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Chapter Author: Rudiger Dornbusch

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Rudiger Dornbusch

In the 1960s, Robert Mundell and Marcus Flemming worked out the formal framework for open-economy macroeconomics that would reign for more than a quarter of a century. The Mundell-Flemming model, built on the assumption that prices move slowly relative to exchange rates and that international capital mobility is a central factor in the transmission of business cycles, continues virtually unchallenged today. Of course, the models we use today have gone further in separating short run and long run, in allowing a role for expectations, and in taking into account the consequences of trade imbalances for asset accumulation. Even the stock market has now become part of the wider model. But the conclusions remain close to those of the Mundell-Flemming model. When we ask what the impact of monetary expansion is on the exchange rate and the balance of trade, the answer continues to be that increased money induces a real depreciation and hence an improvement in the external balance. Where then is the fruit of research in the past ten or fifteen years? These recent advances, even though they are only starting to show all their implications, will significantly advance our understanding of open-economy macroeconomics.

I want to highlight here three separate directions of research. The first is models of imperfect competition with their implications for price adjustment to exchange rate or commercial policy disturbances. The second direction of research is concerned with models of adjustment built around the notion of irreversible investments and the value of waiting. The third research program deals with apparently excessive

Rudiger Dornbusch is Ford International Professor of Economics at the Massachusetts Institute of Technology and a research associate at the National Bureau of Economic Research.

movements in exchange rates in response to disturbances. I will consider these in turn.

11.1 Pricing

There are two models of open-economy macroeconomics. One model assumes a small country that faces given prices in world trade and adjusts, under conditions of perfect competition, to those prices. Depreciation raises prices equiproportionately, and tariff liberalization reduces import prices by the full amount of the tariff cut. The other model, which is used as the pricing assumption in Mundell-Flemming, has prices as a fixed markup over unit labor costs. Wages are assumed fixed in nominal terms and so accordingly are prices. In this model, depreciation brings about an equiproportionate gain in competitiveness or loss in the terms of trade.

The new direction of research considers explicitly an industrial-organization pricing approach as part of the macroeconomic model. Pricing depends on market structure, market segmentation, and the domestic-versus-foreign cost base of participating firms. This approach has obvious fruits in two areas of application. Consider first exchange rate movements. When a currency is depreciated, with wages fixed at home and abroad, foreign firms experience a cost increase in home currency while home firms have no change in their cost. Industry equilibrium is disturbed by the unfavorable cost shock experienced by foreign firms, and industry price must change. The adjustment in price will depend on a host of factors. An example will make this point. Using a partial equilibrium approach to a particular industry, suppose that the product is diversified and that the Salop-circle model describes well the diversification. Assume that consumers are uniformly distributed along the product circle (in terms of their tastes) and that there are four firms, two domestic and two foreign. They alternate so that firms 1 and 3 are foreign, while firms 2 and 4 are domestic. Initially spatial competition has established a symmetric location pattern where firms share the market equally, so that each firm serves an equal number of customers to the left and right.

We now explore the effects of a home depreciation, given fixed unit labor costs in each country.¹ Consider firm 1. The depreciation of, say 10%, raises foreign firms' costs in dollars and raises marginal cost relative to the unchanged marginal revenue of competing the marginal customer away from firm 2 or firm 3. The equilibrium relative price structure will change as firm 1 raises its price and firms 2 and 4 match the increase partially. Figure 11.1 shows the reaction functions of the typical domestic (*DD*) and foreign firms (*RR*). The equations are, respectively:

$$(1) \quad p = (p^* + c/n + w)/2$$

and

$$(2) \quad p^* = (p + c/n + ew^*)/2,$$

where w and w^* are unit labor costs in the respective currencies, c is the consumers' transport cost per unit distance away from the preferred product, and n is the total number of firms supplying the market. The price structure is determined by the Nash equilibrium at point A . The level of prices is higher, relative to unit labor costs, the lower the substitutability and the smaller the number of firms.

Home depreciation, by raising foreign suppliers' marginal cost in home currency, shifts the foreign reaction function from RR to $R'R'$. The relative price of foreign products increases at A' , and the price charged by domestic firms also increases. The elasticity of price with respect to the exchange rate depends on the number of firms in the industry and on the substitutability between alternative suppliers. The range of customers served by foreign firms contracts as a result of their increased relative price, as does their profitability. Home firms expand.

The model can be made more realistic by inclusion of two further considerations. The first is entry and exit. In the above discussion we assumed implicitly that there are no fixed costs and that firms have a fixed location in the product space. The second concerns capacity constraints. Each of these will affect pricing strategies and hence the impact of exchange rate movements on equilibrium prices.

In the postdepreciation equilibrium, the increased profitability of firms whose cost base is in the home market may bring about entry of new firms. These entering firms will select a location that places them optimally between existing firms. The entrants cause industry price to decline relative to the equilibrium at point A' . But they may also force

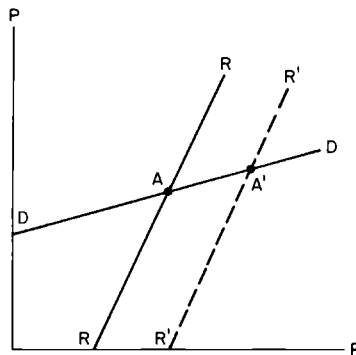


Fig. 11.1

The effect of exchange rate depreciation on relative prices.

high-cost foreign firms altogether out of the market. Of course the possibility of entry will influence the pricing policy of existing firms and hence limit in the first place the price response to depreciation.

Capacity constraints also influence the response of pricing to exchange rate shocks. Suppose that in the initial equilibrium at point *A* all firms are almost capacity constrained. The move to *A'* with a reduction in the relative price of domestic products is therefore not possible, since it would involve an expansion of sales by home firms. In the presence of capacity constraints, domestic firms price so as to maintain constant their volume of sales. Thus they will fully match foreign firms' price increases. The large price response in turn raises the issue of entry of new firms with a domestic cost base or expansion of capacity by existing firms.

These examples already show that there is a fruitful application of industrial organization approaches to open economy price responses. These ideas are important for the discussion of exchange rate effects and for the international transmission of price disturbances. But they apply equally to commercial policy questions. Suppose a small country liberalizes imports. We would expect that with fixed costs in setting up distribution networks, the smaller the country, the smaller the number of diversified products that can profitably be marketed. But that has radical implications: even under free trade we would not expect pricing at the world level. Except for the threat of entry, the size of the market creates an oligopoly structure. Changes in commercial policy such as tariff reduction are unlikely to be passed on fully. In the competition on the circle model, for example, the elasticity of final prices charged by foreign firms with respect to the tariff is less than two-thirds and that of home firms less than one-third. Moreover, if there are few firms and substitution is poor, these elasticities fall off sharply. These conclusions have immediate implications. Most important among these is the finding that opening the economy to induce price discipline will work poorly in very small countries and in industries where there are significant fixed costs and entry costs.

11.2 Waiting

Many investments have the property that they are almost irreversible, except via depreciation or at a significant loss. Pindyck (1986), following a number of earlier authors, has explored the optimal timing of such irreversible investments when the return on the investment project evolves stochastically.

Suppose, concretely, that a firm faces a stochastic demand

$$(3) \quad p = x - aQ,$$

where x denotes the state of demand which follows a Wiener process with drift and has a standard deviation s . Pindyck derives for this case the investment rule drawing on option pricing. The key idea is that the decision to invest amounts to the exercise of an option. The option will be exercised only when the state of demand is sufficiently favorable. Even though a unit of installed capital may already be profitable at a given level of demand, it may be profitable to postpone investment. The irreversibility of investment and the possibility of adverse states of demand place a premium on waiting for sufficiently favorable demand conditions. The optimal capital stock will depend on, among other determinants, the state of demand, x , as well as the variability of demand, s .

$$(4) \quad K' = K'(x, s, \dots).$$

The investment rule is to choose at any point the larger of K' and K , the actual capital stock in place. In figure 11.2 I show the schedule $K'(x, \dots)$ upward sloping. At a given time there will be a realization of demand x_0 and a given capital stock K_0 . At a point like A the firm will not add to capacity. But if demand improves to a level x_1 the firm would add to the capital stock to reach point A' . Thus, small changes in demand, in the region below $K'(x, \dots)$, do not affect investment, while large increases in demand lead to investment. The location of the schedule $K'(x, \dots)$ will depend on the variability of demand. Increased variability reduces the desired capital stock at each level of demand.

This option-pricing approach to near-irreversible investments has many applications in open-economy macroeconomics. I will sketch here only two. Consider first the issue of European unemployment. Unemployment is commonly attributed to an excessively high real wage. It is argued that real wage increases in the 1970s outpaced pro-

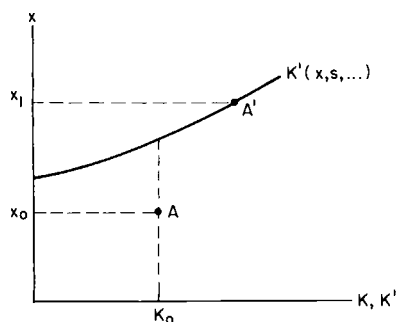


Fig. 11.2 Investment decisions and the value of waiting.

ductivity growth and the adverse effects of energy price increases. Hence unemployment is classical. The option-pricing approach to irreversible investments suggests an alternative interpretation. We can think of labor as an almost-irreversible investment. Attrition of the labor force or severance pay are the only ways in which a firm can relinquish labor.

With a suitable reinterpretation of the Pindyck problem, we can derive as in figure 11.3 the employment problem of the firm. The hiring and firing lines are HH and FF . If demand falls sufficiently low, given the variability and trend growth of demand relative to the rate of labor force attrition through retirement, the firm will fire workers. This defines the line FF , which is the maximum employment level the firm will sustain for a given low-demand level. The schedule HH shows the employment level to which a firm will move in favorable demand states. The corridor in between defines the area where demand changes do not influence employment. If the firm is initially at point A , a fall in demand below x_1 will lead the firm to fire workers, and a rise in demand above x_2 will lead to new hires. Smaller changes in demand have no effect.²

The location of these hiring and firing lines depend on all the parameters that govern the evolution of demand, on labor force attrition, and on severance pay. For that reason the model can help explain how the shift in the stochastic environment from the sixties to the seventies has led to the sharp increase in unemployment. The stochastic environment has deteriorated, since trend growth of demand has declined while the variability of demand has increased. Firms accordingly find that they have excessive labor, and they respond by shedding labor through attrition. In terms of figure 11.3, the corridor widens. The counterpart, of course, is an increase in youth unemployment and long-term un-

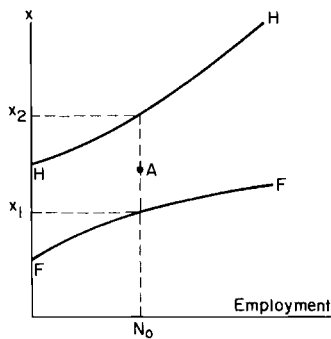


Fig. 11.3

Hiring and firing decisions when employment is quasi-irreversible.

employment. The model also predicts that firms will not show a significant response to a small increase in demand.

The same model can be used for any of a number of investment decisions. Obvious candidates are investment responses to real exchange rate changes. If real exchange rates move randomly, at what point do firms invest to expand capacity or scrap capital? A different kind of question that can be asked in this setting is that of the return of flight capital. The experience is that the return of flight capital tends to be very slow, except when the threat of bankruptcy forces firms to repatriate funds. This issue fits well into the spirit of the quasi-irreversible investment model. The risk of returning capital too early is that conditions deteriorate again, and that a renewed outflow can only occur at a high penalty cost. Hence the investment climate must become sufficiently favorable so that the immediate payoff on returning capital overshadows the prospect of a subsequent deterioration. But that poses a policy problem, because front-loading the benefits to a return of flight capital may run counter to fiscal stabilization and a favorable investment climate, or it may involve a politically unacceptable income redistribution.

11.3 Expecting

The third direction of research which I find particularly fruitful deals with expectations and their impact on portfolio choices and hence exchange rates. In Dornbusch (1976), I showed how once-and-for-all changes in the money stock, with sticky prices in goods and markets and perfect foresight in asset markets, lead to an overshooting of exchange rates. Lyons (1987) and Engel (1987) have rightly pointed out that the once-and-for-all model is not very interesting as a policy experiment. In a much richer model of a stochastic money supply process and rational expectations, they show that innovations in money growth, because they are extrapolated into cumulative increases in money, lead to sizable short-run movements in exchange rates in response to even small changes in money.

This is a promising direction for modelling exchange rate responses, putting the emphasis on the extrapolation of current events. A simple example can explain what is involved. Suppose that innovations in money are serially correlated, and suppose that inflation adjusts only gradually. A positive innovation in money is extrapolated into a cumulative accumulation of money relative to the trend growth. This implies that in the long run, the exchange rate will have moved to a higher path, as will the price level. Because inflation is not fully flexible, in the short run the real money stock is seen as growing, and hence nominal interest rates will be declining for some time before inflation

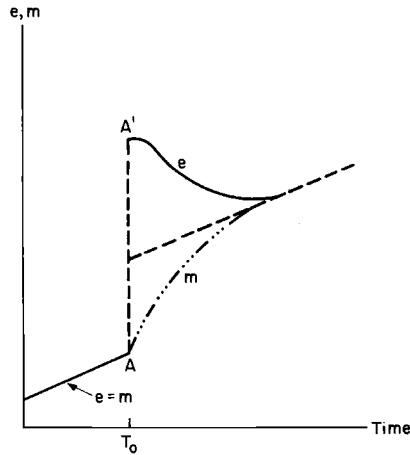


Fig. 11.4 The effect of a monetary innovation on money supply expectations and the exchange rate.

builds up to erode the growth in nominal balances. Ultimately the system returns to the initial rate of inflation, money growth, and depreciation.

Figure 11.4 shows the exchange rate path in response to this experiment. Initially, up to time T_0 the economy moves along the solid line. At T_0 the innovation occurs and is extrapolated. The public recognizes that asymptotically the economy will converge to the higher exchange rate path reflecting the cumulative increase in money relative to trend shown by the dashed line. But there will be an immediate depreciation of the exchange rate from A to A'. The overshooting reflects the fact that forward-looking asset holders anticipate the cumulative depreciation and will only hold domestic assets, in the face of reduced interest rates, if the exchange rate is appreciating. Along the new exchange rate path, the rate of appreciation, following the initial jump, will accelerate for some time as nominal interest rates initially decline. The basic point of this analysis is that the forward-looking expectations about the evolution of money, extrapolating the serial correlation of disturbances, must find their way immediately into the spot exchange rate. The analysis has obvious extensions to fiscal policy and other determinants of the exchange rate.

11.4 Concluding Remarks

The common trend of the three developments I have reviewed is to take open-economy macroeconomics away from a simple and mech-

anistic model. These new ideas do not change the qualitative direction of basic messages. In fact, they are not even surprising. But they do bring with them much more qualified comparative static properties. The response of investment to real exchange rates depends not only on current profitability but also on the anticipated persistence. The effect of innovations in money depends on how the public extrapolates the money innovation. Exchange rate impacts on prices and trade flows depend on the conditions of entry and on the number of firms. I believe these new ideas force us also to modify our testing of hypotheses. Case studies seem a suitable approach to try to start capturing this broader picture.

Notes

1. The discussion here draws on Dornbusch (1987).
2. For a complete model see Bentiola and Bertola (1987).

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