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PRICING TO MARKET WHEN THE EXCHANGE RATE CHANGES

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ABSTRACT

It has been widely remarked that US import prices have not fully reflected movements in the exchange rate. This paper begins with an investigation of the actual extent of "pricing to market" by foreign suppliers. It shows that pricing to market is a real phenomenon, but not universal; in particular, evidence on German export prices suggests that stickiness of import prices is largely confined to machinery and transport equipment. The paper then considers a number of possible models. While the evidence is not sufficient to distinguish among these models, it seems probable that a full explanation will involve both dynamics and imperfect competition.

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It has been widely remarked that the prices of many imports into the US have not fallen to the degree that one might expect given the strong dollar. The most conspicuous examples have been European luxury automobiles, whose US prices have in many cases actually risen in dollar terms despite huge declines in European currencies against the dollar. Since prices in Europe, in European currencies, have not risen dramatically, the effect has been to create large differences between prices of the same automobiles in the US and Europe. The price differential in turn has given rise to "gray markets" in which individuals and firms bypass normal distribution channels to import automobiles directly from Europe.

The phenomenon of foreign firms maintaining or even increasing their export prices to the US when the dollar rises may be described as "pricing to market" (PTM). Pricing to market is an interesting subject for both practical and intellectual reasons. The immediate practical concern is with the effects of a declining dollar on inflation. While many economists expect a declining dollar to contribute to a resurgence of inflation, some observers from the business community have disputed this. They argue that foreign firms did not cut their prices as the dollar rose, and that they will maintain their pricing to market as the dollar falls. Thus these

observers argue that the effects of a decline in the US dollar on import prices will in fact be small.

The intellectual interest of pricing to market is that it offers evidence on the role of market structure in international trade. For the past decade, theorists have been proposing new models of international trade that stress imperfect competition and dynamic aspects. These models have unfortunately often proved difficult to test. The phenomenon of pricing to market, however, offers a possible new piece of evidence. As I will argue below, pricing to market properly understood almost certainly involves both imperfect competition and dynamics, so that its apparent importance is a confirmation of the practical importance of "new wave" models of trade. Furthermore, as we will see below, the importance of pricing to market appears to vary widely across industries. This raises the prospect that by correlating the importance of pricing to market with industry characteristics we will be able to distinguish between alternative unconventional trade models.

This paper does not pretend to offer either a full empirical examination or a definitive analytical treatment of the phenomenon of pricing to market. It is instead offered as a preliminary overview of the subject. The paper begins with some rough evidence on the extent to which pricing to market has actually occurred, and on the relative extent of PTM in different industries. I then turn to some possible theoretical models of PTM. The intention of this theoretical

discussion is to be provocative rather than definitive; that is, I offer a large batch of suggestive models (six in all) without attempting to settle on any one as the right one.

I. Some Empirical Evidence

A. Conceptual issues

Before examining some admittedly rough empirical evidence it is important to be more precise about what we mean by pricing to market. In general, we mean that import prices fall "too little" when a currency appreciates. This should not be taken to mean, however, that PTM is present whenever import prices fail to fall in proportion to the exchange rate appreciation. For a large country like the United States, a less-than-proportional response of import prices to the exchange rate is not in general surprising, and need not lead us to look for exotic explanations.

The best way to define when PTM is and is not occurring is to consider an example. Suppose that we measure the real exchange rate using unit labor costs, and that the US experiences a real appreciation in this sense against both France and Germany. For simplicity, let us in fact take nominal unit labor costs as fixed in

each country. Suppose also that France exports wine to the US, and Germany exports BMWs. Wine is traded on an arms'-length basis by middlemen who are prepared to arbitrage any international price differences; BMW shipments are arranged by the manufacturer, who therefore sets c.i.f. prices in each market rather than simply setting a single f.o.b. price in Germany.

Now even though the law of one price will apply to wine, we would not be too surprised if the dollar price of wine fails to fall as much as the US real appreciation. As French wine becomes cheaper in the US, we will buy more; if the US market is a significant share of French demand, this will drive up the price of wine in francs. The price of wine will not fall as much as the real dollar rises, but the price of French exports to the US will not rise relative to the prices on domestic sales or exports to Germany. This is an example of a case in which the import price appears to fall "too little", yet we would <u>not</u> want to call this a case of pricing to market.

By contrast, suppose that BMW decides for some reason to keep both its dollar prices in the US and its mark prices in Germany constant. In this case the price of BMWs will certainly not fall as much as the dollar rises, but that is not the distinctive point. What would be striking would be that prices of autos in Germany and prices of German exports to France would fall relative to export prices to the US. Indeed, if the prices diverged far enough there would be an incentive for individuals to bypass BMW's distribution channels and

create a gray market. This is the situation that I have in mind when discussing pricing to market.

Notice that when we look at aggregate price indices it does not matter whether the import price effects of an exchange rate change are dampened by garden variety supply and demand considerations, as in the case of wine, or by noncompetitive pricing practices, as in the case of BMWs. The reason for distinguishing PTM is analytical and microeconomic. We understand the competitive model of traded goods prices pretty well (although empirically the behavior of commodity prices in response to exchange rate changes is rather puzzling; see Dornbusch 1985). Thus I focus instead on what seems harder to explain, pricing to market that involves divergent movements in different markets.

The implication of our distinction is that the usual way in which price effects of exchange rate changes are assessed, by comparing some price change directly with an exchange rate movement, will not do in this case. We always need to compare the price change with some measure that takes into account any effect of the exchange rate on world prices of the imported good, so that we can exclude these effects from our measure of PTM.

I have attempted to measure the extent of pricing to market using three kinds of comparison. (Unfortunately, in all cases the price data are unit value indices rather than true price indices. The problems with these measures are well known, but there do not seem to be better

numbers). The first is a comparison of aggregate US manufactures import prices with a "predicted" import price index using export prices of major US trading partners. The second is a comparison of Germany's prices on exports to other EC countries with her prices on extra-European exports. The third is a comparison of prices of German exports to the US and to the rest of the world.

B. Aggregate US manufactures import prices

The first comparison is shown in Figure 1. Three series are shown. First, we show how the actual unit value of US manufactures imports changed from 1980 to 1984. This measure of the import price rose imperceptibly, by 0.5 percent, over the period. Second, we show a "predicted" US import price. This is an average of the manufactures export unit values in dollars of Canada, Japan, the European Community, and developing countries, weighted by their shares in US imports in 1980. This index fell by 9.2 percent from 1980 to 1984. Finally, for reference we include the US manufactures export unit value, which rose 21 percent in four years.

To interpret these series, suppose that each country exported only a single manufactured good, and that this good were sold at a single world price -- i.e., that there were no pricing to market. Then we would expect the aggregate US import price index to fall in proportion to our "predicted" price index. The extent to which this fails to happen can then be interpreted as our measure of PTM.

Clearly, US manufactures import prices fell "too little", by 9.7 percent. If we use the divergence between US and trading partner export prices -- 30.5 percent -- as a measure of the real exchange rate change, then PTM was 9.7/30.5 = .32 of the real exchange rate movement.

C. Aggregate German exports

Figure 2 shows our second comparison. It makes use of the convenient fact that Germany reports separate unit value series for trade with other EC countries and trade with the rest of the world. This is useful, because during the first half of the 1980s Germany had fairly stable exchange rates against most of the EC, while the ecu depreciated sharply against the dollar and to a lesser extent the yen.

Two series are shown, both for finished manufactures. First, we show the ratio of import unit values from EC countries to those from outside the community. This series can serve as an indicator of the extent to which the mark depreciated more in real terms relative to the world at large than it did relative to the EC. By 1984 this measure had declined by 9.4 percent. This is not as large a change as in the case of the US, so that problems of measurement error become even more acute. Nonetheless, there is some evidence of PTM.

The evidence is contained in the second series, which compares German export unit values to the EC with those on exports to the rest of the world. This series shows a decline of 2.5 percent. If Germany did not engage in any pricing to market (and if the price indices for EC and rest of world exports were truly comparable) this number should be zero. Clearly we do not want to lay too much stress on this number, which is within the bounds of measurement error. For what it is worth, however, the implied extent of PTM is 2.5/9.4 = .26, which is not too inconsistent with our results for US import prices.

D. German-US trade

Our last evidence is shown in Figure 3. Here an attempt is made to compare the movement of German export prices to the US with prices to other countries from 1980 to 1983. Again if Germany did not engage in any pricing to market (and if the price indices were comparable) these movements would be identical.

To construct these numbers, the following procedure was used. First, unit values were constructed for German three-digit SITC exports to the US and to all other trading parteners for both 1980 and 1983. Then "price indexes" were constructed by applying these unit values to the bundle of three-digit export quanta that Germany exported to the US in 1980. That is, the measures are supposed to

measure what the 1980 bundle of US imports from Germany would have cost if the US had been able to buy these imports at the prices other countries were paying. These indexes were calculated both for one-digit categories and for German manufactured exports as a whole. The weaknesses of this method are severe enough to make us treat the results with great caution. Nonetheless, it is interesting to have a look, however crude, at the disaggregated pattern of pricing to market.

Let us consider first however the aggregate change. The German price index for manufactured exports to the US, in dollars, appears on our calculation to have fallen by only one percent from 1980 to 1983. (The mark fell by 29 percent in nominal terms). Meanwhile, the price of the same bundle of exports to other countries fell in terms of dollars by 14 percent. This gives us a PTM divergence of 13 percent. Over the same period, US export unit values, as reported in International Financial Statistics, rose 33 percent relative to Germany's. so that the extent of PTM may be estimated at 13/33 = .39 -- a number again reasonably consistent with our estimate for US aggregate imports.

When we look at the data by single-digit SITC, the basic result seems so dramatic that it is hard to discount, the limitations of the data notwithstanding. This is that PTM, instead of being comparable across sectors, in fact occurs in only one sector, machinery and transport equipment. In this sector the export price to the US

actually rises by 5 percent, while the price to other countries falls by 12 percent. Admittedly this is a large sector, but PTM is absent in other large German export sectors such as chemicals and basic manufactures. This selectivity of the occurrence of pricing to market is one of the things that we would like our theoretical analysis to explain.

E. Summarizing the evidence

Our examination of the data may be summarized as saying two things. First, pricing to market when the exchange rate changes is a real phenomenon: both our examination of aggregate US import prices and our data on US-German trade suggest that more than 30 percent of the real appreciation of the dollar was reflected in a divergence between prices of US imports and prices of the same goods in other markets. Second, however, PTM is not universal. Our disaggregated US-German evidence seems to say that pricing to market is limited to the transportation equipment and machinery industries.

We should note that the evidence does not support the extreme claims some have made about the failure of exchange rate changes to be reflected in import prices. A good deal less than half of the rise in the dollar was reflected in a divergence between US and foreign prices of US imports. This is because pricing to market seems to be selective

across sectors, and perhaps also because even when it occurs it is not complete.

On the other hand, the extent of PTM is clearly enough to be significant for macro analyses. That will not, however, be the concern of this paper. Instead, I will now turn to the microeconomic question: How can we explain pricing to market?

II. Theoretical Analysis: Static Models

In our theoretical discussion of the pricing to market phenomenon, we will consider a series of models. These models fall into two classes. First are static models. What I mean by a static model in this context is a model in which the belief on the part of firms that the dollar's rise is temporary does not play any role in their pricing behavior. That is, in these static models the pricing to market would last even if the real appreciation of the currency were expected to remain unchanged indefinitely. It seems a priori unlikely that a static approach would be adequate here, but it makes sense to consider the simplest option first.

Then we will turn to dynamic models. In these models it is assumed to be crucial that the dollar's rise is taken to be temporary. That is, in these models foreign firms are for some reason pricing

based on their expected long run costs rather than on their temporarily low costs during a period of a strong dollar. The point is of course to explain why the firms should adopt such a long run pricing rule.

Let us begin, however, with the static models. Three such models will be considered. First is simple supply and demand. It will become clear that this model cannot account for the key phenomenon of divergent prices, but it is still illuminating to consider what it can explain. Second, we consider monopolistic price discrimination. This model turns out to be somewhat in its implications. Finally, we turn to a simple oligopoly model. This has some nice features, but is ultimately implausible as an explanation of what we observe.

A. Supply and demand

The supply-and-demand model of the price implications of exchange rates goes back at least to Haberler (1949), and has recently been restated by Dornbusch (1985). Thus it needs only brief restatement here. We imagine a world of two countries, US and EC, and two currencies, dollar and ecu. Let P be the dollar price of some US importable, P* the ecu price, e the number of ecus per dollar. Also let S(P), S*(P*) be the supply from each region, while D(P) and D*(P*) are the demands. Then equilibrium may be described by two equations. First, we have world market clearing:

(1) $S(P) + S^*(P^*) - D(P) - D^*(P^*) = 0$

Second, we have the law of one price:

(2) $P^* = eP$

Equilibrium and the effects of a dollar appreciation may be illustrated as in Figure 4, which follows Dornbusch. Clearly a dollar appreciation, while it lowers the dollar price, raises the ecu price. Thus the dollar price does not fall in full proportion to the appreciation. Obviously this depends on the US being a large country: specifically, the elasticity of the ecu price with respect to the exchange rate is

$$\frac{d(S - D)/dP}{d(S - D + S^* - D^*)/dP}$$

Thus the extent to which import prices will fall "too little" will be equal to the US share in the response of world excess demand to price. Since the US <u>is</u> a large country, if the failure of import prices to fall as much as the dollar has appreciated was the only puzzle, the simple supply-and-demand model might be sufficient.

What this model cannot explain, however, is the pricing to market phenomenon of divergence between prices of goods sold to the US and to other markets. Indeed, equation 2, by asserting the law of one price, rules this out by assumption. That is, this analysis can explain why the dollar prices of Volvos and BMWs fail to fall in proportion to the dollar's rise, but it cannot explain why these prices have fallen in Europe relative to the US (that is, literally, a fall in P* relative to eP).

To explain such price divergence, we would have to add another element: we would have to have some kind of specificity of supply to the US market. Suppose, for example, that there were an upward-sloping supply curve for transportation of importables to the US market. Then the law of one price would be replaced with a new relation of the form

(2') $P^* = eP - t$

where t is marginal transport cost, and is increasing in the volume of US imports:

(3) $t = t(D - S)$

Without working this out in full detail, we can immediately see how this would work. A rise in the dollar would be accompanied by a fall in the US price, and thus a rise in US imports. The rise in

imports would however be associated with a rise in marginal transportation costs, and thus with a widened wedge between US and EC prices.

There are, however, several problems with a formulation like this. First, how plausible is it to suppose that marginal transportation costs are strongly upward sloping? Surely we would imagine that given time the supply of transportation is highly elastic. There could be short-run bottlenecks -- but this then brings us into the issue of dynamic response, which we will deal with in the next section. Also, this formulation does not account for the specificity of the pricing to market: why should marginal costs of transport of machinery and transport equipment be much more steeply upward sloping than those for other manufactures?

A possible answer is that what matters are not transport costs per se so much as other costs such as marketing and distribution. These could be highly specific to a particular set of products, and arguably might be more important for autos than for other goods. The marketing and distribution issue is, however, inevitably a dynamic one; thus we reserve fuller discussion until next section.

B. Monopolistic price discrimination

We turn next to the possibility that pricing to market can be explained by monopolistic price discrimination. To make the point most clearly, let us assume that a monopolistic firm can sell either in the US or the EC, and that it has a constant marginal cost in ecus. Transport costs will be ignored. Then the monopolist's optimal pricing rule is:

$$(4)\quad P^* = c^*E^*/(E^* - 1)$$

$$(5)\quad eP = c^*E/(E - 1)$$

where c^* is marginal cost in ecus, and E and E^* are the elasticity of market demand in the US and EC respectively. E and E^* may of course depend on P and P^*.

If P^* does not change, neither will E^*, the elasticity of demand in the EC market. Thus P^* is invariant to e. The question is whether a rise in e will produce a more or less than proportional change in P.

This question corresponds exactly to a more familiar question in the recent theoretical literature on protection under imperfect competition: namely, will a tariff be partly absorbed by foreign firms? As Brander and Spencer (1984) among others have shown, the result depends on the shape of the demand curve. Clearly, if the demand curve has constant elasticity, the US price will fall in full proportion to the exchange rate change. In order to get pricing to

market, we must have a fall in the elasticity of demand; that is, the elasticity of demand must be increasing in the price (so that it falls as the price falls).

Unfortunately this means that the predicted behavior of a monopolist depends crucially on the shape of the demand curve -- or more accurately, on the monopolist's perception of the shape of the demand curve. We might hope to put some bounds on what can happen by looking at the two most popular assumed demand curves, constant-elasticity and linear. The problem is that these bounds are very wide indeed. In the constant elasticity case we have already seen that there will be no pricing to market. In the linear case, on the other hand, the percentage fall in the US price will always be less than half of the percentage exchange rate change. Let E be the intial elasticity of demand, with the monopolist facing linear demand schedules; then we can show that the elasticity of P with respect to e is (E - 1)/2E, which is always less than 0.5.

In principle, then, price discriminating monopoly can explain pricing to market if demand curves have the right shape. It is disturbing to rely so heavily on the shape of demand curves, however. Surely we would prefer to have shifts in the perceived elasticity of demand result from some more fundamental cause. One possibility is that such shifts arise from shifting market share in an oligopolistic market, which we consider next.

C. Oligopoly

Suppose now that the European firm, which still has constant marginal ecu cost of c*, faces a US competitor with constant dollar marginal cost c. How will this affect pricing?

Let us assume in this case that the firms compete in Cournot fashion, each firm taking the other's deliveries to the market as given. Also, to isolate the new element added by imperfect competition, let us assume constant elasticity of market demand, so that there would be no pricing to market by the European firm if it did not have to face a domestic competitor (for an analysis in the linear case, see Dornbusch (1985)).

The basic rule of Cournot competition in the constant elasticity case is that a firm will face a perceived elasticity of demand equal to E/s, where E is the market elasticity and s is the firms's market share. Let s be the market share (in the US market) of the US firm, and s* = 1-s be the market share of the EC firm. Then the pricing rules of the two firms will be

$$(6)\quad P = cE/(E - s)$$

for the US firm and

$$(7)\quad P = c^*E/e(E - s^*)$$

for the EC firm. In equilibrium, market shares must be such that these two pricing rules coincide.

To see the implications of (6) and (7), consider Figure 5. The higher is the import market share, the lower the elasticity of demand perceived by the foreign firm and thus the higher its price for any given marginal cost. Similarly, the higher the import share, the higher the elasticity of demand perceived by the domestic firm and thus the lower the domestic firm's price.

Now suppose that e rises. The foreign firm's pricing schedule will shift down proportionately to this change. Its actual price will however not fall by as much, because its market share will rise and thus its perceived elasticity of demand will fall. Algebraically, we can take logs of both (6) and (7):

$$\ln(P) = \ln(cE) - \ln(E - s)$$

$$= \ln(c^*E) - \ln(e) - \ln(E - s^*)$$

Differentiating and substituting, we get

$$ds = -d\ln(e)[(E - s^*)(E - s)]/[(E - s^*) + (E - s)]$$

for the change in the US share of output, and

$$d\ln(P) = -d\ln(e)(E - s^*)/[(E - s) - (E - s^*)]$$

for the change in the price. I.e., the elasticity of the price with respect to the exchange rate will be less than one.

We should note, however, that this result depends crucially on two unrealistic assumptions. First, we are assuming that the domestic and foreign firm produce perfect substitutes. This is empirically unreasonable for the industries in which we actually seem to see PTM; those manufacturing sectors in which German and US goods would seem likely to be near-perfect substitutes, such as chemicals and basic materials, show no evidence of PTM in practice. Second, competition is assumed to be Cournot in form. Obviously Bertrand competition will lead to a collapse of either imports or domestic production in the perfect substitutes case.

A more realistic model, then, would be one in which the firms produce differentiated products, and probably engage in Bertrand competition. The general point here is that there is no general point: whether the perceived elasticity of demand of the EC firm rises or falls depends on the particular functional form, bringing us back to the problems of the discriminating monopolist.

III. Dynamic Models

The models described in the last section were static in the sense that neither the actual nor the expected duration of the exchange rate change affect the extent of pricing to market. That is, the extent to which import prices fall is independent of whether the dollar has just risen or has been high for a number of years, and is also insensitive to whether the current strength of the dollar is regarded as permanent or soon to be reversed. Intuitively this seems implausible. The extent of pricing to market in the US is often regarded as being due at least partly to the belief of foreign firms that the dollar will fall again in the not too distant future. In this section I present three models that offer possible rationalizations for the idea that import prices will fall less than proportionately to the exchange rate change when that change is either unanticipated or expected to reverse. The first of these models stresses dynamics that arise from the supply side. The second asks whether slow adjustment of demand to the market price will give rise to a slow adjustment of the price itself. Finally, the third attempts to justify price stickiness by a concern of firms for reputation.

A. Supply-side dynamics

In our discussion of the supply-and-demand approach to import prices it was pointed out that increasing marginal transportation costs could explain a failure of import prices to fall as much as one might expect following an appreciation. I suggested, however, that marketing and distribution costs were more likely candidates than transport costs per se, especially given the apparent disparity in the extent of pricing to market across sectors. It was also suggested that upward-sloping marginal cost in this case was more likely to be a short-run phenomenon than a permanent feature. What we would like to do, then, is to formalize the idea that pricing to market can result from temporary bottlenecks to changing import volume.

To do this, let us return to the model of a price discriminating monopolist introduced in the last section, but make one change: we will now suppose that the monopolist has costs to changing deliveries to the market. We might imagine, for example, that foreign auto manufacturers cannot expand their sales without also providing an expanded sales, distribution, and service "infrastructure". To expand this infrastructure is costly, and presumably more costly the more rapid the attempted expansion. Suppose that the dollar rises suddenly. Then there will be no point in cutting prices immediately if there is no capacity to meet the expanded demand. Instead, we would expect prices to fall gradually as the infrastructure is put in place. Furthermore, if the dollar's rise is seen as temporary, foreign firms

will not see it as worth their while to expand the infrastructure much to begin with. So this approach says that the degree of pricing to market should depend both how recently the exchange rate has changed ond on how long the change is expected to last.

We can model this formally as follows. There is an EC firm that sells a good in the US market. It faces a demand curve which we write in inverse form:

(8) $P = P(x)$

where x is the rate of deliveries to the US market. If we want to make a clean separation of the dynamic reasons for pricing to market from the static ones we considered above, we can assume that the demand curve has constant elasticity.

The EC firm's costs will be assumed to consist of two parts. First, there is production cost; marginal production cost will be taken to be constant in ecus. Second, we will attempt to capture the dynamic aspects of marketing and distribution by assuming that there are costs to adjusting the level of US sales, i.e., an adjustment cost which is increasing in the deviation of dx/dt from zero. Let us write this adjustment cost as h(dx/dt): then the firm's instantaneous profits will be

(9) $V = Px/e - c*x - h(dx/dt)$

What the firm will want to do is to maximize the present discounted value of V. Problems of this sort are by now familiar in many parts of economics (see for example Sargent (1979)), so it should not be necessary to rework the solution. Instead, let us simply review the basic characteristics of the outcome. The most useful way to think about the problem is to regard the firm as placing a shadow price on output; if this shadow price is positive, it will expand output, if it is negative, it will contract. The evolution of this shadow price itself depends on the marginal profitability of an increase in x. The optimal solution takes the form of a saddle path.

Suppose that we now shock this system by changing the exchange rate e. The result depends on how permanent the shock is assumed to be. Figure 6 illustrates how the price of imports would behave following a permanent and a temporary exchange rate change. In the case of a permanent appreciation the price would fall only gradually as x rose, in the long run finally falling by the full amount of the appreciation. In the case of a temporary appreciation the price would not only begin rising again after the exchange rate returned to its intial level, it would fall more slowly from the start, and might actually begin to rise before the exchange rate reversal.

Allowing for costs of adjustment, then, can rationalize pricing to market. The extent of PTM in this case turns out to depend both on how long the appreciation has lasted and on how persistent it is

expected to be. These are reasonable things to include in our model, and probably there is a good deal of truth to this explanation. I would doubt, however, whether it is sufficient. In particular, if the divergence of prices between the US and EC markets is wholly due to marginal costs of distribution etc., how do we explain the emergence of gray markets, that is, of individuals bypassing the normal distribution channels? To explain this would seem to require that this model be supplemented with some additional considerations affecting the pricing decision.

B. Dynamics of demand

Another possible route to a dynamic account of pricing to market might be to appeal to slow adjustment of demand. Suppose that there are lags in the effect of price on demand. Then a firm's pricing decision will in effect have an investment-like component, trading off lower profits now for higher sales later. It seems intuitively reasonable that when the lags are long pricing will be dictated by long-run cost rather than short run fluctuations.

Somewhat surprisingly, this intuition is by no means easy to confirm. Analyzing optimal pricing under lags in demand is in general fairly difficult, but the main points can be conveyed with a two-period example. This example gives some presumption that transitory

exchange rate shocks will have less effect on prices than permanent, but it is no more than a presumption.

Consider a foreign firm that plans to sell a good in the US over two periods. In the first period it faces a demand $D_1(P_1)$, in the second a demand $D_2(P_1,P_2)$, where subscripts refer to periods. Marginal costs are c^*/e_1, c^*/e_2 respectively. The firm will seek to maximize

$$(e_1P_1 - c^*)D_1(P_1) + R(e_2P_2 - c^*)D_2(P_1,P_2)$$

where R is a discount factor.

The question we need to answer is whether the price in the first period will fall more if the exchange rate rises in both periods than if it rises only in the first period. That is, will an exchange rate appreciation that is regarded as temporary have less effect on hte price than one that is regarded as permanent? What writing out the model in this way shows is that this question is equivalent to asking whether an increase in e_2 will lead to a fall in P_1.

The answer to this question hinges on how the second period appreciation affects the incentive of the firm to keep its first period price down. We note that the derivative of second period profits with respect to P_1 is

$$(dX_2/dP_1)(e_2P_2 - c^*) < 0$$

where X_2 is second-period sales.

This may be rewritten as

$$[(dX_2/dP_1)(P_1/X_2)][(e_2P_2 - c^*)X_2]/P_1$$

The first term in square brackets here is the cross elasticity of demand; the second term is second period profits themselves. The direction of the effect of e_2 on the price in the first period can be determined by asking how the size of this expression is affected holding P_1 constant; if it increases in absolute value, there will be an increased incentive to hold down the first period price.

What we can say definitely is that the second term will increase: a rise in e will definitely increase second period profits. If we could assume that the cross elasticity of demand would remain unchanged, then we would be sure that a rise in second-period e would lead to a fall in first period P. Unfortunately, we cannot be sure of this. Here as elsewhere in our analysis, the answer seems to be contingent on functional form.

C. Reputation and Pricing

We have now seen that an ad hoc model of dynamic demand, in which lagged as well as current prices are simply assumed to affect the quantity sold, provides only a presumption that pricing to market will be profitable. On wonders, however, whether some less ad hoc formulation of demand dynamics might give a clearer reason for a failure to pass cost reductions on in price reductions. As our final theoretical model, I will suggest a particular version of dynamics that could justify the stickiness of prices without appeal to particular functional forms or arbitrary lags in price effects.

The basic idea is that purchase of imported goods is a two-stage process. First, potential buyers must decide whether to put themselves in the market for a product -- for example, whether to visit the showroom and test-drive a particular firm's automobiles. We must presume that putting oneself into a market is costly, and will be done only if the price is expected to be sufficiently attractive. Second, those in the market must then decide whether in fact to purchase, and how much to buy.

The effect of this two-stage process will be that demand depends not only on the actual price but on the price that customers expect to pay when they decide whether or not to put themselves in the market. The question then is how the expected price gets determined. In practice, the way this seems to happen is that firms cultivate a reputation over time for being in a certain price range. For example, I know that in looking for a car it is sensible to look at the major

Japanese imports, but not worth while looking at Volvos or Mercedes given my resources. We can formalize this process in a simplified way by imagining that a firm announces a price, and that customers arrive on its doorstep provided that they expect it to honor its announcement. If the firm fails to honor its announcement, in future periods it will not be believed.

Let Pe be the price expected by potential customers to prevail, and let N be the number of customers that actually enter a firm's market. Then what we will say is that

(10) $N = N(Pe)$

Letting X be the quantity sold, we will then have a demand function

(11) $X = X(N,P)$

To see the implications of this formulation, consider Figure 7. Two demand curves are illustrated. The first, labelled DD, is what we might call the "ex ante" curve: it represents the eventual quantity sold if the expected price Pe is validated by the actual price P. Corresponding to DD is a marginal revenue curve MR. Given marginal cost c*/e, we show the profit-maximizing price given this demand curve.

Once customers have committed themselves to entering the market, however, the firm will face a less elastic demand curve, illustrated by the "ex post" curve dd. Short run profit maximization would then lead the firm to charge a higher price than Pe, as shown by the fact that the corresponding marginal revenue curve mr lies below marginal cost when the price equals Pe. If the firm takes advantage of its full short run market power in this way, however, the result will be that customers will no longer believe its future announcements, and will expect that the firm will always exploit its ex post monopoly power. Provided that the discount rate is not too high, the cost of this loss of reputation will exceed the benefits of exploiting short run market power, and the firm will thus choose to keep P = Pe.

How does this explain price stickiness? The answer seems clear for <u>increases</u> in marginal cost. An unexpected rise in marginal cost, provided that it is not too large, will be not be passed on in higher prices so as not to lose reputation. Less obvious, perhaps, is that decreases in marginal cost will also not be passed on if they are not too large. The reason is that short-run marginal revenue lies below marginal cost, with price increases prevented by the need to retain reputation. A fall in marginal cost that does not bring it below short-run marginal revenue will therefore not provide an incentive to cut the price; in effect, a firm will treat it as a windfall that allows it to exploit short run monopoly power without breaking its implicit promise not to charge a price in excess of Pe.

In context, this implies a story something like the following: at 1981 exchange rates (say) a European auto manufacturer calculates that its long run profit maximizing price is $20,000. Its short run profit maximizing price would however be higher, because ex post demand is less elastic than ex ante, so that if reputation were not an issue the price would be $30,000. Now suppose that there is a rise in the dollar that lowers marginal cost, so that the short run maximizing price is $24,000. If this rise is not expected to persist, the firm will not find it worthwhile cultivating a reputation as a lower priced seller; and the short run incentives will not lead it to cut its price.

An interesting feature of this story is that it suggests that pricing to market will be more likely to happen where there are substantial firm-specific costs to entering a market, so that ex ante and ex post demand elasticities are very different. One might guess that this will happen where buyers make occasional discrete purchases rather than continuous small ones, and where the products are complex and differentiated enough that the information costs of evaluating quality and thus interpreting prices are high. This combination of features might explain why pricing to market is apparently confined to the machinery and transport equipment sector.

IV. Conclusions

Pricing to market appears to be more than just a curiosum related to luxury European automobiles. The aggregate estimates reported in the first part of this paper suggest that 35 to 40 percent of the real appreciation of the dollar since 1980 has been absorbed by foreign exporters in a rise in their prices to the US compared with prices in other markets. If the German case is representative, however, and if the crude data are to be believed, the phenomenon of pricing to market is not general but is specific to the machinery and transport equipment sector.

Explaining pricing to market is not as simple as one might hope. It seems clear that a perfectly competitive model will not do the trick. Static models of imperfect competition could explain it in principle, but there are serious objections to both a simple explanation in terms of price discriminating monopoly and a slightly more complex explanation in terms of noncooperative oligopoly.

The best hope of understanding pricing to market therefore seems to come from dynamic models of imperfect competition. At this point, my preferred explanation would stress the roles of both supply dynamics, resulting from the costs of rapidly adjusting the marketing and distribution infrastructure needed to sell some imports, and demand dynamics, resulting from the need of firms to invest in reputation.

What is needed at this point is not so much more theory as more data. Clearly the next step will have to be to focus on particular industries, where it is possible both to construct better series on pricing and to use institutional knowledge about the particulars of industries to inform the assumptions of our models.

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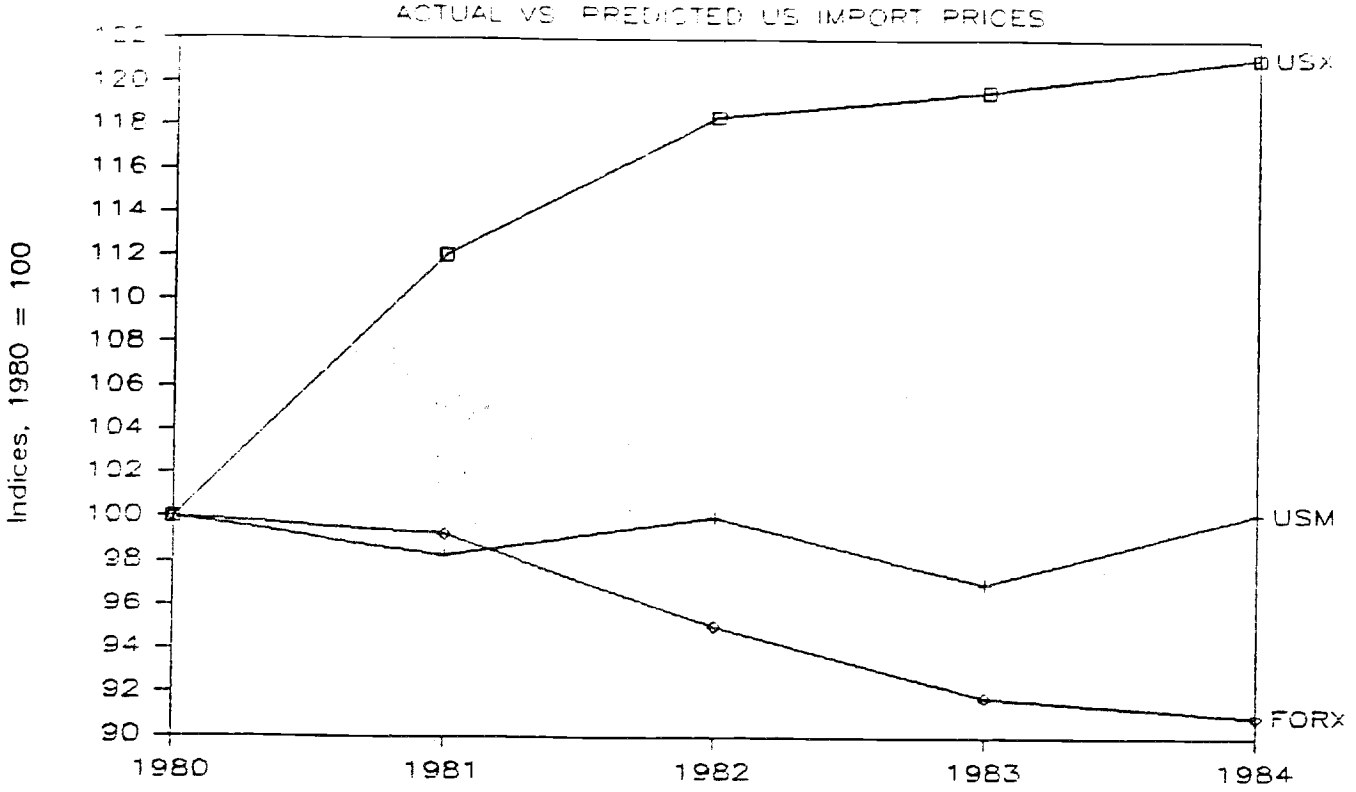
FIGURE 1

ACTUAL VS PREDICTED US IMPORT PRICES



USX = Unit value of US manufactures exports

USM = Unit value of US manufactures imports

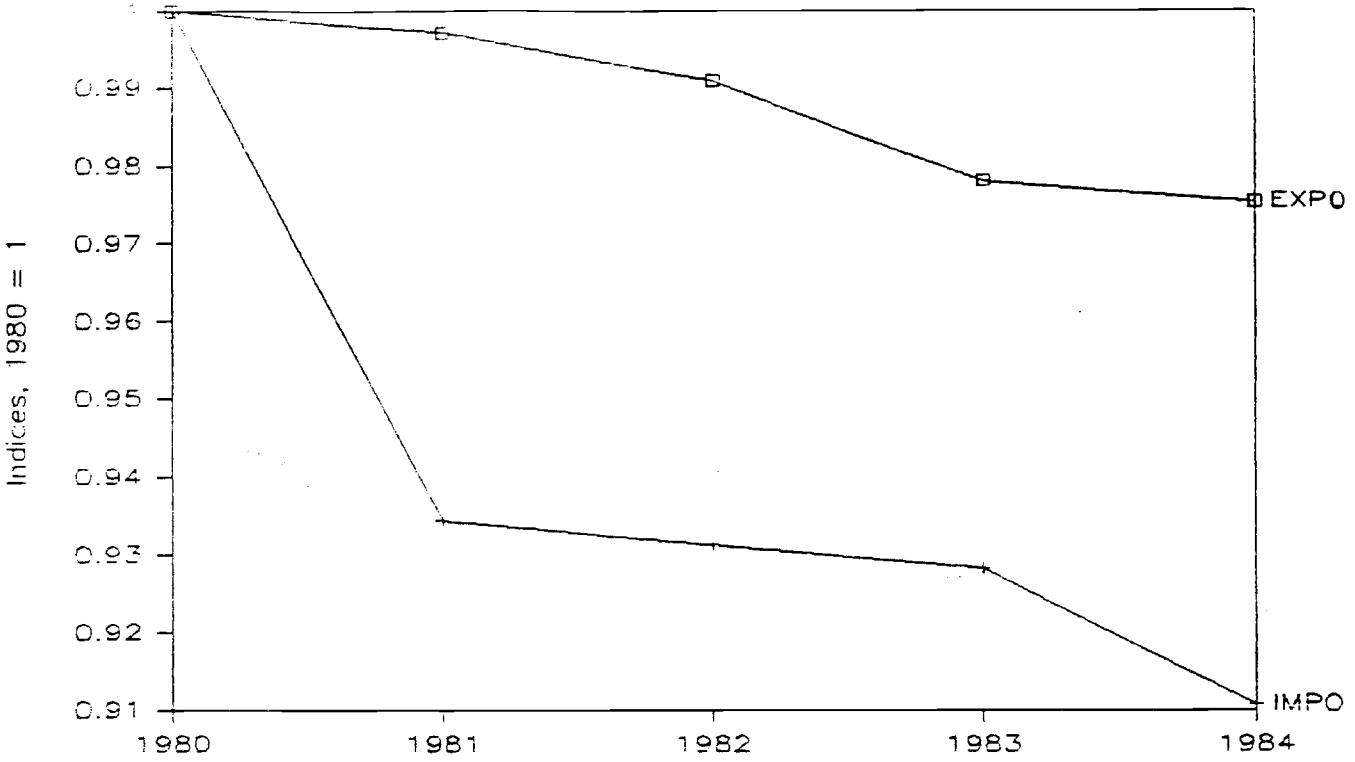
FORX = Unit value of manufactures export by US trading partners

Source: US data from Department of Commerce, United States Trade: Performance in 1984 and Outlook

Foreign data from UN Monthly Bulletin of Statistics

FIGURE 2

GERMAN TRADE PRICES EC VS NON-EC



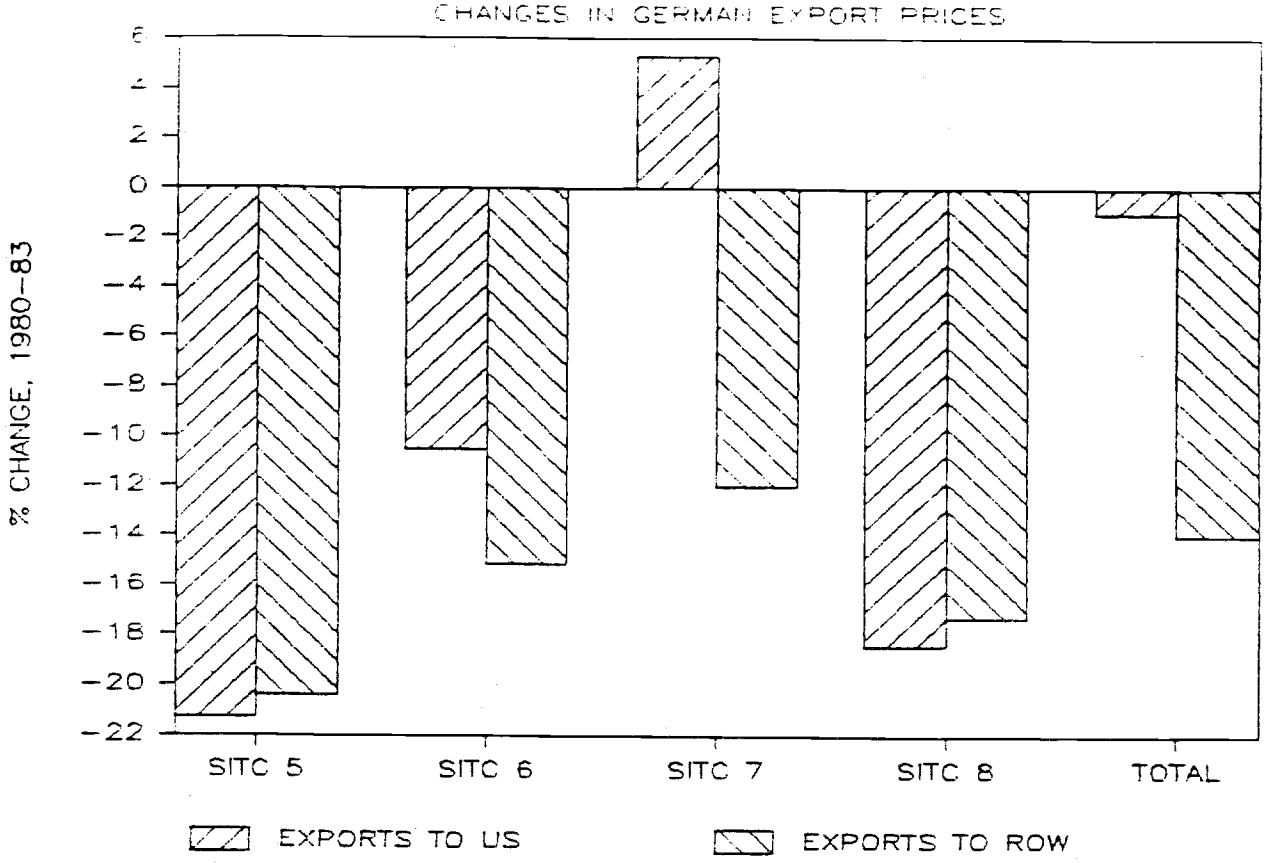
EXPO = Ratio of prices of finished manufactures exports from Germany, EC/non-EC destinations.

IMPO = Ratio of prices of finished manufactures imports into Germany, EC/non-EC sources.

Source: German Statistisches Jahrbach.

FIGURE 3

CHANGES IN GERMAN EXPORT PRICES



SITC 5 = Chemicals and related products

SITC 6 = Basic manufactures

SITC 7 = Machines and transport equipment

SITC 8 = Miscellaneous manufactured goods

Source: UN, Commodity Trade Statistics

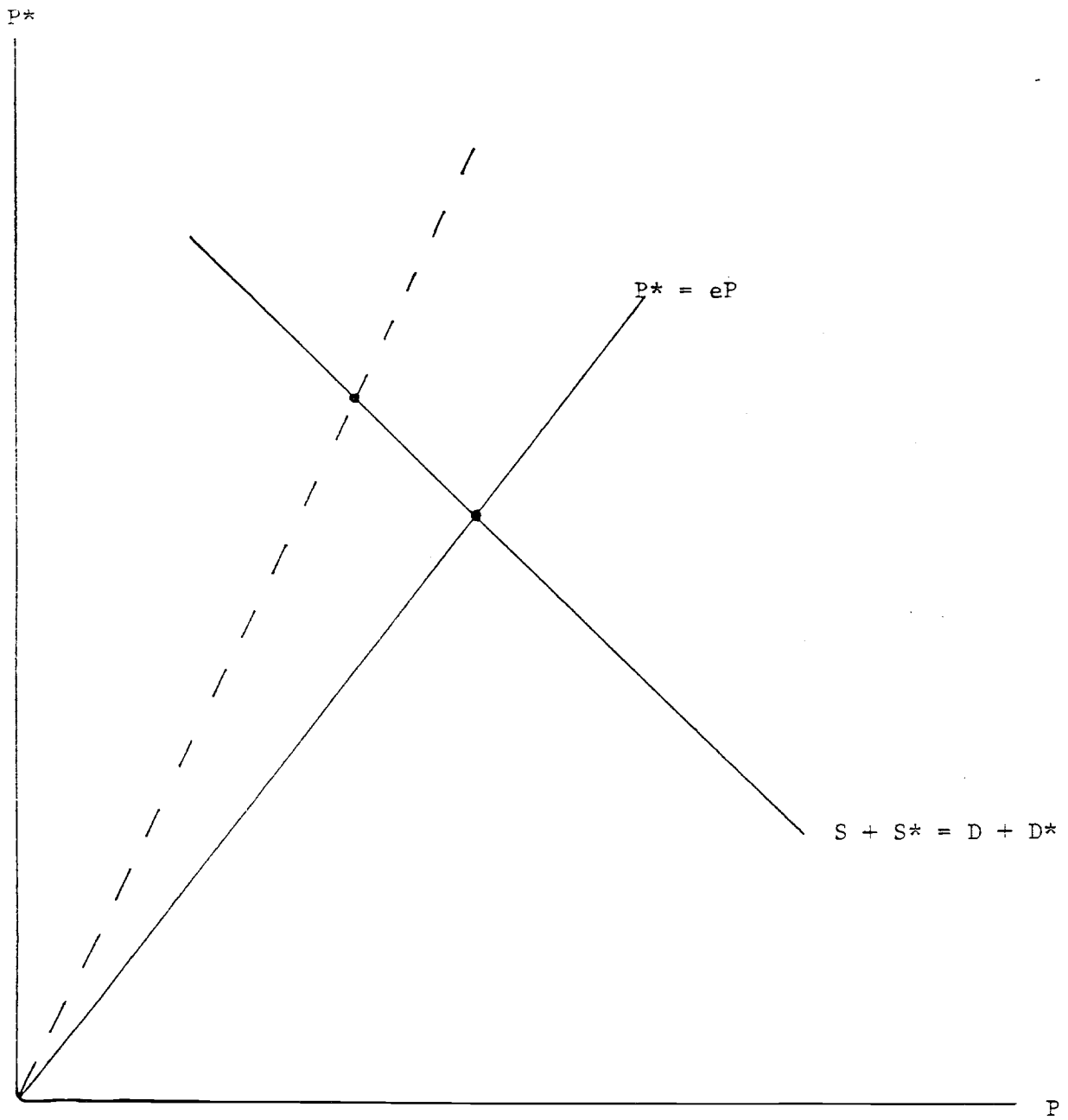


FIGURE 4: Supply and demand model of the price effect

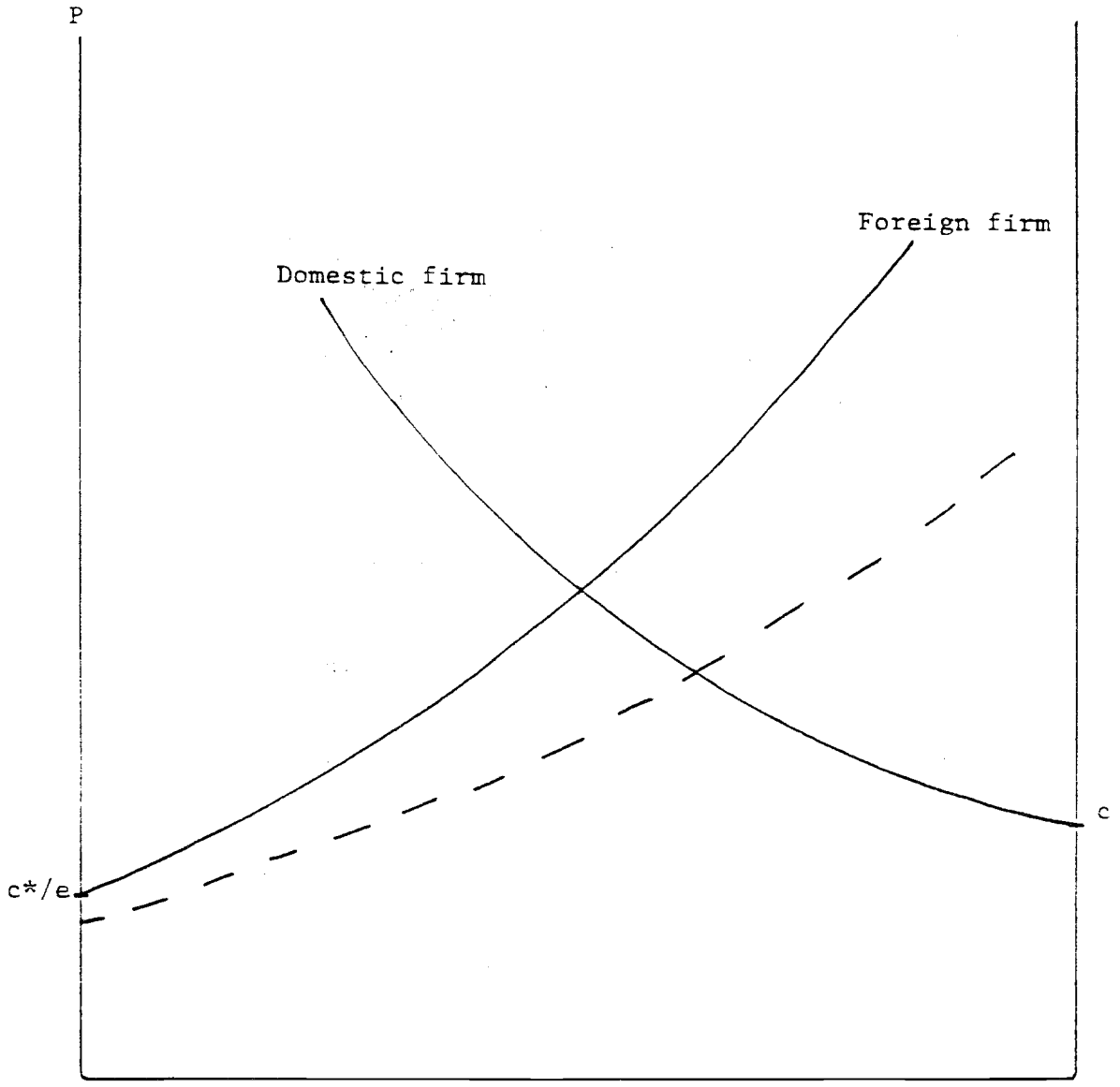


FIGURE 5: Pricing under oligopoly

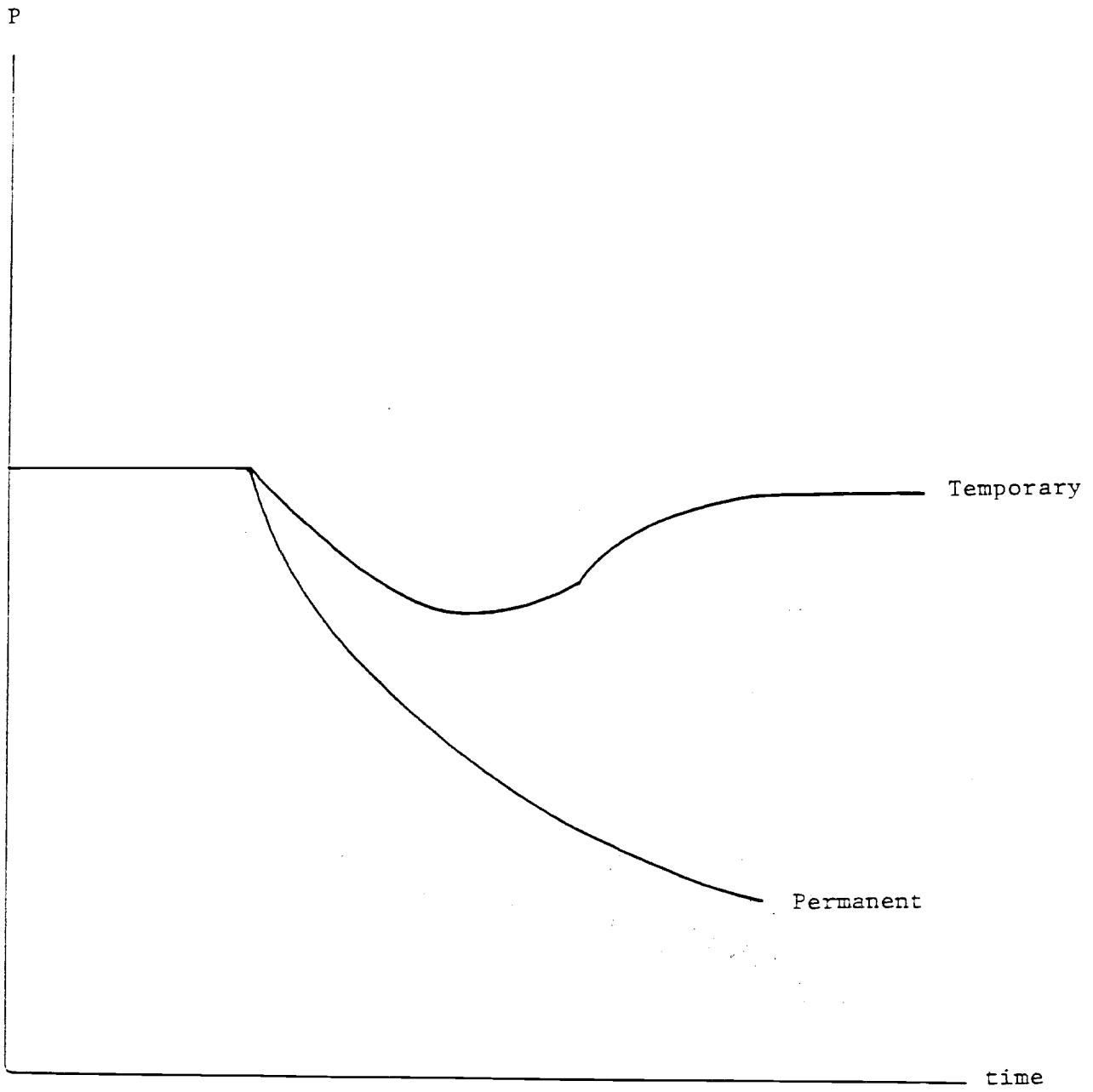


FIGURE 6: Supply dynamics following exchange rate appreciation

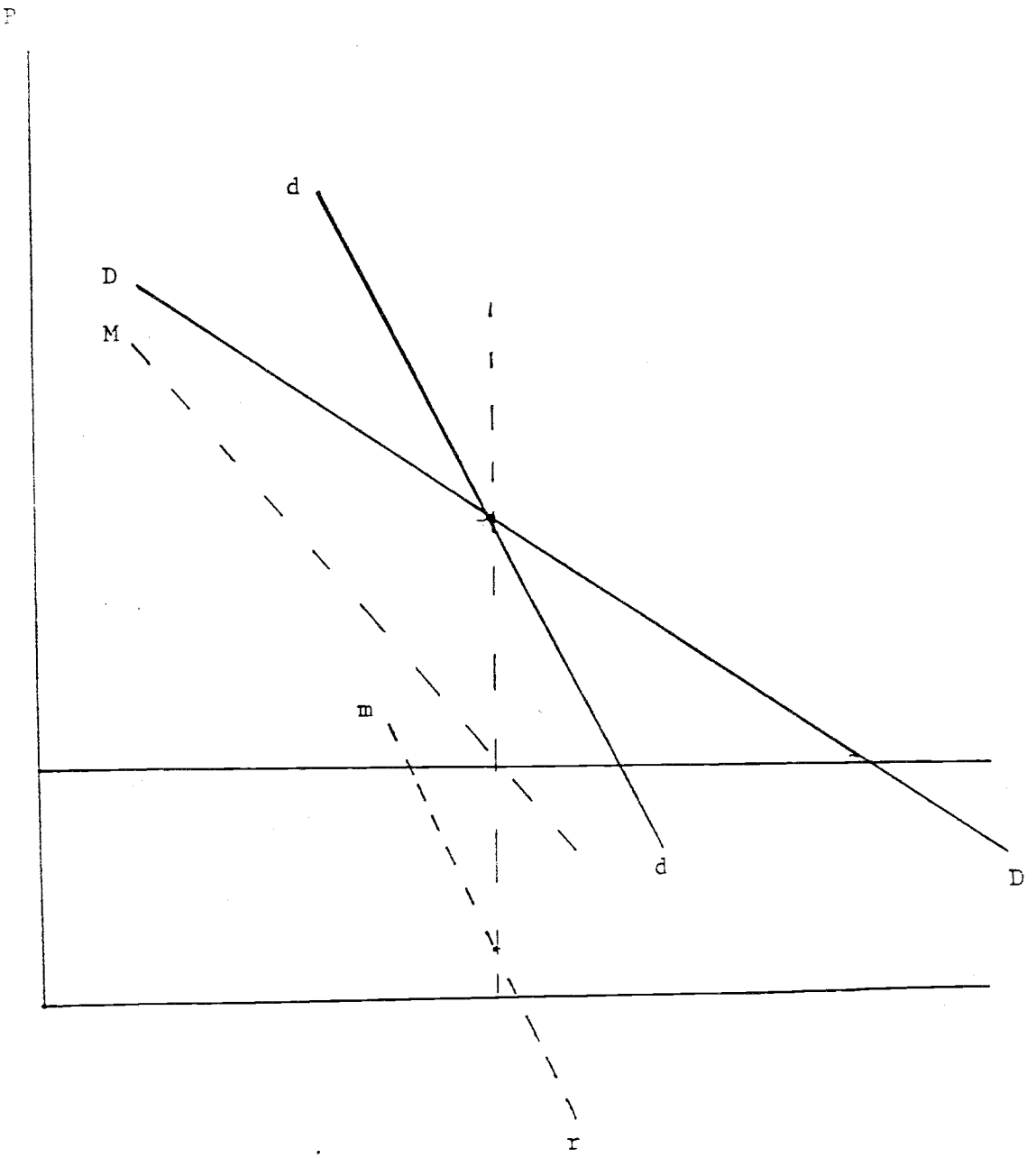


FIGURE 7: Pricing with reputation