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Exchange Rate Fluctuations, Pass-Through, and Market Share

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When the exchange rate fluctuates and the market exhibits hysteresis, planning horizons of domestic and foreign competitors will matter in the determination of pass-through as well as relative market shares of these firms. Using the Cournot duopoly model, it is shown that if the foreign exporter is a long-term maximizer relative to the domestic firm, pass-through will be lower and average export penetration higher than otherwise. [JEL 411, 431, 611]

THE OVERVALUATION of the dollar and its subsequent decline in the 1980s revealed a marked difference in the pricing behavior of Japanese and U.S. manufacturing firms in response to large swings of the exchange rate. U.S. firms tend to pass through fluctuations of the dollar more or less completely to the foreign-currency price of their products, whereas Japanese firms absorb a significant part of a yen fluctuation in the form of flexible profit margins, keeping the foreign-currency price of their products far less volatile than the yen.

Some commentators have criticized the behavior of Japanese export firms, especially when the yen was appreciating, as being predatory, reflecting a single-minded obsession with market share with little regard for profit maximization. But this observation is at odds with economic rationality. Under many market structures, profit maximization requires adjustment of the domestic-currency price of exports to the exchange rate in order to smooth the foreign-currency price. For example, using the Cournot duopoly model, Dornbusch (1987) has shown that the pass-

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through of import prices depends on the relative number of foreign and domestic firms that are competing in the domestic market.

This paper also makes use of the Cournot model, but offers a different explanation for varying degrees of pass-through. The existence of hysteresis and firms' planning horizons are emphasized as important determinants of tradable prices. The model also attempts to link the concept of pass-through with such quantitative variables as the volume of exports and average market share. By considering the effect of a fluctuating exchange rate on firms' profits, it is hoped that new light may be shed on a neglected aspect of international trade under floating exchange rate regime.

Following a review in Section I of the asymmetry in the pricing behavior of Japanese and U.S. manufacturing firms, Section II discusses hysteresis and the corporate planning horizon. Section III presents the duopoly model, which incorporates these discussions, and the model is given solutions under alternative assumptions in Section IV. Section V presents some conclusions.

I. Asymmetry in Pricing Behavior

The concept of pass-through is related to the degree to which import prices reflect movements in the exchange rate. From the foreign exporter's viewpoint, it is the extent to which he "passes through" exchange rate fluctuations to the sales price abroad, rather than absorbing them by adjusting the home-currency price. If the exporter does not alter the shipping price at home, it is the foreign sales price that reflects the exchange rate, and pass-through is said to be complete. In contrast, if the exporter tries to stabilize the sales price abroad by "pricing to market," it is the exporter's shipping price that bears the brunt of exchange rate changes, and there is no pass-through.

To clarify this explanation, consider a Japanese manufacturer who sells merchandise both in Japan and in the United States. Let the unit cost of production be c yen and the yen/dollar exchange rate be e, yielding the following:

domestic sales price (in yen) $p_d = (1 + m_d)c$

export price (in yen) $p_x = (1 + m_x)c$

export price (in dollars) $p_x^* = (1 + m_x)c/e,$

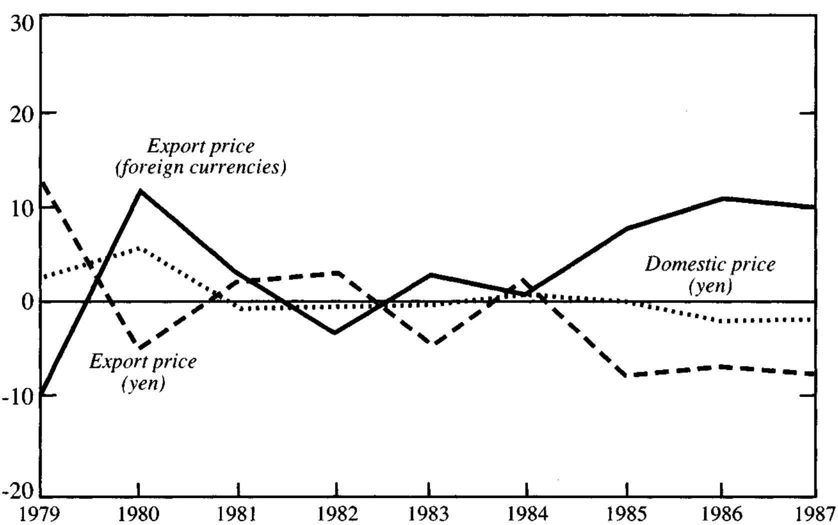
where m_d and m_x are the markups for domestic and export sales, respectively. (These markups will later be determined as part of the equilibrium.) With respect to these relationships, existing evidence suggests

the following for Japanese manufacturing industries. First, the yen-denominated unit cost (c) rises and falls with the yen/dollar rate to the extent that production cost includes imported raw materials. This cost effect of the exchange rate varies among industries: it is important in materials industries such as chemicals and steel, less so in machinery industries, where the raw material content of the final product is usually 10 percent or less. For high-technology industries, the cost effect of the exchange rate is almost negligible (Ohno (1989)). Second, the domestic markup (m_d) does not respond systematically to the yen/dollar rate, whereas the export markup (m_x) is significantly affected by the yen/dollar rate.

Figure 1 plots the annual changes in the domestic and export (f.o.b.) prices of Japanese general machinery industry. In this figure, "foreign currencies" denotes the currency basket reflecting the destinations of Japanese manufactured exports, with weights derived from the International Monetary Fund's multilateral exchange rate model (MERM). The stable domestic price is in clear contrast to the variable export prices in yen and foreign currency, each of which accounts for roughly half of the exchange rate variation. This contrast further implies that Japanese

Figure 1. *Changes in Domestic and Export Prices: Japanese General Machinery*

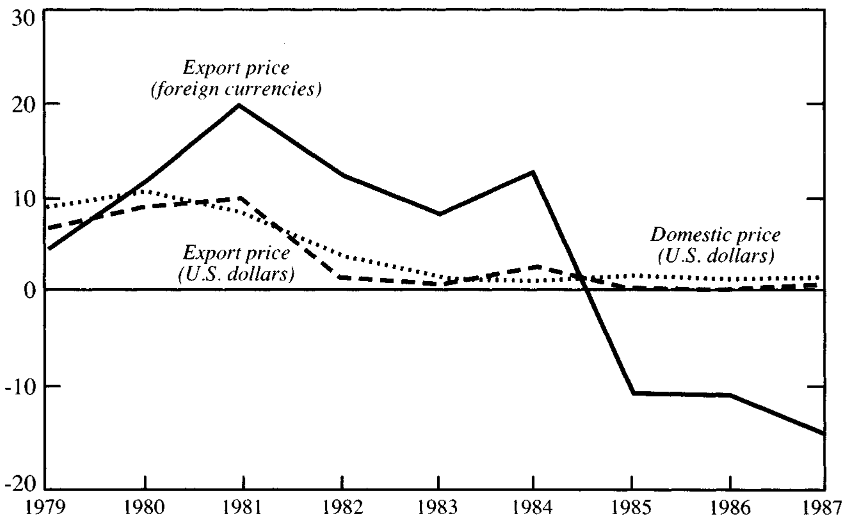
(In percent)



Sources: Bank of Japan and International Monetary Fund.

Figure 2. *Changes in Domestic and Export Prices: U.S. General Machinery*

(In percent)



Sources: U.S. Department of Labor and International Monetary Fund.

manufacturers practice price discrimination between domestic and overseas markets. When the yen appreciates, this practice tends to generate "dumping," whereby the same goods are sold more cheaply abroad than at home. When the yen is undervalued, as in 1983–84, many Japanese goods are often cheaper in Japan than in the United States.

The pricing behavior of U.S. manufacturing firms is fundamentally different from that of their Japanese competitors—both domestic and export markups are virtually unaffected by the fluctuations of the dollar. Furthermore, U.S. manufacturers normally do not practice price discrimination between domestic and foreign customers. As a result, there is no systematic dumping as the exchange rate swings, and pass-through tends to be complete. Figure 2 demonstrates this point. The movement of the dollar rate appears to be reflected entirely in the foreign-currency price of U.S. exports.[1]

[1] Many empirical studies corroborate these findings. See, for example, Woo (1984), Krugman (1987), Hooper and Mann (1987), and Ohno (1989). United States (1988) also offers a good review.

Many hypotheses have been advanced to explain the striking difference in pricing behavior between U.S. firms and firms in other industrial countries, but none seems to be completely satisfactory. One theory emphasizes the dollar's dominant role as an international invoice currency, which tends to keep contracted dollar prices constant in the face of exchange rate fluctuations. However, since contracts can be revised, this explanation would be plausible only for a short run of a few months. Another related view points to the substantial market power U.S. goods have in the rest of the world—but so do Japanese machinery, consumer electronics, and automobiles. Finally, one popular argument is that, with a huge domestic market, U.S. firms do not rely as heavily on exports as Japanese firms do; they can thus afford to be insensitive to exchange rate fluctuations. Looking at the 1980 or 1981 input-output tables of the two economies, one finds that, indeed, Japan recorded a higher export dependency—defined as the ratio of exports to total sales—than the United States in primary metals, electrical and transportation machinery, and precision instruments. In paper, chemicals, and general machinery, however, the export dependency ratios of the United States were higher than Japan's.

In the remainder of this paper a new model is proposed for explaining the asymmetry in pricing behavior between Japanese and U.S. firms, and the quantitative implications of this asymmetry are explored.

II. Hysteresis and the Planning Horizon

Given the resource endowment, technology, and taste of each country, the trade pattern is further determined by two important factors: the existence and degree of hysteresis, and the corporate planning horizon. The dynamic problem of cyclical exchange rate variation and the profit squeeze it generates under the floating exchange rate regime is an aspect of international trade that the traditional Ricardo and Heckscher-Ohlin models do not address directly.

Hysteresis

Hysteresis is a concept taken from physics of certain nonlinearity, whereby the relationship between two or more variables crucially depends on past history. Consider the experiment of first magnetizing a piece of iron by placing an electric magnet around it and then reversing the process. When the electric current is increased gradually from zero, the iron is at first slow to be magnetized, but after a while it becomes more susceptible, and then magnetizes quickly to a saturation point.

Then, as the electric current is gradually decreased to zero, the iron remains magnetized for some time, but then becomes rapidly demagnetized afterwards. Since the iron "resists" the force to alter its present magnetic state, the amount of magnetization depends not only on the electric current applied, but also on whether it is rising, falling, or has turned around halfway.

Resistance to changes from the status quo also exists in economics. Consider two companies, A and B, which produce and market highly substitutable goods—different brands of aspirin, toothpaste, soft drinks, laundry detergents, and so on. If firm A first lowers its price sufficiently to drive out (partially or completely) the product of firm B and then raises the price, it is likely to end up with a larger market share than if it had first set the price high, lost most of its customers, and then lowered the price, even if the final prices happen to be the same. When the market exhibits inertia, the sales of firm A cannot be captured as a simple regression on distributed lags of income and prices.

How can this happen? There are both supply-side and demand-side reasons; together, they impart stickiness to the market share of many manufactured goods.

On the supply side, the cause of market inertia can be attributed to increasing returns to scale. A firm that already has a large market share is in a better position with regard to cost than a firm with a small market share or a firm contemplating entry. First of all, the current market leader has already invested in the "sunk costs" required to start or expand the business—sales and service networks, training, advertising and other promotional efforts to improve the brand image, consumer research, and so on. An upstart firm or a firm with an insignificant market share that must invest in these activities in the future cannot hope to compete with the giant firm and be equally profitable. Second, given the advantage of (static) large-scale production or the (dynamic) learning effect, the mere fact of a firm's being the first to dominate the market ensures its cost advantage over its followers, thus perpetuating its leading position. This entrenched lead makes it all the more difficult for other firms to carve out a larger share of the market.

On the demand side, brand loyalty is another independent cause of market stickiness. For consumer goods like automobiles and stereos or investment goods like machinery and equipment, the buyer does not necessarily choose different brands each time he repurchases the good.[2]

[2] This argument is in contradiction to the Dixit-Stiglitz model where the consumer values variety. Although this may be true for food, drinks, and other entertainment goods and services, a majority of durable manufactured goods seem to be purchased as described in the text.

This is partly because the buyer is simply unaware of other brands, partly because of uncertainty about the quality of an unfamiliar brand, and partly because of the accumulation of human and nonhuman capital associated with the use of the present brand. For instance, someone who owns a personal computer manufactured by firm A is likely also to possess peripherals, software, operational knowledge, and a rapport with a certain dealership that would become useless or less useful if this consumer purchased another brand. Unless this person is dissatisfied with the present model, he or she is likely to replace or upgrade the present machine with another manufactured by firm A.

In a market where hysteresis prevails, whether because of the supply-side or the demand-side reason, additional expenditure becomes necessary to overcome the market inertia and recapture the previously lost market segment. Such "promotional costs" will probably be higher the longer the firm has been out of the market—requiring entirely new efforts in corporate planning, development of an appealing product or design, market research, advertising, and other promotional activities.

Under the circumstances described above, let us assume the existence of a *differentiated* shock, where a group of firms temporarily incur higher costs of production than before, while the production costs of the remaining firms are unchanged. Firms that belong to the first group now face a trade-off between current and future profit. If, on the one hand, they decide to raise their price sufficiently to maximize current profit, the second group of firms could expand operation at the expense of the first group, making the comeback of the latter all the more difficult even if these firms were prepared to lower their price in the next period. If, on the other hand, they choose not to raise their price at all, they would not lose any market share, but they would be forced to accept a loss of potential profit today. In general, a rational firm would raise its price but not to the extent of maximizing its short-term profit when its production costs were temporarily higher than other firms; or it would lower its price but not to the extent of maximizing short-term profit when its production costs were temporarily lower than others. This strategy has the effect of smoothing the market share over time and thereby reducing the other "promotional" costs required to expand business from the previous period.

Fluctuations of the yen/dollar exchange rate are a good example of a differentiated cost shock, whereby the relative production costs of Japanese and U.S. firms competing in the world market are altered. It is therefore not surprising to observe Japanese firms not fully lowering the dollar prices of their exports by their increasing profit margins when

the yen is weak, and not fully raising them by accepting lower profits or even net losses when the yen is strong.[3]

The Planning Horizon

Why, then, do U.S. firms not adopt a similar pricing strategy? The hypothesis advanced here is that their corporate planning horizon is much shorter in time (that is, their discount rate is much higher) than that of their Japanese competitors. Explanations for the well-known preference of U.S. firms for short-term profit are often based on speculation about national psychology or corporate culture, which are beyond the purview of economics. However, there are many economic conditions that promote such corporate behavior in the United States.

First, the role of the stock market is fundamentally different between Japan and the United States. In Japan most stocks are owned by other companies belonging to a corporate group or *keiretsu,* which share the same business interest as the issuer company. In contrast, U.S. stocks are held by individuals and institutional investors who are mainly interested in capital gains. These investors are ready to sell the stock the moment the market perceives financial trouble for its issuer. Although this feature may be advantageous for market liquidity, it draws the attention of business people toward quarterly profits rather than long-term viability.

Second, as noted by HatsoPoulos, Krugman, and Summers (1988), U.S. firms' preference for short-term profit can be attributed to the high cost of capital in the United States relative to Japan. According to these authors, the erosion of U.S. competitiveness is caused by saving and investment rates that are too low, which in turn are the result of policies that raise the rate of time discount and favor consumption over saving—including the fiscal deficit and various aspects of social welfare and income tax systems.

Third, as McKinnon (1989) has noted, high *nominal* interest rates in the United States shorten the term structure of business decision making relative to a low-interest rate country like Japan, even though the differences are due purely to higher inflationary expectations in the United

[3] Various models have been constructed to explain incomplete pass-through based on the concept of hysteresis, including Baldwin (1988a,1988b), Dixit (1987, 1989), Foster and Baldwin (1986), and Froot and Klemperer (1988). The present model, however, is unique in its formulation of linear promotional costs and its emphasis on the corporate planning horizon.

States. This is because the effective "duration" of finance, as defined in any standard textbook, would be reduced in inflationary countries. For any given term-to-maturity structure, the "real" amortization schedule would be more front-end loaded and the "real" payback time would be shorter the higher is the structure of nominal interest rates—even if *real* interest rates were the same.

When hysteresis is present, the constraint of short-term profit maximization placed on U.S. firms can explain the behavioral difference between them and their foreign competitors, as will be seen in the description of the Cournot duopoly model, which follows.

III. The Model

Consider a Japanese export firm and a U.S. domestic firm competing in the U.S. market.[4] The products of these firms are in fact perfect substitutes, but are perceived to be different by consumers as a result of packaging or brand image. Color film, cassette tapes, and floppy diskettes could fit this description. The Japanese firm, with yen-denominated costs and dollar-denominated revenues, maximizes profit in terms of yen. The U.S. firm maximizes profit in dollars, and both its costs and revenues are in dollars. Because of the reasons considered in the last section, the market is assumed to exhibit hysteresis. Each firm incurs promotional costs in addition to production costs when it expands production from the previous period. The assumption of perfect certainty is applied to the alternation of the yen/dollar rate between two levels.

Let the output of each firm be x (Japanese firm) and x^* (U.S. firm), and let p^* be the dollar price in the U.S. market received by both firms. For simplicity, assume a linear (inverse) demand function:

$$p^* = 1 - x - x^*. \tag{1}$$

Next, assume that technology is subject to constant returns to scale. The unit cost of production is c yen for the Japanese firm and c^* dollar for the U.S. firm. The yen/dollar exchange rate takes the value e_0 (high yen, low dollar) in even-numbered periods, and the value e_1 (low yen, high dollar) in odd-numbered periods, with $e_0 < (c/c^*) < e_1$. Since c/c^* is the cost-based competitiveness parity rate, this inequality implies that Japan

[4] Marston (1989) shows that when home and foreign countries are two separate markets and when marginal cost is constant (as is assumed here), one can consider the pricing of Japanese goods abroad independently of that at home. The Japanese market is therefore ignored in this model.

has an *absolute* advantage over the United States in producing this product in one period, and vice versa in the next period. Furthermore, due to hysteresis, each firm incurs the promotional cost of z yen (Japanese firm) or z^* dollar (U.S. firm) for each additional unit sold over the previous period. However, no cost or gain is incurred when a firm reduces the size of its operation. Finally, each firm takes the output of the other firm as given in maximizing (short-term or long-term) profit.

With this setup, let us first consider the behavior of the Japanese firm corresponding to different planning horizons. Continuing to use subscript 0 for even-numbered periods and subscript 1 for odd-numbered periods, one can express the yen-denominated profit of the Japanese firm as

$$\Pi_0 = x_0[e_0(1 - x_0 - x_0^*) - c] \tag{2a}$$

$$\Pi_1 = x_1[e_1(1 - x_1 - x_1^*) - c] - z \quad \max(x_1 - x_0, 0). \tag{2b}$$

The profit for the high-yen period is simply the difference between revenue and production costs; the profit for the low-yen period must also include promotional costs z if the firm is to expand operation.

The planning horizon can be incorporated in this framework as follows. Suppose the Japanese firm ignores tomorrow and decides to maximize today's profit. In this case, the reaction function for each period can be obtained separately by maximizing equation (2a) with respect to x_0 and maximizing (2b) with respect to x_1, yielding

$$x_0 = [1 - x_0^* - c/e_0]/2 \tag{3a}$$

$$x_1 = [1 - x_1^* - (c + z)/e_1]/2. \tag{3b}$$

This is the (extreme) case where the rate of time preference is infinite.

Alternatively, consider the other extreme case where the firm does not differentiate current and future profits, and its rate of time preference is therefore zero. Although there are potentially an infinite number of periods in this model, each two adjacent periods are like any other under the assumption of perfect certainty. The only dynamic complication in the model comes from hysteresis associated with business expansion from period 0 to period 1, which does not spill over to any other periods. The condition for long-term profit maximization can therefore be derived by considering any even-numbered period and the subsequent odd-numbered period. Maximizing $\Pi_0 + \Pi_1$ with respect to both x_0 and x_1 yields

$$x_0 = [1 - x_0^* - (c - z)/e_0]/2 \tag{4a}$$

$$x_1 = [1 - x_1^* - (c + z)/e_1]/2. \tag{4b}$$

These are the reaction functions of the Japanese firm when it maximizes long-term profit. Comparison of equations (3a), (3b) and (4a), (4b) reveals that the only difference between short-term and long-term profit maximization is the extent of the production cutback in period 0. Long-term planning requires that the cutback be more modest than when the firm is more interested in short-term results. Note, however, that the simplicity of these reaction functions is due to the original assumptions—in particular, linear promotional costs. Generalizing them would complicate the solution without necessarily modifying the basic conclusions.

Notice that reaction functions in (3a), (3b) and (4a), (4b) are valid only if $x_1 > x_0$. If the solution obtained from these equations were $x_1 < x_0$, actual outcome would be $x_1 = x_0$, since potential gain from expanding output in period 1 would be more than offset by promotional costs. In this instance, the fixed output level would still be dependent on the firm's planning horizon.[5]

Next, the behavior of the U.S. firm is similarly specified. The U.S. firm is different from the Japanese firm in that it is not affected by the exchange rate directly; the yen/dollar rate matters only to the extent that the rival firm's output responds to it. The dollar-denominated profit of the U.S. firm is

$$\Pi_0^* = x_0^*(1 - x_0 - x_0^* - c^*) - z^* \qquad \max(x_0^* - x_1^*, 0) \tag{5a}$$

$$\Pi_1^* = x_1^*(1 - x_1 - x_1^* - c^*), \tag{5b}$$

where the last term in (5a) is the promotional cost incurred if the firm decides to expand in period 0.

If the U.S. firm maximizes short-term profit, the corresponding reaction functions can be obtained by maximizing (5a) with respect to x_0^* and maximizing (5b) with respect to x_1^*:

$$x_0^* = (1 - x_0 - c^* - z^*)/2 \tag{6a}$$

$$x_1^* = (1 - x_1 - c^*)/2, \tag{6b}$$

whereas, if it maximizes long-term profit, maximizing $\Pi_0^* + \Pi_1^*$ with respect to x_0^* and x_1^* simultaneously yields

$$x_0^* = (1 - x_0 - c^* - z^*)/2 \tag{7a}$$

$$x_1^* = (1 - x_1 - c^* + z^*)/2. \tag{7b}$$

[5] If the firm is a short-term maximizer, output will be equal to x_0, which is set when the yen is strong. If the firm is a long-term maximizer, x will be chosen so as to maximize $\Pi_0 + \Pi_1$ in equations (2a) and (2b) after $x_1 = x_0$ is set.

As before, the two strategies differ only in how deeply output is cut when the firm faces an unfavorable exchange rate. And if the solution implied $x_0^* < x_1^*$, actual output would be constant over time as discussed above.

Equilibrium output and price are derived by combining reaction functions of the Japanese and U.S. firms under varying assumptions about planning horizons as well as the size of exchange rate fluctuations. As an illustration, consider the case where exchange rate fluctuations are such that both firms adjust output every period—that is, $x_1 > x_0$ and $x_0^* > x_1^*$ (alternative cases are classified in Section IV). It is easy to show that the solution takes the following general form:

$$\text{output} = [1 + (\text{rival's marginal cost}) - 2(\text{own marginal cost})]/3$$

$$\text{price} = [1 + (\text{rival's marginal cost}) + (\text{own marginal cost})]/3,$$

where all marginal costs are expressed in dollars.

The solution further depends on whether firms regard only production costs (c or c^*) as marginal cost or they include promotional costs (z or z^*) as well. This, in turn, of course depends on what planning horizons are adopted. For example, assume the Japanese firm maximizes long-term profit, while the U.S. firm maximizes short-term profit. Then, applying the above formula—or alternatively from equations (1), (4a), and (6a)—the solution for period 0, on the one hand, is found to be

$$x_0 = [1 + c^* + z^* - 2(c - z)/e_0]/3 \tag{8a}$$

$$x_0^* = [1 + (c - z)/e_0 - 2(c^* + z^*)]/3 \tag{8b}$$

$$p_0^* = [1 + c^* + z^* + (c - z)/e_0]/3, \tag{8c}$$

where both firms take promotional costs (z and z^*) into account. (The U.S. firm, even though assumed to be myopic, must necessarily face promotional costs in expanding output.) The solution for period 1, on the other hand, is from equations (1), (4b), and (6b):

$$x_1 = [1 + c^* - 2(c + z)/e_1]/3 \tag{9a}$$

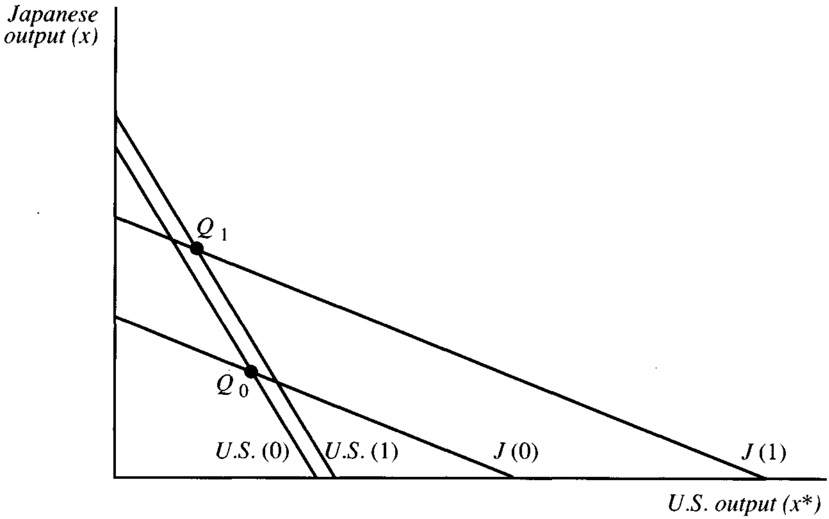
$$x_1^* = [1 + (c + z)/e_1 - 2c^*]/3 \tag{9b}$$

$$p_1^* = [1 + c^* + (c + z)/e_1]/3, \tag{9c}$$

where the U.S. firm no longer takes promotional costs (which would be incurred in the future) into consideration as it retreats. Hence, z^* appears in none of the above three equations.

Figure 3 graphically presents these solutions in which the Japanese firm pursues long-term profit and the U.S. firm maximizes current profit. The vertical axis measures output of the Japanese firm, and the horizontal axis measures output of the U.S. firm. $J(0)$ and $J(1)$ are

Figure 3. *Equilibrium Output: Japanese and U.S. Firms*



Note: $J(0)$ and $J(1)$ are Japanese reaction functions corresponding to equations (4a) and (4b); $US(0)$ and $US(1)$ are U.S. reaction functions corresponding to equations (6a) and (6b); Q_0 and Q_1 represent equilibrium output.

Japanese reaction functions corresponding to equations (4a) and (4b); and $US(0)$ and $US(1)$ are U.S. reaction functions corresponding to equations (6a) and (6b). The slope of $J(0)$ and $J(1)$ is $-½$, and the slope of $US(0)$ and $US(2)$ is -2. Equilibrium output for each period is given by the intersection of $J(0)$ and $US(0)$, and $J(1)$ and $US(1)$, respectively (calculated in equations (8a), (8b), (8c) and (9a), (9b), (9c)). The two equilibria are stable.

IV. Pass-Through and Market Share

In a hysteretic environment, two factors determine the degree of pass-through and the relative market shares of export and domestic firms: (1) the magnitude of exchange rate fluctuations; and (2) planning horizons—short or long—adopted by the two firms. There are four possible combinations of corporate strategies: (1) Japan, short; United States, short; (2) Japan, long; United States, short; (3) Japan, short; United States, long; and (4) Japan, long; United States, long.

Assume that the yen/dollar exchange rate alternates around the competitiveness parity rate (c/c^*) by the same percentage amount in either

direction. This upward or downward deviation from the average can be denoted by $\dot{e} = (e_1 - e_0)/(e_0 + e_1)$. For each of the four combinations of corporate strategies, pass-through, output, and the average market share of the Japanese firm vary as the amplitude of the exchange rate is increased.

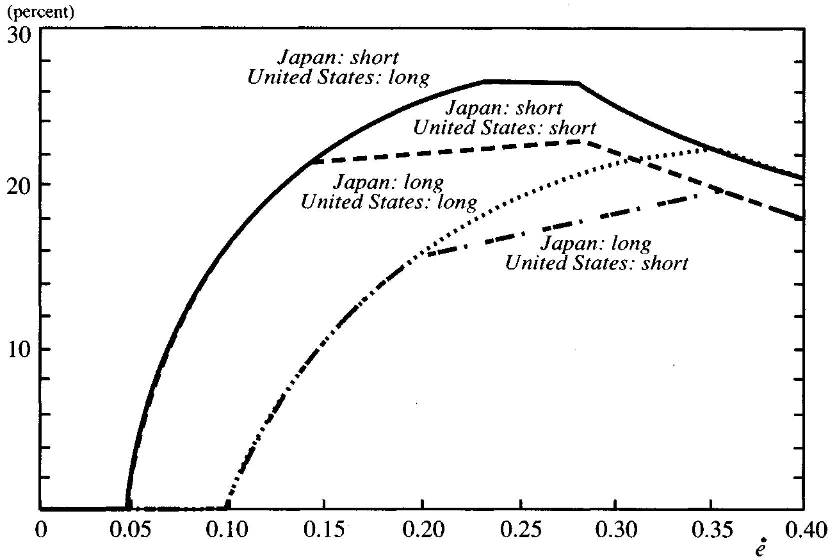
In every case, the behavior of output and price goes through four phases as exchange fluctuations are magnified. First, when the exchange rate fluctuates insignificantly, neither firm responds to the exchange rate, and output and price therefore remain constant over time. This is because potential gain from output adjustment is more than offset by the promotional cost. Second, as the exchange rate becomes sufficiently unstable, the Japanese firm that is directly affected by the exchange rate begins to adjust output.[6] Third, as exchange fluctuations intensify, both firms adjust output according to the exchange rate. (See Figure 3, which shows this phase.) Finally, as the fluctuation becomes extreme, the Japanese firm completely retreats from the U.S. market when the yen is high.

Planning horizons affect the critical points at which these changes take place, as well as pass-through and relative market shares associated with each phase. The latter can be seen more clearly if pass-through (defined as the percentage of exchange fluctuations reflected in changes in p^*) and the average market share of the Japanese firm (defined as simple average of the shares in two periods) are plotted, as in Figures 4 and 5. The following numerical assumptions have been adopted: production cost, c = ¥80, c^* = \$0.6; promotional cost, z = ¥8, z^* = \$0.06. The competitiveness parity rate is therefore ¥133 to \$1.

In every case, pass-through remains zero for a while, then increases and finally decreases as exchange fluctuations become larger. However, pass-through is always lower in case 2 where Japanese firms are long-term maximizers and U.S. firms are short-term maximizers, than in case 3 where the opposite is assumed. Similarly, regardless of exchange fluctuations, the average presence of the Japanese firm is never smaller in case 2 than in case 3. The more forward-looking the export firm is relative to the domestic firm, the lower is pass-through and the higher the export penetration. These figures vividly illustrate the role hysteresis plays in determining price and output under the floating exchange rate regime.

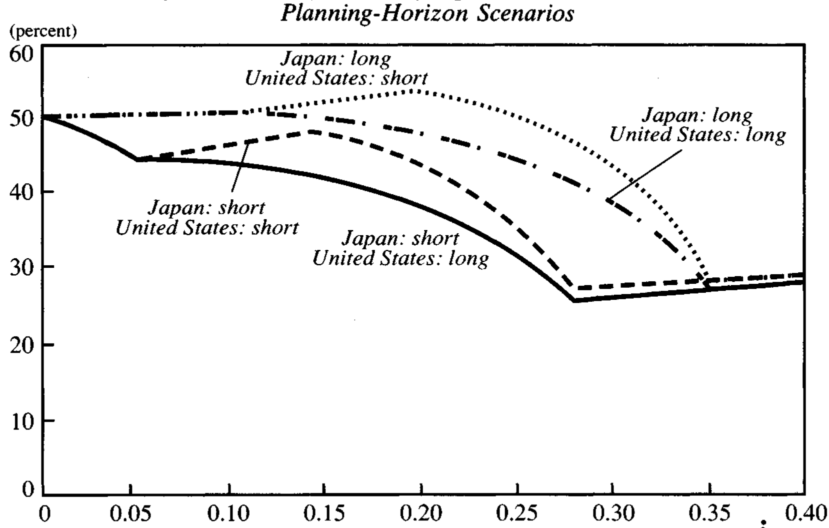
[6] The opposite asymmetry, where only the U.S. firm adjusts output, will never take place. It can be seen from equation (5) that, if $x_0 = x_1$, the U.S. firm faces identical profit-maximization problems in both periods, and therefore $x_0^* = x_1^*$ must hold.

Figure 4. *Pass-Through Under Four Planning-Horizon Scenarios*



Note: ė denotes the deviation from the mean; percentages are based on the numerical examples in the text.

Figure 5. *Average Share of Japanese Firm Under Four Planning-Horizon Scenarios*



Note: ė denotes the deviation from the mean; percentages are based on the numerical examples in the text.

V. Conclusions

Even without any change in technology or tastes, exchange rate fluctuations, which act as a differential cost shock, can alter not only the variances of output and price but their means as well. The model developed here has shown that, in imperfectly competitive markets such as duopoly, the existence of hysteresis, combined with various degrees of time preference, determines pass-through and the trade pattern in the floating exchange rate regime.

The model could be expanded to take further complications into account, without necessarily invalidating the general conclusion. For example, some framework other than the Cournot duopoly could be adopted; uncertainty about the exchange rate might be introduced; and the learning effect could be incorporated, whereby the production cost becomes a decreasing function of cumulative output rather than a constant as assumed here.

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