $R_0^*(s) = P^{*2}(s)$. That is, its real return is unity in each state,

(2.2c) $\quad r_0(s) = 1$, for all s.

Home stocks ($j = h$) are claims to (the home currency value of) home (period 2) output. They are a home currency asset with the home currency return function $R_h(s) = P^2(s)y^2$. Hence the real return function $r_h(s)$ is given by

(2.2d) $\quad r_h(s) = y^2$, for all s.

Similarly, foreign stocks ($j = f$) are a foreign currency asset with the foreign currency return function $R_f^*(s) = P^{*2}(s)y^{*2}$. Hence the real return function is given by

(2.2e) $\quad r_f(s) = y^{*2}$, for all s.

Let us finally note that an Arrow-Debreu security for a particular state

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is given by $Q_m^1 = 1/(1+i_m)$.

6 The real return on a foreign currency bond can also be expressed in terms of the period 2 exchange rate in state s, $e^2(s)$, and the home price level as $r_n(s) = e^2(s)/P^2(s)$, hence depending on exchange rate and home price-level risk. However, in equilibrium in our model the Law of One Price will hold, so this is the same expression as (2.2b).

s is an asset that pays either $P^2(s)$ units of home currency or $P^{*2}(s)$ units of foreign currency in the particular state s, and that pays nothing in other states. Hence, the real return function is given by

(2.2f) $\quad r_s(\sigma) = 1$ for $\sigma = s$, $r_s(\sigma) = 0$ for $\sigma \neq s$, for all states σ.

An Arrow-Debreu security pays a real return equal to unity in one particular state only.

The set J of assets available for trade on the world asset market is completely characterized by the assets' real return vectors. Let us consider the (real) return (generalized) matrix r consisting of the J real return functions $r_j(s)$, $j \in J$. When the number of states of the world, S, is finite, this is an ordinary (S×J)-matrix, with S rows and J columns. When the number of states S is infinite, we can still think of a r as a generalized matrix with infinitely many rows. The components of the return matrix are exogenous to consumers trading on the world asset market, but some or all of the components are endogenously determined in an equilibrium. Therefore, it will be practical to express individual behavior as conditional upon an arbitrarily given return matrix. In equilibrium the given return matrix must of course coincide with the actual equilibrium return matrix as it is determined by price levels and monetary policies, for instance.

In principle the trade pattern in any given set of assets, complete or incomplete, can be examined with our methods. In sections VI and VII we shall however restrict the analysis to the special case when the set of assets include only home and foreign currency bonds ($J = \{m,n\}$). Since we will assume that there are more the two states of the world, the set of assets then considered is incomplete.[7]

Having described the asset market and some possible assets, we shall now look more closely at the home consumer and the constraints he faces. The home consumer has rational expectations and knows the probability distribution F(s) over the states of the world. He has preferences over period 1 consumption, c^1, and state-dependent period 2 consumption, $c^2(s)$. The preferences can be represented by the additively separable expected utility function

$$U(c^1) + \beta E[U(c^2)], \tag{2.3}$$

where $U(\cdot)$ is a standard increasing concave sufficiently differentiable von Neumann-Morgenstern utility function, $\beta > 0$ is is the subjective discount factor, and E[a] denotes the expected value $\int a(s)dF(s)$.[8]

The consumer is entitled to cash revenues from the sale of home output. The sequence of transactions and payments is such that he does not receive these revenues until at the end of each period, whereas he must provide cash in advance to purchase goods in the beginning of each period.[9] The precise

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[7] We recall that the set of assets is said to be complete if the rank of the return matrix r is S, that is, if there are as many independent assets (that is, with linearly independent return vectors) as there are states of the world. Then consumers can reach the same consumption allocation across states of the world with trade on the asset market as they can if they have access to the S Arrow-Debreu securities. If the rank of the return matrix is less than S, the set of assets is said to be incomplete.

[8] As is well known, representing preferences by an additively separable expected utility function does not allow a separation between risk aversion and intertemporal substitution in consumption (see Sandmo (1974) and Selden (1978)).

[9] The model is similar to the ones of Helpman (1981) (except it has uncertainty and only two periods), Helpman and Razin (1982) (except it has no uncertainty in period 1), Lucas (1982) (except it has possibly incomplete markets and only two periods), Persson (1982, 1984) (except it has uncertainty and only two periods), and Stockman (1983) (except it has cash in advance instead of money in the utility function).

sequence of markets and transactions is described in the appendix. There it is also shown that the resulting equilibrium with money is identical to the equilibrium in the analog barter economy.[10] Therefore we can here proceed to define the equilibrium without any reference to money. Money and monetary policy will be introduced in Section V.

Let x denote the home country's (net) import of goods in period 1. Then consumption in period 1 fulfills

$$(2.4) \qquad c^1 = y^1 + x.$$

Let the J-vector $z = (z_j)$ denote the home country's (net) import of asset on the asset market in period 1.[11] Then consumption in period 2 fulfills

$$(2.5) \qquad c^2(s) \leq y^2 + r(s)z, \text{ for all } s,$$

where $r(s)z$ denotes the inner product $\Sigma_{j \in J} r_j(s) z_j$. Substitution of (2.4) and (2.5) into (2.3) allows us to define the trade utility function $\tilde{U}(x,z;r)$, conditional on a given return matrix r, by

$$(2.6) \qquad \tilde{U}(x,z;r) = U(y^1+x) + \beta E[U(y^2+rz)].$$

The period 1 budget constraints for the home consumer can now be written as

$$(2.7) \qquad x + qz = 0,$$

where $q = (q_j)$ is the J-vector of asset prices measured in period 1 goods and qz denotes the inner product $\Sigma_{j \in J} q_j z_j$. This equation can be interpreted as a balance-of-payments constraint, stating that the the current account deficit, x, and the capital account deficit, qz, sum to zero.

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[10] This equivalence result for a cash-in-advance economy with given output is demonstrated in the perfect-foresight case by Helpman (1981).

[11] It is practical to let z denote only the net international trade of the consumer, and to let his initial holdings of domestic assets (claims to period 1 and period 2 output) be implicitly given in the right-hand sides of his constraints (2.4) and (2.5).

The behavior of the home consumer can now be described as the result of maximizing the trade utility function (2.6) subject to the budget constraint (2.7), for given asset prices q, and for a given return matrix r. This results in goods import and asset import functions $x(q;r)$ and $z(q;r)$.[12]

[12] We assume that these functions are single-valued. This does not matter for our results, but simplifies the notation.

Also, we disregard bankruptcy issues, by not restricting consumption to be non-negative.

III. Equilibrium and the Law of Comparative Advantage

A home country autarky equilibrium for a given return matrix r, is an equilibrium without access to the world asset market. That is, asset import is zero,

$$(3.1) \qquad z(q;r) = 0.$$

(Import of period 1 goods is then also zero, $x(q;r) = 0$, but by Walras's Law that equation is redundant.) Equation (3.1) can be solved for the home autarky asset prices q, for a given return matrix r.[13]

The foreign country has a trade utility function over period 1 goods (net) import x^* and asset (net) import z^*, $\tilde{U}^*(x^*,z^*;r)$, defined by the analog to (2.6). Its period 1 budget constraint is the analog to (2.7). Maximization of the foreign country's trade utility function subject to its period 1 budget constraint gives foreign country's goods and asset import functions $x^*(q;r)$ and $z^*(q;r)$. An autarky equilibrium for the foreign country, for a given return matrix r, is an autarky asset price vector q^* that fulfills the analog of (3.1).

In a world equilibrium, finally, home and foreign asset import sum to zero, that is

$$(3.2) \qquad z(q;r) + z^*(q;r) = 0.$$

Equation (3.2) can be solved for the world equilibrium asset prices, for a given return matrix r. (By Walras's Law the world market for period 1 goods is in equilibrium whenever the asset market is in equilibrium.)

The equilibria defined are conditional upon a given return matrix r. It remains to restrict the return matrix to be consistent with the monetary

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[13] There is no contradiction in considering the home autarky price of a foreign currency asset. The foreign currency asset is defined by a real return vector that is here taken as exogenous. The autarky price of any asset with a given real return vector is the equilibrium asset price for which zero trade is an equilibrium.

policies pursued. Before that is done, we shall continue to take the set of assets and the return matrix as given and proceed, exactly as in Svensson (1987), to apply the Law of Comparative Advantage.

For a given return matrix r, the barter economies described by the trade utility function (2.3) and its foreign analog, and the budget constraint (2.7) and its foreign analog, are formally equivalent to static barter economies trading J+1 commodities. Therefore, the standard international trade theorems apply, for instance the Gains-from-Trade Theorem and the Law of Comparative Advantage. Let us therefore directly apply the Law of Comparative Advantage, in the general form advanced by Deardorff (1980) and Dixit and Norman (1980), to the present circumstances.?

Let z be the home country's import of period 1 goods and assets in a world equilibrium, and let q and q* be home and foreign autarky asset prices relative to period 1 goods. Then the <u>Law of Comparative Advantage</u> can be written on the form

(3.3) $(q-q^*)z \geq 0.$

It states that on the average, the home country will import assets whose autarky prices are higher in the home country than in the foreign country. If only one asset is traded we have an exact relation between autarky asset prices and the trade pattern: The asset will be imported (and period 1 goods will be exported) if and only if the autarky price of the asset is higher in the home country than in the foreign country. If more than one asset are traded, the Law of Comparative Advantage provides a "tendency" for a particular asset to be imported if its autarky price is relatively high, rather than an exact relation for import in any individual asset.[14]

[14] As Deardorff (1980) emphasizes, a positive inner product $ab = \Sigma_j a_j b_j \geq 0$ does not exactly provide a positive correlation between the J-vectors $a = (a_j)$ and $b = (b_j)$, unless either $\Sigma_j a_j = 0$ or $\Sigma_j b_j = 0$. This is so, since the sample correlation coefficient cor(a,b) is proportional to the sample covariance cov(a,b) and the latter fulfills $\mathrm{cov}(a,b) = ab - \Sigma_j a_j \Sigma b_j / J$. Deardorff shows how one can construct correlations in two ways. One way is to exploit the balance-of-payments constraint. Let q^t be the asset prices in terms of goods in the world equilibrium. Then (3.3) is equivalent to the statement that the (J+1)-vectors $(0,((q_j - q_j^*)/q_j^t))$ and $(x,(q_j^t z_j))$ are positively correlated, since $x + q^t z = 0$. The other way is to restrict the vector of goods and asset prices to be in the unit simplex. Let (p,q) and (p^*,q^*) be the home and foreign autarky prices of period 1 goods and assets. The standard derivation of the Law of Comparative Advantage gives $(p-p^*,q-q^*)(x,z) \geq 0$. Restricting (p,q) and (p^*,q^*) to be in the unit simplex then implies that the (J+1)-vectors $((1,q)/(1+\Sigma_j q_j) - (1,q^*)/(1+\Sigma_j q_j^*))$ and (x,z) are positively correlated.

For our purpose it is sufficient to interpret (3.3) as stating that there is tendency for asset j to be imported into the home country ($z_j > 0$) when its home autarky price (measured in goods) is higher than its foreign autarky price (measured in goods) ($q_j > q_j^*$).

IV. Autarky Asset Prices and Output Differences

In this section we shall look at the determinants of autarky asset prices. For the case of countries differing only in their period 2 outputs, we shall make simplifying assumptions so as to be able to derive a simple and operational condition, in terms of covariances of outputs and asset returns, for the autarky asset price of a particular asset to be lower in one country.

The home autarky asset price q_j of a particular asset j with return function $r_j(s)$ is simply given by the marginal rate of substitution between asset j and period 1 goods of the trade utility function (2.6) at zero import of goods and assets, $\tilde{U}_j(0,0;r)/\tilde{U}_x(0,0;r)$, where $\tilde{U}_j$ and $\tilde{U}_x$ denote the partial with respect to z_j and x. It follows from (2.6) that the autarky asset price fulfills

$$q_j = \beta E[U_c(y^2)r]/U_c(y^1), \tag{4.1}$$

the familiar expression of the discounted expected utility of period 2 returns over the marginal utility of period 1 consumption.

It is practical to relate the price of an asset to the real interest rate on an indexed bond, and to the risk measure for the asset. First, consider the indexed bond, with returns $r_0(s) = 1$ for all s. Its autarky price, q_0, and the corresponding autarky real interest rate, ρ, fulfill, by (4.1),

$$q_0 = 1/(1+\rho) = \beta E[U_c(y^2)]/U_c(y^1). \tag{4.2}$$

Second, define the autarky risk measure for asset j, Π_j, as

$$\Pi_j = -\mathrm{Cov}[U_c(y^2),r_j]/E[U_c(y^2). \tag{4.3}$$

Third, use the rule $E[xy] = E[x]E[y] + \mathrm{Cov}[x,y]$ to rewrite (4.1), and apply the definitions (4.2) and (4.3). This gives

$$q_j = \{E[r_j] - \Pi_j\}/(1+\rho). \tag{4.4}$$

We see that the asset price can be written as the present value of the difference between its expected return and its risk measure.

The risk measure (4.3) is proportional to the negative of the covariance between the marginal utilities of consumption $U_c(y^2)$ and the returns $r_j(s)$. Hence it is positive or negative depending upon whether period 2 marginal utilities and returns are negatively or positively correlated. The risk measure for an asset can be interpreted as a measure of how risky that asset is relative to the indexed bond. If the risk measure is positive, the asset is riskier than the indexed bond. If it is negative, the asset is less risky than the indexed bond.[15] [16]

It is clear from (4.4) that autarky prices for a given asset may differ across countries because autarky real interest rates, autarky risk measures, or both differ across countries. More precisely, the home autarky real interest rate and the risk measure for asset j should be relatively low for the asset to have a higher home autarky price and for the home country to have a tendency to import the asset.

Let us first consider the effect of different autarky real interest rates. Let the home autarky real interest rate be lower than the foreign autarky real interest rate. Then, for all assets which do not have higher autarky risk measure at home than abroad, home autarky asset prices will be

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[15] The risk premium can be defined as the difference between the expected gross rate of return, $E[r_j]/q_j$, and the gross real rate of interest, $1+\rho$. Then the risk premium is equal to Π_j/q_j and fulfills $\Pi_j/q_j =$ $= -\beta \mathrm{Cov}[U_c(y^2)/U_c(y^1), r_j\ /q_j]$ and is hence the negative of the covariance between the marginal rates of substitution and the ex post rates of return $r_j(s)/q_j$.

[16] Note that the indexed bond has a sure real return, but that the utility value of the return is risky, since marginal utility itself is risky. Hence there is nothing paradoxical with assets that are less risky than the indexed bond. A sure-utility bond (in autarky) ($j = u$) would have returns $r_u(s)$ fulfilling $U_c(y^2)r_u(s) = 1$, hence $r_u(s) = 1/U_c(y^2)$ for all s.

higher, and there is hence a tendency for the home country to import all such assets. For assets with a higher autarky risk measure at home, a lower home autarky real interest rate implies a higher autarky price but not necessarily higher than the foreign autarky price. Nevertheless, we may state that a lower home autarky real interest rate implies a tendency to import (almost) all assets into the home country, to run a capital account deficit and hence be a net lender. If the only asset traded is the indexed bond, we have an exact result and know for sure that the the home country will import the indexed bond and be a net lender.

Let us next turn to differences in autarky risk measures. From (4.4) we see that, for autarky real interest rates not higher at home than abroad, a lower risk measure at home for asset j implies a higher home autarky asset price and hence a tendency for asset j to be imported by the home country. For autarky real interest rates higher at home than abroad, a lower home autarky risk measure implies a higher autarky asset price, but not necessarily higher than in the foreign country. Risk terms are specific to individual assets and depend on the individual risk characteristics of the asset. Hence a difference between risk measures for a given asset gives information about trade in that specific asset; a difference in autarky real interest rates affect autarky asset prices for all assets, and hence gives information about aggregate asset trade, the capital account.

If the countries are identical in all respects, the autarky asset prices will be identical, there is no basis for trade, and zero trade will be a trade equilibrium. Hence, trade here arises because of differences between the countries. The countries can differ either with regard to their outputs, their preferences (including their subjective probability distributions), and with regard to their monetary policies. In Svensson (1987) differences in all these respects, except monetary policies, are considered. Here we shall, in addition to differences in monetary policies, only discuss differences between countries with regard to output/technology (section VI) and with regard to attitudes towards risk (section VII).

In Svensson (1987) differences in both autarky real interest rates and risk measures are extensively discussed. In the present setup, as demonstrated in the appendix, monetary policy and price level risk does not affect autarky real interest rates. Therefore, in order to isolate and highlight the effect of monetary policies we shall make assumptions that ensure that autarky real interest rates are the same, and hence that then only reason for autarky asset price differences is differences in autarky risk measures.

We therefore make the following assumptions:

(A1) The home and foreign countries are identical in all respects except with regard to period 2 outputs.

(A2) Home and foreign period 2 outputs have the same marginal probability distribution but are imperfectly correlated.

It follows directly from and assumptions (A1) and (A2) and equations (4.3) and (4.4) that the two countries will have the same autarky real interest rate,

(4.5) $\rho = \rho^*$.

Then autarky price differences for a particular asset j depends only on autarky risk measure differences.

Under the following assumptions we get a very simple expression for the risk measures:

(A3) The von Neumann-Morgenstern utility function has constant absolute risk aversion, that is,

$U(c) = -e^{-\gamma c}$,

where $\gamma = -U_{cc}/U_c$, the Arrow-Pratt measure of absolute risk aversion, is a positive constant.

(A4) For all assets $j \in J$, $(y^2, r_j(s))$ and $(y^{*2}, r_j(s))$ are jointly normally distributed.[17]

Under assumption (A3) and (A4) it is easy to show that the home autarky risk measure fulfills[18]

(4.6) $\Pi_j = \gamma \mathrm{Cov}[y^2, r_j]$.

The autarky risk measure is simply the product of the absolute risk aversion parameter and the covariance between its return and home period 2 output.

Therefore, under assumptions (A1)-(A4) we can summarize our results as

(4.7) $q_j \gtrless q_j^* \Leftrightarrow \Pi_j \lessgtr \Pi_j^* \Leftrightarrow \mathrm{Cov}[y^2, r_j] \lessgtr \mathrm{Cov}[y^{*2}, r_j]$ "$\Rightarrow$" $z_j \lessgtr 0$,

where "$\Rightarrow$" denotes "implies a tendency to."

Hence, if an assets return is less positively correlated, or more negatively correlated, with home period 2 output than with foreign period 2 output, there is a tendency for the asset to be imported by the home country. If the asset is the only asset traded we have an exact result and know for sure that it will be imported by the home country. We note the simplicity of (4.7) in that it depends only on the return vector for the asset in question and not on the return vectors of other assets. This is of course because the asset price and risk measure are computed in autarky, when there is zero trade in all assets. The simplicity of (4.7) illustrates the convenience in using the Law of Comparative Advantage.

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[17] As usual, the assumption of a normal distribution is problematic, since it implies that period 2 outputs can take negative values with positive probability. With small variances relative to means, it is a minor problem, though.

[18] Under assumption (A4) a theorem by Rubinstein (1976) implies that $\Pi_j = -\mathrm{Cov}[U_c(y^2), r_j]/E[U_c(y^2)] = -E[U_{cc}(y^2)]\mathrm{Cov}[y^2, r_j]/E[U_c(y^2)]$. Under assumption (A3) we have $U_{cc}(y^2) = -\gamma U_c(y^2)$, hence (4.6).

V. Monetary Policy

Demand for currencies is introduced via cash-in-advance constraints. The rule is that home goods must be purchased with home currency, and foreign goods with foreign currency (this is the S-system in Helpman and Razin (1984)). The details are spelled out in the appendix. Here we need only concern ourselves with the resulting period 2 price level equations. Under the assumption that nominal interest rates are positive, the price level equations are the familiar quantity-theory (-of-money) equations

(5.1) $P^2(s) = M^2(s)/y^2$ and $P^{*2}(s) = N^2(s)/y^{*2}$, for all s,

where $M^2(s)$ and $N^2(s)$ are the home and foreign monetary supplies in state s in period 2.

We also note that in equilibrium the Law of One Price must hold. If it would not, home and foreign consumers would in this setup shift all their demand towards goods from one country. Hence,

(5.2) $P^2(s) = e^2(s)P^{*2}(s)$, for all s.

It follows from (5.1)-(5.2) that the period 2 exchange rate equation is

(5.3) $e^2(s) = (M^2(s)/N^2(s))(y^{*2}/y^2)$, for all s.

We have already noted that for nominal assets real returns depend on period 2 price levels. Thus from the expression for the real returns on home and foreign currency bonds (2.2a,b) and the quantity equation (5.1) we see that

(5.4) $r_m(s) = 1/P^2(s) = y^2/M^2(s)$ and
$r_n(s) = 1/P^{*2}(s) = y^{*2}/N^2(s)$, for all s.

Hence the stochastic properties of the return on a bond nominated in a country's currency is completely determined by the stochastic properties of the country's period 2 money supply and output.

In order to know the relevant real returns on nominal assets we therefore need to specify the monetary policies we want to consider. Obviously a large number of different monetary policies can be examined. We shall only specify a small set of four simple bench-mark monetary policies, the consequences of which for the trade pattern in nominal assets we shall examine in sections VI and VII.

It is practical to distinguish between independent and coordinated monetary policies, independent meaning that policy in one country is independent of variables in the other country, and coordinated meaning that policy in one country depends on variables from both countries. Among possible independent policies, let us only consider output-dependent monetary policy with a constant elasticity k of home money supply with respect to home output, that is,[19]

(5.5) $M^2(s) = (y^2)^k$, for all s.

We can refer to the case $k > 0$ as a pro-cyclical monetary policy, and $k < 0$ as a counter-cyclical monetary policy. The case $k = 0$ can be called a passive monetary policy, with money supply constant and state-independent,

(5.6a) $M^2(s) = 1$, for all s.

Equivalently, in view of (5.1) we can say that this policy stabilizes nominal GDP. This is the first monetary policy shall examine below.

We can also conceive of price-level related monetary policies, policies that are designed to have particular effects on the price level. The second monetary policy we shall consider is the special case of a price-stabilizing monetary policy, the output-dependent policy for which the elasticity k equals unity and the price level is constant,

(5.6b) $M^2(s) = y^2$ and $P^2(s) = 1$, for all s.

Equivalently, we can call this an inflation-stabilizing policy.

[19] Since only the risk characteristics of period 2 price levels and returns matter, that is, their dependence on the state of the world, any multiplicative constant for the money supply is irrelevant. For simplicity we set the constant equal to unity in (5.5).

Among coordinated monetary policies we have the exchange-rate related monetary policies, policies that are designed to affect the exchange rate. From the exchange rate equation in (5.3) we have that for a particular exchange rate target $\bar{e}^2(s)$ for all s, home and foreign monetary policy must fulfill

(5.7) $M^2(s) = \bar{e}^2(s)N^2(s)y^2/y^{*2}$, for all s.

A special case is the fixed exchange rate regime when the target exchange rate is constant (state-independent), $\bar{e}^2(s) = \bar{e}$ for all s, for which case the monetary policies must fulfill

(5.8) $M^2(s) = \bar{e}N^2(s)y^2/y^{*2}$, for all s.

The third monetary policy we shall consider is the one-sided peg, the fixed exchange rate regime in which the foreign country pursues an output-dependent monetary policy, and the home country sets money supply according to (5.8) so as to hold the exchange rate constant, that is,

(5.9) $N^2(s) = (y^{*2})^{k^*}$ and $M^2(s) = \bar{e}y^2(y^{*2})^{k^*-1}$, for all s.

The fourth policy is the two-sided peg, the fixed exchange rate regime in which the two countries cooperate so as to hold the world money stock, $\bar{M}$, constant,[20]

(5.10) $M^2(s) + \bar{e}N^2(s) = M$, for all s.

From (5.8) and (5.10) it follows that the monetary policies must then fulfill

(5.11) $M^2(s) = My^2/(y^2 + y^{*2})$ and $N^2(s) = (M/\bar{e})y^2/(y^2 + y^{*2})$, for all s.

Each country's money supply is adjusted so as to be in proportion to the country's share in world period 2 output.

In the appendix the governments' policy instruments are restricted to be money supply and (net) transfers. Neither open market operations nor foreign

[20] Holding the world money stock M constant is of course a special case. Output dependent world money stocks can be considered, for instance.

exchange interventions are considered. However, open market operations and foreign exchange interventions (assuming that foreign reserves are interest bearing foreign currency bonds rather than non-interest bearing foreign currency) are neutral as long as they result in the same money supply.[21] This is so, since the home and foreign countries as modeled are characterized by Ricardian Equivalence (there are no distortionary taxes, money is not distortionary, there are rational expectations, and the consumers' horizon is as long as the horizon of the economies) and since with the given transactions structure, each country's consumer chooses not to hold any of the other country's currency between the periods (see appendix). Put differently, the only things that matter for price levels and exchange rates, and hence real returns, are the home and foreign currency supplies, $(M^1, M^2(s))$ and $(N^1, N^2(s))$ (this is obvious from the quantity equations (5.1) and the exchange rate equation (5.3)). Hence, whether we allow such interventions or not in the present framework is for our purpose irrelevant.[22]

Monetary policy can here be regarded as "pure" monetary policy, without any implicitly associated fiscal policy. This is so even though the money

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[21] In the transactions structure laid out in the appendix the home consumer chooses not to hold any foreign currency between period 1 and period 2. He effectively holds all home currency between the periods, since it is held by home firms to be distributed to home consumers in the beginning of period 2. Therefore, an expansion of the home money stock does not imply any inflation tax on the foreign consumer. That is also the reason why any private currency flows do not appear in the balance of payments (2.7).

[22] See Helpman (1981) and Persson (1982, 1984) for a detailed discussion on different exchange rate regimes and different kinds of central bank intervention in similar perfect-foresight models. Stockman (1983) demonstrates in a similar uncertainty model, although with real balances in the utility function, that a sterilized intervention has no effect on exchange rates and price levels when Ricardian Equivalence obtains.

Since it is the period 2 exchange rates and price levels that are relevant for the risk characteristics of asset returns in our two-period model, and there are no assets except home and foreign currency traded in period 2, the set of possible interventions in period 2 would in any case be limited.

supply is changed by net transfers to consumers, which usually implies that monetary and fiscal policy cannot be separated. The reason is that the monetary structure laid out in the appendix assumes that all monetary transfers received during period 1 and 2 are taxed at 100% at the end of period 2.

VI. Trade in Nominal Assets: Output Differences

In section IV we derived the simple covariance criterion (4.7) for whether there will be a tendency for the home country to import or export a particular asset with given risk characteristics, that is with a given real return vector, when countries differ only with respect to period 2 outputs. In section V we noted that the risk characteristics of the real returns of home and foreign currency are completely determined by the risk characteristics of period 2 outputs and money supply, and we specified four bench-mark monetary policies to be considered: the independent passive and price-level stabilizing monetary polices, and the coordinated one-sided peg and two-sided peg. At last we are ready to use these building blocks to discuss how combinations of monetary polices determine the trade pattern in home and foreign currency bonds.

Hence, we assume that the set of assets consist only of home and foreign currency bonds, that is $J = \{m,n\}$, and consider combinations of the monetary polices mentioned. A summary or the results is given in Table 1.

First, let us take the foreign country to pursue a passive monetary policy (the elasticity k^* of foreign period 2 money supply with respect to foreign period 2 output equals zero), and let us vary the monetary policy of the home country. This corresponds to column (a) in Table 1. From (5.4) and (5.6a) we see that with a foreign passive monetary policy, the foreign currency bonds is a perfect substitute for foreign stocks, since its return is proportional to foreign period 2 output, $r_n(s) = y^{*2} = r_f(s)$, for all s. It is as if there were trade in claims to foreign period 2 output instead of foreign currency bonds. This circumstance we denote by n = f.[23] Furthermore, since the marginal distributions of home and foreign period 2 outputs are equal and the two outputs are not perfectly correlated, we have

$$(6.1) \qquad \Pi_n = \Pi_f = \mathrm{Cov}[y^2, y^{*2}] < (\mathrm{Var}[y^2]\mathrm{Var}[y^{*2}])^{1/2} = \mathrm{Var}[y^{*2}] = \\ = \mathrm{Cov}[y^{*2}, y^{*2}] = \Pi_f^* = \Pi_n^*.$$

Thus, the home autarky risk measure for the foreign currency bond is lower than the foreign autarky measure, and there is a tendency for the home country to import the the foreign currency bond. The foreign currency bond is a perfect substitute for foreign stocks, which are a less risky in the home country than in the foreign country. This result is denoted by "n=f: Import" in the first three rows in column (a) in Table 1.

Suppose the home country also pursues a passive monetary policy (the elasticity k of home monetary supply with respect to home period 2 output equals zero). This corresponds to row (1) in Table 1. It follows directly from the reasoning above that with a passive home monetary policy the home currency bond will be a perfect substitute for a claim to home period 2 output, $r_m(s) = y^2 = r_h(s)$, for all s. Since home stocks are riskier in the home country (the autarky risk measure is lower), there will be a tendency for the home country to export the home currency bond (denoted by "m=h: Export" in the first two columns in row (1) in Table 1).

Suppose instead that the home country stabilizes the home period 2 price level (the elasticity k equals unity). This corresponds to row (2). This implies that the return on the home currency bond is sure, $r_m(s) = 1$, for all

[23] We say that two assets i and j with returns $r_i(s)$ and $r_j(s)$ are perfect substitutes if and only if $r_i(s) = \alpha r_j(s)$ for all s, for some constant $\alpha > 0$, that is, if and only if their returns are proportional. Then the asset prices q_i and q_j fulfill $q_i = \alpha q_j$. Two assets who are perfect substitutes are said to be effectively only one asset.

s, and the home currency bond is a perfect substitute for the indexed bond, which we denote by m = 0. By assumption autarky interest rates and hence the autarky asset prices on the indexed bond are equal. If the home currency bond were the only asset traded, we would know that it will be neither imported nor exported in a trade in equilibrium. However, when the foreign currency bond is also traded, it does not necessarily follow that there will be no trade in equilibrium in the home currency bond. We already know that there is a tendency for the home country to import the foreign currency bond when the foreign country pursues a passive monetary policy. Hence in equilibrium there should be (a tendency to) export of either goods or home currency bonds, or both, to balance the import of foreign currency bonds. We conclude that the home currency bond can be either exported or imported (denoted by by "m=0: ?" in row (2) column (a)).

Next, let us consider the situation when the home country pursues a one-sided peg and fixes the period 2 exchange rate, when the foreign country still pursues a passive monetary policy. With a fixed exchange rate, home and foreign currency bonds become perfect substitutes, since by the Law of One Price $r_h(s) = 1/P^2(s) = 1/(\bar{e}P^{*2}(s)) = r_f(s)/\bar{e}$, for all s. Furthermore, we already know that the foreign currency bond is a perfect substitute to a claim to foreign stocks, and that there is a tendency for the home country to import the foreign currency bond. Since there is now effectively only one asset traded, we even have an exact result rather than a tendency: The home country will import the asset, have a capital account deficit and a current account surplus. This is denoted "m=n=f: Import" in row (3) column (a).

Second, let us briefly consider the possibilities when the foreign country pursues a price-level stabilizing policy (row (b) in Table 1). Then the foreign currency bond is a perfect substitute for the indexed bond. The case when the home country pursues a passive monetary policy (row (1) column (b)) is of course identical to the case in row (2) and column (a), except that the properties of home and foreign currency bonds are interchanged. Hence, the home currency bond is a perfect substitute for home stocks, and there is a tendency for the home country to export home currency bonds. The foreign currency bond may or may not be imported into the home country.

When the home country also pursues a price-level stabilizing monetary policy (row (2) column (b)), both home and foreign currency bonds are perfect substitutes for the indexed bond. Since the relevant autarky asset prices are equal, and there is effectively only one asset traded, we have the exact result that there will be no trade and that the capital and current accounts will each be balanced. Also, since the exchange rate is constant, this policy is equivalent to the home country pursuing a one-sided peg (row (3) column (b)).

Third and last, let us consider the case when both countries engage in a two-sided peg (row (4) column (c)). Since the period 2 exchange rate is fixed, home and foreign currency bonds will be perfect substitutes (m=n). From (5.1) and (5.8) it follows that the return on home currency bonds is given by

(6.2) $r_h(s) = y^2/M^2(s) = (y^2 + y^{*2})/M$, for all s.

That is, home and foreign currency bonds are perfect substitutes for a claim to world output (j=w) with returns $r_w(s)$ given by

(6.3) $r_w(s) = y^2 + y^{*2}$, for all s.

Furthermore, since the marginal distributions of home and foreign period 2 output by assumption are identical, it follows that

(6.4) $\Pi_m = \Pi_w = \mathrm{Cov}[y^2, r_w] = \mathrm{Cov}[y^{*2}, r_w] = \Pi^*_w$.

Then by (4.7) the home and foreign autarky risk measures and hence autarky asset prices are equal. Since there is effectively only one asset traded, we have an exact result. There will be no trade in equilibrium, and the current and capital accounts will each be balanced.

We note the contrast to the case when both countries pursue a passive monetary policy. That equilibrium effectively involves trade in both countries stocks. Indeed, we realize that under assumptions (A1) and (A2), the resulting equilibrium is the Pareto efficient perfectly pooled equilibrium, where each country exports half of its stocks. Then, the capital and current account will also be balanced, although there is nonzero gross trade. In the case with the cooperative peg there is effectively only one assets, claims to world output. Both net and gross trade are zero, and both countries are effectively in their autarky equilibrium.

VII. Trade in Nominal Assets: Risk Aversion Differences

Next, we consider the situation when the home country is more risk averse than the foreign country. To isolate the effect of differences in attitudes towards risk, we want to assume that the countries are identical in all other aspects. We also want to make assumptions so as to equalize autarky real interest rates so as to isolate the effect on the trade pattern in nominal assets of assets' risk measures and the risk characteristics of monetary policies. Since intertemporal substitution and attitude towards risk cannot be separated when preferences are represented by an additively separable expected utility function, some special considerations are required.

The home country being more risk averse means that the countries' von Neumann-Morgenstern utility functions are different. Everything else equal this means that the autarky interest rates need not be equal, even if the countries' period 2 outputs have the same marginal distribution or even if their outputs are perfectly correlated and identical, since the expected period 2 marginal utility in (4.2) need not be equal. Therefore, for autarky interest rates to be equal, the subjective discount factor must be allowed to differ, too. We hence make the following assumptions, which replace (A1)-(A3):[24]

(A1') The home and foreign countries are identical in all respects except their von Neumann-Morgenstern utility functions and their subjective

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[24] Alternatively, we can use a special case of Selden's (1978) formulation, which distinguishes between intertemporal preferences and attitudes towards risk. The attitude towards risk is given by the risk utility function $V(c)$, by which the certainty equivalent period 2 consumption is defined by $V(\hat{c}^2) = E[V(c^2(s)]$. The intertemporal preferences are then given by $U(c^1) + \beta U(\hat{c}^2)$. We can then assume that the two countries have different CARA risk utility functions with the measures of absolute risk aversion fulfilling (A3'), identical $U(\cdot)$ functions, and different subjective discount factors so as to make autarky interest rates equal.

See Svensson (1987) and Persson and Svensson (1987) for applications of Selden's formulation in similar contexts.

discount factors. Home and foreign period 2 output are equal and hence perfectly correlated.

(A2') The subjective discount factors differ so as to make autarky interest rates equal.

(A3') The von Neumann-Morgenstern utility function has constant absolute risk aversion. The home country is more risk averse, that is, $\gamma > \gamma^*$.

We retain assumption (A4).

Since by (4.6)

(7.3) $$\Pi_j - \Pi_j^* = (\gamma - \gamma^*)\mathrm{Cov}[y^2, r_j],$$

it follows that instead of the result (4.7) we now have

(7.4) $$q_j \gtrless q_j^* \Leftrightarrow \Pi_j \lessgtr \Pi_j^* \Leftrightarrow \mathrm{Cov}[y^2, r_j] \lessgtr 0 \text{ "}\Rightarrow\text{" } z_j \lessgtr 0.$$

That is, the home autarky risk measure for asset j is lower (higher) then the foreign autarky risk measure for asset j if and only if the returns are negatively (positively) correlated with home and foreign period 2 output, that is, if and only if asset j is less (more) risky than the indexed bond. Hence, there is a tendency for the more risk averse home country to import assets that are less risky than the indexed bond, and to export assets that are more risky than the indexed bond.

After this we are equipped to discuss how monetary policies affect the trade pattern in nominal assets when the home country is more risk averse. We consider the same combinations of monetary policy as above in section VI. The results are summarized in Table 2.

Let us again first consider the situation when the foreign country pursues a passive monetary policy (column (a) in Table 2). Then the foreign currency bond is a perfect substitute for foreign stocks, but with home and foreign output being perfectly correlated, home and foreign stocks are perfect substitutes for a claim to world output. Furthermore, the covariance between period 2 output and world period 2 output is obviously positive. That is, a claim to world output is more risky than the indexed bond. It follows that the more risk averse home country has a tendency to export foreign currency bonds (n=w: Export) whenever the foreign country pursues a passive policy.

Suppose the home country also pursues a passive monetary policy (row (1) column (a)). Then the home currency bond is a perfect substitute for home stocks, and hence a perfect substitute for world output and foreign currency bonds. There is effectively only one asset traded, and we have an exact result. The home country will export the asset, and have a capital account surplus and a current account deficit (m=n=w: Export). Since home and foreign period 2 outputs are perfectly correlated, this policy combination by (5.3) implies that the period 2 exchange rate is constant. Hence, the policy combination is equivalent to the home country pursuing a one-sided peg (row (3) column (a)). Since the policy combination also implies that the world money stock is constant, it is equivalent to a two-sided peg (row (4) column (c)).

Suppose the home country instead stabilizes its price level (row (2) column (a)). Then the home currency bond is a perfect substitute for the indexed bond. Since autarky interest rates are equal, and there is more than one asset available, we cannot say whether home currency bonds will be exported or imported (m=0: ?).

The case when the foreign country stabilizes its price level and the home country pursues a passive monetary policy (row (1) column (b)) is identical to the previous case in row (2) and column (a), except that the properties of home and foreign currency assets are interchanged (m=w: Export, n=0: ?).

For the case when both countries stabilize their price levels (row (2) column (b)) home and foreign currency bonds are perfect substitutes for the indexed bond. Autarky interest rates are equal and there is effectively only one asset traded. Then we have the exact result that there will be no trade and zero capital and current accounts. Since the exchange rate is constant, this case is identical to the foreign country pursuing a price-level stabilizing policy, and the home country pursuing a one-sided peg (row (3) column (b)).

VIII. Conclusions

We have made assumptions so as to isolate the effect of price level and exchange rate risk on the trade pattern in nominal assets. Although the model allows for (almost) any specified real and nominal assets, in the end we have looked closely only at the case of home and foreign currency bonds. In particular we have assumed that home and foreign currency bonds are the only assets traded, and therefore that the asset market is incomplete. Since price-level and exchange rate risk depend on monetary policies, we have examined the effect of a few bench-mark monetary policies on the risk characteristics of home and foreign currency bonds and on the pattern of trade in such bonds. We have dealt with the two cases when the countries differ either with respect to their period 2 outputs or with respect to their attitudes towards risk.

Let us first summarize the results when the countries differ with respect to their outputs, in that their period 2 outputs are less than perfectly correlated. (i) When monetary policies are such that the exchange rate is variable, home and foreign currency bonds are imperfect substitutes. The risk characteristics of a country's currency bond depend directly on the country's monetary policy. If the country's monetary policy is passive, the bond is a perfect substitute for a claim the country's output, which is more risky for the country than it is for the other country, and there is a tendency for the country to export its currency bond. If the monetary policy is price-level stabilizing, the bond is a perfect substitute for the indexed bond, and it may be traded in any direction. (ii) When monetary policies are coordinated such as to fix the exchange rate, home and foreign currency bonds are perfect substitutes. Their risk characteristic depend on the coordinated monetary policies. If the exchange rate regime is a one-sided peg, and if the non-pegging country is pursuing a passive monetary policy, home and foreign currency bonds are perfect substitutes for a claim to the non-pegging country's output. Then the non-pegging country will export home and foreign currency bonds and have a capital account surplus and current account deficit. If the non-pegging country is pursuing a price-level stabilizing policy, home and foreign currency bonds are perfect substitutes for the indexed bond. There will be no trade, and capital and current accounts will each be balanced. If the exchange rate regime is a two-sided peg, home and foreign currency bonds are perfect substitutes for a claim to world output, there will be no trade, and capital and current accounts will each be balanced.

Second, let us summarize the results when the countries differ with respect to their attitudes towards risk, in that the home country is more risk averse than the foreign country. Their period 2 outputs are assumed to be equal and hence perfectly correlated. Their autarky interest rates are assumed to be equal. (i) When the countries pursue different monetary policies, the exchange rate is variable, and home and foreign bonds are imperfect substitutes. For the country pursuing a passive monetary policy, the country's currency bond is a perfect substitute for a claim to world output, and there is a tendency for the bond to be exported by the more risk averse home country. For the country pursuing a price-level stabilizing policy, the country's currency bond is a perfect substitute for the indexed bond, and the bond may be traded in any direction. (ii) When the countries monetary polices are coordinated and the exchange rate is fixed, home and foreign currency bonds are perfect substitutes. If the exchange rate regime is a one-sided peg, and if the non-pegging country is pursuing a passive monetary policy, home and foreign currency bonds are perfect substitutes to a claim to world output. Then the more risk averse home country will export home and foreign currency bonds and have a capital account surplus and current account deficit. This case is identical to the two-sided peg, since world money supply is constant. If the non-pegging country is pursuing a price-level stabilizing policy, home and foreign currency bonds are perfect substitutes to the indexed bond, there will be no trade and both countries' capital and current accounts will each be balanced.

We see that different monetary policies have dramatic effects on risk characteristics of home and foreign currency bonds, which in turn has dramatic effects on the pattern of trade and even the sign of the aggregate capital accounts. The effects on the pattern of trade is of course not independent of the assumption that home and foreign currency bonds are the only assets traded. Monetary policy has real effects in this framework precisely because asset markets are assumed to be incomplete, and because monetary policy changes the risk characteristics of the real returns of available assets. If indexed bonds and claims to home and foreign output is traded alongside with home and foreign currency bonds, there is no effect on aggregate capital accounts, for the different monetary policies we have considered. Neither is there any relevant effect on the pattern of trade in "effective" assets, since the number of linearly independent effective assets then does not change. If the asset market would be complete, in the sense of the the rank of the real return matrix being equal to the number of states of the world, any monetary policies would in the present framework have no real effects at all. Clearly, it is not restrictive to assume that real world international capital markets are incomplete. Even the simple case of trade in only home and foreign currency bonds has an attractive realistic touch, I think. The amount of international trade in equity is so far relatively small, although rising. International trade in anything remotely similar to an indexed bond is, as far as I know, completely insignificant.[25]

[25] Perhaps a partial explanation to why there is so little trade in indexed bonds in the real world is that a bond indexed to one country's consumer price index, say, would not in general be a perfect substitute for a bond indexed to

These results also provide another demonstration of something that is by now widely acknowledged, namely that reduced-form asset demand functions are very sensitive to the policy regime, in this case the monetary policy and exchange rate regime. For instance, the asset demand functions presumed in simple variants of the portfolio-balance approach to exchange rate determination are simply not stable over the policy experiments usually considered.

The present framework can obviously easily incorporate a large variety of real and nominal assets, and a large variety of monetary policies and exchange rate regimes. Several goods can be added to allow for a discussion of both goods and asset trade. Let us however discuss some of the more severe limitations inherent in the approach, and some related possible extensions. The main advantage of Law of Comparative Advantage, in general and when applied to our context, is that it requires information only about autarky equilibria, and that it is not necessary to solve explicitly for the trade equilibria. The main disadvantage is that it does not give exact results for a given asset but only results in terms of correlations, when there are more than one asset available for international trade. Roughly, the larger the number of assets, the less precise the prediction for each individual asset. More specific results about the pattern and volume of trade, for instance from comparative statics experiments, requires the direct study of the trade equilibria. Since it is frequently more difficult to solve for trade equilibria than for autarky equilibria, solvability of the trade equilibria may require additional restrictions on the model, restrictions not needed when the Law of Comparative Advantage is used. Persson and Svensson (1987) make

another country's CPI, since the CPIs would generally differ. On a micro level, a bond indexed to one investor's individual CPI would generally not be a perfect substitute to a bond indexed to another investor's individual CPI if their preferences and consumption baskets differ.

additional assumptions that allow explicit and simple solutions of such trade equilibria, and undertake a more specific study of how exchange rate variability determine trade patterns and trade volumes in asset trade equilibria.

An important simplifying aspect of the specific model we use is that assets' real return risk characteristics, summarized by the the real return matrix, depends only on outputs and monetary policies. Once the stochastic properties of outputs and monetary policies are specified, the real return matrix is given. In particular, for given monetary policies, the real return matrix is the same in autarky and in a trade equilibrium. If output is endogenously determined (for instance because investment is incorporated), or if the demand for money is specified in some other way than with the cash-in-advance constraints we have assumed, the real return matrix would in general not be exogenous once monetary policy is specified. In particular, the real return matrix would in general not be the same in a trade equilibrium as in an autarky equilibrium.[26]

Our approach can however still be used also when the real return matrix is different in autarky and in trade equilibria. The trick is to derive the real return matrix in the trade equilibrium, and then take that real return matrix as given and compute the corresponding hypothetical autarky asset prices for the given real return matrix. These hypothetical autarky prices then predict the pattern of trade in assets. Of course, the operation requires the solution of (at least part of) the trade equilibrium.

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[26] This complication also arises in the barter economy with real assets like claims to output, when output is endogenous. See Svensson (1987) for a discussion within the context of the barter economy of that complication and related ones when there many periods.

There is a related, and perhaps more fundamental, problem with applying the Law of Comparative Advantage in a monetary economy. The law requires the Gains-from-Trade Theorem to hold. The Gains-from-Trade Theorem need not hold if there are domestic distortions in autarky. Hence, it is crucial how money is introduced. More specifically, it is crucial whether or not money is introduced in such a way that the autarky equilibrium is distorted, that is, whether or not the autarky equilibrium is Pareto efficient. When money is introduced via cash-in-advance constraints and output is exogenous, the autarky equilibrium is Pareto efficient (this is a special case of the result by Helpman (1981) mentioned above, that a monetary trade equilibrium is equivalent to a barter trade equilibrium). If money is introduced in a different way so as to make the autarky equilibrium not Pareto efficient, it must be checked whether there still are gains from trade, before the Law of Comparative Advantage can be used. Whether there are gains from trade will obviously depend on the details of how the demand for money is modeled, and on what monetary policies are being pursued. Further research is needed on this issue.

Appendix: The Sequence of Markets and Transactions

The precise sequence of markets and transactions is the following. In the beginning of period 1 the consumer receives a transfer of home currency, $\bar{M}^1$, from the home government. (This transfer equals the period 1 supply of home currency.) After that he can trade currencies and assets on the world asset market. He takes the set J of assets and the return matrix r as given. Let M^1 and N^1 denote his holdings of home and foreign currency after trading on the asset market. His budget constraint is then

(A.1) $\quad M^1 + e^1N^1 + Q^1z \leq \bar{M}^1,$

where $Q^1 = (Q_j^1)_{j \in J}$ is the J-vector of asset prices in terms of home currency, and Q^1z denotes the inner product $\Sigma_j Q_j^1 z_j$. After the transactions on the asset market are completed, the consumer can purchase goods on the goods market. He must pay for goods produced in the home country with home currency, and for goods produced in the foreign country with foreign currency. Hence, he faces the liquidity constraints

(A.2) $\quad P^1c_h^1 \leq M^1$ and $P^{*1}c_f^1 \leq N^1,$

where P^1 and P^{*1} are the goods prices in home and foreign currency, and c_h^1 and c_f^1 are consumption of goods produced in the home and foreign country. Goods produced in the home and foreign country are perfect substitutes in consumption, and total period 1 consumption is

(A.3) $\quad c^1 = c_h^1 + c_f^1.$

At the end of period 1, or in the beginning of period 2, the consumer receives revenues in home currency from the sale of home output. He learns the state of the world in period 2 , and receives a state-dependent cash transfer from the home government and the state-dependent currency returns on his assets. He can then trade on a world currency market in the beginning of period 2. His budget constraint in state s, is

(A.4) $\quad M^2(s) + e^2(s)N^2(s) \leq P^1y^1 + (\bar{M}^2(s)-\bar{M}^1) + (M^1-P^1c_h^1)$

$$+ e^2(s)(N^1 - P^{*1}c_f^1) + P^2(s)r(s)z.$$

The terms on the right-hand side are revenues from sales of home period 1 output, the cash transfer from the home government (which equals the expansion of the home money supply), home currency left over from the goods market in period 1, the value in home currency of foreign currency left over from the goods market in period 1 ($e^2(s)$ is the state-dependent exchange rate in period 2), and the home currency value of the return on assets. (The expression $r(s)z$ denotes product $\Sigma_j r_j(s)z_j$.)[27] On the left-hand side, $M^2(s)$ and $N^2(s)$ are the holdings of home and foreign currency after trade on the currency market is completed.

After the currency market, the consumer can by goods produced at home and abroad in the goods market, facing the liquidity constraints

(A.5) $\quad P^2(s)c_h^2(s) \leq M^2(s)$ and $P^{*2}(s)c_f^2(s) \leq N^2(s)$, for all s,

where $c_h^2(s)$ and $c_h^2(s)$ are consumption of goods produced in the home and foreign country, respectively. Total consumption in period 2 is

(A.6) $\quad c^2(s) = c_h^2(s) + c_f^2(s)$, for all s.

Towards the end of period 2 the consumer receives revenues $P^2(s)y^2$ in home currency from the sales of home output in state s in period 2. He has to pay a tax $T^3(s)$ in home currency to the home government. Hence he faces the constraints

(A.7) $\quad 0 \leq P^2(s)y^2 + (M^2(s) - P^2(s)c_h^2(s)) - T^3(s)$, for all s.

(The second term on the right-hand side is home currency left over from the period 2 goods market.)

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27 The home currency value of the returns, $P^2(s)r(s)z$, equals the sum of returns on home currency assets, $\Sigma_{j \notin J^*} R_j(s)z_j$, and the home currency value of foreign currency assets, $e^2(s)\Sigma_{j \in J^*} R_j^*(s)z_j$, where $J^* \subset J$ denotes the subset of foreign currency assets.

The home consumer's decision problem is hence to choose consumption $(c^1,(c^2(s)))$, currency holdings $(M^1,M^2(s))$ and $(N^1,N^2(s))$, and asset import z, so as to maximize the expected utility function (2.3) subject to the constraints (A.1)-(A.7).

The home government supplies home currency M^1 in period 1, and $M^2(s)$ in state s in period 2, via net transfers to the home consumer. It also levels the tax $T^3(s)$ on the home consumer at the end of period 2. This tax has to be paid in home currency, but is is indexed such that its real value is equal to home period 2 output in state s. Hence it is given by[28]

(A.8) $$T^3(s) = P^2(s)y^2, \text{ for all } s.$$

This completes the description of the home country's transactions. The foreign country also consists of a representative consumer and a government. The foreign consumer chooses consumption $(c^{*1},c^{*2}(s))$, currency holdings $(M^{*1},M^{*2}(s))$ and $(N^{*1},N^{*2}(s))$, and asset import z*, so as to maximize his expected utility subject to a similar sequence of constraints as the home consumer. At the beginning of period 1 the foreign consumer receives a transfer N^1 of foreign currency from the foreign government. Thereafter he can trade on the world asset and goods market and then faces constraints analog to (A.1)-(A.3). As the home consumer, he takes the set J of assets and the return matrix r as given. At the beginning of period 2 the foreign consumer receives foreign currency revenues from sales of foreign period 1 output, a foreign currency transfer $N^2(s)-N^1$ from its government, and returns on its assets. The foreign consumer trades on the period 2 currency and goods

[28] The only role of this tax is to provide a rationale for the sale of period 2 output, even though the revenues reach the consumer after the goods market is closed. If the tax is introduced it need to be defined in real terms to give a determinate price level in the second period. Alternatively, one can disregard the tax, and simply assume that period 2 output is supplied and sold even though there is no use for the cash revenues received.

markets and then faces constraints analog to (A.4)-(A.6). Finally, at the end of period 2 the foreign consumer receives foreign currency revenues from sales of foreign period 2 output, and must pay a tax $T^{*3}(s)$ in foreign currency to the foreign government, hence facing the constraint analog to (A.7),

(A.9) $\quad 0 \leq P^{*2}(s)y^{*2} + (N^{*2}(s) - P^{*2}(s)c_f^{*2}(s)) - T^{*3}(s)$, for all s.

The foreign government supplies foreign currency $(\bar{N}^1, \bar{N}^2(s))$ and levies the tax $T^{*3}(s)$ in foreign currency at the end of period 2 such that the tax's real value is equal to foreign period 2 output, that is,

(A.10) $\quad T^{*3}(s) = P^{*2}(s)y^{*2}$, for all s.

Equilibrium on the asset market in period 1 requires that demand and supply of currencies are equal, and that home and foreign asset import sum to zero. That is,

(A.11) $\quad M^1 + M^{*1} = \bar{M}^1,\ N^1 + N^{*1} = \bar{N}^1$, and

(A.12) $\quad z^1 + z^{*1} = 0.$

Equilibrium in the goods market in period 1 requires that home and foreign consumption of goods produced in the home country, and in the foreign country, are equal to output of goods in the home and foreign country, that is,

(A.13) $\quad c_h^1 + c_h^{*1} = y^1$ and $c_f^1 + c_f^{*1} = y^{*1}$.

Equilibrium on the period 2 currency market in each state of the world requires

(A.14) $\quad M^2(s) + M^{*2}(s) = \bar{M}^2(s)$ and $N^2(s) + N^{*2}(s) = \bar{N}(s)$, for all s.

Equilibrium on the period 2 goods market in each state of the world implies

(A.15) $\quad c_h^2(s) + c_h^{*2}(s) = y^2$ and $c_f^2(s) + c_f^{*2}(s) = y^{*2}$, for all s.

The equilibrium can be determined from these market equilibrium conditions and the behavioral functions derived from the home and foreign consumers' decision problems. There is, however, a much simpler way to determine the equilibrium. The trick is to use binding liquidity constraints to simplify the consumers' budget constraints. More precisely, we shall show that consumers' budget constraints in equilibrium are equivalent to those in a barter economy.

First, let us note that from (A.7)-(A.10) it follows that in equilibrium the liquidity constraints (A.5) and their analogs for the foreign country are binding in each state in period 2. (Constraint (A.5) for foreign currency must bind if the consumer maximizes his utility. Constraints (A.7) and (A.8) imply (A.5), hence the consumer can in equilibrium fulfill (A.7) and still let (A.5) for home currency bind.) Together with the goods market equilibrium conditions (A.15) this implies that the home and foreign price levels in period 2 fulfill the quantity-theory (-of-money) equations

(A.16) $\quad P^2(s) = M^2(s)/y^2$ and $P^{*2}(s) = N^2(s)/y^{*2}$, for all s,

that is, (5.1).

Under the assumption that the nominal interest rates on home and foreign currency bonds are positive it is optimal for the home and foreign consumers not to hold any excess cash. Then it follows that the period 1 liquidity constraints (A.2) and their analogs for the foreign country are binding, which together with the period 1 goods market equilibrium condition (A.13) implies that the period 1 home and foreign price levels fulfill the quantity-theory equations[29]

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[29] If the nominal interest rate on home currency bonds, say, is zero (that is, if the nominal price on the period 1 asset market of a claim to a sure unit of home currency in period 2 is equal to unity, $1/(1+i) = Q_m^1 = 1$) the consumers are indifferent to the amount of excess home currency balances they hold. It can be shown that the period 1 home price level then is independent of period 1 home currency supply and given by the more complicated equation $P^1 = U_c(c^1)/\beta E[U_c(c^2)y^2/M^2] \leq y^1/M^1$. The equivalence of the monetary equilibrium with that of a barter economy still holds, as Helpman (1981) has demonstrated for the certainty case. (The argument for the uncertainty case is easy to construct.)

Our results about the trade pattern in nominal assets is independent of whether period 1 liquidity constraints bind or not.

(A.17) $P^1 = M^1/y^1$ and $P^{*1} = N^1/y^{*1}$.

We also note that in equilibrium the Law of One Price must hold. If it would not, home and foreign consumers would shift all their demand towards goods from one country. Hence,

(A.18) $P^1 = e^1 P^{*1}$ and $P^2(s) = e^2(s) P^{*2}(s)$, for all s,

that is, (5.2)

It follows from (A.16)-(A.18) that the exchange rate equations are

(A.19) $e^1 = (M^1/N^1)(y^{*1}/y^1)$ and $e^2(s) = (M^2(s)/N^2(s))(y^{*2}/y^2)$, for all s,

that is, (5.3).

Using the quantity equations and the Law of One Price, it is easy to see that the period 1 budget and liquidity constraints for the home consumer can be simplified to $P^1c^1 + Q^1z = P^1y^1$, or

(A.20) $c^1 + qz = y^1$,

where $q = (q_j) = (Q_j^1/P^1)$ is the J-vector of asset prices measured in goods. This implies (2.7). Similarly, the period 2 budget constraint simplifies to $P^2(s)c^2(s) \leq P^2(s)y^2 + P^2(s)r(s)z$, or

(A.21) $c^2(s) \leq y^2 + r(s)z$, for all s,

that is, (2.5).

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Table 1. Summary of Results: Output Differences

Foreign policy:	(a) Passive ($k^*=0$)	(b) Stable price level ($k^*=1$)	(c) Two-sided peg
Home policy:			
(1) Passive ($k=0$)	m=h: Export n=f: Import	m=h: Export n=0: ?	
(2) Stable price level ($k=1$)	m=0: ? n=f: Import	m=n=0: No trade	
(3) One-sided peg	m=n=f: Import	m=n=0: No trade	
(4) Two-sided peg			m=n=w: No trade

Table 2. Summary of Results: Home Country More Risk Averse

Foreign policy:	(a) Passive ($k^*=0$)	(b) Stable price level ($k^*=1$)	(c) Two-sided peg
Home policy:			
(1) Passive ($k=0$)	m=n=w: Export	m=w: Export n=0: ?	
(2) Stable price level ($k=1$)	m=0: ? n=w: Export	m=n=0: No trade	
(3) One-sided peg	m=n=w: Export	m=n=0: No trade	
(4) Two-sided peg			m=n=w: Export

"Export" and "Import" for an asset denotes a tendency for the home country to export or import the asset. "?" denotes either export or import (autarky asset prices are equal but other assets are also traded). "No trade" denotes neither export nor import (autarky asset prices are equal, and no other asset is traded).