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1. Introduction

Media reports on foreign exchange rates are filled with discussions of "overvalued" or "undervalued" currencies. Stories in the financial press about changes in exchange rates frequently state that they affect international competitiveness and employment. The stories often discuss relations between exchange rates and the nation's trade deficit or the federal government's budget deficit. They often state that changes in the exchange rate hurt or benefit the economy, and sometimes discuss policy options available to the government.

Most of these stories are based on a particular disequilibrium theory of exchange rates that has come under increasing criticism in recent years. The disequilibrium theory conflicts with available evidence and an alternative equilibrium theory based on simple economic principles has been developed. The new theory has completely different implications and policy prescriptions than the earlier theory, which underlies most current public policy discussions. This article summarizes the basic elements of the equilibrium approach to exchange rate behavior and the evidence that conflicts with the older disequilibrium theory. It argues that the equilibrium approach to exchange rates is in better accord with this evidence. It concludes with a discussion of the implications of the equilibrium approach to exchange rates for economic policies.

2. Overview of the Issues

The main argument of the paper is the following. Economic theory predicts that real disturbances to supplies of goods or demands for goods cause changes in relative prices, including the "real exchange rate".[1] In a wide variety of circumstances, these changes in the real exchange rate are partly accomplished through changes in the nominal exchange rate. Repeated disturbances to supplies or demands thereby create a correlation between changes in real and nominal exchange rates. This correlation is consistent with equilibrium in the economy, in the sense that markets clear through price adjustments. This is the basis for the "equilibrium approach" to exchange rate changes, and it has several important implications about exchange rate changes. First, exchange rate changes are not "causes" of changes in relative prices, but part of the process through which the changes occur in equilibrium. Second, the question of whether a change in the exchange rate — or more general exchange rate volatility — is "good" or "bad" for the economy is not correctly posed because the exchange rate is an endogenous variable. The right question is whether the underlying disturbances to the economy are "good" or "bad," so (of course) the answer varies with the disturbance. Third, the correlation between nominal and real exchange rates is not exploitable by government policy in the sense that attempts by the government to affect the real exchange rate by changing the nominal exchange rate (e.g. through foreign exchange market intervention, a return to fixed exchange rates, or "target zones" for exchange rates) will fail. Fourth, there is no simple relation between changes in the exchange rate and changes in "international competitiveness" or employment. It is

incorrect, according to the theory, to blame decreased "competitiveness" on the exchange rate. It is equally incorrect to expect that (by itself) an alternative exchange rate system such as fixed rather than floating exchange rates will affect competitiveness. Fifth, there is no simple relation between the exchange rate and the balance of trade or the current account of the balance of payments.[2] Trade deficits do not "cause" currency depreciation, nor does currency depreciation by itself help reduce a trade deficit. Sixth, government budget deficits do not necessarily cause currency appreciation (even if they cause trade deficits). Finally, changes in exchange rates are not related in any simple manner to changes in international interest rate differentials (which may be affected by government budget deficits).

Many of these implications of the equilibrium approach may appear surprising. They conflict with claims that are commonly made in the financial press. But, according to the equilibrium view of exchange rates, many of the assumptions and statements commonly made in the media about exchange rates are simply wrong. This article will explain why.

Some of the propositions stated above may also appear at first to conflict with experience. But, this paper will argue, the experience that appears to conflict with these propositions is only selective. More generally, the evidence is consistent with the implications of the equilibrium approach and fails to support the older, alternative theory.

The alternative "disequilibrium" theories of the exchange rate are based on sluggish adjustment of nominal prices. According to the disequilibrium view, nominal disturbances can cause changes in real exchange rates; changes

in nominal exchange rates are naturally translated into changes in real exchange rates because of slow prices adjustments. This view of exchange rate changes underlies most popular accounts of exchange rate changes and policy discussions in the media. It implies that the correlation between real and nominal exchange rate changes is exploitable by government policy (e.g. by establishing "target zones" for exchange rates or intervening in foreign exchange markets in some other manner). It implies that currencies may become "undervalued" or "overvalued" relative to equilibrium, and that these disequilibria affect international "competitiveness" in ways that are not justified by changes in comparative advantage (adjusted for government policies such as tariffs, regulations, etc.). Some versions of the disequilibrium approach also imply systematic relations between the exchange rate and the trade deficit (or the current account deficit), e.g. they imply that the current U.S. deficit will be reduced eventually by a fall in the value of the dollar, with a "hard landing" or "soft landing" occurring under various conditions that can perhaps be affected by government intervention in foreign exchange markets.

Econometric testing of these models is in its infancy, but there is some evidence that supports the equilibrium models. According to the disequilibrium approach, a change in the real exchange rate occurs in response to changes in the nominal exchange rate because of slow nominal price adjustment. But as prices eventually adjust toward their new equilibrium levels, the real exchange rate should adjust back toward its equilibrium value. Monetary disturbances, then, should create temporary movements in real exchange rates. Initial increases in the real exchange

rate should be followed by decreases within a few years as nominal prices readjust to equilibrium.[3] According to many of the disequilibrium models such as Dornbusch (1976), monetary disturbances should also create temporary movements in nominal exchange rates.[4]

But statistical evidence indicates that changes in real exchange rates tend to be nearly permanent (on average), or to persist for very long periods of time. The evidence also indicates that changes in nominal exchange rates — even very short term day-to-day changes — are largely permanent (statistically). This persistence is inconsistent with the view that nominal shocks, or even temporary real shocks, cause most of the important changes in exchange rates. Instead, it is consistent with the view that most changes in real exchange rates are due to real shocks with a large permanent component. Because changes in real and nominal exchange rates are very highly correlated and have similar variances, it is also consistent with the view that most changes in nominal exchange rates are due to largely permanent real disturbances.

This paper discusses the basics of the equilibrium models, their implications, and their relation to existing evidence.[5] Section 3 presents a simple model on which the remainder of the article builds. Some modifications of the mode are discussed in Section 4. Section 5 discusses some evidence on exchange rates, Section 6 discusses relations between the exchange rate, the balance of trade and some other economic variables, and Section 7 discusses some additional evidence about exchange rates. Finally, Section 8 concludes and raises some policy issues.

3. A Simple Model of Exchange Rates

This section will develop a simple core model of the exchange rate and discuss its properties. Subsequent sections will discuss some additional features that can be added to this model. The simplest model (from an example in Stockman, 1980) embodies the assumptions described below as A0-A6. The role of these assumptions is to clarify the exposition of the equilibrium approach to exchange rates. Most of these assumptions can be dropped without altering the main points of this article. One very important assumption that cannot be dropped without changing many of the results is discussed in Section 4.3. The first five assumptions are:

A0. There is only one period of time, so there is no borrowing or lending. (This assumption will be dropped in Section 6.)

A1. There are two countries, domestic and foreign, that are identical except for the differences spelled out in the other assumptions.

A2. There are two goods. The domestic country produces good X (only), while the foreign country produces only good Y. Output in each country is fixed each period (perfectly inelastic) due to fixed input supplies and technology. Both goods are parishable. There is perfect competition among producers.

A3. The two countries trade so that households can consume both goods. There are no barriers to trade, transportation costs, or transactions costs. Households in each country have the same tastes, expressed here as systems of indifference curves between X and Y (see Figure 1). Both goods are normal.[6]

A4. Households in the two countries are equally wealthy.[7]

The world supplies of X and Y can be divided by world population to obtain per capita supplies x^S and y^S, shown in Figure 1 along with some of the indifference curves.[8] Assumptions A3 and A4 state that households in both countries have the same tastes and resources. So all households will consume the same amounts of both goods. In equilibrium, each household consumes the quantities x^S and y^S, represented by point A in the figure. Because supplies of the goods are perfectly inelastic (i.e. completely insensitive to price changes), tastes for goods affect equilibrium prices but not quantities. The equilibrium relative price of the two goods is determined by the slope of the indifference curves at point A. In particular, the relative price of good Y in terms of good X, π_y, equals the absolute value of the inverse of the slope of the indifference curve passing through point A. Flatter indifference curves represent higher equilibrium relative prices of Y. Steeper indifference curves passing through point A represent lower relative prices of Y. The relative price of Y, π_y, is the real exchange rate (see footnote 1).

Nominal exchange rates become part of the model when money supplies and money demands are incorporated in the model. The nominal exchange rate is the price of foreign money — say pounds — measured in terms of domestic money — say dollars. Assumptions about the money supply and the demand for money in each country are required.

A5. The nominal supplies of domestic and foreign monies, dollars and pounds, are denoted by M^S and M^{*S} and are fixed by the governments (or central banks) of the two countries.

A6. The demand for domestic money, dollars, is

(1a) $M^d/p_X = \alpha$

where M^d is the nominal quantity of dollars demanded, p_X is the nominal dollar price of good X, and α represents the real demand for dollars (in terms of good X), which is treated as exogenously fixed. Similarly, the demand for foreign money, pounds, is

(1b) $M^{*d}/p^*_y = \alpha^*$

where p^*_y is the nominal price of good Y measured in terms of pounds and α^* is the real demand for pounds, measured in terms of Y: α^* is also exogenously fixed.

In equilibrium, money demands and supplies must be equated. Setting $M^s = M^d$ and $M^{*s} = M^{*d}$ in (1) gives solutions for nominal export prices (or GDP deflators) p_X and p^*_y:

(2a) $p_X = M_s/\alpha$ · and

(2b) $p^*_y = M^{*s}/\alpha^*$ ·

The nominal exchange rate enters into the model becuase the relative price of Y in terms of X (which is minus the slope of the indifference curve passing through point A in Figure 1) is

(3) $\pi_y = ep^*_y/p_x$

where e is the nominal exchange rate, i.e. the dollar price of one pound. Notice that the dollar price of the foreign good Y is given by arbitrage in goods markets at $p_y = ep_y^*$. Similarly, the pound price of the domestic good X is $p^*_x = p_x/e$. Substituting (2) into (3) gives an equation for the exchange rate:

$$(4) \qquad e = \frac{M^s \alpha^*}{M^{*s} \alpha} \pi_y .$$

This is the key equation determining the nominal exchange rate. The model can be modified and made more realistic in many ways, but some essential features of (4) will continue to describe exchange rates. This solution has several features, some of them more obvious than others. First, increasing the domestic money supply by k% raises domestic prices by k% and leads to a k% rise in the exchange rate, which means a k% depreciation of the dollar. Second, an increase in α, lowers domestic nominal prices and the nominal exchange rate (i.e. leads to dollar appreciation). Changes in foreign money supply or foreign money demand have the opposite effects on the nominal exchange rate.

A third key feature of (4) is that it involves the relative price, or real exchange rate, π_y. Given the nominal supplies of moneys, M^s and M^{*s}, and given the real demands for moneys measured in terms of the goods produced in each country, α and α^*, an increase in the relative price of imports, π_y,

raises the nominal exchange rate. Recall that an increase in π_y means a flattening of the indifference curve passing through the point in Figure 1 that corresponds to the (per-capita) supplies of goods. There are two possible ways in which an increase in the relative price of imports can occur: a change in demand or a change in supply. (1) Demand may change because tastes change so that the indifference curve passing through point A becomes flatter. Or (2) the supplies of X or Y may change, so that the new supplies are represented by a point in Figure 1 at which the indifference curve is flatter, such as point B (resulting from a rise in the supply of X) or point C (resulting from a fall in the supply of Y).

When a change in supply or in demand occurs, it may affect foreign wealth, domestic wealth, or both. To determine the effects of a change in demand or supply, we must take into account its effects on wealth in each country. For example, suppose domestic output rises exogenously (because of an increase in domestic productivity). The domestic firms that produce the additional output may be owned entirely by people in the domestic country. Alternatively, if foreign households also own shares of stock in domestic firms then the rise in domestic output would also raise foreign wealth — because foreigners would share in the additional dividends or capital gains from shares of domestic firms. Even if only domestic households own domestic firms, an exogenous rise in domestic output will lower the relative price of the domestic good. If its price falls only a little then the domestic country will be wealthier than before — it has more goods to consume or sell. But if the price of domestic output falls very much then the domestic country will be less wealthy than before: e.g. owning ten apples each worth

one banana may be worse than owning eight apples each worth two bananas. In either case, foreign wealth rises because foreigners are able to buy domestic goods at a lower relative price. So, for a concrete discussion, we need to make an assumption about how changes in demand or supply affect the distribution of wealth. Tentatively we assume:

A7. People in both countries hold exactly the same fractions of their wealth in the stock of any firm (so foreigners own as much of domestic firms as domestic residents do, and the same applies to foreign firms).

Assumption A7 implies that a change in supply or demand for goods affects wealth by an equal amount in both countries, because shares of firms are equally owned by both countries. Then foreign and domestic wealth are equal after as well as before any change, so foreign and domestic consumption will be discussed in Section 4.1.

The effects on the exchange rate of changes in demands or supplies of goods can now be summarized. Consider in turn changes in each of x^S, y^S, tastes for goods, α, and α^*, holding money supplies and the other variables fixed.

(a) An increase in the supply of domestic goods raises (lowers) the relative price of foreign (domestic) goods and thereby depreciates the dollar (raises e). The physical quantity of exports also rises, as consumption of the good rises in both countries.[9] An observer, seeing that dollar depreciation is associated with a fall in the relative price of domestic exports and an increase in the volume of exports, might conclude that the

domestic country had become "more competitive" as a result of the depreciation of the dollar. But this interpretation is confused. The change in the exchange rate does not cause changes in relative prices or the quantity of exports. The change in the exchange rate is itself a result of an underlying economic change which also affects other prices and quantities. The distinction is important not only for an accurate understanding of the economy but also for intelligent policy decisions. An observer who mistakenly believes that the "increase in competitiveness" (fall in the relative price of domestic exports) and increase in export volume was caused by a currency depreciation might be tempted to recommend that a further currency depreciation be engineered by increasing the domestic money supply or altering other policies so as to reduce domestic money demand. But, as noted in (d) below, these policy changes would affect the exchange rate without altering "competitiveness" or the quantity of exports.

(b) An increase in the supply of foreign goods lowers their relative price and appreciates domestic money (lowers e). The volume of domestic imports also rises. An observer, who witnesses a simultaneous dollar appreciation, decline in "competitiveness" in the sense of a rise in the relative price of domestic exportables in terms of foreign goods, and rise in the volume of imports, might mistakenly believe that the change in the exchange rate was the cause. He might recommend a rise in the money supply or other policies that reduce domestic money demand in order to mitigate or reverse the dollar's appreciation. But, while those policies may succeed in depreciating the dollar, they would fail to change relative prices (such as the real exchange rate) or the volume of imports.

(c) An increase in the demand for domestic goods and fall in the demand for foreign goods appreciates the dollar. (The demand for foreign goods falls because any change in the demand for domestic goods must be accompanied by a reduction in the demand for something else, given household budgets.) A shift in tastes away from foreign goods toward domestic goods is represented by a steepening of all the indifference curves, as shown in Figure 2. Given supplies of goods at point A, this implies a rise in the relative price of domestic goods.[10] This might be termed a fall in domestic "competitiveness" by some people, although the volumes of exports and imports would be unaffected if the change in tastes occurs in both countries equally (as assumption A3 states).[11] As before, it would be a mistake to conclude that the rise in the relative price of domestic goods was caused by the appreciation of the dollar. Instead, they are both results of an underlying change in demand.

(d) A rise in the domestic money supply or a fall in the domestic demand for money causes dollar depreciation. But relative prices and trade volumes are unaffected because nothing in Figure 1 changes.

It is not possible to discuss trade deficits with this model, because the model includes only a single time period. A dynamic model is required for analysis of such issues as the connections between exchange rates and trade imbalances, interest rates, international capital flows, and budget deficits. The model is expanded in Section 6 so that these issues can be discussed. But there are a number of other important points that can be made without the complications of a dynamic model.

4. Two Modifications of the Model

This section discusses two possible modifications of the model presented in Section 3. Subsection 4.1 contains a discussion that will be useful in section 6: subsection 4.2 develops a modification that will be used in Section 5. Section 4.3 discusses a very important assumption made in the equilibrium theory of exchange rates. Unlike the other assumptions of the model, it cannot be changed without altering many of the results.

4.1 Wealth Redistribution Effects

Suppose Assumption A7 is dropped. An alternative assumption is required to replace it. One alternative is that only domestic households own shares in domestic firms and only foreign households own shares in foreign firms. (This assumption leaves open the question of why households fail to achieve the gains that could be obtained, in terms of lower risk for the same return, by international portfolio diversification.) To keep the discussion simple and concrete, we add a stronger assumption than is necessary for the results. Assume A7 is replaced by the assumption

A8. (i) Firms in each country are owned entirely by households in that country. (ii) The utility function is homothetic, i.e. if a person's income rises and the relative price of goods does not change, then the fraction of his income that he spends on each good does not change.[12]

Assumption A8 implies that changes in the international distribution of wealth can occur, but they do not affect the equilibrium relative price. If wealth is redistributed from the foreign to the domestic country, then the

fall in foreign demand for each good is exactly offset by the rise in domestic demand for that good, leaving the total world demand (and the equilibrium relative price) unaffected. In the figures, A8 implies that all of the indifference curves have the same slope along a line coming out of the origin.

With Assumption A8, the discussions above regarding changes in supplies of goods continue to apply, with one caveat: one country may end up wealthier — and so may consume more — than another.[13] This is illustrated in Figure 3. Assume there are N households in each country, so world population is 2N. World per-capita output of the domestic good is x^S: its total output is $2Nx^S$. Each of the N domestic households owns $2x^S$ of the domestic goods before international trade takes place. An increase in domestic productivity raises total domestic output from $2Nx^S$ to $2N(x^S+z)$. So the per-capita supply of X rises from x^S (point A in Figure 3) to x^S-z (shown as point B). The budget line of a domestic household now goes through point G in Figure 3. Domestic households consume at point D and foreign households consume at point F. Average world consumption is at point B (as it must be, since total demand must equal total supply).

The disucssion above regarding a change in demand for goods also requires only one modification: volumes of exports and imports may be affected. If the demand for domestic goods rises (and the demand for foreign goods falls), then the rise in the relative price of domestic goods raises domestic wealth and reduces foreign wealth. This is illustrated in Figure 4. Initially, all domestic households consume at point A. The budget line going through point A is tangent to the indifference curve at that point. Then tastes change.

and all indifference curves get steeper. In the new equilibrium, domestic households consume at point D and foreign households consume at point F. The volume of domestic exports falls and the volume of domestic imports rises. The fall in exports would probably reinforce the views of someone who thought that the appreciation of domestic money caused the fall in competitiveness. But it would continue to be a mistake to think that the nominal exchange rate change caused the changes in the real exchange rate and the volumes of exports and imports: all are results of an underlying change in households' preferences for goods.[14]

4.2 An Alternative Specification of Money Demand

Suppose Assumption A6. which specified that money demands are given by (1), is replaced by

A9. The demands for domestic and foreign money are given by

(1') $M^d/p_x = f(x^s)$ and $M^{*d}/p^*_y = f^*(y^s)$.

This assumption states that real money demand in each country (in terms of that country's output good) is a function of the country's real income measured in the country's output good. A special case of (1') occurs if real money demands are given by

(5) $M^d/p_x = \alpha x^s$ and $M^{*d}/p^*_y = \alpha^* y^s$

so that money demand in each country is a function of that country's GDP (gross domestic product). Then α and α^* can be thought of as the inverses of the velocity of money in each country.

With Assumption A9, equilibrium nominal prices and the equilibrium exchange rate are given by

$$(2') \qquad p_x = M_s/f(x^S) \qquad \text{and} \qquad p^*_y = M^{*S}/f^*(y^S),$$

and

$$(4') \qquad e = \frac{M^S\ f^*(y^S)}{M^{*S}\ f(x^S)}\ \pi_y\ .$$

To determine the effects of changes in supplies or demands, we again invoke assumption A7 (rather than A8). Replacing the money demand specification (1) with (1') leaves the previous analyses of changes in money demands or supplies unaffected. The effects of changes in the demands for foreign versus domestic goods are also exactly the same as in the previous analyses. But the effects of changes in the supplies of goods are now more complicated.

An increase in the supply of domestic goods has two analytically separate effects. First, it raises π_y as before. Given p_x and p^*_y, (3) shows that this raises e, that is, it depreciates the dollar. This can be called the "relative price effect" of an increase in domestic output. The magnitude of the relative price effect (given the change in supply) is greater when the

demand for the good is more inelastic, i.e. when the elasticity of substitution between foreign and domestic goods is smaller (see footnote 15). This occurs when the domestic and foreign goods are poor substitutes for each other. Second, an increase in domestic output raises the demand for money and, as (2') shows, reduces the dollar price of domestic goods. Given the relative price π_y, this reduces the exchange rate e, that is, it appreciates the dollar. This can be called the "money-demand effect" of an increase in domestic output.

The "relative price effect" and the "money demand effect" push the nominal exchange rate in opposite directions in response to an increase in domestic output. Whether the exchange rate rises or falls depends on the relative sizes of these effects. The nominal exchange rate rises — as before — if and only if the relative price effect dominates the money demand effect, i.e. if and only if the inverse of the elasticity of substitution between foreign and domestic goods is smaller than the income elasticity of the demand for money.[15] In the special case of (5), the income elasticity of the demand for money is one.

Let k denote the income elasticity of money demand. Then the money demand effect alone implies that the exchange rate (and each domestic nominal price) falls k percent for each one percent rise in output. If foreign and domestic goods are sufficiently poor substitutes for each other, then the elasticity of substitution between the two goods will be less than 1/k. Then its inverse is larger than k, so a one percent rise in supply of the domestic good reduces its relative price by more than k percent. This effect alone raises the exchange rate by more than k percent. Combining these two effects, the exchange rate rises.

4.3 An Important Assumption

The models described above have the essential feature that the demand for money in each country is fixed in terms of that country's output, as in (1), (1'), or the special case (5). Equation (5) implies that the nominal demand for money is proportional to nominal GDP. If, instead, the nominal demand for money were proportional to the nominal value of consumption (with the same factor of proportionality, α or α^*), then the demands for moneys would be

$$(5') \qquad M^d = \alpha(p_x x^s + ep^*_y y^s) \quad \text{and} \quad M^{*d} = \alpha^*(p_x x^s/e + p^*_y y^s).$$

In this case, a change in the demand for goods — holding fixed money supplies and α and α^* — would alter π_y as before, but not (5') implies that $p_x x^s - ep^*_y y^s$ and $p_x x^s/e + p^*_y y^s = (p_x x^s + ep^*_y y^s)/e$ are both unaffected by the change in demand. Consequently, e is unaffected. So the change in the relative price π_y occurs through a change in p_x and p^*_y. For example, a shift in demand away from foreign goods and toward domestic goods lowers $\pi_y = ep^*_y/p_x$ by lowering p^*_y and raising p_x (while the weighted average of the two, $p_x x^s + ep^*_y y^s$, stays fixed). An increase in the supply of the domestic good now leaves the exchange rate unchanged. It raises π_y, the real exchange rate. But (5') implies that $p_x x^s - ep^*_y y^s$ and e are unchanged, so p^*_y rises and p_x falls, with e unchanged. Evidently, a very important feature of the models in previous sections is that the demands for money in the two countries are appropriately expressed in "real" terms in terms of

different bundles of goods. In other words, there are measures of "real" money demands in each country that are invariant to shifts in demand across goods or in supplies of goods, and these invariant measures of real money demands differ across countries. This issue seldom arises in macroeconomic discussions of other issues, but it is extremely important in the economics of exchange rates. The remainder of this article returns to the assumption (1'). It is not at all unrealistic that money demands differ across countries in ways similar to the assumptions made in earlier sections, such as (1'). Consumption bundles differ across countries particularly when allowance is made for nontraded goods and the nontraded components such as retail services, local inventories, transportation, etc., that are embedded in the retail prices of even ostensibly "traded" consumer goods.

5. Some Evidence on Actual Exchange Rates

At this point it is useful to view a plot of real and nominal exchange rates and other prices, as in Chart 1. The chart shows the nominal exchange rate e, the real exchange rate π_y, and the ratio of GNP deflators p^*_y/p_x, where p^*_y is the foreign GNP deflator and p_x is the US GNP deflator. The chart graphs quarterly data for Canada, Britain, and Germany (versus the United States) from the early 1970s when exchange rates were allowed to float. The qualitative features of the plot apply also to other pairs of countries with flexible exchange rates.

Notice that the nominal exchange rate and the real exchange rate move together fairly closely. Most variations in exchange rates — at least among countries with reasonably similar rates of inflation (e.g. OECD countries in

the recent past) — are associated with roughly equal variations in the relative price of foreign and domestic goods. This implies that the main source of disturbances to exchange rates must be something — like the changes in supplies or demands for goods discussed above — that changes the relative price, and not disturbances that affect only nominal variables (like changes in money demand or supply). Of course, much of macroeconomics is devoted to studying various possible effects of changes in money supply or demand on real variables such as output and relative prices. But these effects of monetary policy on real variables — if they are important — are temporary (or at least contain large temporary components). As we shall see, most of the evidence indicates that changes in nominal and real exchange rates are approximately (statistically) permanent, which is difficult to explain on the basis of temporary real effects of monetary disturbances.

Another feature of Chart 1 is that the exchange rate varies much more than the ratio of nominal GNP deflators. (This feature also holds for other country pairs and time periods.) It is convenient to call this feature of the data the "excess variability of exchange rates," though this should not be presumed to imply that this variability is bad in any sense, or indicative of a problem with the operations of markets. It is simply a feature of the data whose interpretation is yet to be determined. This feature can easily be explained with the model from Section 3 above, consisting of equations (2), (3), and (4). Variations in supplies or demands for goods — holding M^S, M^{*S}, α, and α^* fixed — affect π_y but not p_x or p^*_y, so all changes in π_y occur through changes in the exchange rate. But the modified model from Section 4.2, consisting of equations (2'), (3), and (4') can explain the

excess variability of exchange rates only under certain conditions. Shifts in demand between foreign and domestic goods change the exchange rate but not the ratio of nominal GDP deflators, so these shifts in demand can explain the excess variability of exchange rates without any additional assumptions. But shifts in supplies of goods only create excess variability in the exchange rate if the elasticity of substitution between foreign and domestic goods is smaller than the inverse of twice the income elasticity of money demand.[16] A one percent rise in domestic output lowers the domestic nominal GNP deflator by k percent, where k is the income elasticity of money demand. If the elasticity of substitution in consumption is 1/k, then a one percent increase in domestic output reduces the new equilibrium relative price of domestic goods by k percent. Since p* is unchanged, the k percent fall in p/ep* occurs automatically by the k percent fall in p, without any change in the exchange rate. This explains why the direction of the exchange rate change depends upon whether the elasticity of substitution is larger or smaller than 1/k. Even if the elasticity is smaller than 1/k, in order to obtain a larger percentage change in the exchange rate than in the ratio of GNP deflators, it is necessary that the relative price effect not only be larger than the money demand effect (in order to counteract it completely), but more than double its size. So demand disturbances can clearly explain the excess variability of exchange rates with this model, but supply disturbances can do so only if the elasticity of substitution between foreign and domestic goods is particularly small.[17]

None of these results depend on whether assumption A7 or A8 is invoked. However, if both A7 and A8 are violated, then supply or demand changes affect

the international distribution of wealth and alter relative prices. In that case, the exact conditions discussed here would have to be modified.

6. The Exchange Rate and the Balance of Trade

If the model described in Section 4.2 (or the one from Section 3) is used to describe the world in each of a series of time periods, then it is possible to discuss the balance of trade, international capital flows, the effects of government budget deficits, and other related issues. This section discusses the operation of the model when nations are able to borrow or lend, i.e. to have trade deficits or surpluses. It then examines the relations between nominal and real exchange rates and the balance of trade in response to various exogenous disturbances.

Suppose there are two time periods rather than one. (The extention to more periods is straightforward.) The two-period intertemporal model can be described by repeating the model from Section 4.2 at each time period. Make assumptions A1, A2, A3, and A4. At each date there are fixed supplies of the domestic and foreign goods. The real exchange rate π_y is equal to (minus) the slope of the indifference curve passing through point A in Figure 1, just as before, at each date. Nominal prices and the exchange rate at each date are given by (2') and (4').

The equilibrium balance of trade, and the effects of various exogenous disturbances, depends on how the international distribution of wealth is affected by exogenous disturbances. (This issue also arose in the one-period models discussed in previous sections, but trade was always balanced in those models.) If a change in supply or in demand in the first period raises

domestic wealth more than foreign wealth, then the domestic country will begin the second period with greater wealth than the foreign country. Assumption A4 (which postulated equal initial wealth) will not apply in the second period. If we make assumption A7 then both countries remain equally wealthy at all times. This corresponds to the model in Lucas (1982). On the other hand, if international trade in financial assets is limited in some effective way, then we may make assumption A8 and changes in supplies or demands may redistribute wealth, which corresponds to the model in Stockman (1980).

We adopt assumption A8 for the remainder of this section.[18] Then the relative price of the two goods is always the slope of the indifference curve passing through point A, but one country may consume more of both goods than the other, because (even if the countries begin with equal wealth) an exogenous disturbance may affect domestic and foreign wealth differently.

We now consider a series of exogenous disturbances, and in each case examine the effects on the real exchange rate, the nominal exchange rate, the balance of trade, and related variables.

6.1 A Permanent Increase in Domestic Productivity

If domestic output rises equally in both the first and second periods, then the relative price of the domestic good falls in both periods. The nominal exchange rate rises, i.e. the dollar depreciates, if the relative price effect dominates the money demand effect, as discussed in section 4.2. Foreign wealth rises (as discussed in section 4.1) because foreign households can import domestic goods at a lower relative price. Domestic wealth rises

unless the fall in the relative price of the domestic good is very large. The case in which domestic wealth rises is discussed in Figure 3, which describes both time periods (since they are the same). Whatever happens to the distribution of wealth and relative consumption levels, international trade is balanced.[19]

6.2 A Temporary Increase in Domestic Productivity

Suppose domestic output rises exogenously in the first period only. Then its relative price falls in the first period. Whether the nominal exchange rate rises or falls depends — as discussed in Section 4.2 — on whether foreign and domestic goods are good or poor substitutes in consumption and on the income elasticity of the demand for money. If the goods are poor substitutes and/or the income elasticity of the demand for money is low, then the relative price effect of the change in output on the exchange rate dominates the money demand effect. Then the exchange rate rises (the dollar depreciates). Whether the domestic country has a balance of trade surplus or deficit in the first period also depends on the degree of substitutability of domestic and foreign goods. Suppose the goods are sufficiently good substitutes that a one percent increase in domestic output reduces its relative price by less than one percent as in Figure 3 (the elasticity of substitution is greater than one). Then the domestic country will have a balance of trade surplus in the first period, and the foreign country will have a deficit. The domestic trade surplus results because the temporary increase in domestic output raises domestic income more than proportionally to foreign income. The first-period budget lines of both countries rotate as

in Figure 3 because of the relative price change. The budget line of the domestic country rotates through point G in Figure 3 because the domestic people own the firms producing the domestic good. The foreign budget line rotates through point E, so the domestic budget line lies above the foreign budget line: the domestic country has greater income at date one. If it were not possible to borrow or lend, then the domestic country would consume at point D and the foreign country would consume at point F in Figure 3. In the second period, with output back to point A, both countries would consume at point A.

But it is possible to borrow and lend, i.e. it is possible to have a trade deficit or surplus. Both countries would like to save some income from period one for consumption in period two. But it is impossible for the world to save in this way because the goods are perishable. The domestic country sees a larger drop in its income and consumption from the first period to the second than does the foreign country. So there is a mutually advantageous trade: the domestic country will have a balance of trade surplus (lend to the foreign country) and the foreign country will have a trade deficit (and borrow). The equilibrium is shown in Figure 5. In the first period, the budget line of the domestic country shifts in while the budget line of the foreign country shifts out. Domestic households consume H in the first period while foreign households consume I. In the second period, this is reversed: the home country has a trade deficit (paid for by principal and interest received as foreigners pay off the loan) and the foreign country a trade surplus. Second-period domestic consumption is at point J while second-period foreign consumption is at point K.

If foreign and domestic goods are sufficiently poor substitutes that a one percent rise in domestic output reduces its relative price by more than one percent (the elasticity of substitution is less than one) then the situation described above is reversed: domestic income is lower than foreign income in the first period. This situation is illustrated in Figure 6. In the absence of borrowing and lending opportunities, domestic consumption would be at point D and foreign consumption would be at point F. With the opportunity to borrow or lend, the foreign country will have a trade surplus and the domestic country will have a trade deficit in the first period. Domestic households will consume at point H in the first period and foreign households will consume at point I. In the second period, domestic consumption is at point J and foreign consumption at point K.

Summing up: a temporary increase in domestic output causes, temporarily, real exchange rate depreciation (a fall in the relative price of domestic goods), and nominal exchange rate depreciation if the relative price effect dominates the money demand effect. This rise in the nominal exchange rate can be accompanied by either a trade surplus or a trade deficit. Trade deficits and exchange rate depreciation do not necessarily go together.

6.3 A Temporary Increase in Demand for Domestic Goods

Suppose the demand for domestic goods rises in the first period because of a temporary change in tastes. (A change in government spending - another reason for a change in demand - will be discussed below.) Indifference curves in the first period shift so that they are steeper than before at every point. Figure 7 illustrates the equilibrium after the shift in

indifference curves. Without the shift, equilibrium consumption for each country would have been at point A. Point A still shows the per-capita supplies of goods. but the increase in the relative price of domestic goods — due to the increase in demand — raises domestic income and reduces foreign income. The domestic country's budget line rotates through point C and the foreign country's budget line rotates through point E. If borrowing and lending were not possible, the domestic households would consume at point D while foreign households would consume at point F.

But borrowing and lending is possible. The domestic country has temporarily high income and would like to save some of it: the foreign country has temporarily low consumption and would like to borrow. So the domestic country has a trade surplus and the foreign country has a trade deficit. In the first period, the domestic country consumes at point H while the foreign country concsumes at point I. In the second period, the domestic country consumes at point J and the foreign country at point K. The temporary trade surplus in the domestic country is associated with real and nominal appreciateion, i.e. the relative price of the domestic good rises and the nominal exchange rate falls (domestic money appreciates).

If there had been a temporary fall (rather than rise) in demand for the domestic good. this would have created a temporary real and nominal depreciation and a (temporary) trade deficit. In this case, depreciation and trade deficits go together, and as time passes the domestic currency appreciates while the deficit is eliminated. Despite this relation between currency depreciation and the trade deficit, it would be incorrect to say that the depreciation caused the deficit (or vice-versa). Both were results

of the underlying change in demand for goods. It would also be impossible for government policy to reduce the trade deficit by monetary policies or similar attempts to stabilize the nominal exchange rate.

6.4 An Expected Future Increase in Demand for Domestic Goods

Suppose the increase in demand for domestic goods — discussed in Section 6.3 — occurs in the second period rather than the first. Suppose it was also expected (in the first period) to occur. Figure 7 will again illustrate the equilibrium with an important modification: the panel labeled "period one" in Figure 5 will apply to period two, while the panel labeled "period two" will apply to period one. In the first period there is no exogenous change in demand or supply. But the expectation of a future increase in demand for the domestic good raises expected future domestic income. Similarly, the change in demand lowers expected future foreign income. The domestic country will want to borrow in the first period while the foreign country will want to lend. That is, the domestic country will have a trade deficit in the first period (and consume at point J) and the foreign country will have a trade surplus (and consume at point K). But relative prices and the nominal exchange rate will be unaffected by expectations of the future. In the second period, domestic real and nominal appreciation will accompany a domestic trade surplus. Second period domestic (foreign) consumption is at point H (point I) in Figure 7.

If the model were modified in some realistic ways, the real and nominal exchange rates would change in the first period. The expectation of an increase in the relative price of the domestic good in the future would tend

to increase its price now (e.g. if it can be stored over time, or if households can substitute consumption of the domestic good now — while it is still cheaper — for consumption of the good later when it costs more). This increase in the relative price of the domestic good would occur partly through a fall in the nominal exchange rate in the first period (just as if the original change in demand had occurred in the first period). With this modification of the model, the first-period trade deficit would be associated with real and nominal appreciation. The size of the first-period appreciation would depend on the degree to which suppliers and demanders can substitute goods over time.

A second modification would reinforce the nominal (though not the real) appreciation associated with the first-period trade deficit. An expected fall in the future nominal exchange rate (dollar appreciation) makes dollars less costly to hold now. If the demand for money were sensitive to its holding cost (the nominal interest rate), then the first-period real demand for dollars would rise by an amount that depends on the interest-elasticity of money demand. This would reduce the nominal exchange rate (and all nominal prices) in the first period, and reinforce the nominal appreciation associated with the trade surplus. Comparing the results in Sections 6.2, 6.3, and 6.4, it is clear that a trade deficit can be associated with either real and nominal depreciation or real and nominal appreciation, depending on the original disturbance (and, in some cases, on the magnitudes of certain parameters).

6.5 An Increase in Demand by the Domestic Country Only

In the examples of changes in demand discussed above, households in both countries change their tastes. Suppose, instead, that only the domestic household increases its demand for the domestic good, due to a temporary change in tastes in the first period. As in the case of a world-wide change in tastes (Section 6.3), the relative price of the domestic good rises in the first period. This occurs through a fall in the nominal exchange rate. So the domestic country experiences real and nominal appreciation in the first period. But, in contrast to the results of Section 6.3, the domestic country can experience either a trade deficit or a trade surplus. Whether the real and nominal appreciation is accompanied by a surplus or deficit depends on which of two effects dominates. On the one hand, the rise in the relative price of domestic exports in the first period creates a temporary increase in domestic real income and a temporary decrease in foreign real income (as in Figure 7). As in Section 6.3, this tends to create a domestic trade surplus in the first period. But there is now another force that may tend to create a trade deficit. If the change in tastes by domestic households represents an increased demand for domestic goods in the first period at the expense of all other goods, including foreign goods in the first period and both goods in the second period, then domestic demand for both goods in the second period falls. The decrease in demand for second-period goods tends to create a domestic trade deficit in the first period. As a result, the domestic country can have either a trade deficit or surplus to accompany its real and nominal appreciation.[20]

6.6 A Domestic Government Budget Deficit

Suppose the government of the domestic country cuts nondistorting (lump-sum) taxes in the first period without changing government spending in either period, (i.e. the government makes lump-sum transfers to domestic households, financed by borrowing). The government raises nondistorting taxes in the second period to pay off principal and interest on the debt. The "Ricardian-equivalence proposition" (Barro, 1981) states that under certain conditions the deficit will not affect interest rates or consumption.[21] Under those conditions, people save the entire tax cut, buy the bonds issued by the government, and use the interest on the bonds to pay the higher future taxes. Among the conditions for Ricardian equivalence in this model are that households fully anticipate the higher second-period taxes, and view those taxes as a liability with present value equal to the current tax cut. In that case, households do not gain wealth from the tax cut because liabilities rise as much as current taxes fall. Under the conditions for Ricardian equivalence, an increase in the government budget deficit has no effect on the real or nominal exchange rate or on the trade balance.

A more interesting case arises when the conditions for Ricardian equivalence are violated. To simplify matters, assume that households are shortsighted: in the first period they entirely ignore the higher taxes that will be imposed in the second period. Assume that households ignore the future taxes because they fail to understand that the government must raise future taxes to pay the additional interest (and principal, in this model) generated by the debt issued in the first period. Then the deficit makes

domestic households feel wealthier, because they get the current tax cut but ignore the higher future taxes.

Under these assumptions, domestic households will spend part of the tax cut and save the rest for future spending. In the new equilibrium, both foreign and domestic households buy the debt issued by the domestic government. Because money supplies and money demands are unchanged, p and p* are unaffectd by the deficit.[22] The interest rate rises because the increase in the quantity of loans demanded by the government exceeds the increase in the quantity of loans supplied by domestic households who save part of the tax cut. That is, the increase in demand for goods in the first period raises the relative price of first-period goods in terms of second-period goods. This relative price is just the real interest rate (plus one). So the higher government budget deficit raises the real interest rate. In addition, the budget deficit causes a trade deficit, because domestic households use the tax cut to buy more imports and to buy more domestic goods (that would otherwise have been exported).

But the budget deficit does not cause a change in either the real or nominal exchange rate, under Assumption A8. Domestic households raise demands for both goods in the first period in such a way that their relative price is unaffected. Because p and p* are also unaffected, so is the nominal exchange rate.

The equilibrium is illustrated in Figure 8. The tax cut makes domestic households feel wealthier and raises domestic demand for goods to point B. Then world demand for first-period goods exceeds supply. The real interest rate rises to induce increased saving (lower demand for first-period goods).

As all households reduce demand for goods in the first period, an equilibrium is reached at which domestic households (who feel wealthier than foreign households) consume at point D and foreign households consume at point F. The domestic country is borrowing to consume more than point A in the first period. When the domestic country repays the foreign country in period two, domestic consumption is at point J and foreign consumption is at point K.

The real and nominal exchange rates could change if domestic and foreign preferences differed. If domestic households had a preference for domestic goods (and vice-versa), then the relative price of the domestic good would rise in the first period. Given p and p*, this rise in p/ep* would occur through a fall in e. So if households in each country have a relative preference for their own country's good, then an increase in the domestic government's budget deficit would raise interest rates, cause a domestic trade deficit, and lead to real and nominal appreciation.[23]

6.8 A Shift in Desired Asset Holding

It is frequently stated that a change in the preferences of investors to hold interest-bearing assets denominated in dollars or pounds affects the exchange rate. If these assets are not perfect substitutes, it is reasonable to assume that households' demand for each type of asset rises with its own rate of returns and falls with the rate of return on the other type of asset.

Begin with an initial equilibrium in which interest rates in the two countries are the same. Then suppose that foreign households change their preferences for assets in the first period: they wish to hold more assets denominated in pounds and fewer denominated in dollars. As foreigners

attempt to buy pound-denominated assets and sell dollar-denominated assets, the relative price of these assets changes. In the new equilibrium, the interest rate on dollar-denominated assets is higher and the interest rate on pound-denominated assets is lower. These interest rates must change until people are willing to hold the existing asset supplies. Because this shift in preferences for assets does not increase or decrease the demands for either good or for either money, the real and nominal exchange rates are left unchanged.[24]

If foreign and domestic assets are imperfect substitutes then the effect of a budget deficit differs slightly from the analysis in Section 6.7. The domestic government is assumed to issue dollar-denominated debt when it has a budget deficit. This increase in the supply of dollar assets lowers the relative price of those assets in terms of other assets, i.e. the domestic interest rate rises relative to the foreign interest rate. In this case, a domestic government budget deficit raises the interest-differential between dollar and pound-denominated assets (and, as before, causes a trade deficit). However, under assumption A8 the real and nominal exchange rates remain unaffected. It is only if tastes differ across countries, with households in each country having a relative preference for their own country's goods, that the domestic country experiences real and nominal appreciation.

7. Additional Evidence and Issues

The typical behavior of real and nominal exchange rates was graphed in Chart 1. Statistical evidence indicates that changes in nominal exchange rates and real exchange rates tend not to be followed quickly by other

changes that either reinforce or reverse the original change. The evidence shows the changes in real and nominal exchange rates are either statistically permanent (in the sense that, on average, they are not reversed or reinforced), or highly persistent in the sense that the exchange rate takes a long time to begin returning toward its original level.[25] Huizinga (1987) finds evidence that the real exchange rate begins to reverse its previous changes only after four to seven years. His evidence covers a period of only twelve years; studies over longer time periods sometimes find even larger amounts of persistence, and the uncertainty in statistical estimation is large enough that, with a few exceptions, the evidence is consistent with completely permanent changes in the real exchange rate. The evidence similarly indicates that changes in the nominal exchange rate are either permanent or highly persistent. As argued in footnote 3, this degree of persistence appears to be too large to explain on the basis of disequilibrium models that postulate sticky nominal prices. Many macroeconomists believe that sticky nominal prices play a major role in business cycles (though there are clearly controversies about this). The length of time over which the economy recovers from recessions would provide a rough estimate of the time it takes the overall price level to adjust to its new equilibrium following a disturbance. This estimate would suggest a period of two to three years. In fact, because there are many reasons for business cycles to persist once they have begun, two to three years is probably an upper bound. Disequilibrium theories of exchange rates, based on sticky nominal goods prices, predict that real and nominal exchange rates should return toward their equilibrium levels when nominal goods prices do. This means that they predict systematic

changes in real and nominal exchange rates that are not found in the data. The equilibrium theory of exchange rates, on the other hand, is consistent with this evidence if the underlying disturbances to the economy are permanent or highly persistent.

Evidence from the forward exchange market also suggests that changes in exchange rates are expected to be roughly permanent, or highly persistent. Many foreign currencies are traded like commodities on organized futures markets and on forward markets. The futures prices and forward exchange rates move roughly the same amount as spot exchange rates do. While the forward exchange rate may contain a risk premium, so it is not equal to the market's expectation of the future nominal exchange rate, it is unlikely that the risk premium moves systematically in just such a way as to mask any expected changes in exchange rates. So available data indicates that people expect changes in exchange rates to be highly persistent rather than temporary as the disequilibrium theories imply. This finding of persistence is inconsistent with the disequilibrium models of exchange rates, but is consistent with equilibrium models that incorporate permanent (or highly persistent) real disturbances. A recent study by Campbell and Clarida (1987) also shows that there is little evidence of any relation between exchange rates changes and real interst rate differentials across countries of the kind that many disequilibrium models predict. Finally, there is only a little evidence to support the contention that government budget deficits per se cause exchange rate changes of the kind predicted by the disequilibrium models or the equilibrium model of Section 6.6, though there is some evidence that variables such as government purchases affect exchange rates as the equilibrium models might suggest (Evans, 1986).[26]

Major questions remain unanswered by current research. Attempts to explain exchange rates empirically using economic "fundamentals," i.e. variables predicted by a theory to have important effects, have generally performed poorly (see, e.g. Meese and Rogoff, 1983a). But the equilibrium approach to exchange rates suggests that the trade balance, output, and other "fundamental" economic variables are not systematically related to the exchange rate in any particular direction, as explained in Section 6. Whether a trade deficit, or increase in domestic output, is associated with depreciation or appreciation depends, according to the theory, on the underlying disturbance. But if real disturbances cause changes in nominal and real exchange rates, then what are these disturbances? Can we identify specific examples of underlying changes in technology, tastes, etc. that cause exchange rate changes? While similar questions also remain unanswered for other economic phenomena such as changes in stock prices or business cycle phenomena, further attempts to identify the important exogenous disturbances seems essential.

Another unresolved question involves the explanation for a different fact: the variability of real exchange rates has been much greater when a country adopts a policy of floating nominal exchange rates than when it pegs (fixes) its nominal exchange rate (as under the old Bretton-Woods system that preceded widespread floating beginning in the 1970s). While the explanation is straightforward from the veiwpoint of the disequilibrium models, any explanation consistent with an equilibrium model must be more subtle. Indeed, this evidence is sometime cited in support of the disequilibrium models and as contradicting the equilibrium models (e.g. by Mussa, 1986).

There are many conditions — not all very realistic — that the economy must meet for the nominal exchange rate system to be totally irrelevant for real exchange rates.[27] One condition requires that all other government policies, including tariffs and quotes on international trade, restrictions on international financial markets, and fiscal policies, are the same under both exchange rate systems. If they are not, then the behavior of real exchange rates may differ under the two systems even if the equilibrium models are right. These issues are currently unresolved.

8. Policy Implications

Clearly the equilibrium theory of exchange rates has radically different policy implications that do disequilibrium theories. First, the government cannot affect the real exchange rate simply by changing the nominal exchange rate, e.g. with policies such as foreign exchange market intervention, target zones, etc. Policies like "talking down (or up) the dollar" may affect the nominal exchange rate because they signal a willingness to pursue policies that affect it: they affect the real exchange rate only if they signal a willingness to pursue policies that affect it. Unfortunately, those policies generally include protectionist measures that reduce overall economic welfare.

Second, the equilibrium models imply that changes in the exchange rate do not "cause" or "reduce" inflation. Clearly, the exchange rate is an endogenous variable. Moreover, if most changes in exchange rates among countries with similar inflation rates are due to real disturbances to supplies of goods or demands for goods, then changes in the exchange rate may

not even be particularly good signals of inflation. Exchange rate changes would not be particularly helpful in formulating monetary policies designed to maintain price stability or low inflation.

Third, the choice of fixed versus flexible exchange rates is, by itself, not important for real exchange rates, the trade balance, etc. The choice of an exchange rate system can then be made on the basis of whether one system provides more discipline to policymakers, or whether one would force a country to maintain a higher (or lower) inflation rate than it would like. Similarly, foreign exchange market intervention, "target zones" for exchange rates, and similar policy proposals should be judged on two main criteria: (i) how they would affect inflation, and (ii) how they would affect government incentives to pursue other policies.

Fourth, and perhaps most important, the government should not invoke protectionist restrictions on trade in goods or financial assets as a response to changes in exchange rates. "undervalued" or overvalued" currencies are not the issue: exchange rates are only reflections of underlying market conditions and government policies. Variability of exchange rates is no more inherently undesirable than variability in a person's mood throughout a day, and both reflect underlying conditions and policies. The main contribution of the equilibrium theory of exchange rates is to suggest an explanation for exchange rate behavior that is consistent with the notion that markets work reasonably well if they are permitted to. If so, the theory can help us avoid the substitution of folly for wiser policies.

Footnotes

1. The real exchange rate is defined in this paper as the relative price of foreign goods in terms of domestic goods. This relative price is also known as the terms of trade. There are other definitions of the real exchange rate, involving relative prices of nontraded and traded goods. Equilibrium models of exchange rates with nontraded goods include Helpman and Razin (1982), Stockman (1983), and Stockman and Dellas (1986).

2. The current account equals the trade balance adjusted for any difference between exports and imports that can be paid for by income earned from ownership of foreign assets. For example, a country that is a net creditor earns income from loans it has made in the past, and could use this income to pay for a perpetual trade deficit. A country that did this would have a trade deficit but a balanced current account.

3. Because nominal price sluggishness is also thought by many economists to be responsible for aggregate business fluctuations, the time involved for the real exchange rate to revert back to its equilibrium level following a disturbance should be similar to the time it takes for recovery from recessions. This argument suggests that the temporary changes in real exchange rates would tend last, on average, no more than a few years.

4. For further discussion, see Obstfeld and Stockman (1985).

5. This paper bypasses a number of associated technical issues, such as the use of optimizing models or the introduction of money into the optimization process. Discussions of these technical issues are often confused with discussion of the basic economic points of the equilibrium models of exchange rates. There is no necessary reason to connect them, so the technical points are left aside here.

6. A person's indifference curves describe his own tastes. Each curve shows the various combinations of goods that the person could consume without being either happier or less happy. Higher indifference curves represent greater happiness. A "normal good" is one that people want to buy more of (given its price) when their incomes rise.

7. Assumption A4 simplifies the description of the model but is not essential. The assumption is useful in drawing Figure 1 because it implies that consumption in both countries can be represented by the same point in the figure.

8. Assumption A1 implies that the two countries have equal populations. Denote these by N, so there are 2N people in the world. Let x^S be the (world) per-capita supply of X, so total production of good X is $2Nx^S$. Similarly, total world supply of Y is $2Ny^S$, and y^S is the per-capita supply.

9. In Figure 1, the increase in supply of domestic goods is represented by a shift from point A to point B. The original budget line of domestic (and

foreign) households goes through point A and is tangent to the indifference curve touching point A. The new budget line goes through point B and is tangent to the indifference curve touching point B. The new, flatter, budget line represents a higher relative price of Y, the foreign good. Equation (4) implies that, because money supplies and money demands are unaffected, the exchange rate e rises, so the dollar depreciates. The quantity of domestic exports obviously rises; foreign households consume more of the domestic good (at point B) than before (at point A).

10. In Figure 2, the indifference curve going through point A becomes steeper at that point due to the change in tastes. Assumption A7 implies that the budget lines of all (domestic and foreign) households continue to go through point A, but rotates so that they are tangent to the new indifference curve. So the relative price of the domestic good, X, rises. All households continue to consume at point A.

11. Section 6.5 discusses a change in tastes in one country alone. In that case, volumes of exports and imports are affected. Also see Section 4.1.

12. That is, the relative amounts of X and Y consumed depends on the relative price but not on income.

13. An increase in the supply of domestic goods will raise exports, as before, but it is possible that the domestic country might reduce rather than increase its own consumption of the good. This can occur if the price of the

domestic good falls sufficiently, as in Figure 6 below. If the utility function is Cobb-Douglas, i.e. if people always spend some fixed fraction of their incomes on each good, regardless of the relative price, then the countries end up equally wealthy after the change in domestic output, just as if Assumption A7 rather than A8 had been invoked. In that case, budget lines for all households go through point B in Figure 1.

14. It might be more realistic to replace assumption A8 by the assumption that people in each country tend to buy relatively more of thier own country's goods. Except under very peculiar conditions, the analyses in this article will continue to apply with few modifications. An exception is discussed in Section 6.7. Goodfriend (1979) addresses some related issues associated with wealth redistributions.

15. The income elasticity of money demand measures the degree to which people want to hold more money when their income rises. The elasticity of substitution between foreign and domestic goods measures the degree to which people are willing to substitute one of the goods for the other. The elasticity is larger as people are more willing to switch from one good to another as one of them becomes more expensive. The income elasticity of the demand for money is $k = x^s f'(x^s)/f(x^s)$, where f' is the derivative of f. The elasticity of substitution is defined as minus the elasticity of x/y with respect to the relative price of x, along an indifference curve. So the elasticity of substitution is defined as

$$\epsilon \equiv - \frac{(p/ep^*)d(x/y)}{(x/y)\ d(p/ep^*)} .$$

Then, in response to a change in domestic output x, holding foreign output y fixed, the elasticity of the real exchange rate with respect to domestic output is

$$(x/\pi_y)d\pi_y/dx = 1/\epsilon.$$

and the elasticity of the nominal exchange rate with respect to domestic output is

$$(x/e)de/dx = (x/p)dp/dx - 1/\epsilon,$$

because (2') implies that $dp^*/dx = 0$. But (2') also implies that $(x/p)dp/dx = -k$. So

$$(x/e)de/dx = (1/\epsilon) - k.$$

16. A rise in domestic output by one percent lowers p by k%, according to (2'), where k is the income elasticity of money demand. Footnote 13 implies that the percentage change in e exceeds k% if and only if $(1/n)-k > k$, which requires that the elasticity of substitution is smaller than 1/2k.

17. See Obstfeld and Stockman (1985). Stockman and Dellas (1986) discuss the issue in the context of a model that also includes nontraded goods.

18. Assumption A1 implies that households discount future utility at the same rate. The results in this section also assume additively separable utility in first and second-period consumption with a time-invariant instantaneous utility function.

19. The balanced-trade result is not robust to slight changes in the assumptions about tastes, but there is little theoretical presumption that the domestic country should have either a surplus or a deficit.

20. A borderline case occurs with time-separable Cobb-Douglas utility (an elasticity of substitution equal to one), in which case trade is balnaced each period.

21. Roughly, those conditions are: perfect capital markets, a long planning horizon for households, rational expectations, and nondistorting taxes.

22. If the demand for money depended on the nominal interest rate, then the increase in the interest rate would reduce money demand in both countries, as world interest rates rise. Then p and p* would both fall. If they fell by the same percentage, then the implications for the exchange rate would be the same as if p and p* were both fixed.

23. Note that this result has nothing to do with the issue of whether foreign and domestic assets are good (or perfect) substitutes or not, or with the effect of a budget deficit on relative interest rates across countries.

24. If money demands depend on interest rates then nominal prices p and p*, and the nominal exchange rate, e, may be affected by the change in asset demands. But — as long as demands for or supplies of goods are unaffected — the real exchange rate is unaffected.

25. Papers that have documented these facts include (among many others) Roll (1979), Adler and Lehmann (1983), Meese and Rogogg (1983a, b, and 1985), Wasserfallen and Zimmerman (1985), Hsieh (1985), Hakkio (1986), and Huizinga (1987).

26. Feldstein (1986) argues that budget deficits affect exchange rates. See also Stockman's comments (1986). Evans (1986) presents evidence that government spending rather than deficits affects exchange rates.

27. Stockman (1983) discusses these conditions.

28. Most of the research in this area has concentrated attention on positive economics rather than on policy. Additional papers that have used equilibrium models or ideas from them include Helpman (1981), Helpman and Razin (1982, 1983), Hsieh (1982), Sachs (1983), Stockman (1985), Stockman and Hernandez (1987), Stockman and Svensson (1987), Stulz (1986), and Svensson (1986). Other discussions of these ideas can be found in Krueger (1983) and Obstfeld and Stockman (1985); a related discussion appears in Friedman (1953).

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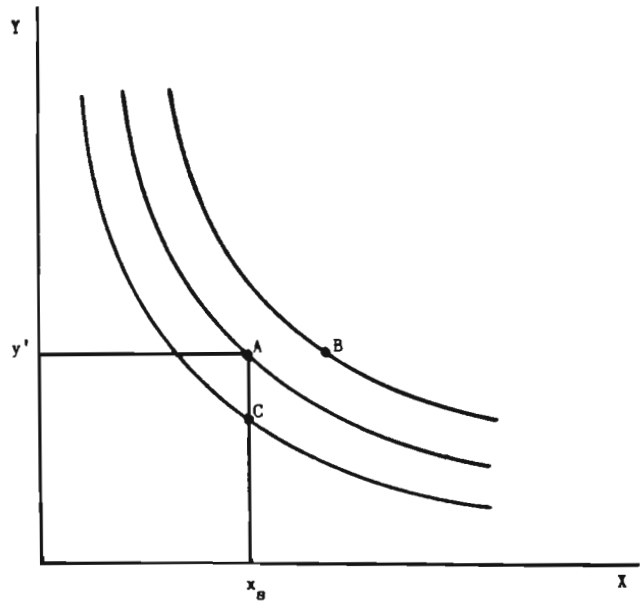

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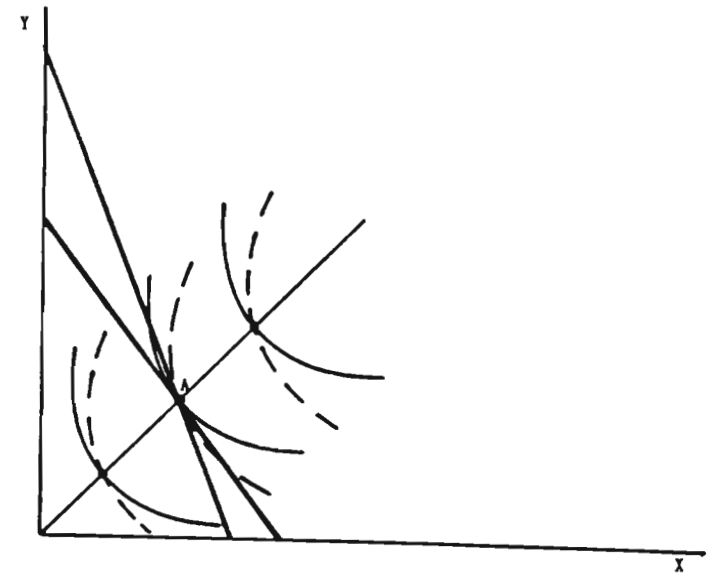

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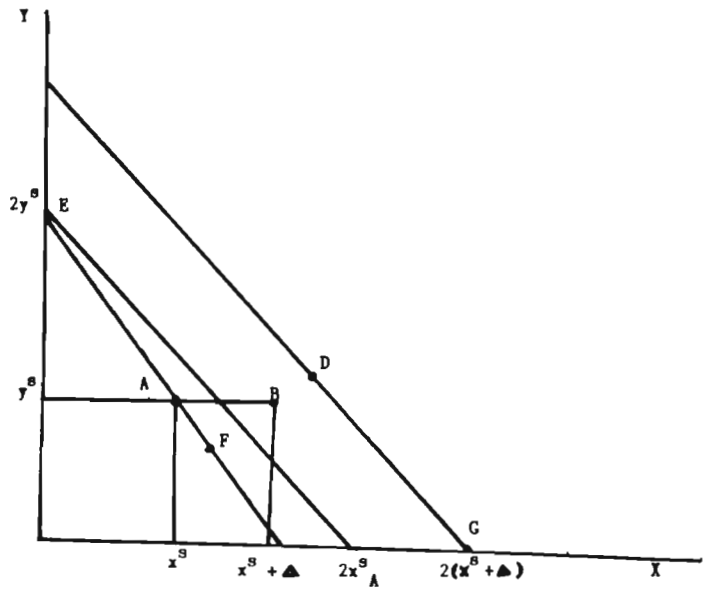

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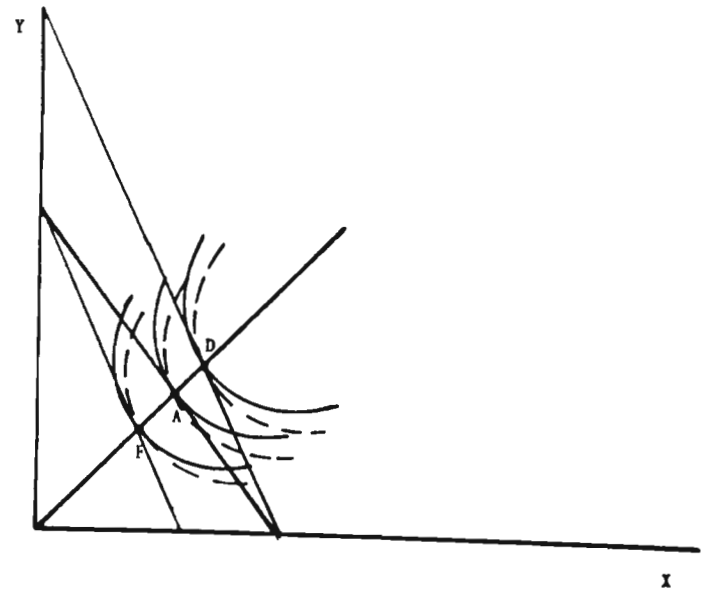

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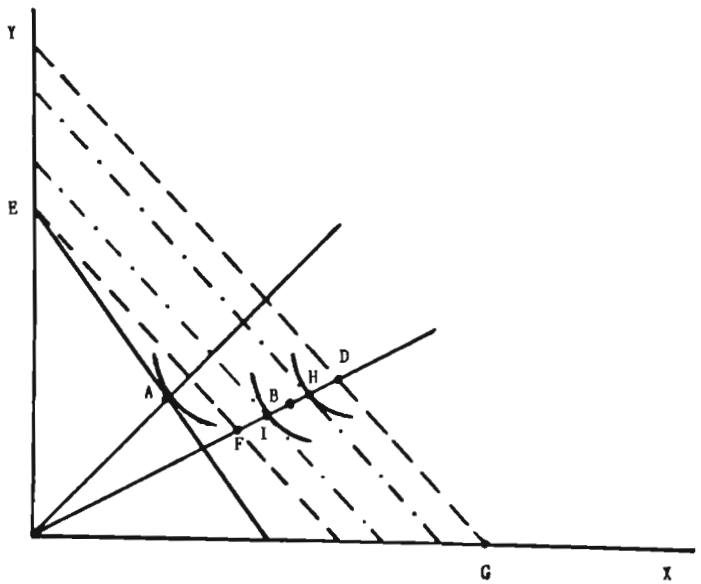

time period one

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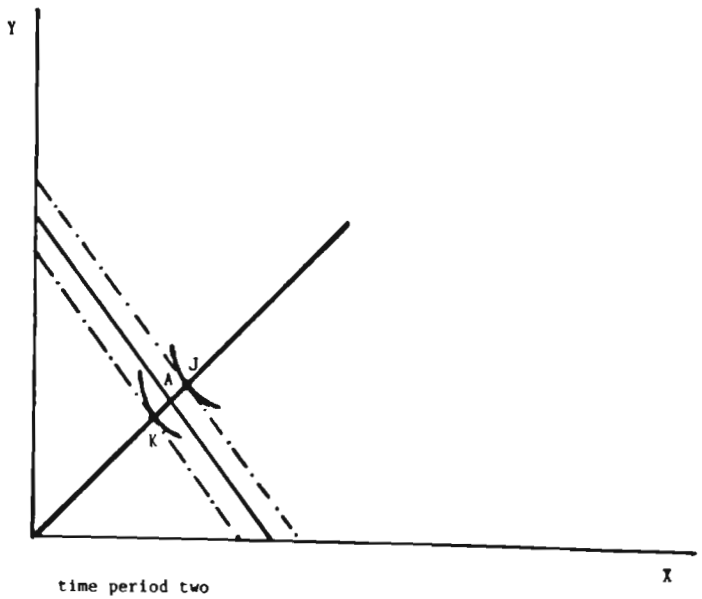

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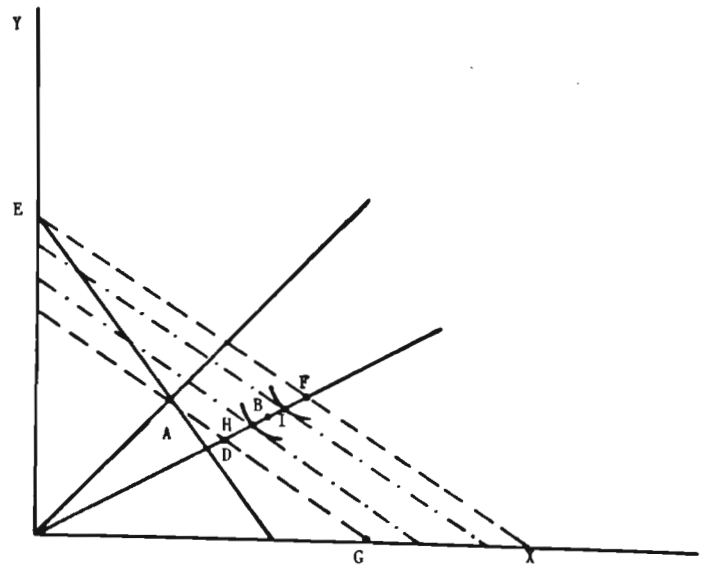

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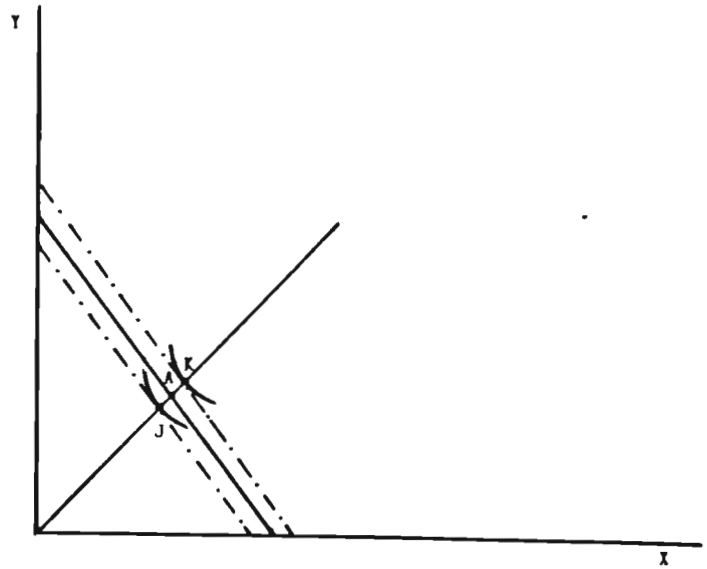

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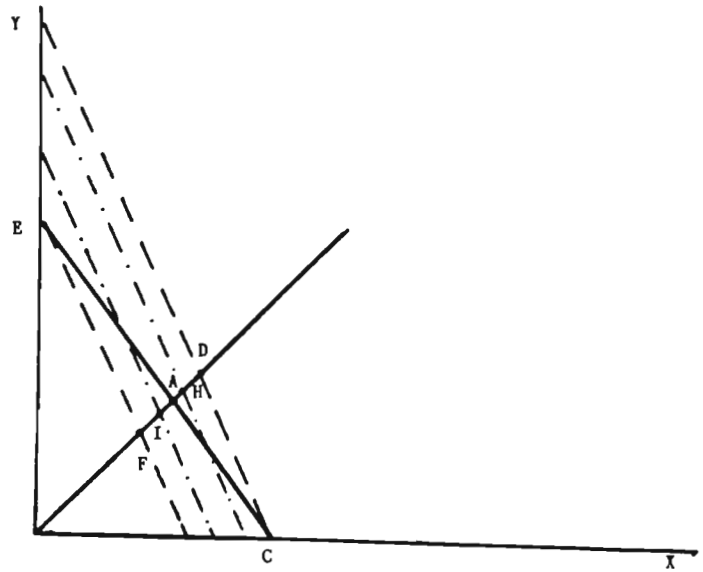

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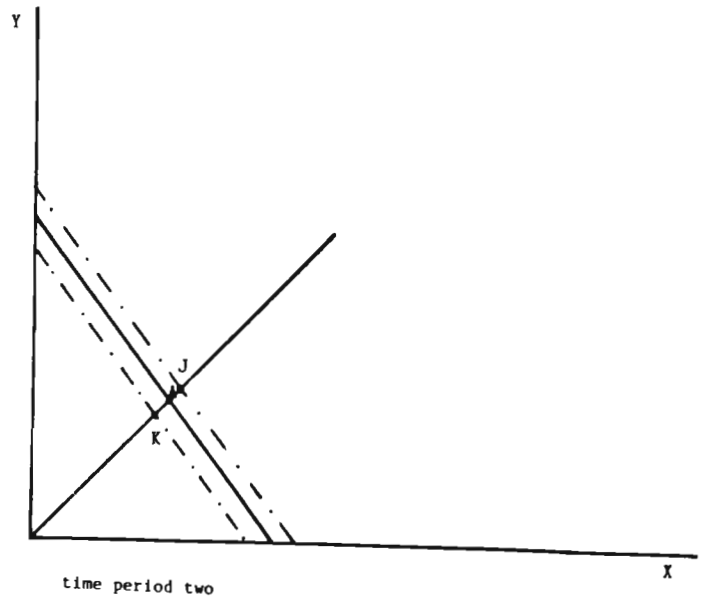

time period two

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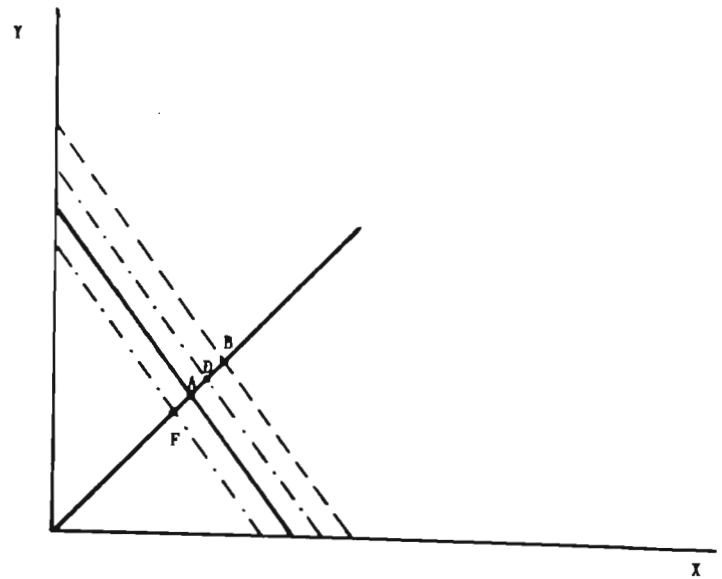
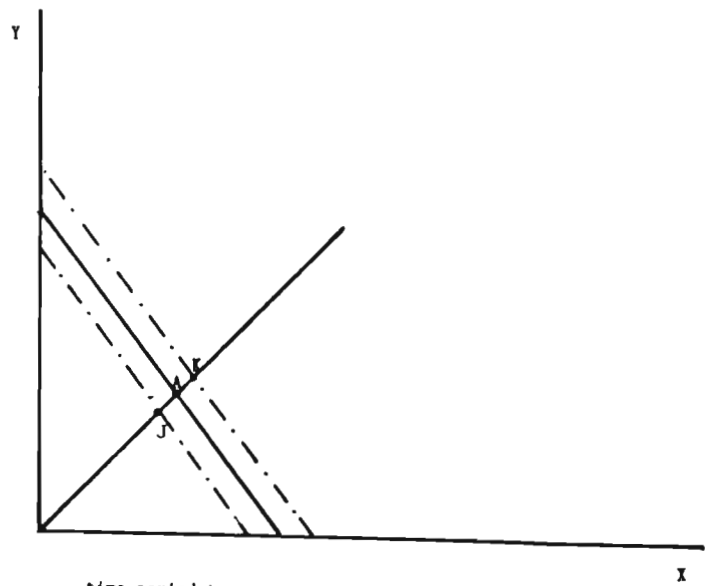


time period one

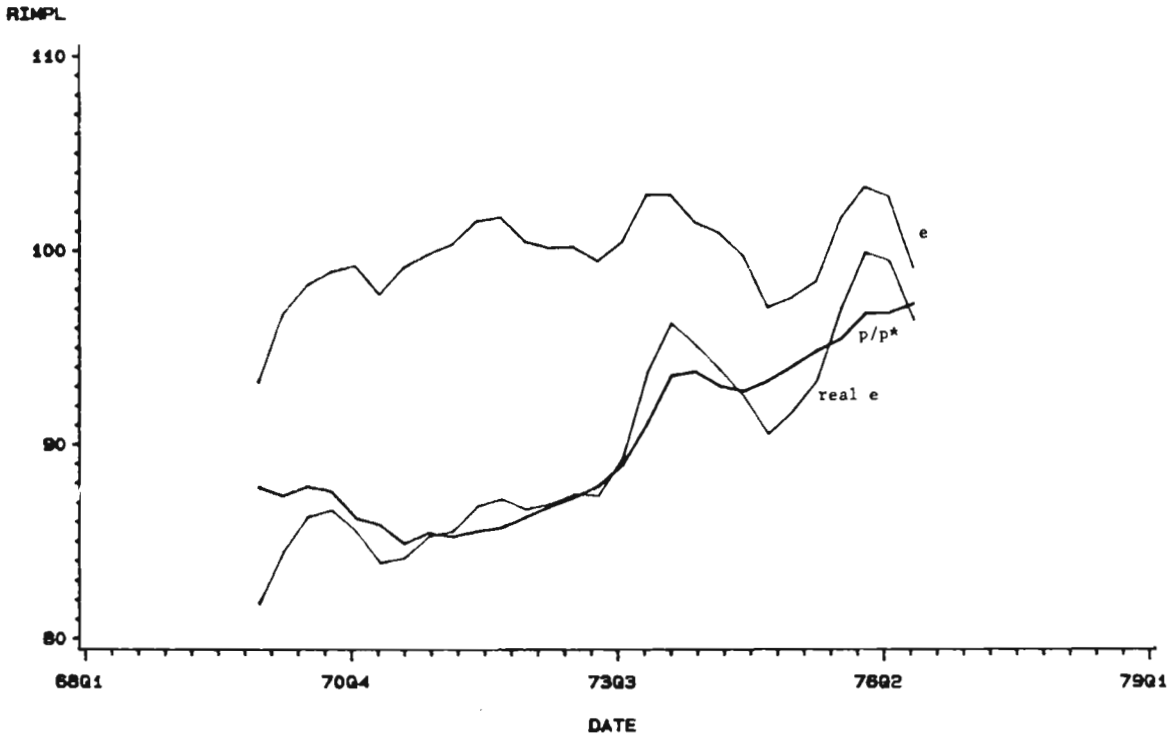
Figure 8



time period two

Figure 8

QUARTERLY CANADIAN GNP DEFLATORS, REAL AND NOMINAL EXCHANGE RATES 1970–1976



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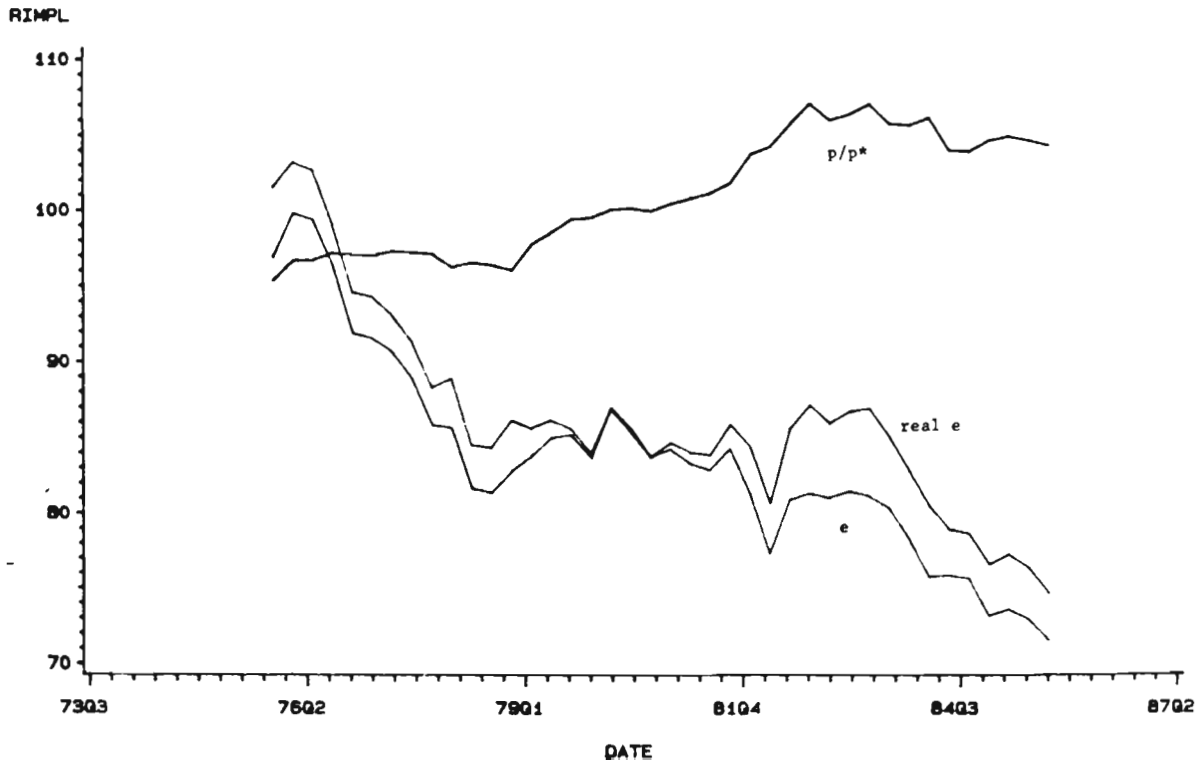

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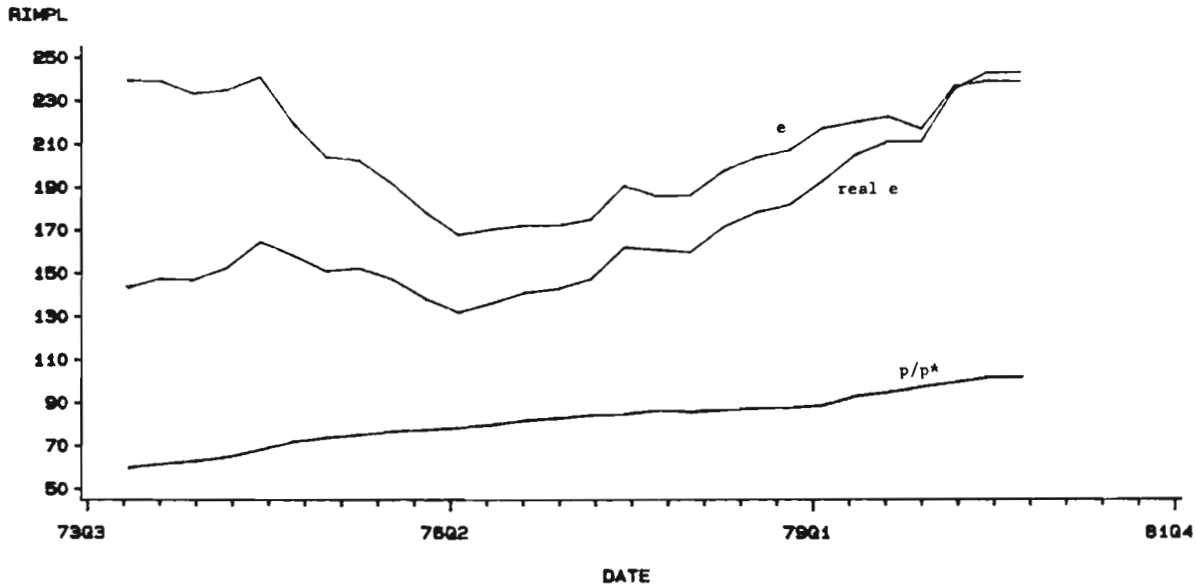

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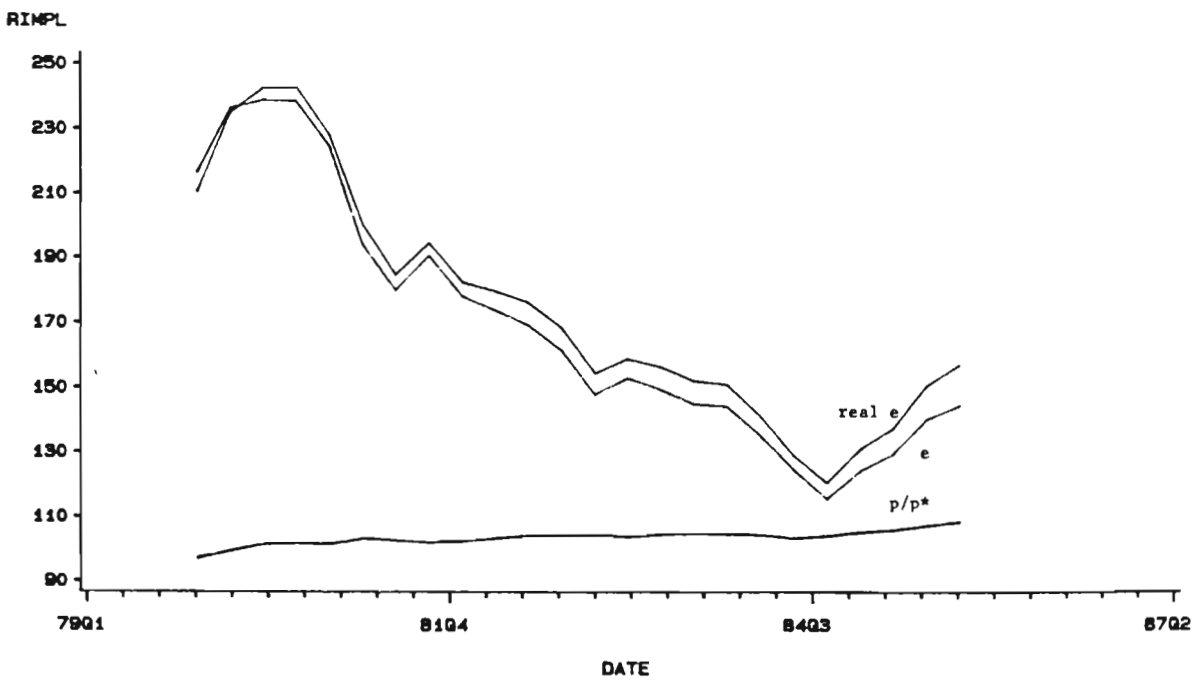

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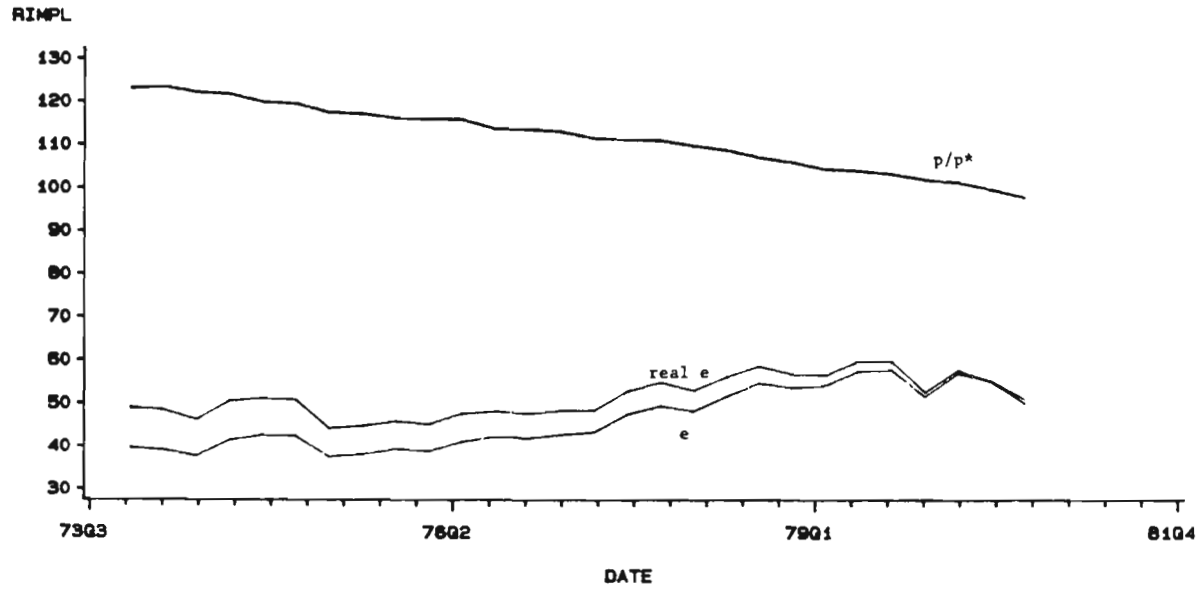

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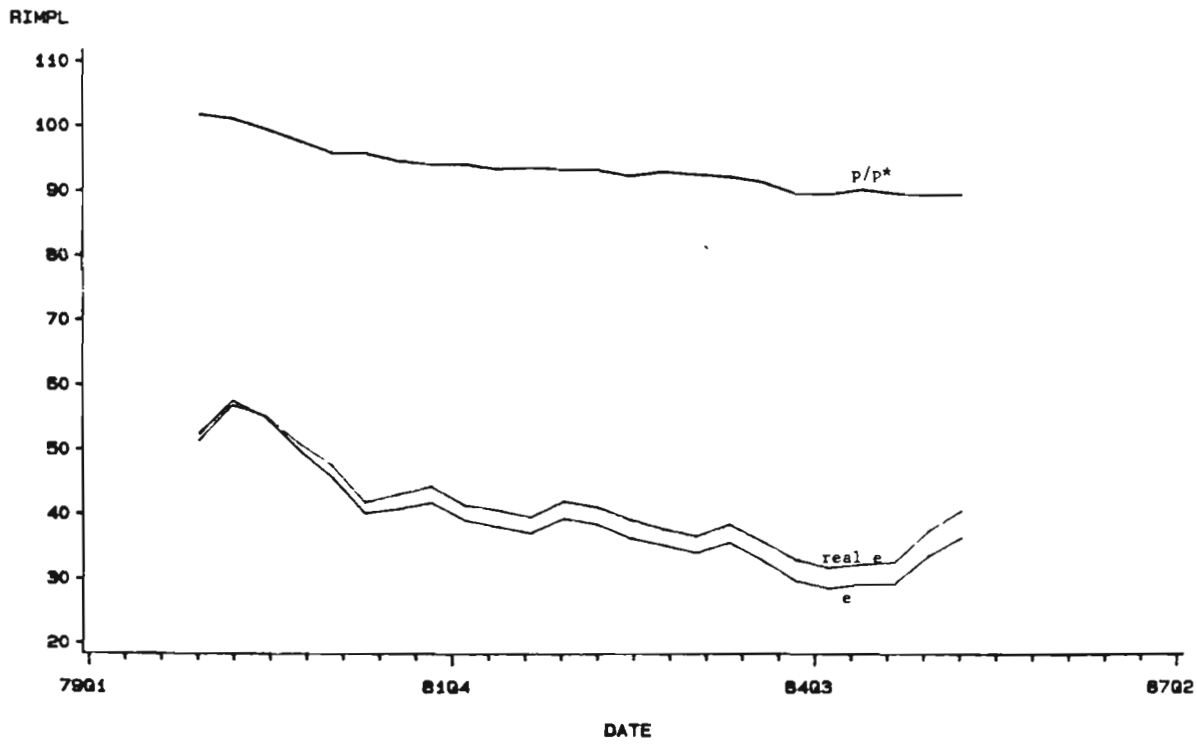

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