DYNAMIC INTERACTIONS BETWEEN TRADE FLOWS AND EXCHANGE RATES: THEORY AND EVIDENCE

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ABSTRACT

This thesis attempts to study theoretically and empirically the dynamic pattern of the effects of exchange rate changes on trade flows. Such a study is motivated by the persistent and sizable trade imbalances observed in the 1970's despite the adoption of the flexible exchange rate system.

Chapter 1, after a brief look at the behaviors of exchange rates and current accounts in the 1970's, reviews recent theories and evidence on exchange rate effects on trade flows.

Chapter 2 studies the implication of the existence of adjustment costs on the supply side for trade flow responses to price changes. It then extends the analysis to incorporate exchange rate dynamics and studies the interaction between the exchange rate and the trade balance.

Chapter 3 looks at some causes and macroeconomic consequences of J-curve effects in a framework consistent with recent theories of exchange rate and macroeconomics. It is shown that unanticipated permanent increase in the money supply creates a J-curve if the public is unable to tell whether disturbances are permanent or temporary.

Chapter 4 carries out an empirical analysis of the huge trade surpluses in Japan in the late 1970's. It is shown that the major cause of the surplus was the severity of the recession experienced by Japan in this period and

that imports of intermediate goods stood as a serious obstacle for a quick and significant effects of exchange rate changes on the trade balance.

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Contents

CHAPTER 1

Introduction

Differences in the assessment of the seriousness of market imperfections, or failures, lie at the heart of different interpretations of economic events and policy prescriptions. Quite often, one school argues that prices are flexible and that the flexibility of prices assures equilibria in markets, enhancing the efficient allocation of resources. Another school points out that prices are frequently very rigid, or that even if prices were fully flexible, low demand and supply elasticities would severely limit the usefulness of price changes in moving resources in the right direction. Moreover, excessive price flexibility may create various instabilities in the economy and may never bring markets into equilibrium. Solow (1980) illustrates such divergences of views on labor market issues.

Such conflicts of views about the performance of market mechanism, when applied to the "foreign exchange market", take the form of the fixed vs flexible rate debate. The issue here is not one of how rigid the price level is, but one of how effective price changes are in eliminating external disequilibrium of a country. Proponents of flexible rates argue that exchange rate changes quickly bring balances in the trade or current account, enabling a country to persue its own macroeconomic policies. On the other hand, doubts about such an ability of exchange rate changes to assure external equilibrium are an important cause of the objection to flexible rates. The absence of such an ability may imply very unstable movements in exchange rates with little impact on current accounts. Therefore, it is of utmost importance to examine whether exchange rate changes exert quick and significant impacts on trade flows. If they do not, the case for flexible rates would have to be reexamined.

The experience of flexible rates by industrial countries in the 1970's provides a piece of evidence to evaluate the ability of exchange rate changes to assure external equilibrium. During the 1970's exchange rates fluctuated widely in the eyes of every observer and, despite this, sizable and persistent current account imbalances have been witnessed. Such results have been a surprise to most economists. Of course, the underlying economic structure has been very unstable in the 1970's due mainly to oil price changes. Nevertheless, the performance of flexible rates has been disappointing.

The purpose of the essays collected here is to study theoretically and empirically some causes of such failure of exchange rate changes to assure external equilibrium. The implication of such a phenomenon for exchange rate dynamics is also studied. This introductory chapter serves to survey recent theories and evidence pertaining to the issues of exchange rate and trade balance dynamics. It is then explained what the present work adds to these existing theories and evidence.

1, Exchange Rates and Current Accounts in the 1970's

Before discussing recent trends in international macroeconomics it is useful to examine briefly the behavior of exchange rates and current accounts in the last two decades. The comparison between two periods, one, the 1960's with fixed exchange rates, and the other, the 1970's with flexible rates, sheds some light into the nature of problems I will discuss later.

Table 1 shows exchange rate and current balance movements for five industrial countries for the period of 1961-1979. A few interesting observations can be made from the figure. First, comparison of the behaviors of current accounts in the 1960's and 1970's reveals clearly the failure of flexible rates to reduce the size of imbalances in current accounts. For some countries, imbalances seem to have widened in the 1970's. Of course, this is not independent from the two huge oil price shocks that took place in the 1970's. Still, it seems fair to say that , despite flexible exchange rates, the problem of current account imbalances remained as serious in the 1970's as in the 1960's. Hence, the need for a theory of exchange rate and trade balance dynamics which takes into account such failure of exchange rate changes to bring about external equilibrium. More importantly, the causes of this disappointing finding have to be studied both theoretically and empirically.

Second, the behavior of year to year changes in exchange rates as shown in Figure 1 seems to exhibit a certain regularity. That is, a current account surplus tends to lead to an exchange rate appreciation, and a deficit to a depreciation. Moreover, a casual glance at the figure suggests that most of the important year to year changes in exchange rates are accounted for by movements in current accounts.

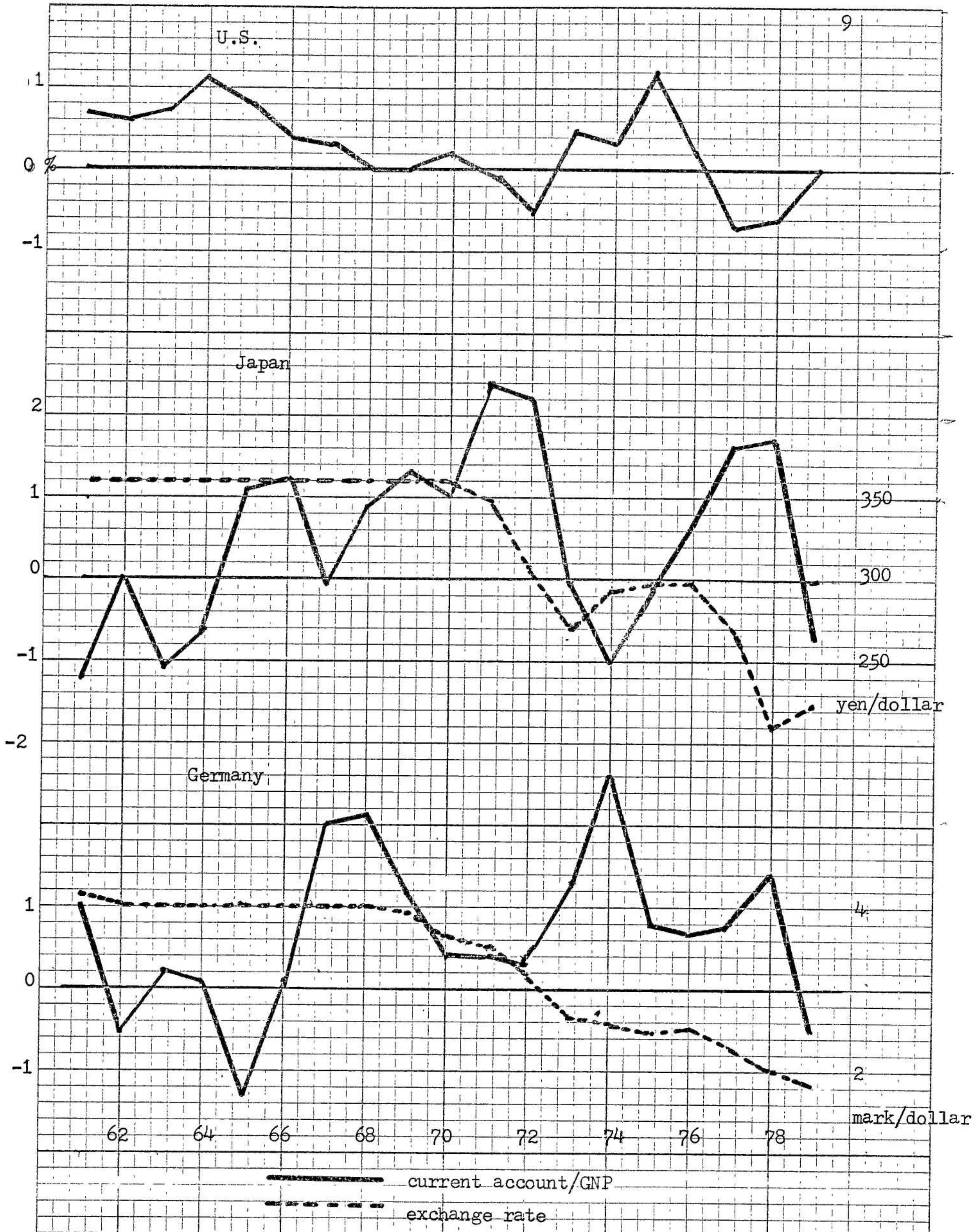
U.S.
1
0 %
-1
Japan
2
1
0
-1
-2
350
300
250
yen/dollar
Germany
1
0
-1
4
2
mark/dollar
62
64
66
68
70
72
74
76
78
current account/GNP
exchange rate

Figure 1

Figure 1 continued

At the same time, however, it is important to recognize the fact that behind such year to year changes in exchange rates is hidden enormous short-run volatility in week to week or month to month movements in exchange rates. This point is illustrated in Figure 2, which shows monthly changes in the Dollar/Deutchmark rate along with annual changes reproduced from Figure 1. The two figures show clearly the nature of exchange rate movements in the 1970's.There are two types of volatility in exchange rate movements: one, wide fluctuations in year to year movements; and the other, short-run volatility around medium-run trends.

I have now pointed out three important features of exchange rates and current accounts in the 1970's :(i) huge and persistent imbalances in current accounts; (ii) medium-run volatility of exchange rates, significantly influenced by current account movements;[1](iii) short-run volatility of exchange rates which resembles that of asset prices in domestic money and financial markets.

As will be argued in the next section, recent developments in international macroeconomics have been quite successful in explaining the third of these three features. They have just begun to rediscover the importance of the second feature. The first feature, despite its crucial importance in policy discussions, has escaped the attention of major trends in the literature. Only occasional references to the so-called J-curve have reminded the profession of its importance.

Figure 2: German mark/ dollar

2, A Brief Review of Recent Developments in International Macroeconomics

This section discusses the extent to which recent developments in the literature have been successful in explaining the three empirical regularities pointed out in the last section. Therefore, no attempt is made to survey all the major issues discussed in the literature.[2]

The classical theory of a flexible exchange rate focuses on the analysis of the possibility that a flexible rate insulates an economy from disturbances arising in the rest of the world. Under the assumption of no capital mobility, the insulation effect of a flexible rate is perfect if there are no terms of trade effects and no effects of import prices on the demand for money.

Then, the important work of Mundell (1968) emphasizes the role of capital mobility in the international transmission of macroeconomic disturbances. Under capital mobility, a flexible rate does not insulate an economy from foreign disturbances. More importantly, his work opened a road to recent theories of exchange rate that focuse on the role of asset markets in exchange rate determination. However, his model employs some restrictive assumptions such as fixed domestic prices, and the absence of exchange rate expectations.

Dornbusch (1976) extended the Mundell model to incorporate exchange rate expectations and a slow adjustment of the price level in response to excess demand in the goods market. Such an extension, together with the assumption of the efficient use of information, has been able to explain jumps of exchange rates in response to new information--short-run volatility of exchange rates. The volatility derives from the instability of exchange rate expectations as in the case of other asset prices. Differential adjustment in the goods and assets markets tends to intensify the volatility in the form of exchange rate overshooting.

Not surprisingly, the asset market view of exchange rates tended to undermine the effects of trade or current balance on exchange rates. In asset markets what matter are the demand for and the supply of the stocks of assets, while the current account is a flow.

However, as seen in the last section, movements in the current account seem to exert important effects on the exchange rate. In a sense, people have focused too much on explaining the short-run volatility of exchange rates, paying little attention to medium-run changes. This unsatisfactory situation has been eased somewhat by important contributions of Kouri (1975) and Dornbusch and Fischer (1980). They argue that a current account surplus induces an increase in the stock of privately held foreign assets, leading to an increase in the demand for money and an exchange rate appreciation. Once such a link between the current account and the exchange rate is established, exchange rate expectations, of course, reinforce the link. Empirical evidence has just begun to come in and much more work is needed on this point.[3]

Finally, turning to the issue of the inability of exchange rate changes to correct trade imbalances, one finds not very many, but several contributions. Magee (1973) emphasizes the role of currency contracts in the generation of J-curve type effects. Juntz and Rhomberg (1975) point out the importance of a number of different lags in weakening the impact of price changes on trade flows. Niehans (1975) and Dornbusch (1976) argue that trade flows respond only to the expected permanent rate. If the permanent rate adjusts slowly to changes in the spot rate, elasticities of trade flows with respect to the spot rate could be very small in the short run. However, they fail to provide a rationale for the slow adjustment of the permanent rate to changes in the spot rate. Also, none of these analyses study the implications of such a behavior of the trade balance for exchange rate dynamics.

In sum, there seems to be a good explanation of the short-run volatility of exchange rates. However, the medium-run volatility of exchange rates has not been fully explained. The effect of current account movements on exchange rates seems to play a key role here. Finally, there has been few systematic attempts to study the causes and significance of the failure of exchange rate changes to correct trade or current account imbalances.

In view of these considerations, this thesis tries to provide some possible explanations of persistent imbalances in the current account. Then, an attempt is made to link such perverse behavior of the trade balance to exchange rate dynamics. Before giving the summary of each chapter, I will discuss some existing evidence on the difficulty of trade balance adjustments by exchange rate changes.

3, Empirical Estimates of Elasticities of Trade Flows

There are a number of attempts to statistically estimate price elasticities of trade flows to determine whether the Marshall-Lerner condition is satified or not. Studies in the 1940's tended to find low elasticities. More recent studies, however, found much larger elasticities and at the end of the 1960s there seems to have emerged a consensus that price elasticities are large enough to satisfy the Marshall-Lerner condition.

However, these studies involved some shortcomings. Most of them adopted a partial equilibrium setting and made no allowance for monetary and income effects. In this regard, it is interesting to note that a study by Miles (1979), which employes a more general equilibrium approach, finds that devaluation has almost no effect on the trade balance.

Another shortcoming of studies in the 1960s is that they seldom attempted to estimate carefully the lag structure of changes in trade flows to price changes. Even if a devaluation, say, ultimately leads to an improvement of the trade balance, how long it takes to do so is of crucial importance for practical purposes. In particular, the trade balance may temporarily worsen before it improves, in which case it traces the so-called J-curve. Practical importance of such a phenomenon came to be realized when a British devaluation in 1967 initially led to a worsening of the trade balance. Also, currency realignment of 1971 did not improve the U.S. trade balance until 1973.

Following these observations, Branson (1972) studies the trade effect of 1971 currency realignments and concluds that a "popular guess" holds that the lag between a change in the exchange rate and a significant improvement in the trade balance is about two years in length. Dornbusch and Krugman (1976) estimate the responses of export shares to price changes and find lags of four to eight quarters. Lawrence (1978) reports a similar estimate in the analysis of U.S. foreign trade. These are shown in Table 1. McPheters and Stronge (1979), Based on a cross-spectral analysis of the U.S. trade balance, also reports an estimate of two years for the lag.

All these results seem to point to the conclusion that there are J-curves, with the lag between a devaluation and an improvement in the trade balance equal to about one and a half to two years. However, the result of Miles cautions against reaching such a conclusion too easily; there may not be any improvements in the trade balance at all following a devaluation. Table 2 shows the estimates of trade elasticities in the short and long run by the IMF world trade model. The table indicates that for five countries there are no adverse effects in the short run. For another five countries there are J-curve effects.[4] For the remaining four countries the sum of export and import elasticities falls short of one even in the long run. Thus, for some countries the adjustment of trade flows are very quick. But for most of the countries price changes do not have significant effects on trade flows in the short run and in some cases they do not seem to have strong long-run effects, either.

Finally, one must be careful in interpreting estimates from a sample which includes both a fixed and flexible rate periods. Under flexible exchange rates, unlike devaluations in a fixed rate system, many fluctuations in exchange rates are only temporary and may hardly exert any impact at all on trade flows. In fact, this was the reasoning that led Niehans and Dornbusch to emphasize the importance of the distinction between actual and permanent changes in the exchange rate.

Table 1

1-A RESPONSE OF TRADE SHARE TO RELATIVE PRICES

country	long-run elasticity	average lag (quarters)
U.S.	- 1. 72	6.9
U.K.	-1.31	4.5
Japan	-1.03	5.4
Germany	-0.1	0.5
Netherlands	-1.52	5.5

Source : Dornbusch and Krugman (1976), quarterly data 1963:1 - 1975:2.

1-B SHORT AND LONG RUN PRICE ELASTICITIES IN U.S. TRADE

number of quarters after price change	imports	exports	sum
0	0.02	0.02	0.04
2	-0.14	-0.17	-0.31
4	-0.53	-0.65	-1.18
6	-1.07	-1.30	-2.37
8	-1.52	-1.85	-3.37
mean lags (quarters)	5.8	5.8	

Source: Lawrence (1978), numbers are cumulated elasticities semiannual data 1962:1-1977:1.

Table 2

Short-Run and Long-Run Trade Price Elasticities in the IMF World Trade Model

country	sum of export and import elasticities	
	short run	long run
Canada	-0.69	-0.69
U.S.	-0.23	-2.12
Japan	-1.93	-2.05
France	-1.72	-2.02
Germany	-0.31	-1.18
Italy	-0.09	-0.09
U.K.	-0.35	-0.70
Belgium	-1.58	-2.88
Denmark	-0.63	-1.63
Netherlands	-0.12	-1.07
Austria	-0.69	-0.92
Norway	-1.70	-4.30
Sweden	-3.09	-3.10
Switzer-land	-0.98	-1.50

Source: Artus and Young (1979), semiannual data 1964-1977, short-run elasticity is the coefficient on the average of relative price term over two-half years; long run is cumulative response over four years.

Another point to be noted, which is closely related to the above, is that changes in the exchange rate and changes in domestic and foreign prices may have different impacts on trade flows. As Orcutt (1950) argues, trade flows may respond differently to small and temporary changes in prices than to large and fairlt permanent changes, such as those caused by a devaluation under a fixed rate system. Wilson and Takacs (1979) examine empirically the validity of such an assertion using data from a period of fixed exchange rates. They find that trade flows react quicker when an exchange rate, rather than exporter's national currency price, caused a change in international prices. As they point out, of course, such a pattern of response may well be reversed under floating rates.

What have we then learned from all these estimates of trade elasticities? First, there seems to be some evidence that price changes exert strong impact on trade flows in the long run. But not for all countries and not for all price changes. Second, there is little evidence that in the short run trade flows respond significantly to price changes. Third, this short run could be as longas a few years.

It is also clear that the quality of these estimates must be improved in several respects. For one thing, a more general equilibrium approach seems to be necessary. This may include the introduction of monetary and fiscal variables, but at the same time the roles of imported intermediate goods whose importance has increased dramatically in the 1970's. With imported intermediate goods playing significant roles, estimating export and import equations separetely may never provide reliable estimates of elasticities. For another, the analysis of the trade balance under flexible exchange rates ought to pay more attention to the distinction between temporary and permanent changes in exchange rates. Practical importance of such a consideration is evident from the observation that very volatile movements of exchange rates tend to make unclear the medium-run trends of them.

4, The Organization of the Essays

Thus, I have pointed out some interesting empirical regularities of flexible rates in the 1970's and then examined where the existing theories and evidence stand in terms of the interpretations of them. An enormous amount of effort has been put into the explanation of the short-run volatility of exchange rates. However, medium to long run movements in exchange rates have not fully been explained. The behavior of the current account has been found to be an important determinant of the exchange rate in this respect.

However, the analysis then has to incorporate the trade balance dynamics in response to exchange rate changes. In this regard, the failure of exchange rate changes to bring about balances in the current account becomes crucially important. Figure 1 and the discussion in the last section have provided some evidence of the significance of such a phenomenon. In the short run exchange rate changes seem to have little impact on trade flows. In the long run, they may or may not.

Given such a background, the three essays collected here try to provide some explanations of small trade elasticities in the short run and possibly also in the long run. As reviewed in the second section, previous studies of such a phenomenon emphasized the role of adjustment lags and costs and the role of exchange rate expectations.

In view of this, the first essay, the next chapter, concentrates on the role of adjustment costs in generating a J-curve type effect. Therefore, it focuses on the analysis of a short-run violation of the Marshall-Lerner condition. Then, the implication of the trade balance dynamics involving a J-curve for exchange rate dynamics is studied by introducing the effect of foreign asset accumulation on the exchange rate. The resulting dynamics involves an unstable spiral between the exchange rate and the trade balance; a trade balance surplus leads to an appreciation of the exchange rate, which in turn creates more surplus in the trade account. Thus, the existence of adjustment costs tends to slow trade balance responses to price changes, with the possibility of a short-run perverse response. Then, because of the effect of trade balance on the exchange rate through assets market, a stock-flow interaction, a flexible rate system may involve an instability.

The second essay, chapter 3, takes a careful look at the role of exchange rate expectations in the effects of exchange rate changes on trade flows. The essay argues that changes in asset prices, including those in exchange rates, work very slowly in their effects on real variables when an economy is characterized by significant adjustment costs and a number of uncertainties concerning the future course of asset prices. It is shown that under such a circumstance, even the assumption of the efficient use of information results in a slow adjustment of expectations. The chapter first treats the case of fixed prices in the goods market and studies how lags in expectations generate a J-curve. The analysis is then extended to include the effects of price changes in the goods market. In the case where the underlying disturbance, or the cause of exchange rate changes, is monetary, there are no long-run effects on trade flows. In the short run there may still be some perverse responses of the trade balance to exchange rate changes. This upsets to some extent the classical Mundell-Fleming view of the effects of monetary policy under flexible rates and illustrates the importance of small short-run trade elasticities in policy discussions.

Finally, the last chapter provideds a more structural reason for small effects of exchange rate changes on the trade balance. The chapter examines the causes of Japanese trade surplus in the late 1970's. Estimates of trade elasticities are produced, paying particular attention to the roles of imported intermediate goods. It is found that the irresponsiveness of the Japanese trade balance to exchange rate changes stems not so much from lags in the adjustment process as from special roles played by oil imports. The price elasticity of this component of the trade balance is found to be very small. Moreover, the existence of imported intermediate goods tends to weaken the impact of exchange rate changes on other components of the trade balance. If an exchange rate change should bring about a significant change in the trade balance, it should change the relative price between home and foreign goods. The first two essays argue that even with a relative price change the adjustments of trade flows are slow. The last essay points out that imported intermediate goods stand as a serious obstacle to this relative price change.

Footnotes

1, Of course, this distinction between short-run and medium-run movements in the exchange rate is somewhat arbitrary. Medium-run movements may better be called those changes in the exchange rate that are caused by current account movements. Moreover, with rational expectations, anything that affects the medium-run course of the exchange rate, if it is anticipated, also affects the short-run movements. However, Figures 1 and 2 seem to indicate that the effects of current accounts on the exchange rate are salient with a time unit of half a year to a year rather than a week or month.

2,See Mussa (1979) or Dornbusch (1980) for this purpose.

3, See Dornbusch (1980), for example. Chapter 4 of this thesis also provides some empirical evidence using the Japanese data.

4, Of course, one has to bear in mind that a shorter a time unit is, more likely it is to find a J-curve.

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Chapter 2

ADJUSTMENT COSTS IN THE THEORY OF EXCHANGE RATE AND TRADE BALANCE DYNAMICS

Almost a decade has passed since the adoption of flexible exchange rates by industrial countries in the early 1970's. Two of the most prominent features of flexible rates in this period, as discussed in the last chapter, have been the high volatility of exchange rates and persistent imbalances in the trade or current account. The magnitude of exchange rate fluctuations has been much larger than expected. The inability of these exchange rate changes to correct trade imbalances has been disappointing.

Recent theories of exchange rates have mostly focused on explaining the causes of the first of these two observations, the volatility of exchange rates. On the other hand, there have been very few contributions aimed at studying the persistence of trade imbalances. Some of the exceptions have been reviewed in the last chapter. The purpose of this chapter is twofold: it first offers an explanation of the persistence of trade imbalances based on the existence of adjustment costs on the supply side. Second, it attempts to analyze the role in exchange rate dynamics of such lagged responses of trade flows to price changes. It is argued that the failure of exchange rate changes to correct imbalances in the trade account in a short period of time is an important cause of volatile movements in the exchange rate.

The particular type of adjustment cost considered in the paper is adjustment costs of labor. Oi (1962) is one of the first to point out the importance of adjustment costs in the theory of labor demand. Solow (1968) provides a rigorous analytical treatment of the issue. Also, Baily (1977) uses a model with adjustment costs of labor in the analysis of wage rigidity. However, some of these adjustment costs, it may be argued, are not very crucial in the U.S. where firms can layoff workers fairly easily thanks to the temporary layoff system. In view of this a model is used in which firms use both skilled and unskilled labor as factors of production. The level of employment of unskilled workers can be changed costlessly, while that of the skilled workers cannot be changed without incurring adjustment costs. Therefore, the stock of skilled workers is changed slowly to changes in demand or costs, providing a link between small elasticities in the short run and large elasticities in the long run.

The volatility of the exchange rate follows from small trade elasticities when trade balance movements affect exchange rate dynamics through foreign asset accumulation. A surplus in the trade account creates an increase in the stock of foreign assets in the next instant, leading to an appreciation of the exchange rate. With the trade balance possibly reacting adversely to an exchange rate change, the economy may exhibit an unstable spiral between the exchange rate and the trade balance.

The analysis is carried out in the context of a fixed price model with static expectations. Short-run wage and price stickiness is a well established view of macroeconomics. The implication of allowing prices to be flexible in a medium to long run will be studied, although in a slightly different context, in the next chapter. With the assumption of static expectations the dynamics of the model stem entirely from the slow adjustment of employment and the accumulation of foreign assets. Allowing agents to have more information, although it opens up the possibility of much richer dynamics, does not change the essential properties of the model.

Section 1 studies the process of dynamic employment adjustment by the firm in response to an exchange rate change. Section 2 extends the model to incorporate exchange rate determination in the assets market and the accumulation of assets over time in order to study exchange rate and trade balance dynamics. A devaluation is shown to generate a J-curve under a fixed exchange rate. Under a flexible rate such dynamics of the trade balance will have a reprecussion effect on the exchange rate, in turn, generating further J-curves. The dynamics produced in such a way seem to accord very closely with our experience with flexible rates.

The last section concludes the chapter by discussing the implications of assuming a more rational expectations formation mechanism.

1, The Behavior of the Export Firm

The supply side of the economy is represented by a single monopolistic firm which sells its output both at home and abroad. The firm faces competition from foreign firms both in the domestic and foreign markets. Foreign and domestic goods are imperfect substitutes and their prices in terms of their own currencies are fixed. Therefore, a change in the nominal exchange rate is a change in the real exchange rate.

The foreign demand for the output of this firm, X, depends on the real (nominal) exchange rate, e, foreign income, y*, and the amount of what I call sales efforts, I, made by this firm. In this sense the firm has non-price meansof competition. In reality, firms can change the amount of sales without using price changes. Advertising may be the most important example. Also, there are a number of other marketing activities that may influence the level of demand; the number of salesmen can be changed; qualities of goods may be changed to attract new customers or to keep present customers. While demand changes may lag considerably behind changes in such sales efforts, I assume that even in the short run the firm can change the level of demand by changing the level of I. I shall ignore any complications that arise from the possibility that such activities may increase imports.

The demand function is now represented as:

$$X = X(e, I),\quad X_e > 0,\quad X_I > 0,\quad X^{2}_{I^{2}} < 0,\quad X^{2}_{eI} = 0 \qquad (1)$$

where the notations are the familiar ones.[1] The foreign income variable is suppressed because it will be assumed to be constant throughout the chapter. It is assumed that the increase in demand out of a marginal increase in sales efforts does not depend on the exchange rate. Admittedly, the study of the sign of this second derivative alone could be a topic for a full-length paper. Intuitively, the absolute value of the demand creation effect of sales efforts seems large so long as the price difference is small. But it may quickly decrease as the firm loses price competitiveness. In addition, it may depend on the market share of the firm. Interesting as these problems are, they are not the direct concern of the present work; hence, the model takes up the simplest case of no interactions between the two factors.

Turning to the demand by domestic agents, I assume that such sales efforts are less important in the domestic market than in the foreign market and ignore their effects on demand. Domestic demand on home goods, D, depends on the exchange rate, domestic income, y, and the stock of real wealth held by domestic residents, w. Private wealth consists of domestic and foreign money balances. Thus,

$$D = D(e,y,w),\ D_e > 0,\ 1 > D_y > 0,\ D_w > 0 \qquad (2)$$

where $w = W/(a+(1-a)e) = (M+eF)/(a+(1-a)e)$. The deflator for the stock of wealth is a linear combination of the domestic and foreign price levels. The stock of domestic and foreign money held by domestic residents are denoted as M and F, respectively. A depreciation of the exchange rate has three effects on the demand for home goods by domestic residents: the substitution effect, the effect of an increase in the price deflator, and the effect of an increase in the domestic value of foreign assets. In the following it is assumed that the sum of the three effects is positive, i.e., a depreciation increases the demand for home goods.[2]

On the supply side, the firm employs both skilled and unskilled workers to produce output. Thus, the level of output, y, is related to the levels of skilled workers, N, and unskilled workers, L_1, used in the production process.

$$y=F(N,L_1),\ F_N>0,\ F_{L_1}>0,\ F_{NN}<0,\ F_{L_1L_1}<0,\ F_{NN}F_{L_1L_1}-(F_{NL})^2\gtrless 0. \quad (3)$$

The amount of sales efforts, I, introduced above is assumed to be related to the number of "salesmen", L_2, hired for marketing activities. Thus,

$$I = I(L_2),\quad I_{L_2}>0,\quad I_{L_2L_2}<0. \quad (4)$$

These salesmen are assumed to be unskilled workers.[3]

The level of employment of unskilled workers can be changed without any cost. However, the stock of skilled workers cannot be changed instantaneously. The firm has to incur adjustment costs, $C(\dot{N})$, in changing the level of N at a speed of $\dot{N}$. It is assumed that C(.) has the following properties:

$$C(.)>0,\ C_{\dot{N}}\cdot\dot{N}\geqq 0,\quad C_{\dot{N}\dot{N}}>0,\ C_{\dot{N}}(0)=0. \quad (5)$$

That is, the adjustment cost increases when the absolute value of the speed of adjustment of employment increases no matter which way the employment is adjusted. Also, the marginal increase in the adjustment cost increases as the absolute value of adjustment speed increases. The first derivative of the adjustment cost function is assumed to be continuous, including the origin, for analytical simplicity.

Assuming no inventory holdings, the problem of the firm is now to maximize

$$\int_0^{\infty}(y-N-(L_1+L_2)-C(\dot{N}))\exp(-it)dt$$

subject to (1)-(5) and the initial level of the stock of skilled workers, N_0. In the maximand, i is an appropriate discount rate, which is assumed to be constant, and static expectations are assumed concerning all future values of the relevant variables. The levels of wages of skilled and unskilled workers are assumed to be equal to one for notational simplicity.

Letting r be the imputed price of N, the necessary conditions for the optimal solution are:

$$\begin{aligned} & X(e,I(L_2))+D(e, y,w)=F(N,L_1) \\ & (1-(1/F_{L_1}))X_I I_{L_2} = 1 \\ & C_N^{\cdot} = r \\ & \dot{r} - ir = 1 - (F_N/F_{L_1}). \end{aligned} \tag{6}$$

Given r and N, $\dot{N}$, L_1, and L_2 are determined from these equations. Simple calculations show that

$$\dot{N} = u(r) \qquad u_r > 0 \tag{7}$$

$$\begin{aligned} & L_1 = L_1(e,N,M,F) \qquad L_{1e} > 0,\ L_{1N} \lessgtr 0,\ L_{1M} > 0,\ L_{1F} > 0 \\ & L_2 = L_2(e,N,M,F) \qquad L_{2e} < 0,\ L_{2N} > 0,\ L_{2M} < 0,\ L_{2F} < 0. \end{aligned} \tag{8}$$

An increase in the imputed price of skilled workers naturally increases the rate of increase of such workers. An exogenous increase in the stock of skilled workers induces the firm to sell more output by increasing sales efforts, or the employment of salesmen; however, the effect on the employment of unskilled workers for production purposes is uncertain. A depreciation of the exchange rate, or any exogenous increase in demand, causes the firm to increase production by increasing the employment of production workers, but at the same time leads to a reduction of sales efforts. From (6) and (8) the levels of exports and production are also determined:

$$X = f(e,N,M,F) \qquad f_e > 0,\ f_N > 0,\ f_M < 0,\ f_F < 0$$
$$y = g(e,N,M,F) \qquad g_e > 0,\ g_N > 0,\ g_M > 0,\ g_F > 0. \tag{9}$$

The two differential equations in (6) determine the time path of N. This is illustrated in Figure 1. Given N_0, the firm chooses r from the unique stable path and then determines other variables by (8) and (9). The long-run value of N, N*, is determined from the r=0 equation by noting that the long-run value of r is equal to zero by virtue of (5). It can be shown that N* is an increasing function of e, M, and F.

$$N^* = N^*(e,M,F). \tag{10}$$

An interesting exercise here is to examine the effects of an increase in the exchange rate on the optimal policy of the firm. Because of the simple structure of the optimizing problem, functions (8) and (9) will continue to describe the firm's optimal policy after a change in the exchange rate. As is illustrated in Figure 2, the r=0 schedule and also the optimal path shift to the right. The firm now chooses a higher value of r for a given value of employment. Therefore,

$$\dot{N} = v(e,N,M,F) \qquad v_e > 0,\ v_N < 0,\ v_M > 0,\ v_F > 0. \tag{11}$$

To sum up, an increase in the exchange rate--an exogenous increase in demand--induces the firm to increase its sales, the long-run level of employment of skilled workers. However, the short-run response of output falls short of the initial increase in demand because the firm decreases sales efforts. Or, to take the case of an appreciation of the exchange rate, although it makes it less profitable for the firm to export, the

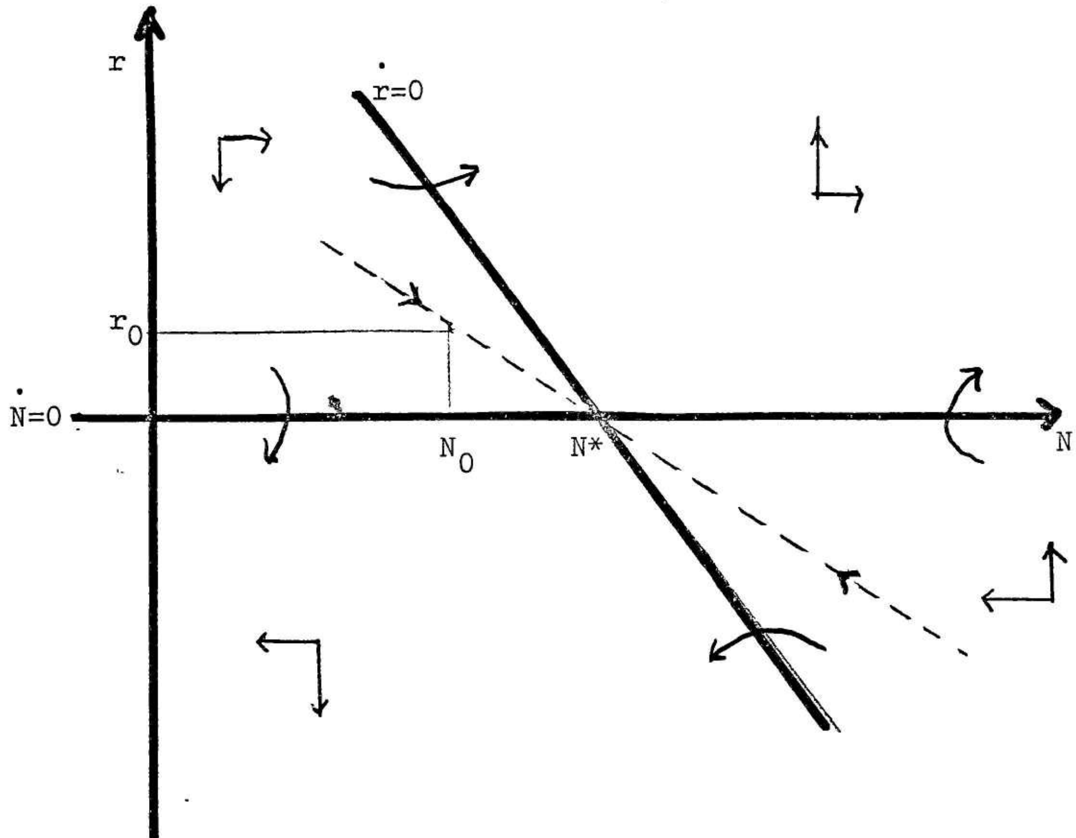

Figure 1

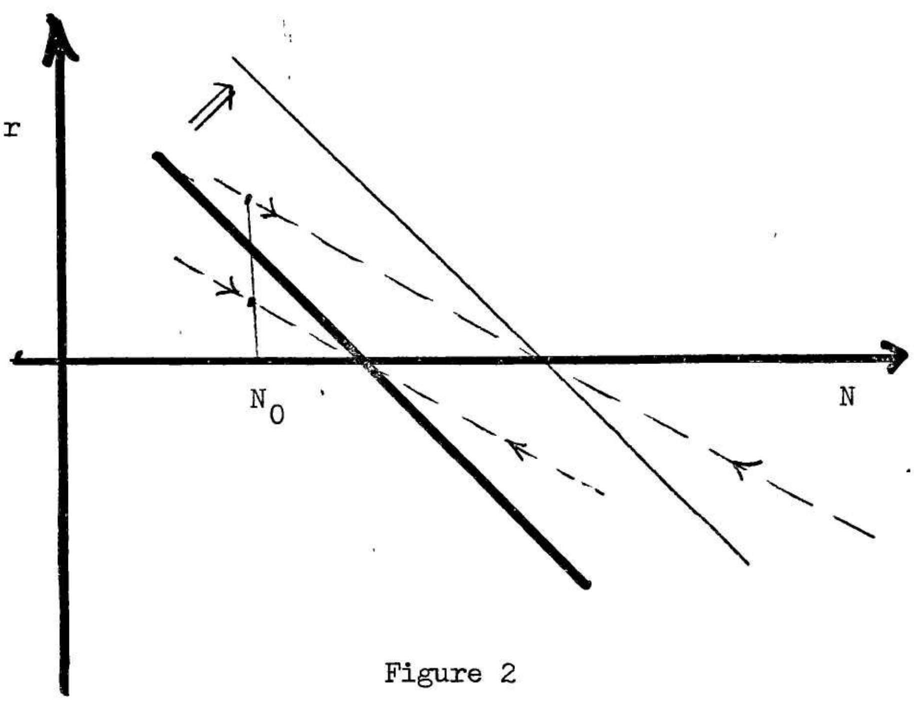

Figure 2

firm tries to maintain the levels of exports and production by increasing sales efforts. Only in the long run exports fall by an amount comparable to the initial decline in demand.

The logic behind this runs as follows: the inability of the firm to adjust the level of employment of skilled workers implies . serious inflexibility of the firm's policy in the face of changing demand. Such inflexibility can be eased by changing the employment of unskilled workers used in the production process. However, this alone should not bear the whole burden of changes in demand. The firm can change the number of salesmen to partially offset the initial change in demand. Over time the firm slowly adjusts the stock of skilled workers in the desired direction. This adjustment process provides a link between small short-run elasticities and (potentially) large long-run elasticities.

2, Exchange Rate and Trade Balance Dynamics

The behavior of the export firm as analyzed in the last section may now be applied to the study of exchange rate and trade balance dynamics on a macroeconomic scale.

The goods market equilibrium condition is one of the constraints of the maximization problem of the firm and, therefore, is always satisfied. The supply of output and the level of exports are functions of the exchange rate, the stock of skilled workers, the money supply, and the stock of foreign assets as shown in (9). The quantity of foreign goods demanded, I_m, by domestic agents is assumed to depend on the same factors as the demand for home goods:

$$I_m = I_m(e,y,w), \qquad I_{me} < 0,\ I_{my} > 0,\ I_{mw} > 0. \tag{12}$$

Using (9), (12) can be rewritten as:

$$I_m = I_m(e,g(e,N,M,F),w) = h(e,N,M,F), h_e \gtrless 0, h_N > 0, h_M > 0, h_F > 0. \tag{13}$$

The ambiguity of the effect of an increase in the exchange rate on I_m will be discussed later.

The specification of the asset market is based on the currency substitution approach. Domestic residents hold domestic and/or foreign money. Foreign residents are assumed not to hold domestic money. Asset demands depend on the expected rate of depreciation of the exchange rate, real income, and the stock of wealth. Then, the money market equilibrium condition is written as:

$$M = L((\dot{e}/e)^*, y, M+eF)^4,\ L_{(\dot{e}/e)^*} < 0,\ L_y > 0,\ L_W > 0 \tag{14}$$

where $(\dot{e}/e)^*$ is the expected rate of depreciation of the exchange rate.

Given the expected rate of depreciation, under a flexible rate system in which the money supply is given, (14) determines the equilibrium exchange rate:

$$e = e(y,M,F,(\dot{e}/e)^*),\quad e_y < 0,\quad e_M > 0,\quad e_F < 0,\quad e_{(\dot{e}/e)^*} > 0. \qquad (15)$$

An increase in income increases the demand for money and leads to an appreciation of the exchange rate. So does an increase in the stock of foreign assets or a decrease in the expected rate of depreciation. Assuming that the wealth elasticity of money demand is less than one, an increase in the money supply creates an excess supply in the money market and leads to a depreciation of the exchange rate.

Under a fixed exchange rate system, the central bank supplies any amount of money the private sector demands in exchange for foreign money. Hence, (14) is satisfied for a given level of the exchange rate by changes in the money supply.

2-a) Devaluation and the J-curve

Before turning to the full analysis of exchange rate dynamics, it is useful to examine the effects of a once and for all devaluation on the trade balance.

The balance of trade, B, can be written as follows:

$$\begin{aligned} B &= X - eI_m \\ &= f(e,N,M,F) - eh(e,N,M,F) \\ &= B(e,N,M,F). \end{aligned} \qquad (16)$$

Thus, the balance of trade is a function of the exchange rate, the stock of skilled workers, the money supply, and the stock of foreign assets.

Assuming that the marginal propensity to spend out of income is smaller than one, an increase in N increases the balance of trade. This can be easily seen by noting that the trade balance is equal to income minus spendings. An increase in the stock of domestic or foreign money, increases the demand for imports through the wealth effect and decreases exports since an increase in demand other than a decrease in the exchange rate reduces sales efforts. Hence, it leads to a decrease in the trade balance.

A devaluation of the exchange rate has several effects on the trade balance. First, it makes domestic goods more competitive, therefore, increases exports and decreases imports. Second, there is a terms of trade effect, which is the effect from an increase in the value of imports, tending to create a deficit. Third, there are two wealth effects: one, the domestic currency value of foreign assets increases, causing a deficit; the other, the deflator for wealth increases, decreasing spendings and leading to a surplus. Finally, there is the important effect discussed in the last section arising from the adjustment cost of skilled workers. The firm tends to offset the increase in demand by decreasing sales efforts. The sum of these effects could go either way. At this point it suffices to point out that a devaluation could well decrease the trade balance.

These have been the immediate effects of a devaluation. In addition, there is a following dynamic effect. Following devaluation, the firm starts to increase the employment of skilled workers, which tends to increase the trade balance. At the same time, non-zero trade balances cause changes in the stock of wealth, providing further influences on the trade balance.

It is now time to turn to the analysis of these two dynamic forces which determine the time path of the economy after a devaluation. Since the model abstracts from the government sector and investment, the stock of wealth increases (decreases) when the economy runs a trade balance surplus (deficit). Hence,

$$\dot{W} = B(e,N,M,F). \tag{17}$$

The time path of N is described by equation (11), which is reproduced below:

$$\dot{N} = v(e,N,M,F). \tag{18}$$

Since the exchange rate does not change over time except at a time of a devaluation, it can be suppressed in equations (17) and (18). Moreover, there is no reason to keep track of the levels of M and F separetely; it is enough to know the level of W. Therefore, the system can be simplified to:

$$\begin{aligned} \dot{W} &= \bar{B}(N,W)\ , \ \bar{B}_N > 0,\ \bar{B}_W < 0, \\ \dot{N} &= \bar{v}(N,W),\ \ \bar{v}_N < 0,\ \bar{v}_W > 0. \end{aligned} \tag{19}$$

Figure 3 shows the phase diagram of the dynamic system (19) for a stable equilibrium. A devaluation shifts the $\dot{N}=0$ schedule upward since it increases the long-run optimal level of N and thus $\dot{N}$. It may shift the $\dot{W}=0$ schedule up or down, depending on whether B_e is negative or positive. The figure treats the case of a negative B_e. Then, starting from an equilibrium point, E_0, a devaluation initially creates a deficit in the trade account. This mainly srises from the fact that the firm initially decreases sales efforts to weaken the impact of the increase in demand. Hence, the stock of wealth decreases over time. At the same time, the firm is slowly increasing the employment of skilled workers, increasing production and

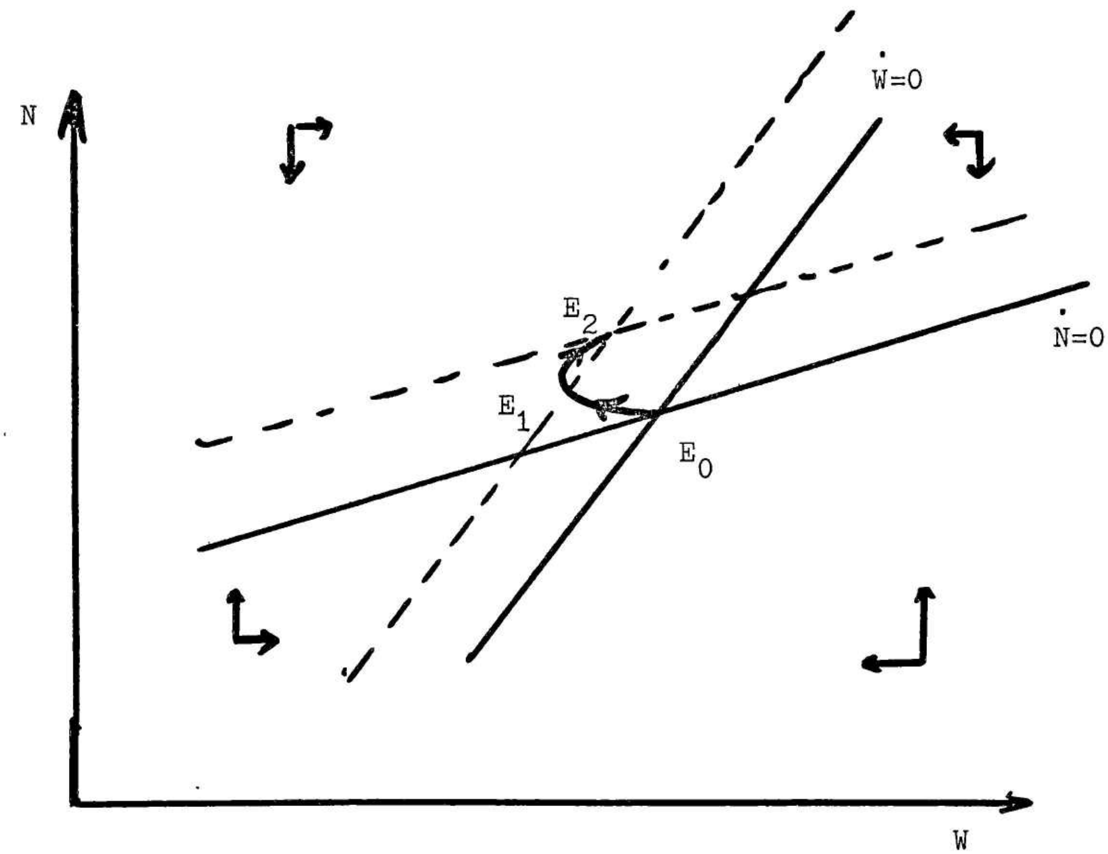

Figure 3

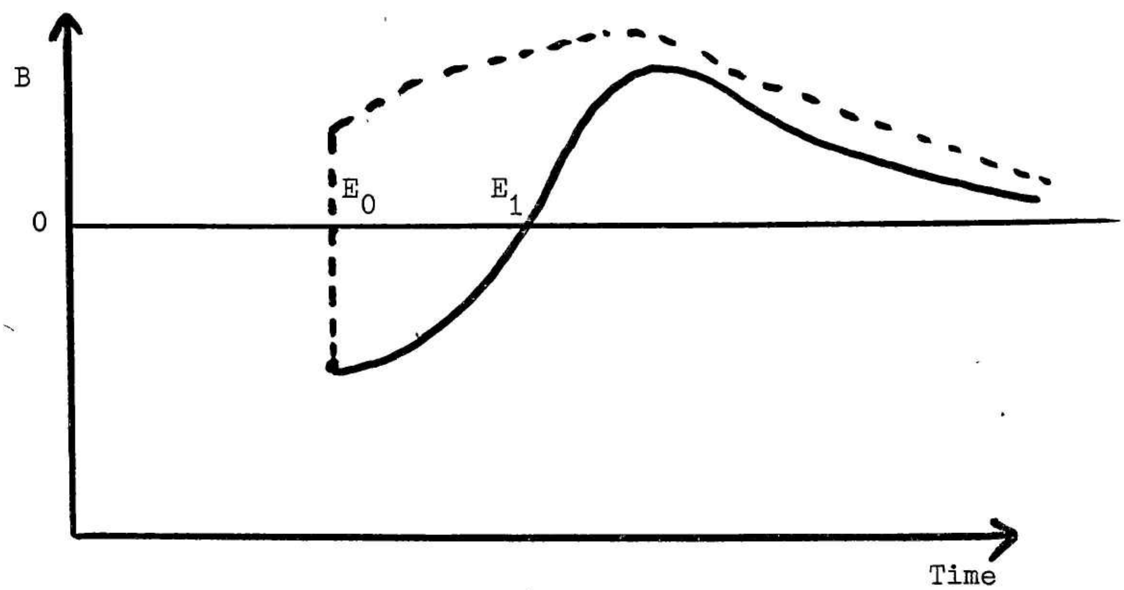

Figure 4

exports. This tends to decrease the trade balance deficit. At point E_1 the level of N becomes large enough to create an equilibrium in the trade account. After that employment continues to expand, the economy runs a trade balance surplus and accumulates wealth until the accumulation of wealth drives the trade balance down to zero at point E_2.

Figure 4 shows the movement of trade balance against time following a devaluation. Initially, a devaluation worsens the trade balance because exports do not increase as much as the increase in demand. As the employment of skilled workers increases, the trade balance turns into a surplus, tracing a J-curve. In the long run the economy accumulates enough wealth to create an equilibrium in the trade account. The dotted curve shows the trade balance in the case where a devaluation at a constant level of N results in a trade balance surplus. In terms of Figure 3 the $\dot{W}=0$ schedule shifts rightward. In this case no J-curves are observed. However, one still finds that the short-run effect of a devaluation on the trade balance is fairly small and that only after the employment of skilled workers has increased enough does a devaluation exert a strong effect on the trade balance.

The major lesson from these analyses is the following: Due to the inflexibility on the supply side, a devaluation creates only a small effect on the trade balance in the short run. As the supply side adjusts slowly to the increase in demand created by a devaluation, the trade balance improves also slowly. Thus, in the short run one ought not regard exchange rate changes as a very powerful way of controlling the trade balance. Moreover, as in Figure 4, the short-run effect could be in the opposite direction to the long-run effect.

A further insight into the role of adjustment cost in the effects of exchange rate change on the trade balance may be gained by considering a case in which the adjustment cost is assymetrical between firing and hiring. Suppose, for example, increasing employment is more costly than decreasing it. Under such a circumstance the adjustment process following a revaluation takes longer than that for a devaluation, creating a bias toward trade balance surplus. To put it differently, in such a case exchange rate changes are less useful for eliminating surpluses than deficits.

On the other hand, it may well beargued that since the adjustment cost treated in the model is that of changing the employment of skilled workers, increasing employment is more costly than decreasing it. This could be justified by various training costs. A devaluation then works more slowly than a revaluation. In any case, to speed up the adjustment process, the government can either employ a macropolicy of changing domestic demand or give subsidies to the firm or workers for employment adjustment.

Finally, Figure 5 shows the case of an unstable equilibrium. The system becomes unstable if and only if in (19) $\bar{v}_W < (-\bar{B}_W/\bar{B}_N)$. The instability is of a saddle point type. The dotted curve indicates an example of the time path of the economy following a devaluation, assuming that B_e is negative. The instability is created in the following manner. A devaluation initially creates a trade balance deficit. Although the firm increases employment for a while, the major effect comes from a decumulation of wealth. Trade deficits induced by a devaluation decreases the stock of wealth, thus expenditure, offsetting the demand creation effect of devaluation. After a while employment starts to decrease, in turn further increasing deficits and reducing the stock of wealth. Such a mechanism would be relevant for a small country where foreign money is an important part of domestic wealth.

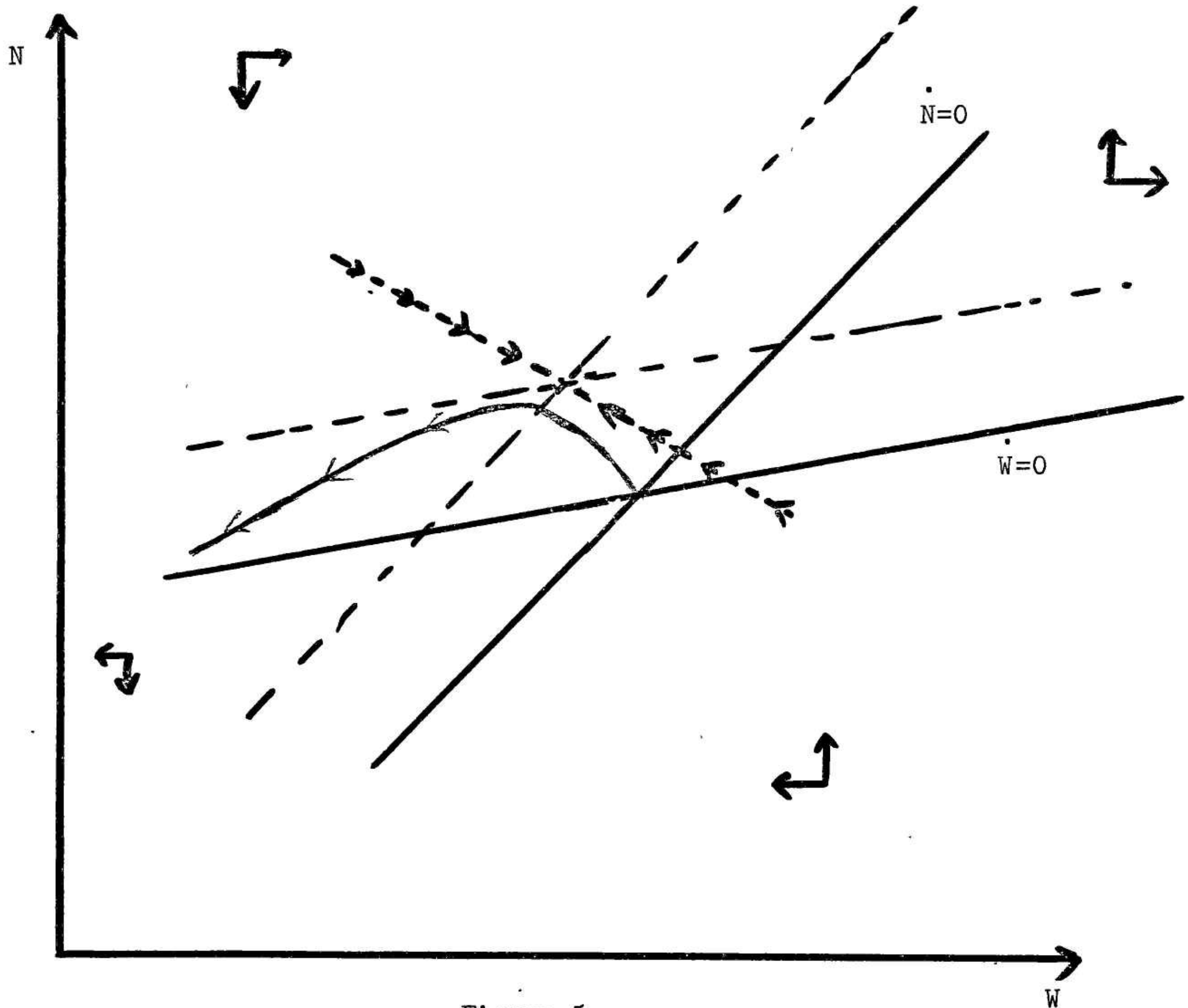

Figure 5

2-b) Exchange Rate and Trade Balance Dynamics under Flexible Exchange Rates

I now turn to the study of dynamics under flexible exchange rates. Expectations concerning the future value of the exchange rate are assumed to be formed in a static manner; that is, $(\dot{e}/e)^*=0$. However, the assumption of long-run perfect foresight gives rise to qualitatively the same dynamics. Therefore, the following analysis may alternatively be regarded as that of the case with long-run perfect foresight by asset holders.

Under a flexible rate, the exchange rate is an endogenous variable described by (15), while the domestic money supply is exogenous. Hence, a trade balance surplus implies an increase in the stock of foreign assets:

$$\dot{F} = B(e, M,N,F)/e \;. \tag{20}$$

Using (9) and the assumption of static expectations, (15) can be rewritten as:

$$e=e(g(e,N,M,F),M,F,0).$$

Solving this for the exchange rate yields a reduced form for the exchange rate:

$$e = E(N,M,F). \tag{21}$$

Assuming that $e_y g_e$ is smaller than one, an increase in the employment of skilled workers leads to an appreciation of the exchange rate, i.e., E_N is negative. So does an increase in F, or E_F is negative. An increase in the money supply may create an appreciation if $e_y y_M$ is large enough. However, this seems very unrealistic and therefore E_M is assumed to be positive in the following. Then, the time path of the economy is described by differential equations (18) and (20) along with (21). An important observation here is that a trade balance surplus, <u>ceteris paribus</u>, leads in the next instant to an accumulation of foreign assets from (20) and then to an appreciation of the exchange rate from (21).

I now proceed to a stability analysis of the system. By linearizing (18) and (20) around the long-run equilibrium, one obtains:

$$\begin{bmatrix} \dot{\bar{F}} \\ \dot{\bar{N}} \end{bmatrix} = \begin{bmatrix} (B_F+E_FB_e)/e^* & (B_N+B_eE_N)/e^* \\ (v_F+v_eE_F) & (v_eE_N+v_N) \end{bmatrix} \qquad (22)$$

where $^-$ here denotes deviations from long-run equilibrium values and the equilibrium exchange rate is e*. The trace and determinant of the right hand side matrix can be calculated as:

$$\text{Trace} = T_{fixed}/e^* + E_FB_e/e^* + v_eE_N \qquad (23)$$

$$\text{Det.} = D_{fixed}/e^* + v_e(B_FE_N-E_FB_N)/e^* + B_e(E_Fv_N-E_Nv_F) \qquad (24)$$

where T_{fixed} and D_{fixed} are the trace and determinant of the corresponding matrix under the fixed exchange rate case. T_{fixed} is negative by assumption. In this section D_{fixed} is assumed to be positive. If this was negative, the system would likely to be unstable. But then the reason for the possible instability would be the same as the one discussed in the last section. Therefore, it is not discussed again in this section. Now, the third term of (23) is negative and the second term of (24) is positive, both tending to make the system stable. Then, unstable cases could arise if B_e is very negative.[5] The case with (24) being negative is shown in Figure 6.

The mechanism for such an instability is as floows: Suppose that there was a trade balance surplus. At the next instant, the exchange rate appreciates through an increase in foreign assets, tending to further increase the

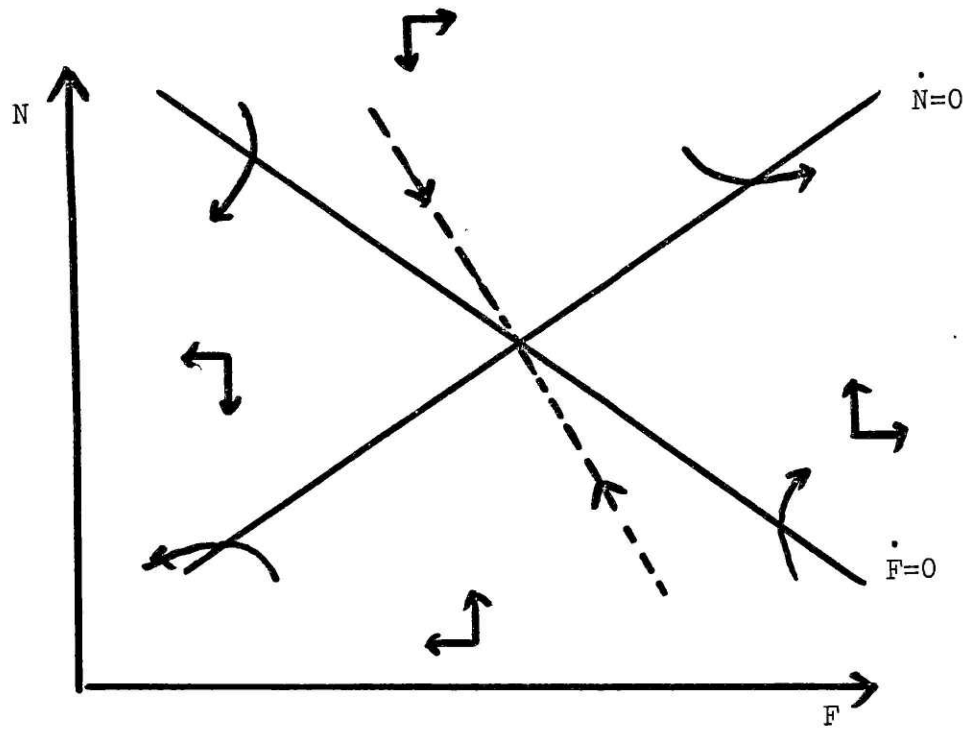

Figure 6

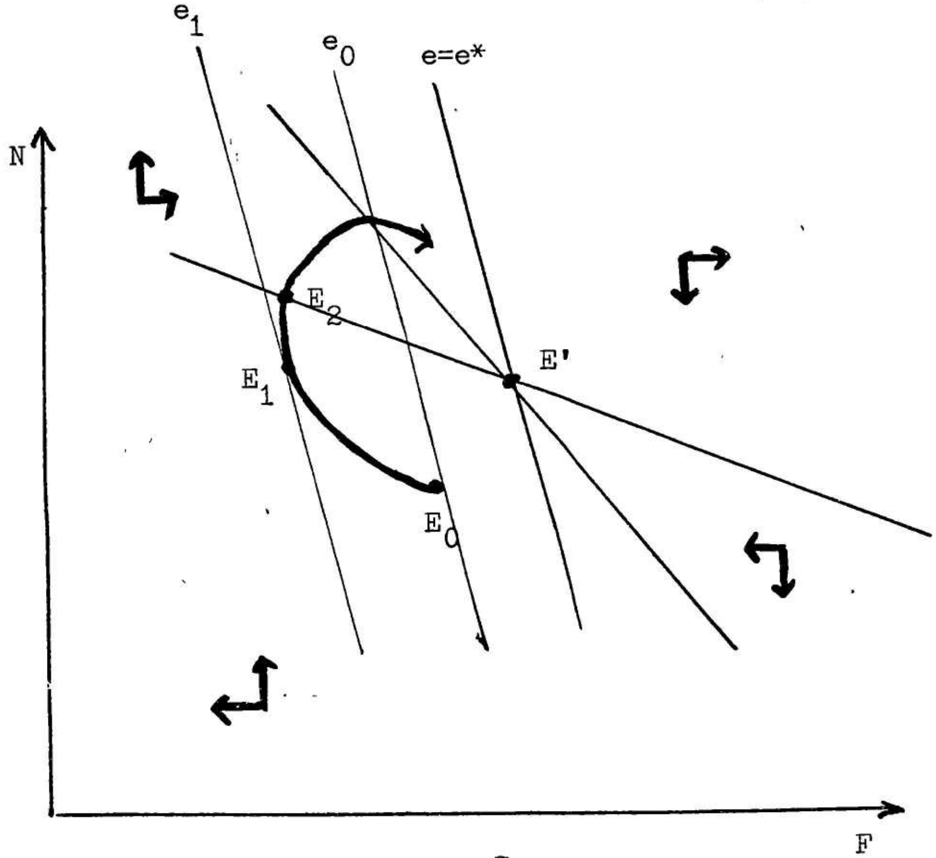

Figure 7

trade balance surplus. This leads to an instability if offsetting effects are not strong enough. In the following I consider only stable cases.

The phase diagram of the system looks like Figure 7, assuming that B_e is negative in order to impose a particularly interesting and realistic structure on the dynamics of the economy. In the figure the locus along which the exchange rate is constant is also shown. This is necessarily steeper than the $\dot{N}=0$ schedule.[6] The approach to the equilibrium could be cyclical or monotonic, depending on the values of parameters.

The effects of an increase in the domestic money supply is now considered to illustrate the dynamics inherent in the model. An increase in the money supply shifts both the $\dot{N}=0$ and $\dot{F}=0$ schedules upward, moving the equilibrium to E' with higher employment of skilled workers. The effect on F is uncertain. Starting from the previous equilibrium, E_0, initially there is a jump in the exchange rate. The exchange rate depreciates because the money supply increase creates an excess supply in the market for domestic money. Moreover, if the long-run value of F increases, the exchange rate overshoots the long-run rate. This is because in the long run the levels of income and foreign money are higher, requiring a higher exchange rate in the short run than in the long run to keep the demand for money at the same level.

However, the real interesting dynamics arises after the initial jump in the exchange rate. The initial depreciation causes a trade balance deficit. This in turn decumulates foreign money and may lead to a further depreciation of the exchange rate as shown by the movement from E_0 to E_1 in the figure. At E_1 the effects of rising employment and thus income take over and the exchange rate starts appreciationg. At the same time, rising N keeps exports increasing. Finally, at E_2, the trade balance deficit ceases and the economy starts to run a surplus, accumulating foreign money. After E_2 the economy may either approach E' monotonically or cycle around E'. In the latter case overshooting of the exchange rate takes place an infinite number of times. Figure 8 shows the time path of e, B, and F for the case of monotonic approach.

At this point it may be useful to compare the above results with those of other authors. The Dornbusch models (1976 a, b) and the Niehans model (1977) are taken up as examples of current theories of exchange rate dynamics. In the Dornbusch models there is an initial overshooting of the exchange rate due to a temporary decrease in the interest rate following an increase in the money supply, which is to be offset by an expectation of a future appreciation of the exchange rate. The nature of possible initial overshooting in the present model is similar to this in the sense that the overshooting is due to the fact that at the initial instant money demand is lower than in the long-run equilibrium unless there is an overshooting.

However, a more interesting finding of the present analysis is that there could be a smooth, medium-run overshooting of the exchange rate as shown in Figure 8. This arises, in the case of an increase in the money supply, from the short-run perverse response of the trade balance to exchange rate changes and the interaction between the trade balance and the exchange rate through foreign asset accumulation.

The niehans model has an initial jump in the exchange rate but fails to provide overshooting because he assumes that the Marshall-Lerner condition is always satisfied. Dornbusch (1976 a) considers a case with a

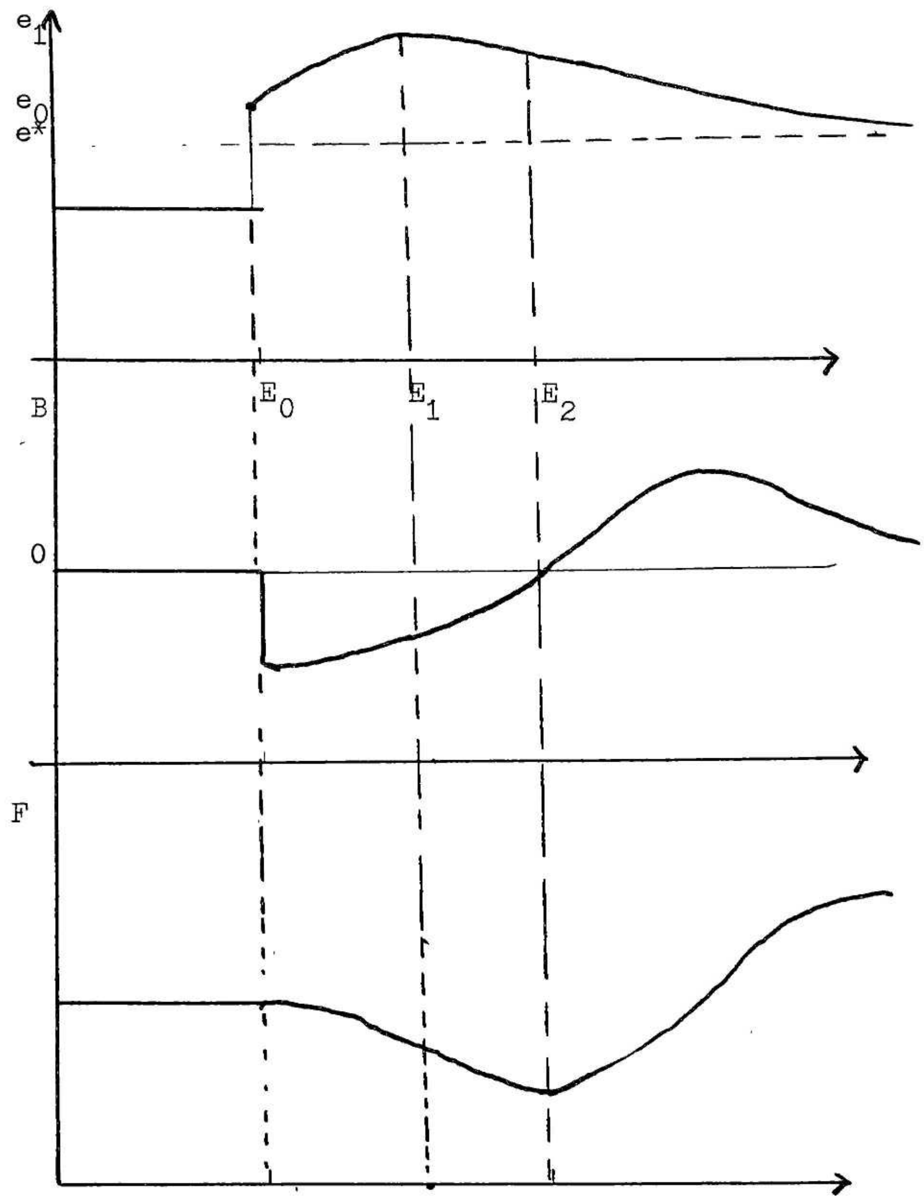

Figure 8

short-run perverse response of the trade balance to exchange rate changes; however, he does not relate the trade balance to asset accumulation and, therefore, does not deal with the feedback effect from the trade balance to the exchange rate. In the above model this link is provided by the explicit consideration of foreign asset accumulation. The short-run trade deficits due to depreciation of the exchange rate leads to foreign money decumulation and provides a possibility of further overshooting of the exchange rate, prolonging the period of trade balance deficit.

Finally, it is to be noted that if B_e is positive, the economy reaches monotonically to the new long-run equilibrium. In other words, there will be no medium-run overshooting of the exchange rate. However, the fact that the last decade has seen many examples of Figure 8 type dynamics makes the analysis of the case with a negative B_e particularly interesting. Of course, the adjustment story which makes B_e small in the short run and large in the long run makes such an analysis plausible.

3, Concluding Remarks

The present work has tried to explain two major empirical regularities of floating rates in the 1970's: exchange rate volatility and large and frequent imbalances in the trade account. Assuming the existence of adjustment costs on the supply side, it has been argued that in the short run exchange rate changes exert only a minor effects on the trade balance. As the adjustment of employment takes place over time, the response of the trade balance becomes larger, possibly resulting in a J-curve type effect.

Exchange rate volatility could be explained by combining such perverse or small response of the trade balance to exchange rate changes with interactions between the trade balance and the exchange rate through foreign asset accumulation. If the trade balance does not respond too much to exchange rate changes, the exchange rate must move up or down by a very large amount to maintain external equilibrium.

It may now be necessary to make some remarks on the implications of using more sophisticated expectations formation mechanisms. As noted in the last section, using the assumption of long-run perfect foresight by asset holders does not change the analysis in any significant manner. It merely increases the elasticity of money demand with respect to exchange rate changes. Another difference is that the initial jump in the exchange rate following an increase in the money supply becomes larger due to a jump in the long-run rate.

However, there is an important advantage in using the long-run perfect foresight assumption; that is, it enables us to analyze the effects of anticipated changes as well as unanticipated ones. For example, suppose an increase in the money supply is expected to take place some time in the future. Then, with long-run perfect foresight the spot rate increases today. Then, it increases the demand for exports and the firm starts increasing employment today as if it had long-run perfect foresight. In this sense the firm benefits from the superior expectations formation mechanism of asset holders.

The case where both the firm and asset holders possess the knowledge of the long-run values of the relevant variables can be treated simply in the following manner. Assume, for simplicity, that the stock of skilled workers is adjusted to changes in the long-run values of e, M, and F. Then, in (18) e, M , and F are replaced by their long-run values. It is easy to see that (9) continues to describe the optimal policy of the firm given the time path of N. As seen above, the formulation of the asset market or the differential equation for foreign money is essentially unchanged. The resulting system can be easily analyzed as in the last section and can be shown to exhibit similar properties to the one studied so far. One important difference between the static expectations case and the perfect foresight case is that the latter necessarily involves a monotonic convergence of employment to its long-run value, while the former may show oscillations around a long-run value. In any case, dynamics of the type of Figure 7 is entirely possible under the perfect foresight assumption. In other words, the essential properties of the dynamics of the model are due to slow employment adjustment and foreign asset accumulation and not to errors in expectations.

Footnotes:

1, The domestic price level and the foreign price level are assumed to be equal to one by an appropriate choice of units.

2, Even if D_e is negative, the following analysis will be unchanged so long as $X_e + D_e$ is positive.

3, Assuming that some skilled workers are necessary to produce "sales efforts" will not change the essential features of the model.

4, It may be better to deflate asset supplies by the price deflator used in the last section. However, this will not result in a major change of the following analysis.

5, When (24) is positive and (23) is negative, the economy oscillates away from the equilibrium, providing another case of instability.

6, Both curves could be upwardly sloped. But the dynamics willremain the same.

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Chapter 3

PERMANENT AND TEMPORARY CHANGES IN THE EXCHANGE RATE AND TRADE BALANCE DYNAMICS

1, Introduction

This paper studies the effects of an unanticipated permanent monetary disturbance on output and the trade balance in a modern macroeconomic framework, consistent with recent theories of exchange rates. The analysis emphasizes the roles of exchange rate expectations and capital mobility in the adjustment process. Expectations are assumed to be formed on the assumption of optimal use of available information. Temporary price and wage rigidities are assumed in order to introduce variations in real variables arising temporarily from monetary disturbances. Such a study is motivated by the fact that, despite the rapid growth in the number of articles devoted to the analysis of flexible exchange rates, not many of them look carefully at the effects of exchange rate changes on real variables of the economy. The attention of these papers have been mostly on providing explanations of the observed volatility of exchange rates. However, the real interesting issue must be the interactions between the exchange rate and other variables of the economy such as the trade balance and output.

One of the most important empirical regularities about such interactions is the so-called J-curve effect--perverse or slow responses of the trade balance to relative price changes. Some recent evidence on J-curve effects is provided by the estimates of the IMF world trade model.[1] In the model, short and long run trade elasticities are estimated for fourteen industrial countries. For nine of them the sum of export and import elasticities is smaller than one in the short run. And then, the sum of the elasticities exceed one in the long run for only five of these nine countries. Thus, the estimates for these nine countries show either the existence of J-curve or small elasticities even in the long run. The purpose of this paper is to study theoretically some possible causes of these observed small elasticities in the short run or both in the short and long run.

1, See Artus and Young (1979).

Previous attempts to explain the causes of such phenomena tended to emphasize institutional and economic rigidities or inertia that slow the adjustment of trade flows to price changes. Magee (1973) studies the role of currency contracts and delivery lags in the effects of exchange rate changes on trade flows. Ueda (1979) studies the interaction between trade balance and exchange rate dynamics by postulating certain types of adjustment costs. The present paper emphasizes the role of exchange rate expectations, especially different effects on trade flows of permanent and transitory changes in the exchange rate. The importance of such a distinction between transitory and permanent changes in prices has long been recognized in the literature. Orcutt (1950) argues that trade flows may respond differently to small and temporary changes in prices than to large and fairly permanent changes, such as those caused by a devaluation under a fixed rate system. Wilson and Takacs (1979) examine empirically the validity of such an assertion using data from a period of fixed exchange rates. They find that trade flows react quicker when an exchange rate, rather than exporter's national currency price, caused a change in international prices. As they point out, of course, such a pattern of response may well be reversed under floating rates. However, most important contributions along these lines have been made by recent literature on the effects of money on output and the trade balance under flexible exchange rates which builds on the traditional Mundell-Fleming model.[1]

Recent analysis of the effects of monetary policy on output and the trade balance stems from the important work of Mundell (1960, 1961, and 1963) and Fleming (1962). They argue that, under high capital mobility, an expansionary monetary policy, by causing a capital outflow and a depreciation of the exchange

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1, Harris and Purvis (1979) and Barro (1978) study theoretically the effects of temporary and permanent disturbances on the exchange rate.

rate, will create a trade surplus and an output expansion. Underlying such a proposition is, of course, the assumption that exchange rate depreciation and an increase in outward lending stimulates net exports. This requires sufficiently high elasticities of the demand for imports in each country.

The Mundell-Fleming conclusion has come under question in some recent literature. Niehans (1975) argues that a monetary expansion may worsen the trade balance and could actually lower income and employment in a model that assumes no capital mobility. His argument is based on the distinction he draws between the actual and "permanent" exchange rate and on an initial perverse response of the trade balance to exchange rate changes. Dornbusch (1976) extends Niehans' analysis to the case of perfect capital mobility and inspects the adjustment process arising from a monetary disturbance. He concludes that in the short run the economy may exhibit the perverse responses discovered by Niehans, but in the long run reaches the Mundell-Fleming equilibrium. In his analysis the short-run perverse trade balance response to exchange rate changes stems from two sources: first, the assumption that physical trade flows respond only to the expected permanent rate, i.e., are not influenced by the spot rate; and second, the assumption that expectations adjust slowly to actual exchange rate changes.

The contributions of Niehans and Dornbusch introduce a new time factor into the adjustment process. However, they do not explain why the <u>expected</u> permanent rate adjusts slowly to changes in the <u>actual</u> permanent rate. Nor is it clear why trade flows are assumed to respond to permanent rate changes and not at all to actual rate changes.

The analysis of this paper builds upon the Niehans-Dornbusch development of the Mundell-Fleming model in the analysis of monetary disturbances under flexible exchange rates. The major contributions of the present paper are the following: First, by introducing explicitly the sources of uncertainty, it reconciles the process in which the expected permanent rate converges to the underlying true permanent rate with the optimal use of information under rational expectations. By doing so, the determinants of the error in the forecast of the permanent rate are made clear. The adjustment process to a disturbance emerges as a reflection of a process by which individuals discover the nature of the disturbance.

Second, in support of the relevance of the effects on the trade balance of permanent changes in the exchange rate, we draw on the existence of a delivery lag for imports and exports. However, it is important to point out at once that a delivery lag, although it plays a key role, is not the essential inertia that produces long lags in the effects of exchange rate changes on trade flows. Rather, lengthy J-curve effects in the present paper result from lagged expectations. Therefore, even a very short delivery lag can be shown to generate long J-curve effects. In placing orders for imports agents must form expectations concerning tomorrow's exchange rate. If today's exchange rate change is perceived to continue into tomorrow,or permanent, it affects agents' spending decisions; if it is considered a transitory change, it does not. This assumption allows us to isolate the speculation problem from the trading problem, as will become clear. When transitory and permanent disturbances are entangled, people do not observe the two types of disturbance separetely. Under such circumstances it is shown that a permanent disturbance generates a J-curve like phenomenon, but the length of the period of perverse responses of the trade balance is dependent upon the speed with which agents discover the nature and learn the magnitude of the disturbance.

Third, the model is then extended to study the effects of some wage and price flexibility on the results. Short-run real effects of monetary disturbances turn on the existence of temporary wage and price stickiness. It is shown that the introduction of flexible prices has the effect of enhancing the importance of perverse responses of the trade balance and output. At the same time, price flexibility reduces the magnitude of improvements in the trade balance in the long run. Needless to say, in the longest of long runs money is neutral and there is no change in the trade balance. Hence, such an analysis may shed some light upon the issue of why we sometimes do not observe large trade elasticities either in the short or in the long run.

Fourth, a slow learning process can be shown to generate persistence in the behavior of output despite the assumption of rational expectations and flexible prices. The implications of this result for theories of the business cycle are discussed. The paper suggests that the failure of the public to recognize whether a disturbance is temporary or permanent has many important macroeconomic consequences.[1] Although the J-curve effect is the particular concern of the paper, we show that it is one of many examples of such consequences. The paper tries to clarify the relation of learning process to the intergration of short and longer run models of macroeconomic systems.

In the next section, the model is set up under the assumption of fixed prices, dealing first with the rational expectations solution of the model under full current information, and then with the extention of the analysis to the case of imperfect information, giving particular attention to the dynamic learning process. In section 3 the same analysis is carried out but assuming wage and price flexibility; the results are then compared with those of section 2. It also contains our conclusion about the generality of the analysis for other macroeconomic problems. Finally, in the last section we discuss some of the implications of the results.

1, Muth(1960) points out the importance of confusion between permanent and transitory disturbances in the context of the theory of consumption function.

2, Fixed Prices and the Effects of a Monetary Disturbance

a) The Model

Consider a small open economy facing a given world interest rate and a perfectly elastic supply of imports at a given price in terms of a foreign currency. Domestic output is supplied perfectly elastically at a given price level. Aggregate spending by domestic residents depends on income and the interest rate. Foreign demand for exports is a function of the terms of trade or the exchange rate. The demand for imports depends on income and the exchange rate. It is assumed that there is a one-period delivery lag both for exports and imports and, therefore, today's levels of exports and imports depend on the expectation of today's exchange rate and income formed yesterday. The actual exchange rate affects today's net exports only through the valuation of imports. This amounts to assuming that contracts for international transactions are written in terms of producers' currencies.[1] When the actual and expected exchange rate or income are different, the value of imports today is different from that expected yesterday. We assume that these expectational errors do not affect aggregate spending or savings. Either the assumption of the use of forward market to cover exchange risks[2] for imports or the assumption of the use of savings to absorb the effects of expectational errors will result in a weakening of the impact of errors in expectations on output.

Let us now characterize the equilibrium condition of the goods market. Aggregate demand for the domestically produced good is equal to aggregate spending plus net exports. Under the assumptions made above aggregate spending, assuming a log-linear form is equal to

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1, The role of delivery lags in J-curve effects has been extensively studied by Magee. Magee (1973) points out the significance of the assumption that foreign trades are invoiced in exporters' currency in the analysis of J-curve effects. Magge (1974) provides some evidence that supports such an assumption. See also Grassman (1973), Hooper and Kohlhagen (1978), and Van Nieuwkerk (1979).

2, The paper by Harris and Purvis op. cit. considers this point more carefully.

$$a_0 - a_1 i_t + a_2 y_t$$

where a_i are positive constants, i_t is the interest rate at time t, and y_t is the log of output at time t. The trade balance, or net exports, T_t, (the log of the ratio of the value of exports to the value of imports) is written as

$$T_t = a_3\ {}_{t-1}e_t - e_t - a_4\ {}_{t-1}y_t \qquad (1)$$

where a_3 and a_4 are positive constants, e_t is the log of the exchange rate. Notations of the type ${}_{t-1}x_t$ indicate the expectation at time t-1 of the random variable x_t conditional on information available at time t-1; domestic and foreign prices are suppressed because they are constant. Coefficient a_3, which is the sum of import and export price elasticity, is assumed to be greater than one; therefore, an increase in the exchange rate, if expectations are correct, increases net exports. The last term represents the effect of income on imports with allowance made for the existence of the delivery lag. We are now in a position to write the equilibrium condition for the domestic goods market.

$$y_t = a_0 - a_1 i_t + a_2 y_t + a_3\,{}_{t-1}e_t - e_t - a_4\,{}_{t-1}y_t \qquad (2)$$

where a_2 is assumed to be smaller than one.[1]

Turning now to the money market, the demand for money is a function of income and the interest rate. Therefore, the equilibrium in the money market requires

$$m_t = b_0 + b_1 y_t - b_2 i_t \qquad (3)$$

where m is the log of the money supply. Interest bearing assets denominated in terms of domestic and foreign currencies are assumed to be perfect substitutes. Accordingly, assuming perfect capital mobility, we obtain

$$i_t = i^* + {}_te_{t+1} - e_t \qquad (4)$$

where i* is the foreign interest rate, which is assumed to be constant.

1, More precisely, output here is defined as aggregate spending times net exports due to the use of log-linear form. In order to define output as the sum of the two components, it is necessary to multiply each by its share in output. However, this procedure in no way affects the following analysis.

identities we can determine the coefficients. They turn out to be

$$\begin{aligned}
\bar{e} &= ((1-a_2+a_4)b_0-a_0b_1)/((a_3-1)b_1) , \\
d_1 &= ((1-a_2+a_4)/((a_3-1)b_1), \\
d_0 &= d_1 + (1-a_2 + b_1d_1)/D_0, \\
\tilde{d}_0 &= (1-a_2)/D_0 \\
\bar{y} &= (b_2i^*-b_0)/b_1 \\
f_1 &= 1/b_1 \\
f_0 &= - (1-a_1 + b_2d_1)/D_0 \\
\tilde{f}_0 &= (a_1-1)/D_0
\end{aligned} \tag{7}$$

where $D_0=b_2(1-a_2)-b_1(1-a_1)$ will be assumed to be positive.[1]

Hence, the time path of the trade balance and the interest rate look as follows:

$$\begin{aligned}
i_t &= i^* - (1-a_2+b_1d_1)/D_0 \, v_t - \tilde{f}_0 \, u_t \\
T_t &= (a_3-1)\bar{e} - a_4\bar{y} + ((1-a_2)/b_1)m^*_{t-1} - d_0v_t - \tilde{d}_0u_t .
\end{aligned} \tag{8}$$

These solutions easily lend themselves to economic interpretations. Permanent increases in the money supply have permanent effects on the exchange rate, income, and the trade balance. As in the Mundell-Fleming worldthe income multiplier is related/to the income elasticity of money demand, since in the long run the domestic interest rate/is equal to the foreign rate. The long-run magnitude of depreciation is derived from the goods market equilibrium condition; that is, the increase in net exports should absorb the increase in income after allowance is made for multiplier effects. The trade balance unambiguously improves in the long run.

In the period when a change in v ocurrs, the effects on the endogenous variables

1, This turns out to be the stability condition of the system (2)-(4) when it is viewed as a system consisting of three endogenous variables y, e, and i, given expected variables.

The model can be completed by specifying the process which generates the nominal money supply. Assuming that the trend growth rate of the money supply is included in the constant term of the demand for money function, we specify, following Barro (1978), the stochastic process of the money supply as follows: the stochastic shocks to the money supply consist of permanent and transitory part. Letting u_t and v_t be the transitory and permanent disturbances, respectively, m_t is equal to [1]

$$m_t = \sum_{i=0}^{\infty} v_{t-i} + u_t \; . \tag{5}$$

The two random terms u and v are white noise processes[2] with variances s_u^2 and s_v^2, respectively. Obviously, the system will be complete once the mechanism which determines expected variables are specified.

b) Solution of the Model under Perfect Information

Let us now obtain the rational expectations solution of the model, assuming full current information. In other words, the information set of a representative individual at time t includes the structure of the model, and the realizations of the stochastic processes (u,v) up to time t.

Now guess at a solution of the form:[3]

$$\begin{aligned} e_t &= \bar{e} + d_1 m^*_{t-1} + d_0 v_t + \tilde{d}_0 u_t \\ y_t &= \bar{y} + f_1 m^*_{t-1} + f_0 v_t + \tilde{f}_0 u_t \end{aligned} \tag{6}$$

where m^*_t is the permanent component of the money supply, or $\sum_{i=0}^{\infty} v_{t-i}$. Substituting this back into the original system, (2), (3), (4) and (5), and requiring them to be

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1, Note that these disturbances could include stochastic shifts in the money demand function. Also, (5) can be made more general by allowing the coefficients of v_{t-i} to be different. Although this permits us to analyze more carefully the shape of the J-curve, it does not alter any of the essential conclusions of the paper.

2, We assume that u_t and v_s are uncorrelated for any t and s.

3, That this form of the solution is natural can be seen as follows: First, project the original system on information available at time t-1. Then, solve the resulting deterministic difference equation for ${}_{t-1}e_t$ and ${}_{t-1}y_t$. They turn out to involve only a constant and m^*_{t-1}. Under rational expectations assumption e_t and y_t must look like (6). See Sargent (1979), Ch. XI, for this method.

are very different from the long-run effects due to the existence of the delivery lag and the possibility of a temporary divergence of i_t from i*. Since a depreciation of the exchange rate only works through an increase in the value of imports in the first period, it decreases the trade balance. And, it tends to exert a negative impact on output. This, then, implies that in the initial period the demand for money falls short of the long-run level and , therefore, leads to an overshooting of the exchange rate. Hence, the interest rate declines. (7) shows that the expansionary effect of the decrease in the interest rate is more than offset by the deflationary effect of depreciation. Thus, output declines in the initial period.

A temporary disturbance affects the endogenous variables only in the first period. The effects are more or less the same as the initial effects of a permanent disturbance. The increase in the money supply lowers the interest rate, and thus causes a depreciation of the exchange rate. Since the absolute amount of the depreciation is smaller in this case than the case of a permanent disturbance, the dampening effect of the increase in the exchange rate is smaller and output could expand.

Figure 1 shows the time path of the endogenous variables following an increase in v. The time path of the trade balance, thus, indicates the existence of a one period J-curve effect. Output also shows a perverse response in the initial period. These are, obviously, results of the existence of the delivery lag. However, both the trade balance and output jump up to their long-run levels in the second period; therefore, these perverse responses of the trade balance and output are confined only to the first period. Unfortunately, the lag between a change in the exchange rate and a change in trade flows observed in the last several years seems to have been much longer than that justified merely by the existence of a delivery lag.[1] In the next section we shall explore circumstances under which such perverse responses may exhibit a certain degree of persistence.

1, Compare an estimate,approximately one quarter, of delivery lags in U.S.-Japan and U.S.-Germany trade provided by Magee (1974) to estimates of the length of J-curve effects discussed in the previous section.

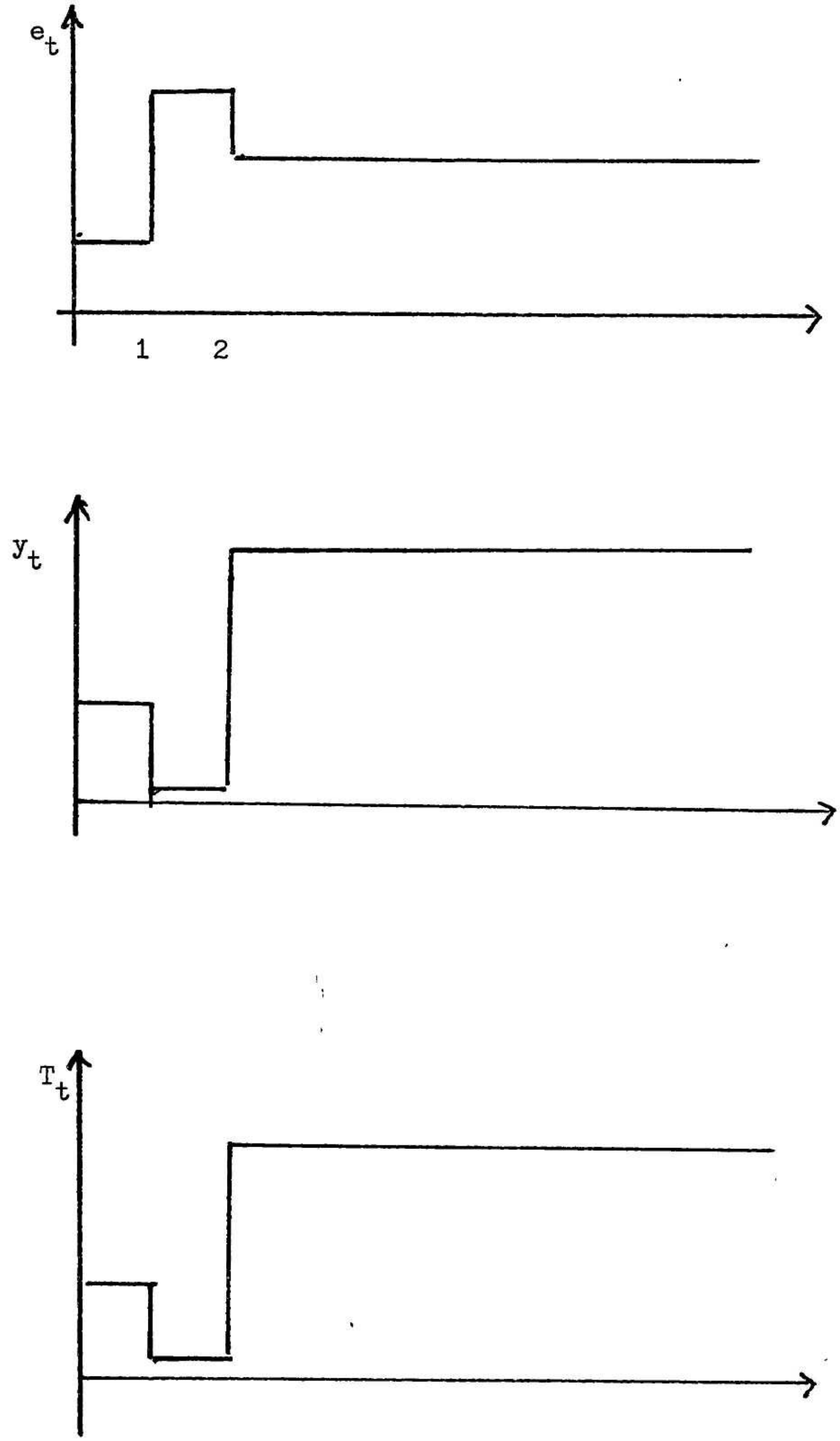

Figure 1

c) Incomplete Current Information

We now introduce one type of restriction on current information sets; that is, although individuals continue to observe m_t at time t, they do not know immediately the division of m_t into permanent and temporary components. In reality, individuals may know the stock of money with fairly short delays, but very few of them seem to possess a clear idea as to what part of a change in the money supply constitutes a permanent change and what part, a temporary change.

In order to characterize the dynamic behavior of the economy under such a circumstance, some further simplifying assumptions are made. First, although individuals do not observe v_t and u_t separetely, we assume that they know the first two moments of the distributions. Second, people are assumed to form least squares estimates, i.e.,forecasts that minimize the mean squared error.

We now consider the following situation. At the beginning of period 1, people know past realizations of v and u. However, as assumed above, from time 1 on, people observe m_t but not v_t or u_t. Alternatively, let

$$x_t = m_t - m_{t-1} = v_t + u_t - u_{t-1}. \qquad (9)$$

Then, for t greater than 1, the information set is $(x_t, x_{t-1}, \ldots, x_1, v_0, u_0, v_{-1}, u_{-1}, \ldots)$. In order to study the effects of an unanticipated permanent monetary disturbance, we compare two realizations of stochastic processes (v_t, u_t) where the two are exactly the same except in period 1 one of them has a realization of v_1 which is higher by one unit than the realization of v_1 in the other. Since the structure of the model is completely linear, comparing the two situations is equivalent to solving the model assuming that both temporary and permanent disturbances are zero in all periods with the exception of v_1 being equal to 1.

We now turn to the discription of the learning process of individuals after time 1.The typical problem for them at time t is to use the information available to forecast the future time path of the money supply. This is necessary to form expectations about the exchange rate; formulas (6) are, actually, weighted averages of the expected future money supplies. Given the simple stochastic property of the money supply, this amounts to making guesses at the levels of present and past permanent disturbances, v_t, $v_{t-1}, \ldots, v_1$. The best linear estimates are obtained by projecting each v on current and past x. The exact formula for these estimates are derived in the appendix. Individuals' expectation of the permanent component of the money supply at time t, ${}_tm^*_t$, turns out to be

$$
\begin{aligned}
{}_tm^*_t &= \sum_{i=1}^{t} {}_tv_i \\
&= 1 - s_u^2 q_1^t/(2s_u^2+s_v^2)(1+q_1^{2t+1}).[1] \qquad (10)
\end{aligned}
$$

Thus, ${}_tm^*_t$ is an increasing function of t and converges to one as t goes to infinity. Not surprisingly, it can be shown that an increase in s_v^2 relative to s_u^2 leads to an increase in ${}_tm^*_t$; an increase in the importance of permanent disturbances relative to temporary disturbances induces people to attach more weight to permanent disturbances in their expectations. Also, it is easy to show that ${}_tm^*_t - {}_{t-1}m^*_{t-1}$ is a decreasing function of t; that is, ${}_tm^*_t$ converges to true m*, but at a decreasing rate.

Now that the time path of ${}_tm^*_t$ is specified, we can determine the dynamic behavior of the economy. The solution is obtained immediately once we recognize the following fact: the distinction between permanent and transitory disturbances matters only through public's expectation of future variables. Consequently, what determines the course of the economy is not the <u>actual</u> permanent or transitory disturbances but permanent and transitory disturbances as <u>perceived</u> by the public. At time t individuals expect the permanent component of the money supply to be equal to ${}_tm^*_t$; the transitory part is perceived to be equal to $m_t - {}_tm^*_t = 1 - {}_tm^*_t$. Thus, the increment in ${}_tm^*_t$, ${}_tm^*_t - {}_{t-1}m^*_{t-1}$, affects the economy as if there was a permanent disturbance at time t of this amount. The solution under imperfect information, therefore, is

1, See the appendix for the definition of q_1. Here it suffices to note that q_1 is between zero and one.

$$y_t = f_1\,{}_{t-1}m^*_{t-1} + f_0({}_tm^*_t - {}_{t-1}m^*_{t-1}) + \tilde{f}_0(1 - {}_tm^*_t)$$

$$e_t = d_1\,{}_{t-1}m^*_{t-1} + d_0({}_tm^*_t - {}_{t-1}m^*_{t-1}) + \tilde{d}_0(1 - {}_tm^*_t) \qquad (11)$$

$$T_t = ((1-a_2)/b_1)\,{}_{t-1}m^*_{t-1} - d_0({}_tm^*_t - {}_{t-1}m^*_{t-1}) - \tilde{d}_0(1 - {}_tm^*_t) \; .$$

Of course, it is easy to verify that these are in fact the right solutions of the system. For later purposes we rewrite the formula for the trade balance in terms of structural parameters.

$$T_t = \frac{1-a_2}{b_1} - r_u\left(\left(d_0 + \frac{1-a_2}{b_1}\right)\left(q_1^{t-1}/(1+q_1^{2t-1})\right) - (d_0 - \tilde{d}_0)\left(q_1^{t}/(1+q_1^{2t+1})\right)\right) \qquad (12)$$

where $r_u = s_u^2/(2s_u^2 + s_v^2)$.

The time paths of these variables are shown in Figure 2. The pattern of the trade balance exhibit the following properties: first, the initial deterioration of the trade balance is smaller than that of the perfect information case. This is due to the fact that people attribute part of the increase in v_1 to an increase in transitory disturbance. Second, the trade balance does not attain its long-run level in the second period as in the perfect information case, but may continue to be below zero for some time. This point will be discussed more at length shortly. Third, in the long run T_t converges to the level of perfect information case.

Let us now consider more carefully the causes of the short-run perverse response of the trade balance. Evidently, lags in expectations are the major cause of the phenomenon. As we have seen above, during the learning process agents behave as if there were new disturbances in each period. New disturbances have negative effects on the trade balance. Over time the magnitude of these "new" disturbances becomes smaller and the accumulation of "past permanent" disturbances begin to exert strong positive effects. Eventually, the trade balance turns into a surplus.

More importantly, the speed with which the trade balance converges to the long-run level depends on the speed with which individuals learn the nature of

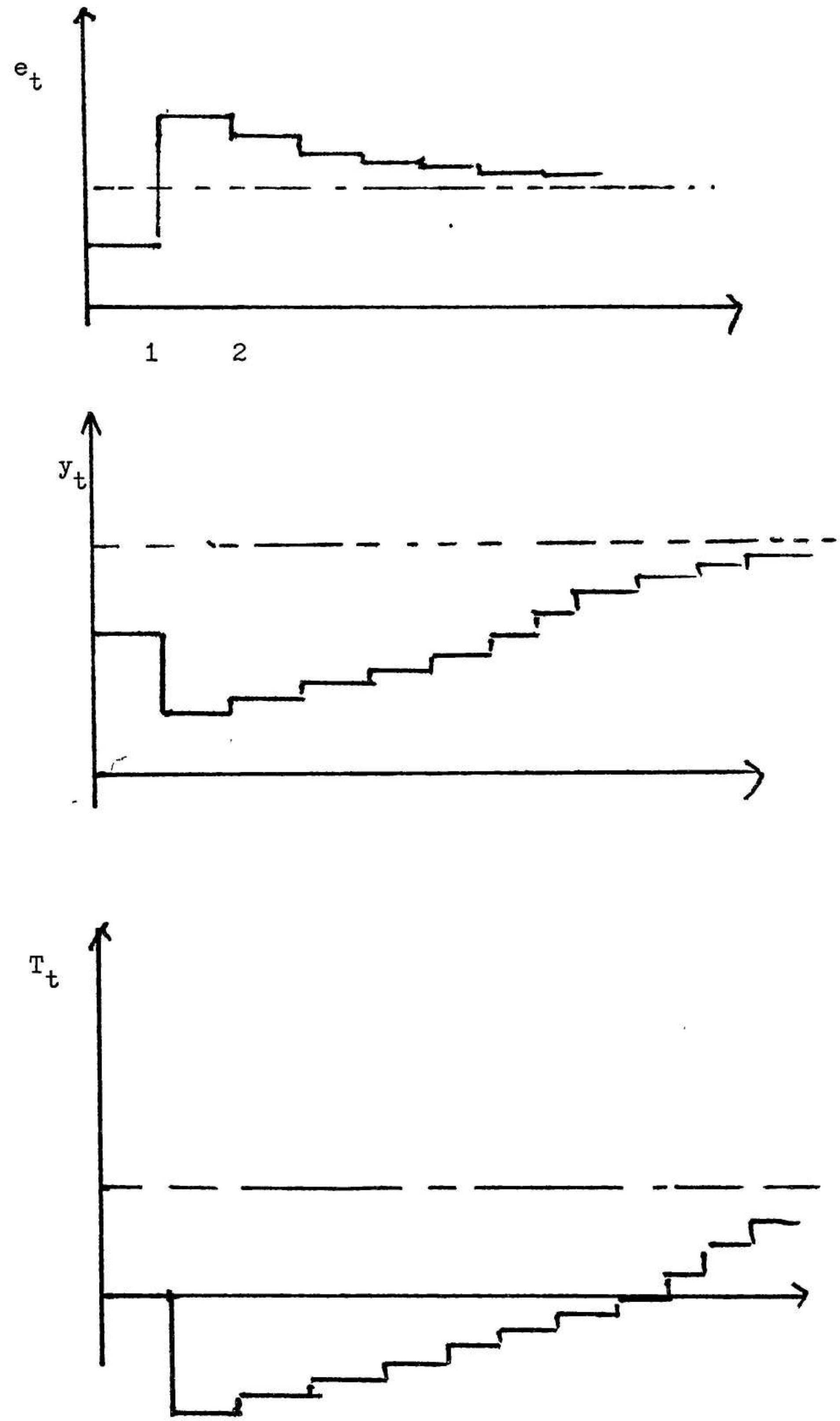

Figure 2

a disturbance. The latter depends on the variance of the permanent disturbance relative to the variance of the transitory disturbance. As the importance of transitory disturbances increases, people attribute a larger portion of an increase in the money supply to an increase in temporary disturbance, slowing the adjustment of real variables to permanent money supply changes. This point can be seen analytically by referring to equation (12). Since d_0 and $d_0-\tilde{d}_0$ are positive, T_t is negative for small t. As t becomes large, terms like q_1^{t-1} and q_1^t decreases. The decrease will be larger, the larger is q_1. By going back to the definition of q_1, one can see that it depends positively on s_u^2/s_v^2.[1]

The time paths of the exchange rate and output can be analyzed in a similar manner. They respond slowly to a permanent disturbance due to lagged adjustment of expectations. Interestingly, there could be several periods of negative changes in output following an increase in the money supply--the possibility pointed out by Niehans.

We now conclude this section by briefly sketching the effects of a temporary increase in the money supply. Under imperfect information part of the increase in the disturbance is perceived to be temporary; therefore, the initial drop in the trade balance is greater than in the case of perfect information. An interesting exercise here would be to compare the pattern of the response of the trade balance to a temporary disturbance to the result obtained above. Presumably, the trade balance would oscillate around zero after a brief period of deficit.

1, More precisely, an increase in s_u^2/s_v^2 has two effects. It tends to decrease the initial deterioration of the trade balance because it decreases the expectation of the permanent component of the money supply. Also, it has the effect of slowing the adjustment process as discussed above. It can be shown that so long as $(1-a_2)/b_1d_1$ is not too small, an increase in s_u^2/s_v^2 prolongs the period of trade balance deficit

3, Flexible Prices and the Effects of a Monetary Disturbance

a) Full Current Information

An important extension of the model is to recognize the role of price and wage flexibilities in the effects of monetary disturbances. This is achieved by postulating a simple price equation which relates current price to current costs, that is, wages, and the GNP gap. Thus,

$$p_t = {}_{t-1}z_t + k({}_{t-1}y_t - y^p) \tag{13}$$

where p_t is the log of the price level, ${}_{t-1}z_t$ is the expectation of the log of the level of nominal wage at time t expected as of t-1, and y^p is the potential output. The right hand side of (17) is projected on information available at time t-1 to allow for the effect of the delivery lag. However, the essential point is that prices are predetermined in the sense that p_t does not respond to new information which comes in in period t. Next, wages are set by long-term contracts. Suppose that all contracts run for N (>1) periods and that a constant fraction, 1/N, of all workers determine their wage contracts in any given time period. A contractis assumed to specify nominal wage levels for the next N periods so as to maintain a fixed real wage level. Therefore, assuming that this real wage is equal to zero, the average wage for the economy as a whole at t is

$$z_t = \frac{1}{N} \sum_{i=1}^{N} {}_{t-i}p_t \tag{14}$$

With all prices and wages predetermined, it will remain true that monetary disturbances bring about deviations of output and the trade balance from their long-run levels.

Under these assumptions the economy is described by the following set of equations:

$$y_t = a_0 - a_1 i_t + a_2 y_t + a_3({}_{t-1}e_t - {}_{t-1}p_t) - (e_t - p_t) - a_4\,{}_{t-1}y_t$$

$$
\begin{aligned}
m_t - p_t &= b_0 + b_1 y_t - b_2 i_t \\
i_t &= i^* + {}_t e_{t+1} - e_t \\
p_t &= {}_{t-1}z_t + k({}_{t-1}y_t - y^p) \\
z_t &= \frac{1}{N} \sum_{i=1}^{N} {}_{t-i}p_t \\
m_t &= \sum_{i=0}^{\infty} v_{t-i} + u_t \quad .
\end{aligned}
\tag{15}
$$

Assuming full current information, the model can be solved for the reduced form. Guess at a solution of the form[1]

$$
\begin{aligned}
y_t &= y^p + \sum_{i=0}^{N-1} \alpha_i v_{t-i} + \sum_{i=0}^{N-1} \tilde{\alpha}_i u_{t-i} \\
p_t &= \bar{p} + m^*_{t-N} + \sum_{i=0}^{N-1} \beta_i v_{t-i} + \sum_{i=0}^{N-1} \tilde{\beta}_i u_{t-i} \\
e_t &= \bar{e} + m^*_{t-N} + \sum_{i=0}^{N-1} \gamma_i v_{t-i} + \sum_{i=0}^{N-1} \tilde{\gamma}_i u_{t-i}
\end{aligned}
\tag{16}
$$

Sustituting (16) back to (15), we obtain solutions

$$
\begin{aligned}
\alpha_0 &= f_0 & \tilde{\alpha}_0 &= f_0 \\
\beta_0 &= 0 & \tilde{\beta}_0 &= 0 \\
\gamma_0 &= ((1-a_2)+ {}_1(D_0+b_1))/D_0 & \tilde{\gamma}_0 &= d_0
\end{aligned}
\qquad
\tilde{\alpha}_i = \tilde{\beta}_i = \tilde{\gamma}_i = 0, \quad 1 \leq i \leq N-1
$$

$$
\begin{aligned}
\alpha_i &= (B_1+b_2(a_3-1)(\gamma_{i+1}-1))/D_i \\
\beta_i &= \frac{Nk}{N-i}(B_1+b_2(a_3-1)(\gamma_{i+1}-1))/D_i \qquad 1 \leq i \leq N-1 \\
\gamma_i &= 1 + (A + (\gamma_{i+1}-1)(D_i'))/D_i
\end{aligned}
\tag{17}
$$

where

$B_1 = a_1+a_3-1+b_2(a_3-1)$, $B_2 = b_1(a_1+a_3-1)+b_2(1-a_2+a_4)$,
$A = 1-a_2+a_4-b_1(a_3-1) = b_1(a_3-1)(d_1-1)$,

$D_i = B_2 + B_1(Nk/N-i)$, $D_i' = a_1 b_1+b_2(1-a_2+a_4)+(a_1+b_2(a_3-1))(Nk/N-i)$, $\gamma_N = 1$.

1, The plausibility of such a solution can be seen by first solving the system for ${}_{t-N}y_t$, ${}_{t-N}p_t$, and ${}_{t-N}e_t$.

Although these are not final reduced form solutions because they contain Υ_{i+1} on the right hand sides, it is possible to study the major implications of the solution in this form. First, all three variables exhibit long-run neutrality in the sense that after N periods, the GNP gap will be equal to zero and that price and the exchange rate are equal to the permanent money supply.

What happens in the short run depends partly on the sign of A or whether d_1 is greater or smaller than 1. If d_1 is greater than 1, the exchange rate overshoots its long-run level in the first N periods following a permanent increase in the money supply; if d_1 is less than one, the exchange rate will be lower in these periods than the long-run level. This result is a natural extension of the fixed price model since d_1 determines the long-run rate of change in the exchange rate under fixed prices. Of course, in the first period the presence of the delivery lag adds an element of overshooting. Figure 3 illustrates these two possibilities for the exchange rate path.

The paths of output and price show slow convergences of these variables to their long-run values except the decrease in output in the initial period. The price level moves up slowly because long-term contracts delay adjustments to a monetary disturbance. In the appendix it is shown that if A is positive (negative), Υ_i decreases (increases) as i increases. Therefore, the adjustment of the exchange rate to a permanent monetary disturbance is monotonic after the second period. With overshooting exchange rates the path of output is also monotonic, while it may not be with undershooting exchange rates. The latter possibility arises from the effect of increases in the exchange rate on aggregate demand; aggregate demand increases through increases in net exports and may offset the effect of increasing prices. On the other hand, the path of the price level is monotonic with undershooting exchange rates and may not be with overshooting exchange rates. In any case after N periods of time prices catch up with the increase in the exchange rate and there will be no real effects.

Finally, the time path of the trade balance can be obtained by using (17),

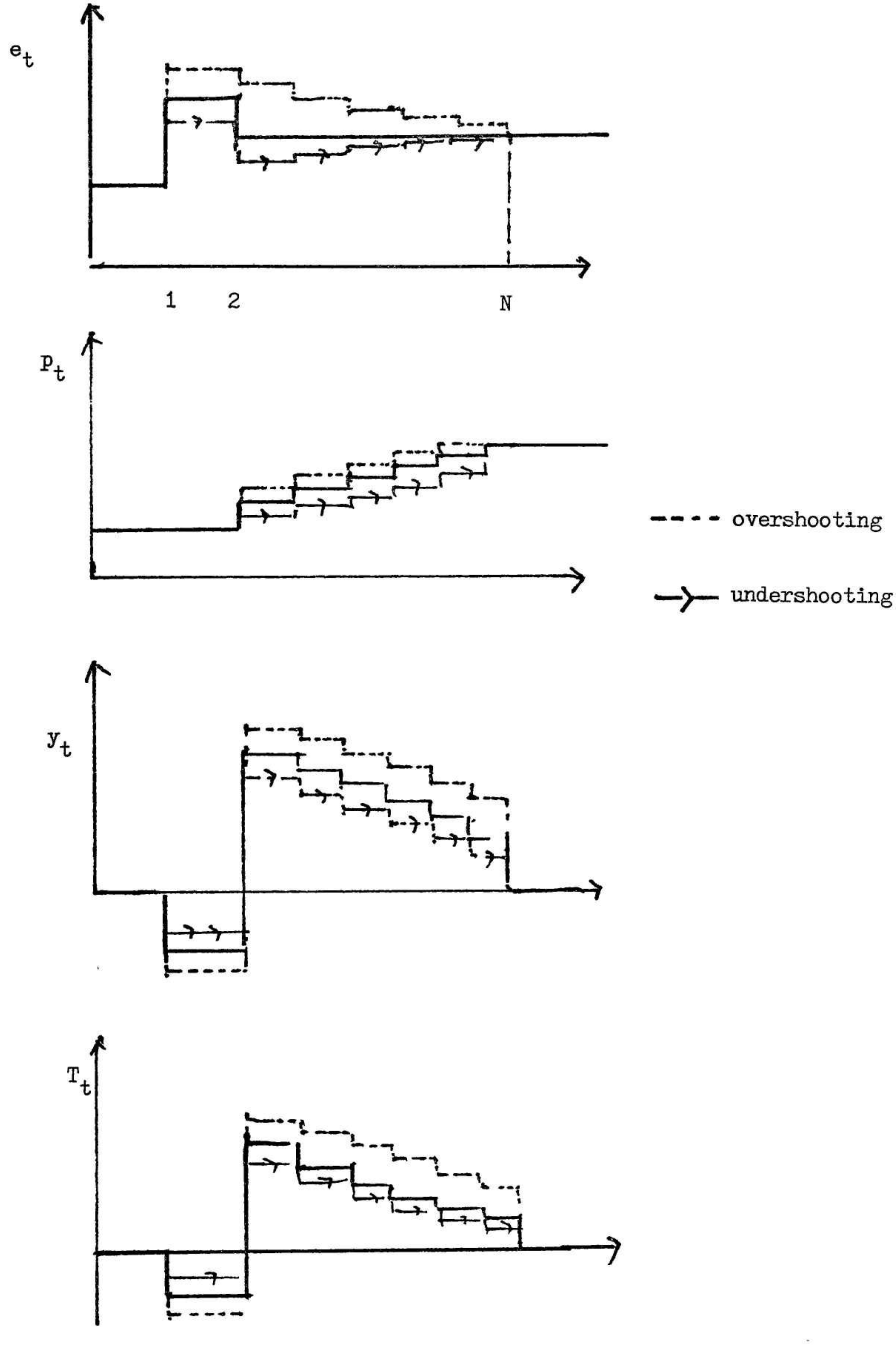

Figure 3

$$T_t = \text{constant} + \sum_{i=1}^{N} n_i v_{t-i} - \gamma_0 v_t - \tilde{\gamma}_0 u_t \tag{18}$$

where
$$n_i = \frac{((a_3-1)B_2 - a_4 B_1 + (\gamma_{i+1}-1)(a_1 b_1 (a_3-1) + b_2(a_3-1)(1-a_2) + \frac{Nk}{N-i} a_1(a_3-1)))}{\frac{Nk}{N-i} B_1 + B_2}$$

Clearly, if a_4 is not too large and if the exchange rate does not undershoot too much n_i is positive for $1 \leq i \leq N-1$. In the following we shall assume that n_i are all positive. Then, as shown in the figure, a permanent increase in the money supply initially causes a worsening of the trade balance, and then, for the next N periods, the trade balance stays in surplus. After Nperiods price changes completely offset exchange rate changes and there will be no effects on the trade balance.

b) Imperfect Information and J-curve Effects

It is now time to solve the model under the assumption that the information set of the public does not include the breakdown of the money supply into permanent and transitory components. Since the information extraction problem of the public is exactly the same as the fixed price case, we turn immediately to the solution of the model.

The solution can be obtained in an analogous manner to the way the solution was obtained in section 2- c). It can easily be seen that the solution is

$$\begin{aligned} y_t &= y^p + \sum_{i=0}^{N-1} \alpha_i ({}_{t-i}m^*_{t-i} - {}_{t-i-1}m^*_{t-i-1}) + \tilde{\alpha}_0 (m_t - {}_t m^*_t) \\ p_t &= \bar{p} + {}_{t-N}m^*_{t-N} + \sum_{i=0}^{N-1} \beta_i ({}_{t-i}m^*_{t-i} - {}_{t-i-1}m^*_{t-i-1}) \\ e_t &= \bar{e} + {}_{t-N}m^*_{t-N} + \sum_{i=0}^{N-1} \gamma_i ({}_{t-i}m^*_{t-i} - {}_{t-i-1}m^*_{t-i-1}) + \tilde{\gamma}_0 (m_t - {}_t m^*_t) \end{aligned} \tag{19}$$

where ${}_s m^*_t$ is public's expectation held at time s of the permanent component of the money supply at time t and coefficients $\alpha_i, \beta_i, \gamma_i, \tilde{\alpha}_0, \tilde{\gamma}_0$ are exactly the same as those defined by (17).

We now analyze the effects of an increase in the permanent component of the money supply. As in the previous section, suppose that the information set of the public includes $(x_t, x_{t-1}, \ldots, x_1, v_0, u_0, v_{-1}, u_{-1}, \ldots)$ and that the realizations of these variables are $(0,0,\ldots,x_1=1,0,0\ldots)$. Then, equation (10) continues to describe the learning process of the public.

Let us first focus on the effect on the trade balance, which can be written as follws:

$$T_t = \sum_{i=1}^{N-1} n_i({}_{t-i}m^*_{t-i} - {}_{t-i-1}m^*_{t-i-1}) - \gamma_0({}_t m^*_t - {}_{t-1}m^*_{t-1}) - \tilde{\gamma}_0(1 - {}_t m^*_t). \quad (20)$$

In order to fully assess the role of price flexibility, let us compare (20) with the time path under fixed prices, (11). By subtracting the right hand side of (20) from that of (11), we obtain

$$\sum_{1=1}^{N-1} \left(\frac{1-a_2}{b_1} - n_i\right)({}_{t-i}m^*_{t-i} - {}_{t-i-1}m^*_{t-i-1}) + \frac{1-a_2}{b_1}\, {}_{t-N}m^*_{t-N}. \quad (21)$$

In the appendix it is shown that so long as A(defined in (17)) is not very negative, n_i is smaller than $(1-a_2)/b_1$. Therefore, assuming this to be the case, (21) is positive. In other words, the trade balance under price rigidity is in most cases higher than that under price flexibility. More importantly,

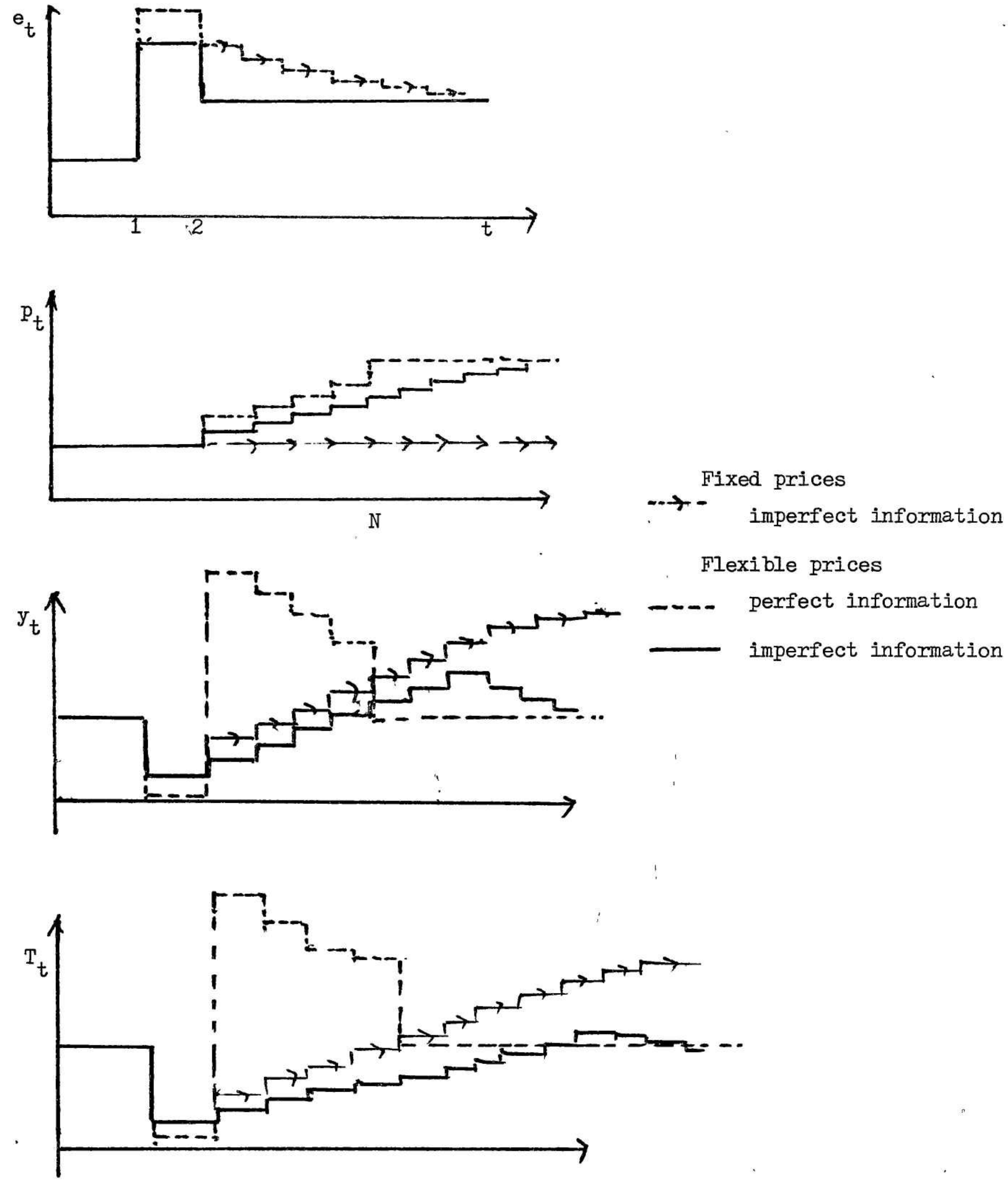
e_t
1
2
t
p_t
N
y_t
T_t
Fixed prices
imperfect information
Flexible prices
perfect information
imperfect information

Figure 4

the period of perverse response of the trade balance is now longer with flexible prices. Another important, but obvious, point of difference between the two cases is that with fixed prices a permanent increase in the money supply exerts a permanent effect on the trade balance while under flexible prices the trade balance converges to zero in the long run. In sum, with flexible prices significant effects of a permanent increase in the money supply manifest themselves in the short run. Furthermore, it may well be the case that the perverse response of the trade balance-- trade balance deficits with depreciating exchange rates-- is the only visible effect on the trade balance. .. The reasoning behind such a result is clear: price increases generated by the increase in the money supply eliminate any substantial long-run effects; also, in the short run they tend to offset the effect of exchange rate changes on the trade balance, increasing the importance of perverse pattern of the behavior of the trade balance.

Figure 4 summarizes the above discussion by presenting the time path of the trade balance and comparing it with the paths in other cases.

c) Imperfect Information and the Persistence in the Movement of Output

One final interesting observation concerning the behavior of the economy under imperfect information is the persistence of the effects of monetary disturbances on income and the trade balance. As Figure 4 makes clear, while under perfect information the effects of a monetary disturbance last only N periods, the effects are long-lasting under imperfect information. This result obviously stems from the failure on the part of the public to correctly perceive the nature of disturbances. The above analysis shows that even under rational expectations in general it takes an infinite amount of time for the public to fully learn the nature of disturbances. During the learning process any increment in the expected permanent component of the money supply affects the economy as if there was actually a new disturbance.

Such a feature of learning processes has been pointed out by such authors as Taylor (1975) and Friedman (1978).[1] The mechanism in this paper is essentially the same as those analyzed by these authors. Our analysis has shown that confusions between permanent and transitory disturbances, which seem to be a fairly common phenomenon, can create long lags in expectations.

Apart from such general features of our framework several points are worth mentioning. First, movements in output in this paper correspond to movements in unemployment[2] unlike many equilibrium attempts to explain business cycles. This has been made possible by the introduction of one period price rigidity. The introduction of long-term contracts, in addition to temporary price rigidity, was not an essential requirement in generating the serial correlation of output. It was necessary to produce positive effects of monetary disturbance on output and the trade balance. Without that an increase in the money supply would have never exerted positive effects on output and the trade balance, and explaining perverse responses of these variables would have been too easy.

Second, the particular combination of assumptions that have been used to produce real effects of nominal disturbances--the delivery lag, temporary price and wage rigidity, and imperfect information--has succeeded in generating a hump-shaped movement of output. (See the figure.) This point may be of some interest in view of the nature of business cycles observed in many countries.

1, See also Mussa (1978).

2, Taylor (1978) offers a mechanism that explains serial correlations in unemployment based on the idea of staggered contracts.

4, Concluding Remarks

This paper has developed a simple macro model of a small open economy in a framework consistent with recent theories of the exchange rate ; that is, exchange rate expectations and capital mobility play crucial roles in the model. The framework is also consistent with the recent macroeconomic literature which builds on rational expectations and temporary price and wage stickiness as a device for providing non-neutrality of money.

It has been shown that the presence of a one period delivery lag and confusions between temporary and permanent shocks create fairly long J-curve type effects. An unanticipated permanent increase in the money supply initially lowers income and the trade balance. Over time, output and the trade balance increase as people gradually increase their expectations of the permanent component of the money supply. The short-run perverse behavior of the trade balance lasts longer the more important is the role of temporary disturbances relative to permanent disturbences.

Under price and wage rigidity the economy attains the Mundell-Fleming equilibrium in the long run. Under price and wage flexibility (or temporary wage and price stickiness) significant effects are brought about in the short run: the perverse response of the trade balance is now longer and improvements in the trade balance in a longer run may be of a negligible order of magnitude; therefore, perverse responses may not be perverse at all and could be considered as normal responses.

These theoretical findings are consistent with the empirical evidence discussed in section 2: fairly long J-curve effects which do not seem to be explained by institutional rigidities alone and the importance of temporary versus permanent changes in relative prices. However, it is important to note that the length of short-run perverse effects changes as the magnitude of temporary relative to permanent disturbances shifts over time. Therefore, fitting an equation with fixed distributed lag coefficients may not produce reliable estimates of price elasticities.

It has also been shown that lags in expectations generate persistence in the movement of output even if price-wage rigidity is limited to a very short period of time. However, the practical importance of such a phenomenon should be determined by appropriate empirical analyses.

The analysis of the paper can be extended in several directions. First, it is easy to incorporate the role of import price inflation. This can be done by simply adding to the price equation a term which is positively related to foreign prices. The implication would be a weakening of the effects of exchange rate changes on trade flows because an exchange rate increase directly causes a price change which offsets its effect on trade flows. In other words, monetary disturbances would create more price changes and less real effects.

Secondly, it is also easy to analyze the effects of anticipated disturbances. Since the analysis would likely be carried out assuming full current information, the framework of the paper does not seem to add any new results to those that have been obtained by other authors. In this case J-curve effects as analyzed in this paper would not be very important.

Thirdly, it would be necessary to study the effects of real disturbances. Evidently, the present model can generate significant long-run real effects, if the shock ocurrs to, say, the potential output. In the short-run, to the extent that temporary disturbances are important, the effects would deviate from those in the long run and there could well be perverse resposes of the trade balance or output. The importance of short run perverse responses compared with the case of a monetary shock depends on whether or not there are more temporary real disturbances than temporary monetary disturbances. An interesting extension of the present model in this respect is to allow for confusions between real and nominal shocks. Then, even if there are very few temporary real disturbances, the existence of nominal shocks can create perverse responses to real shocks.

Finally, what are the policy implications of our analysis? In section 4 it has been shown that a permanent monetary disturbance has long-lasting effects on output and the trade balance even under price flexibility. However, this conclusion is crucially dependent upon the assumption that the "permanent" nature of the disturbance is not known to the public. To the extent that this is not true, long-run effects of monetary policy may be weakened. Then, can we exploit the short-run perverse part of the J-curve in controlling output and the trade balance? This does not seem to be too easy, either. A monetary contraction may improve the trade balance and increase output; however, how long this may last again depends on the expectations of the public about the nature of the policy adopted.

These perverse responses of trade flows to price changes or the unpredictability of them as discussed in section 2, especially those in the 70's--in view of the theoretical analysis of this paper--seem to stem from increases in uncertainty in the recent international economic system. To be sure, the introduction of the flexible exchange rate system, by bringing the great volatility of short-term asset markets into the behavior of relative prices has been partly responsible for the increases in uncertainty. More important, however, seem to have been the impacts of various real shocks such as oil price increases and the resulting monetary instability as the huge stock of oil money flowed into the eurodollar market.

Our analysis implies that, under such increases in uncertainty, even temporary disturbances may force the economy to undergo unnecessary and long process of adjustment. The scope for offsetting such disturbances by the use of aggregate monetary and fiscal policy is also limited.[1] Apart from the difficulty of aggregate policies to offset real disturbances, such moves require the superiority of information of policy makers to the public--a point which seems difficult to establish.

[1] Interventions in foreign exchange markets by monetary authorities to offset tempoarary exchange rate changes may be a good example of this. To the extent that the perception of the authority as to the nature of disturbances is wrong, this could destabilize, rather than stabilize, the market.

Appendix

1, First, we derive equation (10), or, the expectation of the permanent component of the money supply. For this purpose we need to obtain the estimates of v_i. The best linear forecasts of v_i at time t, ${}_tv_i$ turn out to be[1]

$$ {}_tv_i = \sum_{k=1}^{t} \left[Ex_sx_j\right]^{-1}\left[Ev_ix_k\right] x_k , \qquad 1 \leq i \leq t \tag{22} $$

where E is the expectation operator. Since $x_1=1$, $x_2=x_3=\ldots=x_t=0$,

$$ {}_tv_i = s_v^2 w_i \tag{23} $$

where w_i is the i-th element of the first row (or column) of matrix $\left[Ex_sx_j\right]^{-1}$.

Noting that

$$ \left[Ex_sx_j\right] = \begin{bmatrix} s_u^2+s_v^2 & -s_u^2 & & \mathbf{0} \\ -s_u^2 & 2s_u^2+s_v^2 & -s_u^2 & \\ & \ddots & \ddots & \ddots \\ 0 & & -s_u^2 & 2s_u^2+s_v^2 \end{bmatrix} \tag{24} $$

the formula for w_i^t turns out to be[2]

$$ w_i^t = A_1(t)q_1^{i-1} + A_2(t)q_2^{i-1} \qquad 1 \leq i \leq t, \tag{25} $$

where $A_1(t) = q_1/(s_u^2(1-q_1)(1-q_1^{2t+1}))$, $A_2(t) = -q_1^{2t}A_1(t)$,

$q_1 = (2s_u^2+s_v^2-(4s_u^2s_v^2+s_v^4)^{\frac{1}{2}})/2s_u^2$, $\qquad q_2 = 1/q_1$.

If both t and i are equal to 1, this reduces to the familiar formula $s_v^2/(s_u^2+s_v^2)$ in the literature on rational expectations.

1, See Sargent (1979), Ch X, for the derivation of this formula.
2, Note that w_i depends on t ; therefore, the notation w_i^t.

Using the above expression for w_i^t, we can calculate individuals' expectation of the permanent component of the money supply at time t, ${}_tm_t^*$

$$ {}_tm_t^* = \sum_{i=1}^{t} {}_tv_i $$

$$ = s_v^2 \sum_{i=1}^{t} w_i^t $$

$$ = 1 - s_u^2 q_1^t / ((2s_u^2 + s_v^2)(1+q_1^{2t+1})), $$

which is equation (10).

2, Proof of the monotonicity of γ_i.

Let $R_i = \gamma_i - 1$. Then from (17),

$$ R_N = 0, \; R_{N-1} = A/D_{N-1}. $$

Assume that A is positive. The case with a negative A can be treated in a similar manner. Then, since D_i are all positive, $R_N \lesseqgtr R_{N-1} \ldots$ (I). Next, again using (17),

$$ R_{N-i} = (A/D_{N-i}) + R_{N-i-1} D'_{N-i}/D_{N-i} $$

$$ R_{N-i-1} = (A/D_{N-i}) + R_{N-i-2} D'_{N-i-1}/D'_{N-i-1} \qquad (26) $$

Since A is positive, A/D_{N-i} is larger than A/D_{N-i-1}. Now assume that R_{N-s} is larger than R_{N-s-1} for all s smaller than i.

$$ D'_{N-i}/D_{N-i} - D'_{N-i-1}/D_{N-i-1} = (b_2 ANk/(N-i)(N-i-1))/(D_{N-i} \cdot D_{N-i-1}) \geqq 0. $$

Therefore, R_{N-i} is larger than $R_{N-i-1} \ldots$ (II). By invoking the mathematical method of induction, (I) and (II) imply that R_i increases as i increases. Of course, if A is negative, R_i decreases with i.

3, Proof that $(1-a_2)/b_1$ is larger than n_i when $A \geqq 0$.

From the definition of n_i ((18)),

$$ (1-a_2)/b_1 - n_i = (A(a_1 b_1 + (1-a_2)b_2) + (1-a_2)B_1(Nk/N-i) - b_1 R_{i+1}(a_3 - 1) \times $$

$$ (a_1 b_1 + b_2(1-a_2) + a_1(Nk/N-i)))/b_1 D_i. \qquad (27) $$

Now if A is positive, using (26) and the fact that R_i is larger than R_{i+1}, we see

$$R_i \leqq A/((a_3-1)(b_1+(Nk/N-i))). \tag{28}$$

Then, this implies that the right hand side of (27) is larger than

$$((1-a_2)B_1(Nk/N-i) + (1-a_2)b_2(Nk/N-i)A)/(b_1D_i). \tag{29}$$

(29) is clearly positive with a positive A.(The second term of (29) is the difference between the first and the third term of (27) with R_{i+1} replaced by the right hand side of (28).

If A is zero, then obviously all R_i are equal to zero. Hence, (27) immediately implies that $(1-a_2)/b_1$ is greater than n_i.

If A is negative, however, (29) becomes the upper bound for (27). The first term of (29) can be shown to be greater than the absolute value of the second term; however, this does not preclude the possibility that n_i exceeds $(1-a_2)/b_1$. Nonetheless, we may still say that if the absolute value of A is not too large, the second term of (27) dominates the first term and (27) is positive.

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Chapter 4

AN ANALYSIS OF THE 1976-1978 JAPANESE TRADE SURPLUS: ITS CAUSE AND THE ROLE PLAYED BY EXCHANGE RATE CHANGES

1, Introduction

The behavior of the Japanese trade balance in the 70s presents a serious challenge to the student of macro and international economics. The Japanese trade balance has long been in surplus since the mid 60s, but until 1973 the size of surpluses had been moderate and had never been above 10 billion dollars in annual terms. However, after a brief period of deficit in the first half of 1974 following the first oil shock, the trade balance started to increase at a rapid pace, reaching a record high of 24.6 billion dollars in 1978. Such a huge surplus was unprecedented in the history of Japan and was a target of attack by many OECD countries suffering from trade deficits due to higher oil bills. Although the period of surplus ended in the third quater of 1979, perhaps as a result of the second round increases in oil price, there has not yet emerged a consensus of opinions about the cause of the surplus.

This paper carries out a simple econometric analysis of the behavior of the Japanese trade balance in the 70s and offers one possible explanation of the 75-78 surplus. While the analysis of the surplus is the major concern of the present paper, it also takes a look at the determinants of the yen-dollar rate. The basic view here is that the interaction between the two, the trade balance and the exchange rate, must have been a crucial element in the dynamic movements of each variable.

On the trade balance side, export price, export quantity, raw materials and fuels import, and manufactured goods import equations are estimated. An equation for the domestic price of Japanese manufactures goods is also estimated. The motivation for the estimation of these equations are given shortly. On the exchange rate side, the estimation is based on the recent portfolio approach which emphasizes the role of relative asset supplies in exchange rate determination. The effect of exchange rate expectations and the trade balance are also incorporated into the model; the latter affects the exchange rate through its effect on the stock of foreign assets.

The novelty of the approach adopted in this paper, on the trade balance side, lies in its careful analysis of the supply side factors, especially the role of raw materials and fuels imports--henceforth often referred to just as oil imports.--Obviously, this component, accounting for 60 per cent of total imports (in 1977), gives rise to a trade deficit whenever oil price increases dramatically. However, there are some other important effects of oil price changes on the trade balance. These become apparent once one recognizes the role played by the manufacturing sector in Japan's foreign trade. Almost all (more than 98 per cent in 1977) of Japanese exports are manufactured goods. The manufacturing sector uses oil as an important input of which more than 99 per cent is imported. Imports of manufactured goods, at least to a certain extent, reflect buyers' choice between domestic and foreign manufactured goods.

In view of these features of Japanese foreign trade , the following interactions between various components of the trade balance become important. Changes in oil price directly affect export price and the quantity of exports. On the other hand, changes in the demand for exports changes the amount of oil imported. In addition, an increase in the price of domestic manufactured goods sold at home induced by an oil price rise causes people to substitute away from Japanese to foreign manufactured goods. How important these features are is an empirical issue. The paper develops a simple model of the manufacturing sector that can be used to estimate the significance of such effects. The estimates from the model indicate that some of these are quite important. Moreover, they are shown to have a decisive influence on the effects of exchange rate changes on the trade balance. The existence of oil improts tends to reduce the magnitude of the effect of exchange rate changes on the trade balance. In short, if a country imports a significant portion of intermediate goods, the effects of an exchange rate change becomes more complex thanjust a change in the relative price between foreign and domestic finished goods.

In the next section the recent pattern of the Japanese trade balance and the exchange rate is discussed. Then, Section 3 specifies a model and confronts the model with the data. Estimations are all carried out in reduced form so that the results can be used to carry out various simulations which decompose the fluctuations in the trade balance into several factors. The following is the major finding of the empirical analysis. Suppose one decomposes changes in the trade balance into three components, i) the effects of exchange rate changes, ii) the effects of cyclical factors measured by deviations of income growth from the growth of potential output, both at home and aboroad, and iii) the effects of long-run factors such as differences in costs at home and abroad, differences in the growth rate of potential output. Then, for the period of 1975-1978, it is shown that the surplus mainly stemed from the second factor; that is, the surplus increased dramatically because of the severity of recession in Japan during this period that resulted from the stagnation in investment and the oil shock. Of course, such a view has been advocated by a number of people, especially in journalism. The point of the present paper is a careful econometric analysis of the issue. It is found that cyclical position of the Japanese economy has a decisive influence on both exports and imports.

At the same time, one must realize that this was a period of flexible exchange rates. Therefore, there ought to be an explanation for the failure of exchange rate changes to correct these imbalances in the trade account in a short period of time.

The reason must have been either that the exchange rate did not respond too much to the fluctuations in the trade balance or that the effects of exchange rate changes on the trade balance were small for one reason or another.
It is shown that the exchange rate did respond significantly to changes in the trade balance. Thus, the surplus did not decrease because exchange rate changes did not exert a strong impact on the trade balance. Although a J-curve type effect is found, the major problem turns out to be small elasticities even in the long run rather than long lags involved in the responses of trade flows to exchange rate changes.

Finally, the effects of long-run factors are shown to have added up to zero, despite the fact that each of these factors exerted a strong impact on the trade balance. The last section concludes the paper by discussing some implications of the results.

2, An Overview

Figure 1 shows the movement of the Japanese trade balance in dollars and the yen-dollar rate for 1972 to 1979. The abnormally huge size of the surpluses in 1977 and 1978 can be recognized by noting the fact that the 1972 surplus was the largest in the history of Japan. Turning to the relation between the exchange rate and the trade balance, one finds some indications that the two series are negatively correlated. The causality running from the trade balance to the exchange rate seems easy to recognize; 1972 surplus led to an appreciation in the first quarter of 1973; 1974 deficit corresponds to subsequent depreciations; 1975-1978 surplus to 1977-1978 appreciation. The other direction of causation seems slightly harder to establish and a careful econometric analysis is necessary on this point. However, one may note that from the first quarter of 1977 to the second quarter of 1978 increases in the trade surplus were associated with appreciations in the exchang rate. This observation produced a J-curve interpretation of the 1977-78 surplus. According to this view an appreciation of the exchange rate initially increases a trade balance surplus and only slowly leads to decreases in the surplus. Such an argument is extensively used in the analysis of the Japanese trade balance carried out by the Japanese Economic Planning Agency.[1]

Figure 2 looks at some other determinants of the trade balance. The figure plots time series of the trade balance relative to GNP, the difference in real GNP growth rate between Japan and the U.S., and the unit value of Japanese exports relative to that of the world. The first thing to be pointed out is that the 1976-1978 surplus as a fraction of GNP is not large at all compared with previous surpluses. This obviously reflects the growth of the size of the economy.

1, See White Paper (1979) by EPA. They report estimation results of trade equations which show small elasticities in the short run and large elasticities in the long run, leading to the alleged J-curve effect. However, the DW statistics reported are disturbingly low and their results are highly suspect, once the endogeneity of export price or the exchange rate is taken into account.

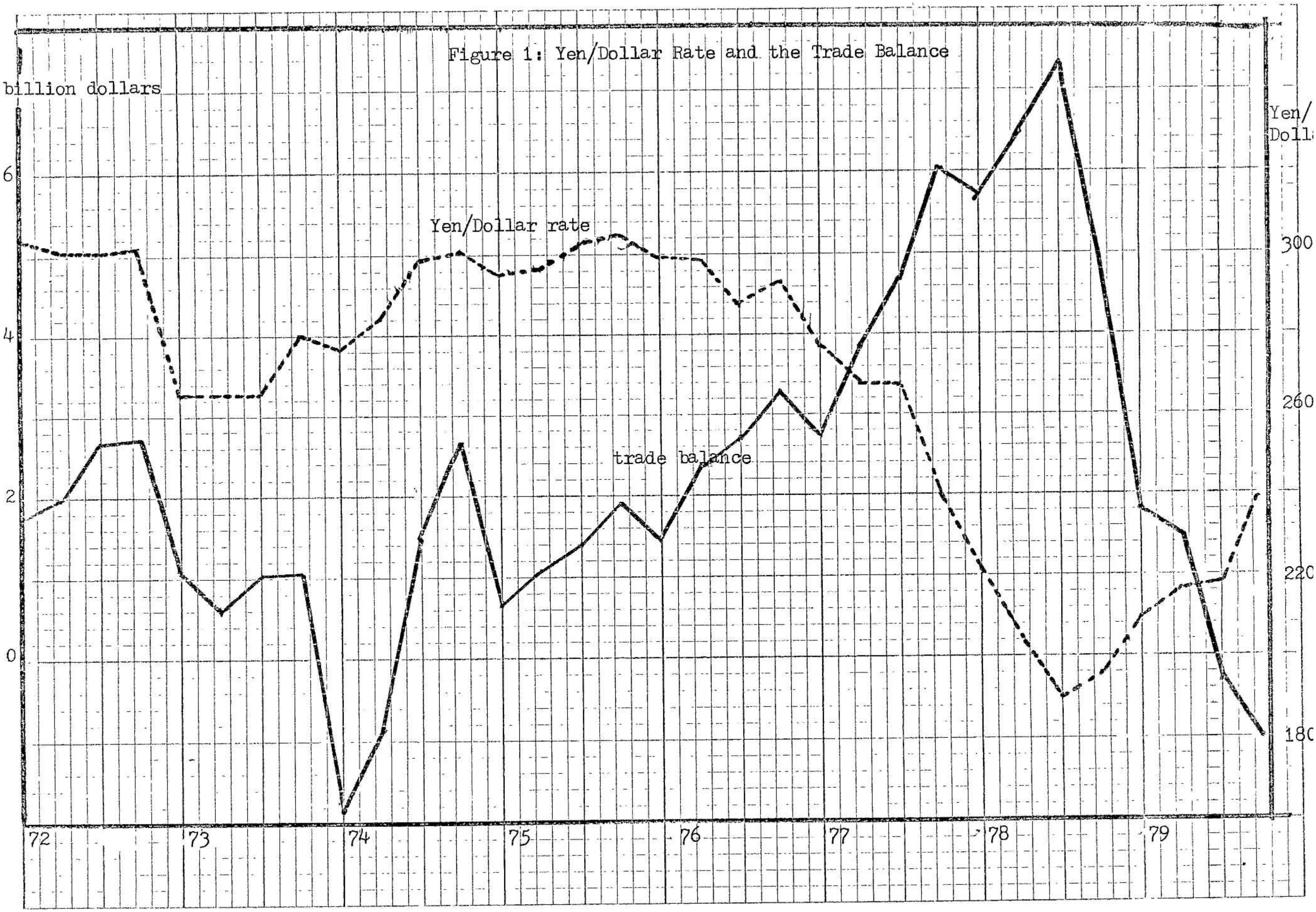
Figure 1: Yen/Dollar Rate and the Trade Balance
billion dollars
Yen/
Dolla
6
4
2
0
300
260
220
180
Yen/Dollar rate
trade balance
72
73
74
75
76
77
78
79

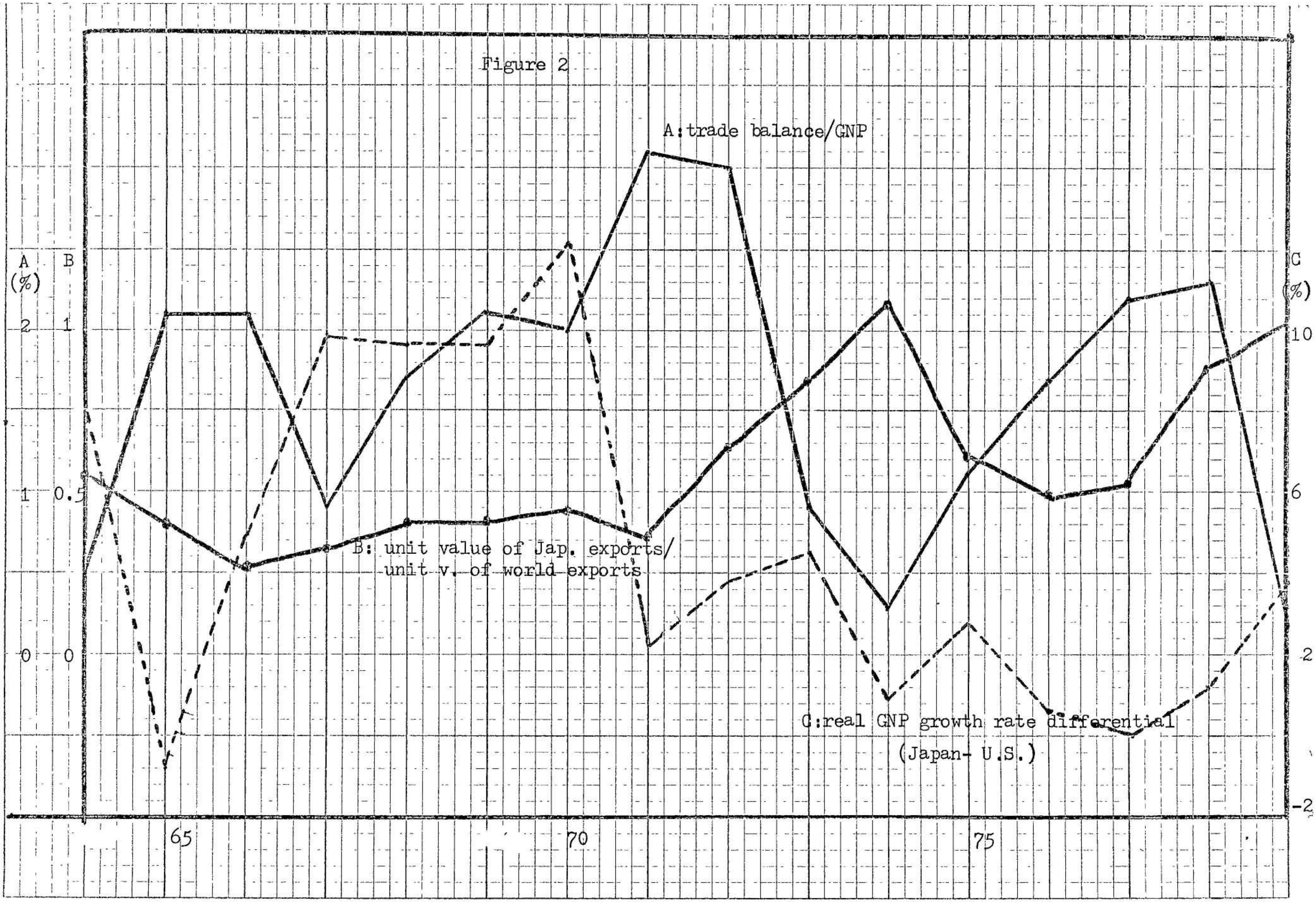
A:trade balance/GNP
A
(%)
B
C
(%)
2
1
10
1
0.5
6
0
0
2
-2
B: unit value of Jap. exports/
unit v. of world exports
C:real GNP growth rate differential
(Japan- U.S.)
65
70
75

Figure 2

As regards the relationships among the three series, one cannot but notice the significant role played by the Japan-US income growth differential; the trade balance and income growth differential exhibit a clear negative correlation. Almost all ups and downs in the trade balance are associated with significant changes in Japan's growth rate relative to the U.S. growth rate. In particular, 1976-1978 surpluses correspond to a sustained period of low Japanese growth relative to the U.S. Next, the relative export price variable also seems to play an important role. Although the negative correlation between this series and the trade balance is more salient for the 70s than for the 60s, cost reductions by Japanese firms in the early to mid 60s (which are only partially shown in the figure) must have had something to do with a long period of surplus in the late 60s and early 70s. In the 70s the relative price variable is more volatile because of exchange rate changes. Do changes in relative price exert different impacts on the trade balance depending on whether they came from exchange rate changes or from other sources? How much of the observed fluctuations in the relative price are due to exchange rate changes and how much to other factors? These are interesting questions relevant for the analysis of the trade balance. Statistical estimates which help answer these questions are provided in the next section.

In order to look more carefully into the determinants of the trade balance, it is useful to look at components of the trade balance. Figure 3 decomposes the trade balance into exports and imports relative to GNP, and compares them with the Japan-US real GNP growth differentials. One would expect to find a positive correlation between imports and income growth differentials and a negative correlation, if any, between exports and income growth differentials. The former is the familiar income effect and the latter may be justified by substitutions on the supply side[1]. The pattern of correlations is more pronounced for exports and less for imports, but is roughly as expected. However, in 1974 and 1975 the behavior of imports

1, Of course, there is also an income effect playing a role here, which is the effect on Japanese exports of increases in foreign incomes.

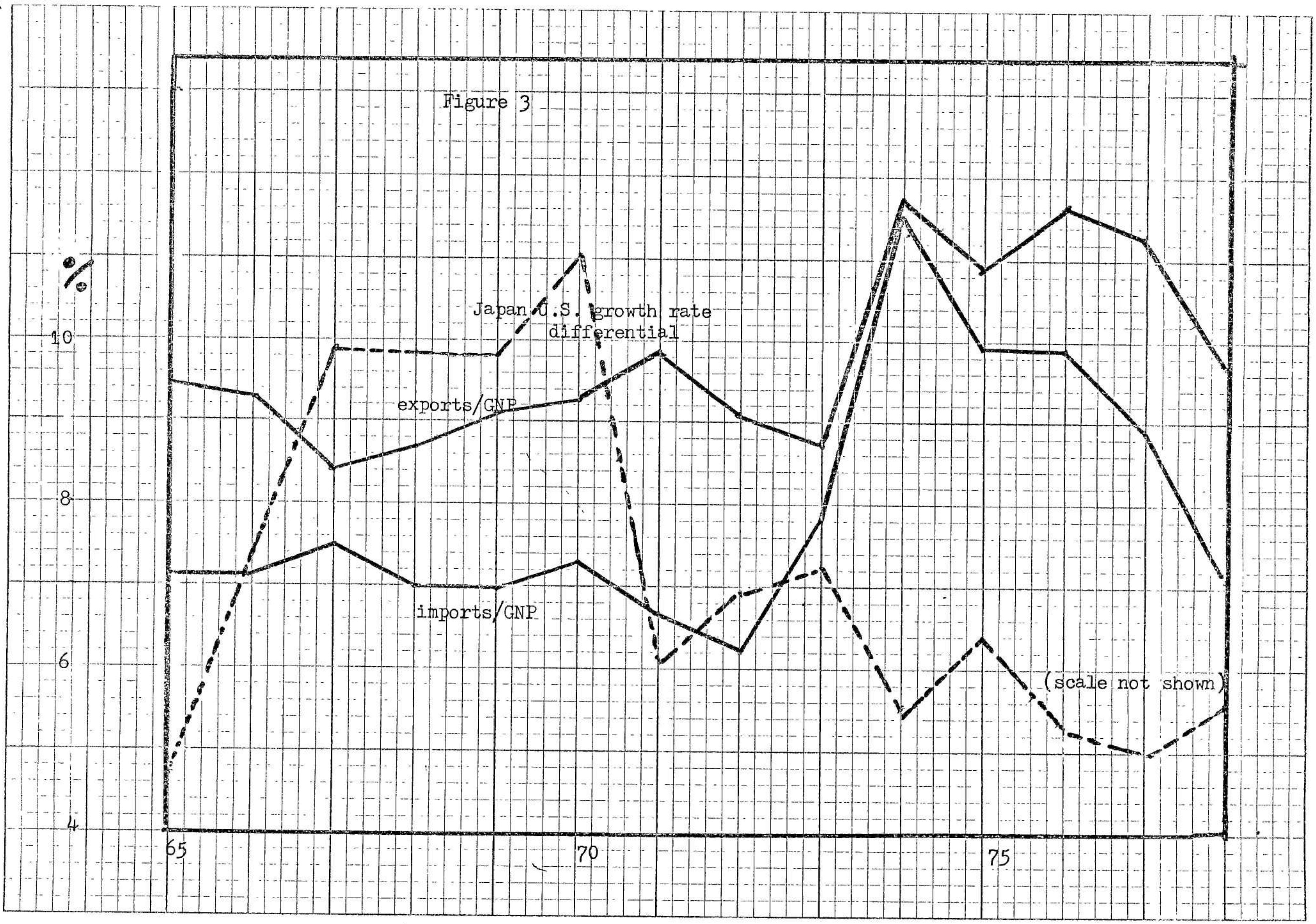
%
10
8
6
4
65
70
75
Japan U.S. growth rate differential
exports/GNP
imports/GNP
(scale not shown)

Figure 3

is unusual and shows the importance of oil price changes. Finally, Figure 4 disaggregates imports into raw materials and fuels and manufactured goods. (Imports of foodstuffs are ignored.) In order to have a rough idea about the price elasticity of these, imports of these goods at fixed (1975) prices--note the difference inscale--and the deflators of these relative to the price of output, measured by the manufactured goods component of WPI are plotted. The prices are output price relative to the deflators. Hence, one would expect to find positive correlations between the quantity series and the price series. The correlation is clearly noticable for manufactured goods imports, but not for raw materials and fuels except in 1974 and 1975, suggesting that the two should be treated separetely in the analysis of the trade balance. The high elasticity of manufactured goods imports with respect to the price of domestically produced manufactured goods relative to foreign manufactured goods suggests substitutions between the two are considerably important. On the other hand, the low elasticity of oil imports may present a serious threat to a quick adjustment of the trade balance to exchange rate changes. The magnitude of these elasticities, of course, must be estimated statistically for a correct assessment of the degree to which exchange rate changes influence the trade balance. At the same time, other determinants of oil imports have to be studied. At a theoretical level, this can be done by recognizing imported oil as a major input in Japan's industrial production. According to the 1975 input-output table, about 50 per cent of oil imports is used either directly or indirectly in the manufacturing sector, whose share in total GNP is just 27 per cent (in 1975).Therefore, factors affecting the demand for manufactured goods, of which exports is an important component, may have some impact also on oil imports. Thus, a model of the Japanese traded goods sector should incorporate these interactions between various components of the trade balance, paying particular attention to the role of imported oil as an input to the manufacturing sector.

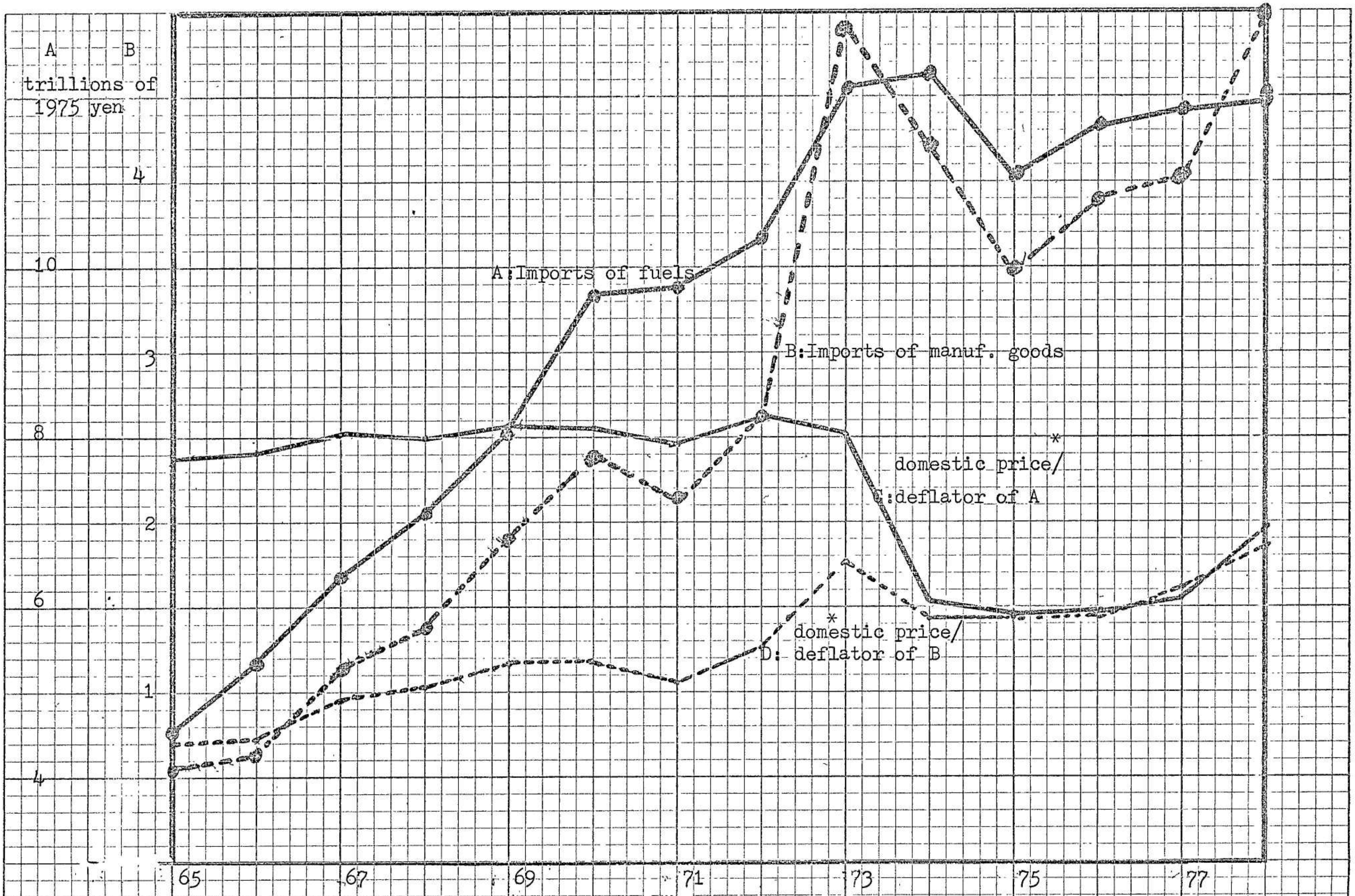

Figure 4

*domestic price of Japanese manuf. goods

3, Empirical Analysis of the Japanese Trade Balance

A) The Model

Following the discussions in the last section I propose to model the Japanese traded goods sector in the following way. All exports are produced in a manufacturing sector consisting of a single monopolistic firm. The firm sells its products at home and abroad. In both foreign and domestic markets it faces competition from foreign producers of manufactured goods. Japanese and foreign manufactured goods are imperfect substitutes. On the supply side, the firm uses labor and oil to produce output. All the oil used comes from abroad. The firm sets the price of its product at home and abroad so as to maximize its profits based on the knowledge of foreign and domestic demand curves. This optimization determines the two prices, quantity of exports, domestic sales, and the demand for oil imports. Any amount of oil can be imported at the going price level for oil. When the domestic price of Japanese manufactured goods is set by the firm, the demand for foreign manufactured goods by the Japanese is also determined. Ignoring food imports, all the determinants of the trade balance can be explained by the behavior of the manufacturing sector. Other sectors of the economy may use imported oil, but this will not cause any serious change in the theory or estimation procedures to be presented below. The manufacturing sector may import some foreign manufactured goods as intermediate goods. This will affect the theory slightly but not the estimation procedures. Empirical estimates reported below suggest that this effect is not very strong. But this may well become an important consideration for Japan in the near future as Asian countries become more competitive in the production of manufactured goods.

Foreign demand for Japanese manufactured goods, X, depends on foreign real income, y^*, and the relative price between foreign manufactured goods, p^*, and Japanese manufactured goods, p.

$$X = X(y^*, p^*/p) \tag{1}$$

where both p and p* are measured in terms of the foreign currency. Domestic demand for Japanese manufactured goods, D, is an outcome of a decision by the Japanese to choose between Japanese and foreign manufactured goods. Assume that total demand for manufactured goods, E, depends on domestic real income, y. Then,

$$D = d(\tilde{p}^*/p_d)E(y)$$
$$M = (1-d)E(y) \qquad (2)$$

where $\tilde{p}^*$ is the price of imported manufactured goods, which may be an imperfect substitute for foreign manufactured goods sold abroad and hence $\tilde{p}^*$ may be different from p*, p_d is the price of Japanese manufactured goods charged at home. This may also be different from pe, where e is the exchange rate. M is the demand for foreign manufactured goods.

Turning to the supply side, the firm uses labor and raw materials and fuels, R, to produce output. The supply side is represented by a cost function, which relates total costs, C, to output, O, exports, and the prices of inputs.

$$C = C^1(O, W, eq^*) + C^2(X, W, eq^*), \qquad (3)$$

where W is the wage level, q^* is the dollar price of oil and the second term has been introduced to allow for the possibility that producing for exports may be more costly than producing for the domestic market. Maximization of profits,

$$epX + p_dD - C,$$

with respect to the control variables subject to constraints (1)-(3) gives the optimal levels of these variables as a function of exogenous variables. Also, imports of manufactured goods has a reduced form expression.

$$X = f_1(\overset{+}{ep^*}, \overset{-}{e\tilde{p}^*}, \overset{-}{eq^*}, \overset{-}{W}, \overset{+}{y^*}, \overset{-}{y})$$
$$ep = f_2(\overset{+}{ep^*}, \overset{+}{e\tilde{p}^*}, \overset{+}{eq^*}, \overset{+}{W}, \overset{+}{y^*}, \overset{+}{y})$$
$$p_d = f_3(\overset{+}{ep^*}, \overset{+}{e\tilde{p}^*}, \overset{+}{eq^*}, \overset{+}{W}, \overset{+}{y^*}, \overset{+}{y}) \qquad (4)$$
$$R = f_4(\overset{+}{ep^*}, \overset{+}{e\tilde{p}^*}, \overset{-}{eq^*}, \overset{?}{W}, \overset{+}{y^*}, \overset{+}{y})$$

$$M = f_5(\overset{+}{ep^*}, \overset{-}{e\tilde{p}^*}, \overset{+}{eq^*}, \overset{+}{W}, \overset{+}{y^*}, \overset{+}{y})$$

where expected signs of the partial derivatives are shown assuming convexity of the cost function. Let us go through the economic meaning of some of the signs of partial derivatives. The negative impact of an increase in domestic demand on exports is a supply side effect due to increases in costs as production for the domestic market expands; exports decline as oil price goes up because the latter is a price of an input. Changes in exogenous variables have a similar pattern of effect on export price and domestic price. It can be shown easily, however, that a change in p^* has a larger impact on p than on p_d, while a change in $\tilde{p}^*$ or y has a larger effect on p_d. The demand for oil is affected directly by factors that influence exports such as ep^* or y^*. In addition to these sign patterns, the theory developed here imposes several cross equation restrictions on the partial derivatives of the above functions. However, these will be ignored for reasons to be explained later. Finally, note that the trade balance, ignoring food imports, can also be expressed as a function of the same set of exogenous variables.

B) Data, Specification, and Estimation Methods

Some of the key variables for export and import equations are taken from[1] the national income accounting data. These include: exports of goods in 1970 billions of yen, X; the deflator for X, ep; imports of raw materials and fuels in 1975 billions of yen, R; imports of manufactured goods in 1975 billions of yen, M; the deflator for R, eq*; the deflator for M, ep*, GNP minus net exports in 1970 billions of yen, y. Other variables come from various sources. World real income, y*, is constructed using the index of production of the Japanese trading partners. The unit value of world manufactured goods, p*, is taken from the UN monthly bulletin. Wage costs are represented by unit labor costs, W, which is calculated as total wage bills per person times employment divided by the index of the production of manufactured goods. The price of domestically produced manufactured goods sold at home, p_d, is measured by the index of producers' price of manufactured goods published by the Bank of Japan, which is that component of wholesale price index exclusive of non-manufactured, imported, and exported goods. The exchange rate is Japanese yen per unit of the U.S. dollar, averages of monthly figures.

All the equations are estimated in reduced form as shown in (4). No cross equation restrictions implied by the theory are imposed. This, clearly, increases the robustness of estimates at the expense of efficiency. Such a procedure is adopted because some of the restrictions imposed on structural equations to make the model tractable does not seem to be very realistic. One of the most serious of these is the assumption that the demand for exports depends only on income and the relative price between foreign and domestic goods. In addition to these

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1, More precisely, only the top ten importers of Japanese goods (in 1975) are included in the calculation of y*. EC is treated as one country. USSR is included, but not China. For some of the OPEC countries where the index of production is not available production of crude oil is used instead. In some cases annual data are extrapolated to obtain quarterly series. Since the equations are estimated in log-linear form, this variable is also logarithmically transformed. This means that first the log of each series is taken and then added up using the trade shares as weights.

product differentiation, quality changes, prompt deliveries, availability of sales agents etc., all these are important factors in the determination of exports. Sato (1977) has presented some evidence that points to the importance of such changes in non-price competitiveness. However, to the extent that changes in these variables occur as results of changes in the variables included in the reduced form, there is no misspecification in reduced form estimation. Of course, if one had an access to good data on such non-price competitiveness, one would want to use structural information in the estimation.

All the equations are estimated in first difference form after the log of each variable is taken. The use of first difference form reflects the suspicion that previous attempts to estimate in levels the dynamic pattern of the effects of exchange rate changes tended to find long lags from spurious correlations of variables due to strong time trends and incorrect treatments of the autocorrelation structure of error terms.[1]

As discussed above, theory has been used to determine variables to be included. The determination of the lag structure is an empirical matter. Lags in demand responses to price or income changes, existence of adjustment costs on the supply side, all tend to bring in lagged exogenous variables on the right hand side of reduced form equations.[2] Therefore, to the extent that the data allowed it, fairly long lags were assumed for each variable and then the longest lag was dropped, if it turned out to be statistically insignificant.

However, there is a possibility of misspecification here if the presence of lags made expectations of future variables important. Nevertheless, this would become serious only if people used variables other than included lagged exogenous

1, See Plosser and Schwert (1978) for a discussion of this point.

2, Lagged endogenous variables may also come in. But then, equations can be rewritten in terms of lagged exogenous variables only, assuming no future variables to come in.

variables to forecast future variables; this possibility, although potentially important, is assumed away in the estimation. A related issue, which is taken into account in the estimation, is the following. If expectations of future variables are important, say, a future value of ep*, a change in ep* today may have different information about future ep* depending on whether it was due to a change in e or to a change in p*. This suggests that one should not constrain the coefficients on these two variables to be the same. Therefore, in the estimation all foreign prices are entered in dollar terms and the exchange rate is entered as a single independent variable. Consequently, if these effects of expectations are not important, the coefficient on the exchange rate shows the sum of the effects of changes in foreign prices.

C) Estimation Results

All the equations are estimated with an instrumental variables estimator because of the presence of the current exchange rate in the equations. All the other variables are taken to be exogenous on the assumption that the foreign and domestic non-traded goods sectors are very large compared with the traded goods sector. The instruments used for the first difference of the log of the current exchange rate are the first difference of the log of the lagged forward rate and that of the difference between the discount rate of the Bank of Japan and the U.S. three month treasury bill rate. Where necessary, Fair's method was used to correct for serial correlation.

C-1) Discussion of Individual Equations

Table 1 presents estimation results for the five equations based on quarterly data from 1971-I to 1979-I. First, the discussions of the estimates of each equation will be offered and then the implications of those for the trade balance will be studied in the next section.

The exchange rate, oil price, and world income are significant determinants of export price in dollars. The wage cost variable was insignificant and hence was not included in the reported equation. In fact, the unit cost variable was significant in none of the equations estimated. This probably reflects the fixed cost nature of wage payments in Japan. Further work is necessary here to carefully estimate the role of adjustment costs of labor in Japanese firms' behavior. A depreciation of the exchange rate decreases the dollar price of exports as expected and has a large effect within one quarter. Then, the effect is somewhat offset in the second and third quarters. In the fifth quarter there is an additional negative effect. The sum of exchange rate effects is .526 and is significantly smaller than one. However, one has to note that a depreciation has the effect of increasing the yen price of oil, in turn increasing export price. When this effect is subtracted, the long-run elasticity of depreciation is not significantly

Table 1

i) Export price

$$dp = \underset{(1.30)}{-.008} \underset{(6.70)}{-.553}\, de \underset{(1.69)}{+.118}\, de_{-1} \underset{(1.38)}{+.069}\, de_{-2} \underset{(.358)}{-.019}\, de_{-3} \underset{(1.80)}{-.142}\, de_{-4} \underset{(5.65)}{+.249}\, dq^*$$

$$\underset{(3.03)}{+.329}\, dp^*_{-1} \underset{(2.80)}{+.681}\, dy^*_{-1} \qquad R^2 = .886, \quad \hat{\rho} = .4995$$

ii) Export volume

$$dX = \underset{(1.93)}{.017} \underset{(2.85)}{+.727}\, de \underset{(3.24)}{+.531}\, de_{-1} \underset{(.294)}{-.038}\, de_{-2} \underset{(2.47)}{-.303}\, de_{-3} \underset{(1.59)}{-.265}\, de_{-4} \underset{(2.27)}{-.252}\, dq^*$$

$$\underset{(1.92)}{+.569}\, dp^* \underset{(2.44)}{-.596}\, dI_{-1} \underset{(2.28)}{+1.38}\, dy^* \underset{(2.37)}{+1.35}\, dy^*_{-1} \qquad R^2 = .720, \; D.W. = 2.30$$

iii) Quantity of raw materials anf fuels imported

$$dR = \underset{(2.65)}{-.023} \underset{(1.71)}{+.365}\, de \underset{(.372)}{+.064}\, de_{-1} \underset{(.953)}{+.092}\, dq^* \underset{(.978)}{+.249}\, dp^* \underset{(4.73)}{+2.09}\, dy \underset{(.753)}{+.383}\, dy^*$$

$$R^2 = .566 \qquad \hat{\rho} = -.258$$

iv) Quantity of manufactured goods imported

$$dM = \underset{(.720)}{.012} \underset{(.151)}{+.067}\, de \underset{(2.24)}{-.589}\, de_{-1} \underset{(.733)}{+.275}\, de_{-2} \underset{(.711)}{+.229}\, de_{-3} \underset{(2.56)}{+.518}\, dq^* \underset{(6.20)}{-.864}\, \tilde{dp}^*$$

$$\underset{(.556)}{-.056}\, \tilde{dp}^*_{-1} \underset{(2.19)}{-.220}\, \tilde{dp}^*_{-2} \underset{(3.65)}{+1.65}\, dI \qquad R^2 = .890 \qquad \hat{\rho} = .220$$

v) Domestic price of Japanese manufactured goods

$$dp_d = \underset{(2.36)}{.007} \underset{(2.03)}{+.220}\, de \underset{(.113)}{+.008}\, de_{-1} \underset{(1.19)}{+.084}\, de_{-2} \underset{(6.45)}{+.281}\, dq^* \underset{(.174)}{+.005}\, \tilde{dp}^* \underset{(2.97)}{+.271}\, dI_{-1}$$

$$R^2 = .859 \qquad D.W. = 1.59$$

Notes: 1, T-statistics are shown in parentheses.
2, $\hat{\rho}$ is the estimated first order serial correlation coefficient.
3, The operator d(.) means $dZ = Log(Z) - Log(Z_{-1})$.

different from one. However, in the first period this pass-through effect is significantly smaller than one. This is probably due to the fact that a large proportion of Japanese export contracts are written in terms of the dollar.[1] Both foreign income and manufactured goods price have a strong impact on Japanese export price with a one quarter lag.

The export quantity equation shows strong impacts of the exchange rate. Most of them come in the first two quarters; there are some offsetting effects in the fourth and fifth quarters, resulting in a total elasticity of .625. The offsetting effects in later periods could be interpreted as adjustments to overreactions to temporary changes in the exchange rate. If temporary changes in the exchange rate are confused with permanent changes, firms may overreact to them initially. As they discover the nature of the exchange rate changes, they would somewhat reverse the initial responses. An interesting extention of the present analysis on this point is to construct a measure of permanent and transitory exchange rate changes and estimate the effects of the two separetely. However, this would be extremely difficult if the confusion between the two plays a role as suggested by the above discussion. Here, I just point out the possibility that if all changes in the exchange rate observed in this period had been of a more permanent nature, then the estimate of the long-run elasticity could have been much larger.[2]

Foreign income has a very large effect on exports with a long-run elasticity of 2.734, exceeding one by a very wide margin. An increase in foreign manufactured goods price also increases the quantity of exports. However, the elasticity is not as large as the income elasticity.and there are no lagged effects. This accords with the effect of the same variable on export price. Other determinants of export volume are a time trend and changes in real private domestic investment,I.[3] The latter was used in place of y because of a better fit of the equation. The time trend

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1, The fact that export price does respond significantly to exchange rate changes within one quarter indicates that contract lengths are not very long.

2, See Ueda (1979) for a theoretical analysis of such a mechanism.

3, This is measured in 1970 billions of yen.

could be regarded as indicating the effects of productivity increases, probably biased toward export production or downward shifts of the C^2 function in equation (3). This,however, is not associated with decreases in export price, (although there is a weak negative time trend in the price equation)[1], and probably corresponds to things like quality improvements or shifts in demand. A decrease in domestic demand increases exports sharply--the so-called export drive effect. This again does not come from price decreases. Exporters may be using various promotional expenditures to control demand or they may be just shifting the direction of supply under near-price taker behavior. Finally, an increase in oil price has a negative impact on export volume since it is an increase in costs.

I now proceed to the discussion of import equations. The equation for the quantity of raw materials and fuels imported is rather poorly estimated. This seems to reflect the growing importance of political factors in the demand for this component of imports. The findings from the reported equation are the follwing. First, the most important determinant of oil imports is the level of domestic activity as indicated by a very large t-statistic, Second, fluctuations in the dollar price of oil do not have an important impact on oil imports at least in the short run. Third, there is a significant negative time trend in the equation, showing the effects of energy savings as a result of the economy's reaction to long-run upward trend of oil price rather than to short-run fluctuations of it. Finally, a depreciation of the exchange rate increases rather than decreases the demand for oil, presumably coming from its effect on exports.

The quantity of manufactured goods imported is influenced by the exchange rate, the price of these goods, oil price, and domestic demand. Both the coefficients on the exchange rate and the deflator of these goods show a fairly large and quick price effect on this component of demand. The coefficients on the two variables,

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1, See Lawrence (1979) for a careful analysis of this point.

however, do not match one for one for the following reasons: first, there is the already discussed effect of exchange rate changes being not necessarily of a permanent nature. Second, a depreciation causes an increase in the yen price of oil, increases the price of domestically produced manufactured goods and thus increases the demand for foreign manufactured goods, partially offsetting the direct negative impact on the demand for such goods. This second effect seems to be very strong as can be seen from the coefficient on the dollar price of oil. As a result, a depreciation of the exchange rate has almost no impact on manufactured goods imports in the first period. Finally, domestic income changes exert a significant impact on manufactured goods imports.

The last equation to be discussed is the one for the domestic price of Japanese manufactured goods. The exchange rate, oil price, domestic demand, and a time trend are the significant determinants of this variable. A depreciation increases domestic price, but its impact is not significantly different from that of an increase in the dollar price of oil. Therefore, the effect of an increase in exports induced by the depreciation is not very strong. On the other hand, domestic demand does affect this price significantly. The large effect of oil price on domestic price confirms the discussion offered above concerning the effect of oil price changes on manufactured goods imports.

C-2) The Determinants of the Trade Balance

It is now time to put together these estimates of individual equations to see what they imply for the behavior of the trade balance. An ideal way to proceed would be to derive an explicit equation for the trade balance from the equations of the components of it. However, this is not easy because the log of each variable is estimated. Hence, several in-sample simulations will be carried out to examine the contribution of each of the determinants of the trade balance.

In order to do this, variables which appear in the right hand sides of estimated equations are grouped into three categories: the exchange rate; cyclical variables, i.e., domestic and foreign incomes relative to potential output; and long-run factors which are price variables, time trends, and changes in potential outputs. For potential output, J. Artus' series[1] is used for Japan; for the rest of the world the average of the growth rates of income during the period is assumed to be always equal to the growth rate of potential output. Although there may be some cyclical fluctuations in foreign prices, this division seems to decompose the determinants of the trade balance into the exchange rate, cyclical factors, and permanent factors. Obviously, exchange rate changes affect the trade balance through their effects on long-run factors and (if incomes are endogenous) on cyclical variables. However, because of the importance of trade balance adjustments due to exchange rate changes, this variable seems to deserve an independent treatment. Before discussing the results of simulations, let us look more carefully at the estimates of exchange rate effects on the trade balance and its components.

C-2-1) The Effects of Exchange Rate Changes on the Trade Balance

First, I add up the estimated elasticities to see what the effects of exchange rate changes on the trade balance look like. The first part of Table 2 summarizes the time pattern of exchange rate effects on export price, export volume, quantity

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1, See Artus (1977).

Table 2

		export price	export volume	volume of raw materials and fuels	volume of manufactured goods	trade balance *
I	0	-.553	.727	.365	.067	-.072
	1	-.485	1.258	.365	-.522	.813
	2	-.368	1.220	.365	-.522	.842
	3	-.386	.917	.365	-.522	.521
	4	-.528	.652	.365	-.522	.114
	long run	-.528	.652	.365	-.522	.114
II		.249	-.252		.518	-1.121
III	0	-.802	.979		-.451	.628
	1	-.734	1.510		-1.040	1.816
	2	-.617	1.472		-1.040	1.895
	3	-.635	1.169		-1.040	1.574
	4	-.777	.904		-1.040	1.167
	long run	-.777	.904		-1.040	1.167

I, Cumulated elasticities from one per cent depreciation

II, The effects of one per cent increase in oil price

III, same as I, but assuming no oil imports

*The effects on the trade balance are calculated assuming food imports behave exactly the same way as manufactured goods imports.

of oil imports, quantity of manufactured goods imports, and the trade balance. In the calculation the imports of foodstuffs are assumed to behave exactly the same way as manufactured goods imports.[1] The share of raw materials and fuels in total imports used in the calculation is based on the 1977 figure, which is 60 per cent. Short-run effects of a depreciation come fairly close to the estimates of the IMF world trade model, which are .25 for imports and 1.68 for exports in the first two quarters.[2] However, long-run effects are somewhat different in that the IMF estimates do not show a decrease in export elasticity in the long run, while this is an important feature of the present export equation. I will come back to this point shortly. The present estimates imply a J-curve effect in the sense that in the first period a depreciation worsens the trade balance and in later periods leads to improvements. However, the perverse part is just one quarter and the magnitude of the worsening of the trade balance is very small, indicating that J-curve effects are not particularly important in the analysis of the Japanese trade balance.

Let us examine some other characteristics of the trade balance adjustments to exchange rate changes. First, exchange rate changes produce very quick and strong impacts on the components of the trade balance except oil imports. Second, the maximum effect on the trade balance comes within three quarters and then the effects quickly dies off, resulting in a long-run elasticity of only .114. This comes from lagged adjustment of export price and decreases in export volume in later periods. However, there is a reason to believe that long-run effects of a permanent depreciation are larger than those reported in the table. As discussed in the last section, the failure to separate the effects of temporary changes in the exchange rate from those of permanent changes may have resulted in an estimate of small

1. This probably has resulted in the exaggeration of the first period perverse effect, since foods imports are less likely to respond to changes in the yen price of oil, which results in a larger elasticity for foods than for oil.

2. See Artus and Young (1979). Note, however, Table 2-I includes the effects of changes in the yen price of oil as a result of a depreciation. Hence, for export volume Table 2-III is a better reference for the comparison, which gives a much closer estimate.

long-run exchange rate elasticity of export volume. Thus, one would expect that the effects of completly permanent changes in the exchange rate might be more long lasting. The comparison with the IMF world model makes this interpretation of the dying off of elasticities in the long run very attractive, because in the IMF model, where no such effect is reported, they constrain foreign price and exchange rate elasticities to be the same and that they estimate the model for the period of 1964 to 1977 in which, on average, temporary fluctuations in the exchange rate may have been less important.

The third feature of the trade balance adjustment is that it is significantly influenced by the high share of fuels in total imports. The second part of Table 2 presents the effects of a one percentage point increase in oil price; export price increases and the volume of exports declines; the volume of manufactured goods imports increases. The first two effects more or less offset. Adding to the third effect the direct effect of higher oil bills, one obtains an estimate of 1.121 per cent for the worsening of the trade balance. Thus, an increase in oil price produces a large trade deficit, very quickly. This is exactly what Japan experienced in the first half of 1974 and in the latter half of 1979 and 1980. Keeping this in mind, let us continue the discussion of exchange rate effects on the trade balance. Of the four effects discussed above about the effects of oil price changes on the trade balance, Table 2-I contains three effects except the direct increase in oil bills in dollar terms; an increase in export price, and the volume of manufactured goods imports, and a decrease in the volume of exports--all as results of an increase in the yen price of oil due to a depreciation. Table 2-III presents the estimates of elasticities in the absence of oil imports and their effects on the other components of the trade balance, which are the three pointed out above. As can be seen, a depreciation produces very large and long-lasting effects on the trade balance. In sum, exchange rate effects on the Japanese trade balance are made very weak because of the high share of oil bills in total imports. More specifically, imports of oil do not respond at all to oil price changes in the short run; oil imports increases rather than decreases with depreciation because exports increase; manufactured goods imports do not decline very much because a depreciation makes oil more costly and increases the price of domestic manufactured goods, offsetting the effect ofan increase in foreign manufactured goods price induced by a depreciation.

C-2-2) <u>An Analysis of the 1976-1978 Trade Surplus</u>

I now turn to the analysis of 1976-1978 trade surplus using results of in-sample simulations based on the estimates reported in Table 1. The procedure is to decompose the behavior of the trade balance into three components, the effects of the exchange rate, the effects of cyclical variables, and the effects of more permanent factors. This is done, for example, for the effects of the exchange rate, by using actual de in the right hand sides of the equations reported in Table1 and equating all other variables to zero. This produces the time path of dp, dX, dR, and dM. Then, using the values of these variables, original levels of p, X, R, and M in the second quarter of 1974, one obtains the time path of p, X, R, and M. Finally, using these the time path of the trade balance is calculated, ignoring food imports. The benchmark period of 1974-II has been chosen since the absolute value of the trade balance was smallest in this quarter. For the second group, cyclical effects, dy and dI are equated to the deviations of these from the growth rate of potential output and dy* is equated to the deviation of dy* from the average of the period. For these two simulations, p* and q* are held constant at their 1974-II levels. Finally, for the third simulation, de is put to zero, dy and dI are equated to the growth rate of the potential output and dy* to the period average. For all other variables, namely, dp*, dp*, dq*, and time trends, actual values are used. To be sure, this procedure involves some problems. First, the simulation paths depend on the choice of initial values.

Second, since the log of each variable is explained by the estimated equations, linear decomposition at this level does not produce linear decomposition for the trade balance.[1] However, there being no obvious way to improve the quality of the simulations, I report the results based on the above procedure.

Figure 5 reports the results of simulations. It shows each simulated path with the actual time path of the trade balance.[2] The results reveal very clearly the nature of the 76-78 trade surpluses. First, exchange rate changes worked in the direction of decreasing the surpluses for the entire 75-78 period. However, as expected from the discussions in the last section, the impacts of exchange rate changes on the trade balance were too small to produce balance between exports and imports. Furthermore, the small J-curve effect found in the last section was not a cause of 77-78 surpluses.

Secondly, notice the striking similarity between the actual path and the path from the second simulation. The cyclical factors continued to produce surpluses throughout the period, reflecting the seriousness and the prolonged nature of the recession in Japan during this period. And the magnitude of the surplus produced by this factor follows very closely that of the actual surplus. During 1976-I to 1978-I the simulated path overestimates the surplus and this overestimated part probably corresponds to the deficit factor coming from exchange rate appreciation in this period.

Finally, the effects of long-run factors are considered. A glance at the simulated path reveals that for most of the time these factors, in the aggregate, did not play a very important role. The exceptions are the beginning and the end of the simulation period, where the simulated path shows significant surpluses. These periods correspond to those in which increases in oil price moderated. As shown in the last section, changes in oil price have a very quick and powerful effect on the trade balance. However, there is a reason to believe that huge surpluses of

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1. Of course, the formula of the trade balance itself also involves a non-linearity.
2. To repeat, the actual path as well as the simulated path does not include foodstuff imports. Therefore, they exaggerate the magnitude of surpluses.

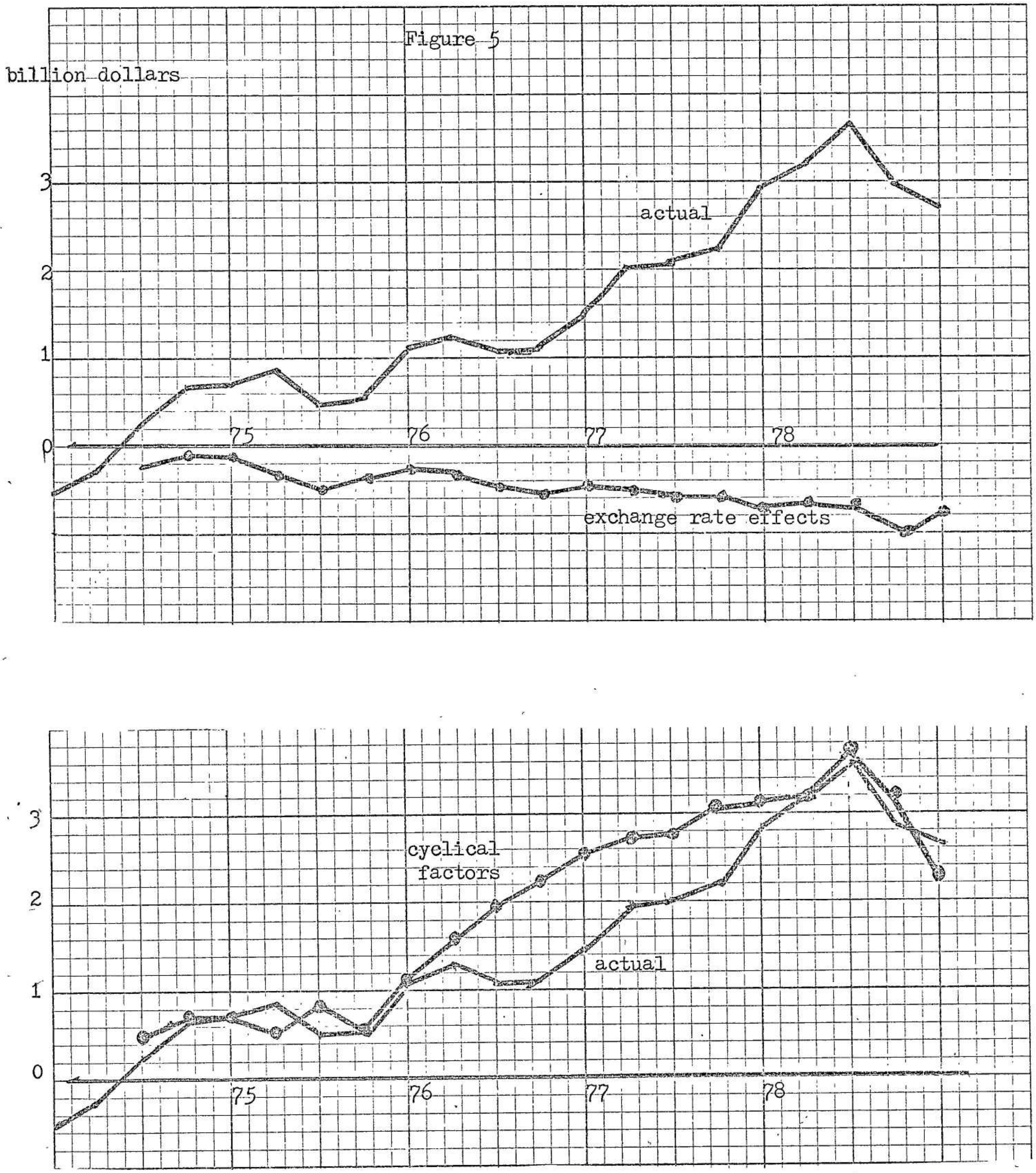
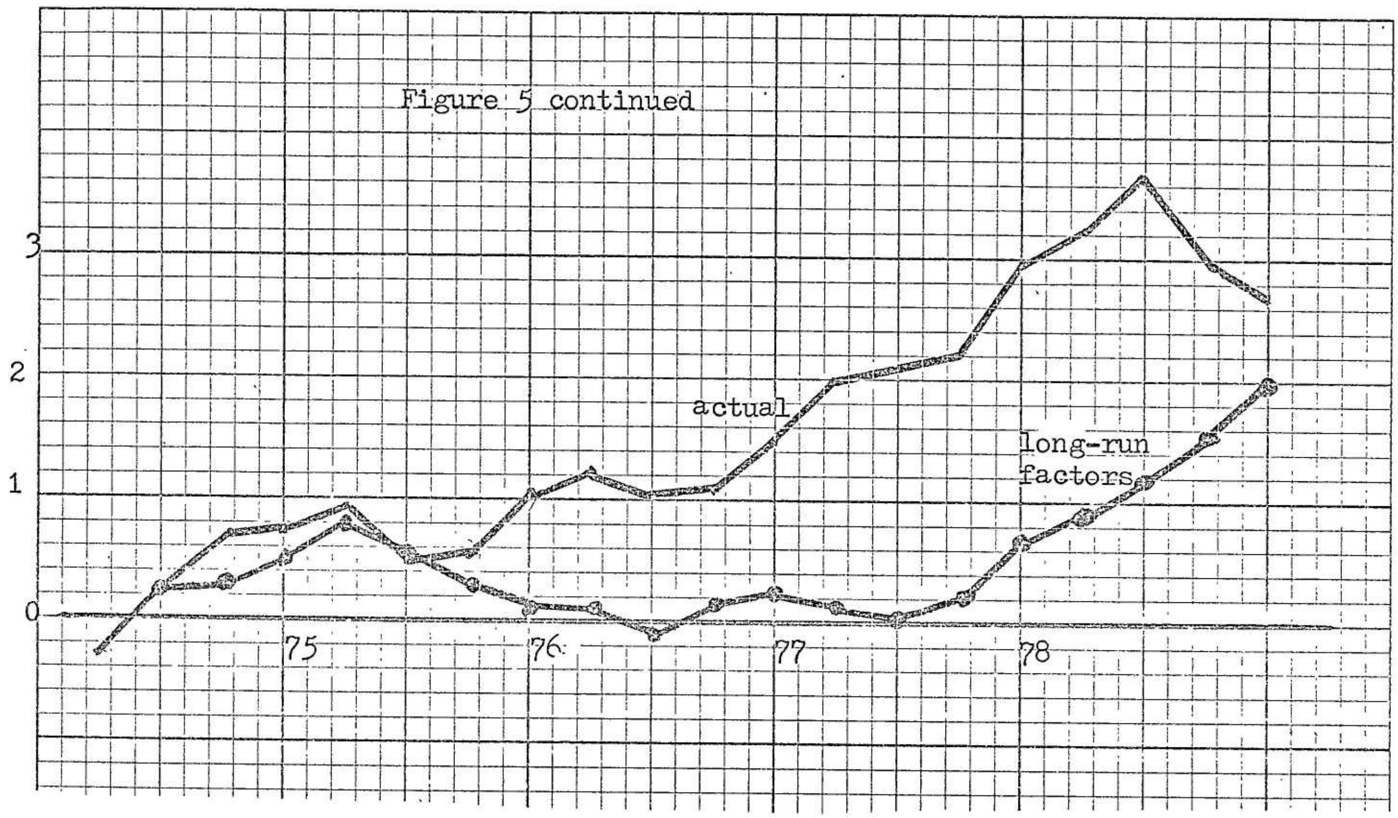


Figure 5
billion dollars
3
2
1
0
75
76
77
78
actual
exchange rate effects
3
2
1
0
75
76
77
78
cyclical factors
actual



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the simulated path in 1978 is exaggerated; several time trends are included in this group of variables and these may have produced rather inaccurate estimates at the far end of the simulation. In any case, although in 1978 decreases in oil price inflation added to the surplus, long-run factors, when aggregated, do not seem to have been a major cause of the 76-78 surpluses.

Hence, one draws from these results that the severity of the recession experienced in Japan during this period compared with the rest of the world was the major cause of the 76-78 surpluses. However, one has to note that this is just one way of looking at the problem. Although the long-run factors tended to produce balance between exports and imports, this is so just because surpluses and deficits canceled out. Increases in oil price were definitely a deficit factor. However, foreign countries also were suffering from inflations caused by the oil shock; foreign price increases tended to produce surpluses. Cost reductions, productivity improvements--reflected in the positive time trend in the export volume equation --energy saving, were a strong surplus factor. It can be shown that when these three are aggregated, one obtains substantial surpluses throughout the period. Finally, Japan's growth rate, although substantially declined, still was above the world growth rate. This itself was a deficit factor, offsetting surpluses coming from the other factors.

In passing it is to be noted that the mechanism by which a recession in Japan increases exports was not made totally clear in the above analysis. This is certainly a topic for future research.

D) The Exchange Rate Equation

So far the analysis has focused on the effects of exchange rate changes on the trade balance. It has been shown that the exchange rate did not exert a strong impact on the trade balance during the period studied in this paper. How about the impact of the trade balance on the exchange rate? This alone could be a topic for a full length paper. Therefore, no attempt is made in this paper to obtain the "best" exchange rate equation one can think of. However, in order to obtain a coherent view about the interactions between the trade balance and the exchange rate dynamics, a simple exchange rate equation based on the portfolio approach is estimated. The trade balance affects the exchange rate through its effect on the stock of foreign assets.

The menu of the assets considered here is money, M2, loans in the "Gensaki" market which is an interfirm short term money market, and interest bearing foreign assets. Holdings of foreign money by domestic residents and holdings of yen assets by non-residents are ignored. The Gensaki market is chosen here because it is in this market that trading companies and other large corporations--speculators in the foreign exchange market--invest their short-run idle money balances. Also, this is one of the very few markets in which interest rates are competitively determined.

To simplify the analysis only the market for foreign assets is considered. Domestic variables such as the money supply, the Gensaki rate etc. are taken to be exogenous except the trade balance. The supply of foreign assets, F*, is calculated by cumulated current account minus foreign exchange market interventions by the bank of Japan. The latter is obtained from changes in foreign reserves of the bank. The demand for real foreign assets depends on the three month Gensaki rate, i, the interest rate on foreign assets, represented by the threemonth U.S. treasury bill rate, i*, real GNP, Y, the stock of realprivate wealth, and the expected rate of depreciation of the exchange rate, proxied by the difference between the forward rate and the spot rate. The stock of wealth is the sum of M2 and F*e; assets and liabilities in the Gensaki market add up to zero, because this is an inter-firm market. The stock of money and foreign assets are deflated by the GNP deflator. Finally, changes in the spot rate clears the market.

Given above assumptions, one can solve the equilibrium condition in the market for foreign assets to obtain a reduced form equation for the spot rate.

$$\mathrm{Log}(e) = a_0 + a_1(M2/pGNP) + a_2(F^*/pGNP) + a_3 i + a_4 i^* + a_5 \log(Y) + a_6 \log(f),$$

where pGNP is the GNP deflator, f is the three month forward rate, and all variables are at the end of the period. The equation is estimated over the period of 1971-II to 1979-IV. The result is reported below:

$$\underset{(.442)}{\mathrm{Log}(e) = -.723} = \underset{(.664)}{1.11\cdot 10^{-7}}(M2/pGNP) - \underset{(2.51)}{5.18\cdot 10^{-9}}(F^*/pGNP) \underset{(4.28)}{-.006}(i - i^*)$$

$$+\underset{(.691)}{.094}\log(Y) + \underset{(17.4)}{.956}\mathrm{Log}(f),$$ [1]

$R^2=.992$, SER=.0148, mean of Log(e)=5.72, D.W.=1.74,

where the coefficient of i and i* are constained to be the same. The estimation method used is an instrumental variables estimator, which is used here to correct for a possible simultanous equation bias coming from the correlation beteen current e and the current first difference of F* of which the trade balance is an important part, or from the correlation between current e and current f. Therefore, F* and log(f) are treated as endogenous and the lagged values of these are used as instruments as well as the lagged spot rate.

The signs are as expected except that on the money supply. The stock of real foreign assets, interest rate differentials, and the forward rate are the significant determinants of the spot rate. Needless to say, the unsatisfactory thing about this equation is that the forward rate or the expected exchange rate is not explained.

1, M2 is in trillions of yen; F* is miliions of dollars. Numbers in parentheses are t-statistics.

But the analysis of the expectation formation mechanism goes beyond the scope of the present paper.

In any case, the stock of foreign assets whose changes from period to period are dominated by movements in the trade balance has been found to be an important determinant of the exchange rate. Thus, one arrives at the view that in the period the equations are estimated the exchange rate was significantly influenced by the trade balance, while exchange rate changes did not produce sizable reductions in trade imbalances. Such a view is consistent with the observed huge fluctuations in the exchange rate and a prolonged period of trade surpluses. Recent literature on the exchange rate tended to emphasize the instability of expectations in explaining the volatility of exchange rates, while the analysis in this paper has shown that the volatility may come from the combination of two things: one, the inability of exchange rate changes to correct trade deficits or surpluses; and the other, significant impacts of the trade balance on the exchange rate.

4, Concluding Remarks

This paper has investigated the causes of 1976-1978 Japanese trade surpluses using a simple econometric model of the Japanese manufacturing sector. The analysis emphasized the role of imported fuels as an important input to this sector. The results strongly points to the conclusion that the severity of the recession experienced in Japan during this period was a major cause of the surpluses. Decreases in the growth rate of domestic demand increase the trade balance by reducing the demand for imports on the one hand, and on the other, by making it possible for the manufacturing sector to use its resources to increase exports.

The reason for the failure of exchange rate changes to decrease the surpluses was also made clear. First, it has been found that exchange rate changes are significantly influenced by movements in the trade balance. Therefore, the large trade surpluses were in fact a cause of 1977-1978 appreciation of the yen. Second, exchange rate changes have only a minor effect on the trade balance. This mainly comes from an important role played by oil imports. The price elasticity of this component of imports is very small; an appreciation of the exchange rate does not increase manufactured goods imports very quickly despite the high elasticity of this component, because an appreciation decreases oil bills and makes Japanese manufactured goods competitive to some extent. Also, a decrease in export volume induced by an appreciation reduces oil imports. Hence, although exchange rate changes have substantial impacts on some of the components of the trade balance, total effects on the trade balance turn out to be very small.

In addition, estimation results indicated that export volume tended to react too much to temporary changes in the exchange rate. This gave rise to offsetting effects few quarters after changes in the exchange rate, making the long-run elasticity of export volume rather small. In a sense faced with an enormous degree of exchange rate changes for the first time in history, Japanese traders took most of the changes as permanent and overreacted to those which were only short-lived. An appealing conjecture for future periods is to argue that since people have now learned that the exchange rate could be very volatile, they will react more cautiously in the future, reducing reactions to temporary changes, but also slowing the responses to permanent changes, making a J-curve type effect more important.

Such a failure of exchange rate changes to eliminate trade imbalances in a short period of time adds another dimension to the fixed vs. flexible rate debate.[1] Or, one might say some evidence has been found for the traditional elasticity pessimism view from the experience of Japan in the 70s. In any case exchange rate flexibility does not guarantee external equilibrium for a country like Japan which depends crucially on imported intermediate goods. At the same time, if the exchange rate flexibility is to ensure balances in the trade account, one must suffer from intolerably huge fluctuations in the exchange rate.

Although the conclusion has been put in such a way as to emphasize the role of cyclical factors, this does not mean that long-run factors were unimportant. Rather, the results suggest that despite strong contributions of individual forces, when aggregated, they produced no decernible effect on the trade balance. More specifically, during the period, foreign prices were also increasing as a result of the oil shock, increasing Japanese exports. There is a positive time trend in the export volume equation and a negative time trend in the imports of oil equation. These two also tended to increase surpluses. On the other hand, high growth of the Japanese economy relative to the rest of the world, although the difference narrowed in this period, and oil price increases were deficit factors. All these factors were of a non-negligible order of magnitude. It just so happened that they added up to almost zero in the period studied in this paper.

Finally, there are some more related issues to be studied such as the impact of oil shocks on Japan relative to the rest of the world in terms of the trade balance or interms of the growth rate of potntial ouput. But for these one needs to study foreign price formation and the interactions between trade and non traded goods sectors.

1, See Artus and Young (1979) for a recent survey of the issue.

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