Expectations and Exchange Rate Dynamics

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The paper develops a theory of exchange rate movements under perfect capital mobility, a slow adjustment of goods markets relative to asset markets, and consistent expectations. The perfect foresight path is derived and it is shown that along that path a monetary expansion causes the exchange rate to depreciate. An initial overshooting of exchange rates is shown to derive from the differential adjustment speed of markets. The magnitude and persistence of the overshooting is developed in terms of the structural parameters of the model. To the extent that output responds to a monetary expansion in the short run, this acts as a dampening effect on exchange depreciation and may, in fact, lead to an increase in interest rates.

I. Introduction

The paper develops a simple macroeconomic framework for the study of exchange rate movements. The purpose is to develop a theory that is suggestive of the observed large fluctuations in exchange rates while at the same time establishing that such exchange rate movements are consistent with rational expectations formation. In developing a formal model we draw on the role of asset markets, capital mobility, and expectations that have been emphasized in recent literature.[1] We draw, too, on the fact

[1] For recent work on flexible exchange rates that shares some of the present emphasis, see Black (1973, 1975), Henderson (1975), Niehans (1975), Dornbusch (1976*a*, 1976*b*), Frenkel (1976), Kouri (1976), and Mussa (1976). The classics remain Fleming (1962) and Mundell (1964, 1968).

of differential adjustment speeds in goods and asset markets. In fact, the dynamic aspects of exchange rate determination in this model arise from the assumption that exchange rates and asset markets adjust fast relative to goods markets.

The adjustment process to a monetary expansion in this framework serves to identify several features that are suggestive of recent currency experience. In the short run, a monetary expansion is shown to induce an immediate depreciation in the exchange rate and accounts therefore for fluctuations in the exchange rate and the terms of trade. Second, during the adjustment process, rising prices may be accompanied by an appreciating exchange rate so that the trend behavior of exchange rates stands potentially in strong contrast with the cyclical behavior of exchange rates and prices. The third aspect of the adjustment process is a direct effect of the exchange rate on domestic inflation. In this context the exchange rate is identified as a critical channel for the transmission of monetary policy to aggregate demand for domestic output.

The effect of monetary policy on interest rates and exchange rates is significantly affected by the behavior of real output. If real output is fixed, a monetary expansion will, in the short run, lower interest rates and cause the exchange rate to overshoot its long-run depreciation. If output, on the contrary, responds to aggregrate demand, the exchange rate and interest rate changes will be dampened. While the exchange rate will still depreciate, it may no longer overshoot, and interest rates may actually rise.

In Part II we develop a formal model in terms of explicit functional forms. That development allows us to derive an analytical solution for the time path of variables and, in Part III, for the expectations that generate the perfect foresight path. In Part IV, the model is used to investigate the effects of a monetary disturbance. While the major part of the analysis is developed for the case of fixed output, an extension to variable output is introduced in Part V.

II. The Model

We will assume a country that is small in the world capital market so that it faces a given interest rate. Capital mobility will ensure the equalization of expected net yields so that the domestic interest rate, less the expected rate of depreciation, will equal the world rate. In the goods market we will assume that the world price of imports is given. Domestic output is an imperfect substitute for imports, and aggregate demand for domestic goods, therefore, will determine their absolute and relative price.

A. Capital Mobility and Expectations

Assets denominated in terms of domestic and foreign currency are assumed to be perfect substitutes given a proper premium to offset anticipated exchange rate changes. Accordingly, if the domestic currency is expected

to depreciate, interest rates on assets denominated in terms of domestic currency will exceed those abroad by the expected rate of depreciation. That relationship is expressed in (1) where r is the domestic interest rate, r^* is the given world rate of interest, and x is the expected rate of depreciation of the domestic currency, or the expected rate of increase of the domestic currency price of foreign exchange:

$$r = r^* + x. \tag{1}$$

Equation (1) is a representation of perfect capital mobility, and it is assumed that incipient capital flows will ensure that (1) holds at all times.

Consider next expectations formation. Here we distinguish between the long-run exchange rate, to which the economy will ultimately converge, and the current exchange rate. Denoting the logarithms of the current and long-run rate by e and $\bar{e}$, respectively, we assume that

$$x = \theta(\bar{e} - e). \tag{2}$$

Equation (2) states that the expected rate of depreciation of the spot rate is proportional to the discrepancy between the long-run rate and the current spot rate. The coefficient of adjustment θ is for the present taken as a parameter. The long-run exchange rate is assumed known, and an expression for it will be developed below. We note further that, while expectations formation according to (2) may appear ad hoc, it will actually be consistent with perfect foresight, as shown in Part III.

B. The Money Market

The domestic interest rate is determined by the condition of equilibrium in the domestic money market. The demand for real money balances is assumed to depend on the domestic interest rate and real income and will, in equilibrium, equal the real money supply. Assuming a conventional demand for money, the log of which is linear in the log of real income and in interest rates, we have[2]

$$-\lambda r + \phi y = m - p, \tag{3}$$

where m, p, and y denote the logs of the nominal quantity of money, the price level, and real income. For the remainder of this part we will take the nominal quantity of money and the level of real income as given.

Combining (1), (2), and (3) will give us a relationship between the spot exchange rate, the price level, and the long-run exchange rate, *given* that the money market clears and net asset yields are equalized:

$$p - m = -\phi y + \lambda r^* + \lambda\theta(\bar{e} - e). \tag{4}$$

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[2] Equation (3) is obtained by taking the logarithm of the money market equilibrium condition $M/P = Y^\phi \exp(-\lambda r)$.

Equation (4) can be simplified by noting that with a stationary money supply long-run equilibrium will imply equality between interest rates, because current and expected exchange rates are equal. This implies that the long-run equilibrium price level, $\bar{p}$, will equal

$$\bar{p} = m + (\lambda r^* - \phi y). \tag{5}$$

Substituting (5) in (4) gives us a relationship between the exchange rate and the price level:[3]

$$e = \bar{e} - (1/\lambda\theta)(p - \bar{p}). \tag{6}$$

Equation (6) is one of the key equations of the model. For given long-run values of exchange rates and prices, it serves to determine the current spot price of foreign exchange as a function of the current level of prices. Given the level of prices, we have a domestic interest rate and an interest differential. Given the long-run exchange rate, there is a unique level of the spot rate such that the expected appreciation, or depreciation, matches the interest differential. An increase in the price level, because it raises interest rates, gives rise to an incipient capital inflow that will appreciate the spot rate to the point where the anticipated depreciation exactly offsets the increase in domestic interest rates.

C. The Goods Market

The demand for domestic output depends on the relative price of domestic goods, $e - p$, interest rates, and real income. The demand function is assumed to have the form

$$\ln D = u + \delta(e - p) + \gamma y - \sigma r, \tag{7}$$

where D denotes the demand for domestic output and where u is a shift parameter.[4] From (7) we note that a decrease in the relative price of domestic goods raises demand, as does an increase in income or a reduction in interest rates. The rate of increase in the price of domestic goods, $\dot{p}$, is described in (8) as proportional to an excess demand measure:

$$\dot{p} = \pi \ln (D/Y) = \pi[u + \delta(e - p) + (\gamma - 1) y - \sigma r]. \tag{8}$$

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[3] In (3) we assumed that the appropriate deflator for money balance is the price of domestic output. An alternative is provided by a deflator that is a weighted average of domestic and import prices. In such a formulation the "price level," q, could be written as $q = \alpha p + (1 - \alpha)e$, where α and $(1 - \alpha)$ are the expenditure shares of domestic goods and imports. With such a formulation (6) would be amended to the following equation: $e = \bar{e} - \beta(p - \bar{p})$, where $\beta \equiv \alpha/[\lambda\theta + (1 - \alpha)]$. None of the qualitative results described below would be affected by this extension.

[4] The complete relative price argument in (7) is $(e + p^* - p)$ where p^* is the logarithm of the foreign price level. Setting the foreign price level equal to unity implies that $p^* = 0$.

We note that the long-run equilibrium exchange rate implied by (8) is[5]

$$\bar{e} = \bar{p} + (1/\delta)[\sigma r^* + (1 - \gamma)y - u], \qquad (9)$$

where $\bar{p}$ is defined in (5). From (9) it is apparent that the long-run exchange rate depends with the conventional homogeneity properties on monetary variables, but obviously on real variables, too.

The price equation in (8) can be simplified by using the definition of the long-run rate in (9) and the fact that interest differences equal expected depreciation, $r - r^* = \theta(\bar{e} - e)$, to become[6]

$$\dot{p} = -\pi[(\delta + \sigma\theta)/\theta\lambda + \delta](p - \bar{p}) = -v(p - \bar{p}), \qquad (10)$$

where

$$v \equiv \pi[(\delta + \sigma\theta)/\theta\lambda + \delta]. \qquad (11)$$

The price adjustment equation in (10) can be solved to yield

$$p(t) = \bar{p} + (p_0 - \bar{p}) \exp(-vt), \qquad (12)$$

which shows that the price of domestic output will converge to its long-run level at a rate determined by (11). Substitution of (12) in (6) gives the time path of the exchange rate

$$\begin{aligned} e(t) &= \bar{e} - (1/\lambda\theta)(p_0 - \bar{p}) \exp(-vt) \\ &= \bar{e} + (e_0 - \bar{e}) \exp(-vt). \end{aligned} \qquad (13)$$

From (13) the exchange rate will likewise converge to its long-run level. The rate will appreciate if prices are initially below their long-run level and, conversely, if prices initially exceed their long-run level.

D. Equilibrium Exchange Rates

The adjustment process of the economy can be described with the help of figure 1. At every point in time the money market clears and expected yields are arbitraged. This implies a relationship between prices and the spot exchange rate shown in (6) and reflected in the QQ schedule in figure 1. The positively sloped schedule $\dot{p} = 0$ shows combinations of price levels and exchange rates for which the goods market and money market are in equilibrium.[7] Points above and to the left of that schedule

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[5] Equation (9) is obtained by setting $\dot{p} = 0$ and $r = r^*$ as is appropriate for the long run where markets clear and exchange rates are constant.

[6] In (8) aggregate demand depends on the nominal interest rate. An alternative formulation allows aggregate demand to depend on the real interest rate, $r - \dot{p}$. Such a formulation requires that we substitute $\rho \equiv \pi/(1 - \sigma\pi) > 0$ in place of π in (11) and the equations below. The restriction that $\rho > 0$ is required for stability.

[7] The $\dot{p} = 0$ schedule represents combined goods- and money-market equilibrium. Setting $\dot{p} = 0$ in (8) and substituting for the domestic interest rate from (3) yields the equation of the goods-market equilibrium schedule:

$$p = [\delta\lambda/(\delta\lambda + \sigma)]e + [\sigma/(\delta\lambda + \sigma)]m + [\lambda/(\delta\lambda + \sigma)][u + (1 - \gamma)y - \phi\sigma y/\lambda].$$
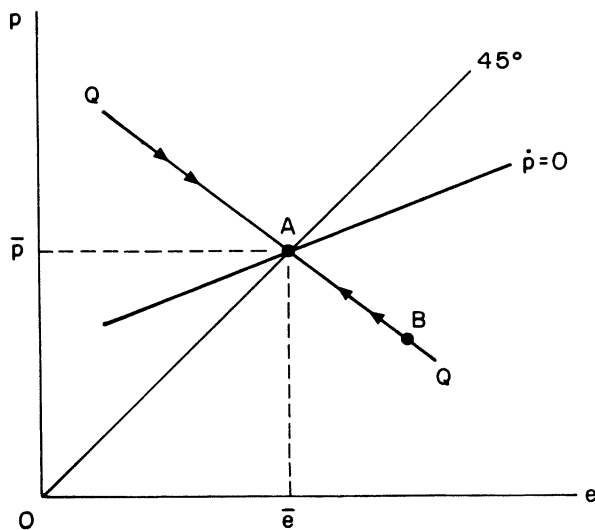
FIG. 1

correspond to an excess supply of goods and falling prices. Conversely, points to the right and below the schedule correspond to an excess demand. The $\dot{p} = 0$ schedule is positively sloped and flatter than a 45° line for the following reason.[8] An increase in the exchange rate creates an excess demand for domestic goods by lowering their relative price. To restore equilibrium, domestic prices will have to increase, though proportionately less, since an increase in domestic prices affects aggregate demand, both via the relative price effect and via higher interest rates.

For any given price level the exchange rate adjusts instantaneously to clear the asset market. Accordingly, we are continuously on the QQ schedule with money-market equilibrium and international arbitrage of net expected yields. Goods-market equilibrium, to the contrary, is only achieved in the long run. Conditions in the goods market, however, are critical in moving the economy to the long-run equilibrium by inducing rising or falling prices. Specifically, an initial position such as point B, with a price level below the long-run level and, correspondingly, an exchange rate in excess of the long-run equilibrium, implies an excess demand for goods because domestic output commands a low relative price and because the interest rate is low. Accordingly, prices will be rising, thereby inducing over time a reduction in excess demand. The path of rising prices is accompanied by an appreciation of the exchange rate. As interest rates rise, as a consequence of declining real balances, the spot

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[8] The 45° line in fig. 1 is drawn through the origin on the assumption that, by appropriate choice of units, the prices of both goods are initially equal.

rate will approach the long-run rate. Once the long-run equilibrium at point A is attained, interest rates are equal internationally, the goods market clear, prices are constant, and expected exchange rate changes are zero.

III. Consistent Expectations

So far we have placed no restrictions on the formation of expectations other than the assumption that the expected rate of depreciation, as shown in (2) is proportional to the discrepancy between the long-run and the current exchange rate. From (12) and (13) we note that the rate at which prices and the exchange rate converge to equilibrium is given by v. From (11) it is apparent that the rate of convergence is a function of the expectations coefficient, θ.

Clearly, for the expectations formation process in (2) to correctly predict the actual path of exchange rates it must be true that $\theta = v$. Accordingly, the expectations coefficient, θ, that corresponds to perfect foresight, or, equivalently, that is consistent with the model is given by the solution to the equation

$$\theta = v \equiv \pi[(\delta + \sigma\theta)/\theta\lambda + \delta]. \tag{14}$$

The consistent expectations coefficient, $\tilde{\theta}$, obtained as the solution to (14), is a function of the structural parameters of the economy[9]

$$\tilde{\theta}(\lambda, \delta, \sigma, \pi) = \pi(\sigma/\lambda + \delta)/2 + [\pi^2(\sigma/\lambda + \delta)^2/4 + \pi\delta/\lambda]^{1/2}. \tag{15}$$

Equation (15) gives the rate at which the economy will converge to long-run equilibrium along the perfect foresight path. If expectations are formed according to (2) and (15), exchange rate predictions will actually be borne out.[10] The characteristics of the perfect foresight path are that the economy will converge faster the lower the interest response of money demand and the higher the interest response of goods demand and the price elasticity of demand for domestic output. The reason is simply that with a low interest response a given change in real balances will give rise to a large change in interest rates which, in combination with a high interest response of goods demand, will give rise to a large excess demand and therefore inflationary impact. Similarly, a large price elasticity serves to translate an exchange rate change into a large excess demand and, therefore, serves to speed up the adjustment process.

[9] In (16) we have taken the positive and therefore stable root of the quadratic equation implied by (14).

[10] Perhaps a remark about the perfect foresight path is in order here. Why should that path command our interest rather than being a mere *curiosum*? The reason is that it is the only expectational assumption that is not arbitrary (given the model) and that does not involve persistent prediction errors. The perfect foresight path is, obviously, the deterministic equivalent of rational expectations.

IV. The Effects of a Monetary Expansion

In this part we will study the adjustment process to a monetary expansion. The analysis serves to derive substantive results but also to highlight the manner in which expectations about the future path of the economy affect the current level of the exchange rate. This link is embodied in consistent expectations and makes the impact effect of a monetary disturbance depend on the entire structure of the economy.

In figure 2 we show the economy in initial full equilibrium at point A, with a long-run price level $\bar{p}$ and a corresponding long-run exchange rate $\bar{e}$ where the level of prices is determined, according to (5), by the nominal quantity of money, real income, and the interest rate. The long-run exchange rate by (9) will depend on the level of domestic prices and characteristics of the demand for domestic goods. The asset-market equilibrium schedule QQ that combines monetary equilibrium and arbitrage of net expected yields is drawn for the initial nominal quantity of money.

An increase in the nominal quantity of money that is expected to persist will cause a goods and asset market disequilibrium at the initial exchange rate and price. To maintain asset-market equilibrium, the increased quantity of money would have to be matched by higher prices and/or a depreciation in the exchange rate. The asset-market equilibrium schedule will shift out to $Q'Q'$, a shift that is (proportionately) equal to the increase in the nominal quantity of money.

It is immediately obvious that the new long-run equilibrium is at point C, where both goods and asset markets clear and exchange rate and price changes exactly reflect the increase in money.[11] This long-run homogeneity result is not surprising, since there is no source of money illusion or long-run price rigidity in the system.

Consider next the adjustment process. At the initial level of prices, the monetary expansion reduces interest rates and leads to the anticipation of a depreciation in the long run and, therefore, at the current exchange rate, to the expectation of a depreciating exchange rate. Both factors serve to reduce the attractiveness of domestic assets, lead to an incipient capital outflow, and thus cause the spot rate to depreciate. The extent of that depreciation has to be sufficient to give rise to the anticipation of appreciation at just sufficient a rate to offset the reduced domestic interest rate. The impact effect of a monetary expansion is, therefore, to induce an immediate depreciation in the spot rate and one that exceeds the long-run depreciation, since only under these circumstances will the public anticipate an appreciating exchange rate and thus be compensated for the reduced interest on domestic assets. This is shown in figure 2 by the move from point A to the short-run equilibrium at point B.

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[11] We have not drawn in fig. 2, the $\dot{p} = 0$ schedule. It is apparent, however, from the homogeneity properties of the model that the $\dot{p} = 0$ schedule will pass through point C.
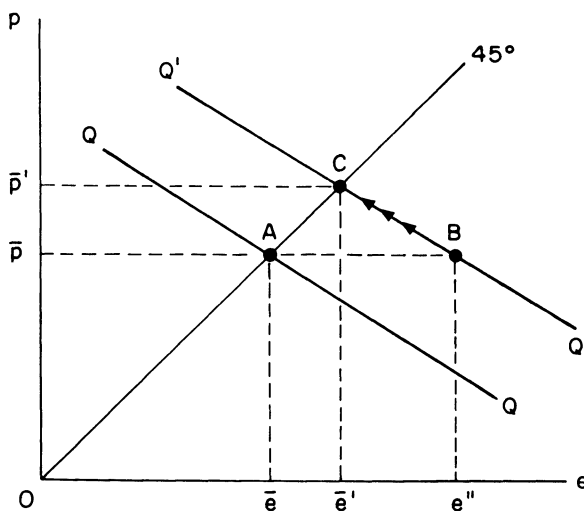
Fig. 2

From (4), noting that $d\bar{e} = dm = d\bar{p}$, we obtain a formal expression for the impact effect of a monetary expansion on the spot exchange rate:

$$de/dm = 1 + 1/\lambda\theta. \tag{16}$$

Equation (16) confirms that in the short run the exchange rate will overshoot. The extent of the overshooting will depend on the interest response of money demand and the expectations coefficient.

A high interest response of money demand will serve to dampen the overshooting because it implies that a given expansion in the (real) quantity of money will only induce a small reduction in the interest rate. A small reduction in the interest rate in turn requires only a small expectation of appreciation to offset it and therefore, given the coefficient of expectations and the long-run rate, only a small depreciation of the spot rate (in excess of the long-run rate) to generate that expectation. A similar interpretation applies to the coefficient of expectations in (16).

It is quite obvious from the preceding explanation that the short-term effects of a monetary expansion, in this model, are entirely dominated by asset markets and, more specifically, by capital mobility and expectations. This feature places in sharp relief the assumption that asset markets and exchange rates adjust fast relative to the goods market and the price of domestic output. It is under these circumstances that a change in the nominal quantity of money is, in fact, a change in the real quantity of money, and the spot rate adjustment serves to achieve equilibrium in the asset markets by creating the expectation of appreciation of just sufficient an extent to balance the reduced interest rate on domestic assets.

The interpretation of (16) has not so far used the restriction that

expectations be rational. That restriction is introduced by substituting (15) in (16) to obtain

$$de/dm = 1 + 1/\lambda\tilde{\theta} = 1 + \frac{1}{\pi(\sigma + \delta\lambda)/2 + [\pi^2(\sigma + \delta\lambda)^2/4 + \pi\delta\lambda]^{1/2}}.$$

(17)

Equation (17) has two implications that cannot be derived from (16). The first is that with an interest response of money demand that approaches zero the initial depreciation remains finite and, in fact, approaches $de/dm = 1 + 1/\pi\sigma$. This result reflects the fact that, for the large interest rate changes that would result in these circumstances, the subsequent path of prices and the exchange rate is governed by the effect of interest rates on aggregate demand.

A second implication of (17) is the fact that the short-run overshooting of the exchange rate is inversely related to the speed of adjustment of the system, $\tilde{\theta}$. That fact is particularly obvious for the case where the speed of adjustment of prices, π, becomes infinite and where, accordingly, the economy jumps instantaneously to the new long-run equilibrium at point C.[12] More generally, those factors that serve to speed up the adjustment process, in particular high interest rate responsiveness of money demand, or aggregate spending, or high price elasticities, will therefore serve to dampen the impact effect of a monetary expansion on the exchange rate. This effect relies entirely on expectations about the subsequent path of the economy, rather than on *current* interaction between goods and asset markets.

Consider next the adjustment process from the short-run market equilibrium at point B to long-run equilibrium at point C. We note from figure 2 that at point B there is an excess demand for goods. That excess demand arises both from the decline in domestic interest rates and from the depreciation in the exchange rate that lowers the *relative* price of domestic goods. Each factor by itself is sufficient to account for this excess demand and, in fact, they constitute independent channels through which monetary changes affect demand for domestic output.

The exchange rate channel has been identified by Fleming and Mundell as an important avenue for monetary policy to act on aggregate demand.[13] In the present context the depreciation of the spot rate that is induced by the conditions of asset-market equilibrium serves to reduce the relative price of domestic goods and thereby to raise aggregate de-

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[12] The slope of the QQ schedule is $dp/de = -\tilde{\theta}\lambda$, and the schedule becomes vertical as $\tilde{\theta}$ approaches infinity.

[13] In the Mundell–Fleming model with prices and interest rates fixed, the depreciation by worsening the terms of trade creates the necessary increase in aggregate demand to support the higher level of income required by monetary equilibrium (for a further discussion see Niehans [1975] and Dornbusch [1976]).

mand and give rise to inflationary pressure as opposed to an increase in output. The importance of this channel is larger, the higher the price elasticity of demand relative to the interest response of aggregate spending.

The lower interest rates and a lower relative price of domestic goods, that are characteristics of the impact effect, will cause domestic prices to rise and therefore be reflected in falling real money balances, rising interest rates, and an appreciating exchange rate. The adjustment process of rising prices over time restores the economy to the initial real equilibrium. An important feature of that adjustment process is the fact that rising prices are accompanied by an appreciating exchange rate. In terms of figure 2, this is described by the move along $Q'Q'$ from B to C. This result is due to the fact that rising prices cause the real money supply to be falling and interest rates to be rising. The rising interest rate, in turn, gives rise to an incipient capital inflow that appreciates the exchange rate at the same rate as interest rates are rising and thus maintains expected net yields in line. The model therefore confirms the link between interest rates and exchange rates that is emphasized in popular interpretations of foreign exchange events. The observation is correct, in the present circumstances, because rising interest rates are accompanied by the expectation of an appreciating exchange rate.

In summarizing this part we note that the ultimate effect of a monetary expansion is an equiproportionate increase in prices and the exchange rate. In the short run, however, the monetary expansion does exert real effects on interest rates, the terms of trade, and aggregate demand. The details of the adjustment process will depend on the economic structure. In particular, terms of trade changes will be both larger and more persistent the lower the speed of adjustment, $\tilde{\theta}$.

A key role in this analysis is played by the sluggish adjustment of prices as compared with asset markets. There is no very persuasive theoretical support for the slow adjustment of goods markets, but the facts clearly point in this direction. While the differential adjustment speed lacks theoretical backing, it implies, nevertheless, a behavior of exchange rates that is suggestive of recent experience.[14]

V. Short-Run Adjustment in Output

So far we have assumed that output is fixed at the full-employment level, $\bar{y}$. In the present part, the analysis is extended to allow for short-run adjustments in output in response to changes in aggregate demand.

[14] An extension of this paper would draw in an explicit manner on stochastic elements to provide a rationale for the short-run stickiness of prices. At the same time, such an extension would have interesting implications for the manner in which expectations are formed. Exchange rate determination in a stochastic setting has been studied by Black (1973), Kouri (1975), and Mussa (1976). Fischer (1976) has used a stochastic framework to evaluate fixed versus flexible exchange rate systems.

Therefore, we replace equation (8) by an equilibrium condition in the domestic goods market,

$$y = \ln D \equiv u + \delta(e - p) + \gamma y - \sigma r, \qquad (18)$$

where y is the log of the actual level of output that in the short run is demand determined. In addition to (18), we require a price adjustment equation which is shown in (19):

$$\dot{p} = \pi(y - \bar{y}). \qquad (19)$$

According to (19) the rate of inflation is proportional to the discrepancy between actual and full employment, or "potential" output, $\bar{y}$. This price adjustment equation is a combination of a relationship between wage and price inflation, a relation between wage inflation and unemployment as in a Phillips curve, and a relation between unemployment and the departure from potential output, $y - \bar{y}$, as described by Okun's law.

It is shown in the Appendix below that the extension that incorporates (18) and (19) in place of (8) leaves most of the analysis of adjustments to a monetary increase unchanged. In particular, the price adjustment will continue to be exponential although the speed of adjustment will depend now also on the income elasticities of demand for domestic goods and real balances, γ and ϕ.

In the present framework it continues to be true that in the short run an increase in the nominal quantity of money is an increase in the real quantity of money. Accordingly, a monetary expansion has the conventional effect of increasing in the short run the level of output and inducing inflation. Since the inflation that is induced by the expansion in real output serves to raise over time the price level, real balances will decline back to their initial level until in the long run the expansion in money is fully matched by increased prices and output has returned to the full-employment level.

The impact effect of a monetary expansion on exchange rates and interest rates may, however, differ significantly from the analysis in Part IV. The new possibility that arises from the expansion in output in the short run is that the exchange rate depreciation will fall short of the monetary expansion rather than exceed it as in (16). That possibility arises because, in the short run, the income expansion raises money demand and may do so sufficiently to actually increase interest rates. If the output expansion were sufficiently strong to raise interest rates, equalization of net yields internationally would require the expectation of a depreciation and therefore a spot rate that falls short of the long-run equilibrium rate. Since the long-run equilibrium rate increases in the same proportion as the nominal quantity of money, it follows that the

spot rate would increase less than the quantity of money. The condition
that gives rise to this case is

$$1 - \phi\delta/(1 - \gamma) < 0. \tag{20}$$

The term $\delta/(1 - \gamma)$ is the elasticity of equilibrium output with respect
to the exchange rate. That term multiplied by the income elasticity of
demand gives the increase in money demand due to a depreciation in the
spot rate. Accordingly, (20) tells us whether at constant interest rates,
and allowing the exchange rate to depreciate in the same proportion as
the increase in money, we have an excess demand or supply of money and,
accordingly, an increase or decrease in interest rates. The possibility of
an excess demand and therefore an increase in interest rates is associated
with a high income elasticity of money demand, high price elasticity, and
a high income elasticity of demand for domestic goods.

The time path of exchange rates and the interest rate therefore depends
on income and price elasticities, and the short-run overshooting of
exchange rates is no longer a necessary feature of the adjustment process.
In fact, if in the short run the interest rate rises and the exchange rate
therefore depreciates less than proportionately to the increase in money,
the adjustment process will be one of rising prices and a depreciating
exchange rate. In this event, therefore, terms of trade fluctuations will be
dampened as compared with the case described earlier where the exchange
rate overshooting introduces large terms of trade variations in the adjust-
ment process.

The analysis of a monetary expansion in this part confirms once more
the Mundell-Fleming result that under conditions of capital mobility and
flexible rates a small country can conduct, in the short run, an effective
monetary policy. More important, the exchange rate proves a critical
channel for the transmission of monetary changes to an increase in
aggregate demand and output. That channel may, in fact, prove to be the
only channel since, as was shown above, the interest rate may actually
rise in the transition. Unlike in the Mundell-Fleming world, extension of
the analysis to the long run shows that the effects of a monetary expansion
are only transitory, since the inflation that is induced by the output
expansion serves to reduce real balances and thereby return interest rates,
relative prices, and real income to their initial level.

The possibility of short-run output adjustment has been shown to
dampen exchange rate movements and possibly reverse the interest rate
effects of a monetary expansion. It is appropriate, therefore, to ask which
of the assumption, fixed or variable output, is a more relevant character-
istic of the adjustment process. The answer no doubt is that the fixed
output adjustment is a suitable characterization of the very short run.
In the very short run we would not expect output to adjust instantaneously

to meet an increase in aggregate demand and, accordingly, the adjustment will be primarily confined to the asset markets and will be characterized by a decline in interest rates and overshooting of exchange rates. In the intermediate run, on the contrary, the present analysis gains relevance, since here we would expect an adjustment of both output and prices in response to increased aggregate demand. On balance, therefore, the fixed output case retains relevance, and particularly so if output adjusts sluggishly to changes in aggregate demand.

Appendix

This Appendix extends the model to include short-run supply responses. For that purpose we replace the price adjustment equation in (8) by a goods-market equilibrium condition (A1) and a price equation (A2):

$$y = \mu[u + \delta(e - p) - \sigma r]; \mu \equiv 1/(1 - \gamma) > 0, \tag{A1}$$

$$\dot{p} = \pi(y - \bar{y}), \tag{A2}$$

where $\bar{y}$ denotes the full-employment level of output and where the price adjustment equation can be thought of as arising from a Phillips-curve relation between wage inflation and unemployment combined with an Okun's-law relation between the deviation from potential output, $y - \bar{y}$, and unemployment.[15]

The specification of the money market and exchange rate expectations remains unchanged, and equation (4) that represents these relations is repeated here for convenience:

$$p - m + \phi y = \lambda r^* + \theta\lambda(\bar{e} - e). \tag{A3}$$

Noting that in long-run equilibrium we have $y = \bar{y}$ and $r = r^*$, we obtain from (A1) the long-run goods-market relationship

$$\bar{y} = \mu[u + \delta(\bar{e} - \bar{p}) - \sigma r^*], \tag{A4}$$

and subtracting (A4) from (A1) we obtain the goods-market equilibrium condition expressed in terms of deviations from long-run equilibrium,

$$y - \bar{y} = \mu(\delta + \sigma\theta)(e - \bar{e}) + \mu\delta(\bar{p} - p), \tag{A5}$$

where we have used the fact that $r^* - r = \theta(e - \bar{e})$.

Next we proceed in a similar manner for the money market and rewrite the equilibrium condition as

$$\phi(y - \bar{y}) + (p - \bar{p}) = \lambda\theta(\bar{e} - e). \tag{A6}$$

Equations (A5) and (A6) can be simultaneously solved to yield the spot exchange rate and the level of output as a function of the existing price level. These solutions are, respectively,

$$y - \bar{y} = -w(p - \bar{p}), \tag{A7}$$

where

$$w \equiv [\mu(\delta + \theta\sigma) + \mu\delta\theta\lambda]/\Delta; \quad \Delta \equiv \phi\mu(\delta + \theta\sigma) + \theta\lambda,$$

and

$$e - \bar{e} = -[(1 - \phi\mu\delta)/\Delta](p - \bar{p}). \tag{A8}$$

[15] To deal with steady-state inflation we would have to add in (A2) the long-run rate of inflation which is given by the rate of monetary growth, which in the present treatment is assumed equal to zero.

Substitution of (A7) in (A2) yields the equilibrium rate of inflation as a function of the price level:

$$\dot{p} = -\pi w(p - \bar{p}).\qquad\text{(A9)}$$

Following the procedure in Part III, rational expectations require that the expectations coefficient, θ, equal the rate at which exchange rates actually adjust, πw:

$$\theta = \pi w,\qquad\text{(A10)}$$

which can be solved for the rational expectations coefficient of adjustment, $\tilde{\theta}$.

Consider next the impact effect of a monetary expansion. Remembering that in the long run an increase in money causes an equiproportionate increase in prices and the exchange rate, we have $d\bar{e} = d\bar{p} = dm$. Therefore, from (A8) we obtain the impact effect of a monetary expansion on the exchange rate as

$$de/dm = 1 + (1 - \phi\mu\delta)/\Delta > 0.\qquad\text{(A11)}$$

Whether the exchange rate increases more or less proportionately than the nominal quantity of money depends on the condition

$$1 - \phi\mu\delta \gtrless 0,\qquad\text{(A12)}$$

which determines, too, whether the interest rate declines or increases.

By (A7) the impact effect on real output is unambiguously positive and equal to $dy/dm = w$. The increase in the rate of inflation is given by $d\dot{p}/dm = \pi w$.

Since from (A9) the inflation rate converges monotonically to the long-run level, we know that output declines monotonically back toward the level of full employment. The exchange rate, following the impact effect, will appreciate, or depreciate, depending on (A12).

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