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Exchange Rate Fluctuations, Pass-Through, and Market Share

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Abstract

When the exchange rate fluctuates and the market exhibits hysteresis, planning horizons of domestic and foreign competitors will matter in determining 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.

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Summary

In setting dollar prices, U.S. manufacturers often disregard exchange rate movements, but leading Japanese exporters adopt a "pricing-to-market" strategy whereby their market share is preserved at the sacrifice of short-term profit. This striking difference in pricing behavior can be explained by market hysteresis (the dependence of variables on past history) and the planning horizon of each competing firm.

Imperfectly competitive markets frequently exhibit inertia. Large firms often perpetuate their dominance even though smaller, less well-known firms can offer products of similar price and quality. When market shares are sticky, cultivating a new customer base or winning back clientele lost to rival firms require extraordinary promotional efforts. Such market hysteresis can derive from supply-side causes, such as increasing returns, or demand-side causes, such as brand loyalty. Firms operating in a hysteretic environment must consider both production cost and "promotional" cost, the latter being incurred only when firms expand output over that in the previous period.

Fluctuation in the yen/dollar exchange rate can cause temporary shocks to the relative production costs of Japanese and American manufacturing firms. As periods of favorable and unfavorable exchange rates alternate, profit-maximizing firms will keep output more stable to avoid excessive promotional cost. If hysteresis is present, price and output will vary according to the planning horizon of the firm.

To illustrate this general principle of variation according to the planning horizon, this paper posits a Japanese firm and an American firm competing in the U.S. market. Pass-through of higher costs and relative market shares depend on the amplitude of exchange fluctuations and four possible combinations of corporate strategy taken by the rival firms, involving short-term profit maximizing and long-term profit maximizing. The classified solutions of the model and a numerical example both confirm 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 in alternative cases. Thus, the model extends popular pass-through literature to include quantitative implications involving output and market share. It sheds a new light on the relationship between the exchange regime and trade patterns, an issue not properly addressed by traditional real trade models.

Exchange Rate Fluctuations, Pass-Through, and Market Share

I. Introduction

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 the fluctuation of the dollar more or less completely to the foreign-currency price of their products, while Japanese firms absorb a significant part of the 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 while the yen was appreciating as being predatory, suspecting single-minded obsession with market share with little regard to the rationality of profit maximization. But this observation is hasty. Under many market structures, profit maximization requires adjustment of the domestic-currency price of exports to the exchange rate in order to smooth its foreign-currency price. For example, using the Cournot duopoly model, Dornbusch (1987) has shown that the pass-through of import prices depends on the relative numbers of foreign and domestic firms which 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. We emphasize the existence of hysteresis--to be discussed more fully below--and firms' planning horizons as important determinants of tradable prices. Our model also attempts to link the concept of pass-through with such quantitative variables as the volume of exports and average market share. By addressing the question of the fluctuating exchange rate and its effect on firms' profits, we hope to shed new light on a heretofore neglected aspect of international trade under the floating exchange-rate regime.

After reviewing the asymmetry in the pricing behavior of Japanese and U.S. manufacturing firms in Section II, we will discuss hysteresis and the corporate planning horizon in Section III. Section IV presents the duopoly model which incorporates these discussions. The model is given solutions under alternative assumptions in Section V. The last section concludes.

II. Asymmetry in Pricing Behavior

The concept of pass-through is related to the degree to which import prices reflect the movement of 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 said to be no pass-through.

To further clarify the matter, consider a Japanese manufacturer who sells his merchandise both in Japan and in the United States. Let his unit cost of production be c yen and the yen/dollar exchange rate be e. Then we have:

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

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

Export price (in dollar): $p^*_x = (1+m_x)c/e$

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 is important in materials industries such as chemicals and steel. However, as far as machinery industries are concerned, 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. Third, the export markup (m_x), in contrast, 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, the "foreign currency" means the currency basket reflecting the destinations of Japanese manufactured exports, with weights derived from the IMF's MERM model. One can observe the contrast between the stable domestic price and the variable export price, where roughly a half each of the exchange-rate variation is reflected in yen and foreign currency. This further implies that Japanese manufacturers price discriminate between the home and overseas markets. When the yen appreciates, this tends to create "dumping," where the same goods are sold more cheaply abroad than at home. When the yen is undervalued, as was 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 rivals: both domestic and export markups are virtually unaffected by the fluctuations of the dollar. Furthermore, U.S. manufacturers normally do not price discriminate between domestic and foreign customers. As a result, there will be no systematic dumping as the exchange rate swings, and pass-through tends to be complete. Figure 2, using the same format as Figure 1, demonstrates this point. Apparently, the movement of the dollar rate is reflected entirely in the foreign-currency price of U.S. exports. 1/

Many hypotheses have been proposed to explain the striking difference in pricing behavior between U.S. firms and firms of 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 the contracted dollar prices constant in the face of exchange-rate fluctuations. However, since contracts can be revised, this explanation loses force beyond the short run of a few months. Another related view points to the fact that American goods have substantial market power 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--thus they can afford to be insensitive to exchange-rate fluctuations. Looking at the 1980 or 1981 input-output tables of the two economies, one finds that Japan indeed has 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. However, in paper, chemicals, and general machinery, the United States has higher export dependency ratios than Japan.

The remainder of this paper proposes a new model for explaining the asymmetry in pricing behavior between Japanese and U.S. firms and explores the quantitative implications of such asymmetry.

III. Hysteresis and 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 corporate planning horizon. We now deal with the dynamic problem of cyclical exchange-rate variation and the profit squeeze it generates under the floating exchange-rate regime. This is the aspect of international trade which the traditional Ricardo or Heckscher-Ohlin models do not address directly.

1/ Many empirical studies corroborate these facts. See, for example, Woo (1984), Krugman (1987), Hooper and Mann (1987), and Ohno (1989). The Economic Report of the President of 1988 also offers a good review.

1. Hysteresis

Hysteresis is a concept of certain nonlinearity in physics, where the relationship between two or more variables crucially depends on past history. Consider an experiment of magnetizing a piece of iron by placing an electric magnet around it. When the electric current is increased gradually from zero, iron is slow to be magnetized at first, but after a while becomes more susceptible and magnetizes quickly to a saturation point. Next, as the electric current is gradually decreased to zero, iron retains magnetization for some time, but becomes rapidly demagnetized afterwards. Since 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 the price sufficiently to drive out (partially or completely) the product of Firm B and then raises the price, it is likely to have a larger market share than if Firm A first sets the price high and loses most of its customers and then lowers 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 which together impart stickiness to the market share of many manufactured goods.

On the supply side, the cause of market inertia can be attributed to various types of increasing returns to scale. That is to say, a firm which already has a large market share is in a better position with regards 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 "sunk cost" required to start or expand the business--sales and service networks, training, advertising and other promotional effort to improve the brand image, consumer research, and so on. An upstart firm or a firm with an insignificant market share which must invest in these activities in the future cannot hope to compete with the giant firm and be equally profitable. Second, if there is the merit of (static) large-scale production or the (dynamic) learning effect, the mere fact of being the first firm to dominate the market ensures the cost advantage over its followers, thus perpetuating its leading position. This makes disturbing the market share all the more difficult.

On the demand side, brand loyalty is another independent cause of market stickiness. Whether 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. 1/ This is partly because the buyer is simply unaware of other brands, partly because of the uncertainty about the quality of the unfamiliar brand, and partly because of the accumulation of human and nonhuman capital associated with the use of the present brand. For instance, if someone owns a personal computer manufactured by Firm A, he is likely to also possess peripherals, software, operational knowledge, and a rapport with certain dealership which would become useless or less useful if he purchased another brand. Unless he is dissatisfied with the present model, he is likely to replace or upgrade the present machine with another of Firm A.

In a market where hysteresis prevails, whether because of the supply-side or demand-side reason, additional expenditure becomes necessary to overcome the market inertia and recapture the previously lost market segment. Such "promotional cost" will probably be higher the longer the firm has been out of the market--requiring entirely new effort at corporate planning, development of an appealing product or design, market research, advertisement 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 cost of production than before while the production cost of the remainder of firms is unchanged. Firms that belong to the first group now face a trade-off between the current and future profit. If--on the one hand--they decided to raise the price sufficiently to maximize the current profit, it would allow the second group of firms to expand operation at the sacrifice of the first group of firms, making the comeback of the latter all the more difficult even though they were prepared to lower the price in the next period. If--on the other hand--they chose not to raise the price at all, they would not lose any market share but be forced to accept a loss of potential profit today. In general, a rational firm would raise the price but not to the extent of maximizing the short-term profit when their production cost is temporarily higher than others, and similarly lower the price but not to the extent of maximizing the short-term profit when their production cost is temporarily lower than others. This has the effect of smoothing the market share over time and thereby reducing the other "promotional" cost required to expand the business from the previous period.

1/ This proposition is opposite to the celebrated Dixit-Stiglitz model where the consumer values variety. While this may be true where food, drinks, and other entertainment goods and services are concerned, a majority of durable manufactured goods seem to be purchased in the way described in the text, where no more than one per customer is needed.

Fluctuations of the yen/dollar exchange rate are exactly such a differentiated cost shock where 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 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. 1/

2. The planning horizon

Why then do U.S. firms not adopt similar pricing strategy? We advance the hypothesis that their corporate planning horizon is much shorter in time (i.e. their discount rate is much higher) than that of their Japanese competitors. U.S. firms' preference of short-term profit is much talked about, and the reason is often sought in national mentality or corporate culture which are beyond the realm of economics. However, there are many economic conditions that promote such corporate behavior in the United States today.

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, American 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. While this may be advantageous for market liquidity, it directs the attention of business people towards quarterly profits rather than long-term business viability.

Second, HatsoPoulos, Krugman, and Summers (1988) attribute the U.S. firms' preference for short-term profit to the high cost of capital in the United States relative to Japan. According to the authors, the erosion of American 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, McKinnon (1989) notes that high nominal interest rates in the United States would shorten the term structure of business decision-making relative to a low-interest country like Japan, even though the differences were due purely to higher inflationary expectations in the United States. This is because the effective "duration" of finance, as defined in any standard textbook, would be reduced in inflationary

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1/ Various models have been presented to explain incomplete pass-through based on the concept of hysteresis, including Baldwin (1988), Dixit (1987, 1988), Foster and Baldwin (1986), and Froot and Klemperer (1988). The present model, however, is unique in its formulation of linear promotional cost and emphasis on corporate planning horizon.

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 rivals. We now turn to the Cournot duopoly model which incorporates the discussion in this section.

IV. The Model

Consider a Japanese export firm and an American domestic firm competing in the U.S. market. 1/ 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 may fit this description. The Japanese firm, with yen-denominated cost and dollar-denominated revenue, maximizes profit in terms of yen. The U.S. firm maximizes profit in dollars, and both its cost and revenue are in dollars. Because of the various reasons considered in the last section, the market is assumed to exhibit hysteresis. Each firm incurs promotional cost in addition to production cost when it expands production from the previous period. We assume that the yen/dollar rate alternates between two levels with certainty.

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:

$$p^* = 1 - x - x^* \qquad (1)$$

Next, we 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 Japanese have absolute advantage over Americans 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 (American firm) for each additional unit sold over the previous period. However, no cost or gain is incurred when it reduces the size of operation. Finally, each firm takes the output of the other firm as given in maximizing (short-term or long-term) profit.

1/ Marston (1989) shows that when home and foreign countries are two separate markets and when marginal cost is constant (as we assume here), one can consider the pricing of Japanese goods abroad independently of that at home. We will therefore ignore the Japanese market in this model.

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, the yen-denominated profit of the Japanese firm can be expressed as:

$$\Pi_o = x_0 \{e_0(1-x_0-x^*_0) - c\} \quad (2a)$$

$$\Pi_1 = x_1 \{e_1(1-x_1-x^*_1) - c\} - z \max(x_1-x_0, 0) \quad (2b)$$

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

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 (2a) with respect to x_0 and maximizing (2b) with respect to x_1, yielding:

$$x_0 = \{1-x^*_0-c/e_0\}/2 \quad (3a)$$

$$x1 = \{1-x^*_1-(c+z)/e_1\}/2 \quad (3b)$$

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. While 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. By maximizing $\Pi_o + \Pi_1$ with respect to both x_0 and x_1, we have:

$$x_0 = \{1-x^*_0-(c-z)/e_0\}/2 \quad (4a)$$

$$x1 = \{1-x^*_1-(c+z)/e_1\}/2 \quad (4b)$$

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

Notice that reaction functions in (3) and (4) 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 cost. In this instance, the fixed output level would still be dependent on the firm's planning horizon. 1/

Next, let us similarly specify the behavior of the American firm. The American 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 American firm is:

$$\Pi^*_o = x^*_0 (1-x_0-x^*_0-c^*) - z^* \max(x^*_0-x^*_1, 0) \quad (5a)$$

$$\Pi^*_1 = x_*1 (1-x_1-x^*_1-c^*) \quad (5b)$$

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

If the American 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:

$$x^*_0 = (1-x_0-c^*-z^*)/2 \quad (6a)$$

$$x^*_1 = (1-x_1-c^*)/2 \quad (6b)$$

whereas if it maximizes long-term profit, we get, by maximizing $\Pi^*_o + \Pi^*_1$ with respect to x^*_0 and x^*_1 simultaneously:

$$x^*_0 = (1-x_0-c^*-z^*)/2 \quad (7a)$$

$$x^*_1 = (1-x_1-c^*+z^*)/2 \quad (7b)$$

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.

1/ If the firm is a short-term maximizer, output will be equal to x_0 set when the yen is strong. If the firm is a long-term maximizer, such x will be chosen as to maximize $\Pi_o + \Pi_1$ in (2) after setting $x_1 = x_0$.

Equilibrium output and price are derived by combining reaction functions of the Japanese and American firms under varying assumptions about planning horizons as well as the amount of exchange rate fluctuations. As an illustration, consider the case where exchange rate fluctuations are such that both firms adjust output every period, i.e., $x_1 > x_0$ and $x^*_0 > x^*_1$ (the next section classifies alternative cases). It is easy to show that the solution takes the following general form:

output = {1+(rival's marginal cost)-2(own marginal cost)}/3

price = {1+(rival's marginal cost)+(own marginal cost)}/3

where all marginal costs are expressed in dollars.

The solution further depends on whether firms regard only production cost (c or c*) as marginal cost or they include promotional cost (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 American firm maximizes short-term profit. Then, applying the above formula--or alternatively from (1), (4a), and (6a)--the solution for period 0, on the one hand, is found to be:

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

$$x^*_0 = \{1+(c-z)/e_0-2(c^*+z^*)\}/3 \qquad (8b)$$

$$p^*_0 = \{1+c^*+z^*+(c-z)/e_0\}/3 \qquad (8c)$$

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

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

$$x^*_1 = \{1+(c+z)/e_1-2c^*\}/3 \qquad (9b)$$

$$p^*_1 = \{1+c^*+(c+z)/e_1\}/3 \qquad (9c)$$

where the American firm no longer takes promotional cost (which would be incurred in the future) into consideration as it retreats. Hence z* appears in none of the equations in (9).

Figure 3 graphically presents these solutions in which the Japanese firm pursues long-term profit and the American firm maximizes current profit. The vertical axis measures output of the Japanese firm while the horizontal axis measures output of the American firm. J(0) and J(1) are Japanese reaction functions corresponding to (4a) and (4b).

Similarly, A(0) and A(1) are American reaction functions corresponding to (6a) and (6b). The former has the slope of -1/2 and the latter has the slope of -2. Equilibrium output for each period is given by the intersection of J(0) and A(0), and J(1) and A(1), respectively (which is already calculated in (8) and (9)). The two equilibria are stable.

V. Pass-Through and Market Share

Under a hysteretic environment, two factors determine the degree of pass-through and the relative market shares of export and domestic firms: (i) the magnitude of exchange rate fluctuations; and (ii) planning horizons--short or long--adopted by the two firms (there are four possible combinations). We can demonstrate this by using our model.

Assume that the yen/dollar exchange rate alternates around the competitiveness parity rate (c/c^*) by the same percentages in either direction. Let us denote this upward or downward deviation from the average by $\dot{e} = (e_1-e_0)/(e_0+e_1)$. For each of the four combinations of corporate strategies, Table 1 summarizes how 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 therefore output and price 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 which is directly impacted by the exchange rate begins to adjust output. 1/ Third, as exchange fluctuations intensify, both firms adjust output according to the exchange rate. (Figure 3 depicted this phase.) Finally, as the fluctuation becomes extreme, the Japanese firm completely retreats from the American 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 we plot pass-through (defined as 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), as in Figures 4 and 5. We have adopted the following numerical assumptions here: production cost, c=80 yen, c^*=0.6 dollar; promotional cost, z=8 yen, z^*=0.06 dollar. The competitiveness parity rate therefore is 133 yen to the dollar.

1/ The opposite asymmetry, where only the American firm adjusts output, will never take place. It can be seen from (5) that, if $x_0=x_1$, the American firm faces identical profit maximization problems in both periods, and therefore $x^*_0=x^*_1$ must hold.

Table 1

Classified Solutions for Pass-Through and Market Share

Exchange Fluctuation ($\hat{e}$)	1/	Case 1 Japan: short U. S. : short	Case 2 Japan: long U. S. : short	Case 3 Japan: short U. S. : long	Case 4 Japan: long U. S. : long
	0%	pass-through: zero Japan's share: decreasing $x_0 = x_1$, $x^*_0 = x^*_1$	pass-through: zero Japan's share: constant $x_0 = x_1$, $x^*_0 = x^*_1$	pass-through: zero Japan's share: decreasing $x_0 = x_1$, $x^*_0 = x^*_1$	pass-through: zero Japan's share: constant $x_0 = x_1$, $x^*_0 = x^*_1$
$\frac{\delta}{2c+\delta}$	5%	pass-through: increasing Japan's share: increasing $x_1 > x_0 > 0$ $x^*_0 = x^*_1$		pass-through: increasing Japan's share: increasing $x_1 > x_0 > 0$ $x^*_0 = x^*_1$	
$\frac{\delta}{c}$	10%		pass-through: increasing Japan's share: increasing $x_1 > x_0 > 0$ $x^*_0 = x^*_1$		pass-through: increasing Japan's share: decreasing $x_1 > x_0 > 0$ $x^*_0 = x^*_1$
$\frac{2\delta^*+\delta}{2c+\delta}$	14%	pass-through: increasing Japan's share: decreasing $x_1 > x_0 > 0$ $x^*_0 > x^*_1$			
$\frac{\delta^*+\delta}{c}$	20%		pass-through: increasing Japan's share: decreasing $x_1 > x_0 > 0$ $x^*_0 > x^*_1$		
$\frac{4\delta^*+\delta}{2c+\delta}$	23%			pass-through: decreasing Japan's share: decreasing $x_1 > x_0 > 0$ $x^*_0 > x^*_1$	
$\frac{1-c^*+\delta^*}{1+c^*+\delta^*}$	28%	pass-through: decreasing Japan's share: increasing $x_1 > x_0 = 0$ $x^*_0 > x^*_1$			
$\frac{2\delta^*+\delta}{c}$	30%			pass-through: decreasing Japan's share: increasing $x_1 > x_0 = 0$ $x^*_0 > x^*_1$	
$\frac{1-c^*+\delta^*+(2\delta c^*)/c}{1+c^*+\delta^*}$	35%		pass-through: decreasing Japan's share: increasing $x_1 > x_0 = 0$ $x^*_0 > x^*_1$		pass-through: increasing Japan's share: decreasing $x_1 > x_0 > 0$ $x^*_0 > x^*_1$
					pass-through: decreasing Japan's share: increasing $x_1 > x_0 = 0$ $x^*_0 > x^*_1$

1/ Percentages are based on the numerical example in the text.

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 are long-term maximizers and Americans 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.

VI. Concluding Remarks

Even without any change in technology or taste, 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. Our model 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 other framework 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 we have assumed here. These are the agenda for future research.

APPENDIX

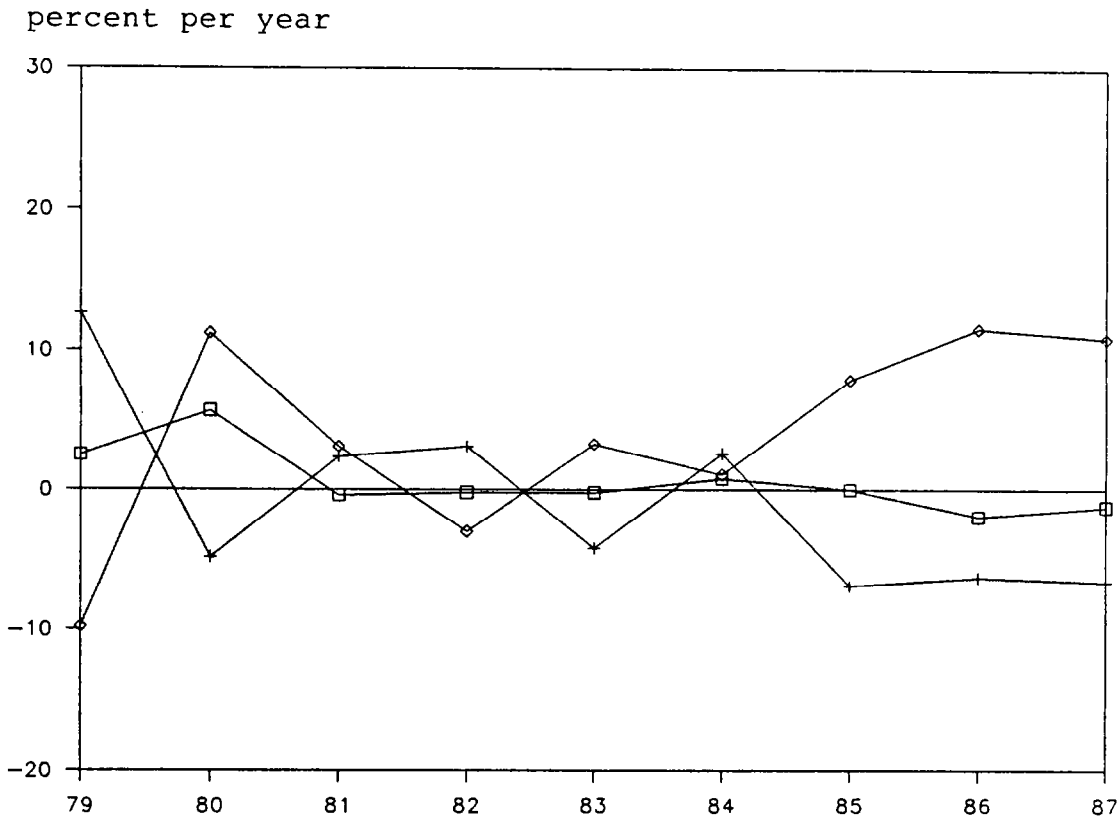


Figure 1.

General Machinery: Japan

□ domestic sales price (in yen)

\+ export price (in yen)

◇ export price (in foreign currency)

Sources: Bank of Japan and IMF.

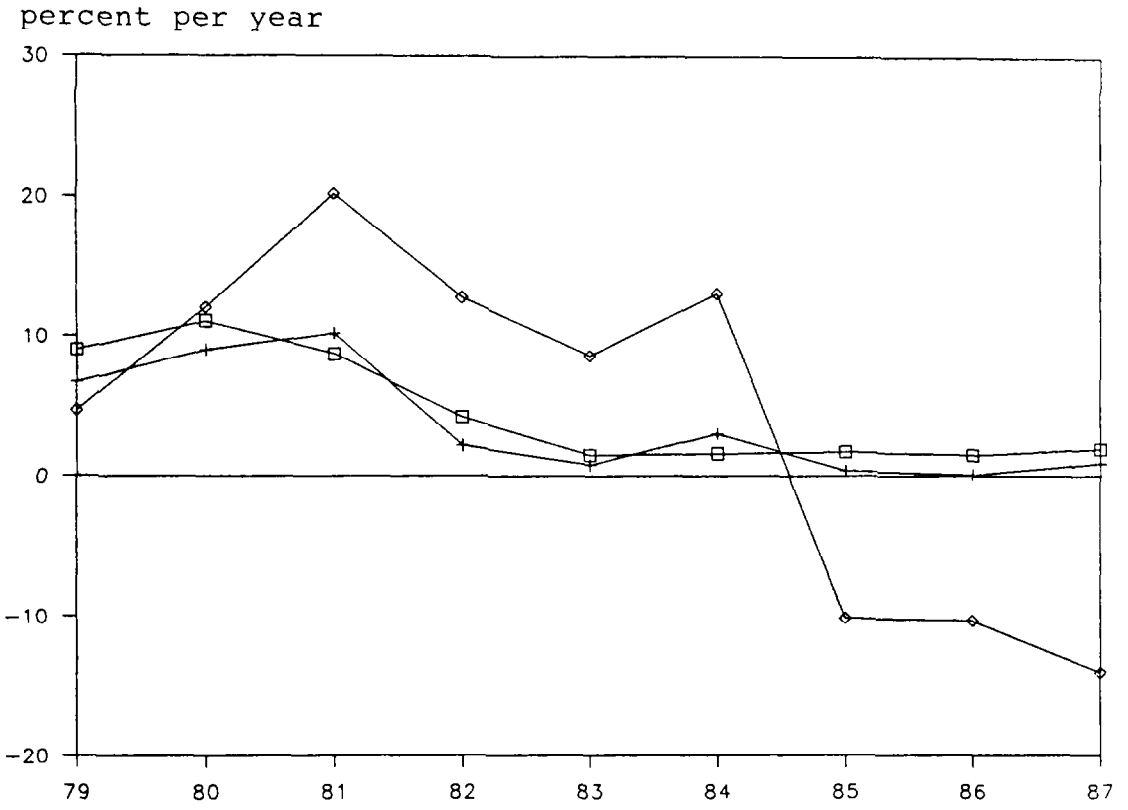


Figure 2.

General Machinery: United States

□ domestic sales price (in dollar)

\+ export price (in dollar)

◇ export price (in foreign currency)

Sources: Department of Labor and IMF.

APPENDIX

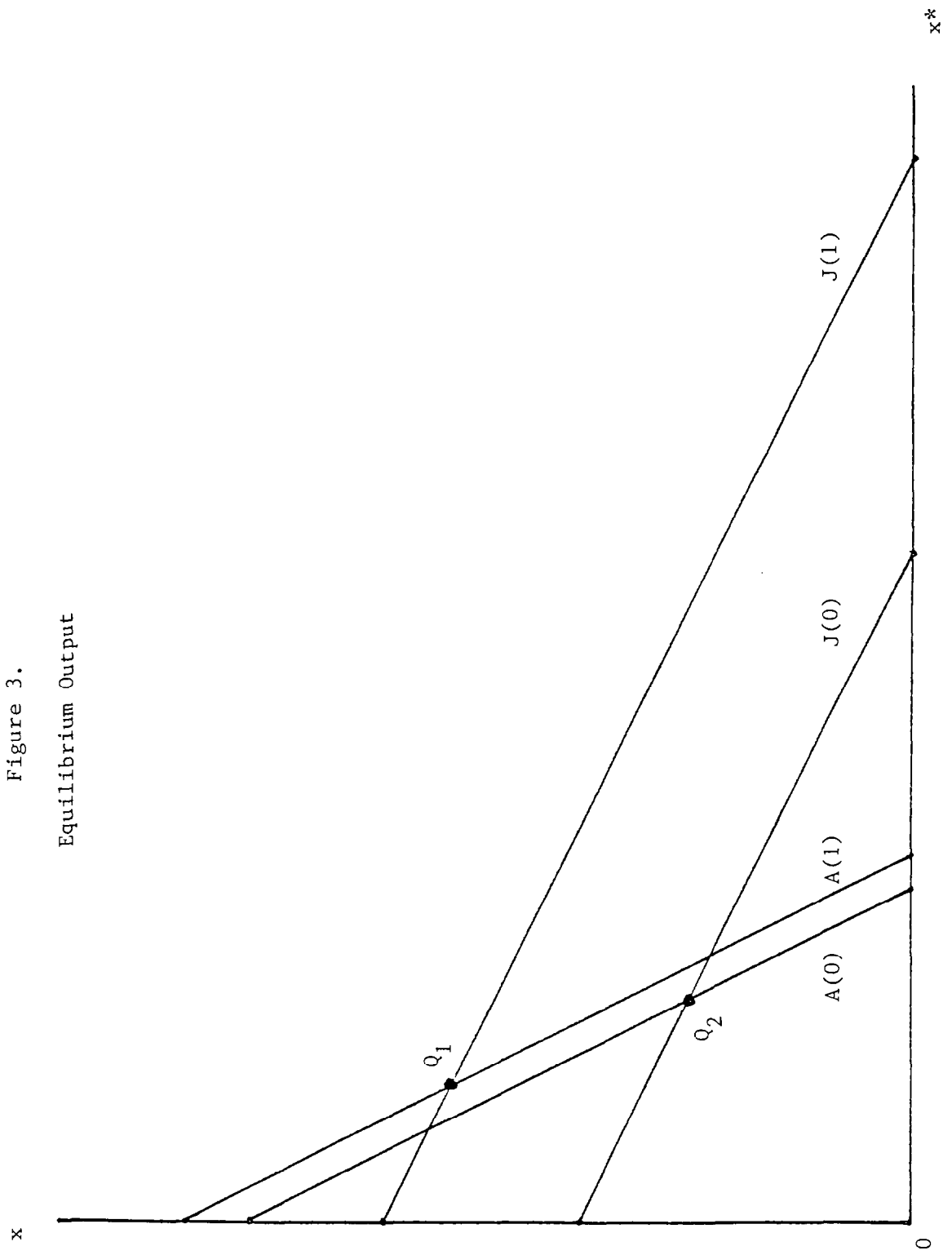


Figure 3.

Equilibrium Output

Figure 4.

Pass-Through

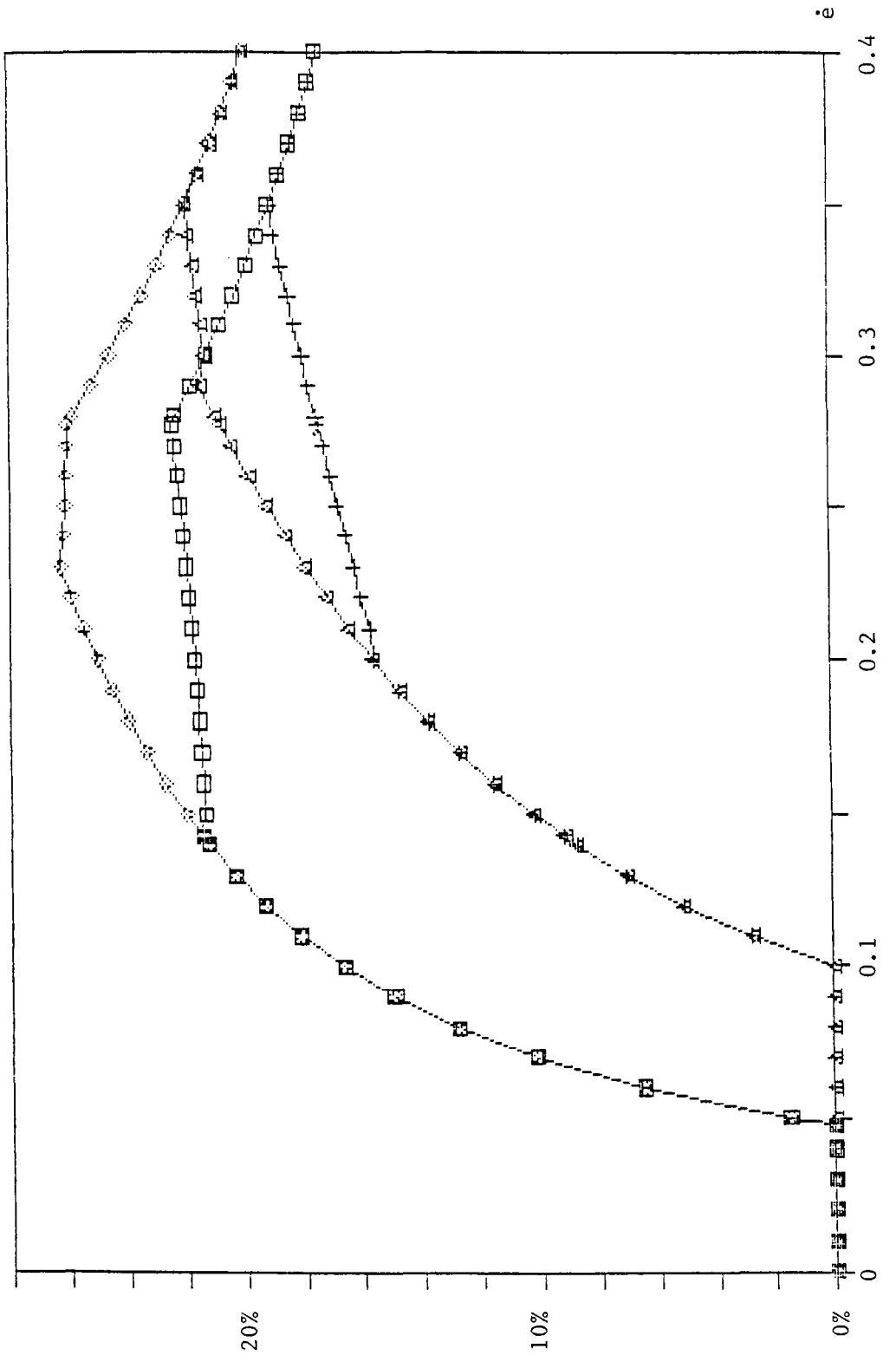
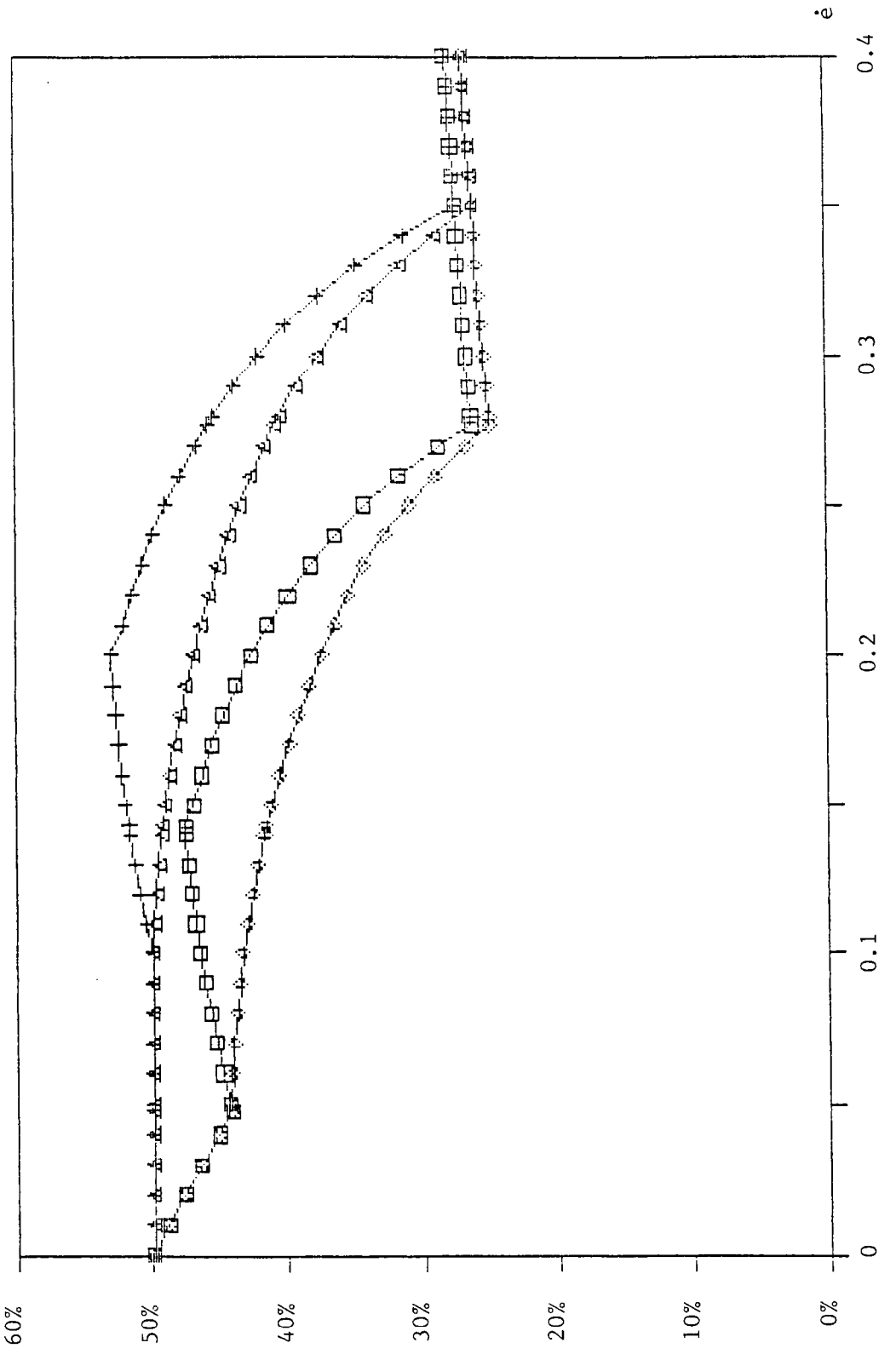


Figure 5.

Average Share of the Japanese Firm



REFERENCES

Baldwin, Richard E., "Some Empirical Evidence on Hysteresis in Aggregate U.S. Import Prices," paper presented at the conference "The Economics of the Dollar Cycle" at Brandeis University (November 1987).

_____, "Hysteresis in Import Prices: The Beachhead Effect," American Economic Review, Vol. 78, No. 4 (September 1988), pp. 773-785.

_____, and Paul R. Krugman, "Persistent Trade Effects of Large Exchange Rate Shocks," NBER Working Paper No. 2017, (September 1986).

Dixit, Avinash, "Entry and Exit Decisions of Firms under Fluctuating Real Exchange Rates," mimeographed, Princeton University (October 1987).

_____, "Hysteresis, Import Penetration, and Exchange Rate Pass-Through," mimeographed, Princeton University (March 1988).

Dornbusch, Rudiger, "Exchange Rates and Prices," American Economic Review, Vol. 77, No. 1 (March 1987).

Foster, Harry, and Richard Baldwin, "Marketing Bottlenecks and the Relationship Between Exchange Rates and Prices," mimeographed (October 1986).

Froot, Kenneth A., and Paul D. Klemperer, "Exchange Rate Pass-Through When Market Share Matters," mimeographed (January 1988).

HatsoPoulos, George N., Paul R. Krugman, and Lawrence H. Summers, "The Problem of U.S. Competitiveness," paper presented at the Fourth International Symposium of the Economic Planning Agency, Tokyo (March 1988).

Hooper, Peter, and Catherine L. Mann, "The U.S. External Deficit: Its Causes and Persistence," Federal Reserve International Finance Discussion Papers, No. 316 (November 1987).

Krugman, Paul R., "Pricing to Market When the Exchange Rate Changes," in Arndt and Richardson, eds., Real-Financial Linkages among Open Economies, MIT Press (1987).

Mann, Catherine L., "Prices, Profit Margins, and Exchange Rates," Federal Reserve Bulletin, Vol. 72, No. 6 (June 1986).

Marston, Richard C., "Pricing to Market in Japanese Manufacturing," paper presented at the IMF seminar (February 1989).

Marston, Richard C., "Pricing to Market in Japanese Manufacturing," mimeographed, University of Pennsylvania (March 1989).

McKinnon, Ronald I., "Toward a Common Monetary Standard Through the Regulation of Exchange Rates," paper presented at the Conference on Global Disequilibrium, Montreal (May 1989).

Ohno, Kenichi, "Export Pricing Behavior of Manufacturing: A U.S.-Japan Comparison," IMF Staff Papers, forthcoming (September 1989).

Woo, Wing T., "Exchange Rates and the Prices of Nonfood, Nonfuel Products," Brookings Papers on Economic Activity, No.2 (1984).

Yamawaki, Hideki, "Export Pricing Behavior and Market Structure," mimeographed, International Institute of Management, Berlin (February 1988).