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THE INTERNATIONAL TRANSMISSION OF INFLATION IN THE SHORT RUN

by

Gerard Caprio, Jr.

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Economics)
in The University of Michigan
1976

Doctoral Committee:

Associate Professor Alan V. Deardorff, Chairman
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To my parents

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CHAPTER I

INTRODUCTION

In the post-World War II literature dealing with international trade and finance, little theoretical attention has, until very recently, been given to the transmission of inflation from one country to another. This is readily understandable for two very good reasons. First is the point that, until recently, inflation has been a minor problem for the advanced, industrialized nations. Instead, with the legacy of the Great Depression and the predominance of Keynesian thinking, these countries and, consequently, their economists were more concerned with the real income (or output) effects arising from foreign economic disturbances and associated stabilization policies. The second reason for the neglect of the transmission of inflation is that the economics profession believed that this process was well understood in terms of models designed for the analysis of the effects of foreign disturbances on domestic income.

These short-run, Keynesian models suggest that, under a fixed exchange-rate system, expansionary (contractionary) disturbances abroad will produce an economic expansion (contraction) in the home economy due to the

increased (decreased) demand for domestic products and the consequent change in the domestic trade balance. However, under flexible exchange rates, any change in the balance of payments will be prevented by a change in the exchange rate and, therefore, it is widely believed that the domestic economy will be insulated from foreign disturbances. These conclusions have become popularized especially in textbooks.[1] Applied to the transmission of inflation, the suggestion is that, under fixed rates, increased inflation abroad will act to raise the inflation rate at home while, under flexible rates, the domestic economy will experience a proportionately equal appreciation of the exchange rate and thus be completely insulated in the short run.

The idea that flexible exchange rates insulate an economy from foreign inflation is not held solely by Keynesian textbook authors. Turnovsky and Kaspura (1974, p. 374), who employ a sophisticated version of the short-run, small-open-economy model, are able to state that they obtain

> ...the expected result, namely, that with flexible exchange rates the country is able to insulate itself completely from inflationary pressures abroad. Any rise in prices overseas is offset exactly by an appreciation of the exchange rate, leaving constant the price of imported goods in terms of domestic currency.[2]

In the context of a different model, Milton Friedman (1953, p. 199) became a promulgator of the insulating

property of flexible rates when he stated that

> If, under such a system (flexible rates) any one country inflates, the primary effect is a depreciation in its exchange rate. This offsets the effect of internal inflation on its international trade position and weakens or eliminates the tendency for the inflation to be transmitted to its neighbors.... Inflation and deflation in any one country will then affect other countries primarily insofar as it affects the real income position of the initial country; there will be little or no effect through purely monetary channels.

Although Friedman did not provide an explicit model, it seems likely that he was thinking in terms of a full employment, quantity-theory model. In such a long-run model, a country's rate of inflation can vary only if its money supply changes. While higher foreign inflation will tend to increase the domestic balance of payments and hence its money supply, the exchange rate appreciation will eradicate the balance-of-payments surplus.[3] If we take a long-run view or assume that the exchange rate adjusts instantaneously, then it follows that the domestic economy will be completely insulated from foreign inflation.[4]

The above argument points to the popularity of the conclusion that flexible exchange rates insulate an economy from foreign inflation. While this conclusion is not widely debated for the long run, it will become clear in the course of this study that several specialists in international economics, notably Mundell, Krueger, Haberler, and Fleming would not agree with it in the

short run. However, the explicit models provided bv these economists (i.e., Mundell (1964, 1968) and Krueger (1965)) assume unemployment and fixed prices and are thus inappropriate for the study of the transmission of inflation.

Our objective in this study is to provide an explicit model of the international transmission of inflation in the short run. Although both fixed and flexible exchange-rate models will be developed, particular attention will be paid to the latter. It will be demonstrated that, in a flexible exchange-rate system, an increase in foreign inflation will, in general, affect the domestic inflation rate. The direction and magnitude of this transmission effect will be seen to depend primarily on: (a) the source of the increase in the foreign inflation rate; (b) the international mobility of capital; (c) the employment situation at home and abroad; and (d) the manner in which speculators form their expectations of the future spot exchange rate. We shall also demonstrate that, given an increase in the foreign inflation rate, the increase in the domestic inflation rate can be greater in a flexible than in a fixed exchange-rate system.[5] It should be mentioned that Mundell especially recognized the importance of capital mobility in the transmission of economic disturbances under flexible rates. In this light, our study can be viewed as an extension of his work. However, our results go beyond his since we find

a transmission mechanism even in the absence of capital flows.

The analysis proceeds as follows. In Chapter II we shall review critically the standard models used to investigate the transmission question. Chapter III contains the development of a two-country, full employment model and a discussion of the transmission of inflation in such an environment. However, the conclusions drawn from this model are of dubious validity, given the combination of inflation and unemployment found in the major industrialized countries today. Moreover, it will become clear that the full employment assumption limits the situations in which transmission can be expected under flexible rates. In order to have a more realistic and a more general model of the dissemination of inflation under fixed and flexible exchange-rate systems, we shall employ a Phillips' curve model in the fourth chapter to examine further the transmission of inflation. By the end of that chapter, it will be clear that, under flexible rates, the behavior of capital transactors is of key importance in the transmission process. Consequently, in Chapter V, we shall develop a stock-adjustment model of capital flows under flexible rates and then apply our results to the model of the preceding chapter. Finally, Chapter VI follows with a summary of our results and suggestion for future research.

Footnotes

[1]See, for example, Branson (1972, p. 317) and Ott, Ott and Yoo (1975, pp. 153-54).

[2]Emphasis added.

[3]In the absence of an exchange rate change, the money supply would remain constant if the monetary authorities sterilized the balance-of-payments surplus. However, in Friedman's long-run framework, such sterilization is not practical.

[4]Friedman's statement that the transmission may only be weakened is presumably a (rare) concession that the short-run might be important and that the exchange rate might not adjust instantaneously.

[5]However, this finding does not detract from the argument in favor of flexible exchange rates. Indeed, the relative insulating properties of fixed and flexible rates cannot be used to choose between these two systems (unless the degree of interdependence among countries is the criterion) since it is difficult to predict whether foreign disturbances will be beneficial or detrimental. Instead, the importance of this finding is its implication for public policy. If countries were truly insulated by flexible exchange rates, then policymakers would not have to worry about taking any offsetting measures. However, the conclusions of this study indicate that policymakers will have to concern themselves with such stabilization policies and that, in some circumstances, these policies will be more important under flexible than under fixed exchange rates.

CHAPTER II

A CRITIQUE OF THE APPLICATION OF STANDARD MODELS TO THE STUDY OF THE TRANSMISSION OF INFLATION

2.1 A General Framework for the Analysis of an Open Economy

For the reasons noted in the introduction to this study, comparatively little attention has been given to the modeling of the transmission of inflation in the period since World War II.[1] The simplistic conclusions of a full employment model with flexible wages and prices have been extended to a variety of situations in an uncritical and often inappropriate manner. In order to clarify matters then, what is needed is a more explicit modeling of the transmission process for different situations. We shall begin in this chapter by examining some of the Keynesian macroeconomic models of international finance and apply them to the transmission of economic disturbances. Having accomplished this task, we shall be in a position to develop a better approach to study this phenomenon.

A convenient point for departure is provided by Deardorff (1975). The two-country model that he employs is given by the following equations:

$$Y_1 = A_1(\overset{+}{Y_1},\overset{-}{r_1}) + B_t(\overset{-}{Y_1},\overset{+}{Y_2},\overset{-}{T}) \qquad (2.1)$$

$$Y_2 = A_2(\overset{+}{Y_2},\overset{-}{r_2}) - TB_t(\overset{-}{Y_1},\overset{+}{Y_2},\overset{-}{T}) \qquad (2.2)$$

$$M_{1s} = L_1(\overset{+}{P_1},\overset{+}{Y_1},\overset{-}{r_1}) \qquad (2.3)$$

$$M_{2s} = L_2(\overset{+}{P_2},\overset{+}{Y_2},\overset{-}{r_2}) \qquad (2.4)$$

$$B = B_t(\overset{-}{Y_1},\overset{+}{Y_2},\overset{-}{T}) + B_k(\overset{+}{r_1},\overset{-}{r_2}) \qquad (2.5)$$

where

Y_i = income (output) of country i, in units of i's output;

P_i = price level of country i's output, in units of the i^{th} currency;

r_i = interest rate in country i;

M_{is} = nominal money supply in country i;

L_i = nominal demand for money in country i;

A_i = absorption by country i, in units of i's output;

B_t = balance of trade of country one, in units of country one's output;

B_k = balance on the capital account of country one, in units of country one's output;

B = balance of payments of country one;

R = exchange rate (price of country two's currency, in terms of country one's currency); and

$T = P_1/R\ P_2$ = terms of trade (price of country one's output, in terms of country two's output).

The signs above the arguments of these equations represent the "direction of functional dependence, and accord with the assumptions that are usually made about these effects."[2]

Equations (2.1) and (2.2) are the conditions for product market equilibrium in countries one and two (the home economy and the rest of the world), respectively. In effect, each country produces one good and consumes both its own and the other country's product. The absorption function is merely an abbreviation for total expenditure by the residents, firms, and government of each country or, in other words, consumption plus investment plus government spending. Thus, the first two equations state that the supply of and the demand for each good should be equal in equilibrium.

Equations (2.3) and (2.4) represent the standard conditions for equilibrium in each economy's money market.[3] As Kyle (1972) has noted, it is theoretically preferable to replace the price level of each country's output in the money demand functions with an appropriately weighted index that reflects the price level of the bundle of goods consumed by the residents of each country. However, the exact form of equations (2.3) and (2.4) will be retained in order to simplify the analysis.[4] Finally, the absence of reserve flows in these equations implies that the monetary authorities are conducting offsetting

sterilization operations when the balance of payments is nonzero.

Equation (2.5) is the definition of the balance of payments. The capital account specification subsumes the formerly popular idea that capital flows in response to the interest rate differential. These capital flows are presumably due to the fact that the residents of each country hold both domestic and foreign assets and vary their holdings of these assets as the interest rates change.[5] Given this basis for the movement of capital, there are two objections to the above model.

First, according to modern portfolio theory, it is the rate of change of interest rates, rather than their levels, that is important in determining the net capital flow. In fact, we shall see in Chapter V that, under certain conditions, the use of interest rate levels can be justified in the short run. A second objection can be made by pointing to the absence of foreign and domestic interest rates in equations (2.3) and (2.4), respectively. For the residents of each country are holding a portfolio composed of their own currency and the assets of each country. Thus, for example, as the foreign interest rate rises, the residents of country one alter their bond holdings in favor of those issued by country two, while the division of their portfolios between money and bonds should be but is not directly affected. This

objection is not too serious, however, since this effect is indirectly captured in the above model by the increase in the domestic interest rate induced by the increase in the interest rate abroad.[6] Moreover, in this chapter we are not interested in the "best" theoretical model, but are instead interested in examining a conventional model of the balance of payments especially in terms of how it deals with the transmission of inflation.

The above model is a short-run, static representation of an open economy. There are no provisions for economic growth, portfolio growth and balance, or for changing expectations of future price levels or the exchange rate.[7] Another salient feature of the model is that it cannot be solved unless some of the variables are assumed to be exogenous, since there are ten variables (Y_1, Y_2, P_1, P_2, r_1, r_2, M_1, M_2, R, B) and only five equations. The last two variables are the easiest to handle, for if the exchange rate is exogenous, then we have a fixed-rate system with an endogenous balance of payments, while if the exchange rate is endogenous, as in a flexible exchange-rate system, then the balance of payments can be exogenously set equal to zero.

Next, the income and price variables are dealt with according to whether the economy is at full or less-than-full employment. If there is full employment in country i, then Y_i is exogenous and P_i is endogenous. On the

other hand, with less-than-full employment in country i, Y_i is endogenous and P_i is exogenous. Finally, the money market is handled analogously, with either r_i or M_{is} being exogenous according to whether the monetary authorities of country i are pegging the interest rate or the money supply.

Consequently, due to the different permutations of assumptions that could be made regarding the exchange rate system, the employment situation, and the nature of monetary policy, the simple five-equation system yields not one model but rather thirty-two![8] Unfortunately, little effort appears to have been devoted to the solution of these five-equation models.[9] Instead, the temptation has been to select different combinations of three equations, depending on the size of the economy in question. Let us see then what has been done. In what follows, we rely heavily on Deardorff's work.

A. The Small, Open Economy

Traditionally, in international finance, an economy is said to be small if any change in its income, price level, or interest rate does not (significantly) affect these variables in the rest of the world. In terms of equations (2.1) to (2.5), country one is small if two conditions hold. First, any change in the balance of

trade due to changes in country one's economic variables must be so small that there is no significant impact on the income or price level of country two.[10] Second, in the capital market, any changes in the demand for foreign bonds by the residents of country one must not appreciably affect the price of these bonds.[11] Since these conditions imply that country-two variables will not change as a result of any variations in domestic economic variables, it is common to assume that all country-two variables are exogenous.[12] Therefore, small-open-economy models are typically composed of equations (2.1), (2.3), and (2.5).

Following the early literature on the transmission of economic disturbances, we can make the Keynesian assumption of a fixed price level and money supply, implying that income and the interest rate in country one are endogenous. Thus, we have two small-open-economy, IS-LM models with the endogenous variables being (Y_1, r_1, B) or (Y_1, r_1, R), according to whether the exchange rate is fixed or flexible, respectively. In either case, we can totally differentiate equations (2.1), (2.3), and (2.5) and solve the resulting system for dY_1, dr_1, and either dB or dR.

Consider an exogenous increase in country two's income level. It is easy to show that the effect on the domestic income level is given by:[13]

$$\left(\frac{dY_1}{dY_2}\right)_B = \frac{m_2 L_1^{r_1}}{\Delta_B} > 0 \qquad (2.6)$$

under fixed exchange rates and

$$\left(\frac{dY_1}{dY_2}\right)_R = \frac{L_1^{r_1}(B^T - B_t^T)}{\Delta_R} = 0 \qquad (2.7)$$

under flexible exchange rates, where

$$\Delta_B = (s_1+m_1)L_1^{r_1} + A_1^{r_1} L_1^{Y_1} < 0;$$

$$\Delta_R = B_t^T(s_1 L_1^{r_1} + A_1^{r_1} L_1^{Y_1} - L_1^{Y_1} B_k^{r_1}) > 0;$$

$$s_1 = 1 - A_1^{Y_1} > 0;$$

$$s_2 = 1 - A_2^{Y_2} > 0;$$

$$m_1 = -B_t^{Y_1};$$

$$m_2 = TB_t^{Y_2};$$

$$P_1 = P_2 = R = T = 1, \text{ initially;}$$

$$B_t = B_k = B = 0, \text{ initially; and}$$

where superscripts denote partial derivatives (i.e., $A_1^{r_1} = \partial A_1/\partial r_1$, etc.).

The chain of events behind these two multipliers is easy to comprehend. The increase in foreign income improves the domestic balance of trade. If the exchange rate is

pegged, then this increase is permitted to occur and, from equation (2.1), it follows that the domestic income level will increase. However, if the exchange rate is flexible, then it will appreciate, from country one's viewpoint, until the balance of payments is again equal to zero. Since the capital account balance has not changed, it follows that the trade balance must return to its former level and, therefore, the domestic income level will remain unchanged.[14]

Although the above model is quite simple, nevertheless it seems to be the foundation for the belief that flexible exchange rates insulate an economy from foreign disturbances while, under fixed exchange rates, these disturbances are transmitted to the home economy. Moreover, for small-economy models in general, this conclusion is quite robust. For example, we could assume that there is full employment in the home economy and study the transmission of foreign disturbances by employing the same three equations and assuming that either (P_1, r_1, B) or (P_1, r_1, R) are the endogenous variables. Despite the absence of ongoing inflation in either of these cases, we can examine the effect of an increase in the foreign price level on the price level at home.[15] It can be shown that, under fixed rates:

$$\left(\frac{dP_1}{dP_2}\right)_B > 0 \qquad (2.8)$$

while, under flexible rates:

$$\left(\frac{dP_1}{dP_2}\right)_R = 0 \quad . \tag{2.9}$$

In equations (2.6) and (2.7), the demand for the domestically-produced good increased due to the increase in foreign income, while in equations (2.8) and (2.9) the same result is caused by an increase in the relative price of the foreign product. Since neither the cause of the increase in demand nor the employment situation at home should affect the direction of the transmission effect, the results in equations (2.8) and (2.9) are not surprising.

However, it would be unwise to generalize from the foregoing results that, under fixed exchange rates, an increase in the foreign rate of inflation will cause an increase in inflation at home while, under flexible exchange rates, this transmission effect will be negated. It will be recalled that, in assuming the existence of a small open economy, all country-two variables were taken as exogenous. The exogeneity of these variables was meant to describe their independence from the influence of economic factors in the small, open economy. However, this assumption implies, by its disregard for equations (2.2) and (2.4), that the foreign economic variables are independent of each other! For example,

given either of the exogenous disturbances in equations (2.6) and (2.7), or equations (2.8) and (2.9), we would normally expect that there would be a rise in the nominal demand for money abroad and a consequent increase in the interest rate (r_2). This latter increase would tend to deteriorate the capital account balance of the home economy. While such an event would not affect the fixed exchange-rate multiplier (equation (2.8)), it would, as we shall later demonstrate, alter the conclusion that flexible exchange rates insulate an economy from foreign price increases.[16] The small-economy model cannot capture this chain of events. Instead, it can only describe the ramifications of an increase in the price level of the foreign good, ceteris paribus. However, as we shall see in Chapters III and IV, these other things will not generally remain constant.[17]

A related argument against the use of a small-economy model in a study of the transmission of inflation (or of economic disturbances, in general) is that such a model does not allow us to consider the effects of changes in foreign economic policy. The question of the transmission of inflation is how the inflation rates (or, in the model of equations (2.1) to (2.5), the price levels) of different economies are related and how the answer to this question is sensitive to the exchange-rate system. As economists, we like to think that (an increase in)

inflation does not just simply occur, but rather is caused by changes in economic factors, notably by excessive (government) spending and/or money creation. The small-open-economy model only permits us to analyze the transmission of the first type of inflation and this is a serious drawback.

To summarize the argument of this subsection, we have made two criticisms of the applicability of the small-open-economy model to the study of the transmission of inflation. First, the model implies that foreign economic variables are independent of each other and thus overlooks the effect of a change in one of these variables (e.g., the foreign price level or inflation rate) on others (e.g., the foreign interest rate). Second, the exogeneity of foreign variables implies a neglect of situations in which two or more foreign variables, such as the rate of inflation and the interest rate, vary simultaneously because their changes were induced by government policy, such as money creation. For these reasons we shall employ two-country models for the remainder of this study.[18]

B. The Two-Country, or Foreign-Repercussions Model

The traditional two-country or foreign-repercussions model, developed by Metzler (1942) and Machlup (1943), is composed of equations (2.1), (2.2), and (2.5), with

the endogenous variables being either (Y_1, Y_2, R) or (Y_1, Y_2, E). Under fixed exchange rates there will be economic interdependences between two countries, or between one country and the rest of the world. To see this point, we can totally differentiate equations (2.1), (2.2), and (2.5) to obtain

$$\begin{vmatrix} (s_1+m_1) & -m_2 & 0 \\ m_1 & (s_2+m_2) & 0 \\ m_1 & -m_2 & 1 \end{vmatrix} \begin{vmatrix} dY_1 \\ dY_2 \\ dR \end{vmatrix} - \begin{vmatrix} 0 & t_1^T & 1 & 0 \\ 1 & -t_1^T & -1 & 0 \\ 0 & t_1 & 1 & 1 \end{vmatrix} \begin{vmatrix} dA_2^0 \\ dP_2 \\ dR_1^0 \\ dR_k^0 \end{vmatrix} \qquad (2.10)\text{-}(2.12)$$

where a superscript of zero denotes a shift of a function and all other variables have been previously defined.[19] The income multipliers for exogenous increases in foreign government spending ($dA_2^0 > 0$), the foreign price level ($dP_2 > 0$), the balance of trade ($dR_1^0 > 0$) and the balance on the capital account ($dR_k^0 > 0$) are:

$$\frac{dY_1}{dA_2^0} = \frac{m_2}{\Delta_H} > 0 \; ; \qquad (2.11)$$

$$\frac{dY_1}{dP_2} = \frac{-s_2 t_1^T}{\Delta_H} > 0 \; ; \qquad (2.14)$$

$$\frac{dY_1}{dR_1^0} = \frac{s_2}{\Delta_H} > 0 \; ; \qquad (2.15)$$

$$\frac{dY_1}{dB_k^o} = 0 \ , \tag{2.16}$$

where

$$\Delta_B = s_1 s_2 + s_1 m_2 + s_2 m_1 > 0.^{20}$$

The first three multipliers are positive since each of the exogenous changes acts to improve, either directly or indirectly, the balance of trade. From equation (2.1), it is clear that the latter change increases income at home which, in turn, results in a further increase (or a smaller decrease) in income abroad. In the first case of expansionary foreign fiscal policy, income abroad increases and thus the two income levels move together. In the next two cases this is not so because the exogenous change implies a shift in demand away from good two.[21] The fourth multiplier attests to the sterilization operations being conducted by the monetary authorities.

Consequently, we can conclude that, under fixed exchange rates, a foreign disturbance will affect the domestic economy if it entails a change in the trade account balance. However, if the sole result of the disturbance is an alteration of the capital account balance, then the domestic economy will be insulated. Under flexible exchange rates, precisely the opposite conclusion holds. For with flexible exchange rates,

the left-hand side of equations (2.10) to (2.12) becomes

$$\begin{bmatrix} (s_1+m_1) & -m_2 & B_t^T \\ -m_1 & (s_2+m_2) & -B_t^T \\ m_1 & -m_2 & B_t^T \end{bmatrix} \begin{bmatrix} dY_1 \\ dY_2 \\ dR \end{bmatrix}$$

and the right-hand side remains unchanged. Thus, the multipliers for the same exogenous changes are now:

$$\frac{dY_1}{dA_2^o} = \frac{dY_1}{dP_2^o} = \frac{dY_1}{dB_t^o} = 0 \; ; \qquad (2.17)$$

$$\frac{dY_1}{dB_k^o} = \frac{-1}{s_1} < 0 \quad . \qquad (2.18)$$

The domestic economy is insulated from the effects of the first three disturbances since each of these changes affects only the trade account.[22] Therefore, the change in the balance of trade is equal to the change in the balance of payments and, since the exchange rate is flexible, it will appreciate to restore these two balances to their original level (zero). On the other hand, in equation (2.18), the initial improvement in the balance of payments is given by the increase in the capital account balance. The resultant appreciation acts to worsen the trade balance and thereby produces a decline in income at home.

Thus far we have said nothing about the transmission of inflation in a foreign-repercussions model of the

balance of payments. This omission is hardly surprising, since it is impossible to use equations (2.1), (2.2) and (2.5) to discuss static transmission under flexible exchange rates.[23] For in order to investigate the aforementioned disturbances, we would want the endogenous variables to be (P_1, Y_2, R). However, since P_1 and R operate only through the terms of trade, there are really only two endogenous variables, three equations, and a zero determinant of coefficients.[24]

Thus, the foreign-repercussions model, as presented here, says nothing about the transmission of inflation. However, it is quite possible that economists have generalized from equation (2.17) and concluded that there will be no transmission of inflation. In order for this to be true, it is clear from equation (2.18) that inflation must not affect the capital account. In Chapters III, IV and V, we shall demonstrate that, under a wide variety of conditions, the latter conclusion is false.

One of the main problems in adapting the foreign-repercussions model to the question of static transmission is the absence of money markets. The omission of equations (2.2) and (2.4) is not surprising when we recall that this model was developed when the "money does not matter" school of Keynesianism was at its peak.[25] However, it is not easy to understand why such little effort has been devoted to the study of the transmission

process in a foreign-repercussions model with money markets. In Chapter III we shall focus our attention on such a project.

2.2 The Recognition of Transmission Effects in Standard Models

The first economists to dissent from the view that, under flexible exchange rates, an economy will be completely insulated from foreign disturbances were Laursen and Metzler (1950). Their model was based on the assumption that the terms of trade should be an argument of each country's absorption function. Under flexible exchange rates, the terms of trade can generally be expected to change and the consequent alteration of real expenditure will then act to destroy the insulating property of floating rates.

The argument that a change in the terms of trade affects the absorption function begins by noting the effect of the terms of trade on real income. A rise in the terms of trade corresponds to a fall in the number of units of good one needed to procure a unit of good two. Thus, the real income of the residents of country one corresponding to a given amount of money income will increase. If, as Laursen and Metzler believe, the proportion of income consumed is a decreasing function of real income, then money expenditure will fall provided that the other components of expenditure, notably investment, do not change.

Deardorff (1975, Appendix B) has shown that this terms-of-trade effect on absorption can be incorporated into equations (2.1) – (2.5) by expressing our real units in the price-deflated sense rather than in the units-of-output sense. Thus, he expresses price-deflated absorption as a function of price-deflated income and the interest rate, or:

$$\frac{P_1 A_1}{\bar{P}_1} = f_1\left(\frac{P_1 Y_1}{\bar{P}_1},\ r_1\right) \qquad (2.19)$$

where $\bar{P}_1$, a price index of goods one and two, is defined by

$$\bar{P}_1 = P_1^{(1-\alpha_1)} (RP_2)^{\alpha_1} \qquad (2.20)$$

and $\alpha_1 = \frac{M_1}{TA_1}$ = the proportion of total expenditure spent on imports.

Combining these two equations yields:

$$A_1 = T^{-1} f_1(T^{\alpha_1} Y_1,\ r_1) \quad , \qquad (2.21)$$

from which it can be shown that

$$\frac{\partial A_1}{\partial T} = \alpha_1 T^{-1} Y_1 \left(\frac{\partial A_1}{\partial Y_1} - \frac{A_1}{Y_1}\right) \quad . \qquad (2.22)$$

Consequently, an increase in the terms of trade will produce a decline in absorption if the marginal propensity to absorb is less than the average propensity. Since Laursen and Metzler are holding investment and government spending constant, these marginal and average

propensities to absorb are, respectively, the marginal and average propensities to consume. Thus, the Laursen-Metzler criterion for the negativity of A_1^T is the same as Deardorff's, given in equation (2.22).[26] Since this effect is symmetric, it follows that A_2^T is positive.

As is probably obvious by now, the main problem with the Laursen-Metzler analysis is that it neglects the possibility of terms-of-trade effects on investment and government spending. Although the latter effect can be assumed to be zero, the former effect should be positive. If inputs to the production process of good one are imported, then an increase in the terms of trade will act to increase investment.[27] Theoretically, it is impossible to determine whether the positive investment effect will outweigh the negative effect on consumption. Laursen and Metzler merely state that, even allowing for the effect on investment, they believe that A_1^T is negative. Although we shall include a negative terms-of-trade effect on absorption, we shall be careful to remember that it is ambiguous and probably empirically insignificant.[28]

It is significant that Laursen and Metzler assume that capital does not flow between countries. Taking up this point, Mundell (1964, and 1968, Ch. 18), argues that it is precisely the mobility of capital that destroys the insulating property of flexible exchange rates. Although his theory is quite correct, his analysis is weakened in

applicability to the transmission question by his assumptions of fixed prices and perfect capital mobility. Therefore, his model will not be presented here. However, our model in Chapter III is a Mundellian model with full employment and a more general assumption about capital mobility, while in Chapter IV we expand the model of equations (2.1) to (2.5) by allowing for an inflation-unemployment tradeoff. Thus, our intellectual debt to Mundell is great.

The next contribution worth mentioning is that of Haberler (1974, p. 184), who states:[29]

> A popular view--Harry Johnson calls it 'a simple view of the Hume price-specie flow mechanism'--is that inflation spreads by the more inflationary countries loosing reserves to less inflationary countries, increasing money supply there and driving up prices. This requires, of course, the existence of sufficient international reserves and their replenishment when necessary.

In other words, a country can import inflation from abroad merely by running a balance-of-payments surplus.[30] Those who take the untenable position that this is the only way by which inflation can be imported are forced to the conclusion that inflation cannot be transmitted if the exchange rate adjusts instantaneously to surpluses or deficits in the balance of payments.

Haberler demonstrates that he does not fall into this trap by stating (p. 190) that floating

> ...can shield a country from purely monetary influences from abroad, that is from imported inflation and deflation, but it cannot protect a country from the real changes and shifts in international demand including changes in the terms of trade which are almost always associated with inflation and deflation.[31]

This statement would be the epitome of perfection if Haberler had indicated clearly that these real changes can lead to the importation of inflation in the short run. The remaining chapters of this study will demonstrate how and under what conditions this can occur.

Two final contributions, not to be discussed at this point, are by Krueger (1965) and Fleming (1974). Krueger's views on the transmission process are basically similar to those of Mundell, though we shall have cause to mention her noteworthy contribution in the next chapter. Fleming's thoughts are much more intricate and are not substantiated by the use of a specific model. However, we shall argue that the models of Chapters IV and V provide an adequate description of the adjustment processes that Fleming describes.[32]

2.3 Conclusion

In this chapter it has been demonstrated that the standard short-run models of the balance of payments cannot be applied uncritically to a study of the transmission of inflation. The small-open-economy model, as normally expressed, is invalidated by its implicit

assumption of the independence of economic variables in the rest of the world from other rest-of-the-world factors. The foreign-repercussions model cannot even be adapted to the question of static transmission due to the absence of money markets.[33] However, this model does provide the hint that inflation can be transmitted abroad if it affects the international flow of capital. Finally, the views of those who have recognized the possibility of transmission under flexible rates were discussed briefly. We shall now turn to models that elucidate these considerations explicitly.

Footnotes

[1]Notable exceptions to this statement are the articles by Turnovsky and Kaspura (1974), Mundell (1971, Ch. 15), Scarfe (1973) and Shinkai (1973). The first of these articles serves as the foundation for the model of Chapter IV and will be discussed there. The second is not of interest for our study since it is a long-run, steady-state analysis. The third article examines the dynamic behavior of a small, open economy as it cycles about a long-run solution. In the short run, Scarfe's study is similar to that of Turnovsky and Kaspura. Finally, Shinkai's brief note assumes a constant rate of foreign inflation. Since we are instead concerned with the effects of an increase in this rate on the domestic inflation rate, we shall ignore Shinkai's article.

[2]Deardorff (1975, p. 6). As Deardorff notes, the sign of the effect of the terms of trade on the trade balance amounts to the assumption that the Marshall-Lerner condition holds.

[3]Those who disagree with this statement are invited to assume that each money-demand function is homogeneous of degree one in prices. However, the more general format will be retained in the text.

[4]Stern (1973) also uses a price index, P, in his money-demand function, where $P = \alpha RP_2 + (1-\alpha)P_1$, $\alpha = M_1/TA_1$ = the proportion of total expenditure by country one spent on country two's product. See also Richardson (1971) for more on this price index. We shall again mention this price index in Sections 2.2 and 4.1.

[5]Capital flows could also arise from the financing of direct foreign investment. We shall assume that this component of capital flows is fixed (in the short run) until the fifth chapter. Finally, we should note that the bond market is omitted from equation (2.1) to (2.5) by Walras' Law.

[6]As bond holders increase their holdings of foreign bonds, the price of domestic bonds falls, inducing a decline in the demand for money.

[7]See Myrhman (1974) for an excellent summary of portfolio balance models in international finance.

[8]Of course, due to the symmetrical treatment of the two countries, only eighteen of them could possibly be interesting.

[9]A notable exception is the article by Swoboda and Dornbusch (1973), where a variant of the model in equations (2.1) to (2.5) is used to examine a foreign repercussions model under fixed exchange rates.

[10]As Deardorff (1975) points out, from equation (2.2), this simply means that TB_t is very small relative to A_2.

[11]Several economists, notably Mundell, have expressed the assumption of smallness in the capital markets by positing perfect capital mobility and perfect substitutability of domestic and foreign bonds. Following Deardorff (1975), it seems wise to separate the issues of smallness and substitutability. Therefore, we shall assume that the bonds of the two countries are not viewed to be identical.

[12]For a recent article in which this is done, see Turnovsky and Kaspura (1974).

[13]A subscript B or R denotes which of these variables is endogenous.

[14]It can be shown that r_1 and B will increase if the exchange rate is fixed and remain unchanged if R is allowed to vary.

[15]Henceforth, this effect of one price level on another will be called static transmission. Note that these prices are really the prices of the goods produced at home and abroad.

[16]The fixed-rate multiplier remains the same due to the assumption that the monetary authorities conduct offsetting sterilization operations in order to leave the money supply unchanged in the face of a balance-of-payment surplus or deficit.

[17]In Chapter III, it will be demonstrated that the other country-two variables will remain constant only if there is full employment abroad and if P_2 increased due to an increase in M_{2S}.

[18]It may, of course, be possible to devise other means of incorporating the small-country assumption. However, since our goal is to study the transmission of inflation, we shall put off a rehabilitation of the small-open-economy model for future research. As an aside, it is worthwhile noting that small economies may choose to peg their currencies to a strong currency due to tradition, optimum currency area arguments, etc. Thus it may be more relevant to use a model that is applicable to a situation in which only the dollar group, the pound group, etc. float in relationship to each other, while within each multinational group, the exchange rates are pegged.

[19]There should, of course, be other variables on the right-hand side (i.e., dA_1^o, dr_1, dr_2, dP_1, dR). However, we are only interested in the variables given in equations (2.10) to (2.12) and therefore have assumed that the other exogenous variables do not change.

[20]Whenever we refer to the balance of trade, on the capital account, or of payments, we shall be speaking from country one's viewpoint and hence be referring to B_t, B_k or B, respectively.

[21]The reader can easily verify the changes in Y_2 and/or consult Deardorff (1975).

[22]Throughout this study we shall employ a two-stage approach in describing changes that occur in a flexible exchange rate system. The first stage consists of changes in economic variables, including B, assuming that dR = 0. In the second stage we shall then let the exchange rate change to eradicate the surplus or deficit in the balance of payments. Of course, in the models used in this study, these changes occur instantaneously. However, this two-stage approach is justified on heuristic grounds.

[23]See footnote 15.

[24]It can be seen that any increase in expenditure in country one (A_1) will increase P_1 and, since B_k is exogenous and B = 0 in equilibrium, R would have to increase (depreciate) by the same amount. However, there is then no way in which the excess demand can be choked-off--Y_1 is constant, A_1 is higher and B_t is constant--and, therefore, there is no solution to the model. Prices keep rising in country one and the exchange rate depreciates at the same rate. The reader will recognize this case as being similar to the closed-economy case

in which the government pegs the interest rate and accommodates any increase in demand by expanding the money supply. This explanation was inspired by one given by Deardorff (1975, note 14) in the context of a (P_1, P_2, R) model.

[25]Monetarists will be quick to say that this was the nadir rather than the acme.

[26]If $C = h(Y)$ and $C/Y = H(Y)$, $H'(Y) = 1/Y\ (h'(Y) - C/Y)$. Thus, the statement that "the proportion of income consumed is a decreasing function of real income" holds iff the average propensity to consume exceeds the marginal propensity.

[27]Even without imported inputs, Deardorff (1975) points out that an increase in T will raise the return to investment which, of course, will act to encourage more investment.

[28]The main purpose for the inclusion of this effect is that Laursen and Metzler's judgment may be correct and, if so, it is worthwhile to understand the role of the terms-of-trade effect on the transmission process. However, it is to be hoped that some econometrician is reading this study!

[29]The statement referred to by Johnson can be found in Johnson (1973 and 1972).

[30]It is also necessary that the monetary authorities are either unwilling or unable to sterilize the balance of payments.

[31]Author's own emphasis.

[32]I would like to thank Thomas D. Willett for pointing out these last two articles cited in the text. Willett also argued that the conventional wisdom among international economists is probably that there is transmission under flexible exchange rates if capital is mobile. Although the author is inclined to agree with this argument, it again seems that the rest of the profession has not appreciated this point due to the absence of specific models. We shall provide these models in this study and also show that there can be transmission of inflation even if capital is immobile.

[33]This statement is only true for flexible exchange rates. It is possible to analyze a (P_1, Y_2, B) model.

CHAPTER III

THE TRANSMISSION OF INFLATIONARY IMPULSES IN A TWO-COUNTRY, FULL-EMPLOYMENT SETTING

3.1 The Model

In the previous chapter we saw that, due to the assumption of fixed prices and the absence of money markets, the standard foreign-repercussions model is inadequate for the task of analyzing the transmission of inflation. In this chapter, we shall examine the complete two-country model of equations (2.1) to (2.5) under the assumption that there is full employment at home and abroad. Variations of this model have been analyzed in the literature. Mundell (1964, 1968) examined a model similar to equations (2.1) to (2.5) assuming that there is unemployment (or variable output) at home and abroad. His contribution is particularly noteworthy since he compared the situations of perfectly mobile and immobile capital and found that, under flexible exchange rates, there will be transmission of economic disturbances in the former case but not in the latter.

Maintaining the unemployment assumption, Swoboda and Dornbusch (1973) and Stern (1973, Ch. 10) have analyzed a Mundellian model in the cases of immobile and

less-than-perfectly mobile capital flows. However, they did not cover the case of flexible exchange rates. On the other hand, Krueger (1965) looked at a two-country, Mundellian model under floating rates. However, since she assumed that monetary policy is characterized by an endogenous money supply (i.e., Keynesian neutral monetary policy), her conclusions differ from those below since we make the opposite assumption of an endogenous interest rate (i.e., orthodox neutral monetary policy).

Two-country models that assume full employment at home and abroad have been developed by Metzler (1968) and Holmes (1972, 1973). Metzler's analysis deals solely with a fixed exchange-rate system and, given this assumption, his conclusions are similar to those below. Holmes revises Metzler's analysis by assuming perfect substitutability between the bonds of the two countries and by developing a capital flow function that depends on the terms of trade.[1] The latter assumption accounts for the dissimilarity between his conclusions and ours in a fixed exchange-rate system and the similarity between these conclusions in a floating-rate system. We shall comment on where and why the conclusions below differ from those of the aforementioned articles in the instances in which these differences are interesting.

The two-country model that we shall investigate in this chapter is contained in the following equations:

$$\bar{Y}_1 = A_1(Y_1, r_1) + B_t(Y_1, Y_2, T) \tag{3.1}$$

$$\bar{Y}_2 = A_2(Y_2, r_2) - TB_t(Y_1, Y_2, T) \tag{3.2}$$

$$M_{1s} = L_1(P_1, Y_1, r_1) \tag{3.3}$$

$$M_{2s} = L_2(P_2, Y_2, r_2) \tag{3.4}$$

$$B = B_t(Y_1, Y_2, T) + B_k(r_1, r_2) \tag{3.5}$$

where

$\bar{Y}_i$ = full employment income (output) in country i, in units of i's output.[2]

All other variables and the signs of all partial derivatives have been defined in the previous chapter.

These equations could be solved in a straightforward manner for fixed and flexible exchange-rate systems with the endogenous variables being (P_1, P_2, r_1, r_2, B) and (P_1, P_2, r_1, r_2, R), respectively. A less direct but easier method is to first make substitutions to reduce the number of variables and equations. Since the functions in equations (3.3) and (3.4) are monotonic in r_1 and r_2, these equations can be rearranged by solving for the inverse function of each interest rate. In other words, we can write

$$r_1 = \ell_1(Y_1, P_1, M_{1s}) \tag{3.6}$$

$$r_2 = \ell_2(Y_2, P_2, M_{2s}) \tag{3.7}$$

where

$$\ell_i^{Y_i} = \frac{-L_i^{Y_i}}{L_i^{r_i}} > 0 \quad ;$$

$$\ell_i^{P_i} = \frac{-L_i^{P_i}}{L_i^{r_i}} > 0 \quad ;$$

$$\ell_i^{M_{is}} = \frac{1}{L_i^{r_i}} < 0 \quad ,$$

for $i = 1,2$.

These functions can then be substituted into equations (3.1), (3.2) and (3.5) whenever the appropriate interest rate appears. We then define a new absorption function for each economy, given by:

$$\begin{aligned} \tilde{A}_i(Y_i,P_i,M_{is}) &\equiv A_i(Y_i,\ell_i(Y_i,P_i,M_{is})) \\ &\equiv A_i(Y_i,r_i) \end{aligned} \tag{3.8}$$

where

$$A_i^{Y_i} = A_i^{Y_i} + A_i^{r_i}\,\ell_i^{Y_i} = 1 - \tilde{s}_i < 1 \quad ;^{3}$$

$$A_i^{P_i} = A_i^{r_i}\,\ell_i^{P_i} < 0 \quad ;$$

$$A_i^{M_{is}} = A_i^{r_i}\,\ell_i^{M_{is}} > 0.$$

The capital account function also contains interest rates. Its revised form is:

$$\begin{aligned} \tilde{B}_k(Y_1,P_1,M_{1s},Y_2,P_2,M_{2s}) &\equiv B_k(\ell_1,\ell_2) \\ &\equiv B_k(r_1,r_2) \end{aligned} \tag{3.9}$$

where

$$\tilde{B}_k^{Y_1} = B_k^{r_1}\,\ell_1^{Y_1} > 0 \quad ;$$

$$\tilde{B}_k^{P_1} = B_k^{r_1}\,\ell_1^{P_1} > 0 \quad ;$$

$$\tilde{B}_k^{M_{1s}} = B_k^{r_1}\,\ell_1^{M_{1s}} < 0 \quad ;$$

$$\tilde{B}_k^{Y_2} = B_k^{r_2}\,\ell_2^{Y_2} < 0 \quad ;$$

$$\tilde{B}_k^{P_2} = B_k^{r_2}\,\ell_2^{P_2} < 0 \quad ;$$

$$\tilde{B}_k^{M_{2s}} = B_k^{r_2}\,\ell_2^{M_{2s}} > 0 \quad .^4$$

Making these substitutions reduces equations (3.1) to (3.5) to the following three-equation model:

$$\bar{Y}_1 = \tilde{A}_1(Y_1,P_1,M_{1s}) + B_t(Y_1,Y_2,T) \qquad (3.10)$$

$$\bar{Y}_2 = \tilde{A}_2(Y_2,P_2,M_{2s}) - TB_t(Y_1,Y_2,T) \qquad (3.11)$$

$$B = B_t(Y_1,Y_2,T) + \tilde{B}_k(Y_1,P_1,M_{1s},Y_2,P_2,M_{2s}) \; . \qquad (3.12)$$

With these equations we can now proceed to examine static transmission in a full employment setting under fixed and flexible exchange rates.

3.2 Transmission In A Fixed-Rate System

A. The Capital Mobility Case

In this section we shall assume that capital does flow internationally.[5] Equations (3.10) to (3.12) can be totally differentiated, with the endogenous variables

being (P_1, P_2, r_1, r_2, B) and with the interest rates suppressed to obtain:

$$\begin{bmatrix} (\tilde{A}_1^{P_1} + B_t^T) & -B_t^T & 0 \\ -B_t^T & (\tilde{A}_2^{P_2} + B_t^T) & 0 \\ -(\tilde{B}_k^{P_1} + B_t^T) & (-\tilde{B}_k^{P_2} + B_t^T) & 1 \end{bmatrix} \begin{bmatrix} dP_1 \\ dP_2 \\ dB \end{bmatrix} =$$

$$\begin{bmatrix} 0 & 0 & -1 & 0 \\ -1 & -\tilde{A}_2^{M_{2s}} & 1 & 0 \\ 0 & \tilde{B}_k^{M_{2s}} & 1 & 1 \end{bmatrix} \begin{bmatrix} dA_2^0 \\ dM_{2s}^0 \\ dB_t^0 \\ dB_k^o \end{bmatrix} , \qquad (3.13) - (3.16)$$

with the determinant of coefficients of the left-hand side, Δ_B, equal to

$$\tilde{A}_1^{P_1} \tilde{A}_2^{P_2} + B_t^T(\tilde{A}_1^{P_1} + \tilde{A}_2^{P_2}) > 0 \quad .$$

The directions of the effects of an increase in each of the exogenous variables on the endogenous variables (P_1, P_2, B) are presented in Table 3.1, while their mathematical forms are given in Table 3.2. With expansionary foreign fiscal policy $(dA_2^o > 0)$, the demand for both products is increased and, therefore, so is the price of each good. The ambiguous effect of this disturbance on the balance of payments resembles the well-known result from small-open-economy models that the effect of fiscal policy on the trade account operates in the opposite direction

TABLE 3.1

FIXED-RATE SIGNS

	dP_1	dP_2	dB
dA_2^0	+	+	?
dM_{2s}^0	+	+	?
dB_t^0	+	-	+
dB_k^0	0	0	+

TABLE 3.2

FIXED-RATE MULTIPLIERS

	dP_1	dP_2	dB
dA_2^0	$\frac{-B_t^T}{\Delta_B}$	$\frac{-(\tilde{A}_1^{P_1}+B_t^T)}{\Delta_B}$	$\frac{B_t^T(\tilde{A}_1^{P_1}-\tilde{B}_k^{P_1}) - \tilde{B}_k^{P_2}(\tilde{A}_1^{P_1}+B_t^T)}{\Delta_B}$
dM_{2s}^0	$\frac{-\tilde{A}_2^{M_{2s}}B_t^T}{\Delta_B}$	$\frac{\tilde{A}_2^{M_{2s}}(\tilde{A}_1^{P_1}+B_t^T)}{\Delta_B}$	$\frac{\tilde{B}_k^{M_{2s}}\tilde{A}_1^{P_1}\tilde{A}_2^{P_2}+\tilde{A}_2^{M_{2s}}\tilde{A}_1^{P_1}(B_t^T-\tilde{B}_k^{P_2})}{\Delta_B}$
dB_t^0	$\frac{-\tilde{A}_2^{P_2}}{\Delta_B}$	$\frac{\tilde{A}_1^{P_1}}{\Delta_B}$	$\frac{\tilde{A}_2^{P_2}(\tilde{A}_1^{P_1}-\tilde{B}_k^{P_1}) + \tilde{A}_1^{P_1}\tilde{B}_k^{P_2}}{\Delta_B}$
dB_k^0	0	0	1

from its effect on the capital account. In this case, the ambiguity is caused by the uncertain effect on the capital account.[7] Both interest rates have increased due to the increased transactions demand for money and, consequently, the change in the net capital flow cannot be predicted on theoretical grounds alone. The balance of trade has improved since, although the real income level in each country is fixed, the terms of trade, T, has decreased.[8]

An increase in the foreign money supply ($dM_{2s}^{o}>0$) produces effects through prices similar to the above since the demand for each product is again increased. However, although the domestic interest rate is higher, it is uncertain whether the foreign interest rate is higher or lower. Both the demand for and the supply of foreign money have increased, with the former being caused by the increased price level abroad. Thus, the balance-of-payments effect is again ambiguous although the underlying reason differs from the above case. The reader can verify from Table 3.2 that the terms of trade is again lower and, as a result, the balance of trade again higher. Of course, in both of these instances, it is precisely the improvement in the balance of trade that effects the transmission.

When the exogenous disturbance is a change in taste in favor of country one's output ($dB_{T}^{o}>0$), the changes in

the price levels are quite expectedly opposite in sign. Since the interest rate rises (falls) at home (abroad), the capital inflow increases and thus the balance of payments is improved on both accounts. Finally, in the case of an exogenous increase in the net inflow of capital, the price levels (and interest rates) are unaffected due to the complete sterilization by the monetary authorities. Naturally, the balance of payments improves by the same amount as the increase in the net capital inflow.

B. Immobile Capital

When capital is immobile, that is, when $B_k^{r_i} = 0$, the price level changes induced by the various exogenous disturbances remain exactly the same as in the above section.[9] The unimportance of capital flows (or lack thereof) in the context of these multipliers is again a consequence of the assumption of complete sterilization of the balance of payments. Mundell (1964, 1968), Swoboda and Dornbusch (1973), Metzler (1968), and Holmes (1972, 1973) do not obtain this result since they assume that, for various reasons, the domestic money supply is affected by surpluses and deficits in the balance of payments. Although it would be straightforward to incorporate the assumption of nonsterilization into our model, we shall not do so since our main interest is in

the flexible-rate model, where sterilization (or the lack thereof) does not matter.[10]

The sole changes due to the immobility of capital are in the third column of Tables 3.1 and 3.2. These balance of payments multipliers are now:

$$\frac{dB}{dA_2^0} = \frac{\tilde{A}_1^{P_1} B_t^T}{\Delta_B} > 0 \qquad (3.17)$$

$$\frac{dB}{dM_{2s}^0} = \frac{\tilde{A}_2^{M_{2s}} B_t^T \tilde{A}_1^{P_1}}{\Delta_B} > 0 \qquad (3.18)$$

$$\frac{dB}{dB_t^0} = \frac{\tilde{A}_1^{P_1} \tilde{A}_2^{P_2}}{\Delta_B} > 0 \quad . \qquad (3.19)$$

Naturally, the signs of these multipliers are all positive since, in each of these cases, the balance of trade was observed to improve. When capital is immobile, the trade balance is equal to the balance of payments and, consequently, the above signs are easy to comprehend.

The results of this section on fixed-rates are all rather simple and, perhaps, uninteresting for those who are acquainted with the literature of international finance. Less obvious and more interesting are the effects of these same exogenous disturbances under floating exchange rates, to which we now turn our attention.

3.3 Transmission In A Flexible-Rate System

The model of equations (3.10) to (3.12) can be converted to the flexible exchange-rate case by setting B, the balance of payments, equal to zero and letting the exchange rate, R, be endogenous. The differential version of this model is now:

$$\begin{bmatrix} (\tilde{A}_1^{P_1} + B_t^T) & -B_t^T & -B_t^T \\ -B_t^T & (\tilde{A}_2^{P_2} + B_t^T) & B_t^T \\ -(\tilde{B}_k^{P_1} + B_t^T) & (-\tilde{B}_k^{P_2} + B_t^T) & B_t^T \end{bmatrix} \begin{bmatrix} dP_1 \\ dP_2 \\ dR \end{bmatrix} =$$

$$\begin{bmatrix} 0 & 0 & -1 & 0 \\ -1 & -\tilde{A}_2^{M_{2s}} & 1 & 0 \\ 0 & \tilde{B}_k^{M_{2s}} & 1 & 1 \end{bmatrix} \begin{bmatrix} dA_2^0 \\ dM_{2s}^0 \\ dB_t^0 \\ dB_k^0 \end{bmatrix}, \qquad (3.20) - (3.22)$$

where

$\Delta_R = B_t^T(-\tilde{A}_2^{P_2}\,\tilde{B}_k^{P_1} + \tilde{A}_1^{P_1}\,\tilde{B}_k^{P_2} + \tilde{A}_1^{P_1}\,\tilde{A}_2^{P_2})$ = the determinants of coefficients of the left-hand side, and $\Delta_R < 0$.

We can now proceed to analyze the exogenous disturbances under consideration in the alternative cases of mobile and immobile capital.[11]

A. The Capital Mobility Case

Consider first an increase in foreign government spending. The effects of this disturbance on both price levels, the exchange rate, and the terms of trade are:

$$\frac{dP_1}{dA_2^0} = \frac{-B_t^T \tilde{B}_k^{P_2}}{\Delta_R} > 0 \quad ; \tag{3.23}$$

$$\frac{dP_2}{dA_2^0} = \frac{-B_t^T(\tilde{A}_1^{P_1} - \tilde{B}_k^{P_1})}{\Delta_R} > 0 \quad ; \tag{3.24}$$

$$\frac{dR}{dA_2^0} = \frac{B_t^T(\tilde{A}_1^{P_1} - \tilde{B}_k^{P_1}) - \tilde{B}_k^{P_2}(\tilde{A}_1^{P_1} + B_t^T)}{\Delta_R} \gtreqless 0 \quad . \tag{3.25}$$

$$\frac{dT}{dA_2^0} = \frac{\tilde{A}_1^{P_1} \tilde{B}_k^{P_2}}{\Delta_R} < 0 \quad . \tag{3.26}$$

(3.26)

The first of these multipliers represents a transmission effect, while the signs of the first two multipliers tell us that this effect is positive.[12] In the flexible-exchange-rate version of the foreign-repercussions model (i.e., the (Y_1, Y_2, R) model of Chapter II), we observed that increased demand in country two could not be transmitted to the home economy. In that model the absence of a monetary sector implied that such a disturbance could not affect the capital account, leaving the exchange rate free to appreciate to

insure an unchanged trade account. However, in the present model, increased prices abroad raise the foreign demand for money and hence the foreign interest rate. The latter occurrence leads to a capital outflow from (or reduced inflow to) country one and a consequent depreciation (or smaller appreciation) in the exchange rate, raising the demand for the domestic product. The improvement in the trade account balance follows from the assumed constancy of real income in each country and the deterioration in the terms of trade (from equation (3.26)). In this manner, positive transmission is effected.

Since this is a foreign-repercussions model, the increase in the domestic price level does have feedback effects for the foreign economy. The higher price level at home acts to increase the domestic interest rate and reduce (increase) the capital outflow (inflow). The latter acts to reduce (increase) the depreciation (appreciation) and thereby increases the foreign price level. The higher domestic interest rate also reduces domestic absorption and, since real income is constant, the trade balance must increase. The effect of the latter change on the exchange rate again causes a further rise in the foreign price level.

Hence, we can conclude that the presence of interest-induced capital flows leads to a positive (static) transmission effect when the exogenous disturbance is a

change in government spending. Holmes (1972) reaches the same conclusion, while in Krueger's model (1965) there can only be transmission if the exogenous disturbance is monetary policy.[13] Finally, two additional points should be mentioned. First, it is noteworthy that, in our model, the larger is the induced capital flow (i.e., the larger is $B_k^{r_i}$ in absolute value), the smaller (larger) is the inflationary impact abroad (at home) of expansionary foreign fiscal policy.[14] In other words, transmission reduces the own-country impact of own-country fiscal policy.

Second, we see from equation (3.25) that $\frac{dR}{dA_2^0} > 0$ if

$$\tilde{B}_k^{P_2}(\tilde{A}_1^{P_1} + B_t^T) > B_t^T(\tilde{A}_1^{P_1} - \tilde{B}_k^{P_1}) \quad .$$

However, from Table 3.2 it is clear that if the above inequality holds, then expansionary foreign fiscal policy will worsen the balance of payments in a fixed exchange-rate system. In other words, if the balance of payments would deteriorate under fixed rates, then the exchange rate will depreciate under floating rates provided that economic behavior (i.e., the various partial derivatives) and the exogenous disturbance are the same in each system. More importantly, if, under floating rates, the above inequality holds and, therefore, the exchange rate depreciates, then the transmission effect under floating rates will exceed that of fixed rates. Holding P_1

constant, the decline in the terms of trade and hence the improvement in the trade balance will necessarily be greater in the former instance than in the latter. The larger initial improvement in the balance of trade implies greater excess demand for the domestic good and will, of course, produce a greater price rise than in the fixed-rate case. As Fleming (1974, pp. 91-93) notes, economists are willing to believe that an increase in fiscal policy will improve that country's balance of payments. However, the above argument implies that this willingness should be translated into an admission that transmission can be greater with floating than with fixed rates.[15]

Several other multipliers are of interest in this model. An exogenous change of taste in favor of country one's export good ($dB_t^0 > 0$) does not affect domestic prices since the exchange rate, itself an argument of that function, appreciates to restore balance-of-payments equilibrium. Alternatively, an exogenous shift in favor of domestic securities ($dB_k^0 > 0$) appreciates the exchange rate, reduces the balance of trade, and thus gives rise to a negative transmission effect.[16]

Finally, and perhaps most interestingly, the multipliers for an increase in the foreign supply of money are:

$$\frac{dP_1}{dM_{2s}}\bigg|_{0} = \frac{B_t^T(-\tilde{A}_2^{M_{2s}}\,\tilde{B}_k^{P_2} + \tilde{B}_k^{M_{2s}}\,\tilde{A}_2^{P_2})}{\Delta_R} = 0 \quad ;^{17} \tag{3.27}$$

$$\frac{dP_2}{dM_{2s}}\bigg|_{0} = \frac{-B_t^T(\tilde{A}_2^{M_{2s}}\,\tilde{A}_1^{P_1} - \tilde{A}_2^{M_{2s}}\,\tilde{B}_k^{P_1} + \tilde{B}_k^{M_{2s}}\,\tilde{A}_1^{P_1})}{\Delta_R} > 0; \tag{3.28}$$

$$\frac{dR}{dM_{2s}} = \frac{\tilde{A}_2^{M_{2s}}(\tilde{B}_k^{P_1}\,B_t^T - \tilde{A}_1^{P_1}\,B_t^T) - \tilde{B}_k^{M_{2s}}\,\tilde{A}_1^{P_1}\,B_t^T}{\Delta_R} < 0; \tag{3.29}$$

$$\frac{dT}{dM_{2s}} = 0 \quad . \tag{3.30}$$

The explanation for this result is a bit involved and can best be comprehended by a step-by-step approach. Initially the expansionary monetary policy will lower the foreign interest rate, increase the foreign price level, and thus lead to improved capital- and trade-account balances.[18] Then the exchange rate will appreciate to eliminate the deficit in the balance of payments, increasing, in the process, both P_2 and r_2. Equilibrium will be arrived at when the balance of payments is zero, and this can only occur at the original value of r_2. Were the adjustment process to reach an equilibrium with a higher price level and a lower interest rate abroad (both compared to the original equilibrium), country two's capital account balance would be smaller and its trade account larger than initially. However, equation (3.2) tells us that, with Y_2 fixed and $A_2^{r_2} < 0$,

it would be impossible for country two to have both an improved trade account and a lower interest rate. Therefore, the adjustment process has to continue until r_2, B_k, and B_t are all at their original level, P_2 is higher and R is lower. Prices in country two and the exchange rate change in equal magnitude but opposite directions, leaving T, the terms of trade, intact (see equation (3.30)) and insulating all domestic economic variables in the process.

It should be emphasized (and will become clearer in Chapter IV) that the lack of transmission in this case depends crucially on the assumption of full employment abroad. From the argument in the preceeding paragraph, it is clear that it is due to this assumption that the foreign interest rate must return to its original level in order to preserve equilibrium.[19] Krueger (1965) finds that expansionary monetary policy will lead to negative transmission, but only because this type of policy in her model is represented by an exogenous decrease in the interest rate. Holmes (1972), who uses orthodox neutral monetary policy, reaches the result given in equation (3.27). Table 3.3 provides a convenient summary of the effects of the exogenous disturbances that were considered in this section.

TABLE 3.3

FLEXIBLE-RATE SIGNS

	dP_1	dP_2	dR
dA_2^0	+	+	?
dM_{2s}^0	0	+	-
B_t^0	0	0	-
dB_k^0	-	+	-

B. Immobile Capital

When international capital movements are prohibited, all of the transmission multipliers are zero.[20] The balance of payments is, in this case, equal to the balance of trade, and both of these balances will be constrained to be equal to zero by the endogenous movement of the exchange rate. Since transmission can only be effected by a change in the balance of trade, the above statement follows directly. The conclusion that no transmission is possible when exchange rates are flexible and capital is immobile is a conclusion that has been stated, in one form or another, by Mundell (1964, 1968), Krueger (1965), and Holmes (1972). In the next chapter, we shall see that this conclusion depends crucially on the absence of terms of trade effects on absorption and on the absence of imported inputs. While the former

qualification has been noted by the above authors, the latter has apparently been ignored.

3.4 Conclusions and Qualificaitons

The main conclusion of this chapter can be seen in Tables 3.1 and 3.3. Under a fixed exchange-rate system and regardless of the capital mobility assumption, exogenous disturbances in foreign fiscal or monetary policy or in the balance of trade were found to cause a transmission effect. An exogenous change in the capital flow function has no effect on the real variables of the model. With a flexible exchange rate and interest-rate-induced capital flows, expansionary foreign fiscal policy was observed to induce positive transmission, as in the fixed-rate model. Moreover, the possibility that, in this case, the transmission effect would be greater under flexible than under fixed exchange rates was discussed. Finally, a lack of transmission under flexible rates occurs when: (1) the exogenous disturbance is in the monetary sector or in the trade account and capital is mobile; or (2) there is any exogenous disturbance and capital is immobile.

However, the model and, consequently, its conclusions suffer from two rather notable defects. First, it was observed in the last chapter that either the price level or

the level of real income in each economy has to be exogenous in our five-equation model. In other words, the model restricts us to considering only horizontal or vertical aggregate supply curves, respectively. Endogenous price changes, which can only arise in the latter case, have to be demand-induced when supply is fixed.[21] This Keynesian orientation accounts for the omission of supply-induced transmission. Specifically, there are few models in international finance that consider a world in which each country imports some of its inputs from abroad. In the next chapter we shall demonstrate that the inclusion of imported inputs does affect the transmission process and the conclusions just noted.

Second, no account has been taken of capital movements based on speculative motives. Following the literature, we have been assuming that the capital account formulation which was first applied to situations in which the level and expected rate of change of the exchange rate did not change is also appropriate in a flexible exchange rate system. In the fifth chapter, we shall observe that changes in these variables will affect the net capital inflow and hence the transmission process.

Footnotes

[1]Holmes develops his capital flow function by arguing that the net capital inflow is given by the excess of investment over savings and that savings (following Laursen and Metzler) depends on the terms of trade. The argument that $B_k = I-S$, where I = investment and S = savings, holds only when the government budget is balanced and, as Holmes (1973, p. 1417) notes, when there are no official (or accommodating) capital flows. Thus, the balance of payments, as we have defined it, must always be zero and it is not surprising that our pegged-rate conclusions differ. Although Holmes is correct in pointing out that his model is characterized by full equilibrium, it is not obvious that this is desirable in a short-run model. Moreover, we prefer the behavioral capital account specification in the text since, as will be demonstrated in Chapter V, it can be developed from a portfolio model under fixed exchange rates. Under flexible exchange rates, the conclusions of this chapter have to be modified to account for capital flows due to variations in the level and expected rate of change of the exchange rate. See Chapter V for more on this point.

[2]The definition of full employment output is, of course, arbitrary. We can assume that it represents a level of output consistent with the four percent unemployment rate that was the goal of the Kennedy-Johnson era. The important feature of $\bar{Y}_i$ is that it is fixed.

[3]Normally, $A_i^{Y_i}$ is the marginal propensity to spend and s_i is the corresponding propensity to save, with both assumed to be positive and less than one. Since $A_i^{r_i} A_i^{Y_i} \ell_i^{Y_i}$ is negative, $\tilde{A}_i^{Y_i}$ is also less than one. $\tilde{A}_i^{Y_i}$ is clearly not the usual marginal propensity to spend. However, it may be thought of as a propensity that takes monetary sector equilibrium into account. Ditto for $\tilde{s}_i$.

[4]The signs of these partial derivatives are easy to remember. For example, $\tilde{B}_k^{M_{2s}} = \partial B_k/\partial M_{2s}$. An increase in the foreign money supply lowers the interest rate (r_2) and thus will increase the net capital inflow (B_k). Similar reasoning can be used to understand the derivatives of the functions capped by a squiggle.

[5]In other words, the signs of the partial derivatives of the capital account (i.e., those following equation (3.9)) are as given. In Section 3.2B, where capital is assumed to be immobile, these derivatives will be set equal to zero.

[6]As in Chapter II, the exogenous variables that are not of interest have been omitted.

[7]This statement can be verified by examining Table 3.2.

[8]$dT = dP_1 - dP_2 - dR$. Setting $dR = 0$, the change in the terms of trade, from Table 3.2, is:

$$dT = \frac{\tilde{A}_1^{P_1}}{\Delta_B} dA_2^0 < 0 \quad .$$

Since B_t^T is assumed to be negative, B_t is increased.

[9]See the first two columns of Table 3.2 to verify this statement.

[10]In order to incorporate nonsterilization, we merely have to set $M_{1s} = D_1 + F_1$ and $\dot{F}_1 = B = 0$, where D_1 = component of the money supply of country one backed by domestic credit; F_1 = the home-country's foreign exchange reserves. Altering the foreign money supply equation in a similar fashion and fixing the total stock of foreign exchange reserves in the world is all that is necessary to complete the model. See Swoboda and Dornbusch (1973) and Johnson (1973) for more on this model.

[11]The reader should recall that the two interest rates are still endogenous. This accounts for our ability to analyze a (P_1, P_2, R) model (see Chapter II, p. 22 and footnote 24).

[12]By positive (static) transmission we mean a situation in which both price levels move in the same direction due to a disturbance in one of the economies. Negative (static) transmission applies to situations in which the price levels move in opposite directions.

[13]We shall demonstrate that expansionary foreign monetary policy will not affect the domestic price level.

The differences between our conclusions and Krueger's is due to our different assumptions about monetary policy (see the first section of this chapter for a discussion of her model).

[14]This point can be appreciated by examining equations (3.23) and (3.24) and by recalling the definitions of $\tilde{B}_k^{P_2}$ and $\tilde{B}_k^{P_1}$.

[15]Fleming states that the balance of payments will decline (or the exchange rate will devalue) if capital is highly mobile. As noted in Section 3.2A, an increase in foreign fiscal policy will not have a definite effect on the capital account since both the foreign and the domestic interest rates will rise. Fleming's reasoning only applies to the small-economy case. From the inequality noted in the text, we see that increasing $B_k^{r_i}$ (in absolute value) will increase both sides of the inequality (since $\tilde{B}_k^{P_i} = B_k^{r_i}\, \ell_i^{P_i}$). The inequality will hold if $\tilde{B}_k^{P_2}$ is relatively large--that is, if the increase in the foreign price level raises the interest rate abroad significantly and thus causes a capital flow to that country. If $\tilde{B}_k^{P_2} = \tilde{B}_k^{P_1}$, then the inequality reduces to:

$$\tilde{B}_k^{P_2}\, \tilde{A}_1^{P_1} > B_t^T\, \tilde{A}_1^{P_1}$$

or

$$\tilde{B}_k^{P_2} > B_t^T \quad .$$

In this case, relatively high capital mobility will "do the trick." However, it is not clear that foreign and domestic price increases should have identical effects (absolutely) on the capital account, especially since the price increases are not likely to be equal.

[16]See Table 3.3 at the end of Section 3.3A.

[17]This is arrived at by substitution, using the ℓ-functions.

[18]Again, we continue to speak from the viewpoint of country one.

[19]The same is true in a closed-economy, full-employment, IS-LM model.

[20]This can be verified mathematically by setting all of the partial derivatives of the capital account equal to zero. Thus, a mere glance at equations (3.23) and (3.27) confirms the lack of transmission noted in the text.

[21]Recall that transmission arises in this model only when the equilibrium level of the balance of trade changes. We could have considered exogenous changes in supply ($d\bar{Y}_i$). However, this disturbance is not very interesting and misses the forthcoming point in the text.

CHAPTER IV

THE TRANSMISSION OF INFLATIONARY INPULSES IN A PHILLIPS' CURVE ENVIRONMENT

As noted in Chapter II, the standard, textbook models of international finance are ill-equipped to analyze the transmission of inflation. Inflationary disturbances were analyzed in Chapter III, but only at the expense of an "un-Keynesian," full-employment assumption. In this chapter, the basic five-equation model will be amended in order to allow for both price and output flexibility in a two-country setting. The exogenous disturbances analyzed in the last chapter will also be examined in this one and the differences between the findings of the two models will be discussed. While only the flexible exchange-rate case will be examined in the text, comparisons with the fixed exchange-rate case will be made. The mathematics of the latter case will be relegated to an appendix.

Section one contains an explanation of the Phillips' curve model and a discussion of its limitations. In section two the model is used to investigate the transmission of inflation when international capital movements are allowed. The exogenous disturbances considered in

that section are examined in section three under the assumption that capital movements are prohibited. The conclusions of this chapter, summarized in section four, are that transmission should be expected under flexible exchange rates and that the extent and direction of the transmission effect primarily depend upon the source of the initial disturbance and the mobility of capital. As in the last chapter, we find that it is possible for transmission to be greater with flexible than with fixed rates. However, in contrast to the conclusions of Chapter III and, indeed, contrary to the conclusions found in the literature, there is transmission when capital is immobile and the Laursen-Metzler effect is ignored. The uniqueness of this latter finding will be seen to arise from the development of a supply side of the basic model. Finally, the reader should be alerted to our continued dismissal of speculative behavior. An examination of this behavior in a flexible exchange-rate environment will be postponed until Chapter V.

4.1 A Two-Country Model of the Balance of Payments

In a recent article, Turnovsky and Kaspura (1974) circumvented the first weakness of the five-equation model by allowing for a trade-off between inflation and unemployment.[1] However, the applicability of their

model is limited by their use of the small-open-economy assumption.[2] The model presented in this chapter is developed by extending Turnovsky and Kaspura's model to a two-country framework. As we shall see momentarily, our model (like their's) is a one-period model and, consequently, we can investigate only the impact effects of any disturbance. Since each disturbance examined below will presumably have effects beyond a single period, our model is limited. However, in a similar context, Niehans (1975, p. 280) points out that we may live forever in a very short-run world where disturbances are reversed before their full effect is realized. Moreover, by accepting this limitation, we are able to analyze a more sophisticated model of the international transmission of inflation. Thus, we believe that the benefits of our model outweigh its costs.

The basic five equations of Chapter II serve as the foundation of the Phillips' curve model and thus they are retained here subject to some minor changes. The extension of that model involves the addition of four equations. Two of these equations define the rates of change of the domestic and foreign price indices. In order to obtain these equations, let P and Q be the price indices in countries one and two at the beginning of the current time period. Since these indices can be defined as geometrically weighted averages of the prices

of foreign and domestic goods, we have:

$$P = (RQ_1)^a \, P_1^{(1-a)} \tag{4.1a}$$

$$Q = (\frac{P_1}{R})^b \, Q_1^{(1-b)} \tag{4.1b}$$

where

P_1 = the price level of country one's output at the beginning of the time period, in units of country one's currency per unit of the domestic good;

Q_1 = the price level of country two's output at the beginning of the time period, in units of country two's currency per unit of the foreign good;

R = the exchange rate at the beginning of the period, as defined previously; and

a,b = the proportion of total expenditure each country spends on the other country's output.[3]

Following Turnovsky and Kaspura, we can assume that P and Q are relatively insensitive to changes in real income and the real interest rate or, in other words, that a and b are constants. Although this assumption is limiting, it will subsequently become clear that it does not affect our analysis.[4] These price indices can be written in terms of the rates of change of the various price levels by noting the relationship between each current price level and its value during the preceeding period. Specifically, we have:

$$P_1 = P_{1,-1}\ (1+p_1) \qquad (4.2a)$$

$$Q_1 = Q_{1,-1}\ (1+q_1) \qquad (4.2b)$$

$$P = P_{-1}\ (1+p) \qquad (4.2c)$$

$$Q = Q_{-1}\ (1+q) \qquad (4.2d)$$

where the negative one in a subscript refers to the previous time period and where lower case letters represent the time rates of change of their upper case relatives.

Equations (4.1) and (4.2) enable us to write the rates of inflation of the overall price indices as functions of the commodity inflation rates. This task is easily accomplished by listing the prior period's analogues to equations (4.1a) and (4.1b) and then by dividing equations (4.1a) and (4.1b) by the former to obtain:

$$\frac{P}{P_{-1}} = \frac{(R\ Q_1)^a}{(R_{-1}\ Q_{1,-1})^a}\ \frac{P_1^{(1-a)}}{P_{1,-1}^{(1-a)}} \qquad (4.3a)$$

$$\frac{Q}{Q_{-1}} = \frac{(P_1/R)^b}{(P_{1,-1}/R_{-1})^b}\ \frac{Q_1^{(1-b)}}{Q_{1,-1}^{(1-b)}} \quad . \qquad (4.3b)$$

Utilizing the definitions of inflation rates in equations (4.2a)-(4.2d) implies that

$$(1+p) = \frac{1}{R_{-1}^a}\ (R(1+q_1))^a (1+p_1)^{1-a}_1 \quad , \qquad (4.4)$$

$$(1+q) = R_{-1}^b\ \left(\frac{1+p_1}{R}\right)^b\ (1+q_1)^{1-b} \quad , \qquad (4.5)$$

where p and q denote the proportionate rates of change of P and Q, respectively. Since, from the vantage point of the beginning of the period in question, the value of the exchange rate during the last period is fixed, it follows by differentiation of equations (4.4) and (4.5) that any percentage change in the inflation rate of either price index is a constant-weighted average of the percentage changes in the commodity inflation rates.

At this point, two comments are in order concerning the interpretation of the above equations. First, the reader should note that proportionate changes, such as $(1+p_1)$, will henceforth be referred to as inflation rates. Focusing on proportionate changes does simplify some of the mathematics of this chapter. Moreover, since we shall be concerned with changes in the inflation rate and since $(1+p_1)$ cannot change unless p_1 changes, no generality is lost. Second, the reader may well be puzzled at the form of equations (4.4) and (4.5). Surely it would be more consistent to write equation (4.4) as:

$$1+p = (1+\dot{R})^{a} \ (1+q_1)^{a} \ (1+p_1)^{1-a} \quad ,$$

where $(1+\dot{R}) = R/R_{-1}$. This latter form of (4.4) is analytically preferable since $(1+\dot{R})(1+q_1)$ represents the proportionate change in RQ_1, or the import price level. However, since we are interested in the level of the exchange rate as an endogenous variable, we shall retain

equations (4.4) and (4.5) as written. The expression $R(1+q_1)$, which will be employed in the text below, will be referred to as the rate of inflation of import prices, or the import inflation rate.

The other two equations that are needed to complete the model represent the trade-off between inflation and unemployment in each country. Again, following Turnovsky and Kaspura, the rate of inflation of commodity i's price depends upon the difference between actual and full employment output in country i, the inflation rate of import prices, and the expected rate of inflation in country i, or:

$$1+p_1 = f_1(Y_1-\bar{Y}_1,\ R(1+q_1),\ \pi_1) \qquad (4.6)$$

$$1+q_1 = f_2(Y_2-\bar{Y}_2,\ (1+p_1)/R,\ \pi_2) \qquad (4.7)$$

where

π_i = the expected rate of change of the price level (P,Q) in country i;

f_{ij} = the partial derivative of f_i with respect to the j^{th} argument, i = 1,2 and j = 1,2,3;

$f_{ij} > 0$;

$\eta_1 = \dfrac{R(1+q_1)f_{12}}{1+p_1}$ = the elasticity of $(1+p_1)$ with respect to $(R(1+q_1))$;

$\eta_2 = \dfrac{(1+p_1)f_{22}}{R(1+q_1)}$ = the elasticity of $(1+q_1)$ with respect to $(1+p_1)/R$,

and all other variables have been defined previously. The reason for the inclusion of the first term in each of the above equations is clear. The second argument in each equation, the inflation rate of each economy's import prices, is included to allow for the importing of inputs in the production of each good.[5] Since the production of each good requires other inputs, notably labor, we shall assume that

$$0 < \eta_i < 1$$

for i = 1,2.[6] Finally, the third argument, the expected rate of inflation in each country, is exogenous and enters indirectly into the above equations. Specifically, we assume that this argument is present due to its effect on the rate of change of wages.[7]

Having allowed for the presence of an inflation-unemployment trade-off, we can now collect our equations and obtain a Phillips' curve, two-country model of the balance of payments, or

$$Y_1 = A_1(Y_1, r_1-\pi_1, T) + B_t(Y_1, Y_2, T) \qquad (4.8)$$

$$M_{1s} = L_1(Y_1, r_1, P_{-1}(1+p), \pi_1) \qquad (4.8a)$$

$$Y_2 = A_2(Y_2, r_2-\pi_2, T) - T\,B_t(Y_1, Y_2, T) \qquad (4.9)$$

$$M_{2s} = L_2(Y_2, r_2, Q_{-1}(1+q), \pi_2) \qquad (4.9a)$$

$$B = B_t(Y_1, Y_2, T) + B_k(r_1, r_2) \qquad (4.10)$$

$$1+p_1 = f_1(Y_1-\bar{Y}_1,\ R(1+q_1),\ \pi_1) \tag{4.11}$$

$$1+q_1 = f_2(Y_2-\bar{Y}_2,\ (1+p_1)/R,\ \pi_2) \tag{4.12}$$

$$1+p = \frac{1}{R_{-1}^{a}}\,(R(1+p_1))^{a}\,(1+p_1)^{(1-a)} \tag{4.13}$$

$$1+q = R_{-1}^{b}\,(\frac{1+p_1}{R})^{b}\,(1+q_1)^{(1-b)} \quad . \tag{4.14}$$

As the reader will observe, the equations (4.8)–(4.10) of the basic model are substantially unchanged, save for a few minor modifications. First, the presence of ongoing inflation necessitates the use of the real rather than the nominal interest rate in each absorption function.[8] Second, we have included the terms of trade in each absorption function, as promised in Chapter II, in order to understand the possible role of the Laursen-Metzler effect in the transmission process. Third, ongoing inflation also entails the inclusion of the expected rate of inflation in each money demand function.[9] Finally, we have (for the moment) included the overall price index in each country, rather than the price of each country's output, in the money demand functions.

Before proceeding to employ this model in the investigation of the transmission of inflationary impulses, several comments are in order. The most important feature of this model is that it is limited to a single time period as is the case with Turnovsky and Kaspura's model. In their model this limitation envinced itself in

the normalization of all price variables and the exchange rate of the previous period at unity. In other words, they set $P_{-1} = Q_{-1} = P_{1,-1} = Q_{1,-1} = R_{-1} = 1$. This normalization enables them to write equations (4.2a), for example, as $P_1 = 1+p_1$, and then to substitute the latter inflation rate for the former price level. At the end of a single period this substitution loses its validity. In the differentiated version of the model we shall use a similar normalization for the price levels and the exchange rate at the beginning of the current period. Therefore we shall be assuming that, regardless of the values of these variables during the previous period, the model is in static equilibrium at the outset. Given the divergent inflation rates throughout the period, as well as any of the exogenous disturbances to be considered, the price levels and the exchange rate will necessarily have different values by the end of this period. Therefore, we cannot use the model to make any conclusions for future periods since the price levels and the exchange rate of the current period will be different from their normalized value at the outset.

Furthermore, both our model and that of Turnovsky and Kaspura are not valid beyond a single period due to the assumed absence of speculative behavior. We assume an equilibrium exchange rate at the outset of the current period and yet divergent inflation rates. During a

single period it is reasonable to assume that speculators will not be able to adjust to this situation. For longer periods of time this assumption is entirely unreasonable, necessitating the specification of speculative behavior. This subject will be addressed in the next chapter. Its absence in this chapter reinforces the single period limitation.[10]

Another noteworthy feature of the model is the allowance for a trade-off between inflation and unemployment in each economy. This addition to the basic five-equation model is equivalent to the introduction of an aggregate supply curve for each economy. To appreciate this point, consider the formulation of an aggregate supply curve for the domestic economy. Extending the Blinder-Solow approach (1974, p. 30) to the open-economy case, we could express the supply price as a function of real output (or income), the level of import prices, and the expected price level.[11] In other words, we could write

$$P_1 = F_1(Y_1, RQ_1, E(P))$$

where

E(P) = the expected price level.

Writing a similar aggregate supply curve for country two and replacing equations (4.13) and (4.14) with equations (4.1a) and (4.1b) would then yield a model with price and output flexibility. Such a model is virtually

identical to the model of equations (4.8) to (4.14) and, therefore, the reader may mentally substitute "price level" for "inflation rate" wherever the latter appears below. One advantage of our model, as it appears in equations (4.8) to (4.14), is that it is perhaps a better heuristic device for describing transmission in a world characterized by ongoing inflation. A second potential advantage is that it is a very small step towards a more dynamic model of the balance of payments. However, its main advantage is that it is a two-country extension of the Turnovsky-Kaspura model. By remaining as close as possible to the assumptions of their model, we shall be able to reinforce the critique of small-open-economy models that was provided in Chapter II.

4.2 The Transmission of Inflationary Impulses When Capital is Mobile

A. The Solution of the Model

As the model appears in equations (4.8) to (4.14), it is assumed that capital is internationally mobile and responds to nominal interest rates. A common, albeit outdated, theory is that capital flows in response to nominal interest rate differentials, an interpretation that is subsumed in the more general specification in equation (4.10). Although this theory has been severely questioned, it will be retained here due to its extreme

simplicity and its approximate short-run validity. However, in Chapter V we shall argue that both the level and the expected rate of change of the exchange rate belong in a properly specified capital account function. This amendment is not made in this chapter since we wish to underline the role of imported inputs in the transmission process.

In order to solve this model and to simplify the explanation of the various multipliers, we shall assume that each economy spends a very small portion of its income on imports.[12] In this case, country i's prices will have little weight in the price index of country j, rendering it possible to ignore equations (4.13) and (4.14) and to have the price level of country i's output in the i^{th} money demand function.[13] We can then replace equations (4.8a) and (4.8b) with:

$$M_{1s} = L_1(Y_1, r_1, P_{1,-1}(1+p_1), \pi_1) \qquad (4.8b)$$

$$M_{2s} = L_2(Y_2, r_2, Q_{1,-1}(1+q_1), \pi_2) \quad .[14] \qquad (4.9b)$$

With the assistance of the above assumption, our model can be solved in a manner analogous to that of the last chapter by assuming money market equilibrium. The result is the following five-equation model:[15]

$$Y_1 = \tilde{A}_1(\overset{+}{Y_1}, \overset{-}{P_{1,-1}(1+p_1)}, \overset{+}{M_{1s}}, \overset{-}{\pi_1}, \overset{-}{T}) + B_t(\overset{-}{Y_1}, \overset{+}{Y_2}, \overset{-}{T}) \qquad (4.15)$$

$$Y_2 = \tilde{A}_2(Y_2, \overset{+}{Q}_{1,-1}(1+q_1), \overset{-}{M}_{2s}, \overset{+}{\pi}_2, \overset{-}{T}) - TB_t(Y_1, Y_2, T) \tag{4.16}$$

$$B = B_t(Y_1, Y_2, T) + \tilde{B}_k(\overset{+}{Y}_1, \overset{-}{P}_{1,-1}(1+p_1), \overset{-}{M}_{1s}, \overset{-}{\pi}_1, \overset{-}{Y}_2, \overset{-}{Q}_1(1+q_1), \overset{+}{M}_{2s}, \overset{+}{\pi}_2) \tag{4.17}$$

$$1+p_1 = f_1(\overset{+}{Y}_1 - \overline{Y}_1, \overset{+}{R}(1+q_1), \overset{+}{\pi}_1) \tag{4.18}$$

$$1+q_1 = f_2(\overset{+}{Y}_2 - \overline{Y}_2, (1+p_1)/R, \overset{+}{\pi}_2) \quad , \tag{4.19}$$

where the signs above the variables denote the direction of functional dependence.

This five-equation model can be solved once the endogenous variables are chosen. In order to examine the transmission of inflation in a flexible exchange-rate world, it is convenient to let (Y_1, Y_2, R, p_1, q_1) be endogenous, in addition to the (suppressed) nominal interest rates, r_1 and r_2. Differentiating equations (4.15) to (4.19) and collecting the endogenous variables on the left-hand side yields:

$$\begin{bmatrix} -(\tilde{s}_1+m_1) & m_2 & -(A_1^T+B_t^T) & \tilde{A}_1^{P_1}+\frac{A_1^T+B_t^T}{1+p_1} & \frac{-(A_1^T+B_t^T)}{1+q_1} \\ m_1 & -(s_2+m_2) & -A_2^T+B_t^T & \frac{A_2^T-B_t^T}{1+p_1} & \tilde{A}_2^{q_1}+\frac{B_t^T-A_2^T}{1+q_1} \\ m_1-\tilde{B}_k^{Y_1} & -(m_2+\tilde{B}_k^{Y_2}) & B_t^T & -(\frac{B_t^T}{1+p_1}+\tilde{B}_k^{P_1}) & \frac{B_t^T}{1+q_1}-\tilde{B}_k^{q_1} \\ f_{11} & 0 & (1+q_1)f_{12} & -1 & f_{12} \\ 0 & f_{21} & -(1+p_1)f_{22} & f_{22} & -1 \end{bmatrix} \begin{bmatrix} dY_1 \\ dY_2 \\ dR \\ dp_1 \\ dq_1 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 & -1 \\ -1 & -\tilde{A}_2^{M_{2s}} & 0 & 1 \\ 0 & \tilde{B}_k^{M_{2s}} & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} dA_2^o \\ dM_{2s}^o \\ dB_k^o \\ dB_t^o \end{bmatrix} \qquad (4.15a)-(4.19a)$$

Note that $P_1 = Q_1 = R = T = 1$ and that $\frac{dT}{T} = dT = \frac{dp_1}{1+p_1} - \frac{dq_1}{1+q_1} - dR$.

The determinant of coefficients of the left-hand side, Δ, is ambiguous on comparative static grounds alone. However, application of the correspondence principle does imply a sign for Δ.[16] Assuming that output in each country increases (decreases) when demand is

greater (less) than supply and that the exchange rate depreciates (appreciates) when there is a balance of payments deficit (surplus) allows us to write the following dynamic system:[17]

$$\dot{Y}_1 = \tilde{A}_1(\ ) + B_t(\ ) - Y_1 \qquad (4.15b)$$

$$\dot{Y}_2 = \tilde{A}_2(\ ) - TB_t(\ ) - Y_2 \qquad (4.16b)$$

$$\dot{R} = -B_t(\ ) - \tilde{B}_k(\ ) \qquad (4.17b)$$

$$0 = f_1(\ ) - (1+p_1) \qquad (4.18b)$$

$$0 = f_2(\ ) - (1+q_1) \quad . \qquad (4.19b)$$

Since the total derivative of the right-hand side of these equations is the same as the left-hand side of equations (4.15a)–(4.19a), we can utilize the former to determine the sign of the latter's determinant. For this purpose, let x be the 3X1 column vector ($\dot{Y}_1$, $\dot{Y}_2$, $\dot{R}$) and y be the 2X1 column vector (p_1, q_1). Then we can write the differential version of equations (4.15b)–(4.19b) as:

$$\dot{x} = Cx + Dy \qquad (4.20)$$

$$0 = Ex + Fy \quad , \qquad (4.21)$$

where $\begin{bmatrix} C & D \\ E & F \end{bmatrix}$ is the partitioned left-hand side of equations (4.15a)–(4.19a) and the dimensions of the submatrices are: C - 3X3, D - 3X2, E - 2X3, and F - 2X2. Solving (4.21) for y yields $y = -F^{-1}Ex$. Substituting

greater (less) than supply and that the exchange rate depreciates (appreciates) when there is a balance of payments deficit (surplus) allows us to write the following dynamic system:[17]

$$\dot{Y}_1 = \tilde{A}_1(\ ) + B_t(\ ) - Y_1 \qquad (4.15b)$$

$$\dot{Y}_2 = \tilde{A}_2(\ ) - TB_t(\ ) - Y_2 \qquad (4.16b)$$

$$\dot{R} = -B_t(\ ) - \tilde{B}_k(\ ) \qquad (4.17b)$$

$$0 = f_1(\ ) - (1+p_1) \qquad (4.18b)$$

$$0 = f_2(\ ) - (1+q_1) \quad . \qquad (4.19b)$$

Since the total derivative of the right-hand side of these equations is the same as the left-hand side of equations (4.15a)–(4.19a), we can utilize the former to determine the sign of the latter's determinant. For this purpose, let x be the 3X1 column vector ($\dot{Y}_1$, $\dot{Y}_2$, $\dot{R}$) and y be the 2X1 column vector (p_1, q_1). Then we can write the differential version of equations (4.15b)–(4.19b) as:

$$\dot{x} = Cx + Dy \qquad (4.20)$$

$$0 = Ex + Fy \quad , \qquad (4.21)$$

where $\begin{bmatrix} C & D \\ E & F \end{bmatrix}$ is the partitioned left-hand side of equations (4.15a)–(4.19a) and the dimensions of the submatrices are: C - 3X3, D - 3X2, E - 2X3, and F - 2X2. Solving (4.21) for y yields $y = -F^{-1}Ex$. Substituting

this solution into equation (4.20) implies that:

$$\dot{x} = (C - DF^{-1}E)x \quad . \tag{4.22}$$

Since the matrix $(C - DF^{-1}E)$ is 3X3, it is necessary condition for the stability of the dynamic system that the determinant of this matrix is negative.

We are now in a position to determine the sign of Δ, since $\Delta = \begin{vmatrix} C & D \\ E & F \end{vmatrix} = |C-DF^{-1}E||F|$.[18] Given that $|C-DF^{-1}E|$ is negative, it follows that Δ is opposite in sign to $|F| = 1 - f_{12}f_{22}$. However, $f_{12}f_{22}$ equals $\eta_1\eta_2$, the product of the elasticities of each good's inflation rate with respect to the inflation rate of the imported good.[19] Since each of the elasticities is less than one, it follows that $|F|$ is positive and, consequently, Δ is negative. Having established this sign, it is now possible to determine the signs of the various multipliers that are of interest in the context of the transmission question. It is to this task that we now turn our attention.

B. Fiscal Policy Transmission

During the last few years it has often been said that one of the main causes of the rapid inflation that continues to plague the major industrial countries was the simultaneous expansion of government spending in

these economies.[20] The implication of this theory is that the inflationary effects of fiscal policy are transmitted abroad, producing higher inflation rates in the home economy and in the rest of the world. However, those who adhere to the standard models that were outlined in Chapter II could hardly accept such reasoning in a flexible exchange-rate world since, according to their models, transmission is impossible in such circumstances. Yet in our model, there is indeed cause to be concerned about increased government spending abroad, for the impact of this policy on the inflation rate of domestically-produced goods is:

$$\frac{dp_1}{dA_2^o} = \frac{-1}{\Lambda}\,(f_{12}(1+q_1)(-1+\eta_2)(\tilde{s}_1 m_2 + m_2\tilde{B}_k^{Y_1} + \tilde{B}_k^{Y_2}(s_1+m_1)) + f_{11}(1-\eta_2)(m_2 A_1^T + \tilde{B}_k^{Y_2}(A_1^T+B_t^T)) - (1+p_1)f_{11}f_{22}\, m_2\, \tilde{B}_k^{q_1} + f_{21}(-(1+q_1)f_{12}(\tilde{s}_1+m_1)\tilde{B}_k^{q_1} + f_{11}\tilde{B}_k^{q_1}(A_1^T+B_t^T))] \quad . \tag{4.23}$$

The above multiplier is observed to be positive save for three terms. This result is readily interpretable since the economic forces at work are similar to those of the previous chapter. Increased public

expenditure abroad moves that economy along its Phillips' curve, raising both income (Y_2) and the rate of inflation (q_1). Both of these changes cause an appreciation of the exchange rate and an increase in the foreign interest rate (r_2).[21] However, the latter occurrence tends to depreciate the exchange rate and thus transmit an inflationary impulse to the domestic economy. Indeed, the multiplier expression (4.23) tells us that, given a certain amount of capital mobility ($B_k^{r_i}$), the greater is the increase in the foreign interest rate resulting from higher inflation ($\ell_2^{q_1}$) and income ($\ell_2^{Y_2}$) abroad, the greater will be the transmission effect.[22] This effect will be smaller as the rise in the domestic interest rate in response to increased income ($\ell_1^{Y_1}$) is larger, since the increase in the domestic interest rate will reduce the outflow of capital. Moreover, to the extent that the terms of trade increase, absorption in country one will decline, tending to lower income and relieve the domestic inflation. However, in line with the arguments of Chapter II, this effect may well be empirically insignificant.

A very novel and paradoxical discovery, not to be found in the literature, is that the transmission effect will be smaller as m_2, the foreign marginal propensity to import, is larger. Increases in m_2 raise the already improved balance of trade and, therefore, imply a

greater appreciation of the exchange rate for any given change in the capital account balance. In a Mundellian model, the size of the exchange-rate change does not matter. However, from equations (4.18)-(4.19), we see that the size of such changes are important. From equation (4.18), it follows that the larger is the appreciation (due here to a larger m_2), the smaller will be the increase in the domestic inflation rate. Mundell could not obtain this effect since he did not include imported inputs in his model.

In Table 4.1, a convenient summary of the effects of various parameters on the direction and magnitude of the transmission multiplier (4.23) is provided.

TABLE 4.1

FISCAL POLICY TRANSMISSION

Increases in: / Effects on:	$B_k^{r_2}$	$\ell_2^{q_1}$	$\ell_2^{Y_2}$	$\ell_1^{Y_1}$	m_2	$-B_t^T$
$\frac{dp_1}{d\Lambda_2^o}$	+	+	+	-	-	+

To summarize the effects of increased foreign government spending, it appears that the capital inflow into country two prevents a complete offset of the higher foreign inflation by an equiproportional appreciation of the exchange rate.[23] Therefore, the inflation rate of

import prices will rise and, from equation (4.18), this implies that the domestic inflation rate will increase. Furthermore, the level of income in the home economy will also presumably rise and thus lead to higher inflation due to demand-pull forces.[24] If the single period of our model is of sufficient duration to allow for foreign repercussions, then the higher income level, inflation rate and interest rate in country one will rebound to increase these variables in country two. All of these effects are embodied in our two-country model. It is, of course, true that the multiplier will be zero or negative when capital mobility is small or nonexistent. This possibility will be examined in the next section. Negative transmission and, especially, the lack of any transmission at all are presumably not to be expected, though in the end this is an empirical judgment.

It is interesting to compare the above analysis with a fixed exchange-rate model. Those who consult Appendix B will see that the transmission multiplier dp_1/dA_2^o is unambiguously positive when the exchange rate does not vary. This well-known result is due to the fact that higher foreign inflation will be completely reflected in the domestic economy's import prices and that the improved trade account, not dampened by any exchange rate change, will raise domestic income. Once again, both of these factors will act to increase the

domestic inflation rate. As noted in Chapter III, transmission will be greater under flexible than under fixed exchange rates if the increase in the foreign interest rate precipitates such a large capital outflow from the domestic economy that a depreciation results. However, in our Phillips' curve model, this result is due not only to the greater improvement in the trade account but also to the greater increase in import prices that could occur under flexible rates. Since Fleming (1974, p. 93) refers explicitly to the latter effect, it seems plausible that he is implicitly thinking in terms of our Phillips' curve model. Although we agree with Fleming that the relative insulation afforded by flexible rates is an empirical issue, it should be clear that the theoretical argument cannot be complete until we deal with exchange-rate speculation under flexible rates. This topic will be explored in the following chapter.

C. Monetary Policy Transmission

Under the fixed exchange-rate regime that characterized the world economic environment until early 1973, policy makers were also worried that a country pursuing rapid monetary expansion could export inflation to the rest of the world by increasing the world monetary base. In the last chapter, we saw that this concern is unnecessary in a world of full employment and flexible exchange

rates.[25] However, the absence of transmission does depend crucially on the existence of full employment, as we shall see below. At this point it is worthwhile mentioning that in a model characterized by fixed exchange rates and an inflation-unemployment trade-off, expansionary monetary policy abroad will increase the domestic inflation rate.[26] The trade account balance will be improved due to the higher income level and inflation rate abroad and thus the domestic inflation rate will be pulled upwards by increased demand. With the exchange rate fixed, import prices will necessarily be inflating more rapidly and hence the transmission will be exacerbated by a cost-push effect.

In the flexible exchange-rate model of this chapter, there is also transmission of monetary policy disturbances, though of the opposite direction. The multiplier for an increase in the foreign money supply is:

$$\frac{dp_1}{dM_{2s}^o} = \frac{-1}{\Lambda}\Big[f_{11}(1-\eta_2)\Big(m_2\tilde{B}_k^{M_{2s}}(A_2^T+A_1^T) + m_2A_1^T\tilde{A}_2^{M_{2s}} + s_2\tilde{B}_k^{M_{2s}}(A_1^T+B_k)\Big) + (1+q_1)f_{12}(\eta_2-1)\Big(\tilde{s}_1m_2(\tilde{B}_k^{M_{2s}}+\tilde{A}_2^{M_{2s}}) + \tilde{B}_k^{M_{2s}}(\tilde{s}_1s_2+s_2m_1)\Big)\Big] \quad . \tag{4.24}$$

All of the terms in this expression are negative, save

for the term involving the terms of trade effect on absorption in country two. In line with the argument of the last chapter, this effect is likely to be small and, in any event, may well be offset by the effect on absorption in country one.[28] The economic forces at work in this instance are clear. Expansionary monetary policy abroad lowers the interest rate and increases the income level and inflation rate in that economy. Consequently, both the trade and capital accounts of the domestic economy are improved, producing an unambiguous appreciation of the exchange rate. Were an increased foreign inflation rate the sole cause of the exchange rate change, as in the full employment case, then the appreciation would exactly offset the greater inflation abroad. However, this is clearly not the case here and thus the appreciation is proportionately larger, resulting in lower import prices in country one. Furthermore, since both accounts would have improved under fixed exchange rates, and since an appreciation produces balance-of-payments equilibrium only by reducing the trade account balance, it follows that the trade account balance will be lower in equilibrium. Therefore, income in country one will also be lower, creating a further impetus for lower domestic inflation. Finally, given that domestic income and the balance of trade are lower in equilibrium and that foreign income is higher, the terms of trade must

have improved. This improvement should lower expenditure in the domestic economy and increase it abroad, giving us the slight ambiguity that was discovered. As noted in Chapter II, Krueger (1965) also argued that this multiplier is negative, though for very different reasons.

It is interesting to note that, under flexible exchange rates, domestic policy makers should be concerned about other nations that are attempting to reduce their own inflation rates by means of monetary restraint, as this will serve to worsen the inflationary problem at home. Although this observation may sound peculiar, it is actually rather straightforward. Imagine a two-country setting in which the exchange rate is flexible and yet dirty floating is possible. Now suppose that country two wishes to alleviate its inflation and tries to achieve this goal by bidding-up the price of its currency. Naturally, this policy will be successful. However, it will also worsen the inflationary problem in country one as more people demand country one's now (relatively) cheaper product. Thus far what we have described is commonly accepted, as it is but the obverse of the competitive devaluations of the 1930s. Yet country two's policy is basically the same as monetary restraint. Both policies entail the purchasing of country two's currency by their central bank, with the sole difference being the means of payment--bonds in one case and foreign exchange in the other. In each case the (negative) transmission is effected by the

exchange rate change. Unfortunately, this lesson seems to have been learned well by policy makers. For economists, it provides a justification of the above multiplier.

D. Exogenous Disturbances in the Balance of Payments

Another way in which domestic inflation can be affected by the international environment is through disturbances in either the capital or trade account of the balance of payments. For example, there may be an exogenous change of taste in favor of country one's securities ($dB_k^o > 0$) or products ($dB_t^o > 0$). In a fixed exchange-rate system, assuming that the monetary authorities sterilize reserve flows, these disturbances can be readily analyzed. An exogenous improvement in the capital account increases the balance of payments by the same amount and has no effect on the domestic inflation rate.[29] The only noticeable difference in the short run is that the foreign exchange reserves of the domestic central bank will be larger, while those of their foreign counterpart will be smaller. On the other hand, increases in the trade account raise country one's income and put upward pressure on the domestic inflation rate from the demand side. However, the income level and rate of inflation abroad will be lower, with the latter occurrence putting downward

pressure on the domestic inflation rate from the cost side. Consequently, the overall impact on country one's inflation rate is theoretically ambiguous and can only be resolved by empirical study.

Under a flexible exchange rate regime, the impact of these disturbances is different. The change in the domestic inflation rate attributable to an exogenous improvement in the capital account balance is:

$$\frac{dp_1}{dB_k^o} = \frac{-1}{\Delta}[f_{11}(-1+\eta_2)(-m_2(A_2^T+A_2^T)-\tilde{s}_2(A_1^T+B_t^T)) + m_2(1+p_1)f_{11}f_{22}\tilde{A}_2^{q_1}+(1+q_1)f_{12}(-1+\eta_2)(\tilde{s}_1\tilde{s}_2+\tilde{s}_1m_2+\tilde{s}_2m_1) - f_{21}f_{11}\tilde{A}_2^{q_1}(A_1^T+B_t^T)+(1+q_1)f_{12}f_{21}(\tilde{s}_1+m_1)\tilde{A}_2^{q_1}] \qquad (4.25)$$

The sole ambiguity in this expression arises from the terms of trade effect on absorption in country two, as in equation (4.24). The economics of this case is fairly simple. Under a flexible exchange rate system, any increase in the capital inflow must be balanced by a deterioration in the trade balance, a result that is effected by an appreciation of the exchange rate. The latter change causes a shift in demand that tends to lower income at home and increase it abroad. Thus, the demand side forces act to decrease inflation at home and to increase it abroad. Somewhat surprisingly, the cost side will also operate in the same direction. That this is

so can be seen by focusing on the change in the terms of trade. Given the changes in incomes and the trade account balance, the terms of trade must be higher, implying that $\frac{dp_1}{(1+p_1)} > \frac{dR(1+q_1)}{R(1+q_1)}$. If the right-hand side of this expression, or the proportionate change in the import inflation rate, is positive, then the domestic inflation rate must have increased by more. Yet this is impossible, since the elasticity of p_1 with respect to $R(1+q_1)$ has been assumed to be less than one and domestic income has declined. Thus, the import inflation rate must decline, assuming stability, and the domestic inflation rate will indeed be lower.

The other effect which we wish to consider in this section is the impact of an exogenous improvement in the trade account under flexible rates. The impact on the domestic rate of inflation is given by:

$$\frac{dp_1}{dB_t^o} = \frac{1}{\Delta}[f_{11}(-1+\eta_2)(-\tilde{B}_k^{-}{}^{Y_2}(A_2^T+A_1^T)+\tilde{s}_2^{+}A_1^T)$$
$$+ (1+q_1)f_{12}(-1+\eta_2)(-\tilde{s}_2^{-}\tilde{B}_k^{+}{}^{Y_1}+s_1\tilde{B}_k^{-}{}^{Y_2}-\tilde{s}_1^{-}\tilde{s}_2)$$
$$+ (1+p_1)f_{11}f_{22}s_2\tilde{B}_k^{-}{}^{q_1}+f_{21}f_{11}(\tilde{B}_k^{-}{}^{q_1}(A_2^T+A_1^T)+\tilde{A}_2^{+}{}^{q_1}A_1^T)$$
$$- (1+q_1)f_{12}f_{21}(\tilde{B}_k^{-}{}^{Y_1}\tilde{A}_2^{-}{}^{q_1}+s_1\tilde{B}_k^{-}{}^{q_1}+s_1\tilde{A}_2^{-}{}^{q_1})] \qquad (4.26)$$

Even if the ambiguities arising from the terms of trade effect on absorption are set aside, we are still in doubt as to the sign of this multiplier. Initially an improved

trade account will appreciate the exchange rate in order to restore balance of payments equilibrium. Thus, the rate of inflation will tend to decline at home and increase abroad. Since the nominal interest rates in each country will then move in the same respective directions, capital will flow abroad. However, with a worsened capital account, the domestic balance of trade will be higher than it was initially (before any of the changes took place) and, therefore, so will the level of domestic income. With demand-pull factors acting to increase inflation and cost-push factors acting to decrease it, it is impossible to say what will happen to the domestic rate of inflation.[30] As we shall see in the next section, to which we now turn, this multiplier is negative when capital is immobile. Consequently, we see again that the extent of capital mobility is crucial in determining the sign of the transmission effect.

4.3 Transmission in the Case of Immobile Capital

As we discussed in Chapter II, one of the problems with the current thinking about transmission under flexible exchange rates is the implicit or explicit assumption of capital immobility. The results of the last section demonstrate that capital flows do indeed play an

important role in the transmission of inflationary disturbances. In this section we shall examine the transmission question under the assumption that capital is immobile. Although the conclusions of this section are of limited real world applicability, nevertheless they do shed some light on the economic forces at work in the transmission process. Moreover, the results are interesting in and of themselves since they reveal the sensitivity of the conclusions of the Mundellian model to the assumed dichotomy between price and output flexibility and the absence of imported inputs.

The model of Section 4.2 is adopted to the immobile capital assumption by setting the capital account balance and all of its partial derivatives equal to zero. In this case, Δ_1, the determinant of the coefficients of the left-hand side of equations (4.15a)–(4.19a), is necessarily negative since we are merely looking at a special case of the more general model. Consequently, we can proceed to examine the comparative static changes of interest under the assumption that the model is dynamically stable.

The impact of the exogenous disturbances analyzed in the last section can be rapidly dealt with since we are already familiar with the general case. Consider first an increase in government spending abroad. The multiplier representing the effect of this change on the

domestic inflation rate is:

$$\frac{dp_1}{dA_2^o} = \frac{-1}{\Delta_1}\left((1+q_1)f_{12}(-1+\eta_2)\tilde{s}_1 m_2 + f_{11}(1-\ _2)m_2 A_1^T\right) < 0 \quad . \qquad (4.27)$$

This is perhaps the most surprising result for those who have concerned themselves with the transmission question. Increased fiscal spending abroad raises that country's income and inflation rate and thus unambiguously improves the trade account balance of the home economy. However, since the balance of trade is now equal to the balance of payments, this improvement will be prevented by an appreciation of the exchange rate. The negative transmission evinced in equation (4.27) arises from the fact that the percentage fall (appreciation) of the exchange rate exceeds the percentage increase in the foreign inflation rate. For if these two percentage changes are equal, country one's trade balance would still be improved due to the higher income abroad. Hence the exchange rate must appreciate by more than the increase in the foreign inflation rate and the domestic inflation rate is thus lower from the cost side. The greater is the foreign marginal propensity to import (m_2), the greater will be the appreciation. Moreover, the decline in the home inflation rate is further enhanced by the rise in the terms of trade and the concomitant fall in domestic absorption.

Equation (4.27) emphasizes the fact that the size of the exchange rate change necessary to restore balance of payments equilibrium is important in our model. As noted above, this feature of our model arises from the assumption of imported inputs. In the standard Mundellian model, there are no imported inputs ($f_{12} = f_{22} = 0$), no terms of trade effects on absorption ($A_1^T = A_2^T = 0$) and, therefore, no transmission when capital is immobile. Although we too are skeptical about the Laursen-Metzler effect, it would be rather absurd, in this age of the oil crisis, to doubt the assumption of imported inputs. Although we concur with others of Mundellian persuasion that $\frac{dp_1}{dA_2^o}$ is likely to be positive when capital is mobile, our reasons are somewhat different. Estimations of the transmission effect based on Mundell's model will be biased towards zero (in absolute value) since they would only look at demand-side influences and neglect any cost-push elements in the transmission process.

Moving on to consider transmission that is induced by monetary policy, we see that the effect of expansionary foreign monetary policy on the home inflation rate is given by:

$$\frac{dp_1}{dM_{2s}^o} = \tilde{A}_2^{M_{2s}} \frac{dp_1}{dA_2^o} < 0 \quad .^{31} \qquad (4.28)$$

This result is hardly surprising. In Section 4.2C we saw that expansionary monetary policy abroad lowered the domestic inflation rate by producing an unambiguous appreciation. The immobility of capital does not change this conclusion and, by invoking the argument of the preceeding paragraph, an unambiguous lessening of the domestic inflation rate is to be expected.

Lastly, the impact of an exogenous improvement in the trade account is:

$$\frac{dp_1}{dB_t^o} = \frac{1}{\Delta}[\underset{-}{f_{11}(-1+\eta_2)s_2 A_1^T} - \underset{+}{(1+q_1)f_{12}(-1+\eta_2)\tilde{s}_1\tilde{s}_2} + \underset{+}{f_{21}f_{11}\tilde{A}_2 q_1 A_1^T} - \underset{+}{(1+q_1)f_{12}f_{21}\tilde{s}_1\tilde{A}_2 q_1}] < 0 \quad . \tag{4.29}$$

Since the terms of trade must improve to restore equilibrium in the balance of payments, the domestic inflation rate has to decline. The argument should be familiar at this point.

The conclusions of this section have been easy to infer since capital flows were not present to muddle the analysis. All of the changes examined were those which tended to appreciate the exchange rate. In a flexible exchange rate system without capital movements, any force which acts to appreciate the exchange rate will produce an economic contraction at home and an expansion abroad. As long as the initial disturbance entails some

change in real output, the relative inflation rates will change and thus some type of transmission will be effected.

4.4 Conclusion: Inflation in the Short Run

The results in this chapter and the last suggest that a change in the foreign inflation rate will normally affect the domestic inflation rate. The direction and magnitude of this impact primarily depend upon: (a) the source of the foreign disturbance; (b) the employment conditions at home and abroad; (c) the degree of capital mobility; and (d) the exchange-rate system. The argument that there is no transmission under flexible rates is theoretically valid only if full employment is assumed and either capital is internationally immobile or the source of the disturbance is expansionary monetary policy abroad.[32] Otherwise, some type of transmission is to be expected. Moreover, we saw that it is possible for there to be greater transmission with flexible than with fixed exchange rates.

Those who defend the insulating property of flexible rates may seek refuge in the argument that, under such a system, countries are only insulated from monetary, as opposed to real, disturbances abroad.[33] However, proponents of this doctrine can easily fall prey to the idea

that a higher foreign inflation rate entails only monetary effects. This reasoning is generally false. When both price and output are allowed to fluctuate, any force which acts to increase the inflation rate will generally affect the level of output and thus have real ramifications, implying that relative inflation rates (or relative prices) must change. Hence the conclusion of this chapter that any external disturbance will normally alter the domestic inflation rate.

It is interesting to compare the findings of this chapter with those of Turnovsky and Kaspura. They conclude that, in the small country case, there will in general be no transmission effect under flexible exchange rates. This contradiction between their results and ours may appear mysterious at first, especially since the model of this chapter was developed by extending their model to a two-country framework. However, this contradiction is only illusory, for they investigate transmission by assuming that there is an exogenous increase in the foreign inflation rate while all other foreign variables remain constant. Thus they are examining a monetary disturbance and are assuming away the possibility of any real changes. We did the same in the last chapter when we analyzed the effects of an increase in the foreign money supply at full employment.[34] In that case there was no transmission either and hence no

contradiction. Turnovsky and Kaspura merely examine the special case from which some members of the Keynesian school derive the conventional wisdom concerning the insulation afforded by flexible rates. This chapter does not call into question the conventionality of looking at this special case. However, its latter attribute is indeed dubious.

The most interesting attribute of our model is that the magnitude of exchange rate changes plays an important role in the transmission process. This attribute is not found in the Mundellian model and is entirely due to the presence of imported inputs. Moreover, we found that the Mundellian model underestimates the absolute value of the transmission effect by its neglect of supply side influences. As a final note, the reader should recall that both Mundell's model and ours omit the effects of exchange rate changes on capital flows. Since capital flows have been demonstrated to be of crucial importance in determining the direction and magnitude of the transmission effect, this omission is serious. In order to remedy this defect, we now turn to a consideration of capital flows under flexible exchange rates.

Footnotes

[1]See section 3.4 for a discussion of these weaknesses. The relationship between their Phillips' curve relation and a positively-sloped, aggregate-supply curve will be made clear below.

[2]See section 2.1A for a critique of the small-open-economy model as applied to the transmission of economic disturbances.

[3]For example, $a = M_1/TA_1$. In other words, these price indices are the same as in equation (2.20). The change in notation for foreign-good prices is meant to simplify the reading of this study.

[4]This assumption does not matter because we shall discard these price indices, for simplicity, and focus on the rates of change of P_1 and Q_1.

[5]Turnovsky and Kaspura also state that this argument allows for the possibility of entry-limit pricing in an oligopolistic import sector. We choose to ignore this justification in order to avoid other alterations in our model due to noncompetitive assumptions.

[6]Turnovsky and Kaspura also make this assumption. An explicit derivation of this relationship is provided in Appendix A.

[7]In our notation, Turnovsky and Kaspura obtain an equation similar to equation (4.6) from:

$$p_1 = \alpha_0 + \alpha_1(Y_1 - \bar{Y}_1) + \alpha_2 w_1 + \alpha_3 \frac{(\Delta RQ_1)}{(RQ)_{-1}}$$

$$w_1 = \beta_0 + \beta_1 U_1 + \beta_2 \pi_1$$

$$U_1 = \delta_0 + \delta_1(Y_1 - \bar{Y}_1) \quad ,$$

where

w_1 = the rate of change of (money) wages in country one; and

U_1 = the unemployment rate in country one.

Substituting the second and third equations into the

first yields:

$$p_1 = a_0 + a_1(Y_1 - \bar{Y}_1) + a_2[R(1+q_1)-1] + a_3 \pi_1 \quad ,$$

or a special case of equation (4.6).

[8]If this is not clear, the reader should consult Turnovsky (1974), Jorgenson (1963) and/or Ando, Modiglioni, Rache and Turnovsky (1974).

[9]See Friedman (1956). This variable (π_i) is unimportant in our analysis since we assume that it is exogenous and we do not examine the effects caused by its exogenous change.

[10]The Turnovsky-Kaspura model for fixed exchange rates suffers from a similar limitation since they make no provisions for reserve flows stemming from speculation. In Chapter V we shall provide for capital flows based on speculative motives.

[11]The latter would arise from the effect of this variable on the wage rate and is similar to the treatment of π_1 in footnote 7. See Appendix A for a more rigorous description of the relationship between the supply and Phillips' curves.

[12]It seems to be an empirical fact that large economies tend to have smaller marginal and average propensities to import than do small economies. If this were theoretically demonstrable, then we could prove it and thus assert that our model describes the behavior of large economies. However, since it is not a theoretical proposition, we shall assume it without justification.

[13]In other words, we are preceeding as we did in section 3.1.

[14]This idea that foreign prices are not very important could be pursued by letting π_i be the expected rate of inflation of the i^{th} country's output. However, this assumption is not really necessary since expectations are exogenous.

[15]For a full explanation of the squiggle (~) notation, see equations (3.6) and (3.7) and the ensuing

argument. Note that $\ell_i^{\pi_i} = -L_i^{\pi_i}/L_i^{r_i} < 0$ and that $A_i^{\pi_i} = A_i^{r_i}\ell_i^{\pi_i} - A_i^{\pi_i}$. Since $L_i^{\pi_i}$ is likely to be quite small, we shall assume that $A_i^{\pi_i}$ is negative. $\tilde{A}_i^T = A_i^T$ and is less than or greater than zero as $i = 1$ or $i = 2$, respectively, in accordance with Laursen and Metzler (see Chapter II).

[16]See Samuelson (1970, Ch. IX).

[17]Dots above variables indicate time derivatives. Empty parentheses are merely a shorthand device and the omitted arguments can be found in equations (4.15)–(4.19). Note that the inflation equations are assumed to hold always or to exhibit instantaneous adjustment.

[18]See Gantmacher (1960).

[19]These elasticities were defined below equations (4.6) and (4.7).

[20]This idea has been spoken and written so often as to make citation superfluous. Nevertheless, readers desiring to see this argument in print are referred to Branson (1975), Perry (1975), Teigen (1975) and Selden (1975). These articles contain discussions of other possible causes of worldwide inflation.

[21]As in Chapters II and III, we shall continue to speak of the exchange rate and the balances of trade, on the capital account and of payments from the point of view of the home economy (country 1), unless otherwise stated.

[22]In order to relate this statement to the multiplier expression (4.23), recall that $\tilde{B}_k^{q_1} = B_k^{r_2}\ell_2^{q_1}$ and $\tilde{B}_k^{Y_2} = B_k^{r_2}\ell_2^{Y_2}$.

[23]The word "appears" is used because it will in fact become clear in section 4.3 that it is not solely the mobility of capital that fosters the nonzero transmission effect.

[24]See Appendix B for dY_1/dA_2^o and other income multipliers.

[25]In the full-employment model, $dP_1/dM_{2s}^o = 0$ under flexible rates.

[26]See Appendix B for the mathematics of this result.

[27]Note that the absence of "squiggles" above s_1 and s_2 in several of the terms in equation (4.24) is intentional.

[28]From Chapter II, $A_1^T = -s_1M_1$ and $A_2^T = s_2M_2$ if trade is initially balanced, all prices are initially set at unity, and if investment is independent of the terms of trade.

[29]All of the domestic economy's variables remain unchanged, as in the last chapter. Only the composition of the money supply is altered, as the monetary authorities sell the domestic currency for foreign exchange and then sell the same amount of bonds, leaving the money supply unchanged. See Appendix B for dp_1/dB_k^o and dp_1/dB_t^o under fixed rates.

[30]In the model of Chapter III, dp_1/dB_t^o was equal to zero since both of these effects were absent. Income could not change due to the full-employment assumption, while cost-push effects were not possible in the absence of imported inputs.

[31]dp_1/dA_2^o is given in equation (4.27).

[32]See Chapter III for the full-employment model.

[33]In a letter to the editor of the New York Times (June 13, 1975) co-authored by F. Bergsten, R. E. Caves, H. G. Johnson, W. J. Fellner, G. Haberler, A. Meltzer, and M. von N. Whitman, the statement was made that

> ...Floating enables some countries to have lower rates of inflation than their neighbors.
>
> True, under floating, unlike under fixed parities, rapidly inflating countries cannot reduce their inflation by "exporting" it to others; each country has to swallow and endure the consequences of the inflation that it generates. However, floating cannot prevent home-made inflation, and it cannot protect a country from "real"

shocks from abroad.... But it can protect a country from imported inflation and deflation.

[34]The reader may verify that in the last chapter dp_1/dM_{2s} will be zero as long as there is full employment abroad; the employment conditions at home have no bearing on the transmission question in this instance.

CHAPTER V

CAPITAL MOVEMENTS AND THE TRANSMISSION PROCESS IN A FLEXIBLE EXCHANGE RATE SYSTEM

In the last chapter it became clear that capital transactors play a crucial role in the transmission process. Thus, in order to describe the transmission effects of foreign disturbances, it is necessary accurately to specify their behavior. Unfortunately, the capital account specification employed in the previous chapters is not suitable for a flexible exchange rate system. As will be demonstrated in the first section of this chapter, both the level and the expected rate of change of the exchange rate belong in a properly specified capital account function. Of course, in a fixed-rate system, both of these variables are exogenously constant and therefore our fixed exchange-rate multipliers are still correct. However, in a flexible exchange-rate system, the values of these variables will generally change and, using modern portfolio theory, we can show how such changes will affect the capital account balance.

In section one, portfolio theory is employed to develop an appropriate formulation of the capital account under a flexible exchange-rate system. Section two contains an application of this theory to the Phillips'

curve model of Chapter IV. It will become clear that the direction of the transmission effect depends upon the manner in which capital transactors form their expectations of the future exchange rate. Consequently, the latter part of section two contains alternative formulations of exchange rate expectations and a discussion of the implications of each for the transmission of inflation. Finally, in section three, we briefly introduce direct foreign investment and consider its effects on the transmission question. Chapter VI follows with a summary of our conclusions and suggestions for future research.

5.1 A Stock-Adjustment View of Portfolio Capital Movements Under Flexible Exchange Rates

As noted in the previous chapter, the simple formulation of the capital account hitherto employed has been severely questioned by the adherents of modern portfolio theory. Our specification of the capital account function, adopted from Mundell (1960, 1962), suggests that capital flows are a function of the level of interest rates, while

> Recent portfolio theory, however, would indicate that it is the changes in the interest rate differential between the domestic and foreign money markets that is responsible for the volatile capital flows between nations, rather than the size of the differential. In other words, capital flows are, to a large extent, adjustments of capital stocks held in different financial centers. Such adjustments would come to an end after a

> period of time if the yields of different centers stay constant, even though at different levels. (Tsiang, 1975, p. 195.)

There have been quite a few attempts to develop a formulation of the capital account consistent with the above argument.[1] In the vast majority of these instances, fixed exchange rates and/or long-run portfolio equilibrium are/is assumed. Given the orientation of the last chapter, we are interested in the behavior of capital transactors in a short-run, flexible-rate model and, consequently, we shall have to develop the appropriate theory. However, it will become clear that these previous approaches were quite helpful in the formation of the theory below.

Assume that the residents of each country hold their wealth in the form of infinitely short-term assets (or bonds) that are issued at home or abroad. More specifically, let us define:

$$W_1 = B_1 + RF_1 \tag{5.1}$$

$$W_2 = \frac{B_2}{R} + F_2 \quad , \tag{5.2}$$

where

W_i = the total wealth of the residents of country i, in units of the i^{th} country's currency;

B_i = the desired holdings of the assets of country one by the residents of the i^{th} country, in domestic (country one) currency units;

F_i = the desired holdings of the assets of country two by the residents of the i^{th} country, in foreign currency units.

The proportion (ϕ_i) of either country's wealth that is held in the other country's assets depends negatively on the rate of interest at home and positively on the foreign interest rate and the expected rate of appreciation of the foreign currency, or:[2]

$$\frac{RF_1}{W_1} = \phi_1(r_2 - r_1 + R^*) \qquad (5.3)$$

$$\frac{B_2/R}{W_2} = \phi_2(r_1 - r_2 - R^*) \quad , \qquad (5.4)$$

where

R^e = the expected exchange rate one period hence;

$R^* = (R^e - R)/R$ = the expected rate of appreciation of country two's currency (= the expected rate of depreciation of the domestic currency);

r_i = the nominal rate of interest on the assets of country i;

$\phi_i' > 0$.

These equations describe the desired portfolio holdings by the residents of each country.

The desired net stock of foreign indebtedness, K, can then be expressed as:

$$K = B_2 - RF_1 \quad , \qquad (5.5)$$

where K is in units of the domestic currency. The net capital inflow (B_k) is equal to k, the rate of change of the net stock of foreign indebtedness, plus the net interest payment inflow. Following Tsiang (1975), we can assume that both domestic and foreign portfolios adjust from their actual to their desired composition with a coefficient of partial adjustment, μ.[3] Denoting the actual holdings (last period) of each asset by a subscript of negative one, we have:

$$k = \mu(K-K_{-1})$$

$$= \mu(B_2-B_{2,-1}) - \mu R(F_1-F_{1,-1}) \quad . \qquad (5.6)$$

Interest payments are not made on last period's (actual) holdings nor on the desired holdings of each asset. Instead, interest is paid on the current holdings which are bounded by these two extremes. Nevertheless, we can approximate the net interest payment inflow by $(r_2RF_1 - r_1B_2)$.[4] Consequently, the net capital inflow is given by:

$$B_k = k + r_2RF_1 - R_1B_2$$

$$= (\mu-r_1)B_2 - (\mu-r_2)RF_1 + \mu(RF_{1,-1}-B_{2,-1}) \quad . \qquad (5.7)$$

Given our short-term orientation, we shall assume that wealth does not vary over time due to saving. Instead, wealth changes only in response to capital gains and losses that, as is apparent from equations (5.1) and

(5.2), are incurred as a result of the variation in the level of the exchange rate. In order to capture the effects of an exchange rate change on the capital account balance, it is necessary to remove the desired values of B_2 and F_1 from equation (5.6). For example, rewriting equation (5.1) for some initial (i.e., the previous) period, we have:

$$W_{1,-1} = B_{1,-1} + R_{-1} F_{1,-1} \quad . \qquad (5.8)$$

If the level of the exchange rate were to change, then the level of wealth would be altered. This new level of wealth (W_1) is clearly given by:

$$W_1 = B_{1,-1} + R F_{1,-1} \quad . \qquad (5.9)$$

At this point, the domestically-owned portfolio is out of equilibrium and investors will proceed to alter their holdings of foreign assets to satisfy

$$RF_1 = \phi_1 W_1 \quad , \text{ or}$$

$$RF_1 = \phi_1(B_{1,-1} + RF_{1,-1}) \quad . \qquad (5.10)$$

Adding and subtracting $(\phi_1 R_{-1} F_{1,-1})$ to the right-hand side of this equation yields

$$RF_1 = \phi_1 W_{1,-1} + \phi_1(R-R_{-1})F_{1,-1} \quad . \qquad (5.11)$$

In words, this equation simply states that the desired holdings of foreign assets by domestic residents equal

their former holdings of these assets plus a fraction (ϕ_1) of any capital gain or loss arising from an exchange rate change. We can also perform a similar operation on the term (B_2) and express the net capital inflow as:[5]

$$B_k = (\mu - r_1)(R_{-1} W_{2,-1} + (R-R_{-1})F_{2,-1})\phi_2 - (\mu - r_2)(W_{1,-1} + (R-R_{-1})F_{1,-1})\phi_1 + \mu(RF_{1,-1} - B_{2,-1}) \quad . \tag{5.12}$$

As the reader will observe, this equation is identical to its predecessor, equation (5.7), in the absence of any exchange rate variation since, in that case, $R = R_{-1}$, $W_{1,-1} = W_1$, and $W_{2,-1} = W_2$. However, when the exchange rate does change, only the latter equation yields the correct prediction of the change in the capital flow, which is:[6]

$$(B_k^R)_{dR^*=0} = (\mu - r_1)\phi_2(1-\phi_2)W_{2,-1} + \mu\phi_1(1-\phi_1)\frac{W_{1,-1}}{R_{-1}} + r_2\phi_1^2\frac{W_{1,-1}}{R_{-1}} \quad . \tag{5.13}$$

The economic content of this equation is straightforward. Consider the situation of a domestic portfolio that contains foreign assets of $F_{1,-1} = \frac{\phi_1 W_{1,-1}}{R_{-1}}$. Now suppose that there is a devaluation of the home currency (i.e., an increase in the exchange rate). The domestic value of these claims to foreign currency rises by the number

of these claims times the increase in the domestic value of foreign currency. Consequently, the increase in the domestic value of domestically-owned foreign assets, which equals the capital gain to domestic wealth, is $\phi_1 W_{1,-1}/R_{-1}$ per unit of change in the exchange rate. Thus far there has been no flow of capital. However, the domestic assetholders do not wish to hold the entire increase in their wealth abroad, but will instead leave ϕ_1 of this gain (or $\phi_1^2 W_{1,-1}/R_{-1}$) abroad and return $(1-\phi_1)$ of the gain (or $(1-\phi_1)\phi_1 W_{1,-1}/R_{-1}$) to their home economy to invest in domestic assets. The former effect gives rise to an increased interest payment inflow while the latter represents a stock-adjustment inflow that will be distributed over time. The change in the allocation of foreign asset holdings is analogous to the above, with the sole difference being the direction of the interest payment flow.[7] We assume that the rate of stock adjustment, μ, exceeds either interest rate and, therefore, $(B_k^R)_{dR^*=0}$ is positive.

As the reader may have observed by now, the original capital flow equation (5.12) would yield an incorrect value of $(B_k^R)_{dR^*=0}$ since it embodies the assumption that any increase in the domestic holdings of foreign assets implies a capital outflow. However, when the exchange rate changes, the domestic values of these assets changes automatically without any capital flow. Equation (5.12) handles this situation correctly by looking at the change

in asset holdings after an exchange-rate variation. Thus, equation (5.12) is to be preferred as a description of capital flows in a flexible exchange-rate system.

In this formulation of the capital account balance, we have a theory in which the net capital inflow depends upon both the level and the expected rate of change of the exchange rate in addition to the domestic and foreign rates of interest.[8] In other words, we can express equation (5.12) as:

$$B_k = B_k(r_1, r_2, R^*, R) \quad . \tag{5.14}$$

The signs of the partial derivatives of this equation can be determined by differentiating equation (5.12) with respect to the variable of interest, as we have already done for the level of the exchange rate. For example, the effect of an increase in the domestic interest rate on the net inflow of capital is given by:[9]

$$B_k^{r_1} = RW_2((\mu - r_1)\phi_2' - \phi_2) + (\mu - r_2)\phi_1' W_1 \quad . \tag{5.15}$$

As the domestic interest rate increases, there will be a stock adjustment by the investors of both countries in favor of the assets of country one. The stock-adjustment effect is represented in the above equation by the terms that are multiplied by μ. Although this is a once-and-for-all effect, it will take some time to complete. There is also the continuing effect of the increased interest payment outflow (or reduced inflow),

represented by the terms multiplied by r_1 or r_2, that is due to the stock adjustment. Finally, there is a once-and-for-all decrease in the net capital inflow ($-\phi_2 RW_2$ per unit of change in r_1) since our assets are infinitely short term. The net result of these three effects is an ambiguous expression in equation (5.15). However, we believe that $B_k^{r_1}$ is positive in the short run for two reasons. First, as mentioned above, we assume that the coefficient of portfolio adjustment (μ) exceeds either interest rate (r_i). In the short run, the stock-adjustment effect will overwhelm the flow effect since the stocks must change before interest payments can change.[10] Second, the third effect will be very small since few of the internationally traded assets are infinitely short term. Thus, we shall assume that $B_k^{r_1}$ is positive. Using the same approach, we can argue that $B_k^{r_2}$ is negative.[11]

The effect of an exogenous increase in the expected rate of appreciation (depreciation) of country two's (one's) currency is found to be:

$$B_k^{R^*} = -(\mu - r_1) R \phi_2' W_2 - (\mu - r_2) \phi_1' W_1 \quad . \qquad (5.16)$$

In this case, the current exchange rate is held constant, implying that $dR^* = dR^e$.[12] Consequently, the expectation of an appreciation (depreciation) of the foreign (domestic) currency will lead to a capital outflow (or

reduced inflow) due to the stock-adjustment effect. Naturally, the higher stock of foreign assets held by country one's residents and the lower stock of domestic assets held by foreigners will imply a future increase in the net interest payment inflow. The former effect is again expected to dominate the latter in the short run, implying that $B_K^{R^*} < 0$.

Finally, we wish to consider the effect of a change in the level of the exchange rate on the capital account balance. Having already considered this effect when the expected rate of change of the exchange rate is constant, we can write the more general case as:

$$B_k^R = (B_k^R)_{dR^*=0} + \frac{\partial R^*}{\partial R} B_k^{R^*} \quad . \qquad (5.17)$$

If a depreciation (appreciation) leads to the expectation of a further depreciation (appreciation), that is, if $\partial R^*/\partial R > 0$, then this expression will be ambiguous. On the one hand, a depreciation produces wealth effects which tend to cause a capital inflow. On the other hand, the expectation of a further depreciation reduces the expected returns to the domestic asset and therefore tends to cause a capital outflow, rendering the overall effect ambiguous. However, if $\partial R^*/\partial R < 0$, then a depreciation will evoke the expectation of an increased return to the domestic asset and thereby reinforce the capital inflow due to the wealth effect. Of course, if

$\partial R^*/\partial R = 0$, then an exchange rate change will only entail wealth effects, enabling us to assert that a capital inflow will ensue.

At this juncture, it is clearly necessary to make some assumption concerning the formation of exchange-rate expectations. Then, given the general formulation of the capital account in equation (5.14), we can reexamine the Phillips' curve model of Chapter IV with the more rigorous specification of the behavior of capital transactors that we have just presented. Both of these tasks will be taken up on the next section, to which we now turn.

5.2 The Transmission of Inflation Under Flexible Exchange Rates

A. Adaptive Exchange Rate Expectations

The incorporation of equation (5.14) into the model of Section 4.2 necessitates some assumption concerning the formation of exchange-rate expectations. In this section we shall assume that expectations are adaptive and given by:[13]

$$R^e = R + \lambda(R-R_{-1}) \tag{5.18}$$

where

λ = the elasticity of expectations, with $\lambda \geq -1$.

In this case, $R^* = \frac{R^e-R}{R} = \frac{\lambda(R-R_{-1})}{R}$. When λ is less than

zero, we have inelastic or regressive expectations which, as stated previously, imply that a devaluation produces the expectation of a future appreciation equal to (less than) the devaluation when $\lambda = -1 (-1 < \lambda < 0)$. Expectations are neutral ($\lambda = 0$) when an exchange rate change evokes the expectation of no further exchange-rate change. Finally, elastic or extrapolative expectations ($\lambda > 0$) apply to a situation in which an exchange-rate change in a given direction is expected to continue (i.e., a devaluation leads to the expectation of a future devaluation).

On a theoretical basis, there is little that can be said about the actual value of the elasticity of expectations. Niehans (1975) seems to think that it is reasonable to assume inelastic expectations, arguing that when, for example, the exchange rate devalues, there is surely some devaluation large enough to produce the expectation of an appreciation. Undoubtedly, this statement is true. However, unless such large changes always occur, it does not follow that expectations will be inelastic. Furthermore, it is not clear how large is "large."

Nonetheless, we shall favor the case of inelastic expectations in this section. For in the system of dirty floating that is in force today, the foreign exchange authorities are deliberately intervening to reduce

exchange-rate fluctuations.[14] If these authorities are serious about keeping exchange rates close to their prevailing levels, then it will be profitable for capital transactors to expect that this will be the case or, in other words, to have inelastic expectations. Also, it can be argued that any flexible exchange-rate system will evolve into a system characterized by such intervention.[15] Thus, inelastic expectations may be found whenever exchange rates are theoretically flexible. However, since the case for inelastic expectations is based on armchair reasoning, we shall provide results for all values of λ.

From equations (5.17) and (5.18), the effect of an exchange rate change on the capital account balance is:[16]

$$B_k^R = (B_k^R)_{dR^*=0} + \lambda R_{-1} B_k^{R^*} \quad , \qquad (5.19)$$

where

$$\lambda R_{-1} B_k^{R^*} \gtreqless 0$$

as

$$\lambda \lessgtr 0 \quad .$$

Thus, a depreciation of the exchange rate will lead to a capital inflow whenever expectations are inelastic or neutral. However, if expectations are elastic, this effect will be ambiguous, as mentioned above. It should come as no surprise to the reader that the direction of capital flows following an exchange rate change has an important bearing on the transmission equation.

In fact, we are finally in a position to modify the model of Section 4.2 where the absence of both the level and the expected rate of change of the exchange rate implied that we were ignoring the wealth effects of exchange rate changes and assuming neutral expectations.[17] In order to accomplish this task, we must substitute the capital account formulation of equation (5.14) into equations (4.10) and (4.17) and employ equation (5.19) in the differentiated version of the model. Consequently, the sole alteration of the left-hand side of equations (4.15a) to (4.19a) involves the element in the third row and third column, which now becomes $(B_t^T - B_k^R)$. The right-hand side of these equations could be altered to allow for exogenous changes in the future exchange rate (R^e). However, it will become clear that such changes can be analyzed by exogenous shifts in the capital flow function. Therefore, we shall leave the right-hand side intact.

With these substitutions, the determinant of coefficients, Λ_3 is still negative given our assumptions concerning dynamic stability.[18] Moreover, it can be shown that:[19]

$$\Lambda_3 = \Lambda - B_k^R \Lambda_2$$

where

Λ = the determinant of coefficients of equations (4.15a)—(4.19a);

Δ_2 = the determinant of the same system under fixed rates;

$\Delta < 0$;

$\Delta_2 > 0$.

Hence Δ_3 is larger (smaller) in absolute value than Δ when B_k^R is positive (negative). This relationship between Δ and Δ_3 can be readily interpreted. Consider the effect of increased foreign government spending on the exchange rate. According to the model of Chapter IV, this ambiguous effect is C_{23}/Δ, where C_{23} is the cofactor of the element in the second row and the third column. In this chapter, the presence of wealth effects and expected changes in the exchange rate, both induced by changes in the current exchange rate, alters this multiplier to C_{23}/Δ_3. When these two effects offset each other, $B_k^R = 0$ and the two multipliers are equal, as we should expect. However, if B_k^R is positive, then we should expect a smaller exchange rate change since capital is moving towards the devaluing country and is thus automatically dampening any movement of the exchange rate. Yet

$$\left(\frac{dR}{dA_2^o}\right)_{B_k^R>0} < \left(\frac{dR}{dA_2^o}\right)_{B_k^R=0}$$

implies that $|\Delta_3| > |\Delta|$, as stated above.[20] A similar argument in the case of very elastic expectations ($B_k^R < 0$) implies the opposite relationship between these

determinants. The result that

$$\left(\frac{dR}{dA_2^o}\right)_{B_k^R>0} < \left(\frac{dR}{dA_2^o}\right)_{B_k^R=0} < \left(\frac{dR}{dA_2^o}\right)_{B_k^R<0}$$

should be remembered for future reference.

The above paragraph provides a convenient introduction to the question of the transmission effects engendered by increased government spending abroad. The multiplier is:

$$\frac{dp_1}{dA_2^o} = \frac{-1}{\Delta_3}\left(B_k^R\left(-f_{21}f_{11}\frac{(A_1^T+B_t^T)}{(1+q_1)} + (\tilde{s}_1+m_1)f_{12}f_{21} + m_2f_{11}\right)\right.$$

$$\left. + \Delta\left(\frac{dp_1}{dA_2^o}\right)_{B_k^R=0}\right) \quad . \qquad (5.20)$$

In the previous chapter we argued that the last term of this expression is likely to be positive.[21] Suppose that this is so and that, in addition, expectations are such that B_k^R is positive. The consequence of these suppositions is that both the numerator and the denominator of equation (5.20) are of the same sign and therefore $\left(\frac{dp_1}{dA_2^o}\right)_{B_k^R>0}$ is positive. However, we cannot say whether the alteration of the capital account function tends to increase or decrease transmission since both the numerator and denominator of $\left(\frac{dp_1}{dA_2^o}\right)_{B_k^R>0}$ exceed, respectively, the numerator and denominator of

$\left(\frac{dp_1}{dA_2^o}\right)_{B_k^R=0}$. To understand this result, recall the explanation of the transmission of inflation given in Section 4.2. Increased foreign government spending improves the trade account and worsens the capital account (of the home country), while the exchange rate either appreciates (by less than the increase in foreign inflation) or depreciates. Now suppose that exchange rate-induced capital flows occur. If the domestic exchange rate has appreciated, capital will flow abroad due to the wealth effect and the expectation of a future depreciation.[22] This increased capital outflow tends to depreciate the exchange rate and increase the transmission effect. If, on the other hand, the exchange rate has depreciated, then capital will flow into the home country and both the exchange rate change and the transmission effect will be dampened. Thus, the comparison of these multipliers depends on the effect of fiscal policy on the balance of payments. In either case, however, the domestic inflation rate will be higher.

In this context, it is interesting to note that when the value of B_k^R is not only positive but also quite large, the exchange rate will not vary by much. Indeed, if B_k^R were infinite, then capital transactors would be performing the task of the monetary authorities in a fixed-rate system, buying foreign exchange whenever the

currency tends to appreciate and selling in the opposite instance. Consequently, for large values of B_k^R, there will be little difference between the transmission effects under flexible and fixed exchange rates.[23]

When B_k^R is negative but not so much as to cause instability, the explanation of the underlying economic forces at work is symmetric to the argument of the preceeding paragraphs. In this case, both the numerator and the denominator of equation (5.20) are smaller than the numerator and denominator of $(\frac{dp_1}{dA_2^o})_{B_k^R=0}$. If expansionary fiscal policy abroad produces an initial appreciation of the exchange rate, then the capital inflow will increase and further appreciate the exchange rate. Therefore, the transmission effect would be dampened and there is the possibility that zero or even negative transmission would result. If, instead, the exchange rate depreciated initially, then the capital outflow would increase and so would the depreciation and the transmission effect. In both of these instances the possibility of instability in the foreign exchange market is quite clear. All of these effects are summarized in Table 5.1. The signs in each box indicate the effect of the introduction of exchange-rate-sensitive capital flows on the transmission effect, given the effect of expansionary fiscal policy on the exchange rate.

TABLE 5.1

FISCAL POLICY TRANSMISSION AND SPECULATION

	$\frac{dR}{dA_2^o} < 0$	$\frac{dR}{dA_2^o} > 0$
$B_k^R > 0; \quad \lambda \leq 0$	++	--
$B_k^R > 0; \quad \lambda > 0$	+	-
$B_k^R = 0; \quad \lambda > 0$	+-	+-
$B_k^R < 0; \quad \lambda > 0$	-	+++

Reading across any row enables us to compare the effects of the introduction of a certain type of capital flows in different situations of exchange-rate variation. Moving from the top (bottom) to the bottom (top) of the left- (right-) hand column, we proceed from the situation in which the transmission will be greatest to where it will be least. For example, the two negative signs in the top right-hand box indicate that exchange-rate-sensitive capital flows tend to decrease transmission when the exchange rate has depreciated relative to when the exchange rate has appreciated. Moreover, given a depreciation of the exchange rate, the signs in the right-hand column indicate that as B_k^R decreases algebraically, the impact of capital flows tends to increase the transmission. Thus, Table 5.1 provides a handy reference

for the effects of speculation on fiscal policy transmission.

The remaining exogenous disturbances considered in the previous chapter can be briefly dealt with since we now understand the role of capital flows that are sensitive to the exchange rate. The multipliers for these disturbances are:

$$\frac{dp_1}{dM^0_{2s}} = \frac{-1}{\Delta_3}\,(B^R_k\,A_2^{M_{2s}}(-f_{11}f_{21}\,\frac{B^T_t}{1+q_1} + (s_1+m_1)f_{12}+m_2f_{11}) + \Delta(\frac{dp_1}{dM_{2s}})_{B^R_k=0}) \; ; \tag{5.21}$$

$$\frac{dp_1}{dB^0_k} = \frac{-1}{\Delta_3}\,\Delta(\frac{dp_1}{dB^0_k})_{B^R_k=0} \; ; \tag{5.22}$$

$$\frac{dp_1}{dB^0_t} = \frac{1}{\Delta_3}(B^R_k(2f_{21}f_{11}\,\frac{B^T_t}{1+q_1} - s_1f_{12}f_{21} - 2m_1f_{12}f_{21} - m_2f_{11} - s_2f_{11} + A_2^{q_1}f_{22}f_{11}) + \Delta(\frac{dp_1}{dB^0_t})_{B^R_k=0}) \; . \tag{5.23}$$

In equation (5.21), it is clear that when B^R_k is positive (negative), the negative transmission will be decreased (increased) since, in this case, the numerator is decreased (increased) while the denominator is increased (decreased), in absolute value. Recalling, from the previous chapter, that expansionary foreign monetary policy will tend to improve both accounts of the balance of payments, from the home country's point of view, it

is easy to see that the appreciation of the exchange rate will tend to be reversed (accentuated) when B_k^R is positive (negative). The consequences for the domestic rate of inflation are obvious.

An exogenous increase in the capital inflow will have smaller or larger effects on the home rate of inflation, compared to the case in which $B_k^R = 0$, accordingly as B_k^R is positive or negative. This point is readily understood upon the realization that, when B_k^R is positive (negative), any exogenous capital inflow is identical to a smaller (larger) net inflow when capital flows are immune to the influence of the exchange rate. Finally, the explanation for the final multiplier is analogous to the above.

The results of this section indicate that the inclusion of the exchange rate and its expected rate of change into the capital account function reinforces our theme that an economy is not generally insulated from exogenous foreign disturbances. This point follows from the admission that exchange rate-sensitive capital flows amount to another possible real effect of exogenous disturbances. In other words, with non-neutral expectations and the wealth effects induced by exchange rate changes, there is a greater likelihood that capital transactors will reallocate their portfolio in the face of increased foreign inflation. This reallocation affects the exchange rate and, in turn, the other real variables

of the model. Consequently, complete insulation is unlikely. Indeed, if exchange rate expectations are very inelastic, there will be little difference between the transmission effect of the fixed and the flexible exchange rate system.

Before leaving the adaptive expectations model, we can make one final variation in the above analysis following Niehans (1975). Assuming, for the sake of argument, that expectations are inelastic, it is clear that it is no longer necessary for stability that the Marshall-Lerner conditions hold.[24] In fact, as Niehans reminds us, it is widely accepted that trade elasticities are low in the short run, implying that B_t^T is positive. If B_t^T is positive and sufficiently large, while the foreign exchange market is still assumed to be stable (i.e., $B_k^R > B_t^T$), then it is possible that all of our multipliers would be reversed in sign.[25] While it would be tedious to explain all of these cases, let us focus on one exogenous disturbance in order to understand the economic forces at work.

Consider then an increase in foreign government spending when expectations are inelastic and the Marshall-Lerner conditions do not hold. With the higher interest rate and income abroad, the home country's capital account will be worsened and the trade account will be improved. Suppose that the magnitudes of these changes

are such that the domestic balance of payments is higher, implying that the exchange rate will appreciate. Given low trade elasticities, the appreciation will tend to further improve the trade balance. Therefore, there must be an even larger outflow of capital, compared to the pegged-rate case, and, as Niehans suggests, this can only come about by such a large appreciation that capital taansactors expect a later depreciation. If the appreciation is sufficiently large (i.e., if B_t^T is large enough), then it will more than offset the higher foreign inflation and lead to a reduced inflation at home.

The argument above indicates that, in order to ascertain the domestic effects of higher foreign inflation, we must know not only the source of the higher inflation abroad but also the trade elasticities and the elasticity of exchange rate expectations. Clearly there is room for empirical work here. More important, from a theoretical viewpoint, is the sensitivity of our conclusions to the manner in which capital transactors form their expectations of the future exchange rate. We shall now look briefly at this topic.

B. Alternative Formulations of Exchange Rate Expectations

In the previous section we assumed that capital transactors form their exchange rate expectations on an

adaptive basis. Given the numerous factors that affect the movement of the exchange rate, the high degree of uncertainty involved, and the possible intervention by the monetary authorities, this formulation does make some economic sense. However, it is possible that there are other formulations of exchange-rate expectations that may be more profitable and/or more descriptive of real world behavior. In this section, we shall briefly consider such formulations and their effect on the transmission of inflation.

One possible formulation, suggested by Richardson (1975), is that speculators could strongly believe that the current exchange rate is the long-run, equilibrium rate.[26] In terms of our notation, this is merely the case in which $\lambda = -1$ and B_k^{R*} is large (or infinite) in absolute value. As stated above, the exchange rate will tend to remain fixed and the transmission effects will thus approximate the fixed exchange-rate case.

Another possibility is that speculators may think that, with flexible exchange rates, any variation in the foreign inflation rate will be offset by an equal but opposite change in the exchange rate. This is equivalent to saying that it is the current terms of trade, rather than the current exchange rate, that is expected to remain unchanged. Mathematically, we can express this formulation as:

$$R^* = \tau_1 - \tau_2 \tag{5.24}$$

where

τ_i = the rate of inflation of the i^{th} country's output that is expected by capital transactors.[27]

If the expected rates of inflation are themselves adaptively formed, then we have:

$$\tau_1 = p_1 + \alpha_1(p_1 - p_{1,-1}) \tag{5.25}$$

$$\tau_2 = q_1 + \alpha_2(q_1 - q_{1,-1}) \tag{5.26}$$

where

α_i = the elasticity of expectations for the i^{th} product's inflation rate.

It is possible to analyze the effects of this formulation on the transmission of inflation without reexamining the entire model. Consider an increase in foreign government spending. If the domestic inflation rate is expected to remain unchanged, then we have (in place of (5.25)), $d\tau_1 = 0$ and

$$dR^* = -(1+\alpha_2)dq_1 \quad .[28] \tag{5.27}$$

If $\alpha_2 > -1$, then R* will decrease since speculators are convinced that q_1 will not return to its initial rate. Thus, capital will tend to flow towards country one for speculative purposes. Of course, it is not possible

to predict the direction of the capital flow since the foreign nominal interest rate will be higher. Moreover, there is the uncertain direction of the wealth effect. It is uncertain because we are not able to determine the direction of the exchange-rate change in its absence. Thus the sign of the transmission effect is indeterminate.

If $\alpha_2 = -1$, as is the case with perfectly inelastic expectations, then R* will remain constant. Speculators now believe that q_1 will remain constant, so there will be no capital flows that are motivated by speculative purposes. In this case, the analysis is similar to the case of perfectly-inelastic and adaptively-formed exchange-rate expectations.

Another, perhaps more realistic formulation of exchange rate expectations is that R^e, the expected future spot rate, depends negatively on the current balance of trade. If

$$R^e = g(B_t) \qquad (5.28)$$

with

$$g' < 0 \quad ,$$

then improvements in the balance of trade gives rise to the expectation of an appreciation. This formulation could be very descriptive of reality if speculators believe that surpluses (deficits) in the balance of trade are strongly correlated with surpluses (deficits) in the balance of payments. If speculators do behave

in accordance with equation (5.28), then any exogenous disturbance that tends to increase the foreign inflation rate and, therefore, improve the balance of trade, will lead to a capital inflow due to the expectation of an appreciation of the exchange rate.[29] Of course, the wealth effect will still be operating in the opposite direction. Consequently, it is again impossible to predict the sign of the transmission effect.

A final formulation that we should consider is the case of rational expectations.[30] Unfortunately, this is not possible within the confines of our one-period model. For, in our model, rational expectations imply that capital transactors know exactly the outcome next period of each exogenous disturbance and are only in doubt about which disturbance will occur. However, as was made clear in Section 4.1, our model cannot be solved for future periods. It is limited to an examination of the first-period impact of various disturbances. Consequently, we cannot make rational expectations operational in this model.

Although it would be possible to propose other formulations of exchange-rate expectations, it is doubtful that it would add significantly to our knowledge. The arguments of this section suggest that an empirical study of the behavior of capital transactors would be fruitful. More importantly, it should be clear that, in the presence

of capital flows induced by the wealth effects of exchange-rate variations, one would be hard pressed to invent a formulation of expectations that would guarantee complete insulation from foreign inflation.

5.3 A Brief Note on Direct Foreign Investment

Until now we have ignored the direct foreign investment component of capital flows. This omission is common to many short-run, open-economy models and is usually based on the argument that such investment is determined by long-term considerations.[31] Consequently, direct investment is normally regarded as being exogenously constant in the context of short-run models.

It seems, however, that this assumption is more stringent than is both necessary and appropriate. In our discussion of portfolio investment, we assumed that wealth is fixed in the short run and that the residents of each country merely had to allocate their wealth between domestic and foreign assets. In other words, they had to decide how much they should lend in each market. The concomitant assumption for direct investment is that investors have already decided on the level of foreign investment and that they merely have to determine how much to borrow in each market.

This dichotomy between investment and financing decisions is sensible since the former is based on factors that are unlikely to change in the short run (e.g., the defensive or offensive strategy vis-a-vis competitors) while the latter should depend on short-run factors. Since lending is a short-run decision, then so is borrowing. If we do make this distinction, then it is important to realize that it is the financing of foreign investment that gives rise to capital flows. Thus, if we are to regard the financing decision as a short-run variable, we should have a theory that explains how it and the induced capital flows vary in the short run.

The essence of this theory has already been provided. Consider the case of a domestic firm that is investing in country two for the sales of its product, good three, to the world economy. The short-run exogeneity of the foreign investment decision implies that the firm has a certain stock of debt, D_1, in the units of foreign currency. This debt is divided between liabilities at home (H_1, in home currency) and abroad (G_1, in foreign currency).[32] Thus, we have

$$D_1 = \frac{H_1}{R} + G_1 \quad , \tag{5.29}$$

and we can argue that the firm desires to set

$$\frac{H_1/R}{D_1} = \beta_1(r_2 - r_1 + R^*) \tag{5.30}$$

with

$$\beta_1' > 0 \quad .$$

Increases in the foreign nominal interest rate, for example, will lead the firm to borrow more at home and less abroad. However, borrowing at home for foreign investment implies a capital outflow as the borrowed domestic currency is exchanged for the foreign currency that will be used for investment abroad. Moreover, if the firm's affiliate is responsible for the repayment of the loan, then: (a) there will be a future capital inflow as the interest is repaid; and (b) borrowing abroad implies no exchange of currencies and hence no flow of capital. This suggests that, as far as foreign investment is concerned, $B_k^{r_2}$ is negative. Similarly, it is easy to verify that $B_k^{r_1}$ is positive and $B_k^{R^*}$ is negative. Finally, a depreciation of the dollar reduces the foreign currency value of domestic and total liabilities by the same amount. In order to reattain portfolio balance, the domestic firm will increase domestic liabilities (H_1) and hence decrease the net capital inflow.[33] Thus, given the above assumptions, we can write the net foreign investment inflow as:

$$B_k = B_k(r_1, r_2, R^*, R) \quad , \qquad (5.31)$$

$$\quad\quad + \quad - \quad - \quad -$$

with the partial derivatives having the same signs (in

the short run) as before, when we considered portfolio investment, except for $(B_k^R)_{dR^*=0}$. When the exchange rate changes, the crucial question is whether the wealth effect on portfolio investment is greater or less than the "debt" effect on direct investment. If the former effect is larger, than the preceeding analysis is not affected. On the other hand, if the latter effect is larger (equal), then $(B_k^R)_{dR^*=0}$ is negative (zero) and many alterations would be necessary. It is, of course, impossible to deduce theoretically which effect is dominant since the answer depends upon the absolute sizes of wealth and debt and the fractions of each that are held, respectively, in the assets and liabilities of each country. Empirical research is necessary in this area and its outcome will clearly affect the qualitative results concerning the transmission of inflation that were found in this study.

Different results would be found if we: (a) let the good produced by the foreign affiliate be good i, where i = 1 or 2; or (b) took a longer-run viewpoint. Assumption (a) implies that the i^{th} real rate of interest (equal to the i^{th} nominal interest rate minus the expected rate of inflation of good i's price), rather than the i^{th} nominal interest rate would be relevant in the financing decision. This would also be true for portfolio investment if the return on the i^{th} asset were fixed in terms of the i^{th} product. Finally, assumption (b) would

imply that debt could change as the level of foreign investment varied. The concomitant assumption for portfolio investment is that wealth varies due to savings. Thus, although our analysis of direct investment would be different under different assumptions, the same is true of our treatment of portfolio investment. We have chosen the assumptions stated in the text to facilitate the analysis and approximate reality. Our success in the latter realm can only be evaluated by empirical study.

Footnotes

[1]For example, see Tsiang (1958, 1975), Levin (1972), Morton (1970), Kouri and Porter (1974), Branson (1968), Willett and Forte (1969), Lee (1969), Bryant and Hendershott (1970), Miller and Whitman (1970), Hodjera (1971), and Tower (1974). Our approach was developed after a reading of Tsiang (1975), though he assumes fixed exchange rates.

[2]The ϕ-functions can be derived from the Tobin (1958) and Markowitz (1959) portfolio approach or by the Keynes (1936, Ch. 17) and Tsiang (1958) route. The reader should note that there is only one value for R^e. Thus, we are assuming that all investors have identical expectations of the future spot rate.

[3]This assumption is not very popular in the literature. In the list of articles cited in footnote 1, only Tsiang (1975) allows for lags in the adjustment of foreign and domestic portfolios. We obviously like this assumption and believe that it can be justified by a decision lag due to exchange-rate expectations. Although a change in any of the variables that effect the desired composition of portfolios may elicit a quick response by capital transactors, it is doubtful that this will be the full response. Instead, it seems likely that portfolio managers will adjust only partially and then adopt a "wait and see" attitude to deduce the probable effect of the disturbance on the exchange rate. Moreover, in the real world, portfolio managers are assimilating vast amounts of information and they are rarely, if ever, blessed by only one disturbance. Thus, it appears that the assumption of partial adjustment makes a good deal of sense.

[4]Tsiang (1975) uses the same approximation. It is preferable to have interest being paid on desired (rather than actual) holdings, as we have done, since we can then approximate the change in the interest payment flow due to changes in desired holdings. This would be impossible with interest payments on last period's holdings, since the latter do not change.

[5]The transformation of the (B_2) term is as follows. Let

$$W_{2,-1} = \frac{B_{2,-1}}{R_{-1}} + F_{2,-1}$$

before the exchange rate change and

$$W_2 = \frac{B_{2,-1}}{R} + F_{2,-1}$$

afterwards. In order to reattain portfolio balance, foreign investors will set

$$B_2 = \phi_2 R\left(\frac{B_{2,-1}}{R} + F_{2,-1}\right)$$

or

$$B_2 = (R_{-1} W_{2,-1} + (R-R_{-1})F_{2,-1})\phi_2 \quad .$$

[6]As the notation suggests, we are considering a situation in which the change in the level of the exchange rate has no effect on the expected rate of change, R*. In general, R* can be expected to vary when R changes, and we shall consider this case momentarily.

[7]Foreign assetholders incur a capital loss on the domestic assets they hold equal to $\phi_2 W_{2,-1}$ times the decrease in the foreign currency value of the domestic currency. In order to reattain portfolio balance, they will increase their holdings of domestic assets by $(1-\phi_2)$ times the capital loss. It is this increased holdings of domestic assets that accounts for the interest payment outflow.

[8]The dependence of capital flows on the latter three variables arises from the dependence of the ϕ functions on these variables.

[9]Note that this expression is obtained without assuming that $R = R_{-1}$. Those who wish to verify this result should recall that $R_{-1}W_{2,-1} + (R-R_1)F_{2,-1} = B_{2,-1} + RF_{2,-1} = RW_2$ and $W_{1,-1} + (R-R_{-1})F_{1,-1} = B_{1,-1} + RF_{1,-1} = W_1$.

[10]Eventually, the stock-adjustment effect will dwindle and be overwhelmed by the flow effect. However, we are only concerned with the very short run here since we want a capital account specification for our one-period, Phillips' curve model. Finally, note that, in the short run, we have overstated this flow effect by having interest paid on desired holdings.

[11]Morton (1970) notes these effects and comes to the same conclusions as to the signs of B_k^{r1} and B_k^{r2} in the short run.

[12]Again, note that we are not assuming that $R = R_{-1}$. See footnote 9 for assistance in the derivation of equation (5.16).

[13]Adaptive expectations originated with Cagan (1956). See also Foley and Sidrauski (1971) for more on this subject.

[14]In the language of the recent Rambouillet Conference, monetary authorities are empowered to prevent "erratic" fluctuations in exchange rates. If these authorities can convince capital transactors that they will intervene to keep exchange rates close to some levels (or trends), then the capital transactors will proceed to displace these authorities as the stabilizing force in the market. This is actually what we may be seeing today.

[15]This evolution may be due to central bankers' fear of floating rates, the so-called havoc that floating produces for traders (who ignore the forward market), the notion that floating destroys the incentive for a firm control of the money supply, etc. Although all of these arguments are open to criticism, they may nonetheless be the basis for the recent move to legitimize intervention.

[16]Actually, the second term should read $\frac{\lambda R_{-1} B_k^{R^*}}{R^2}$. In following the practice of the last chapter, we have set $R = 1$.

[17]Indeed, the results of the last chapter are only valid if $B_k^R = 0$, that is, if expectations are sufficiently elastic as to render

$$\frac{\partial R^*}{\partial R} = \frac{-(B_k^R)_{dR^*=0}}{B_k^{R^*}} \quad .$$

[18]In particular, the assumption that the foreign exchange market is stable implies that

$$-B_t^T + B_k^R = -B_t^T + (B_k^R)_{dR^*=0} + \lambda R_{-1} B_k^{R^*} > 0 \quad ,$$

or, in words, a devaluation must improve the balance of payments. Until the end of this section we shall assume that the Marshall-Lerner conditions hold ($B_t^T < 0$). The above equation implies an upper limit on λ, and this limit, λ^*, is equal to:

$$\frac{B_t^T - (B_k^R)_{dR^*=0}}{R_{-1}\, B_k^R} \quad .$$

[19]This relationship follows automatically given that the matrix for the fixed-rate system (in Appendix B) has a third column of (0,0,1,0,0).

[20]$(\frac{dR}{dA_2^o})_{B_k^R=0}$ represents the value of the multiplier when $B_k^R = 0$ or, in other words, it is the value of this multiplier in the model of Chapter IV. Note that we are referring to the absolute values of these multipliers, since their signs are ambiguous.

[21]See equation (4.23) and the ensuing argument.

[22]Of course, it does not matter what λ is as long as B_k^R is positive.

[23]When B_k^R is infinite, $dR/dX = 0$, where X represents any disturbance. In this case we can show that $dp_1/dA_2^o = (dp_1/dA_2^o)_B$, where the former multiplier is from equation (5.20) and the latter is the fixed-rate multiplier from equation (B.2) of Appendix B. An examination of equation (B.2) implies that we can express equation (5.20) as:

$$\frac{dp_1}{dA_2^o} = \frac{-1}{\Delta_3}(B_k^R\, \Delta_2 (\frac{dp_1}{dA_2^o})_B + (\frac{\Delta dp_1}{dA_2^o})_{B_k^{R*}=0}) \quad .$$

Dividing the numerator and denominator of the right-hand side of B_k^R and then letting $B_k^R \to \infty$ implies that:

$$\frac{dp_1}{dA_2^o} = \frac{1}{\Delta_2}(\frac{dp_1}{dA_2^o})_B\, \Delta_2 = (\frac{dp_1}{dA_2^o})_B \quad .$$

Thus, the transmission effect is the same regardless of the identity of the group that is fixing the exchange rate. Using this method, it is possible to show that, if $B_k^R \to \infty$, then $dp_1/dX = (dp_1/dX)_B$, where X represents any exogenous disturbance.

[24]See footnote 15.

[25]This is so because the denominator would still be negative, while the change in the sign of B_t^T could alter the sign of the numerator.

[26]This may well have been the case during Canada's experimentation with flexible rates (1950-1962).

[27]This is no reason why τ_i should equal π_i, since the variables represent expectations by different groups who are functioning in different markets.

[28]Note that $\partial R^*/\partial R = 0$.

[29]All of the exogenous foreign disturbances that we have studied have tended to increase the foreign inflation rate and income level. If q_1 rose and Y_2 fell (e.g., if the foreign Phillips' curve were to shift), then it is possible that the balance of trade would decline.

[30]For explanations of rational expectations, see Muth (1961), Sargent (1973) and Sargent and Wallace (1973, 1975).

[31]There are many articles that point to this conclusion. For example, see Richardson (1971a) or Stern (1973, Ch. 8).

[32]Just as a creditor will lend in two markets to maximize yield subject to risk, a debtor will borrow in both markets to minimize cost subject to risk.

[33]This result can be generated by using the approach of Section 5.1. A consideration of direct investment in country one by the firms based in country two would not alter these signs (just as in the case of portfolio investment by foreigners).

CHAPTER VI

CONCLUSIONS AND COMMENTS

This completes our analysis of the transmission of inflation in the short run. In the first three chapters of this study, we outlined two contradicting views on the transmission of inflation under flexible exchange rates. The first and most popular view is that flexible rates provide complete insulation from foreign inflation. This argument is based on two short-run models, namely the small-open-economy model and the Metzler-Machlup foreign-repercussions model. Both of these models were found to be inappropriate for the study of the transmission of inflation. The former model assumes that all foreign economic variables are independent among themselves and, consequently, can only analyze exogenous foreign inflation. Given the absence of money markets, the latter model is unstable in a full-employment, flexible exchange-rate situation and, therefore, it is unsuitable for an investigation of the transmission process. However, in Chapter III, we saw that the addition of money markets led to the possibility of transmission under flexible exchange rates.

The second view, held by several specialists in international economics and stated by Dornbusch (1975, p. 148), is that

> Flexible rates will not insulate a country against real disturbances originating abroad, nor will they insulate a country against foreign monetary disturbances since the latter will, at least in the short run, exert real effects. Capital mobility will ensure the transmission of monetary disturbances....

The basis for this argument is the foreign repercussions model with money markets, or, in other words, the model of Chapter III.[1] Two basic problems with this model are: (a) the lack of a supply side (i.e., the aggregate supply curve is either vertical or horizontal); and (b) the absence of capital movements based on variations in the level and expected rate of change of the exchange rate. In Chapters IV and V, we attempted to remedy these problems by allowing for an inflation-unemployment trade-off and by developing a stock-adjustment model of capital flows under flexible exchange rates.

Several basic conclusions emerge from our analysis. First, as mentioned above, the small-open-economy model is unsuitable for an investigation of the transmission of inflation. Second, there can be no theoretical presumption that flexible exchange rates insulate an economy from foreign inflation in the short run. Instead, the direction and magnitude of the transmission effect depend primarily on: (a) the cause of the increase in the

foreign inflation rate; (b) the international mobility of capital; (c) the employment situation at home and abroad; and (d) the manner in which speculators form their expectations of the future spot rate. Third, when capital is mobile, it is possible that the transmission of inflation will be greater under flexible than under fixed exchange rates. This possibility, which arises when increased foreign inflation is caused by expansionary fiscal policy abroad, is due to the directionally-uncertain impact of fiscal policy on the exchange rate. Fourth, and contrary to the proponents of the second view (i.e., Mundell, Krueger, Fleming, etc.), there will be transmission even when capital is immobile and the terms of trade does not affect absorption. This result stems from our inclusion of the role of the price of imported inputs in the determination of domestic goods' prices. Although armchair empiricisim is by no means conclusive, it appears that the current oil crisis provides a good example of cost-induced transmission and renders our theory more descriptive of reality than its Mundellian alternative. Moreover, the inclusion of imported inputs implies a fifth conclusion that is also at variance with the literature, to wit, that the size of the exchange rate change necessary to restore balance-of-payments equilibrium affects the magnitude of the transmission effect. Sixth, when capital movements

based on speculative motives and exchange rate changes are considered, the transmission process becomes more complex. However, given the different formulations of exchange-rate expectations that were considered in the text, there can still be no presumption that the transmission effect will be zero under flexible rates.

The model used to arrive at these conclusions employed several restrictive assumptions. The most serious stricture placed on the generality of our conclusions is the single period framework. Consequently, in the Phillips' curve model, we are confined to an examination of the impact effects of economic disturbances. However, all of the changes considered in the text give rise to feedbacks in future periods and, although they may be important, our model cannot analyze them. More importantly, when trying to incorporate speculative capital movements, we discovered that this one-period restriction prevented us from examining the case of rational expectations. Despite these limitations, we chose to investigate this model since its direct comparability with the Turnovsky-Kaspura model enabled us to underscore the deficiency of the small-open-economy model in the analysis of the transmission process.

A related limitation, common to most models of international finance, is the assumption that the balances

of payments, of trade, and on the capital account are all initially equal to zero. The consequent limitation of our results to a neighborhood of this initial position is, perhaps, not too serious since we are only dealing with a one-period model. Another limitation, also found in the literature, is the assumption that, with flexible rates, the exchange rate adjusts instantaneously to eliminate any surplus or deficit in the balance of payments. We made this assumption in order to retain as much comparability as possible with the literature. It should be quite obvious that, if the exchange rate adjusts with a lag, even simple models will predict the presence of a transmission mechanism under flexible rates. Our more traditional assumption concerning exchange-rate adjustment emphasizes the other factors that will effect the transmission of inflation.

Both the conclusions and the limitations of our model provide a number of suggestions for future research on the transmission of inflation. On the theoretical side, it is most important to extend the Phillips' curve model beyond a single period. As implied above, such an extension would permit us to examine feedback effects and also to incorporate more sophisticated methods of the formation of exchange-rate expectations, such as rational expectations. Moreover, now that we understand the transmission process with instantaneous exchange-rate adjustment,

we could allow for lags in the adjustment of this variable. This latter suggestion is extremely important for empirical investigations of the transmission process.

Another desirable theoretical extension would be to account for the phenomenon of diversified currency holdings. As Chen (1973) points out, there is an incentive for the citizens of each country to hold domestic and foreign currencies, both for transactions and precautionary reasons. This incentive, although evident in a fixed exchange-rate system, will be pronounced in a flexible-rate system.[2] With diversified currency holdings, the exchange rate will directly determine both balance of payments and money-market equilibrium and thus further reduce the possibility that exchange-rate changes will nullify the domestic effect of foreign inflation. Moreover, as Richardson (1975, pp. 13-16) notes, transmission based on diversified currency holdings will continue in the long run since it is based on the attainment of an equilibrium condition.[3] Thus it should be interesting to integrate diversified currency holdings with short-, intermediate-, and long-run models of the balance of payments.

The model investigated in Chapters IV and V should provide a good basis for the empirical investigation of the transmission of inflation. As indicated in Chapter IV, Kwack (1975) has already tested an equation similar

to our Phillips' curve relation and found that import prices are an important determinant of domestic prices. In a disaggregated, general equilibrium framework, Helliwell (1974) linked the Canadian quarterly model, RDX2, to the MPS model of the United States and found transmission effects similar to those described in Chapter IV.[4] However, both his model and ours (in the fourth chapter) neglect the role of changes in the level and expected rate of change of the exchange rate in the determination of capital flows. Yet, in Chapter V it became clear that changes in both of these variables have definite effects on capital flows and, thus, on the direction and magnitude of the transmission effect. Consequently, effort should be directed at an empirical specification of the capital movements in a flexible exchange-rate world. Special attention should be paid to tests of alternative hypotheses concerning the formation of the expected future spot rate by capital transactors. Some time and effort might be saved by consulting the literature on the stock market, since this market bears great resemblance to the foreign exchange market.

In conclusion, we should emphasize that our study does not detract from the argument in favor of flexible exchange rates. That argument is quite properly based upon the question of the allocative efficiency of a flexible exchange-rate system. The extent of the

transmission of inflation or, more generally, of economic disturbances, cannot be a criterion for the choice between fixed and flexible exchange-rate systems since it is not possible to know the nature of these disturbances. Instead, our study is important for its illustration of the necessity of stabilization policies to offset foreign economic disturbances in a flexible exchange-rate system. Our theoretical research merely provides the direction in which these policies should be applied. Empirical work is clearly needed to provide policymakers with the requisite information required to implement these policies with greater assurance.

Footnotes

[1]However, it is possible that Dornbusch is assuming Keynesian neutral monetary policy. See Chapter III for more on this subject.

[2]As Chen indicates, the Eurodollar market did develop under the Bretton Woods system. However, with flexible rates, the possibly "... wider short-term variations in the real value of domestic money...would force upon the citizen the need to diversify currency holdings." (Chen, 1973, p. 108.)

[3]On the other hand, transmission due to different lags in adjustment will, of course, disappear in a long-run framework.

[4]See Helliwell et al. (1971) and Helliwell and Maxwell (1974) for a description of RDX2. Ando and Modigliani (1975) provide a description of the current MPS model.

APPENDICES

APPENDIX A

THE PHILLIPS' CURVE EQUATIONS

In this appendix we derive the Phillips' curve equation (4.6) for country one. The derivation of equation (4.7) for country two is analogous to that presented below and hence is omitted.

Let the production of good one be given by the aggregate production function

$$Y_1 = F(L,M,\bar{K}) \qquad (A.1)$$

where

L = the quantity of labor;

M = the quantity of good two (the imported input);

$\bar{K}$ = the fixed capital stock;

F = the aggregate production function, homogeneous of degree one.

Assuming that inputs are purchased competitively and that the output market is competitive, it follows that:[1]

$$W = P_1 F_L \qquad (A.2)$$

$$RQ_1 = P_1 F_M \qquad (A.3)$$

where

W = the price of labor, or the wage rate, and

where subscripts denote partial derivatives (e.g., $F_L = \partial F/\partial L$, etc). Differentiating equations (A.1) to (A.3) and solving for dP_1 yields:

$$dP_1 = \frac{P_1|F|dY_1}{\gamma} - \frac{(F_L F_{MM} - F_M F_{LM})}{\gamma} dW$$

$$- \frac{(F_M F_{LL} - F_L F_{ML})}{\gamma} dRQ_1 \qquad (A.4)$$

where

$$|F| = F_{LL} F_{MM} - F_{LM}^2 > 0;$$

$$\gamma = -F_M^2 F_{LL} - F_L^2 F_{MM} + 2 F_{LM} F_L F_M > 0 .^2$$

This equation implicitly defines an aggregate supply curve where the supply price is an increasing function of output, the wage rate, and the domestic price of foreign imports. Thus, we have:

$$P_1 = h(Y_1, W, RQ_1) \quad . \qquad (A.5)$$

However, the same equation (A.4) also suggests that

$$dP_1 = j(dY_1, dW, dRQ_1) \quad . \qquad (A.6)$$

Letting the differentials (dP_1, dY_1, dW, dRQ_1) be approximated by ($P_1 - P_{1,-1}$, $Y_1 - \bar{Y}_1$, $W - W_{-1}$, $RQ_1 - RQ_{1,-1}$) respectively, and considering the relationship between the change in wages and unemployment noted in footnote 7, Chapter IV, implies that we can write

$$1+p_1 = f_1(Y_1-\bar{Y}_1,\ R(1+q_1),\ \pi_1) \quad , \qquad (A.7)$$

or, in other words, equation (4.6).

This derivation of the Phillips' curve equation supports the statement, made in Chapter IV, concerning the equivalency of the aggregate supply curve approach and the Phillips' curve approach. Moreover, since the aggregate production function (equation (A.1)) is implicit in the Phillips' curve relation, we can prove that η_1, the elasticity of the inflation rate of domestically-produced goods with respect to the import inflation rate, is less than unity. For in the general, n-input case, we can write equation (A.1) as:

$$Y_1 = F(V_1,V_2,\ldots,V_n) \quad . \qquad (A.8)$$

Imposing the zero-profit condition implies that

$$P_1 = \sum_i k_i \frac{V_i}{Y_1} \quad , \qquad (A.9)$$

where

k_i = the price of the i^{th} factor.

Differentiating equation (A.9) yields:

$$\frac{dP_1}{P_1} = \sum_i \frac{k_i V_i}{P_1 Y_1} \frac{dk_i}{k_i} + \sum_i \frac{k_i}{P_1} \sum_j \frac{V_i/Y_1}{k_j} dk_j \quad . \qquad (A.10)$$

If the production function is homogeneous of degree one, then the second term is zero and it follows that the

elasticity of output price with respect to the price of any input is less than unity.[3] Since equation (A.10) could be interpreted as was equation (A.6), it follows that $\eta_i < 1$ for $i = 1,2$.

Footnotes

[1]Note that we have said nothing about the supply side of the labor market. This omission is intentional since it allows us to assume a Phillips' curve relation.

[2]All first and cross-partial derivatives are assumed to be positive, while the second derivatives (F_{LL}, F_{MM}) are assumed to be negative. These assumptions imply that γ is positive. $|F|$ is assumed to be positive or, in other words, the production function is strictly concave and the second-order conditions for a profit maximum hold. See Henderson and Quandt (1971, Ch. 3).

[3]To prove that the second term of equation (A.10) is equal to zero, minimize cost subject to the production function constraint. One of the first-order conditions is, of course, that $Y_1 = F(V_1, V_2, \ldots, V_n)$. If F is homogeneous of degree one, then this can be written as:

$$F\left(\frac{V_1}{Y_1}, \frac{V_2}{Y_1}, \ldots, \frac{V_n}{Y_1}\right) = 1 \quad .$$

Differentiation of this equation yields:

$$\sum_i F_i \sum_j \frac{\partial (V_i/Y_1)}{\partial k_j} dk_j = 0 \quad .$$

Since $F_i = \frac{k_i}{P_1}$, the statement in the text follows.

APPENDIX B

SOME TRANSMISSION MULTIPLIERS

In Chapter IV, reference was made to several multipliers that were not included there. It is the purpose of this appendix to provide these multipliers. Section one deals with the fixed exchange rate system, while section two is based on the assumption that the exchange rate is flexible.

A.1 Transmission Under Fixed Exchange Rates

In order to obtain the transmission multipliers with dR = 0, the balance of payments, B, must replace the exchange rate as an endogenous variable in equations (4.15)–(4.19). Differentiating these equations yields (4.15a)–(4.19a) with the third column of the left-hand side subtracted from each side of the equations. Its former position on the left-hand side is taken by the column vector (0,0,1,0,0,)dB. To obtain the sign of the determinant of coefficients, or Δ_2, we merely repeat the procedure employed in the text. Equation (4.17b) is then replaced by

$$0 = -B_t(\ ) - B_k(\ ) + B \quad , \qquad (4.17c)$$

and $\begin{bmatrix} C_2 & D_2 \\ E_2 & F_2 \end{bmatrix}$ now represents the partitioned left-hand

side of the system, with the dimensions of the submatrices being: C_2 - 2 x 2; D_2 - 2 x 3; E_2 - 3 x 2; F_2 - 3 x 3. Since $|C_2 - D_2 F_2^{-1} E_2|$ must be positive for stability and $|F| = 1 - f_{12}f_{22}$, it follows that $\Delta_2 = |C_2 - D_2 F_2^{-1} E_2||F_2|$ is also positive. Assuming stability, the transmission multipliers and their signs are:

$$\frac{dp_1}{d\Lambda_2^o} = \frac{1}{\Lambda_2}(-f_{21}(\frac{f_{11}(A_1^T+B_t^T)}{1+q_1} - f_{12}(\tilde{s}_1+m_1)) + m_2 f_{11}) > 0 \quad (B.1)$$

$$\frac{dp_1}{dM_{2s}^o} = \tilde{A}_2^{M_{2s}} \frac{dp_1}{dA_2^o} > 0 \quad (B.2)$$

$$\frac{dp_1}{dB_k^o} = 0 \quad (B.3)$$

$$\frac{dp_1}{dB_t^o} = \frac{1}{\Lambda_1}(f_{21}(-f_{11}\tilde{A}_2^{q_1} - f_{12}\tilde{s}_1 + \frac{f_{11}}{1+q_1}(A_1^T+A_2^T)) + \tilde{s}_2 f_{11}) , \quad (B.4)$$

which is ambiguous.

The economic justification for these multipliers is supplied in the text. The reader should observe that the mobility of capital does not enter into any of these expressions.

A.2 Flexible Exchange Rates

Certain statements were made in the text concerning the impact of various exogenous disturbances on the level of income. The multipliers which substantiate these

effects are as follows:

$$\frac{dY_1}{d\Lambda_2^o} = \frac{+}{\Lambda}^{-1}[(1-\eta_1) f_{21} \overset{+}{B}_k^{q_1} (\Lambda_1^T + B_t^T)$$
$$+ (1+q_1) f_{12} \bar{(}-1+\eta_2) (-m_2 \overset{-}{B}_k^{p_1} + m_2 \overset{-}{\Lambda}_1^{p_1} + B_k \overset{+}{Y}_1 \Lambda_1^{p_1})$$
$$- (1+q_1) f_{12} \overset{-}{f}_{21} \overset{-}{B}_k^{q_1} \overset{-}{\Lambda}_1^{p_1} + (1+p_1) f_{22} (\eta_1 \overset{+}{-1}) m_2 \overset{-}{B}_k^{q_1}$$
$$+ (1-\eta_2) \overset{-}{(}1-\eta_1) (m_2 \overset{-}{\Lambda}_1^T + \overset{-}{B}_k^{Y_2} (\Lambda_1^T + B_t^T))] \qquad (B.5)$$

$$\left.\frac{dY_1}{d\Lambda_2^o}\right|_{B_k=0} = \frac{-1}{\Lambda}[(1+q_1) (-1+\eta_2) \overset{+}{f}_{12} m_2 \Lambda_1^{p_1} + \overset{-}{(}1-\eta_2) (1-\eta_1) m_2 \Lambda_1^T] \qquad (B.6)$$

$$\frac{dY_1}{dM_{2s}^o} = \frac{+}{\Lambda}^{-1}[(1+q_1) f_{12} (-1+\eta_2) (\Lambda_2^{M_{2s}} (-m_2 \overset{-}{B}_k^{p_1} + m_2 \overset{-}{\Lambda}_1^{p_1})$$
$$+ \Lambda_1^{p_1} (s_2 + \overset{-}{m}_2) \overset{-}{B}_k^{M_{2s}})$$
$$+ (1-\eta_2) \overset{+}{(}1-\eta_1) (m_2 \Lambda_1^T \Lambda_2^{M_{2s}} + \overset{+}{B}_k^{M_{2s}} (s_2 (\Lambda_1^T + B_t^T)$$
$$+ m_2 (\overset{+T}{\Lambda}_2 + T \overset{-T}{\Lambda}_1)))] \quad . \qquad (B.7)$$

$$\left.\frac{dY_1}{dM_{2s}^o}\right|_{B_k=0} = \frac{+}{\Lambda_1}^{-1}((1+q_1) f_{12} \overset{+}{(}-1+\eta_2) m_2 \Lambda_2^{M_{2s}} \overset{-}{\Lambda}_1^{p_1}$$
$$+ (1-\eta_2) (1-\eta_1) \overset{-}{m}_2 \Lambda_1^T \overset{-}{\Lambda}_2^{M_{2s}}) \qquad (B.8)$$

$$\frac{dY_1}{dB_k^o} = \frac{-1}{\Delta}[(1+q_1)f_{21}\overset{+}{\tilde{A}}_1 p_1 \tilde{A}_2 q_1 + f_{21}(-1+\eta_1)\overset{=}{\tilde{A}}_2 q_1 (A_1^T+B_t^T)$$

$$+ (1+p_1)f_{22}(1-\eta_1)m_2\tilde{A}_2^{-} q_1$$

$$+ (1+q_1)f_{12}(-1+\eta_2)(m_2\tilde{A}_1^{+} p_1 + s_2\tilde{A}_1 p_1)$$

$$+ (1-\eta_2)(1-\eta_1)(m_2(A_2^T+A_1^{+T}) + s_2(A_1^{-T}+B_t^T))] \quad . \qquad (B.9)$$

Despite the seeming complexity of these multipliers, their interpretation follows rather easily. For example, when capital is mobile, an increase in foreign government spending produces ambiguous effects on the level of domestic income. The deterioration of the capital account caused by the increased income level and inflation rate abroad dampens the appreciation of the exchange rate and thus acts to increase the domestic income level and inflation rate. However, the latter occurrence will tend to raise the domestic interest rate and thus allows for the possibility of a lower income level at home. Also, as we see in equation (A.5), the terms of trade effect on absorption operates in the direction of lower income.

On the other hand, if capital is immobile, as in equation (A.6), then we expect that the level of domestic income will increase. In this case the trade balance is held at zero and the domestic interest rate is lower due to decreased inflation at home. Consequently, if we

neglect the terms of trade effect on absorption, the level of domestic income will be higher.

Given either an exogenous increase in the foreign money supply or a change in taste in favor of the home country's securities, we see in equations (A.7)–(A.9) that the level of domestic income would tend to decrease were it not for the effect of the lower domestic inflation rate on the domestic interest rate. However, despite the ambiguities of these income multipliers (A.5), (A.7) and (A.9), we are now in a position to understand how it was possible for the argument in the text to proceed as if these signs were determinate. For any disturbance which initially tends to lower income and inflation at home could not possibly render the latter variable ambiguous due to ambiguities in the former. In other words, even if income is higher in equilibrium, it is only because of the monetary feedback of a lower inflation rate. Obviously, the inflation rate has to be lower in order to produce this feedback. Thus the omission of this feedback in the text is justified as its inclusion does not alter the results.

As the reader may have noted, the multiplier representing the effect of an improvement in the balance of trade on the level of domestic income has been omitted. In the case of capital mobility, this omission is justified due to the length of this expression and its ambiguity. Moreover, as the effects of such a change on

the rate of inflation are also ambiguous, there is nothing to be gained by the inclusion of the former. In the case of capital immobility, the income multiplier is ambiguous due to the monetary feedback. The interested reader may verify this statement.

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