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INTERMEDIATE IMPORTS, THE TERMS OF TRADE, AND THE DYNAMICS OF THE EXCHANGE RATE AND CURRENT ACCOUNT

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ABSTRACT

This paper studies the macroeconomic effects of an increase in the price of an imported intermediate production input. The framework of the analysis is a small open economy with a floating exchange rate and endogenous terms of trade, in which saving depends on residents' (variable) rate of time preference. In this setting, an intermediate price shock may lead to an appreciation of the exchange rate in both the short run and the long run, and is likely to occasion a current-account surplus. The terms of trade between foreign and domestic finished goods always improve in the long run.

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1. Introduction

Popular analysis of recent exchange-rate experience has centered on the behavior of intermediate materials prices and its effects on the external accounts of the importing countries. When technical substitution away from an imported production input is difficult, it is argued, a rise in its price leads immediately to a higher import bill, a current-account deficit, and an incipient deficit in the balance of payments. Balance-of-payments equilibrium, in turn, requires a depreciation of the exchange rate, which must be greater the lower the degree of substitutability between foreign and domestic finished goods.

While the analysis just sketched commands widespread agreement, it is not obviously based on any theory of saving, or on consideration of the general equilibrium of markets for goods and assets. This paper, therefore, examines its assertions in a model of an open economy that imports an intermediate factor of production. Although the model introduced here is perhaps overly simple, its implications are of interest in that they lead us to qualify received notions concerning the effect of "oil shocks" on the exchange rates and current accounts of importing countries.

In particular, we find that an intermediate import price increase is likely to occasion a current-account surplus, although a deficit may ensue in certain circumstances. The exchange rate may appreciate or depreciate, both in the long run and in the short run, as a result of the disturbance. Paradoxically, it is when intermediate- and finished-

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balance between foreign and domestic assets. As a by-product of the paper, we show how, in the Dornbusch-Fischer framework, a current deficit may be accompanied by an appreciating exchange rate and improving terms of trade.

The paper is organized as follows. Section 2 describes the long-run equilibrium of the economy, concentrating on the terms of trade and stock of claims on foreigners. The section goes on to consider the long-run effect of an intermediate import price rise on the economy's real equilibrium. Section 3 extends this framework, introducing a money market and allowing short-run deviations of income from spending. The resulting dynamic model is employed to study the impact effects of the price disturbance, the dynamics of the exchange rate under perfect foresight, and the transition to stationary-state equilibrium. Section 4 presents some concluding remarks.

$$Y = F(I,N), \tag{1}$$

where Y denotes output of the home product, I the input of the imported factor of production, and N the input of labor. Under wage flexibility, $N = \bar{N}$, the full-employment labor force, at all times. $\bar{N}$ is a constant, independent of the real wage.

We denote by π the foreign-currency price of the intermediate good; like the foreign-currency price of the imported consumption good and the world rate of interest, it is fixed from the standpoint of the home country. Demand for intermediate materials is determined by competitive profit maximization, and therefore satisfies

$$\tau\pi = F_I(I,\bar{N}) = f'(I), \tag{2}$$

where τ denotes the terms of trade, defined as the price of foreign consumption goods in terms of home goods. From (2) we derive the demand curve for the intermediate factor,

$$I = I(\tau\pi), \qquad I'(\tau\pi) = 1/f''(I(\tau\pi)) < 0. \tag{3}$$

Domestic output and the real wage, through (3), depend on the terms of trade as well as the world price of intermediates. A rise in the product $\tau\pi$ implies a more labor-intensive production technique and a lower marginal product of labor.

Home-country residents derive utility from consumption of foreign and home goods. Their preferences are uniform, and may be represented by the instantaneous utility function $U(C^f,C^h)$. Given a level Z of consumer spending (expressed in units of domestic output) and terms of trade τ, constrained utility maximization gives the demand functions

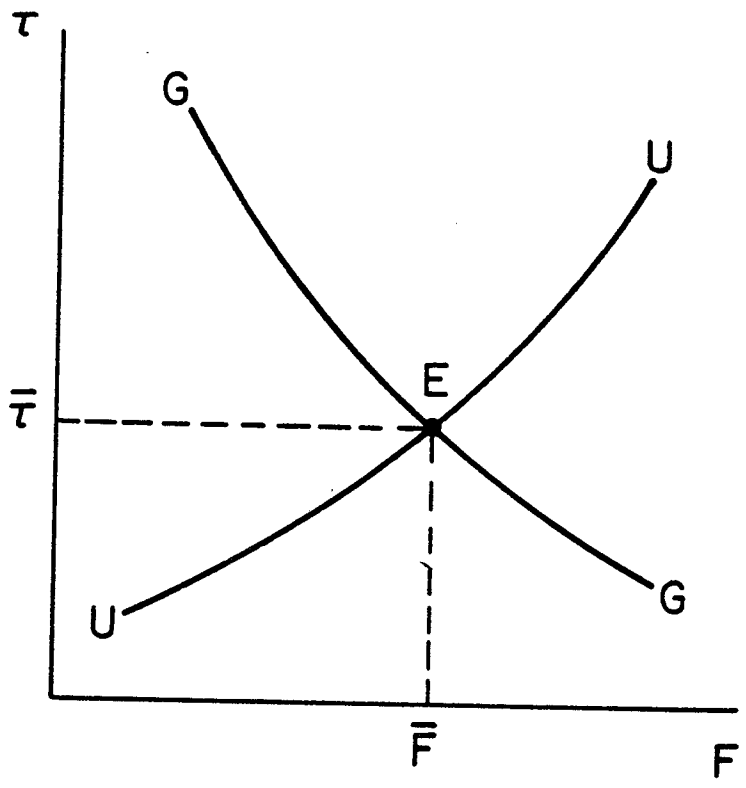

Figure 1

not be the case. Starting from a point on GG, a rise in F increases income, and so, entails excess demand for the home good at the initial terms of trade. But while a rise in the relative price of home goods (a fall in τ) reduces excess demand by switching world spending away from domestic goods and stimulating output, the concomitant rise in real income encourages domestic spending on domestic goods, and so works in the opposite direction. When the price effects dominate, the GG schedule slopes downward as shown in fig. 1, but when the income effect is dominant because price elasticities are small, it slopes upward. Defining

$\theta_X \equiv 1 - \theta_D$, the share of domestic output consumed by foreigners,

$\sigma_D \equiv (\tau/D^h)\frac{\partial D^h}{\partial \tau}\Big|_U$, the compensated elasticity of domestic demand for home goods with respect to the terms of trade,

$\sigma_X \equiv (\tau/X)X'(\tau)$, the elasticity of foreign demand for home goods with respect to the terms of trade,

$\eta \equiv -\tau\pi I'(\tau\pi)/I(\tau\pi)$, the price-elasticity of demand for the imported factor,

$\gamma \equiv \tau\pi I(\tau\pi)/f(I(\tau\pi))$, the share of domestic output imputable to the imported factor,

we may express the slope of GG as

$$\frac{d\tau}{dF}\Big|_{GG} = \frac{D_Z^h r\tau^2}{[D_Z^h\theta_X - (\theta_D\sigma_D + \theta_X\sigma_X + \gamma\eta)]f(I(\tau\pi))} . \qquad (8)$$

The denominator of (8) shows how the slope of GG depends on the relative

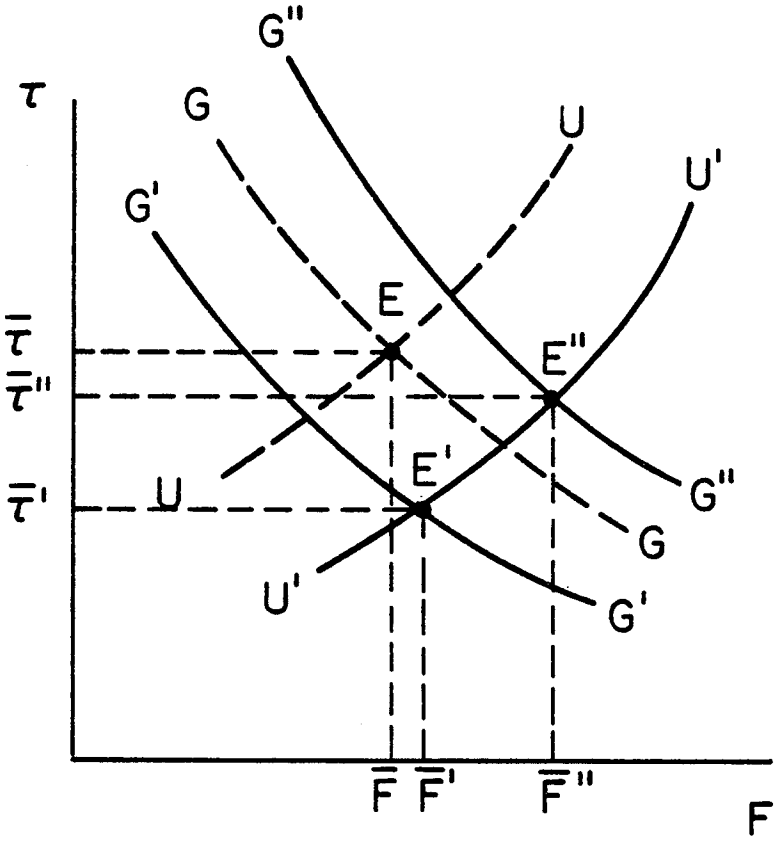

Figure 2

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terms-of-trade change that maintains goods-market equilibrium when all income is spent. When the downward shift of UU at E is greater than that of GG, sustainable utility falls as π rises, for the terms-of-trade improvement that would clear the goods market if saving were zero does not compensate the home country for the fall in domestic value-added. But when the downward shift of UU at E is less than that of GG, sustainable utility rises. In the first case, in which sustainable utility falls, the economy returns to its stationary utility level $\bar{U}$ by accumulating claims on foreigners. This process augments both the stationary-state inflow of interest payments and stationary-state spending, increasing sustainable utility through a direct service-account effect and an induced terms-of-trade effect. In the second case, in which sustainable utility rises, the economy can return to the lower stationary utility level $\bar{U}$ only by running down its stock of foreign claims, thereby ensuring a smaller service surplus and less favorable terms of trade asymptotically.

The suggestion that an intermediate import price increase may raise sustainable utility on impact is rather counter-intuitive. But if demand for domestic output is sufficiently price-inelastic, it is possible that the sustainable terms-of-trade improvement caused by the fall in domestic output is great enough to yield a net increase in domestic welfare.[5] This type of phenomenon is familiar from the literature on immiserizing growth. Although we have not introduced tariffs into the analysis, it is now clear why a country with an optimal tariff in place can never experience a decrease in its long-run stock of foreign claims as a result of a rise in materials prices. Such a country is already at its maximum

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[5] Of course, a necessary condition for this is that GG in fig. 2 shift downward when π rises.

imported materials and labor implies a greater fall in domestic output, and thus, a greater eventual improvement in the terms of trade relative to the loss in value-added caused by the rise in π. But the economy's long-run utility level is fixed at $\bar{U}$ by (4), so a greater improvement in the terms of trade must be accompanied by a smaller improvement in the external asset position. A similar line of reasoning shows why a greater average price elasticity of demand for home goods must lead, all else remaining equal, to a higher long-run stock of claims on foreigners.

The negative relationship between η and $d\bar{F}/d\pi$ deserves emphasis, for it contradicts the conventional view associating current-account weakness with limited possibilities for technical substitution away from intermediates. The conventional view is deficient because it ignores the effect on saving of changes in π. In the present context, as we have seen, a low price elasticity of demand for intermediate imports entails a small long-run rise in the relative price of home goods in response to an increase in π. If η is sufficiently small, the economy will be able to regain its initial utility level only through the accumulation of foreign assets.

accumulation and the current account,

$$\dot{F} = (1/\tau)[X(\tau) - \tau D^{f}(\tau,Z) + r\tau F - \tau\pi I(\tau\pi)]. \qquad (14)$$

To complete the model, we need to specify the determinants of the money prices of home-produced goods and foreign exchange. Before doing so, however, we note that relative prices are determined independently of developments in the money market. From the goods-market equilibrium condition (13) and the expenditure function (11), the equilibrium terms of trade depend on the stock of foreign assets, F, alone. The model therefore exhibits a complete dichotomy between its real and monetary sectors.

We make the assumption that nominal money demand is proportional to nominal output. The proportionality factor is a decreasing function of the expected rate of increase, ε, of the exchange rate, e, which is defined to be the domestic-currency price of foreign exchange. Letting M denote the nominal money supply and P the nominal price of the home good, we may write the condition of money market equilibrium as

$$M = \mu(\varepsilon)Pf(I(e\pi/P)), \qquad \mu' < 0, \qquad (15)$$

on the assumption that foreigners do not hold domestic money. In (15), we have used our earlier convention that the foreign-currency price of the imported consumption good equals 1. This allows us to write the terms of trade as $\tau = e/P$.

Conditions (13) and (15) determine short-run equilibrium values of the exchange rate and the price of home goods, conditional on the stock of foreign assets, F, and an expected rate of depreciation, ε. As F and ε change over time, the short-run equilibrium of the economy will change as well, allowing the terms of trade and stock of foreign bonds to converge

$$\bar{\tau} = \bar{e}/\bar{P}. \tag{18}$$

It is convenient to approximate (17) in a neighborhood of long-run equilibrium by the linear equation

$$\dot{e} = \bar{\Lambda}_e(e - \bar{e}) + \bar{\Lambda}_F(F - \bar{F}). \tag{19}$$

In (19),

$$\bar{\Lambda}_e = -\mu/\mu' > 0,$$

$$\bar{\Lambda}_F = -\frac{\mu\bar{e}\bar{\tau}D_Z^h(r+\theta)(1+\gamma\eta)}{\mu' f(I(\bar{\tau}\pi))[D_Z^h\theta_X - (\theta_D\sigma_D + \theta_X\sigma_X + \gamma\eta)]} > 0,$$

and all functions are evaluated at long-run equilibrium. It is the assumption of Walrasian stability in the goods market that allows us to sign $\bar{\Lambda}_F$ (cf. (8)); we return to this point in a moment.

To study the dynamic behavior of the linear system consisting of (12) and (19), we derive its phase portrait in a neighborhood of the long-run equilibrium, $E = (\bar{F},\bar{e})$. This is shown in fig. 3. The stock of foreign assets is stationary, by (12), only when $F = \bar{F}$. Thus, the $\dot{F} = 0$ locus is vertical at $\bar{F}$, with foreign asset holdings increasing to its left and decreasing to its right. The locus of points such that $\dot{e} = 0$ has slope

$$\left.\frac{de}{dF}\right|_{\dot{e}=0} = -\bar{\Lambda}_F/\bar{\Lambda}_e < 0.$$

The exchange rate is depreciationg above this locus, and appreciating below it, for $d\dot{e}/de = \bar{\Lambda}_e > 0$.[8]

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[8] If the exchange rate rises from a point on the $\dot{e} = 0$ locus, the price of home goods must rise as well to preserve goods market equilibrium. This, in turn, necessitates a rise in the velocity of money, and so a depreciating exchange rate.

As is typically the case in models with self-fulfilling expectations, the long-run equilibrium E is a saddlepoint: there is a unique convergent path SS along which the exchange rate approaches a stationary value. We use this fact to elimate the indeterminacy of the equilibrium exchange rate, assuming that agents choose as the equilibrium rate the value given by the convergent saddlepath. This rules out hyper-inflations and hyper-deflations unrelated to actual or anticipated movements in the money supply.[9]

The saddlepath SS slopes downward, implying that a current deficit must be accompanied by a depreciating exchange rate, and a current surplus by an appreciating rate. Further, these nominal exchange-rate movements are also real exchange-rate movements: the terms of trade must deteriorate during the course of a deficit, and improve during the course of a surplus, as is easily established.[10]

This relationship between the terms of trade and the current account has been emphasized by Dornbusch and Fischer (1980) in the flexible exchange rate context. It arises because a declining stock of foreign claims entails a declining level of spending that must be accompanied by a falling relative price of home output if the goods market is to clear continuously. But it is of interest to recall that the relationship holds only when substitution elasticities are sufficiently high in a neighborhood of E to rule out Walrasian instability in the home goods market. When this is not the case, a current deficit will be accompanied

[9] Even when the exchange rate exhibits explosive behavior, the underlying real variables -- the foreign asset stock and terms of trade -- converge to their long-run equilibrium values. This is just a reflection of the model's dichotomous nature.

[10] One argument is the following. Suppose the terms of trade deteriorate during the course of a surplus. Then, by (3), output will fall along the path to long-run equilibrium, and this will put upward pressure on the price of home goods, by (15). But since the rate of appreciation is decreasing as well, the velocity of money will rise over time, also putting upward pressure on P. Now if P is rising and e falling, the terms of trade are improving, contrary to the initial assumption. Thus, the behavior of the terms of trade is as described in the text.

of the required terms-of-trade adjustment must be accommodated by a shift in the stationary-state exchange rate.[12]

Using (20), we can derive the impact response of the exchange rate to an intermediate import price rise. As is shown in the appendix, the saddlepath SS is described by the equation

$$e - \bar{e} = \frac{-\bar{\Lambda}_F}{\bar{\Lambda}_e + \Theta} (F - \bar{F}). \tag{21}$$

Assuming that the economy is initially at long-run equilibrium, differentiation of (21) yields the short-run exchange-rate response[13]

$$\frac{de}{d\pi} = \frac{d\bar{e}}{d\pi} + \frac{\bar{\Lambda}_F}{\bar{\Lambda}_e + \Theta} \frac{d\bar{F}}{d\pi}. \tag{22}$$

Equation (21) relates the impact depreciation of the exchange rate to the long-run depreciation and cumulative current account surplus made necessary by the rise in π. Because $\bar{\Lambda}_F/(\bar{\Lambda}_e + \Theta) > 0$, it is evident that the exchange rate will "overshoot" its long-run value when $d\bar{e}/d\pi$ and $d\bar{F}/d\pi$ have the same sign, but will "undershoot" or even mispredict its long-run direction of change when their signs differ. To illustrate the variety of possible adjustment patterns, we use (21) to analyze the economy's response to an intermediate import shock in three alternative sets of circumstances. For convenience, we reproduce (10), giving the long-run derivative of $\bar{F}$:

$$\frac{d\bar{F}}{d\pi} = \frac{I(\bar{\tau}\pi)[\theta_D\sigma_D + \theta_X\sigma_X - (1 - \theta_D - \gamma)\eta]}{r(\theta_D\sigma_D + \theta_X\sigma_X + \gamma\eta)}.$$

We first consider the case in which, at the initial equilibrium,

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[12] Obviously, the exact form of condition (20) arises from our assumption that money-demand is unit-elastic with respect to output. The reader will find it easy to derive the analogous condition under a more general specification of money demand.

[13] We make use here of the fact that F is a predetermined variable that can change only over time.

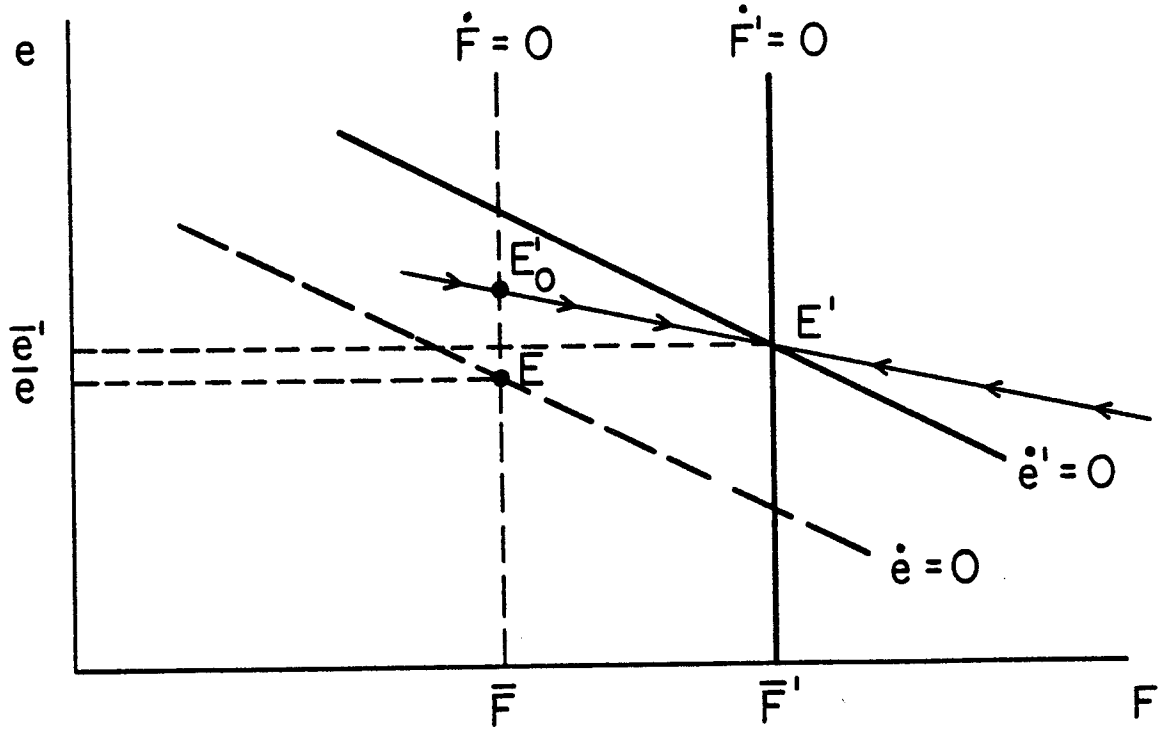

Figure 4

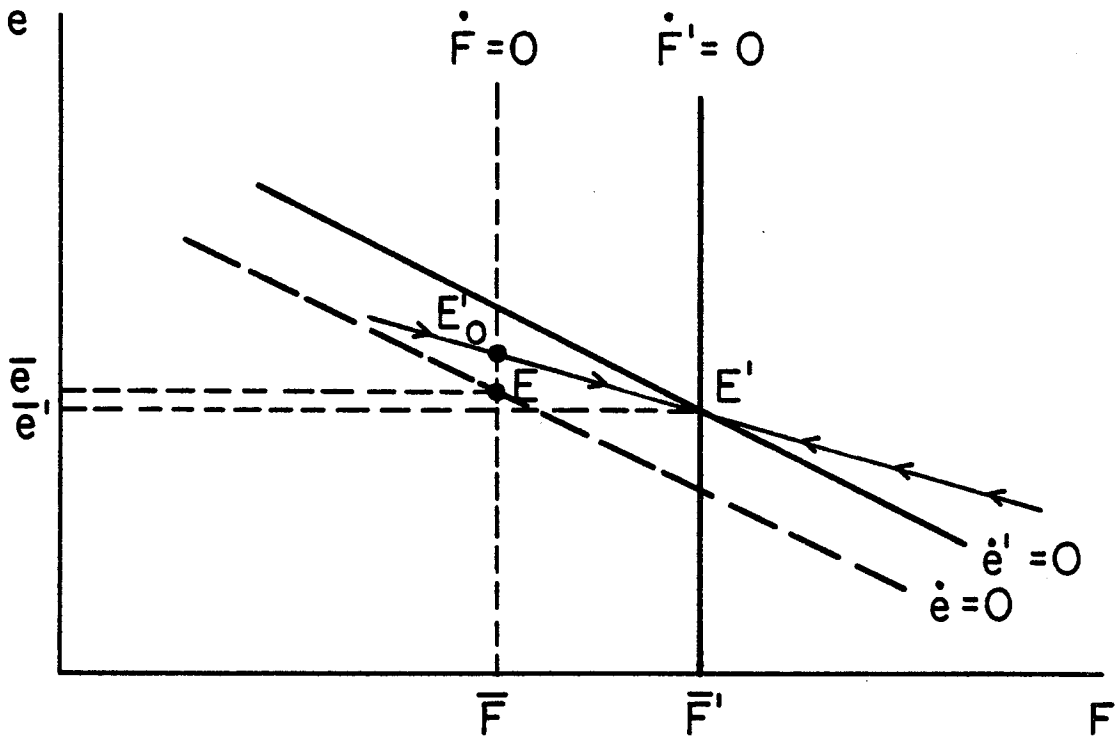

Figure 5

is to leave the terms of trade more favorable than they were before the price shock.[15]

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[15] If the economy is initially in long-run equilibrium, the proportional impact effect of a rise in π on the terms of trade is

$$\frac{\pi}{\bar{\tau}}\frac{d\tau}{d\pi} = -\frac{\gamma(D_Z^h - \eta) + D_Z^h(\theta\bar{\tau}\pi/f(I(\bar{\tau}\pi)))\frac{d\bar{F}}{d\pi}}{D_Z^h\theta_X - (\theta_D\sigma_D + \theta_X\sigma_X + \gamma\eta)} .$$

With reference to fig. 2, the expression shows that when the GG schedule shifts to the right ($D_Z^h > \eta$), the terms of trade deteriorate in the short run. When GG shifts to the left ($D_Z^h < \eta$), the terms of trade will improve in the short run if the shift is great enough to ensure a long-run decline in $\bar{F}$. This confirms the assertion in the text. Finally, if GG shifts leftward, but the stationary-state stock of foreign claims rises, the short-run effect of the disturbance on the terms of trade is ambiguous.

Appendix

In this appendix, we solve the differential-equation system of section 3 and derive the equation describing its convergent saddlepath.

When linearized in a neighborhood of long-run equilibrium $(\bar{F},\bar{e})$, the system may be written in the matrix form

$$\begin{bmatrix} \dot{F} \\ \dot{e} \end{bmatrix} = \begin{bmatrix} -\Theta & 0 \\ \bar{\Lambda}_F & \bar{\Lambda}_e \end{bmatrix} \begin{bmatrix} F - \bar{F} \\ e - \bar{e} \end{bmatrix}.$$

The matrix of the system is lower triangular; its characteristic roots are $-\Theta$ and $\bar{\Lambda}_e$. One of these is negative and one positive, confirming the diagrammatic derivation of the saddlepoint property in section 3. It is worth noting that even when the domestic goods market is unstable in Walras' sense in a neighborhood of $(\bar{F},\bar{e})$, this point continues to be a saddlepoint. Rational expectations equilibrium exists and is unique even when $\bar{\Lambda}_F < 0$.

A general solution to the system can be written

$$F_t - \bar{F} = k_1 \frac{-\bar{\Lambda}_e - \Theta}{\bar{\Lambda}_F} \exp(-\Theta t),$$

$$e_t - \bar{e} = k_1 \exp(-\Theta t) + k_2 \exp(\bar{\Lambda}_e t),$$

where k_1 and k_2 are arbitrary constants determined by initial conditions. Because solutions originating on the saddlepath converge to the stationary state, these must correspond to the initial condition $k_2 = 0$. The saddle-

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