THREE ESSAYS ON DYNAMIC EXPORT COMPETITION

by

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Submitted to the Department of Economics
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ABSTRACT

Various aspects of export competition are analyzed from dynamic perspectives.

Export pricing decisions are examined, in Chapter One, by focusing on the effects of demand uncertainty and exchange rate fluctuation on the sustainability of noncooperative collusion among oligopolistic exporting firms. The export pricing equation is estimated with the regime classification dummy which is allowed to follow a Markov transition process. The case of four Japanese industries during 1976 - 1988 shows that (a) the sustainability of noncooperative collusion is high and the duration of collusive phase is long in the machinery industry, (b) unanticipated fall in export demand triggers competitive pricing in the textiles industry, (c) current and future expected market size may affect the pricing decision, although the results in our case are not strong, and (d) current exchange rate appreciation increases the probability of collusion breakdowns in all industries.

Chapter Two examines the effect of exchange rate expectations on dynamic export pricing decisions within realistic expectation formation mechanisms. The Euler equation of an exporting firm in a customer market is estimated by making use of the results from survey data studies. The analysis is extended by the introduction of the Bayesian learning process. The investigation of Japanese industries shows that (a) the export price has a persistent impact on export demand and the future expected currency depreciation with a long time horizon lowers the current export price in the machinery industry, (b) the deviation from the ex-post rational exchange rate expectations affects the export price level by around three percent in the midst of exchange rate adjustment, and (c) the pass-through is lower when current exchange rate is perceived to be temporary rather than permanent.

Dynamic factors may lead firms to higher exports when their currency appreciates. In Chapter Three, a model with asymmetric adjustment costs predicts more sluggish withdrawal from foreign market for a firm with higher expected export expansion costs. On the other hand, the deep-pocket effect compels highly export-dependent firms to reduce exports more because of financial constraint. In this case, higher export dependence implies either higher stake or heavier burden for a firm reducing export. The individual firm-level export adjustments by Japanese companies are examined. The cross-section data shows that the currency appreciation makes the market structure of each industry change mainly by increased dispersion among small firms. By dividing firms based on their financial ties, I find evidence consistent with the theoretical predictions.

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS

INTRODUCTION

The exchange rate adjustment in the 1980s is an epoch-making event not only for businessmen and policy makers but also for economists. The drastic adjustment process provides us a precious opportunity to test the relevancy of economic theories. This thesis tries to examine various aspects of export competition from dynamic perspectives. After models are constructed, their relevancy will be empirically investigated.

In many fields of economics, dynamic models and/or imperfect competition models have replaced the conventional static perfect-competition models. The international economics is no exception. Krugman (1987) proposes six kinds of dynamic or imperfect competition models to explain the "pricing-to-market." Dornbusch (1988) indicates three major research topics in international economics: pricing, waiting, and expecting, all of which incorporate dynamic and/or imperfect competition aspects. In this thesis, repeated strategic interactions, sluggish customer flows, and costly quantity adjustments will be the core parts of our three dynamic models of export competition.[1] Industrial organization features will be introduced to this thesis by noncooperative collusions among exporting firms and by the effects of firm size, export dependence, and financial viability on firm's export adjustment decisions.

As long as we are interested in the dynamic aspect of business behaviors, both "expectations" and "history" are crucial if we borrow the terminology by Krugman(1991).[2] The expectations about future should have an important impact

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[1] In relation to the six models of pricing-to-market by Krugman(1987), Chapter One extends his third model(oligopoly) to dynamics, Chapter Two relies on a version of the sixth model(reputation), and Chapter Three is based on the fourth model(supply-side adjustment cost).

[2] Krugman (1991) makes the relation of "history v.s. expectations" clear in the context of choice between multiple equilibria in a two-sector model of industrial adjustment.

on current decisions when past decisions have persistent effects. Put another way, export pricing (or quantity) decision has an investment-like aspect and thus must be forward-looking. In this thesis, the noncooperative collusion enforcement mechanism (a punishment phase after a deviation), the extrapolative/regressive exchange rate expectation formation, and the Bayesian learning process will be considered to capture this implication to our context of dynamic export competition.

The relevancy of the theory will be empirically explored in the case of Japanese industries in each chapter. The reason for this choice is that unprecedented drastic yen exchange rate adjustments since the oil shocks must provide high power to statistical tests discriminating various economic models.

FIGURE EXCHANGE RATE

(yen/dollar)
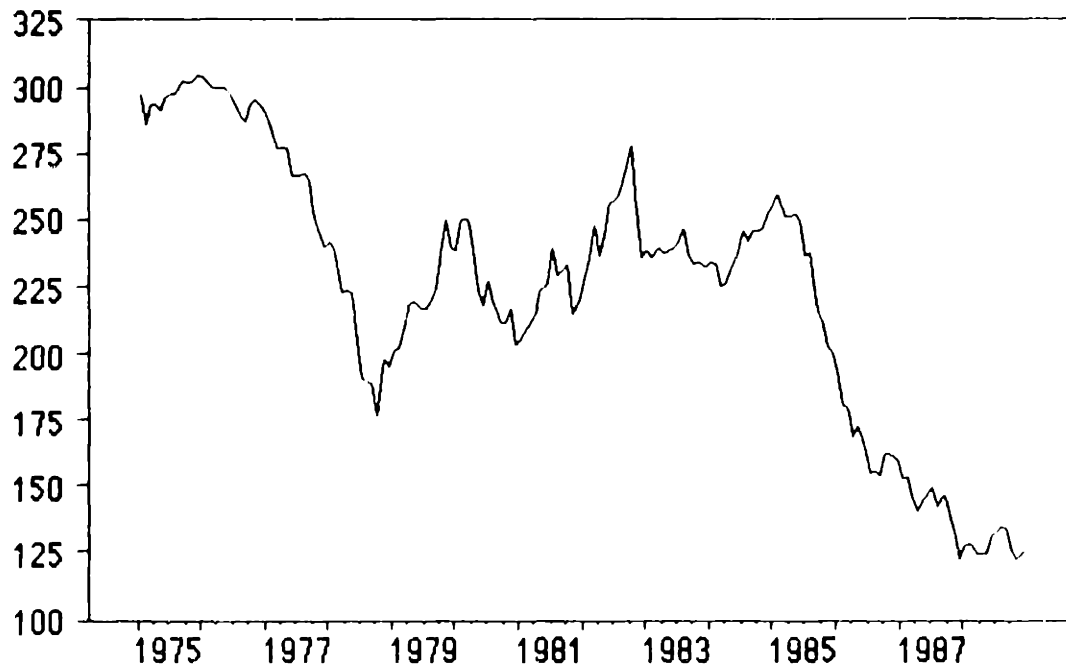
In this Introduction, we will relate our work to previous literatures and explain our motivations in what follows:

Chapter One analyzes the export price competition by focusing on the sustainability of noncooperative collusion among oligopolistic exporting firms.

Various kinds of imperfect competition models originated in industrial organization have been applied to international economics.[3] As for the export pricing under exchange rate changes, static oligopoly models such as Cournot have been intensively studied. Dornbusch (1987a) triggers this line of research.

Once we get out of the static framework, there are many other models of dynamic oligopoly price competition in industrial organization, which are also applicable to export pricing. Two major strands of dynamic pricing models are supergame and reputation.[4] Chapter One examines the former, while we will discuss the latter in Chapter Two.

In Chapter One, we compare two supergame models ("price war" models) which yield quite contrasting implications. One model focuses on uncertainty (unanticipated demand fall) while the other stresses the fluctuations (demand changes over time) as a cause triggering collapse of noncooperative (self-sustaining) pricing regime.[5] By adapting into the export pricing context, Chapter One examines the causes of export price changes by these two models. In industrial organization, since Porter (1983), the former model has been studied by various methods using the same data about a U.S. railroad cartel in the 19th

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[3] Krugman(1990) is a survey of this linkage.

[4] The short-run price rigidity or menu cost model will be another major dynamic pricing model popular especially in macroeconomics although less extensively studied in industrial organization literature.

[5] The former model theoretically originates in Green and Porter (1984) and the latter in Rotemberg and Saloner (1986)

century. On the other hand, Rotemberg and Woodford (1991) provide extensive evidence supporting the latter model on markup cycles.

To capture the persistent aspect of pricing regime, Markov transition process is assumed about the regime classification dummy in the switching regression. Thus, we can analyze the effect of "history" (whether firms have been in the collusive or competitive phase) on current export pricing where firms take account of "expectations" (about a rival's choice or about future exchange rates).

Chapter Two examines the effect of exchange rate expectations on dynamic export pricing decisions.

Although some have already empirically studied dynamic export pricing models based on the customer market theory, they found the effect of exchange rate expectations insignificant. On the other hand, according to the recently accumulated many survey data studies of exchange rate expectations, the rational expectation hypothesis seems unrealistic in the case of exchange rates and the expectations actually held in the marketplace are likely to be approximated by extrapolative or regressive expectations.

By combining these two strands of research, Chapter Two makes clear the role of exchange rate expectations in export pricing decisions when export demand is dynamic due to such factors as reputation effect and when exchange rate expectations ex-post on average deviate from the rational expectations.[6] Since exchange rate adjustments in the 1980s are likely to be interpreted as temporary, expectations are quite crucial in contemporary export pricing. In estimating the dynamic export pricing equation (Euler equation), the use of survey data results

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[6] In Chapter Two, the implications of Bayesian learning process (like Lewis (1988)) is also discussed.

enables us to obtain the realistic conclusion:The exchange rate expectations with a longer time horizon into the future affect the current export price as the past export prices influence the export demand more persistently. In other words, we empirically confirm the significant role of "expectations" about exchange rates in export pricing in a customer market where "history" matters.

Chapter Three introduces a dynamic export model with adjustment costs. Main focuses are on the diversity of export adjustments across firms and the effects of expectation dynamics.

Theoretically, entry/exit decisions under exchange rate changes have been formalized by the hysteresis models of Baldwin and Krugman (1989) and of Dixit (1989b). Since the actual export adjustments of firms are quite different even in the same industry, additional research is necessary to fill the gap between the representative-firm theory and the reality. Chapter Three investigates the individual firm-level export data to study the effects of firm size, export dependence, and "deep pocket" on export adjustment decisions. In this sense, Chapter Three enriches the international economics by introducing the empirical industrial organization elements.

Another point explored in Chapter Three is the effect of expectation dynamics on export adjustments. Since the adjustment costs make the "history" matter in dynamic export decisions, the "expectations" should also be crucial. If the ongoing currency appreciation is perceived to be temporary, the export quantity reduction will be delayed. We study this issue by several methods such as conducting simulations and interpreting actual pass-through changes.

The three chapters of this thesis will provide valuable insights for at least some aspects of dynamic export competition in the real world. The relevancy and

the limit of various models, which will be made clear by our empirical studies, will be a source of future research.

CHAPTER ONE

EXPORT PRICING

AND

SUSTAINABILITY OF NONCOOPERATIVE COLLUSIONS

1. Introduction

The drastic export price changes after the oil shocks reveals the important features distinguishing export price competition from domestic price competition: the uncertainty about foreign market conditions and volatile exchange rate fluctuations. This chapter analyzes export pricing by focusing on the effects of uncertainty and fluctuation on the sustainability of noncooperative collusion among exporting firms.

Within conventional models assuming perfect competition, firms find no problem in raising export prices in terms of foreign currency, fully reflecting exchange rate appreciation or unexpected booms in foreign markets.

Many businessmen, however, actually struggle with the problem caused by export demand uncertainty and exchange rate instability. They are often unwilling to raise export prices in terms of foreign currency, as we actually observe the case of Japanese export pricing under drastic yen appreciation after 1985. Some missing part between their serious concern and economic theory should be filled.

Since the perfect competition model is too primitive to describe contemporary export price competition, imperfect competition models developed in industrial organization have been introduced to explain changes in price-cost margin.[1] Partial pass-through of exchange rate changes into export price[2] has been

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[1] Dornbusch (1987a) is one of the pioneering works in this field, applying some industrial organization models such as Cournot and Dixit-Stiglitz to export price adjustment under exchange rate changes.

[2] Hooper and Mann (1989), for example, estimate the pass-through coefficient for nine countries by constructing estimated series of marginal costs from weighted-average of unit labor compensation and price indices for raw material and energy input.

analyzed as a result of strategic interactions among oligopolistic or monopolistically competing firms.[3]

Beyond this static framework, there still remain many issues to be analyzed in the dynamic aspects of export price competition.[4]

This chapter provides a framework to analyze the dynamic export price competition among firms by interpreting observed export price variations over time as a result of changes in sustainability of noncooperative collusion among oligopolistic exporting firms.

If entry/exit cost of the industry is not negligible, firms may charge prices higher than competitive levels by some kind of implicit noncooperative way of coordinating decisions. However, since this "collusion" is not at all formal and compelling, sustaining the collusive pricing in the industry becomes difficult when some firms deviate or when serious disturbances occur.

In this chapter, two models are introduced, by applying industrial organization theory, to examine the effect of export demand uncertainty and exchange rate fluctuations on the individual firm's incentive to deviate from the collusive equilibrium.

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[3] Another important issue which could be studied in the static framework is the "pricing to market" named by Krugman (1987). Marston (1990) examines it about Japanese manufactures.

[4] Besides our model discussed in this chapter, there are many models which try to explain dynamic export price competition from different perspectives. Although most of them do not explicitly consider strategic interactions like ours, among them are the following : Dixit (1989b), assuming Brownian motion about exchange rate movements, shows that export price pass-through is quite low when no entry/exit takes place, by a numerical simulation. As for the volatility of exchange rate fluctuations, Froot and Klemperer (1989), for example, show that more volatile exchange rates give a risk-neutral firm an incentive to cut export price. Klein (1990) concludes that higher volatility induces export volume expansion by studying U. S. exports in 1976 - 1986.

The first model, which theoretically originates in Green and Porter (1984), focuses on the effect of unobservability of other firms' decisions upon the pricing. Since a firm cannot know a rival firm's price, one has to infer it from unanticipated changes in export demand. If export demand becomes unanticipatedly low, each firm gets suspicious about the possibility of other firms' secret price undercutting. Thus, collusive pricing breaks down even if no firm actually deviates from it when a negative demand shock arrives.

The mechanism described above captures the essence of export price competition in the real world in that unpredictable export demand changes hinder firms' inferring rivals' decisions from aggregate export demand movements. Since export demand is often complicatedly determined by many factors, some unpredictable shocks affect the export demand and thus undermine the self-sustainability of noncooperative collusion.

The second model, which was originally developed by Rotemberg and Saloner (1986) analyzing the "price wars during booms", emphasizes the cyclical aspect of export demand movements. If the current level of export demand is higher than future expected demand, the present time offers a good opportunity for deviation. This theory predicts destabilization of noncooperative collusion under a high level of current export demand or under current depreciation of the exporter's currency.

Within this second model, the effect of future exchange rate changes can also be examined. The prediction by this model will be that the noncooperative collusions are relatively destabilized when export demand is decreasing or when the exporter's currency is on the appreciating trend because the diminishing gain from future deviation prompts a firm to deviate earlier.

Estimation of econometric models which capture the essence of these theory models is indispensable to test the relevancy of these theories.

The most straightforward way to test the first theory, which was taken by Baker (1989), is to estimate the export pricing (or supply) equation with the dummy which is defined by the estimation error of export demand function. Although this approach is intuitive, another approach needs to be taken since a thus exogenously defined dummy does not necessarily coincide with the "true" switches which are unobservable.

The second approach will proceed as follows: first, estimate the probability of being in the "collusive/competitive" phase by the maximum-likelihood method, then determine the switching dummy endogenously by Bayes' rule. This is an application of the technique proposed by Porter (1983). The probability thus calculated can be interpreted as representing "relative sustainability/ vulnerability" of noncooperative collusion among exporting firms. To capture the original implication of the enforcement mechanism (deviation/punishment) assumed in the theory, the regime classification dummy will be allowed to follow a Markov transition process. This second approach will be supplemented by probit regressions for the analysis of determinants of the export pricing regime switches. After that, performances of these two econometric approaches will be evaluated by specification test method, if necessary.

To apply these theories and econometric models, experience of export pricing by Japanese industries after the oil shocks will be examined.

The reason that Japanese industries are chosen is that their export pricing behavior during yen appreciation especially after 1985 has been attracting widespread attention among businessmen and policy makers and has been analyzed by many economists with various approaches.

The choice of this sample period (1976 - 1988) will enable us to examine the export pricing during the era of unprecedented exchange rate changes and of drastic economic fluctuations after the oil shocks.

This chapter is structured as follows: Section 2 introduces the two models theoretically formalizing dynamic export price competition. Section 3 constructs the econometric model and explains some approaches to test the relevancy of the theoretical predictions. Section 4 reports the estimation results about Japanese industries. Section 5 concludes the analysis with summary and remarks.

2. Theory

In this section, two theoretical models describing the export price competition are introduced, upon which their empirical counterparts will be built in the next section for econometric estimations.

2.1. Basic framework

Most of the contemporary export price competition among industrialized countries are conducted in industries where imperfect competition is prevalent.

In many oligopolistic industries, firms can somehow "coordinate" their pricing decisions without formal agreements and earn positive profits ("tacit collusion" in industrial organization language), as is suggested by the theory of infinitely repeated games. Hence, the analysis of enforcement mechanisms of such collusion

is important in studying the characteristics of dynamic export price competitions in the real world.

Suppose that firms compete in prices and that each firm cannot directly observe the prices chosen by competitors. Facing such uncertainty, it is rational for a firm to infer others' price from one's own export demand; a secret price cut by a rival firm takes place if one's export demand becomes lower than expected. A deviation of a firm from the collusive price is thus detected, the collusion is broken down, and it drives firms into the "competitive" (or "punishment") phase. Severe punishment through low enough profit and longer enough length deters a deviation. As supergame theory shows, given the discount rate of the firms, there exist the price level and minimal punishment length that sustain the collusion without inducing a deviation.

Necessary requirements for this framework to be realistic are, for example, that those exporting firms have some degree of market power in the export market and that entry/exit costs are not negligible in the industry. Otherwise, firms cannot charge any price above competitive price, and there is no room for collusions in pricing decisions. Empirical relevancy of the assumptions will be discussed in Section 4 with estimation results about Japanese industries.

Before introducing the theory models, clarification of information structure surrounding the export pricing is important because the timing issue is critical in dynamic models.

Consider the following timing which closely corresponds to the reality:

1. The exchange rate becomes known.[5]

2. Each firm chooses its export price.[6]

3. Aggregate export demand is revealed to the individual firm.

In addition to this timing assumption, we have to specify the pricing behavior of individual firm to analyze the dynamics of export price competition. The following two modelings will be useful:

If uncertain factors which cannot be known by the individual firm at the time of pricing decisions play a crucial role in export demand determination, the enforcement mechanism described above sometimes breaks down even if no firm deviates from the collusive pricing. The uncertainty about export demand makes it impossible for the individual firm to distinguish a rival's secret price cut from an exogenous negative shock to the export market. In other words, the fact that each firm has to decide on export pricing before knowing all relevant information about export market conditions is the source of collapse of noncooperative collusion in this case. The first theory model explained in the next section focuses on this aspect.

On the other hand, firms may choose the export price mainly by observable factors such as current exchange rate, when export demand is mainly determined

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[5] Since we assume no menu costs and no adjustment process for changing prices, there is no uncertainty issue about current exchange rate in our framework. Different assumptions about the order of timing are found, for example, in a theory model by Fisher (1989) and an econometric model by Marston (1990).

[6] Here, we assume that the firm's actual (though implicit) decision variable is the yen price, even if export contracts in the real world may be concluded in terms of the dollar in many cases. (For the case of Japanese exports, 32.2% are invoiced in yen and 62.3% are in U.S. dollars in 1982 which will be the middle of our sample period in section 4. See Hamada and Horiuchi (1987)) One of the supports for this assumption can be found in the empirical evidence that many Japanese firms adopt the "in-house" exchange rate and always evaluate the revenue of each contract in terms of the yen converted by this rate. See, for example, Ito (1990). Giovannini (1988) examines the choice of denomination currency in exports and concludes that fixing export price in foreign currency is preferable for risk-neutral firms.

by them. Then there is no issue of uncertainty about export pricing because each firm knows the current exchange rate before pricing decisions are made, and the only issue left is the timing of deviation from collusive pricing, or the effect of exchange rate fluctuations on the individual firm's incentive. The second theory model examines this side of export price competition.

Whether the "uncertainty effect" or the "fluctuation effect" is the better description of real-world export pricing depends on characteristics of market structure of each industry. In this sense, empirical tests of these theories should be conducted on an industry basis, as will be discussed in Section 4.

2.2. Uncertainty effect

Consider an industry where domestic firms supply products to a foreign market in a simple two-country framework. Let us call the importing country's currency as "dollar" and the exporting country's currency as "yen", just to make things concrete and to facilitate discussions in empirical study about Japanese case later in this chapter.

Suppose firms are risk neutral and maximize expected present value of future export profit W:

$$W = E[\Sigma_t \, \delta^t \, \pi_t] \tag{1}$$

where δ is the discount factor $(0 < \delta < 1)$ and π is the export profit per period.

Without collusions, no firm can earn positive profit because noncooperative Bertrand price competitions are repeated in every period.

Next, consider the following trigger strategy; keep choosing the collusive price as long as the collusion is sustained and charge the competitive price during the punishment phase once the collusion breaks down.[7]

Since export demand fluctuates by uncertain factors, firms have to infer the breakdown of collusion from an unanticipated fall in export demand and solve the dynamic programming problem as follows[8]:

Let V^+ (V^-) be the present discounted value of a firm's future export profit starting from the time t on when firms are in the collusive (competitive, respectively) phase.

Suppose that there are two possible states of export demand in each period: with probability r ($0 < r < 1$), export demand is "high" because of sustained collusion and with probability $(1-r)$, export demand is "low" because of some firms' secret price cut and/or because of negative shock to demand from outside.

Then, by stationarity,

$$V^+ = r(\pi^c + \delta V^+) + (1 - r)\delta V^- \tag{2}$$

where π^c denotes the collusive level of export profit of a firm per period. The above equality says that, with probability $(1 - r)$, the collusion sustained so far breaks down at any moment in time, and the punishment phase starts from then on, even if no firm undercuts the collusive price.

Given the length of punishment period T,

$$V^- = \delta^T V^+ \tag{3}$$

The necessary condition for no firm to deviate from the collusive pricing is the following incentive constraint:

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[7] We do not discuss the optimality of this trigger strategy in this mainly empirical thesis, but theoretical works about it have already abounded.

[8] The framework of the analysis for the general case closely follows the explanation of Green-Porter model in chapter 6 of Tirole (1988).

$$V^{+} > r(\pi^{m} + \delta V^{-}) + (1 - r)\delta V^{-} \tag{4}$$

where π^{m} denotes the profit of the firm that undercuts the collusive price.

From (1) and (2),

$$V^{+} = r\pi^{c} / [1 - r\delta - (1 - r)\delta^{T+1}] \tag{5}$$

$$V^{-} = \delta^{T} r\pi^{c} / [1 - r\delta - (1 - r)\delta^{T+1}]. \tag{6}$$

As for the choice of T, by substituting (5) and (6) into (4) and by assuming joint profit maximization ($\pi^{c} = \pi^{m} / n$) among n firms in the collusive phase, we obtain

$$n r\delta + (n - 1 - nr)\delta^{T+1} > n - 1. \tag{7}$$

There exists a minimal T satisfying (6) as long as n is not so small ($n - 1 - nr < 0$). Then, firms choose this minimal T and can reduce the loss of profit in the punishment phase. This completes the description of the enforcement mechanism in a general setting.

To study the effect of export demand uncertainty on export pricing collusions, we need an explicit model of the mechanism by which the demand uncertainty affects the export profit of a firm.

The export profit per period for a firm i ($i = 1, ..., n$) at period t is given by

$$\pi_{it} = (p_{it} - c) D(p_{it}/e_{t}, p_{-it}/e_{t}, p^{*}_{t}, y^{*}_{t}) + u_{t} \tag{8}$$

where P_{i} denotes the export price charged by firm i and P_{-i} is other firm's price. Marginal cost is assumed to be constant (c) for simplicity. Both P and c are expressed in terms of yen, and "e" is the exchange rate (yen per dollar). The export demand D also depends on the price offered by competing foreign firms and the income level of the importer countries (p^{*}, y^{*}, both expressed in dollars). As usual, $D_{1} < 0$, $D_{i} > 0$ ($i = 2, 3, 4$) (where D_{i} is partial derivative of D with

respect to the i-th argument),"u" denotes the disturbance term which cannot be known at the time of pricing decision and assume $E(u_t) = 0$ for all t, where E is the expectation operator.

Now, consider the case where export demand becomes unanticipatedly low in spite of collusive pricing by all exporting firms. Then, the profit is lower than expected:

$$\pi = (p^c - c) D$$

$$= (p^c - c) (E[D(p^c/e, p^c/e, p^*, y^*)] + u)$$

$$< (p^c - c) E[D(p^c/e, p^c/e, p^*, y^*)]$$

$$= \pi^c$$

where p^c denotes the collusive price chosen by exporters, and the realized "u" in this case is negative.

Since each firm cannot know exactly the price of a rival's export, no firm can distinguish a rival's secret price cuts from exogenous negative export demand shocks, even if all the firms know the export demand function correctly. Thus, an unanticipated export demand fall triggers a breakdown of collusion. Let us call this "uncertainty effect."

This model gives us an interesting interpretation about the nature of price vars; if this "uncertainty effect" really dominates, then, export price cutting is "involuntary" in that it is inevitable to sustain the collusion and may be desired by no firms.

2.3. Fluctuation effect

In this section, we introduce an alternative model which explains export price competition from a different perspective. Some of the results sound quite

different from those of the previous model, but it does not mean that they are contradictory. Explicit contrast of basic assumptions is rather important

The second model emphasizes the cyclical aspect of exchange rate movements, and its effect on export pricing, which was first studied by Rotemberg and Saloner (1986) about dynamic price competition among domestic firms under macroeconomic fluctuations.

To simplify, let the export demand for firm i be a function of prices charged by firms:

$$D_{it} = D(p_{it}/e_t, p_{-it}/e_t) \tag{9}$$

As was discussed in Section 2.1, there is no uncertainty in export demand determination in this model, since the current exchange rate is observable before the pricing decision.

To see the essence of this model, consider the simplest case where the sequence of exchange rate (e_t) is i.i.d. (Since i.i.d. assumption about exchange rate movement is empirically problematic, it will soon be relaxed.) Then, the collusive level of profit is given by

$$\pi^c = (p^c - c) \, D(p^c/E(e), p^c/E(e))$$

which is constant over time because of i.i.d. assumption.

If the current exchange rate is depreciated compared with its future expected value ($e_t > E(e_s) = E(e), s > t$), the incentive for a firm to deviate from the collusive equilibrium gets higher than usual because current deviation brings about higher profit than that by future deviation:

$$\pi^m_t = \max_{p_t} (p_t - c)\, D(p_t/e_t,\ p^c/e_t)$$

$$> \max_{p_s} (p_s - c)\, D(p_s/E(e_s),\ p^c/E(e_s))$$

$$= E(\pi^m_s)$$

for any $s > t$.

This result sounds contradictory to that by the previous model in that this asserts that the competitive phases emerge more often under "high" export demand. The difference, however, derives from the following: the previous model focuses on the comparison of "anticipated" current export demand with realized demand, while this model compares the current export demand with the future one. The difference in the assumption about the timing is crucial. Export price is chosen before total export demand becomes known in the first model. In the second model, however, the decision to undercut the price is made after knowing the actual exchange rate.[9] Let me call this driving force in the second model the "fluctuation effect."

Now, extend this model to study the general case without i.i.d. assumption about exchange rate movement, following Rotemberg and Woodford (1991) which examines the effect of business cycles on markups[10]

Consider the case where the incentive compatibility constraint is binding:

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[9] Another important difference is that the first model predicts periodic switches between collusion and competition even if no firm deviates, while no switches are observed in equilibrium in the second model.

[10] Rotemberg and Woodford (1989) report simulation results.

$$\pi^m_t - \pi^c_t + x_t \tag{10}$$

where $\pi^m_t (\pi^c_t)$ denotes per-period profit of the deviating firm (per-period profit under collusion, respectively) as before, and x_t is the future profit from the next period on ($x_t - W_t - \pi_t$ from (1)).

(10) can be rewritten as, by dropping time subscript,

$$(p^m - c) D(p^m/e, p^c/e) - (p^c - c) D(p^c/e, p^c/e) + x \tag{11}$$

where p^c is the collusive price which depends on the exchange rate and future profit and p^m is the price chosen by the deviator:

$$p^c - p^c(e, x)$$

$$p^m = \arg\max_p (p - c) D(p/e, p^c/e).$$

The effect of current exchange rate change on export price can be examined by just differentiating both sides of (11) with respect to "e" as follows:

$$(p^m - c) [D_1^m(-p^m e^{-2} + e^{-1} \partial p^m/\partial e) + D_2^m(-p^c e^{-2} + e^{-1} \partial p^c/\partial e)] + D^m \partial p^m/\partial e$$

$$- D^c \partial p^c/\partial e + (p^c - c)(D_1^c + D_2^c)(-p^c e^{-2} + e^{-1} \partial p^c/\partial e) \tag{12}$$

where $D^m = D(p^m/e, p^c/e)$

$D^c = D(p^c/e, p^c/e)$

$D_1 = \partial D/\partial(p_i/e)$

$D_2 = \partial D/\partial(p_{-i}/e)$

Let the own- and cross-elasticity of export demand be c_1 and c_2 ($c_1 > c_2 > 0$). Then,

$$\partial p^c / \partial e - A / B$$

where

$$A = e^{-1} [(\epsilon_2{}^m - \epsilon_1{}^m)(p^m - c)D^m - (\epsilon_2{}^c - \epsilon_1{}^c)(p^c - c)D^c] - (D^m + \epsilon_1{}^m \pi^m / p^m) \partial p^m / \partial e$$

$$B = D^c [(1 - c/p^c)\epsilon_1{}^c - 1] + [\epsilon_2{}^m (p^m - c)D^m - \epsilon_2{}^c (p^c - c)D^c] / p^c.$$

By assuming constant elasticity of export demand,

$$A = e^{-1} (\epsilon_2 - \epsilon_1) (\pi^m - \pi^c) - (D^m + \epsilon_1{}^m \pi^m / p^m) \partial p^m / \partial e$$

$$B = \epsilon_2 (\pi^m - \pi^c)/p^c + D^c [(1 - c/p^c)\epsilon_1 - 1].$$

Since the deviating firm's profit is higher than the collusive profit $(\pi^m > \pi^c)$, and since $\epsilon_1 > \epsilon_2$ and $\partial p^m / \partial e > 0$, then, $A < 0$ and $B > 0$ as long as export demand is elastic enough. (If export demand is inelastic to its own price, then, export price competition is uninteresting.)

Therefore, we confirm that the previously obtained result is robust without i.i.d. assumption:

$$\partial p^c / \partial e < 0$$

which means lower export price under current exchange rate depreciation.

Next, we can study the effect of future changes on the current export price within the same model. Differentiating (11) with respect to X yields

$$(p^m - c) D_2{}^m (e^{-1} \partial p^c / \partial X) - D^c \partial p^c / \partial X + (p^c - c)(D_1{}^c + D_2{}^c)(e^{-1} \partial p^c / \partial X) + 1 \quad (13)$$

By rearranging,

$$\partial p^c / \partial X - B^{-1} > 0.$$

Therefore, export price is higher when the exchange rate depreciation or export market expansion is expected in the future. Although this result was not obtained in the previous i. i. d. setting, the underlying reasoning is intuitively appealing; the collusion is more easily sustained at the same current exchange rate level when expected future export sales is on the expanding trend than on the declining trend. Let us call this "expected fluctuation effect" in contrast to the previously discussed "current fluctuation effect."

Thus, when firms form their expectations about future exchange rates from current exchange rate, for example by extrapolation, we could examine the effect of the "direction" of the exchange rate adjustment, not only the "level" of the exchange rate, on export pricing in this second model. This model is appealing in that it may provide a clue to analyze the obvious asymmetry in Japanese experience: cutting export price drastically in yen terms during yen appreciation phase.

The similar results can be obtained in a different context by Haltiwanger and Harrington (1991) who extend Rotemberg-Saloner model by introducing deterministic cycles of demand movements[11].

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[11] Gottfries (1988) analyzes the dynamic optimization of an exporting firm with flow of customers, who only gradually respond to price changes, and estimates the Euler equation for the Swedish manufacturing case, though he finds "only limited support" for his theory. In contrast to the collusion model, his customer-market theory predicts opposite fluctuation effect, i e , current market expansion raises current price because firms exploit from current customers and future expected market expansion lowers current price because firms "invest" for customer-base expansion.

Froot and Klemperer (1989) study the effect of future exchange rate changes by the two-period model framework where the market-share variable is directly included into the profit function. They also predict the opposite direction of fluctuation effect, but their empirical study reports that the expectation effect is not significant.

Rotemberg and Woodford (1991) compare these models about markups under business cycles and find supports for the collusion model.

3. Econometric model

This section constructs the econometric model which captures the main essences of the theory models given in the previous section. We introduce several approaches to test the existence of switches and the significance of their causes predicted by the theory.

3.1. Econometric model

The export price p chosen by a firm depends on the marginal cost (MC) and on the elasticity of export demand (ϵ). (Here, both p and MC are expressed in terms of yen.) Various behavioral assumptions about pricing of firm j ($j = 1,..., n$) are summarized by

$$p_{jt} (1 - \theta_{jt} / \epsilon) = MC (q_{jt}) \qquad (j = 1,..., n)$$

where θ equals one when firms choose price by maximizing joint profit (i.e. monopoly pricing), and θ equals zero when firms compete in prices noncooperatively (Bertrand competition). The value of θ is between zero and one in oligopolistic industries (for example, $\theta = 1/n$ when firms compete in the Cournot fashion), and θ can be interpreted as a measure of collusiveness (or inverse of index for competitiveness) of the industry.

Then, in equilibrium, for an industry as a whole, after aggregating over j,

$$p_t (1 - \theta_t / \epsilon) = MC (q_t). \qquad (14)$$

By assuming log-linearity about $MC(q)$[12] and demand function, the pricing equation is given by

$$\ln p_t = \beta_0 + \beta_1 \ln q_t + \beta_2 \ln W_t + \beta_3 I_t + \Sigma_i d_i DUM_{it} + v_t \qquad (15)$$

Here, "I" is the key indicator variable taking zero in "collusive" phase and one in "competitive" phase for negative β_3[13], of which the definition will be explained in detail later, W denotes the input cost or factor price which affects the pricing behaviors from outside the industry, DUM_i (i = 2,..., 12) are seasonal dummies for monthly data, and v is the i.i.d. error term with mean zero.

When export quantity and seasonal dummies are not significant, the pricing equation becomes

$$\ln p_t = \beta_1 + \beta_2 \ln W_t + \beta_3 I_t + v_t. \qquad (16)$$

Further, consider the corresponding export demand function without imposing constraints on the coefficients

$$\ln q_t = \alpha_0 + \alpha_1 \ln p_t + \alpha_2 \ln e_t + \alpha_3 \ln p^*_t + \alpha_4 \ln y^*_t + \Sigma_i d_i DUM_{it} + u_t \qquad (17)$$

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[12] By assuming specific functional forms about MC, we can avoid constructing estimated series of MC which may contain serious measurement errors.

Another way of avoiding this problem is making use of Shephard's Lemma in microeconomic theory. For example , Ohno (1987) estimates trans-log cost function by this method to study the export pricing of U.S. and Japanese manufacturers.

[13] Pricing equation in collusive phase is assumed to have identical functional form to that in competitive phase, except only for the constant term.

where e denotes the exchange rate of the yen, P^* and y^* are the price level and income of the importing countries, u is the i. i. d. error term with mean zero. Naturally, $\alpha_1 < 0, \alpha_i > 0$ (i=2,3,4). And the price-elasticity of export demand is c = $-\alpha_1$. Thus, a system of export market consists of (15) (or (16)) and (17).[14]

Since the goal of this paper is to see the significance of the coefficient of the switching dummy I (β_3) and the magnitude of its impact by estimating the pricing equation of the industry, we have to find an appropriate series of ($I_t \mid t = 1,..., T$). Although there may be many possible candidates for the "appropriate" (I_t), we take the following two approaches:

(A) Define (I_t) exogenously and check its significance.

(B) Detect (I_t) endogenously from data, then search causes of those switches.

Baker (1989) takes Approach (A) to analyze the pricing of steel in the U.S. during the Great Depression. Approach (B) combines a part of the methods developed in Porter (1983), Lee and Porter (1984) and Porter (1985) in studying the pricing of railroad cartel in the U.S. during the 1880s.

Following these preceding research about domestic industries, the main focus of the econometric model developed in this section is on the test of the existence

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[14] By assuming that the perfect competition ($\theta = 0$) prevails in the competitive phase (I = 1), a measure of "collusiveness" in the collusive phase (θ) can be calculated from estimates of export demand and pricing equations by

$$\theta = a_1 [\exp(b_3) - 1].$$

Although the assumption of perfect competition in the competitive phase may not be satisfied in some cases (for example, fixed cost of entry/exit is not negligible), θ will be calculated for Japanese industries by using the estimates in section 4.

Hereinafter, a, b (alphabet) denote the estimate of α, β (Greek letter).

of the switches in pricing behaviors and of the causes of those switches, instead of the explicit test on the specific kind of enforcement mechanism itself.

3.2. Estimations

3.2.1. Estimation with exogenous dummy

The approach (A) in the previous section is suitable to test the "uncertainty effect." The economic reasoning underlying this approach is rather straightforward: the first theory model suggests defining the switching dummy based on the unanticipated change in export demand by

$$I_t - 1 \text{ , if } u_t < 0 \qquad (18)$$
$$- 0 \text{ , otherwise}$$

where u_t is the estimation error of the export demand function.

After estimating the export demand function (17) by two-stage least squares, the pricing equation (15) or (16) is estimated with a thus defined dummy.

As was considered in the previous theory section, each firm charges the collusive price so long as no firm deviates from this equilibrium. Since a firm cannot observe directly the export price chosen by other competing firms, a firm decides to switch to the "competitive" pricing when export demand becomes unanticipatedly low because there is some possibility that a rival firm may undercut the collusive level of price.

Suppose a firm forms its estimate about the export demand by the function (17). Then, it is rational for a firm to switch its pricing strategy depending on the sign of the estimated residual (u) of this export demand function: i.e., negative

U implies the possibility of some firms' defection and drives firms into a "competitive" period. This leads us to the definition of the switching dummy given above.[15]

Under this definition, the essence of the first theoretical model is boiled down to the one-tailed test of the null hypothesis that H_0: $\beta_3 < 0$.

The choice of functional form of export demand equation, however, is so critical that it may affect the results of this approach. This is one of the motivations leading us to the next approach, where the definition of the switching dummy does not directly depend on the export demand function.

3.2.2. Estimation with endogenous dummy

As was mentioned, the previous approach has a problem in that it may seriously depend on the specific functional form of the export demand function.

The more serious and fundamental problem of that approach, however, derives from the unobservability of the "true" sequence of (I_t). In other words, the sequence of dummies exogenously defined by the unanticipated change in export demand does not necessarily coincide with the true switches even if the theoretical model is valid because each firm may have a different estimate of demand from ours and because some factors other than demand changes may have an impact on pricing. The exogenous dummy is a measure of the true switching factor with some error. As in the usual cases of errors-in-variables models in econometrics, least squares estimation yields biased estimators[16].

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[15] A slightly different definition is given in Baker (1989). He considers the case where the threshold level does not necessarily coincide with zero.

[16] The issue of measurement error is examined by Hajivassiliou (1989). In his paper, in addition to the measurement error about switching dummy itself, errors in explanatory variables for the switching dummy is also analyzed and he proposed simulation estimation methods which can avoid problems caused by maximum-

Instead of using the imperfect sample separation information derived from the export demand function, we can estimate the probability of being in the "competitive" period (λ) by maximum likelihood and can classify each period into "collusive" or "competitive" phase based on the estimation result[17]. After that, we can search determinants of switches by regressions of the endogenously determined dummy as the binary dependent variable. This consists of the essence of this approach which we will explain in what follows.

Suppose that the iid sequence of $(I_t \mid t = 1,...,T)$ follows the Bernouilli distribution[18]

$$I_t = 1 \text{ with probability } \lambda \tag{19}$$

$$= 0 \text{ with probability } (1$$

Then, the log likelihood function is given by

$$L = \sum_t \ln f(P_t)$$

with the probability density function

$$f(P_t) = \lambda \, g(P_t \mid I_t = 1) + (1 - \lambda) \, g(P_t \mid I_t = 0)$$

where g is the conditional density given I_t.

By assuming normal distribution $N(0, \sigma^2)$ about the error term v, we can estimate the probability λ and coefficients β of the pricing equation by maximum likelihood. These estimates, in turn, determine the the probability of

likelihood. This may improve our study in that our constructed export "quantity" variable may potentially be measured with errors.

[17] Here, we follow the procedure taken by Porter(1983). But, on the other hand, Lee and Porter(1984) examine the method where imperfect information (in our case, unanticipated export demand changes) is also taken account of in regime classification.

[18] As Porter (1983) pointed out, if the enforcement mechanism analyzed in the theory section actually works, then the switches are not independent over time but rather serially correlated. We will later relax the i.i.d. assumption and allow the correlation by introducing a Markov process.

($I_t = 1$) for each period by the following, Bayes' rule:

Prob ($I_t - 1$)

$$- \lambda g(P_t| I_t - 1) / [\lambda g(P_t| I_t - 1) + (1 - \lambda) g(P_t| I_t - 0)] \qquad (20)$$

This calculated probability classifies the whole sample period into "competitive" phase and "collusive" phase by

$$I_t = 1 \quad \text{if Prob}(I_t = 1) > 0.5$$
$$= 0 \quad \text{otherwise.}$$

Thus, the switching dummy I_t is endogenously determined from the data.

Another interpretation can be given to this probability, though it deviates from the original econometric procedure. Rather than focusing on the rigid threshold level of 0.5, we can interpret this probability as a continuous measure of "relative vulnerability/sustainability" of noncooperative collusion; i.e., higher probability of $I = 1$ means that the collusion is more vulnerable, less sustainable.

The original implication of noncooperative collusion models, however, may not be captured by the i.i.d. assumption about the switching dummy which we have just introduced. The competitive or collusive phases predicted by the theory, which is consisted of punishment period after deviation, may persist more than one period. Hence, Prob($I_t = 1$) may be serially correlated rather than i.i.d. Consider the estimation including the dummy variable whose process is a Markov chain with the following transition probability:

$$\lambda_{ij} = \text{Prob}(I_t - j | I_{t-1} - i). \qquad (21)$$

Following Cosslett and Lee (1985), we allow the possibility of the Markov transition in our switching dummy.[19] After obtaining estimates of λ_{ij}, we can calculate the regime probability of the competitive or collusive phase by

$$\lambda_i - \lambda_{ij} / (\lambda_{ij} + \lambda_{ji}) \tag{22}$$

assuming stationarity. Further, the estimated mean duration of the phase i will be given by $1/\lambda_{ij}$.

Thus, the export pricing behavior is classified into two phases. We cannot, however, interpret it meaningfully because the determination mechanism of the switching dummy is unknown. Then, the next step should be the search for the determinants of this switching dummy, or the test of predictions about the effects of variables on the sustainability of collusion given by theory models. Since I_t is a discrete (binary) dependent variable, probit (or logit) regressions are employed.

Included variables as regressors will be unanticipated changes in export demand, export demand itself, exchange rate and others. The regression on estimation error in export demand is intended to test the uncertainty effect. The fluctuation effect will be tested by the regression on current or future expected export demand.

3.2.3. Comparison of two approaches

Two approaches to test the theoretical predictions have been introduced, but, to reach the final conclusion, the performances of these approaches should be compared, for example when contradictory results are obtained from them.

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[19] In the actual estimation, we employ the simpler estimation procedure by Goldfeld and Quandt (1973) which also yields consistent estimators. Cosslett and Lee (1985) propose a more efficient estimation. Ellison (1990) simultaneously estimates pricing/demand parameters and regime shift dynamics.

The specification test of Hauseman (1978) is applicable to our case, as Hajivassiliou (1986) pointed out in a simple disequilibrium model example. The estimator with endogenous dummy does not depend on the information derived from export demand function, while estimator with exogenous dummy fully makes use of it. Then, if the switching dummy is really determined by the unanticipated export demand changes, the former is inefficient. The consistency of the latter depends on the correctness of the information from export demand function, while the former is always consistent. Therefore, under the null hypothesis that the export pricing regime is actually classified by the unanticipated export demand changes, the test statistics defined below follows the χ^2 distribution

$$H = (b_1 - b_2)' \, (V(b_1) - V(b_2))^{-1} \, (b_1 - b_2) \tag{23}$$

where b and V are the coefficient vector and variance-covariance matrix of the maximum-likelihood estimates of the export pricing equation and subscript "1" and "2" mean that the dummy is determined without and with employing export demand residuals, respectively.

4. The case of Japanese industries in 1976 - 1988

This section reports various estimation results of export pricing equations for four Japanese industries in 1976 - 1988, with the description of the data used in estimation.

4.1. Data description

Data employed in estimation are described in this section. The appendix to Chapter One will provide additional explanations of them in detail.

The export prices (p) in yen terms for various classifications of Japanese goods are reported by the Bank of Japan. Of those series, we use the following four industries to estimate equations: machinery, metals, chemicals and textiles.[20]

The conventionally used index for export quantity (q) is defined by value index divided by unit-value index. To avoid troubles caused by unit-value index[21], in this thesis, export "quantity" is defined by the export value (which is reported in trade statistics) divided by the corresponding export price "p".

Another variable included in the pricing equation is the input cost or factor price (W) of each industry. Compared with other variables such as wage and raw material prices, input price based on Input-Output table may be better at capturing the cost conditions for each industry in our case.

Included as explanatory variables in the export demand equation are the exchange rate of the yen (yen/U.S. dollar rate and/or nominal effective exchange rate) (e), the producers price index as a proxy for the price offered by foreign competitors and the industrial production as a proxy for importer's income since GNP data are not available on a monthly basis (both for U.S. and OECD European countries) and monthly dummies for seasonal adjustment.

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[20] The main reason for our choice of industrial classification is data availability, but there remains a problem about assuming collusion at this level of disaggregation.

[21] For example, export unit-value index is calculated as average value of various (possibly time-varying) products exported under the same classification, while export price index is based on the fixed, same brands of the products.

Our choice of sample period (January 1976 - December 1988, 156 monthly observations) enables us to investigate the pricing behavior of Japanese firms under drastic fluctuations of the exchange rate of the yen throughout the period after the oil shocks. The basic statistics of export price and quantity are summarized in Table 1.

4.2. Estimation results

The results of estimation of export pricing equations for four industries are reported in Tables 2 and 3.[22]

4.2.1. Exogenous dummy approach

Table 2 reports the results of the approach employing the exogenous dummy based on the unanticipated change in export demand. Estimated standard errors are in parentheses below the estimated coefficients.

The export demand function of which the estimated residuals form the dummy is estimated by the two-stage least-squares (2SLS), which yields consistent estimators for simultaneous equations like ours. Since export quantity and seasonal dummies are not significant in the export pricing equation, they are omitted from final estimates. As a result, pricing equations can be estimated by ordinary least squares method (OLS) because export demand and pricing equations (16) and (17) form a recursive system.

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[22] All the variables employed in estimation are in the logarithm of the original data. Export demand functions are estimated after taking the first-difference to deal with serial correlation. Export pricing equation is not estimated in the first-difference form. Ellison (1990) refers some reasons for this, while Cosslett and Lee (1985) consider the case of serial correlation of order one for both equations.

All four regressions of the export demand function record high fit[23] and all the estimated coefficients have right sign as predicted by the theory ($\alpha_1 < 0$, $\alpha_i > 0$ (i=2,3,4) in (17)) (not shown in the table to save space).

As Table 2 shows, the coefficient of the switching dummy (β_3) is negative in three industries and significantly different from zero for the textiles industry if we choose the 20% significance level. In the chemical industry, the sign of the coefficient is positive but insignificant (its t-value is the lowest of the four).

4.2.2. Endogenous dummy approach

The estimation results by the maximum-likelihood without employing information from export demand residuals are shown in Table 3[24].

The coefficient of the dummy is significantly different from zero in the textiles industry at any conventional significance level and also in the machinery industry at the 10% significance level. This shows that there exist switches in export pricing in these industries.[25] A comparison of Table 3 with Table 2 confirms that, as is pointed out in Lee and Porter (1984), the least-squares method indeed underestimates the absolute value of the switching dummy

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[23] R^2 (after degree of freedom adjustment) of each export demand is as follows:

Machinery	0.7701
Textiles	0.9383
Metals	0.9104
Chemicals	0.8860

[24] Iterative calculations are converged for all four equations. Initial value for λ is set at 0.5, which implies the uniform prior probability about switches. The sign of the coefficient of the dummy is negative, but it does not mean that the first theory model is correct because, in this approach, the switching dummy is not defined by unanticipatedly high export demand.

[25] We have to note, however, that this significance is "marginal" in that the likelihood ratio test rejects the null hypothesis of no switches only in the textiles industry.

coefficient compared with maximum-likelihood. And the coefficients of the input cost are reasonably positive and significant in all industries.

The export price in the competitive period is lower than that in the collusive period by

$$(P(\text{collusion}) - P(\text{price war})) / P(\text{price war}) = \exp(-\beta_3) - 1. \qquad (24)$$

The estimates indicate the following export price fall in the competitive phase:

Machinery	0.94 %
Textiles	5.24 %
Metals	1.84 %
Chemicals	0.08 %

All of which are quite moderate compared with the cartel breakdown case reported by Porter (1983) showing more than 60% price variation between regimes. This is because of the small absolute value of the switching dummy coefficient $(-\beta_3)$. As will be discussed later, a regime shift in export pricing in our case may be clear only in the textiles industry and almost no regime probability change is observed in the chemical industry.

The probabilities of being in the "competitive" phase (λ_1) are different among industries: lowest in the machinery industry $(\lambda_1 = 0.29)$ and highest in the textile industry $(\lambda_1 = 0.92)$, which may imply the difference in the difficulty of coordinating price decisions in the industry, although the degree of "collusiveness" (θ) in the collusive phase varies across industries as follows:[26].

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[26] As was explained in footnote 14, θ can be calculated from the estimates (a, b).

Machinery   0.0980

Textiles   0.1035

Metals   0.0325

Chemicals   0.00099

where $\theta = 1$ means joint-profit maximization under the assumption that perfect competition ($\theta = 0$) prevails in the "competitive phase" ($I = 1$).

Although variation across industries is substantial, all the θ are far from one which implies that Japanese firms compete quite intensively even in the "collusive" phase in all industries.

By introducing Markov process into the switching dummy series, richer results become available. [27]

For example, the probability of collusion breakdown ($\lambda_{01} = 0.37$) in the machinery industry is approximate to that of the chemical industry (0.31) but the regime probability of a competitive period (λ_1) is much lower in the machinery industry ($0.29 < 0.67$), because price wars in the chemical industry are more persistent ($\lambda_{11} = 0.84 > 0.11$). In other words, estimated mean duration of price war ($1/\lambda_{10}$) is much longer in the chemical industry than in the machinery industry (6.39 months > 1.12 months), although the collusive phase also tends to persist longer ($1/\lambda_{01} = 3.19$ months > 2.71 months).

As for the metal industry, the probability of continuing a price war ($\lambda_{11} = 0.83$) is almost the same as for the chemical industry (0.84), but the pricing collusion is much more volatile ($\lambda_{01} = 0.76 > 0.31$). As a result, the expected duration of the

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[27] As for the textile industry, only the result of i.i.d. Bernouilli case is reported in Table 3 because iterative calculation allowing Markov transition did not converge.

collusion phase is quite short $(1/\lambda_{01} = 1.32$ months), and price wars persist long $(1/\lambda_{10} = 5.79$ months).

The probability, computed by (20), of being in the "competitivo" phase, or the "relative vulnerability" of noncooperative collusion for each month is drawn in Figure 1 for four industries. Time paths are quite different across industries. A glimpse of the figure gives us some clear features as follows:

   --- The collusion in the machinery industry becomes significantly

      vulnerable after the drastic yen appreciation process since 1985, although

      the probability of $I_t = 1$ is always smaller than 0.5, which means no

      all-out price wars in our sample period.

   --- In the textiles industry, firms charge competitive prices almost all the

      time in our sample period with some exceptional periods of short-lived

      collusions.

   --- The sustainability of collusion in the metal industry gets almost

      monotonically lower over time rather than being characterized by

      periodical switches.

   --- The variation of collusion vulnerability in the chemical industry over

      time is quite small (prob($I=1$) moves from 0.310 to 0.317) with a relatively

      big rise around 1978, although the variance of export price level of this

      industry is the largest of our four industries (Table 1).

Although analyses such as developed later are necessary to discuss the exact causes of differences in the "sustainability" among industries and its changes over time, industrial features summarized above may find intuitive interpretations in the following way:

   --- The industries with substantial market power such as the machinery

      industry and oligopolistic industries such as the chemicals industry tend

to have a lower probability of $I = 1$.

--- The industry with less market power and with larger numbers of firms are likely to be in the competitive phase for a longer time as in the case of the textiles industry.

--- The sustainability of collusion in industries where cost conditions are crucial tends to be strongly affected by such episodes as "oil shock" (e.g., the chemicals industry in 1978).

--- The sustainability of collusion may decline over time as the market power of the member firms diminishes in the export market, as in the case of the metal industry which includes steel.

Thus, although none of them should be exaggerated because shifts in the pricing regime are not significant in some industries, we obtain the estimated sustainability of noncooperative collusion which reveals reasonable industrial features. Additional research concentrated in the specific industries is necessary to explain the variations across industries but these variations are rather reasonable than embarrassing, since the relevancy of our theory model heavily depends on the market structure of the industry. Besides, the example of chemical industry reminds us of the risk of depending on the variance of price level itself in evaluating the price variations under regime switches.

4.2.3. Probit regressions

To study determinants of the phase of competition (I_t), we conduct various forms of probit regressions with I_t as a discrete dependent variable, the results of which are reported in Table 4.[28]

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[28] We also conducted the same forms of logit regressions, but only the results of probit are reported because both are quite similar. Linear regressions of Prob($I=1$), instead of probit regressions of I, are conducted for the metal and chemical industries because no significant regime shifts are observed in those industries. Since our main interest is in

First, the relevancy of the uncertainty effect is examined. The unanticipated fall in export demand has an impact on raising the probability of breakdown of collusion in all industries, especially significantly in the textiles industry. This result again shows that assuming critical role of demand uncertainty in export pricing is plausible in the textiles industry.

The results of regressions on export quantity vary among industries; current export market expansion significantly raises the vulnerability of collusions in the machinery and the chemical industries, while an opposite or insignificant effect is observed in the metal and the textile industries. This regression is intended to test the current fluctuation effect.

Next regressions are with the current exchange rate as a regressor. In all industries, appreciation in the current month significantly triggers the emergence of competitive pricing. If export prices are pre-set before knowing the current exchange rate realizations, this result implies that unanticipated export demand decrease caused by current currency appreciation triggers the collusion breakdowns, as predicted by the uncertainty effect. As long as the current exchange rate is known before the export pricing decision, as is assumed in the second model, however, this same result may be interpreted as evidence against the current fluctuation effect.

the study of relative sustainability of collusion, we adopt a relaxed threshold level in defining the dummy rather than sticking to 0.5. Although this deviates from the original econometric procedure, otherwise, there are too few switches to analyze their causes. The dummy equals one if the probability of I is greater than 0.4 in the machinery industry. The textile industry follows the original procedure, defining I = 1 if Prob(I=1) > 0.5.

Final regression is on expected export market growth[29] to test the expected fluctuation effect.[30] Although neither of the results is statistically significant, different features become clear; the expected future export demand growth may stabilize the current collusion in the metals and textiles industries, as predicted by the fluctuation effect, while the opposite direction (future market expansions accelerates current price competition as is predicted by the customer market theory) is observed in the machinery and the chemical industries.[31]

Since none of the results summarized above is overwhelmingly in favor of one model over the other, both models seem to possess some explanatory power for different cases.[32]

4.2.4. Specification test

Combining the results of both approaches suggests that unanticipated export demand changes affect sustainability of collusion in the textiles industry.

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[29] The export quantity growth is defined as the quantity in the next period estimated from the export demand function divided by the current export quantity. The result is not significantly changed if we substitute the estimated quantity with realized quantity in the next period.

[30] We should have also conducted the regressions on expected exchange rates to test the expected fluctuation effect. However,the exchange rate forecast error is quite persistent and far from "rational" as is reported in many survey data studies. Because the treatment of exchange rate expectations is worth some independent work, we left it to future studies.

[31] This result from the regression on expected export growth contradicts that on current export quantity because each prescribes a different theory to the same industry. However, this may not be the problem of economic theory, but the data problem. In the machinery and chemical industries (metals and textiles, respectively), positive(negative) export growth and higher(lower) current export demand level are simultaneously observed with exchange rate appreciation. Then, we cannot separate these entangled effects in our simple regression framework.

[32] Since a substantial share of Japanese exports is subject to trade-protection-related measures (for example, automobiles, steels and MFA), the results obtained in this section might be distorted.

Therefore, it is useful to conduct the specification test discussed in Section 3.2.3. abou. the textiles industry to determine whether the unanticipated export demand change is the determinant of pricing regime switches.

The test statistics H are calculated by (23)[33];

$$H = 6.1811.$$

Under the 2.5% significance level, the null hypothesis that unanticipated export demand change is the correct regime classification information cannot be rejected.

The result of the specification test shows that the econometric loss from treating unanticipated export demand changes as the correct regime classification information is small in the textiles industry. However, the results should be interpreted with caution because we observe only three significant episodes of export pricing regime shift in our sample.

5. Conclusions

Two models have been introduced by applying industrial organization theory so that we can examine export price variations as a result of changing sustainability of noncooperative collusion among exporting firms

The first model considers the mechanism by which unanticipated changes in export demand affect the vulnerability of noncooperative collusion in export pricing. Since rival firms' decisions are not perfectly observable, an

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[33] The maximum-likelihood estimates with exogenous dummy are not shown in Table 2 or 3, but are quite similar to those by two-stage least squares.

unanticipated fall in export demand triggers the breakdown of the collusion ("uncertainty effect").

The second model focuses on the effect of the export market size or exchange rate movements on the timing of possible deviations from collusion. In this model, effects of both current and future expected changes can be studied:

--- It predicts that current export market expansion or currency depreciation raises the incentive to deviate because current gain from deviation is large compared with that in the future ("current fluctuation effect").

--- As for the effect of future changes, competitive phases more often emerge during the process of export market shrinkage or currency appreciation because the gain from deviation will get smaller in the future ("expected fluctuation effect").

Econometric estimation of empirical counterparts of these theory models are conducted by various estimation techniques.

First, to test the uncertainty effect, the dummy is exogenously defined by the estimated residual of export demand function. This approach is intuitive in that this procedure reflects the underlying behaviors of the firms; firms may form their expectations by estimating an export demand function and infer others' possible defections from the estimation errors.

Second, the regime indicator dummy is endogenously determined by maximum likelihood estimation and, after that, the significant causes of switches are searched by various regressions. This second approach is preferable to the first one because the exogenously defined dummy has a error-in-variable problem. We also allow the regime classification dummy to follow a Markov transition process to capture the persistent aspect of export pricing decisions under the collusion/punishment enforcement mechanism assumed in the dynamic oligopoly theory.

The performance of these two approaches are compared by the Hauseman's specification test.

The case of four Japanese industries in 1976 - 1988 is studied as an empirical application. The choice of this case enables us to examine the export pricing behaviors of the firms with some market power under drastic exchange rate fluctuations, which seems to satisfy most of the assumptions for the theory models developed here.

The estimation of the export pricing equations with the exogenous dummy shows that unanticipated export demand decrease may induce the competitive pricing in the textiles industry under a generous significance level.

The "relative sustainability / vulnerability" of noncooperative collusion (, or probability of the "collusive / competitive" phase) calculated from the estimates with the endogenous dummy reveals reasonable industrial features; For example, noncooperative collusion in the machinery industry, which may possesses strong market power in the export market, is always quite stable so that no all-out price wars are observed in our sample period, but was relatively vulnerable after the drastic yen appreciation since 1985. The textiles industry is almost always in the competitive export pricing regime with only a few periods of short-lived collusions.

The regressions of the endogenous dummy on various explanatory variables yield several important results as follows:

Unanticipated fall in export demand weakens the "sustainability" of noncooperative collusion in the textiles industry, which is consistent with the uncertainty effect. The current export market expansion triggers the competitive pricing in the machinery and chemical industries, as predicted by the current fluctuation effect. Noncooperative collusion are destabilized in all industries when

the current exchange rate is appreciated. Future expected export market growth affects current export pricing, but evidence in our case is not significant.

As the specification test implies, treating unanticipated export demand changes as *the* true determinant of the switches in export pricing regime is correct in the textiles industry.

The econometric study of this case confirms, at least as a first approximation, the relevance of dynamic oligopoly model in export pricing for some industries. Divergence of the results across industries is not embarrassing but rather reasonable because such models based on industrial organization theory heavily depend on the industry-specific factors such as market structure.

Although other work such as employing more disaggregate data will enrich the content of Chapter One, this study may have draw valuable insight of the nature of export pricing in the real world by focusing on the time-varying sustainability of noncooperative collusion among oligopolistic exporting firms.

Appendix

[Export price] (p)

FOB price in terms of yen (Laspeyres index)

Source: Bank of Japan "Economic Statistics Annual" various issues

Classifications : (1) textiles ,

      (2) metals and related products ,

      (3) chemicals

      (4) machinery (including transport equipment)

[Export quantity] (q)

Export "quantity" is defined by export value (custom clearance basis) divided
by export price (p).

Source : Ministry of Finance , Government of Japan "Custom clearance
      statistics"

Classifications ; same as those of export price

[Input cost] (W)

Input price based on Input-Output table (wholesale price for domestic input
and import CIF price for imported input.)

Source : Bank of Japan "Economic statistics annual" various issues

Classifications : (1) textiles ,

      (2) basic metal products and metal products ,

      (3) chemicals

      (4) machinery and equipment

[Exchange rate] (e)

The yen-U.S. dollar rate is the monthly closing rate (yen per dollar).

Source : Bank of Japan "Economic statistics annual" various issues

The nominal effective exchange rate of the yen is calculated by the

weighted average of destination countries' currency per yen with weight

based on trade in manufactured goods between 17 industrial countries.

Source : International Monetary Fund " International Financial Statistics"

[Foreign producer price] (PUS, PEU)

Producer price in the U.S. (PUS) and in OECD European countries (PEU).

Source : OECD "Main Economic Indicators : Historical Statistics 1969 - 1988" (1990)

[Foreign industrial production] (IUS, IEU)

Total industrial production of U.S. (IUS) and of OECD European countries (IEU).

Source : OECD "Main Economic Indicators : Historical Statistics 1969 - 1988" (1990)

TABLE 1 BASIC STATISTICS

	INDUSTRY	MEAN	STANDARD DEVIATION	MAXIMUM	MINIMUM
EXPORT PRICE	MACHINERY	94.99	7.573	106.5	78.90
	TEXTILES	88.60	8.531	105.9	73.40
	METALS	87.96	12.80	113.4	66.00
	CHEMICALS	82.70	15.90	111.6	54.90
EXPORT QUANTITY	MACHINERY	18548.7	6061.70	30788.0	6337.5
	TEXTILES	1206.7	235.05	1820.9	565.26
	METALS	3732.4	529.79	5078.2	2391.9
	CHEMICALS	1567.6	422.27	2872.1	740.74
EXCHANGE RATE		218.37	47.502	303.67	121.85

(NOTES)

1. The export price index is in yen term and standardized at 1980 = 100.

2. The export quantity is defined as export value (in million yen) divided by the export price index.

3. The exchange rate is the yen value per U.S. dollar (yen/dollar).

4. See the appendix to this chapter for detailed definitions.

TABLE 2 ESTIMATION WITH EXOGENOUS DUMMY
(EFFECT OF UNANTICIPATED DEMAND DECREASE)

$$\ln P_t = \beta_0 + \beta_1 \ln W_t + \beta_2 I_t + v_t$$

$$I_t = 1 \quad \text{if} \quad u_t < 0 \qquad , u_t = Q_t - D(P_t)$$

	MACHINERY	TEXTILES	METALS	CHEMICALS
constant	2.599457***	-0.9556367	-0.8765496***	0.8438129***
	(0.4209812)	(0.1594886)	(0.2768561)	(0.2409083)
W	0.4305098***	1.015405***	1.193671***	0.8096844***
	(0.09269586)	(0.3536094)	(0.06182939)	(0.05486874)
I	-0.007897699	-0.006216897*	-0.008616335	0.00260639G
	(0.01254121)	(0.006288194)	(0.01297462)	(0.02110306)
R^2	0.11702685	0.84330762	0.70787918	0.58514672

(NOTES)

1. The significance of coefficient estimate is denoted by asterisks as follows:

   *** significantly different from zero at 1% level

   ** significantly different from zero at 10% level

   * significantly different from zero at 20% level

2. R^2 is the coefficient of determination after degree of freedom adjustment.

3. Regressors in export demand function are constant term, export price, exchange rate, total industrial production in U.S. and OECD European countries, producers price index in U.S. and OECD European countries, and monthly dummies. Instruments for two-stage least squares are input cost, and all the regressors excluding export price.

TABLE 3 ESTIMATION WITH ENDOGENOUS DUMMY (SWITCHING REGRESSION)

$$\ln P_t = \beta_0 + \beta_1 \ln W_t + \beta_2 I_t + v_t$$

$$\text{Prob}(I_t = j \mid I_{t-1} = i) = \lambda_{ij} \ (i,j = 0,1), \quad v_t \sim N(0,\sigma^2)$$

	MACHINERY	TEXTILES	METALS	CHEMICALS
constant	2.598769***	-0.07422129***	-0.8685013***	0.8448950***
	(0.006181402)	(0.009172240)	(0.1804444)	(0.142161)
W	0.4303779***	1.019955***	1.194218***	0.8098548***
	(0.001370240)	(0.001961374)	(0.01129105)	(0.2697919)
I	-0.009379912**	-0.05106331***	-0.01825822	-0.0007960488
	(0.006197851)	(0.01948610)	(0.2922540)	(0.08827423)
σ	0.07703460***	0.03645665***	0.07945429***	0.1296814***
	(0.004115482)	(0.002116463)	(0.003871947)	(0.03372322)
λ_1	0.293206	0.9152139	0.8145814	0.6672086
λ_0	0.706794	0.0847861	0.1854186	0.3327914
λ_{01}	0.3691916	-----	0.7588793	0.3138129
λ_{11}	0.1100373	-----	0.8272606	0.8434759
λ_{10}	0.8899627	-----	0.1727394	0.1565241
λ_{00}	0.6308084	-----	0.2411207	0.6861871

TABLE 4 DETERMINANTS OF VULNERABILITY OF NONCOOPERATIVE COLLUSION

$$I_t - \gamma_0 + \gamma_1 Z_t$$

Z	MACHINERY	TEXTILES	METALS	CHEMICALS
u_t	-0.3676389	-3.575905*	-0.006761879	-0.00015104
	(1.725456)	(3.004167)	(0.05162009)	(0.002183520)
$\ln q_t$	6.346538***	0.3063871	-0.07694750***	0.0039x2544***
	(1.357473)	(0.9000405)	(0.01783148)	(0.0002856554)
$\ln e_t$	-20.89742***	-8.736571***	-0.09443353***	-0.00468178***
	(7.948692)	(2.558194)	(0.008327563)	(0.000x401410)
$\ln(q_{t+1}/q_t)$	0.1576985	-0.2269821	-0.001783026	0.3799053
	(0.7867137)	(0.7910989)	(0.01511159)	(0.0007312837)

(NOTES)

1. The estimated coefficient of $Z(\gamma_1)$ of each regression is reported in the table with the standard error in parentheses. The estimated constant term(γ_0) is omitted from every case to save space.

2. For the machinery and textiles industries, probit regressions of I are conducted, while ordinary linear regressions of probability of $I=1$ are conducted for the metals and chemicals industries.

3. The significance of coefficient estimate is denoted by asterisks as follows:

    *** : significantly different from zero at 1% level

    ** : significantly different from zero at 10% level

    * : significantly different from zero at 15% level

FIGURE 1   RELATIVE VULNERABILITY OF COLLUSION (Prob(I_t =1))

[MACHINERY]
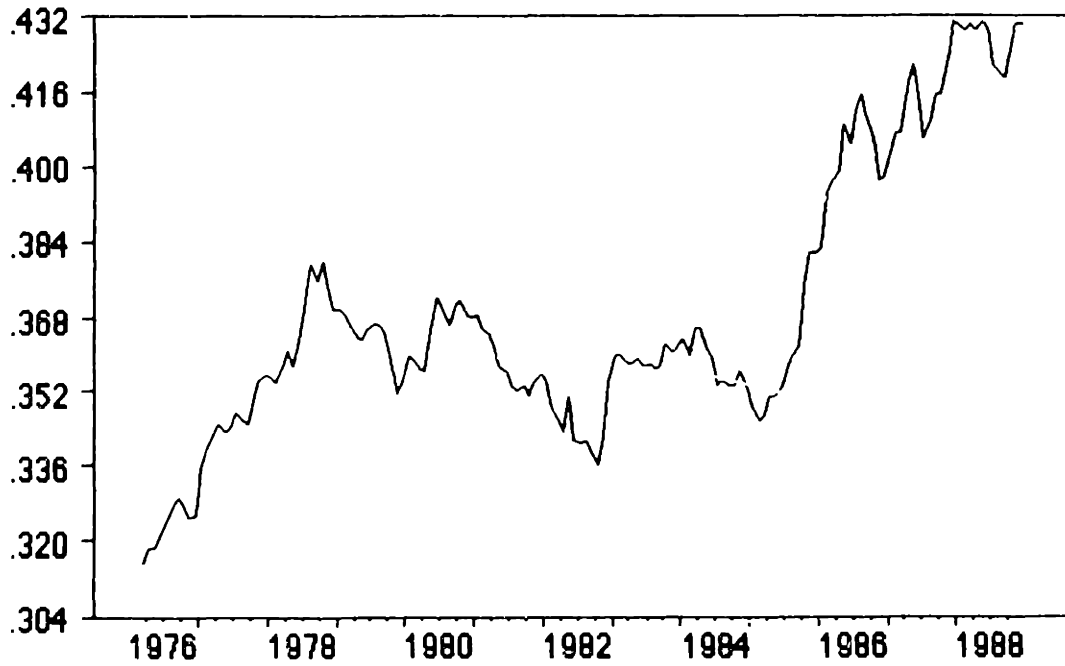
[TEXTILES]
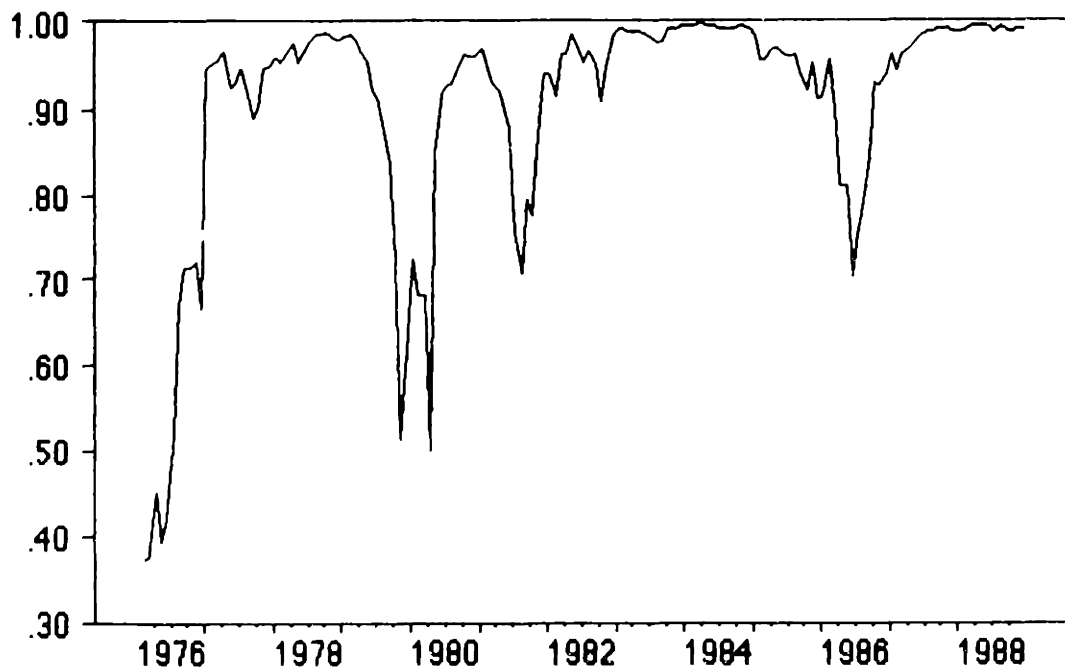
[METALS]

[CHEMICALS]

CHAPTER TWO

DYNAMIC EXPORT PRICING

AND

EXCHANGE RATE EXPECTATIONS

1. Introduction

Export pricing behaviors during the drastic exchange rate adjustment process in the 1980s have attracted wide-spread attention. As long as reputation of quality or habit-formation is an important factor in pricing decisions, expectations should also be crucial. The exchange rate expe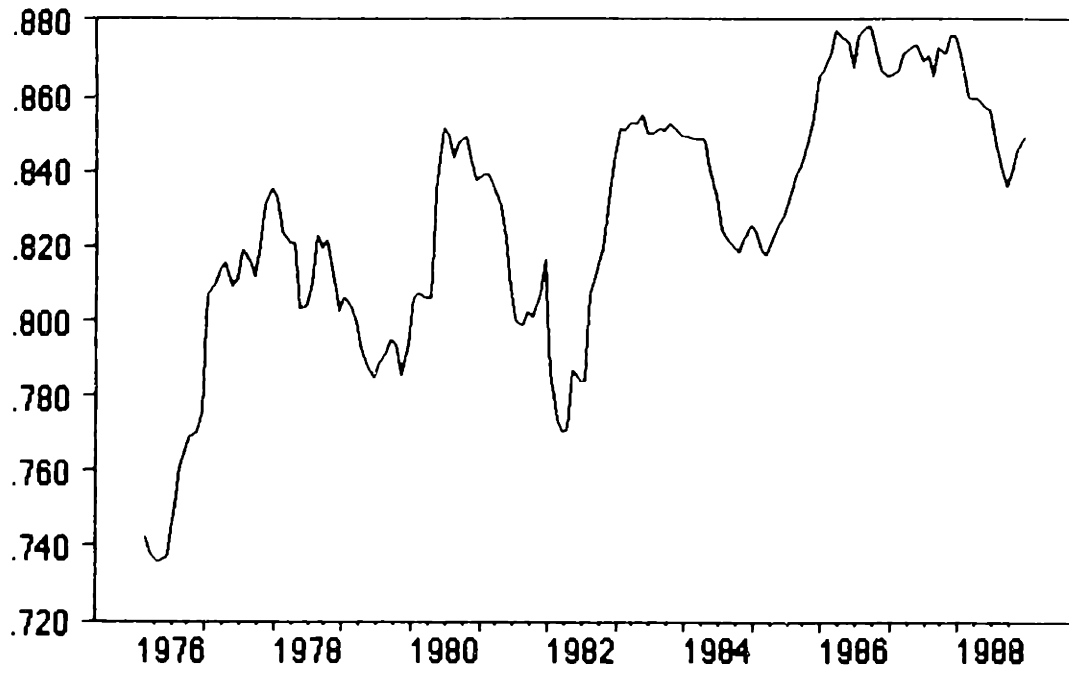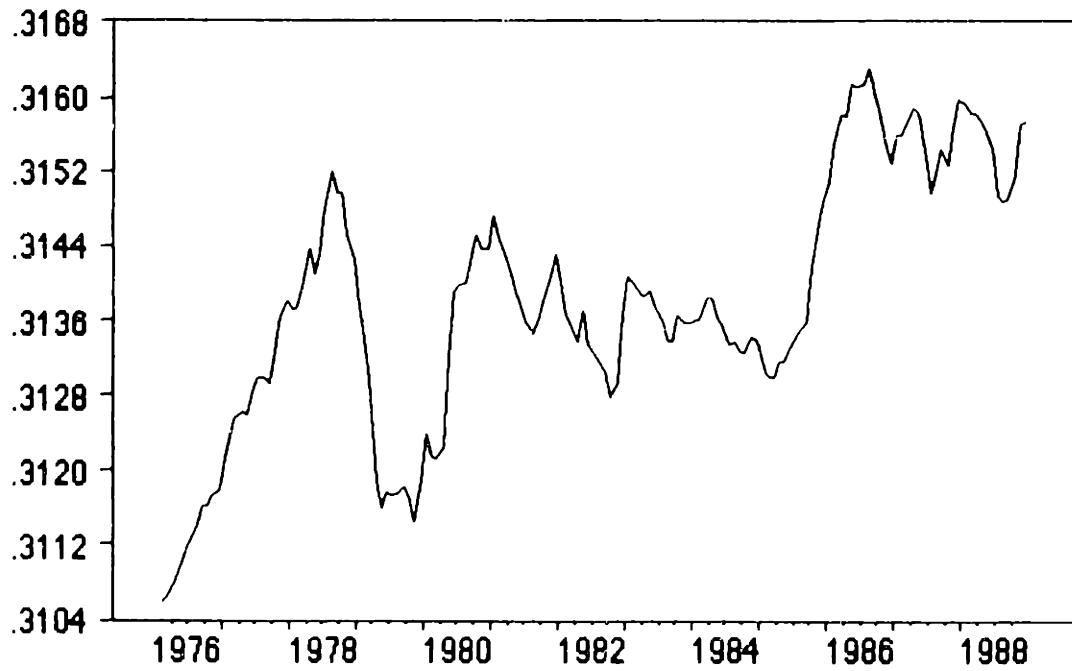ctations are, however, empirically quite persistently ex-post biased. The purpose of this chapter is to analyze the effect of exchange rate expectations on export pricing within realistic expectation formation mechanisms. After introducing a dynamic model of export pricing in a customer market, the expectation effect will be examined in the case of Japanese industries by making use of the results of survey data studies. The implication of Bayesian learning process will also be discussed.

Since the role of history or investment-like consideration is significant in export pricing decisions in the real world, expected exchange rates should naturally be an indispensable element in theory models.[1]

The introduction of future exchange rates into the models under the assumption of rational expectations, however, has been rarely successful in empirical applications, although instrumental variable estimations of expected variables are now common in many other fields of economics. Actually some previous empirical work did not find the significant exchange rate expectations effect which is predicted by economic theory and is quite intuitive. One of the most often-cited reasons for this failure is the "irrationality" of exchange rate

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[1] Krugman (1991) examines the relative importance of "history v.s. expectations" in a dynamic two-sector model of adjustment.

expectations. Studying various survey data, many strongly reject the rational expectation hypothesis based on tests of unbiasedness and orthogonality.

Since various survey data about exchange rate expectations and extensive studies about them have recently been accumulated, one practical compromise will be brought about by the estimation making use of these results. In other words, instead of sticking to the ex-post rational expectation hypothesis about exchange rates, it might be better to estimate the expectation effect on export pricing by deriving the "expected" exchange rate series from the accumulated results of survey data studies. We will study the magnitude of price difference caused by the deviation from ex-post rational exchange rate expectations.

In the context of pass-through or pricing-to-market, one of the main issues in our study will be the effect of expected persistence of current exchange rate adjustment on export pricing. The pass-through should be lower under temporary exchange rate changes than under permanent ones. We will examine it by comparing the predicted export price under static exchange rate expectations with that under extrapolative/regressive expectations drawn from survey data.

Although the persistent bias is frequently reported in many survey data studies, expectation formation mechanisms such as extrapolation lack a solid foundation in formal economic theories. However, a consistent interpretation will be provided by introducing "peso problems" as follows: Expectations are formed ex-ante "rational" (in the sense that firms use all information available at that time), although outside observers may regard it as "irrational" ex-post because of persistent prediction errors. Since firms take account of the tiny possibility of a sudden switch (reversal) of exchange rate changes at any point in time caused by, for example, unpredictable policy intervention, expectations are biased if no switches materialize ex-post. The learning process may aggravate this error in pricing decisions. If firms are not confident about switches which have already

occurred, a learning period will be necessary to convince them that the switch really took place. Then, "peso problem" persists even after the switches.

This chapter is motivated by the experience of the Japanese export price cut under the yen appreciation after 1985. Our model will provide new interpretation that solves some part of the "puzzle" in the following way: Japanese firms chose their export prices based on "ex-post biased" exchange rate expectations while they forecasted future exchange rates "ex-ante rationally", anticipating the "reversal" to yen depreciation which did not actually take place. We will investigate the case of Japanese industries by exploiting the rich accumulation of various survey data studies about the yen exchange rate expectations.

This chapter is organized as follows: Section 2 introduces a dynamic export pricing model in a customer market. Section 3 discusses the estimation of our model. Section 4 examines the case of export pricing of four Japanese industries after the oil shock. Section 5 extends our analysis by introducing the Bayesian learning process. Section 6 concludes the chapter.

2. Theory

2.1. Previous results

As Krugman (1987) notes, analysis of dynamic aspects (both in "supply-side" and in "demand-side") is crucial for understanding the export pricing behaviors in the real world. The effect of supply-side dynamics with sunk cost of entry/exit on export pricing has been studied, for example, by simulations in Dixit (1989b).

Studies of demand-side dynamics with slow adjustment of customers and reputation like the model which we will discuss in this chapter include, for example, Froot and Klemperer (1989) who construct a simple two-period duopoly model where the market-share variable is directly included in the profit function. A direct application of the customer-market model of Phelps and Winter (1970) to export pricing is found in Dohner (1984). He formalizes the dynamic optimization program of an exporter, assuming no uncertainty or perfect foresight.

2.2. A model of dynamic export pricing

In this chapter, we introduce a model of dynamic export pricing of the same type as is constructed by Gottfries (1988), who explicitly formalizes the Euler equation of an exporting firm with customer-market theory. Instead of assuming the ex-post rational expectations as he did, we differ from his in detailed discussions about exchange rate expectations in the next section.[2]

2.2.1. Model

To begin with, consider the following intertemporal profit maximization of a firm exporting in a simple two country framework. To facilitate discussions, let us make the case concrete by calling exporters as Japanese firms and the export market as the U.S.

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[2] In a context of price discrimination, Giovannini (1988) examines the effect of "exchange rate surprise" on export pricing. He assumes the specific Calvo-type price staggering with geometric distribution. Our model differs from his in that he still assumes orthogonality about expectations, in other words, "surprise" in his case comes from prefixed portion of prices.

$$\text{Max } V_t - \Sigma \delta^{s-t} E_t[(p_s - c_s)q_s] \qquad (1)$$
$$\text{s} \geq t$$

where   p : export price (in terms of yen)

c : marginal cost (in terms of yen)

q : export quantity

E_t : expectation operator conditional on available information at time t

δ : discount factor (assumed to be constant ($0 < \delta < 1$)).

Next, introduce a demand-side dynamics through customer flows as follows:

$$q_t = \theta_t x_t \qquad (2)$$

$$= \theta_t (1 + \eta - \eta \, p_t / e_t)^{v_0} \, x^{v_1}_{t-1} \, x^{v_2}_{t-2} \ldots x^{v_k}_{t-k} \ldots \qquad (3)$$

where   x : customer stock of the firm

y^* : foreign income

p^* : foreign price level

e : exchange rate (yen/dollar)

$$\theta_t = \theta(y^*_t, p^*_t) \qquad (4)$$

Naturally, $\partial\theta/\partial y^* > 0$, $\partial\theta/\partial p^* > 0$ and let $\eta > 0$, $v_i > 0$ (all $i \geq 0$).

(3) implies that the current export demand is determined by the current export price in dollar terms and by the geometric weighted average of history of customer stocks because customers respond to dollar price changes only gradually over time. Specific functional forms in (2) and (3) are chosen so that the final form of pricing equation becomes tractable.

Then, the first-order condition for maximization is obtained by differentiating (1) with respect to x.[3]

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[3] The following derivations closely follow Gottfries (1988). We differ from his model in allowing that pricing effect persists more than one period (,theoretically infinitely) to capture the original implications of reputation effect. He interprets "e" in our model as the "average price of competitors", not as the exchange rate. Ours also differs from his in simplifying that marginal cost is constant.

$$\partial V_t/\partial x_t - E_t[(p_t-c_t)\partial q_t/\partial x_t + q_t\partial p_t/\partial x_t + \delta q_{t+1}\partial p_{t+1}/\partial x_t + \delta^2 q_{t+2}\partial p_{t+2}/\partial x_t +$$

$$... + \delta^k q_{t+k}\partial p_{t+k}/\partial x_t + ...] = 0 \qquad (5)$$

Substituting (3) and multiplying x_t/e_t yields the following Euler equation:

$$p_t/e_t = \alpha_0 + \alpha_1 c_t/e_t + \sum_i E_t[\beta_i (e_{t+i}q_{t+i} / e_tq_t) + \gamma_i (p_{t+i}q_{t+i} / e_tq_t)] \qquad (6)$$

where

$$\alpha_0 = (1+\eta) / \eta(1+v_0) > 0$$

$$\alpha_1 = v_0 / (1+v_0) > 0$$

$$\beta_i = -\delta^i (1+\eta)v_i / \eta(1+v_0) < 0$$

$$\gamma_i = \delta^i v_i / (1+v_0) > 0$$

The sign of coefficient $\beta_i < 0$ (for all positive i) indicates that the current export price is lower when future market expansion or future currency depreciation is expected. This effect of future exchange rate changes on current export pricing ($|\beta_i|$) gets greater as customers respond to past price changes more persistently, or v_i ($i\geq 1$) is larger.

To see the impact of exchange rate expectations on export pricing, differentiate (6) with respect to the expected exchange rate with i-period horizon ($_te_{t+i}$)

$$\partial(p_t/e_t)/\partial_t e_{t+i} = \beta_i E_tq_{t+i} / e_tq_t < 0 \qquad (7)$$

$$\text{where } \beta_i = -\delta^i (1+\eta)v_i / \eta(1+v_0) < 0$$

which implies that the export price is lower when future currency depreciation is expected and that the current export price cut under a given size of expected

depreciation is deeper as the market size is expected to grow $(E_t q_{t+1}/q_t)$ or as the customer's response to price changes is more persistent $(v_1/(1+v_0))$, *ceteris paribus*.

Thus, following Gottfries (1988), we have formalized the intuition that expected exchange rate changes play more crucial role in the current export pricing as past prices affect customer flows more persistently.

2.2.2. Implications

Next, let us put our model in the perspective of pass-through literatures.

Within a static model with the perfect competition assumption, the export price should always chosen equal to the marginal cost:

$$p_t/e_t = c_t/e_t$$

The static models of imperfect competition (such as Cournot) explains the partial pass-through:

$$p_t/e_t = \alpha_0 + \alpha_1 c_t/e_t \qquad (8)$$

Dynamic models such as the customer market theory adds complication through expectations:

$$p_t/e_t = \alpha_0 + \alpha_1 c_t/e_t \cdot \Sigma E_t [\beta_1 (e_{t+1} q_{t+1} / e_t q_t) + \gamma_1 (p_{t+1} q_{t+1} / e_t q_t)] \qquad (6)$$

If systematic ex-post expectation error is allowed, the export price level will be further different from the level predicted by static models

Consider the case where the exchange rate is appreciating but expected to depreciate in the near future Then, the sequence of various models above mentioned will predict different degree of pass-through as follows. The simplest model of static perfect competition predicts the export price rise in dollar terms proportional to the current yen appreciation. According to the static imperfect competition models, the increase in the dollar export price should be less than the current yen appreciation The exporters choose much less price increase if

they take account of the expected future yen depreciation. If the expectations held by exporters are persistently biased toward yen depreciation, then, the export price level should be further lower.

After obtaining estimates of pricing coefficients, we will compare the export price levels predicted by these static/dynamic models with the actually observed export price.

To check the empirical relevancy of our model, econometric estimation of the Euler equation is indispensable. In Section 3, we will discuss various issues about estimation and propose a practical approach.

2.2.3. Alternative model

Before moving to empirical studies, it is valuable to introduce the other model which could explain the dynamic export pricing from a different perspective.

In oligopolistic industries, firms can raise price by some informal mechanisms which are traditionally called "noncooperative collusion" in industrial organization. Since this mechanism is not compelling, thus chosen price must satisfy the incentive compatibility constraint which states that no firm can gain by deviating from the prevailing price. This is the intuition which is originally formalized by the model of "price-wars during booms" in Rotemberg and Saloner (1985).

The noncooperative collusion model and the customer market model sharply differ in the prediction about the effect of exchange rate changes on the dynamic export pricing as following:[4]

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[4] Bils (1989) constructs a customer-market pricing model, which implies the same direction of price movements as Rotemberg and Saloner (1985), not as Gottfries (1988). By assuming that "high demand is associated with high inflow of potential new customers" (pp.700), his two-period monopolist model yields countercyclical pricing.

--- By the noncooperative collusion model, the incentive to undercut the
collusive export price should be high when the future exchange rate is
anticipated to _appreciate_ because the current gain from deviating is
high compared with future anticipated loss from being punished.

--- By the customer market model, the incentive to cut export price should
be high when the future exchange rate is anticipated to _depreciate_
because the future anticipated gain from the expanded customer base is
high compared with the loss from lowering price to current customers.

The difference mentioned above is due to the difference in the timing of gain
and loss; i.e. the firm gains after obtaining large customer base at the expense
of loss from current customers, while the deviating firm gains now by
undercutting the collusive price at the expense of future loss from being
punished.[5]

3. Estimation

3.1. Previous results

It will be useful to discuss the issues in approaches taken by other economists
in dealing with exchange rate expectations.

He refers to procyclical advertising expenditure (not price level itself) as an evidence
to support his theory

[5] By focusing on this sharp contrast, we could discriminate these two theories, as
Rotemberg and Woodford (1991) did about the effect of anticipated future profitability
on aggregate markups

3.1.1. Instrumental variable estimation with orthogonality assumption

As many economists estimate individual agent's Euler equations which include expected variables, we can directly estimate the export pricing equation by instrumental variables without constructing arbitrary series of "expected" variables.

This instrumental variable estimation, however, requires the orthogonality condition which is satisfied under the rational expectation hypothesis. Since our interest is in the impact of deviation from ex-post rational expectations, we cannot take this approach. In other words, the test based on the instrumental variable estimation is the test of joint hypotheses: the customer market model and the (ex-post) rational expectations. As many empirical studies show, the rational expectation hypothesis is often strongly rejected in the case of future exchange rates. Hence, we have to look for another approach.

Gottfries (1988), however, takes this method in estimating the export pricing equation of our type for the Swedish manufacturing case and finds "only limited support" for the customer market theory.[6] He cites the rational expectation assumption as one of the reason for this results, saying "The applicability of rational expectations is not obvious." (pp. 18)

3.1.2. Exploiting differences between markets

By exploiting the difference of expected exchange rate effects on different markets under pricing-to-markets situation, Froot and Klemperer (1989) examine

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[6] Some differences from our case should be noted : (1) His model does not allow customer's response to price to persist more than one period, which may not capture the original implication of reputation effect. (2) His equation is nonlinear because he considers a more general case about cost function (Cobb-Douglas). He reports the estimates for linearized version of his nonlinear pricing equation taking account of simultaneity with export demand.

the same issue as ours by running regressions of export price differential between four markets on current and expected exchange rates during 1981 - 1986. Expected exchange rates are drawn from survey data or interest rate differentials. They conclude that "there is no overwhelming evidence that expected future depreciation influences the degree of pricing to market" (pp. 649), although they constrain pricing coefficients equal for all industries.

3.2. Estimation

3.2.1. Estimating the Euler equation based on survey data studies

As we have discussed in the previous section, we will face many problems in estimating the export pricing equation.

However, as is summarized in Takagi (1990), studies of various survey data about exchange rate expectations held by actual economic agents in the marketplace have been accumulated and begun to yield some interesting results. Hence, we will be able to contend ourselves with estimating the dynamic export pricing equation (6) by relying on the "expected" exchange rate derived from other's survey studies.[7]

Following the "calibration" approach, we can construct series of "expected" exchange rates by using the results of those survey studies. With this "expected"

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[7] As many note, the forward rate cannot be an unbiased predictor of future exchange rate , for example, because of time-varying risk-premium. Hence, we cannot substitute forward rate for expected exchange rate in our export pricing equation. Kaminsky and Peruga (1991) decompose the difference between realized exchange rate and forward rate into expectation bias caused by peso problem and risk premium in the case of the U.S. dollar during 1979 and 1985

values in hand, we can directly estimate the dynamic export pricing equation. Although the approach depending on survey studies is not optimal at all because of measurement error in the expected exchange rate variable, it must be worth trying because of the limited availability of "reliable" series of "expected" exchange rate actually held by exporting firms.[8]

Then, the following dynamic pricing equation (6) will be estimated by assigning instrumental variables for p_{t+i} and q_{t+i}[9] and employing the "expected" exchange rate drawn from survey data studies.[10]

$$p_t/e_t = \alpha_0 + \alpha_1 \, c_t/e_t \cdot \sum_{i=1}^{h} E_t \, [\beta_i \, (e_{t+i}q_{t+i} \, / \, e_t q_t) + \gamma_i \, (p_{t+i}q_{t+i} \, / \, e_t q_t)] \qquad (6)'$$

Although it is straightforward to estimate (6) without any constraint, imposing the geometric lag assumption on the coefficients will be appropriate to capture the original implication of the customer market theory because the impact of past prices on demand should fade uniformly with the passage of time.[11] Remember $\beta_i = -\delta^i (1+\eta)v_i / \eta(1+v_0)$, the discount rate $0 < \delta < 1$ and v_i gets smaller as i grows. Suppose that $v_i = v^i$ $(0 < v < 1)$. Hence, we will also estimate (6) with the following constraints on the coefficients:

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[8] As is reported in many survey data studies including Ito (1990), heterogeneity of expectations among individuals is significant. This may limit the usefulness of "mean" value of expectations employed in those studies. This problem may not be solved even when we choose disaggregate industrial classifications for our estimation.

[9] The instruments list is in Note 4 below the Table 2A.

[10] If we misspecify the forward lag length (h), only the last coefficient at t+h (not all the coefficients at t,t+1, ... t+h) is inconsistent under the AR(1) assumption.

[11] In addition to this economic reasoning, the multicollinearity may become severe in estimating the unconstrained regression.

$$\beta_i = \beta \lambda^i \qquad\qquad\qquad (9)$$

$$\gamma_i = \gamma \lambda^i \qquad\qquad (i = 1, 2, 3, \ldots)$$

where $\quad \beta = - (1+\eta) / \eta(1+v_0)$

$\quad\quad\quad \gamma = 1 / (1+v_0)$

$\quad\quad\quad \lambda = \delta v$

Under the assumption of geometric lag, we can simplify the Euler equation (6) which includes sequence of expected variables by the following transformation like Koyck's in the adaptive expectations model. Multiply $e_t q_t$ on both sides of (6) and subtract it from the one-period ahead version after taking E_t, which cancels out sequence of expected variables on the right-hand side of (6) and leaves only the variables at $t+1$;[12]

$$p_t/e_t = \mu_0 + \mu_1 c_t/e_t + E_t [\mu_2(c_{t+1}q_{t+1}/e_t q_t) + \mu_3(e_{t+1}q_{t+1}/e_t q_t) + \mu_4(p_{t+1}q_{t+1}/e_t q_t)]$$

$$(10)$$

where $\quad \mu_0 = \alpha_0$

$\quad\quad\quad \mu_1 = \alpha_1$

$\quad\quad\quad \mu_2 = - \lambda \alpha_1$

$\quad\quad\quad \mu_3 = \lambda (\beta - \alpha_0)$

$\quad\quad\quad \mu_4 = \lambda (1+\gamma)$

Then, the estimation of (10) gives us the sequence of coefficients (β_i) by

$$\beta_i = (\mu_0 - \mu_1 \mu_3/\mu_2) (-\mu_2/\mu_1)^i \qquad\qquad (11)$$

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[12] We have assumed "h" to be infinity in this case. If we take account of the problem of MA structure in the error term, we will need one more instrumental variable.

3.2.2. Effect of exchange rate expectations on export price

One of the most important questions about our model will be the magnitude of the impact of exchange rate expectations on the pricing decision. More specifically, we will examine the following three issues in this section: (a) how much the export price will change with respect to exchange rate expectations of each month in the future in the partial-derivative sense, (b) how much the export price will be affected by the deviation from the ex-post rational expectations (or by the forecast error implied by survey-based expectations), (c) how much the export price will change depending on the perceived persistence of current exchange rate (permanent or temporary). These questions are quite crucial especially when we discuss the application of our model and its policy implications. In spite of its intuitive argument and its important implication, less has been so far known about the numerical magnitude of these effects.

First, to see the impact of the exchange rate expectations on pricing, take the partial derivative of (6) with respect to $_t e_{t+i}$:

$$\partial(p_t/e_t)/\partial {}_t e_{t+i} = \beta_i \, q_{t+i} \, / \, e_t q_t \qquad (12)$$

This measures how much the export price level is altered when the i-month-ahead exchange rate expectation changes, *ceteris paribus*.

Next, let the forecast error toward depreciation at i-month horizon be d_{t+i} ($= {}_t e_{t+i} - e_{t+i}$). Then, if an exporting firm does not form its expectation ex-post rationally, the export price will deviate by

$$d(p_t/e_t) = \sum_i d_{t+i} \, \partial(p_t/e_t)/\partial {}_t e_{t+i}$$

,keeping other things equal. (The summation is taken over all i as long as the pricing effect persists.)

By dividing this by p_t/e_t and substitute (12), the percentage change in export price caused by a given forecast error ($d_{t+i} | i = 1,2,3,...$) can be calculated by

$$dp_t / p_t = \sum_i \beta_i d_{t+i} q_{t+i} / p_t q_t \qquad (13)$$

This measures how many percent the export price would be changed by the deviation from the ex-post rational expectations about exchange rates.

Another important experiment will be in the context of pass-through. The comparison of the export price predicted by static expectations about exchange rates with that predicted by survey-based expectations makes clear the effect of perceived persistence of current exchange rate on the export pricing. Comparing these two export prices enables us to investigate the theoretical prediction that the pass-through is lower under temporary exchange rate changes than under permanent ones, as Krugman (1987) discusses in a dynamic model of pricing-to-market with adjustment costs. If firms anticipate that the current exchange rate is permanent, the export price level predicted by our dynamic model can be calculated by setting exchange rate expectations to be static ($_t e_{t+i} = e_t$). On the other hand, if the current exchange rate is perceived to be temporary, then firms will form their expectations by extrapolation or mean-reversion ($_t e_{t+i}$ drawn from survey study) Therefore, we will compute (13) for $d_{t+i} = e_t - _t e_{t+i}$

4. The case of Japanese industries

4.1. Description of the data

Data employed in estimation are described in this section. Appendix A to Chapter Two will provide additional explanations of them in detail.

The export prices (p) in yen terms for various classifications of Japanese goods are reported by the Bank of Japan. Of those series, we use the following four industries: machinery, metals, chemicals and textiles.[13]

The conventionally used index for export quantity (q) is defined by value index divided by unit-value index. To avoid troubles caused by unit-value index[14], export "quantity" is defined by the export value (which is reported in trade statistics) divided by the corresponding export price p.[15]

Another variable included in the pricing equation is the marginal cost (c) of each industry. Compared with other variables such as wages and raw material prices, input prices based on Input-Output table may be better at capturing the cost conditions for each industry in our case.

Included as instrument variables for estimation are the lagged regressors, the foreign producers price index as a proxy for the price offered by foreign

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[13] The data availability is the main reason for our choice of this classification. More disaggregate data might be more desirable to avoid the aggregation problem, although heterogeneity of expectations will still exist even in that case.

[14] For example, export unit-value index is calculated as average value of various (possibly time-varying) products exported under the same classification , while export price index is based on the fixed, same brands of the products.

[15] The exchange rate employed in this chapter is the yen-dollar rate, not the "effective" rate of the yen. Although the effective rate is more appropriate in the pricing context, all the survey data are on the U.S. dollar rate, not the effective rate. In addition to this, Japanese exports are quite often invoiced in dollar terms, not in yen or in destination country's currency.

competitors, the foreign industrial production as a proxy for income since GNP data are not available on monthly basis (both for U.S. and OECD European countries).

Our sample period ranges from January 1976 to December 1988 (156 monthly observations).[16] This choice of sample period will enable us to examine the Japanese experience which have attracted attention by its low pass-through.

As for the "expected" exchange rate, we rely on the survey data studies. Although estimating equations directly employing expectation survey data will be straightforward, we construct the "expected" exchange rate by the following functional form because all the available survey data sets cover only short period of time and contain relatively limited information[17]:

$$_tS_{t+i} = (1+g) s_t - g s_{t-i} \qquad (i = 1, 3, 6, 12) \qquad (14)$$

where $s_t = \ln e_t$ and we choose the parameter value "g" as the unweighted arithmetic mean of others' survey studies summarized in Table 1

This functional form flexibly allows both the band-wagon extrapolation case (positive g) and the reverting distributed lag case (negative g).[18] Our case shows

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16 The exchange rate data starts from one year earlier to form the "expected" series.

17 Among the famous survey data sets. *Economist* data has no information about one-month ahead expectations and begins at 1981. MMS (Money Market Service) data begins at 1982 and covers only one-month ahead expectations and shorter. Amex data is discontinued at 1985, has no information other than six and twelve month expectations, and the survey timing is relatively imprecise (conducted by mail, not by telephone). About the detail of the surveys see Appendix A to this chapter.

18 We do not choose the other popular functional form ("regressive") to avoid the issue of "normal" value, although many tried constant, moving-average or purchasing-power-parity level.

the clear "twist" over time ; i.e. extrapolation in the short run (one month) and "mean-reversion" in the long run (three months and longer).[19]

Although we will mainly rely on the constructed "expectation" series by (14) in the following study, the estimation directly based on the expectation survey data itself will be useful to check the robustness of the results.[20] Hence, in some cases, the estimation results directly employing survey data will also be reported together with those employing constructed survey-based expectations (14).[21] Figure 2 illustrates the exchange rate expectations of one- and twelve - month horizon reported in survey data compared with the realized exchange rates. The substantial and persistent forecast errors biased toward yen depreciation are obvious in 1985 - 1986. Figure 1 shows the actual exchange rates in our entire sample period.

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[19] Since any survey data have no information about expectations in months other than 1,3,6, and 12, we construct the expected exchange rate series for other months by interpolations.

[20] I acknowledge Professor Kenneth Froot for providing me the survey data of both the *Economist* and MMS

[21] Expectations with three, six, and twelve month horizon are taken from *Economist* data in each month Expectations of one month horizon are from MMS data in the week of the middle of each month Other months are formed by interpolation

We estimate (14) for our survey data. The result confirms the same observation ("twist") ; g = 0.19 (1 month), 0.01 (3 months), -0.09 (6 months), -0.14 (12 months). Then, since our survey data lean toward more extrapolative expectations (less reversion) than the average in Table 1, we can check the robustness not only of the functional form but also of the parameter value "g" in (14) by estimating export pricing equation for both cases

4.2. Results

4.2.1. Estimations of the export pricing equation

The results of estimation of dynamic export pricing equation are reported in Tables 2A, 2B, and 3. Tables 2A and 2B show the equation with geometric constraint, and Table 3 is the result without the constraint.[22] Table 2A (and 3) employs the extrapolative/regressive exchange rate expectation defined by (14), while Table 2B is based on the expectation survey data.[23] Examine the results of each industry in the following:

In the machinery industry, the estimation imposing the geometric constraint on coefficients yields remarkable results; all the coefficients are significant, have the correct signs as predicted by the theory, and explanatory power is very high (Table 2A). More than anything else, the implied (β_i| i=1,2,3,...) shows a quite reasonable feature; the export price has such a persistent impact on demand that it lasts significantly for one or two years and totally diminishes only after about 10 years. (See the graph of "-β" below Table 2A.) The estimates based on the survey data approximate to those based on extrapolative/regressive expectations and have the same signs (Table 2B).[24] Most of the estimates without the constraint are also negative, although they are not significant (Table 3).

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[22] The time horizon (h) in the unconstrained case is chosen as h = 12. To deal with possible serial correlations, we estimate all equations by the Cochrane-Orcutt method.

[23] Due to the survey data availability, the sample period for estimation with survey data is from November 1982 to January 1988, while that with constructed exchange rate expectations is from January 1976 to December 1988. The unconstrained version is not estimated with survey data because of the degree of freedom problem.

[24] The implied slope of (β_i) is much steeper than before; i.e. the persistent effect of export price on export demand almost diminishes within one year in the case of our survey data.

Therefore, as far as the machinery industry is concerned, our conclusion that the customer-market theory well characterizes the export pricing is robust.

The estimation with geometric constraint for the case of metal industry also shows that all the coefficients are significant. The implied (β_i) persists and gradually declines over time, but, contrary to that in the machinery industry, the value is always positive, which means that future expected appreciation (not depreciation) triggers export price wars as is predicted by the noncooperative collusion model. (See the graph of β below Table 2A.) The survey data based estimates confirm this sign of β (Table 2B). However, it may be premature to draw the final conclusion because the estimates from the unconstrained version are not dominantly positive (Table 3).

One intuitive interpretation of our result may be that reputation effect of customer-market theory tends to be more powerful for automobiles and consumer electronics while cyclical market size expansions/shrinkages are likely to dictate the pricing competition in steel industry.[25]

The estimation imposing the geometric constraint records high explanatory power also for the case of textile and chemical industries, but the implied (β_i) does not decline over time (not shown in Table 2A). With survey data, however, the chemical industry yields negative and declining β, which is consistent with the customer-market theory (Table 2B). In the textiles industry, most of the expected terms are significant in the unconstrained regression, although the signs of estimated coefficients are volatile (Table 3).

The result that the customer-market theory well explains the machinery industry only is reasonable rather than disappointing. As Krugman (1987) pointed

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[25] Rotemberg and Woodford (1991) reports that negative correlation of markups with output is higher in more concentrated industries. Rotemberg and Saloner (1986) refers countercyclical property of cement price.

out, the reputation story is suitable only to goods which are characterized by occasional discrete purchases and complex differentiation; that is the machinery industry in our case.

4.2.2. Effects of exchange rate expectations on export price

Now we have obtained the estimates of pricing coefficients β, and this enables us to calculate the effect of exchange rate expectations on export price.

First, Figure 3A illustrates the exchange rate expectation effect on export price in the machinery industry The expectation effect in this case is defined by partial-derivative (12) The exchange rate expectation with a substantially long horizon has an impact on current export pricing decisions, as the expectations two years ahead still possess about 40% of the effect of one-month-ahead expectations. This long horizon of future expectations for pricing decisions is consistent with the export demand function which is persistently affected by past export prices

Second, to see the deviation from the ex-post rational expectations, Figure 3B shows the percentage export price change caused by exchange rate forecast error which is implied by the average of survey data studies in Table 1 The upper graph of Figure 3B shows the case of estimates under the geometric distribution constraint, while the lower graph does that without the constraint.[26]

Figure 3B tells us that machinery export price in 1985 was lower by nearly two to three percent (constrained case) or five percent (unconstrained case) than

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[26]The horizon of summation "h" is chosen to be 12 or 24 months for the constrained case (thick line for 24 months and dotted line for 12 months) and 12 months for the unconstrained case

would have been under no persistent forecast error, and this forecast-error effect persists throughout 1986.[27]

Third, let us check whether the forecast-error effect is negligible in exchange-rate-expectation effect on export price.

Figure 3C shows the share of forecast-error effect in the total expectation effect. From (13), the share is defined Δs

$|dp_t/p_t(\text{caused by forecast error alone})| / |dp_t/p_t(\text{caused by expectation as a whole})|$

$= |\Sigma b_i \, d_{t+i} \, q_{t+i} / p_t q_t | / |\Sigma b_i \, {}_t e_{t+i} \, q_{t+i} / p_t q_t |$

$= |\Sigma b_i \, ({}_t e_{t+i} - e_{t+i}) \, q_{t+i}| / |\Sigma b_i \, {}_t e_{t+i} \, q_{t+i} |$ 　　　　　　(15)

which measures the percentage of price change caused by forecast error alone in the price change caused by expectations as a whole. The graph illustrates that the substantial share of expectation effect is actually the forecast-error effect. In other words, if we rule out the persistent forecast error, 20 to 25 % of the exchange rate expectation effect on export pricing in 1985 will be neglected. The neglect of this portion of expectation effect may be one of the reasons for the counterintuitive results from previous studies which did not find a significant role of expected exchange rate in export pricing.

Next, Figure 3D illustrates the effect of perceived persistence of the current exchange rate. At the peaks such as 1986, the export price would have been higher by 0.3 % if exporting firms had anticipated that the exchange rate at that time persisted permanently. Although the magnitude in our case is small, we can confirm the theoretical prediction that export price during currency appreciation is lower when firms perceive the current exchange rate to be temporary.

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[27] The result from the expectation survey data is omitted to keep the graph clean because it is approximate with the constructed expectation case with constraint (h = 12). The same is true for the metal industry.

Finally, Figure 3E is a graph about export price level itself, not in percentage. This figure shows that the actually observed export price (lowest thick line) is lower than that predicted by the static partial pass-through model (8) (highest dotted line) and that the export price predicted with the dynamic expectation effect of 12 months horizon (dotted line in the middle) accounts for about half of this gap.[28] Since the yen exchange rate is generally on the appreciating trend in the long run since the late 1970s, the substantial forecast errors toward depreciation may have caused a lower Japanese export price level than is predicted by the static model (8) which does not include the expectation effect. Figure 4B reports that the actual metal export price after 1985 ranges between the level predicted by the static model and by the dynamic model and that the dynamic effect implied by our estimates works in the wrong direction in the early 1980s.

Figures 4A, 5, and 6 show the forecast-error effect for the case of metals, textiles, and chemicals. Since the results from the unconstrained estimates are so volatile, the moving-average version (+/- two months) of them is calculated. In the case of metal industry, the result from the constrained estimate is shown by the dotted line in the same graph. The result from the expectation survey data is also shown for the chemical industry. All three cases report around three percent of export price changes at the peak, which is roughly the same magnitude as that for the machinery industry under the constrained estimate.

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[28] The difference caused by the expected persistence of current exchange rate, which is discussed in the previous paragraph about Figure 3D, cannot be visually distinguished in the scale of Figure 3E.

5. An Extension : Learning Process

Although we have explored the effect of expectations (or forecast errors about future exchange rates) on the current export pricing and have empirically confirmed the reasonable theoretical predictions, our reliance on other's survey data studies has a problem in that no formal explanation has yet been given to the generation mechanism of observed persistent forecast error. In this section, by considering the possibility of learning process, we extend our analysis so that persistent forecast errors could partly be consistent with optimizing economic theories. We will also examine the magnitude of the learning effect by a simulation.

5.1. Theory

5.1.1. Previous results

Investigations of various survey data strongly reject the rational expectation hypothesis. For example, tests of unbiasedness and orthogonality conducted by Frankel and Froot (1987) and by Ito (1990) reject the rationality.

Expectations held by rational agents, however, may be ex-post on average biased because of the anticipation of uncertain future switches, while this anticipation could affect current exchange rate determination at the same time.[29] To discuss "sustainability" of current exchange rate, Krugman (1985) performs simulations with anticipation of US dollar stabilization policy in the future. Speculative attack models, which originated in Salant and Henderson (1978) and

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[29] Engel and Hamilton (1990) estimate exchange rate models allowing switches and conclude that "long swing" model dominates random walk model in explaining actual exchange rate changes.

was first applied to international economics by Krugman (1979) and whose stochastic version was examined by Flood and Garber (1984), study the effects of market anticipation about future regime collapse. These speculative attack models have revived in the recent context of target-zone policy (for example, Krugman and Rotemberg (1990)) Smith and Smith (1990) is an example of empirical applications, where they identify the speculative portion in actual British exchange rate changes in the 1920s.[30]

By introducing the learning process, Lewis (1988) provides alternative interpretation to the seemingly "irrational" expectations. She concludes that systematic expectation errors during a learning process is "rational" conditional on the available information and agent's belief. Lewis (1989) attributes around half of the prediction errors in the U.S. dollar exchange rate in the early 1980s to the learning effect. The learning model differs from the speculative attack models in that expectation errors persist even after a switch because agents are not convinced of the switch which is not directly observable.

5.1.2. A Model of Bayesian Learning

In this section, we have to construct a model of exchange rate determination. To concentrate on the learning effect, consider the following simple model:

$$s_t = \phi_0' x_t + m_t + \phi_1 (E_t (s_{t+1}) - s_t)$$ (16)

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[30] Ito (1990) refers to the possibility of "peso problem" in discussing the failure of the rationality test in his survey data study.

where m is the policy variable which assumed to be unobservable by exporting firms and x denotes other exogenous variables affecting the exchange rate determination. ϕ_1 is the semi-elasticity.

Suppose that m takes either of the following two possible values:

$$m_t = m^0 + c_{0t} \quad \text{with probability } \pi_{0t}$$

$$= m^1 + c_{1t} \quad \text{with probability } \pi_{1t}$$

where c_{it} is a random variable i.i.d. distributed to normal with mean zero and variance σ^2. Assume $m^1 > m^0 = 0$ without loss of generality and naturally $\pi_{0t} + \pi_{1t} = 1$ for all t.

By solving forward, (16) reduces to

$$s_t = (1-\theta) \sum \theta^j \phi_0' E_t x_{t+j} + (1-\theta) m_t + (1-\theta) \sum \theta^j E_t m_{t+j}$$

where $\theta = \phi_1 / (1+\phi_1) \quad (0 < \theta < 1)$.

Since $E_t m_{t+j} = m^1 \pi_{1t}$ for all $j > 0$, we obtain

$$s_t = {}_t X_t + (1-\theta) m_t + \theta m^1 \pi_{1t} \tag{17}$$

where ${}_t X_t = (1-\theta) \sum \theta^j \phi_0' E_t x_{t+j}$. The exchange rate determination is thus affected by insufficient confidence.

The probability of each state (π_{0t}, π_{1t}) is updated over time by Bayes' rule, given the prior belief (π_{00}, π_{10}) which may be possibly affected by the earlier history of policy interventions:

$$\pi_{1t} = \pi_{1,t-1} f(m_t | m^1) / (\pi_{1,t-1} f(m_t | m^1) + \pi_{0,t-1} f(m_t | m^0)) \tag{18}$$

where f is the probability density function.

The expectation bias is

$$E_t s_{t+1} - s_{t+1} = ({}_t X_{t+1} + (1-\theta) E_t m_{t+1} + \theta m^1 E_t \pi_{1,t+1}) - (X_{t+1} + (1-\theta) m_{t+1} + \theta m^1 \pi_{1,t+1}).$$

Assume that the only uncertainty is from policy switches $({}_tX_{t+1} = X_{t+1})$ for simplification. Then, by taking conditional expectations on $m_t = m^0$, the forecast error if no depreciation policy is taken is as follows:

$$\zeta_t - E_t [E_t s_{t+1} - s_{t+1}|m^0] - m^1 (\pi_{1,t} - \theta\pi_{1,t+1}) > 0. \tag{19}$$

The above inequality follows from $m^1 > 0$, $0 < \theta < 1$, and $\pi_{1,t+1} < \pi_{1,t}$ under $m_t = m^0$.

This means that expectations are ex-post systematically biased toward the yen depreciation when the true policy in our sample period is appreciation-oriented (m^0), because agents ex-ante anticipate policy switch to m^1 $(> m^0)$ with positive probability π_{1t}.

Therefore, since assessed subjective probability of switch (π_{1t}) is revised only gradually over time through Bayesian learning process (18), exchange rate expectations held by rational exporting firms are persistently biased almost all the time.

To see the behavior of exchange rate forecast error (ζ_t), differentiate (19) with respect to the size of expected reversal (m^1) and to the initial belief (π_{10}).

$$sign(\partial\zeta_t/\partial m^1) - sign(\pi_{1,t} - \theta\pi_{1,t+1}) > 0$$

$$sign(\partial\zeta_t/\partial\pi_{10}) - sign(d\pi_{1t}/d\pi_{10} - \theta \, d\pi_{1,t+1}/d\pi_{10}) > 0$$

which implies that the prediction error toward currency depreciation during appreciation process is wider as the expected size of reversal is greater or as the initially assessed probability of reversal is higher.

Combining this result with our dynamic export pricing model yields the following conclusion. If the export demand can be characterized by sluggish customer flow where the history of price changes has a persistent impact on future customer stock, then the exchange rate forecast error at one point in time

has a long-lasting effect on export pricing decisions. Put another way, as long as pricing decision has investment-like aspect, the export price cut is more drastic, for example, when exporting firms have not yet learn the fundamental or policy change to currency appreciation during the early stage of currency appreciation process (e.g. 1986 after the Plaza-G5 in 1985).

In other words, the export pricing which seems to be "irrational" from the viewpoint of ex-post observers (econometricians) could partly be "ex-ante rational" because, in forming exchange rate expectations, exporting firms take account of the possibility of a future switch which dose not materialize at last. And the deviation from the "ex-ante rational" export price from the "ex-post rational" one is determined by the Bayesian learning process which in turn depends on the initial beliefs held by firms (possibly influenced by earlier history of policy interventions).

Our model yields valuable insights about exporter's different responses to permanent and to temporary exchange rate changes, as Krugman (1987) points out. During currency appreciation process, exporters should cut their export price more drastically if they regard this appreciation as only temporary, not as permanent. This is interpreted in our model as follows: if the continuing appreciation is anticipated to be temporary, then, the assessed probability of switch to depreciation in the next period should be high and this leads to expected exchange rate biased towards depreciation which results in a lower export price. Thus, our model provides a clue to examine the effect of anticipated persistence of exchange rate adjustment process on export pricing decisions.

5.2. Simulation study

5.2.1. Construction of an hypothetical learning process

Based on various historical episodes about policy changes surrounding the exchange rate determination, various hypothetical paths of forecast error could be constructed by applying our learning model.

Since there is no decisive evidence about expectation formation in the real world, we have to contend ourselves with constructing examples of hypothetical path of expectations by making use of various information sources which were available to firms at the time of pricing decisions. Table 4 lists the events which may have affected the yen exchange rate expectations in chronological order. Figure 1 illustrates the actual path of exchange rate of the yen during our sample period.

Figure 7 depicts one hypothetical series of forecast error which we will use in our following study. The assessed probability of exchange rate reversal in the next period is measured on the vertical axis. (If yen appreciation is anticipated during depreciation process, the probability times -1 is plotted.) This is not at all the only path but rather just one example of the many plausible series which could be constructed from the same information set as ours.[31] (Specific parameter values for this path are shown in notes below Figure 7.)

We also need to specify the value of θ, or the semi-elasticity ϕ_1 in the exchange rate model ($\theta = \phi_1/(1+\phi_1)$), but reliable estimates of ϕ_1 without

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[31] Figure 7 is drawn for the rather extreme case where the initial belief about reversal in learning process (π_{10}) is set at 1/3 and the size of reversal (m^1) is set at +/- 0.1, which is quite rare in our sample period and the parameter values of uniform distribution in speculation process are chosen such that final probability is around 1/3.

misspecification are hard to obtain. Hence, as an example, we report the case of $\phi_1 = 1$, which corresponds to the lower value case in Lewis (1989).[32]

The periods during which learning proceeds have been chosen based on the events listed in Table 4. We will go into somewhat greater detail about the reasons for the choice of each period in Appendix B to this chapter.

5.2.2. Learning effect on export pricing

Figure 8 reports the estimated percentage change in export price calculated by (13) for the case of machinery industry.[33] (The thick solid line corresponds to the case of $h = 24$ and the dotted line to $h = 12$ months.)

The price changes caused by the learning process are at most +/- 0.2 %. Since the forecast-error effect estimated from survey study results reaches about two to three percent, the learning effect introduced in this section may explain nearly ten percent of the forecast-error effect implied by the survey-based expectations.

Since the extrapolative expectation formation employed in the earlier part of this chapter has some counterintuitive features such as prediction errors toward further yen depreciation (not appreciation) in 1984, our hypothetically constructed series may improve the relevance of our assumed expectation bias. In addition to this, if we relax the assumption that the only source of expectation error comes from the learning, our result may have been further improved.

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[32] We have also tried the value $\phi_1 = 19$ which corresponds to higher value case in Lewis ($\phi_1 = 18$), but the resulted price changes are too small. The case of $\phi_1 = 0.5$ which corresponds to lowest value case in Smith and Smith (1990) is not reported just to save space. The value $\phi_1 = 0$ corresponds to the case where the exchange rate determination in the market is not affected by expectations although expectations are affected by market realizations.

[33] The estimates of pricing coefficients (β) is from Table 2A under the constraint of geometric distribution.

Therefore, although it may not be the dominant factor dictating all the observed errors, the Bayesian learning model could provide a partial clue to understand the persistent forecast error and its effect on export price levels.

6. Conclusions

By making use of the results of survey data studies, the effect of exchange rate expectations on export pricing decisions has been examined.

First, a dynamic model of export pricing has been introduced by focusing on the customer flows which respond to price changes only gradually over time, based on Gottfries (1988). The model predicts current export price cuts when the future exchange rate of exporter's currency is expected to depreciate because expected future gain from the expanded customer-base is high compared with loss from lovering the price to current customers.

Second, the relevancy of our theory has been explored by estimating the Euler equation of an exporting firm. Although some previous studies tried to find support for the expectation effect, they did not confirm the intuitive role of exchange rate expectations. Since the assumption of ex-post rational expectations may not be appropriate under the persistent prediction error, we have estimated the pricing coefficients by deriving the "expected" exchange rates from survey data studies.

Third, by introducing the Bayesian learning process in exchange rate expectations, the observed persistent error has been consistently analyzed within the standard optimizing economic theory. The learning model of Lewis (1988) could provide the foundation to formalize the ex-post "irrational" expectation

within the framework of ex-ante rational optimization behaviors. The model predicts that when a switch in exchange rate adjustment is anticipated with non-zero probability, expectations should be ex-post biased, even if agents form their expectations ex-ante rationally, or fully make use of all available information.

The case of export pricing in four Japanese industries after the oil shock has been examined to test the relevancy of our model. Their low pass-through from exchange rate changes into export prices is a "puzzle" from the viewpoint of conventional economic theory.

The results from the case of machinery industry have been quite convincing. As is suggested by the reputation effect in the customer market theory, the sequence of past export prices over several years persistently affects the current export demand following the geometric distribution, and, again as the theory predicts, future expected currency depreciation with a substantially long time horizon significantly lowers the current export price. The deviation from the ex-post rational exchange rate expectations, which is measured by the forecast error derived from the survey-based expectations, affects the export price level by three to five percent during the peak. The results from other industries also confirm the forecast-error effect around this magnitude.

The different responses to permanent and to temporary exchange rate changes are observed; The pass-through is lower under the exchange rate change which is anticipated to be temporary rather than permanent, although the magnitude of this difference in our case is small.

Almost all the results obtained from the realistically constructed extrapolative/regressive exchange rate expectations which we discussed above are robust since they are confirmed by actual survey data about exchange rate expectations.

One hypothetical learning error series has been constructed from historical evidence. Our series accounts for nearly ten percent of the forecast-error effect under survey-based values in the machinery industry. Hence, although it may not be the dominant factor for the persistent error, the Bayesian learning model could explain a significant portion of the deviation from the ex-post rational expectations.

Although other studies employing more disaggregate data may enrich the content of Chapter Two, this study can contribute to an understanding of the role of expectations in export pricing where the pricing decision has a persistent effect on demand and where the assumption of ex-post rational (or unbiased) expectations about future exchange rates is implausible. The numerical magnitude has been made explicit so that the implication of our model to the real world becomes clearer. The task left to future work may include the explicit introduction of the model of exchange rate determination which we discussed only briefly, although this might be difficult because exchange rate models are often monetary models not well-integrated with the micro-based industrial pricing models.

Appendix A

[Export price] (p)

FOB price in terms of yen (Laspeyres index)

Source: Bank of Japan "Economic Statistics Annual" various issues

Classifications : (1) textiles ,

(2) metals and related products ,

(3) chemicals

(4) machinery (including transport equipment)

[Export quantity] (q)

Export "quantity" is defined by export value (custom clearance basis) divided
by export price (p).

Source : Ministry of Finance , Government of Japan "Custom clearance

statistics"

Classifications: same as those of export price

[Cost of production] (c)

Input price based on Input-Output table (wholesale price for domestic input
and import CIF price for imported input.)

Source : Bank of Japan "Economic statistics annual" various issues

Classifications . (1) textiles ,

(2) basic metal products and metal products ,

(3) chemicals

(4) machinery and equipment

[Exchange rate] (e)

The realized (or current) yen-U.S. dollar rate is the monthly closing rate
(yen per dollar). Source : Bank of Japan "Economic statistics annual"
various issues

The expected exchange rate is calculated by (14) with parameter value "g"
from Table 1 unless stated otherwise. However, in some cases, we directly use
survey data expectations. Expectations with horizon of 3, 6, and 12 months
are taken from *Economist* data and those with one-month horizon are from
Money Market Service (MMS) data. (The diskette containing both data is
provided by Prof. K. Froot.) The Economist Newspaper, Ltd. conducts telephone
surveys about expectations with horizon of three months or longer since 1981
and reports the results in *Economist Financial Report* MMS conducts, since
1982, weekly or bi-weekly surveys about short-term expectations in both New
York and London, of which we employ New York results. More detailed
description of various survey data sets are found in Frankel and Froot (1987)
and Takagi (1990), for example.

[Foreign producer price] (PUS, PEU)

Producer price in the U.S. (PUS) and in OECD European countries (PEU).
Source : OECD "Main Economic Indicators : Historical Statistics 1969 - 1988"
  (1990)

[Foreign industrial production] (IUS, IEU)

Total industrial production of U.S. (IUS) and of OECD European countries (IEU).
Source : OECD "Main Economic Indicators : Historical Statistics 1969 - 1988"
  (1990)

Appendix B

Our hypothetical series of expected exchange rates under learning process is constructed in the following way:

1. Based on historical episodes such as summarized chronologically in Table 4, choose the periods during which learning (or speculation) proceeds.

2. For periods of learning, set the initial belief about exchange rate switch in the next month (π_{i0}) and the size of reversal (m^i). By assuming normal distribution and conditional perfect foresight (i.e. if no switch occurs, expected exchange rate coincides with the realized one.), calculate the assessed probability of reversal in each month (π_{it}) by using Bayes theorem (18). Then, construct a series of forecast error as follows:

$$E_t[s_{t+1}|m^0] - s_{t+1} - (1-\theta) m^i \pi_{it}$$

,or[34] $d_{t+1} - {}_te_{t+1} - e_{t+1} - e_{t+1} (\exp[(1-\theta) m^i \pi_{it}] - 1)$

Although the learning model developed in the previous section well explains the persistence of expectation bias, the error predicted by that model always converges to zero through learning the true value. The expected probability of switch in the real world, however, sometimes like the early 1980s, grows over time, contrary to the learning process. This kind of situation has been extensively studied in the context of speculative attack to the government's policy fixing the exchange rate with limited reserves. The speculative attack models could supplement the learning model, although the accumulation of

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[34] Since the exchange rate model is expressed in terms of logarithm, transformation is necessary. But, our transformation is rather casual in that $E_t[\ln e_{t+1}|m] \neq \ln E_t[e_{t+1}|m]$, strictly speaking.

various models prevents us from reproducing the model for our case[35] The theoretical prediction of these models relevant for us is that expected probability of sw:tch increases, often at accelerating pace, over time before the switch.

3 For speculation periods, set the parameter value, assuming uniform distribution about critical level of exchange rate e*, following the speculative attack model by Dornbusch (1987b). Calculate the probability of reversal for each month For example, in the case of possible reversal to appreciation during continuing depreciation process, choosing a upper value for critical exchange rate.[36]

$$\pi_{t:} - Prob (e^* \cdot e_{t+1} | e^* \rangle e_t) = (e_{t+1} - e_t) / (\overline{e} - e_t)$$

Once an forecast error series has been constructed, the percentage price change caused by this error is calculated by (13).

The reason for our choice of periods of learning and speculation are as follows:

1 The y·n appreciation lasts nearly three years since 1976.1 until the Carter Administration's announcement of decisive measure to defend the dollar in 1978.11. In the early stage of the appreciation, the expectation of reversal to yen depreciation may grow as yen appreciation continues. In the later stage, however, this expectation may gradually diminished as people learn that the exchange rate adjustment is not temporary. For example, in 1977.9, the

---

[35] The main difference is in that speculative attack models focus on the effect of expectations on realized exchange rates, while ours on the effect of expectations (which are affected by realized exchange rates) on export pricing.

[36] Here, we assume that the critical exchange rate e* is the only source of uncertainty, or perfect foresight about the exchange rate in the case of no reversal. Then, if the exchange rate appreciates a bit before the anticipated substantial reversal, the probability of reversal (π_{lt}) in that period will be set equal to zero, although the definition yields negative value

Government of Japan takes measures to alleviate the damage caused by the yen appreciation. Then, at some point before 1977.9 the threshold must have been passed. We choose the sharp acceleration of yen appreciation in 1977.6 as the event demarcating these two phases.

2. After 1978:11, the yen rate keeps depreciating for more than one year and the anticipation of reversal may grow over time. In our case, we choose as the peak of speculation, 1979.10 when US F.R.B. announces the change in open market operation procedures which leads to expanding interest rate differential and affects the exchange rate determination later.

3. Since the yen stabilization measure in 1980.3, the yen is appreciating until early 1981 when the first Reagan Administration starts. During this process, learning that the yen should be depreciated may persist until U.S. changes to explicit non-intervention policy under increasing interest rate differential.

4. Throughout the first half of 1980s, the yen is generally on the depreciating trend.

The anticipation of reversal may surge when the Bank of Japan raises interest rates in 1982.3, explicitly aiming at promoting yen appreciation. This anticipation may persist through learning process until the sudden yen appreciation in 1987.11

After the sudden appreciation lasting only two months, yen depreciation continues and the dollar `over`-valuation becomes almost obvious after the mid-1984. The yen rate depreciates, especially after 1984.9, without any slight halt in spite of decreasing interest rate differential.

5 After 1985.2, especially after the G-5 at Plaza in 1985.9 the yen keeps appreciating at rapid pace. The expectation of reversal may persist at least until G-7 at Louvre in 1987.2 explicitly announcing the stabilization of current exchange rates. Because of the old Japanese tradition of government intervention

especially for export, and because of the nature of this exchange rate adjustment process which seems to be triggered by one policy change at the Plaza, Japanese exporters may have actually expected that the Japanese government take the policy to stop the yen appreciation. As a matter of fact, the government policy stance had actually changed and no substantial intervention for depreciating yen were taken, contrary to their expectations. And since the exchange rates adjustment after 1985 was really unprecedented, the assumption of learning process instead of rational expectations is quite suitable for our case.

Since the government of Japan announces, in 1987:5, the "Emergency Economic Measures" including enormous fiscal expansion to alleviate the recession aggravated by accelerating yen appreciation in the spring, people may believe that intervention for depreciating the yen is still possible even after the G-7 at Louvre. Then, we choose 1988:1, when heavy interventions follow the previous month's G-7 confirming the Louvre arrangement, as the final month of the learning process.

TABLE 1 SUMMARY OF EXCHANGE RATE EXPECTATION SURVEY STUDIES

$$_t S_{t+1} = (1 + g) S_t - g S_{t-1}$$

	i = 1 MONTH	i = 3	i = 6	i = 12
Takagi (1990)	-----	0.039	-0.299	-0.380
	0.121	0.069	-----	-----
	-----	-0.143	-0.178	-0.342
	-----	-----	-0.291	-0.441
	0.029	-0.122	-0.249	-----
	0.08	-0.08	-0.17	-0.33
Ito (1990)	0.011	-0.137	-0.220	-----
MEAN	0.06	-0.06	-0.235	-0.373
OUR CHOICE	0.1	-0.1	-0.2	-0.4

(NOTES)

1. The estimates of "g" are shown in the table.

2. Takagi (1990) summarizes other's survey studies including Frankel and Froot (1987). The figures in this table are drawn from his Table 7 (pp. 15).

3. The figures denoted as Ito (1990) are those of his cross-section average.

TABLE 2A
EXPORT PRICING EQUATION WITH CONSTRAINT (GEOMETRIC)

$$p_t/e_t = \mu_0 + \mu_1 c_t/e_t + \mu_2(c_{t+1}q_{t+1}/e_tq_t) + \mu_3(e_{t+1}q_{t+1}/e_tq_t) + \mu_4(p_{t+1}q_{t+1}/e_tq_t) + v_t$$

[MACHINERY]

	COEFFICIENT	STANDARD ERROR
μ_0	0.1591911***	0.02645873
μ_1	0.6042715***	0.07617803
μ_2	-0.5767969***	0.09198808
μ_3	-0.1546906***	0.02671381
μ_4	0.9557373***	0.06298959
ρ	0.1430002	0.1369765
R^2	0.99475962	

$$\beta_i = (\mu_0 - \mu_1\mu_3/\mu_2)(-\mu_2/\mu_1)^i$$

$|\beta_i|$ (– – β_i)

(YEAR)
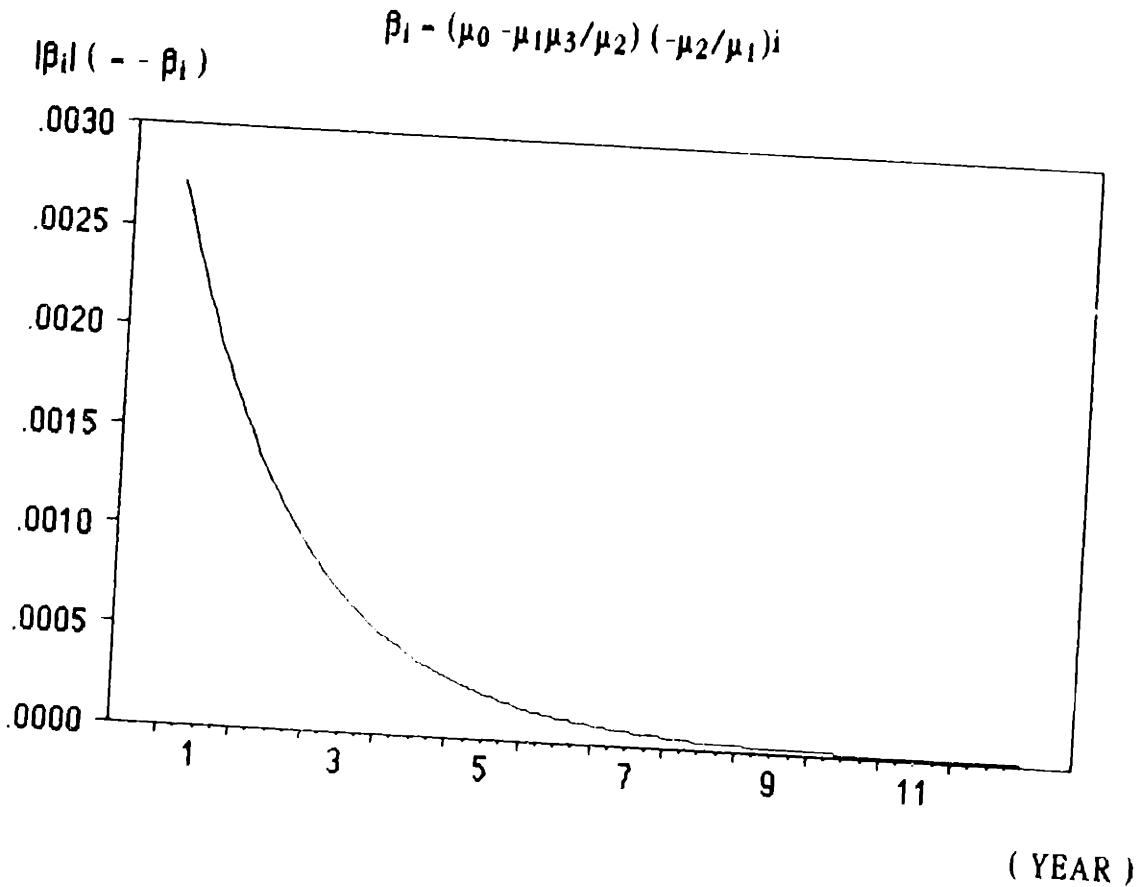
(NOTES)

1. R^2 is the coefficient of determination after degree of freedom adjustment.

2. Coefficients of monthly dummies are not shown in the tables to save space.

3. "ρ" denotes the estimate of first-order autocorrelation by Cochrane-Orcutt method.

4. Instrumental variables for estimation are constant, (c_t/e_t), IUS_t, IUS_{t-1}, IEU_t, IEU_{t-1}, PUS_t, PUS_{t-1}, PEU_t, PEU_{t-1}, $({}_te_{t+1}/e_tq_t)$, $(1/e_tq_t)$, $(c_{t-1}q_{t-1}/e_{t-2}q_{t-2})$, $(e_{t-1}q_{t-1}/e_{t-2}q_{t-2})$, $(p_{t-1}q_{t-1}/e_{t-2}q_{t-2})$, and monthly dummies.

5. The significance of estimate is denoted by asterisks as follows:

  *** : significantly different from zero at 1 % level

  ** : significantly different from zero at 5 % level

  * : significantly different from zero at 10 % level

(Notations)

p_t : Export price (in terms of yen)

q_t : Export quantity

e_t : Exchange rate (yen/dollar)

${}_te_{t+k}$: Expected exchange rate in the k month later (See Table 1.)

c_t : Marginal cost (in terms of yen)

IUS_t : Total industrial production in U.S. (1985 = 100)

IEU_t : Total industrial production in OECD European countries(1985 = 100)

PUS_t : Producer price in U S (1985 - 100)

PEU_t : Producer price in OECD European countries(1985 - 100)

(METALS)

	COEFFICIENT	STANDARD ERROR
μ_0	0.1325755***	0.03536464
μ_1	0.6399042***	0.08284355
μ_2	-0.6162699***	0.08911560
μ_3	-0.1253591***	0.03351875
μ_4	0.9483224***	0.03288077
ρ	0.1820550*	0.1314724
R^2	0.98680778	

$$\beta_i - (\mu_0 - \mu_1\mu_3/\mu_2)(-\mu_2/\mu_1)^i$$

β_i

(YEAR)
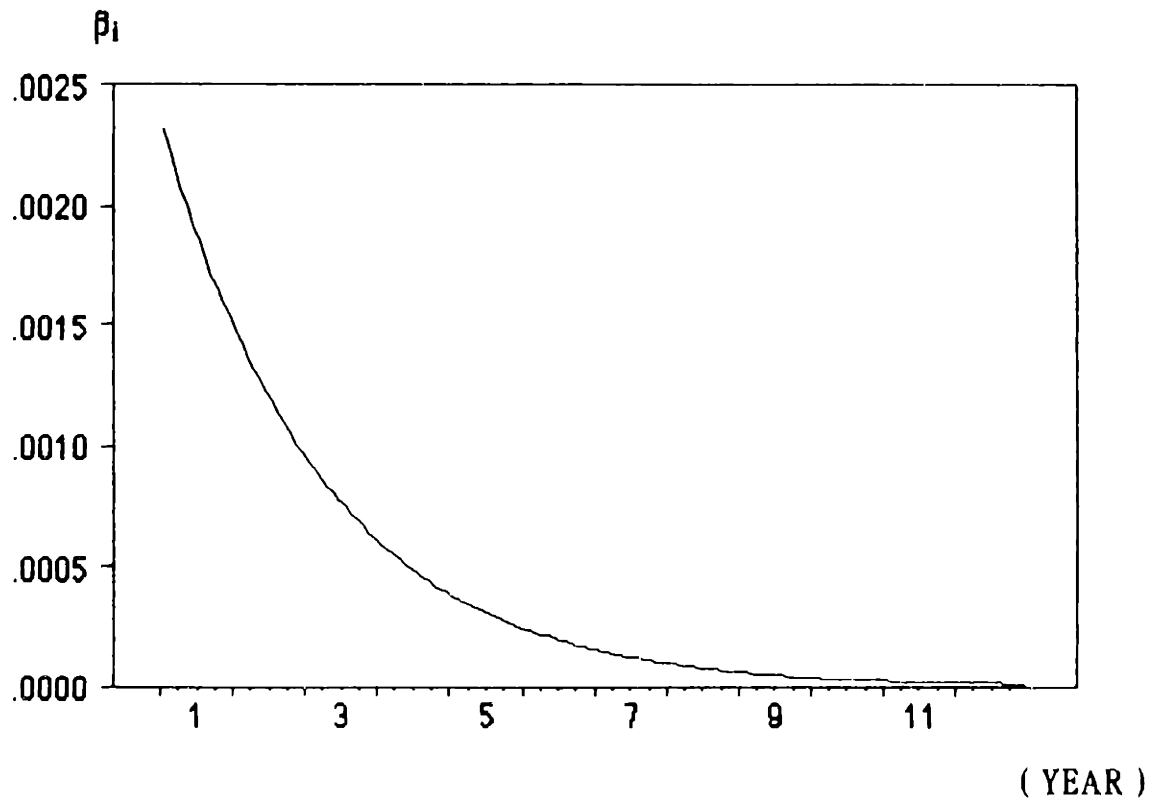
TABLE 2B
CONSTRAINED EXPORT PRICING EQUATION
WITH SURVEY DATA

[MACHINERY]

	COEFFICIENT	STANDARD ERROR
μ_0	0.1175944***	0.02159012
μ_1	0.6415449***	0.03983798
μ_2	-0.4487525**	0.1979604
μ_3	-0.09041946**	0.04030167
μ_4	0.7310003***	0.2801313
ρ	0.3591062**	0.1687039
R^2	0.99447540	

[METALS]

	COEFFICIENT	STANDARD ERROR
μ_0	0.08118375***	0.02633849
μ_1	0.6387524***	0.06901667
μ_2	-0.5750713***	0.08236632
μ_3	-0.06766599**	0.02928028
μ_4	0.8793520***	0.09298253
ρ	0.1400070	0.2369745
R^2	0.97308041	

(NOTE)

The expected exchange rate ($_te_{t+1}$) is from the MMS survey data. The sample period is from November 1982 to January 1988. Other variables and specifications are the same as Table 2A

[CHEMICALS]

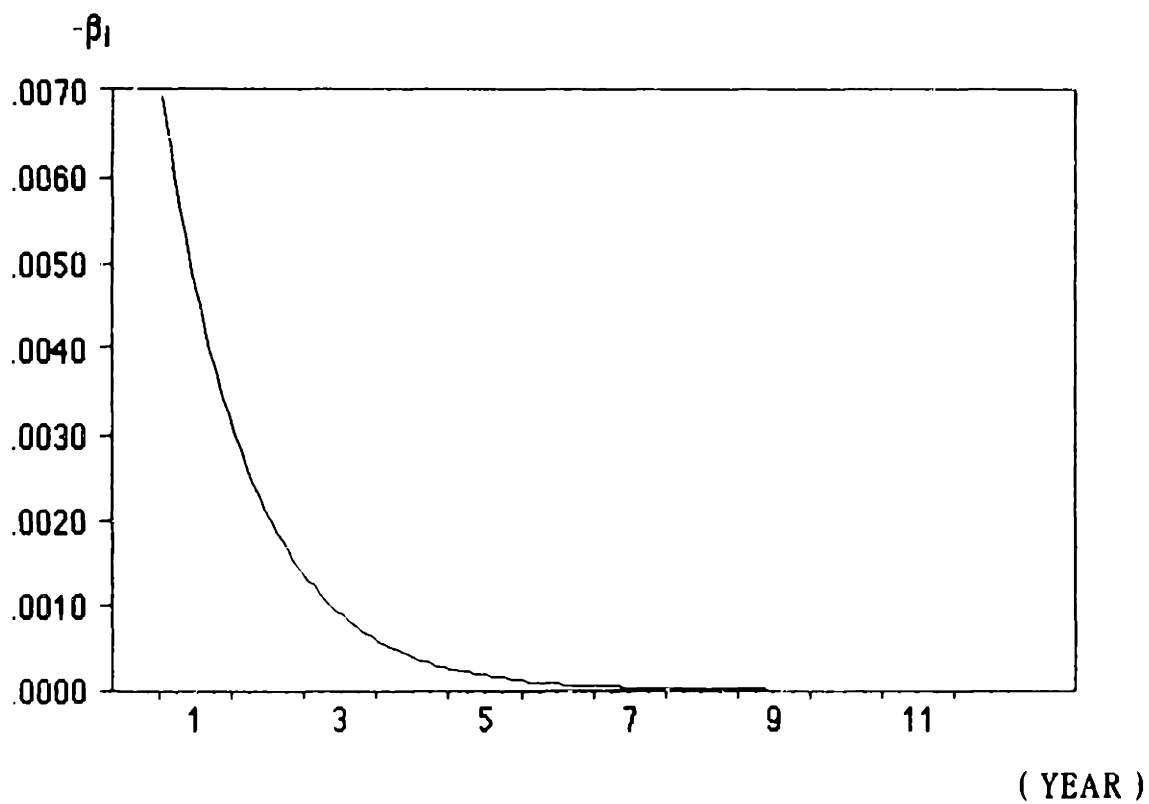|	COEFFICIENT	STANDARD ERROR
μ_0	0.1626018***	0.04606878
μ_1	0.4055639***	0.1067528
μ_2	-0.3785581***	0.1159615
μ_3	-0.1586841***	0.04861174
μ_4	0.9400697***	0.1115125
ρ	0.3991057***	0.1764075
R^2	0.88205300	

TABLE 3

UNCONSTRAINED EXPORT PRICING EQUATION

$$p_t/e_t = \alpha_0 + \alpha_1 c_t/e_t \cdot \sum_{i=1}^{12} [\beta_i (e_{t+i}q_{t+i} / e_t q_t) + \gamma_i (p_{t+i}q_{t+i} / e_t q_t)] + u_t$$

[MACHINERY]

	COEFFICIENT	STANDARD ERROR
α_0	0.2133411***	0.03872041
α_1	0.4252766***	0.07498805
β_1	-0.007533275	0.05349591
β_2	-0.04312051	0.06135419
β_3	-0.03104892	0.06644685
β_4	0.007056655	0.07686284
β_5	-0.07541646	0.06561466
β_6	0.03225164	0.06620810
β_7	-0.03375534	0.06620130
β_8	-0.04179168	0.05957426
β_9	-0.006639903	0.05879571
β_{10}	0.04576285	0.05305265
β_{11}	-0.01076374	0.5710071
β_{12}	0.04721973	0.04735756
ρ	0.656825***	0.1426765
R^2	0.98732955	

(NOTES)

1. Estimated coefficients γ_i (i = 1,2,...,12) and monthly dummies are omitted from the table to save space

2. Instrumental variables are the same as those for the constrained version except the lag of regressors (13 months). See NOTES 4 for Table 2A.

	[METALS]	[CHEMICALS]	[TEXTILES]
α_0	0.4119632*** (0.05867829)	0.3163989*** (0.06532508)	0.3625384*** (0.06329618)
α_1	0.02702477 (0.03340011)	0.03738040 (0.03882991)	0.1204914** (0.05537656)
β_1	-0.5442048*** (0.1167482)	-0.5116382*** (0.1057307)	-0.4558087*** (0.07955912)
β_2	0.1069915 (0.2104687)	0.2396819* (0.1638746)	0.1971001** (0.1042966)
β_3	-0.01814947 (0.2275144)	0.04273049 (0.2421644)	-0.2168656** (0.1306285)
β_4	0.02558097 (0.1906437)	-0.1445046 (0.1879225)	0.2705874** (0.1294557)
β_5	-0.08093280 (0.1877210)	0.01471380 (0.1498154)	-0.3920326*** (0.1551579)
β_6	0.1795505 (0.1673833)	0.1100695 (0.1641326)	0.4649048*** (0.1648939)
β_7	-0.06512375 (0.1385262)	-0.04864873 (0.1656874)	-0.4169920*** (0.1706696)
β_8	-0.1422286 (0.1653687)	-0.04505327 (0.1397285)	0.3579343** (0.1696341)
β_9	0.05697637 (0.1256524)	0.1427566 (0.1398276)	-0.3679566*** (0.1633203)
β_{10}	0.1775815* (0.1197985)	-0.1278783 (0.1467220)	0.3563265*** (0.1351171)
β_{11}	-0.05300962 (0.1053703)	0.1027940 (0.1201853)	-0.1431799* (0.1033792)
β_{12}	-0.04192305 (0.05749191)	-0.06666733 (0.06772353)	0.01407761 (0.05623076)
ρ	0.4654427* (0.3004770)	-0.5691923*** (0.2320583)	-0.8867593*** (0.1042419)
R^2	0.92505277	0.89674087	0.94304697

(NOTE) The standard errors are in parentheses below the estimated coefficients.
See NOTES on the previous page.

TABLE 4   CHRONOLOGY

1973	The First Oil Shock
1977	Carter Administration repeatedly tries to "talk down" the dollar to reduce the U.S trade deficit. (The yen appreciation since 1976.1 accelerates in 1977 6)
1977.9	Japan takes the measures to counter yen appreciation.
1978.11	U.S announces the measures to defend the dollar.
1979.1	The Second Oil Shock
1979.10	U.S. F.R.B changes open market operation procedures.
1980.3	Japan announces the measures to stabilize the yen and U.S announces the measures to resist inflation.
1981.2	The first Reagan Administration starts (change to "explicit non-interventioninst" policy)
1982.3	Bank of Japan begins to raise interest rate for appreciating yen (This policy continues until the drastic yen appreciation in 1982.11.)
1984.5	Yen-Dollar Agreement (liberalizing capital flows) concluded, but the yen depreciation continues, especially after 1984 9 without an halt
1985.2	The second Reagan Administration starts ("signs" of change in exchange rate policy)
1985.9	G-5 at Plaza ("encouraging" "non-dollar currency appreciation") triggering yen appreciation which continues until 1986.7 without any slight halt

1986.9	Japan adopts the measures to cope with yen appreciation.
1987.2	G-7 at Louvre (stabilization "around current levels")
1987.5	Japan takes Emergency Economic Measures (substantial fiscal expansion to stimulate domestic demand)
1987.10	Stock market crash
1987.12	G-7 (implying "a floor" for dollar value)
1988.1	"Heavy around-the-clock intervention" to support the dollar

(Source) Frankel (1990), from which all the quotations are cited, and Japan's
White Paper on Economy (various issues)

(yen/dollar)   FIGURE 1   EXCHANGE RATE
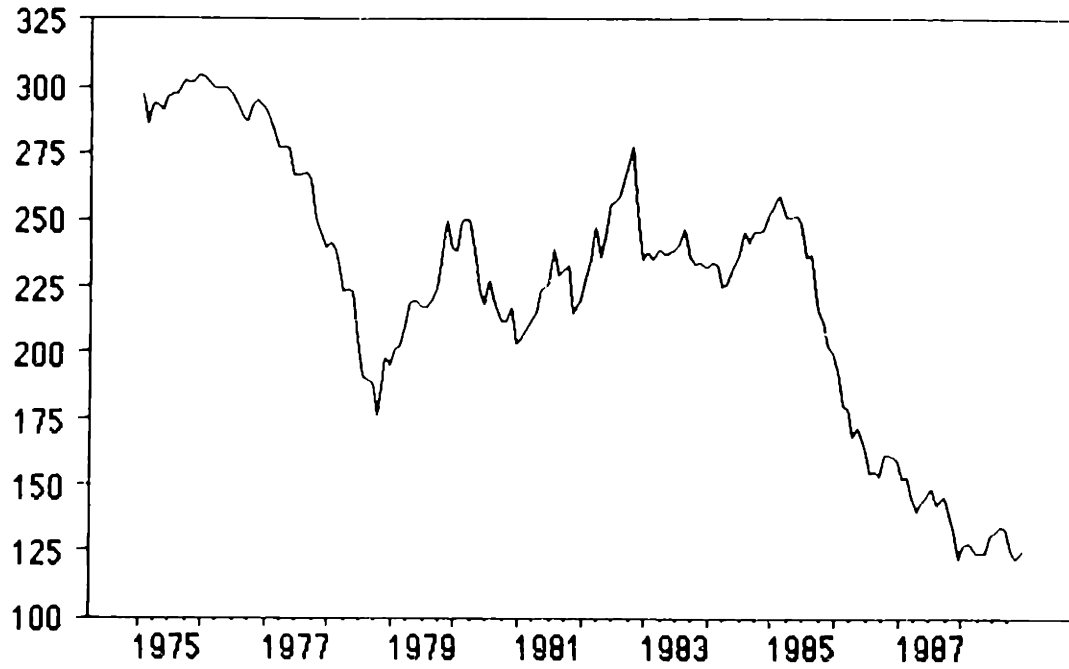
(yen/dollar)   FIGURE 2   EXCHANGE RATE EXPECTATIONS SURVEY DATA
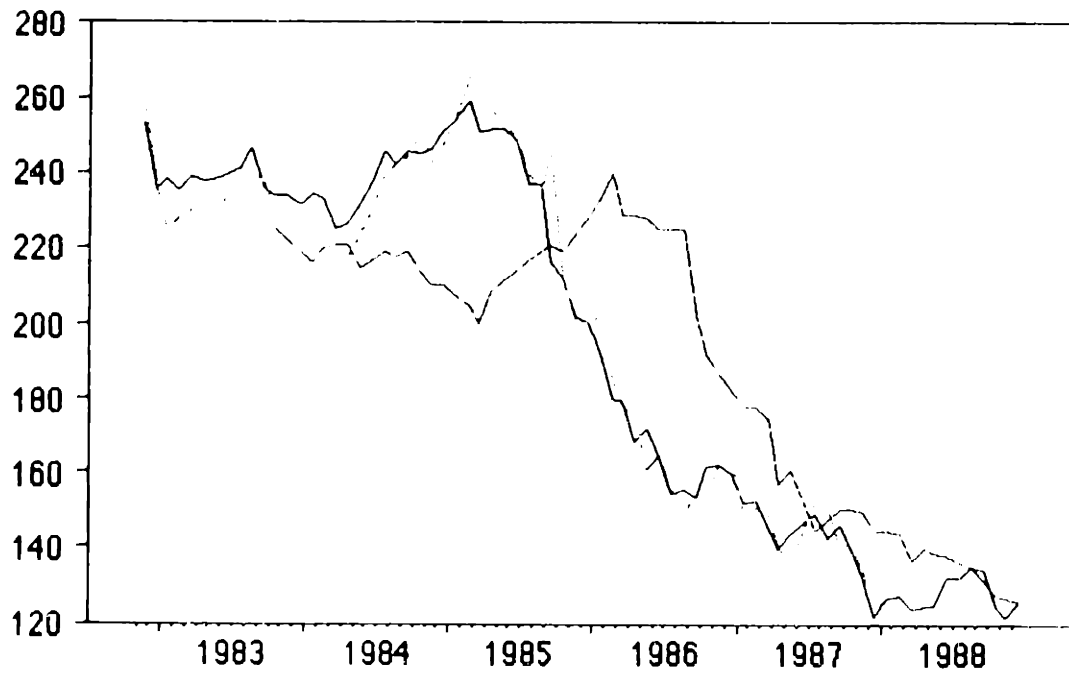
(NOTE) The thick line corresponds to actual current exchange rates. The dotted line is one-month ahead expectation from MMS data and the distanced dashed line starting from late 1983 is 12-month ahead expectation from *Economist* data.

FIGURE 3A EXCHANGE RATE EXPECTATION EFFECT ON EXPORT PRICE
[MACHINERY]
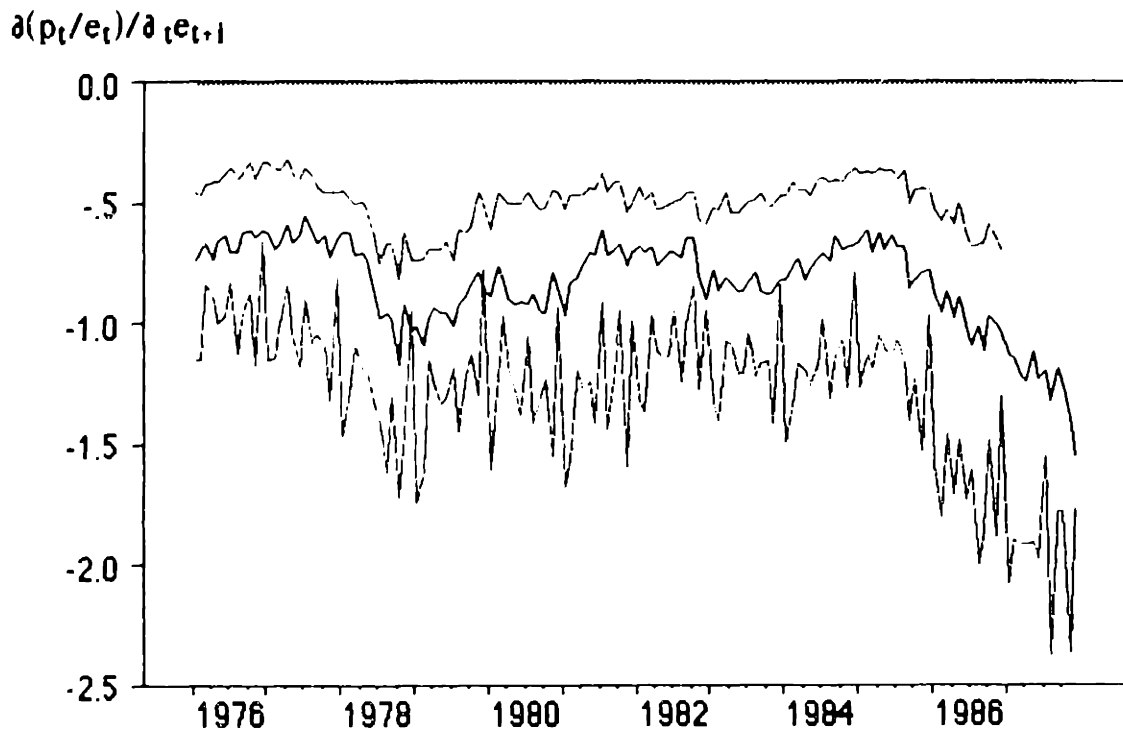
$\partial(p_t/e_t)/\partial_t e_{t+1}$

(NOTE)

Three graphs represent (12) $(\partial(p_t/e_t)/\partial_i e_{t+1} - \beta_i q_{t+i}/e_t q_t)$ with constrained estimates of β and $i = 1, 12,$ and 24 months from below.

FIGURE 3B   FORECAST-ERROR EFFECT ON EXPORT PRICE
[MACHINERY]
[CONSTRAINED (GEOMETRIC LAG IMPOSED)]

dP_t/P_t (%)
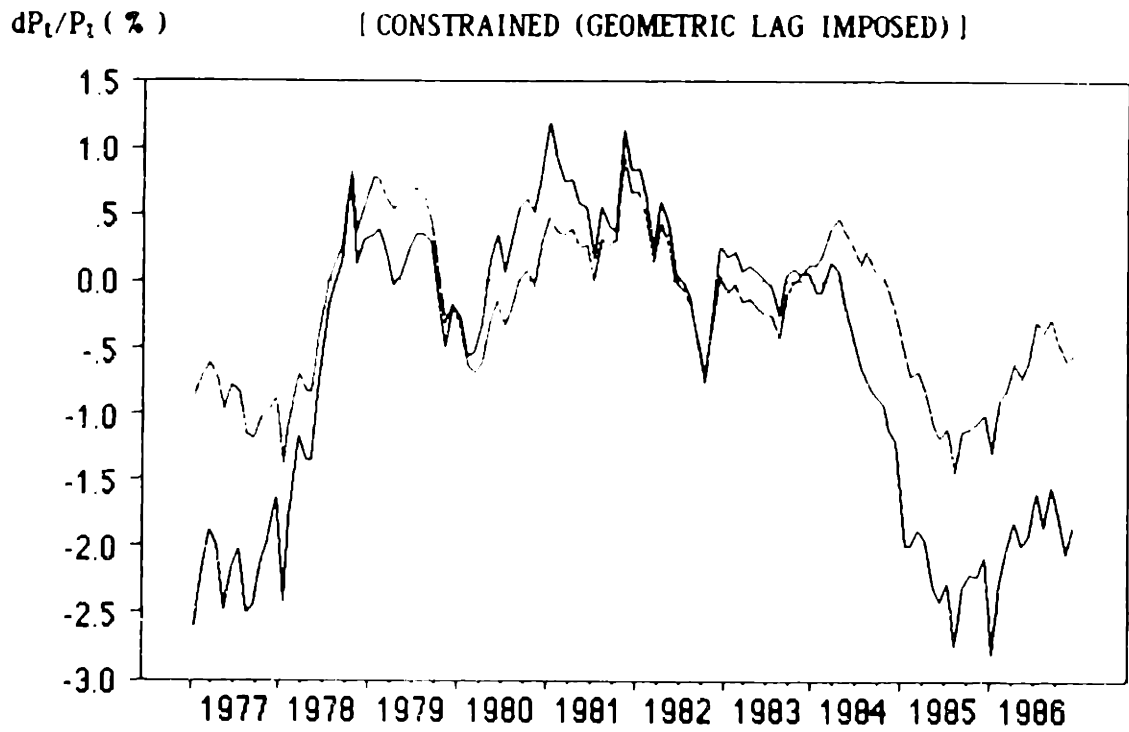
(NOTE)   The thick line corresponds to h = 24 and the dotted line to h = 12 months

[UNCONSTRAINED]

dP_t/P_t (%)
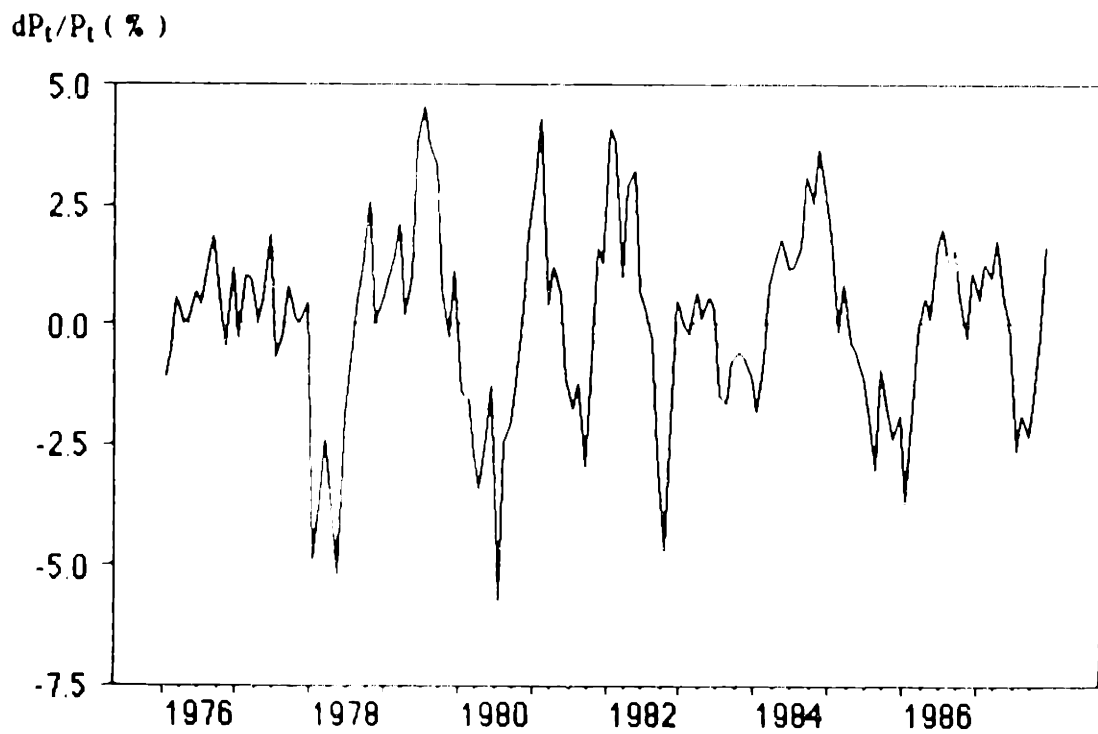
FIGURE 3C   SHARE OF FORECAST-ERROR EFFECT IN EXPECTATION EFFECT
(MACHINERY)
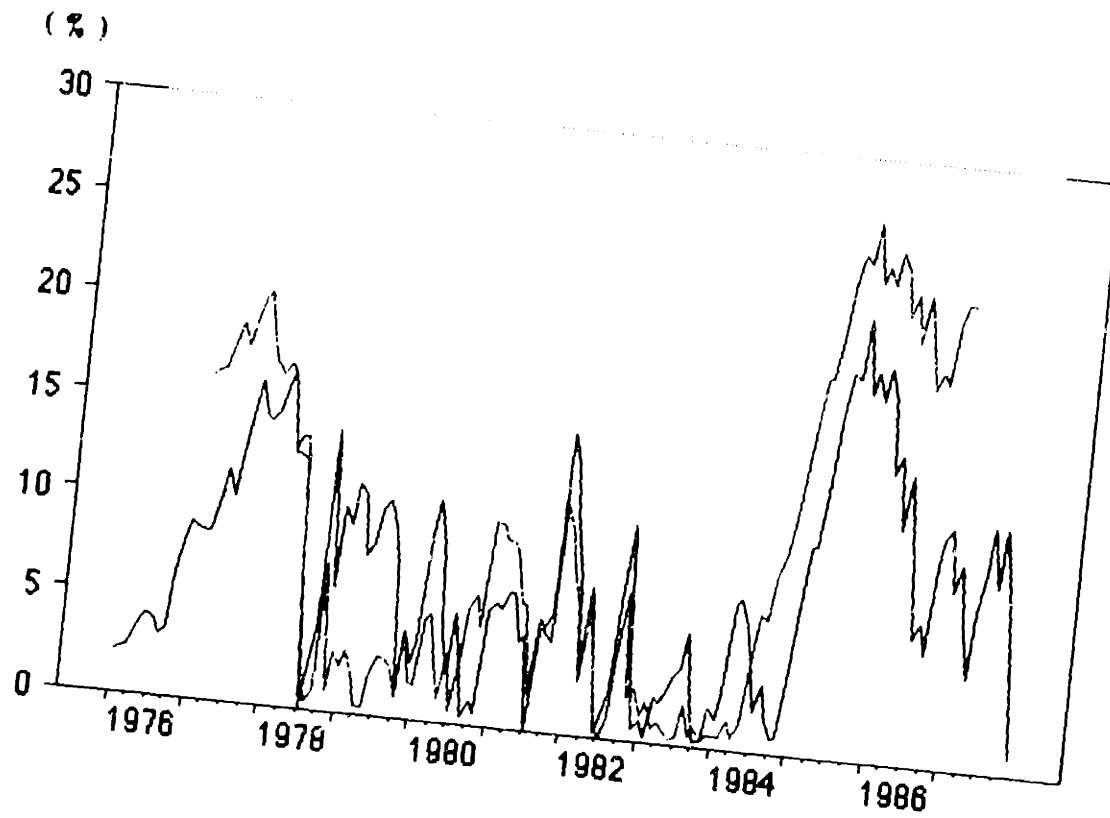
(NOTE) See (15) in the text for the definition of the "share." The thick line corresponds to h = 12 months and the dotted line to h = 24. The estimates of pricing coefficients are from the constrained regression shown as Table 2A.

TABLE 3D   EFFECT OF EXPECTED PERSISTENCE OF CURRENT EXCHANGE RATE
ON EXPORT PRICE (PERMANENT V.S. TEMPORARY)
[MACHINERY]

dP$_t$/P$_t$ (%)
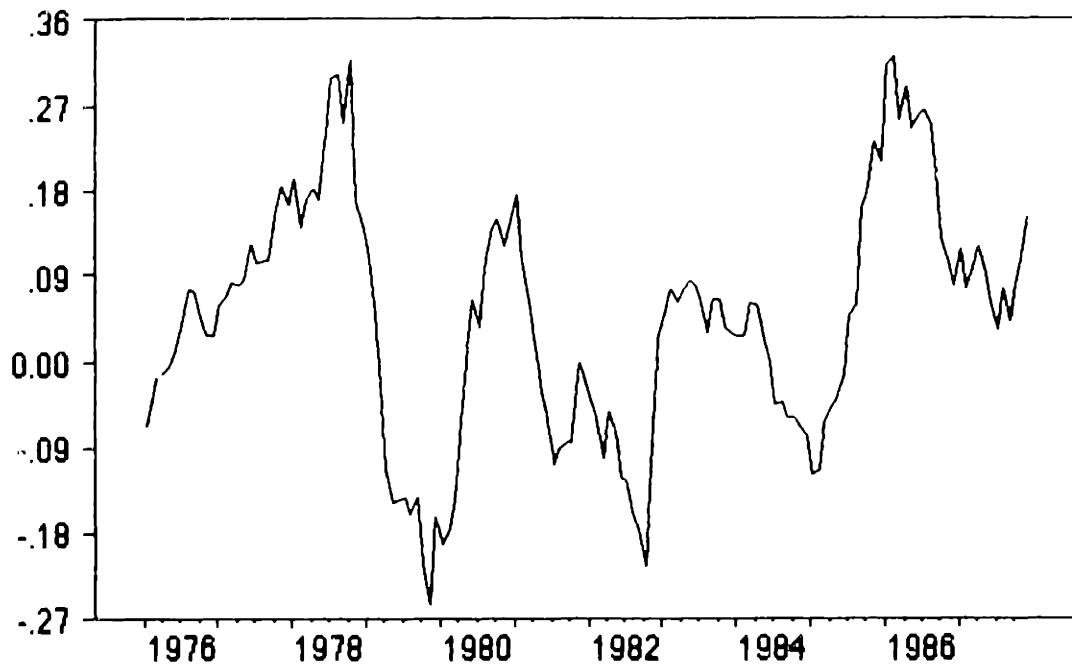
(NOTE)   The figure draws the following ratio in percentage:

((export price estimated with static expectations) - (export price estimated with survey-based expectations)) / (actual export price)

The estimates of export pricing coefficients are drawn from the constrained regression (10) and h = 12.

FIGURE 3E   EXPORT PRICE LEVEL
(ACTUAL, STATIC, DYNAMIC)
[MACHINERY]
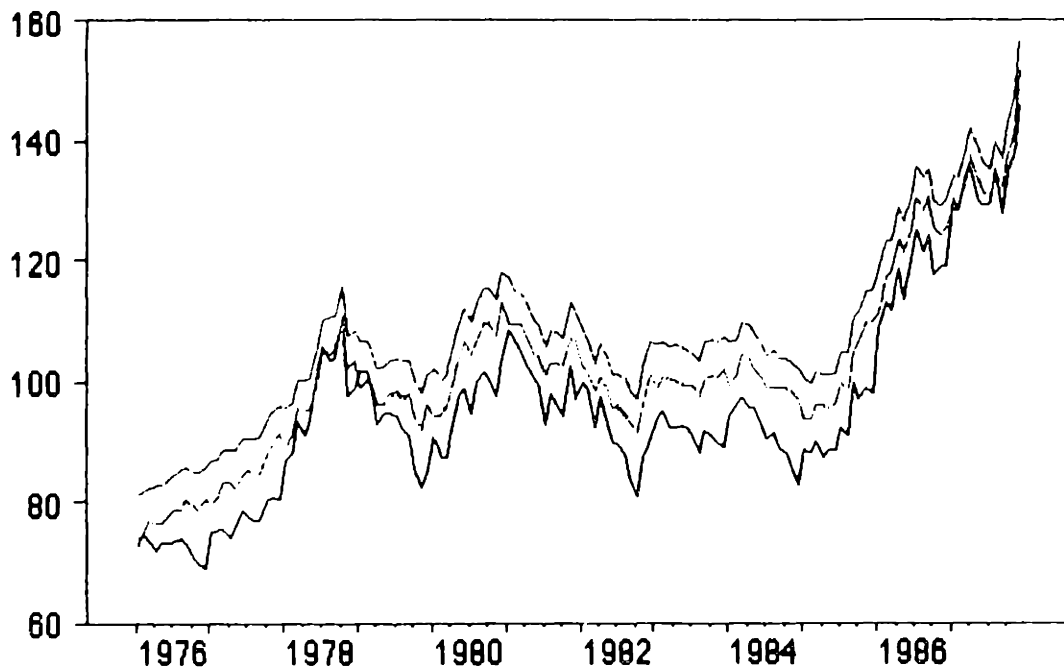
(NOTE)

The three lines in the Figure represents, from below, actual export price, export price predicted by the dynamic model (6) with 12 months horizon, and export price predicted by the static model (8). The estimates of pricing coefficients are from the constrained regression. The actual export price (in dollar terms) is seasonally adjusted and standardized at mean = 100.

FIGURE 4A   FORECAST-ERROR EFFECT ON EXPORT PRICE [METALS]

[UNCONSTRAINED (MOVING-AVERAGE, thick line) / CONSTRAINED (dotted line)]
dP$_t$/P$_t$ (%)
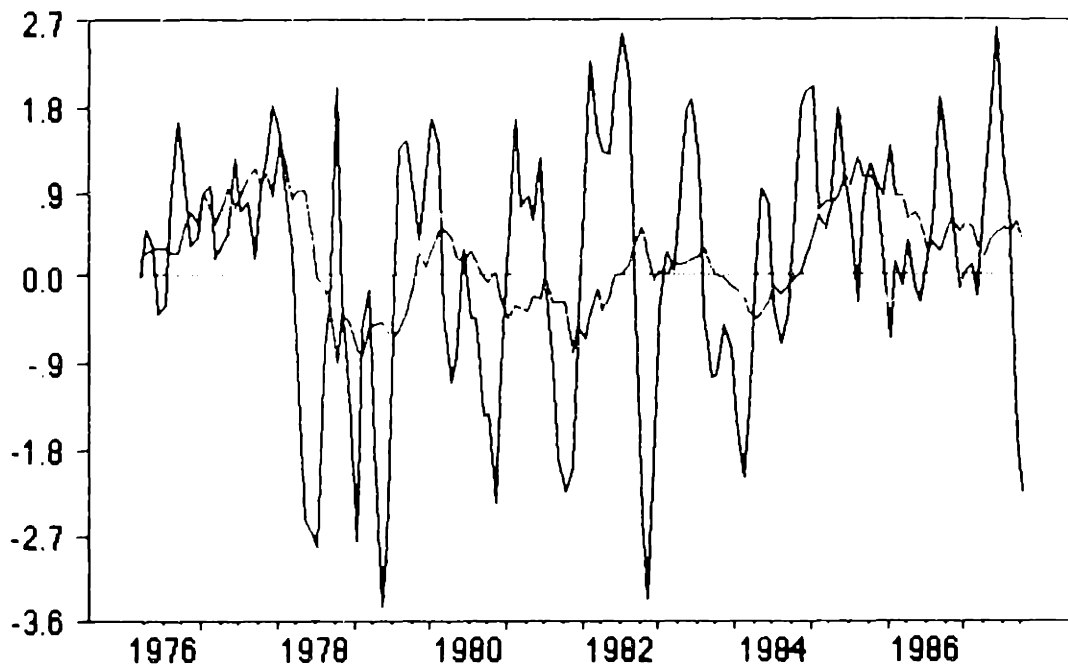
FIGURE 4B   EXPORT PRICE LEVEL (ACTUAL, STATIC, DYNAMIC) [METALS]
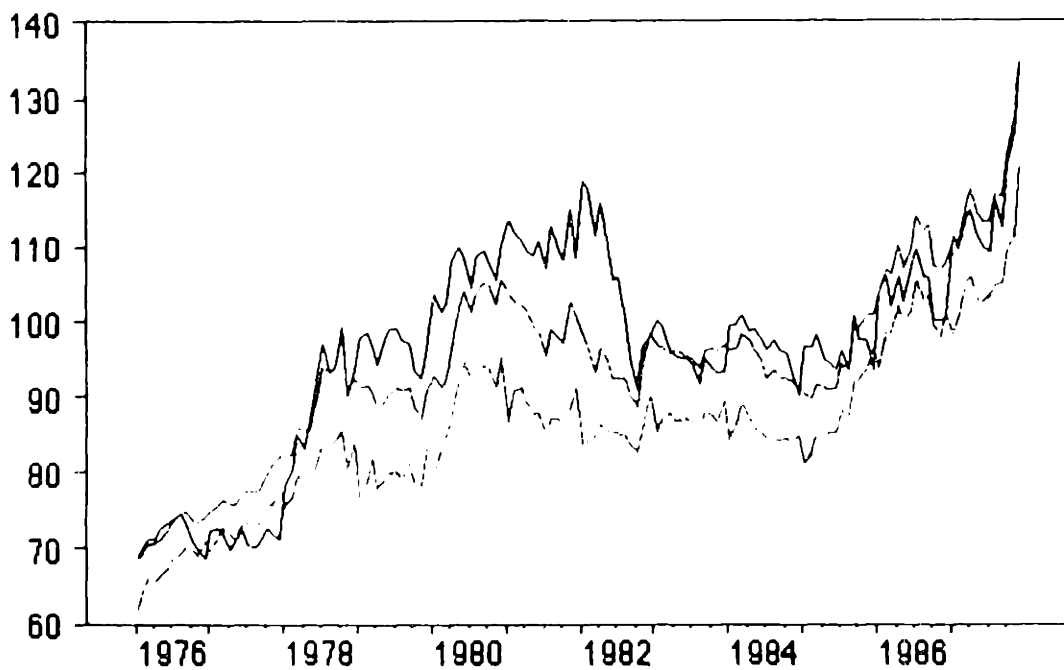
(NOTE) The highest thick line represents the actual export price (seasonally adjusted, standardized at mean=100) and the dotted line in the middle is the price predicted by the static model (8) and the dotted line at the bottom is the price predicted by the dynamic model (6).

FIGURE 5   FORECAST-ERROR EFFECT ON EXPORT PRICE
[TEXTILES]

UNCONSTRAINED (MOVING-AVERAGE)
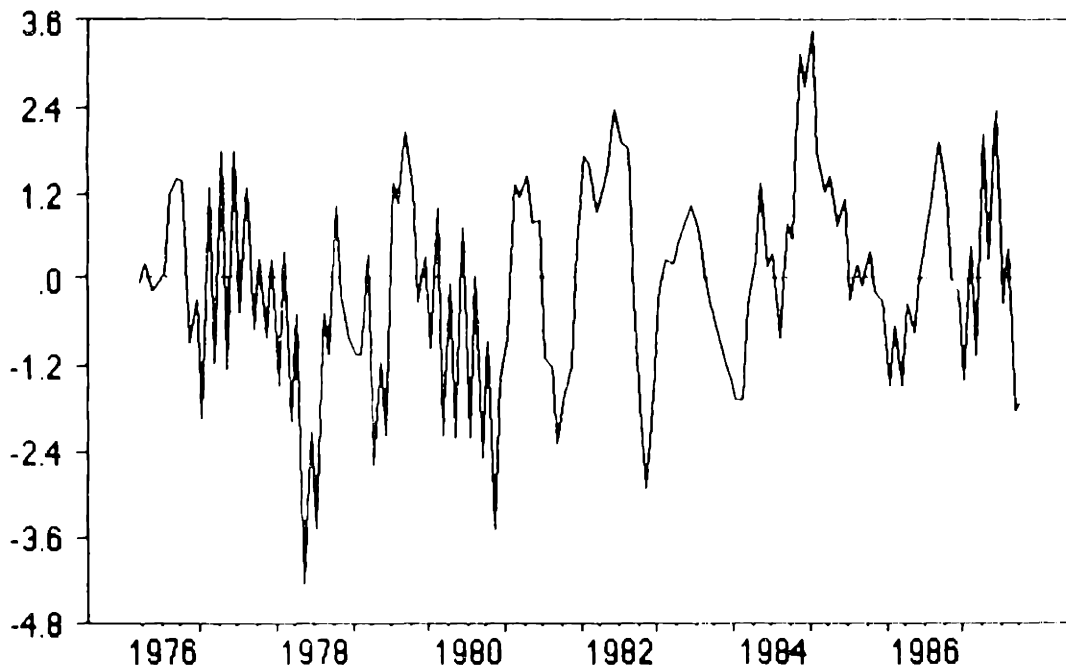
dP$_t$/P$_t$ (%)

FIGURE 6　FORECAST-ERROR EFFECT ON EXPORT PRICE
[CHEMICALS]

UNCONSTRAINED (MOVING-AVERAGE)
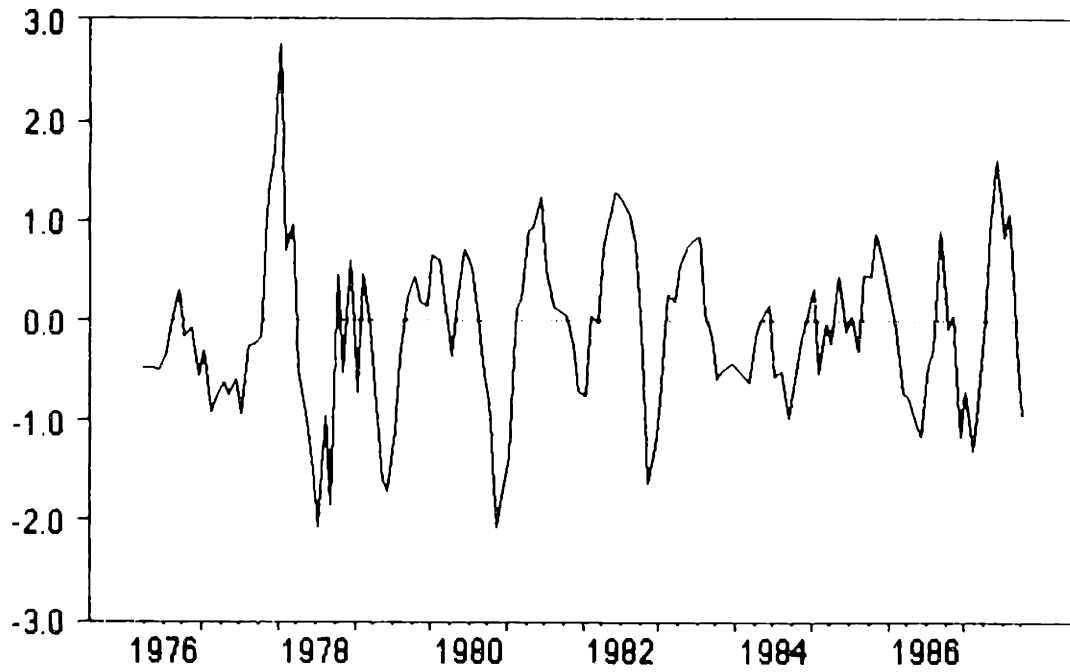
dP_t/P_t (%)

CONSTRAINED(GEOMETRIC) / SURVEY DATA

dP_t/P_t (%)
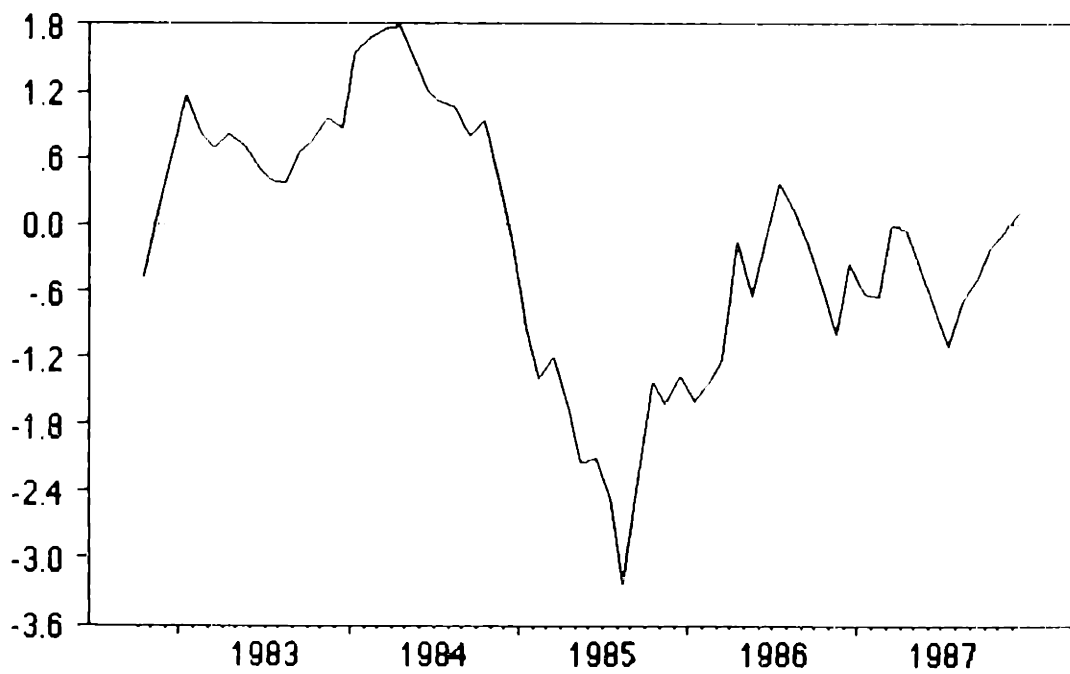
FIGURE 7   AN EXAMPLE OF ASSESSED PROBABILITY OF SWITCH
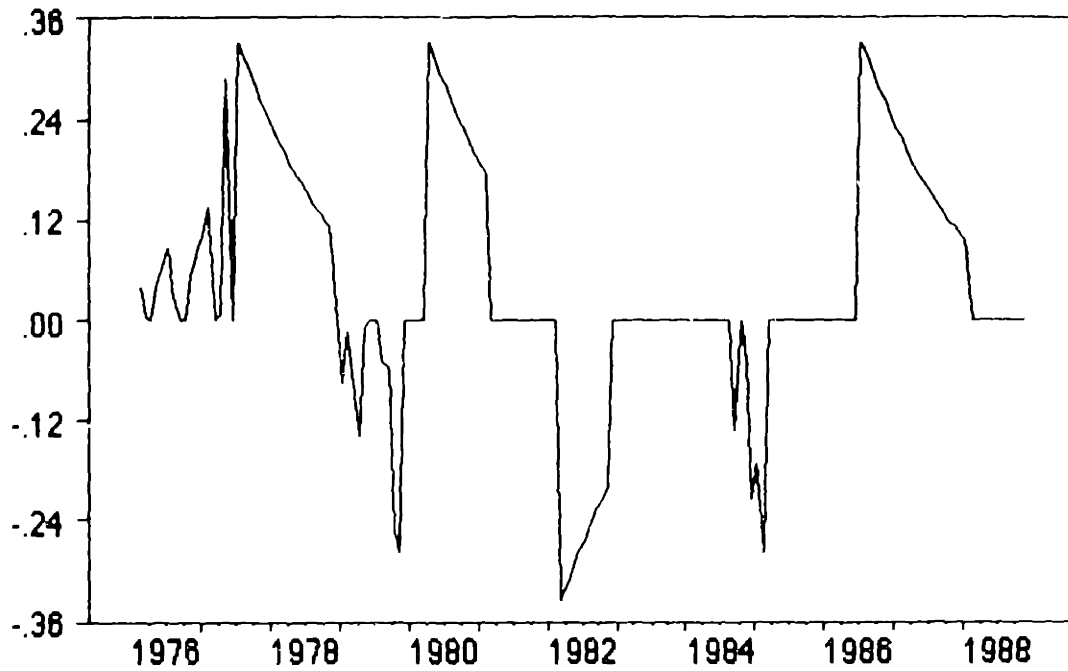
(NOTES)

1. LEARNING

    1977. 7 -- 1978. 11, 1980.4 -- 1981. 2, 1986. 7 -- 1988. 1 (depreciation expected)

    1982. 3 -- 1982. 11 (appreciation expected)

        $\pi_{10} = 1/3$, $|m^1| = 0.1$, normal distribution with $\sigma = 0.24$

2. SPECULATION

    1976. 1 -- 1977. 6 (depreciation expected)

    1978. 12 -- 1979. 11, 1984.9 -- 1985. 2 (appreciation expected)

    uniform distribution with $\underline{\varrho} = 240$ (1976-77), $\overline{\theta} = 280$ (1978-79), $\overline{\theta} = 270$ (1984-85)

3. The assessed probability times -1 is plotted when appreciation is expected.

FIGURE 8   EFFECT OF LEARNING ON EXPORT PRICE

[MACHINERY]

dP$_t$/P$_t$ (%)
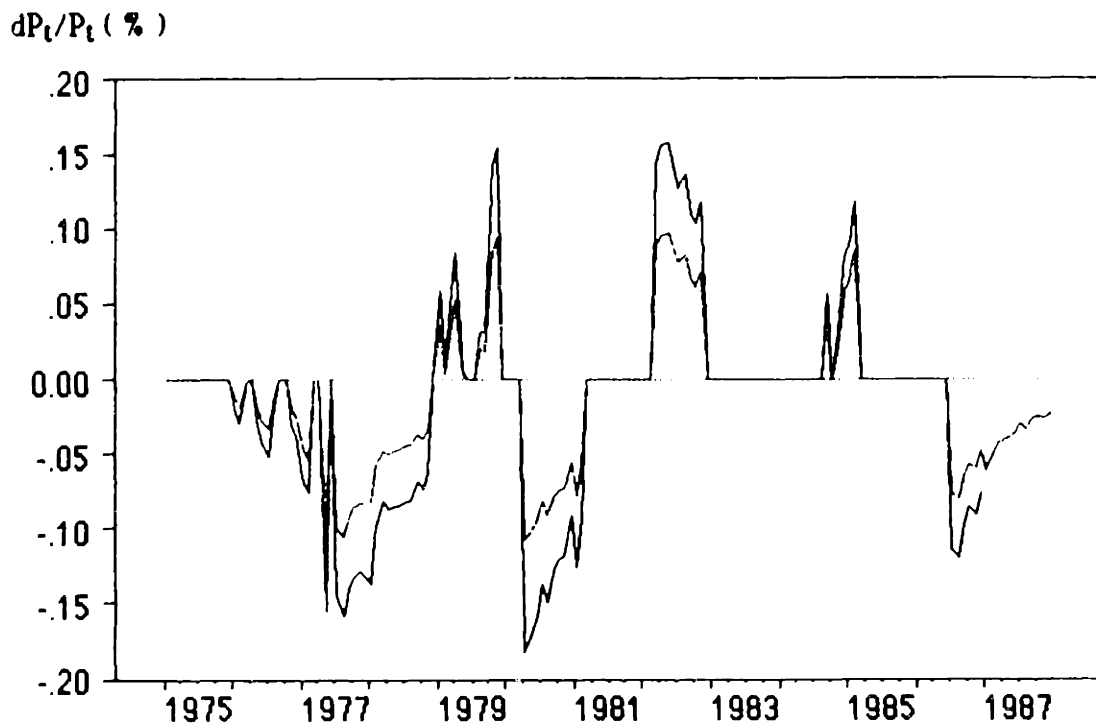
(NOTE) The thick line corresponds to h = 24 and the dotted line to h = 12 months.
The estimates of pricing coefficients are from the constrained regression
reported in Table 2A.

CHAPTER THREE

ADJUSTMENT COSTS, EXPORT DEPENDENCE,

AND

WITHDRAWAL FROM FOREIGN MARKET

1. Introduction

Exchange rate changes compel exporting firms to adjust their exports. Export adjustments in the real world, however, show remarkable diversity across firms even in the same industry. This chapter constructs a dynamic export adjustment model which predicts more persistent exports under exchange rate appreciation for firms with higher expected export expansion costs. On the other hand, firms heavily depending on exports are likely to be forced to reduce exports more during currency appreciation because of financial constraints. The individual firm-level export data in the Japanese case will be examined to make clear the effects of firm size and export dependence on export adjustment decisions.

First, the investigation of individual firm-level data of export adjustments will reveal many features which will enrich the previous representative-firm model. Our study will hopefully fill the gap between the entry/exit theory in international economics and domestic empirical studies in industrial organization. Although results from various industries will be mixed naturally, richer dynamics (e.g. firm size distribution or industry concentration changes) will emerge. The cross-sectional study is especially important because the export adjustment costs may vary significantly across firms and industries. The motivation to study this issue is beyond pure curiosity because who survives exchange rate appreciation determines the future market structure of export sector of a country and hence has important policy implications.

Second, we will study the effect of firm size in the export market and the effect of firm's export dependence on export adjustment decisions. If we borrow the terminology of Lieberman (1990), the main issue of our empirical study will be to analyze whether smaller or more export-dependent firms are "shaken out"

or they "stake out" larger or less export-dependent firms during exchange rate appreciation. The effect of financial constraint under capital market imperfection or the "deep-pocket" effect will be introduced to formalize the conventional wisdom which suggests that more diversified firms could sustain the damage from keeping higher export share during currency appreciation. Then, necessary export reduction for a firm increases with his initial export dependence because higher export dependence means heavier "burden". On the other hand, some might argue that highly export-dependent firms often stick to exports because they have nowhere to retreat. This story suggests us that firms more seriously dependent on export tend to make less export reduction because higher export dependence means higher "stake" in the export market. If the deep-pocket effect is strong, and if highly export-dependent firms are more likely to face binding financial constraint under currency appreciation, the prediction of our adjustment cost model will be offset by the countervailing deep-pocket effect. The study of these firm-specific effects will have deep implications to industrial and competition policy.

Third, to study these issues, we will construct a theory model which has a realistic feature about the effect of expectations. In the real world, a firm seriously takes account of the future re-entry costs when it decides to exit because exiting from export business will be a nightmare in an industry with huge entry costs if the current exchange rate appreciation turns out to be only temporary, not permanent. Under the Brownian motion assumption, however, the effect of entry costs on exits is numerically quite weak, as was reported in various simulations. Thus we will consider the other polar case, two-state Markov process. We will also consider the continuous adjustment of export quantity with linear asymmetric adjustment costs rather than entry/exit decisions. Our model is

not at all contradictory to the previous models but it makes more explicit the implications of expectation effects of entry costs on exit decisions

The rest of this chapter has three sections. Section 2 introduces a model formalizing dynamic export decisions with adjustment costs. Section 3 examines the individual firm-level export adjustments by Japanese companies in the late 1980s yen appreciation. Section 4 concludes.

2. Theory

2.1. Previous results

Mainly motivated by the persistent import penetration into the U.S. market during the dollar devaluation process after 1985, various models have been proposed.

By applying the option pricing techniques under the assumption of Brownian motion about exchange rate movements, a series of works by Dixit (1989 a,b) elaborates the analysis of "hysteresis" in trade initiated by the model with sunk entry costs by Baldwin and Krugman (1989). They reveal the "inaction band" which breaks the relation between short run exchange rate changes and trade flows. As is pointed out by Krugman (1989), the Brownian motion approach is especially novel since it shows that hysteresis could occur even without any lags, regressive expectations, or mean-reversion in exchange rate changes.

Although the entry/exit cost models quite well explain why U.S. firms did not resume export business even after the dollar devaluation,[1] their explanation about the effect of entry costs on exit decisions still has a room for further research. The simulation result by Dixit (1989b) shows that, within plausible range of exchange rates, the number of firms keeping exports after currency appreciation *decreases* as the entry costs rise.[2] If we are interested in the expectation effect by which higher entry costs make export level higher during currency appreciation, it will be better to replace the Brownian motion assumption.[3]

While the relevant problem for a firm could be well described as continuous export quantity adjustments, Dixit (1989a) considers the all-or-nothing decision of "exit v.s. stay".[4] Although the firm-level entry-exit model could be consistent with continuous adjustments at aggregate level, it may be useful to construct a model which allows continuous adjustment at individual firm level.[5]

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[1] Empirical studies along this line, especially based on formal models, are rare. One of the exceptions is Aït-Sahalia (1991) directly simulating the Bellman equations for the case of two U.S. industries.

[2] In a context of labor adjustments, Bentolila and Bertola (1990) construct a model with linear firing/hiring costs under shocks following Brownian motion. By simulations, they conclude that higher firing costs bring about *higher* employment level because a firm is more reluctant to fire. Here, as Saint-Paul (1990) pointed out, higher firing costs do not significantly make a firm *hire* less because a firm may not consider the possibility of future firing when it decides to hire under the random-walk uncertainty. Dixit's result is the same: high entry costs hinder entry strongly, while they retard exit only insignificantly.

[3] "The effect of adjustment cost on long-run average deviation from the frictionless optimum is one order of magnitude smaller than that on inaction ranges", as Bertola and Caballero (1990) pointed out (pp 251). Therefore, in the Brownian motion framework, although higher entry costs retard export reduction by widening inertia band, the absolute export level is on average lower as entry costs get higher.

[4] Actually, only 4 out of 309 Japanese exporting firms in export-oriented manufacturing industries dropped out of export business after the drastic yen appreciation in the late 1980s which we will discuss in Section 3.

[5] It is possible to obtain continuous adjustment at the industry level from the fixed entry/exit cost model. Dixit (1989b) considers an industry consisting of n firms each

2.2. Model

Suppose that a firm exports to the foreign market in a simple two-country framework. To facilitate discussions, let us consider the case where a Japanese firm exports to the U.S. market and call exporter's (importer's) currency yen (dollar, respectively). Further suppose that the only source of uncertainty is the exchange rate movements.

A firm's maximization program can be summarized by, in discrete time,

$$V(q_t) = \max \Pi(X_t) + \delta E[\ V(q_{t+1})|\ \Omega_t\ ] \tag{1}$$

where V is the value function in dynamic optimization and Π is the per-period export profit for a firm. δ is the discount factor ($0 < \delta < 1$, assumed to be constant). Here, we assume that adjusting export quantity is costly. Then, the state variable is the export quantity (q) and the control variable is the export adjustment ($X_t = q_t - q_{t-1}$). $E[.|\ \Omega_t]$ denotes the expectation operator conditional on all the information available at time t (hereinafter, denote $E_t[.]$ for short).

By differentiating both sides of (1) with respect to X,

$$\Pi'(X_t) = \delta E_t[V'(q_{t+1})] \tag{2}$$

Differentiating (1) with respect to q yields

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producing one unit. The other more elaborate way to get continuous adjustment is the explicit aggregation. Bertola and Caballero (1990) is a rare example with an empirical application. They allow both linear and fixed sunk cost of adjustment, assuming Brownian motion.

$$V'(q_t) - \delta E_t[V'(q_{t+1})] \tag{3}$$

by making use of the envelope theorem.

Then, from (2) and (3), we obtain the following Euler equation:

$$\Pi'(X_t) - \delta E_t[\Pi'(X_{t+1})] \tag{4}$$

which states the equalization of marginal profits from export adjustments over time.

Next, let the per-period export profit for a firm be

$$\Pi_t - (p_t - c_t) q_t - b_t X_t \ 1_{(X>0)} \tag{5}$$

where "1" denotes the indicator function which is equal to one if $X_t > 0$ (expanding export) and zero if $X_t \leq 0$. Let output price (p), marginal production cost (c), and export adjustment cost (b) be expressed in terms of yen.[6]

We assume that the export adjustment cost is asymmetric (export reduction cost is zero). This simplifying assumption is realistic because expanding market share in the foreign market normally tends to need much more expenses than just shrinking it. Since there is few reasons to believe that the cost of just stopping export business is so high that Japanese firms find it more profitable to keep exporting under such drastic yen appreciation as after 1985, the high exit cost alone is not sufficient to explain the sluggish reduction in Japanese exports.

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[6] The costs for expanding export include, for example, sales promotion expenses in foreign markets which may be often denominated in dollars, not in yen. However, whether "b_t" is denominated in yen or dollars does not affect our qualitative results.

Besides, as many business episodes tell us, it is often not the exit costs but the entry costs that may be enormous for individual firm operating in foreign markets.

Thus, the introduction of export adjustment costs makes the export decision "dynamic". In other words, the export decision cannot be made without taking account of expectations about future exchange rate changes because changing (especially increasing) already-chosen export quantity is costly.

To concentrate on the dynamics of export decision, we assume the following log-linear export demand function (a_0 constant and $\theta > 0$):

$$q_t = a_0 \, (p_t/e_t)^{-\theta} \qquad\qquad (6)$$

where the exchange rate (yen/dollar) is denoted by e. The assumption of constant elasticity distinguishes us from the static models of partial pass-through.[7]

By substituting the inverse demand function into (5), the per-period export profit becomes[8]

$$\Pi - a e \, q^{\mu} - cq - bX \, 1_{(X>0)} \qquad\qquad (7)$$

where "a" is constant and $\mu = 1 - (1/\theta)$ $(0 < \mu < 1)$.

---

[7] The "supply-side dynamics" model in Krugman (1987) assumes it for this purpose. Under the constant-elasticity export demand function, the exchange rate pass-through is perfect (one) without dynamic mechanism. The results obtained in the following is, however, robust for linear export demand function, for example.

[8] Here, we assume that an exporting firm is the monopolist in the industry in the foreign market. However, the results obtained in the following is robust even if we assume perfect competition. The reason we did not choose perfect competition is just that the pass-through degenerates to zero under simple price-taking ("small-country") framework.

Although our assumption of asymmetric adjustment costs in (5) is realistic, we have to introduce another assumption to explicitly formalize the mechanism by which high entry costs retard exits.

Reentering the export market will be disastrous for a firm as it has to rebuild distribution networks and reputations in the foreign market once it made an exit. Therefore, as long as there is some chance of recovery (or yen depreciation), staying in the export market and waiting for a recovery can be a better strategy than exiting shortly after one "bad news". In this sense, "entry costs are exit costs" since it is the high re-entry cost that retards exits as Londregan (1990) finds in a different context.[9] As was reviewed in Section 2.1, however, this effect is not strong in the previous models assuming Brownian motion about exchange rate movements. In other words, since changes following Brownian motion are generally gradual, entry costs have very little impact on exit decisions because future re-entry possibility is too subtle for a firm contemplating an exit.

Therefore, in this chapter, we consider the other polar case, assume that the exchange rate in the long-run follows the two-state Markov process[10]. Although it is difficult to choose the appropriate process to describe empirical exchange rate changes, this assumption will reveal the role of expectations in exit

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[9] "Exit barriers are entry barriers," a part of the title of the paper by Eaton and Lipsey (1980) on the durability choice in entry deterrence game, inspires me with the phrase "entry costs are exit costs."

Londregan (1990) examines entry/exit under exogenous industrial life cycle. His model is different from ours in that his profit function is deterministic and his main focus is on strategic interaction between duopoly firms.

[10] Although techniques employed in our theoretical study of Markov process owes much to Saint-Paul(1990)'s macro- labor economics model, his main interest is in the multiplicity of equilibria caused by the voluntary quit decisions on workers' side.

decisions.[11] Suppose that "e" in (7) takes either appreciated value or depreciated value $\underline{e}$ or e^* ($\underline{e} < e^*$) and that transition probabilities are given by

$$\lambda - prob(\, e_{t+1} - e^* \mid e_t - \underline{e}\,)$$

$$\rho - prob(\, e_{t+1} - \underline{e} \mid e_t - e^*\,).$$

Then, together with (7), the firm's dynamic program (1) is simplified to

$$V(q^*) - (ae^*q^*\mu - cq^* - bX^* 1_{(X > 0)}) + \delta(\,(1-\rho)V(q^*) + \rho V(\underline{q})\,) \tag{8}$$

$$V(\underline{q}) - (\,a\,\underline{e}\,\underline{q}\mu - c\,\underline{q} - b\,\underline{X}\,i_{(X > 0)}) + \delta(\,(1-\lambda)V(\underline{q}) + \lambda V(q^*)\,) \tag{9}$$

where $q^*(\underline{q})$ denotes the export quantity under currency depreciation (appreciation, respectively)

Therefore, the firm's export decision is given as follows:

(a) If the exchange rate is at the depreciated level ($e = e^*$), differentiating (8) with respect to q^* yields

$$0 - a\,\mu\,e^*\, q\mu^{-1} - c - b + 0$$

because $(1-\rho)V'(q^*) = 0$ and $X \leq 0$. Then, by rearranging,

$$q^* - \alpha[\,(c+b)\,/\,e^*\,]^{-\theta} \tag{10}$$

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[11] Although the random-walk model has been traditionally regarded as a good approximation of empirical exchange rate, recently, other possibilities are being explored. For example, Engel and Hamilton (1990) report that long swings between two states dominates the random-walk model. Anyway, our focus in this chapter is not in the more realistic exchange rate approximation, but in the framework by which we can study the effects of expectations on dynamic export adjustments.

where $\alpha = (a\mu)^\theta$. Thus, the export quantity choice during currency depreciation degenerates to the simple static or myopic optimization. In the currency depreciation state, high export expansion costs naturally make the export expansion slow down (higher b, lower q in (10)) because expanding exports needs expenses now.

(b) If $e = \underline{e}$, by differentiating (9) with respect to $\underline{q}$

$$0 - a \, \mu \, \underline{e} \, \underline{q}^{\mu-1} - c + \delta\lambda b$$

because one unit of export reduction now will raise the cost by "b" in the next period (discounted at the rate δ) if the exchange rate reverts to depreciated level (occurring with probability λ). Rearranging yields

$$\underline{q} - \alpha [(c - \delta\lambda b) / \underline{e}]^{-\theta} \tag{11}$$

This decision rule means that the export reduction is "delayed" if costs of re-expanding export (b) are high or if there is high chance (λ) of yen depreciation.[12] Contrary to q* in (10), in the currency appreciation state, higher export expansion costs make the export level *higher*(higher b, higher q in (11))

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[12] The result obtained in (11) (export quantity increases with expected adjustment costs) is robust.

For example, with linear export demand function,

$$\underline{q} - \alpha - \beta(c - \delta\lambda b)/\underline{e} \qquad \text{where } \alpha, \beta \text{ are positive}$$

And, with the assumption of perfect competition or price-taking $(p_t = e_t)$,

$$\underline{q} - (\underline{e} + \delta\lambda b)/c$$

(We have assume quadratic cost function $C(q) = cq^2/2$ in the case of perfect competition because export quantity becomes indeterminate without relaxing constant marginal cost in this case.)

because reducing exports now will turn out to be costly in the future as the firm will re-expand them.

As in the hysteresis models, export quantity under the same exchange rate level can differ depending on the direction of exchange rate adjustments. This is because higher entry costs make export quantity smaller when the currency is depreciating as in (10) but make it larger when the currency is appreciating as in (11), compared with the case of no expected adjustment costs ($\delta\lambda b = 0$).

Before moving to the next section, let us compare our model with the "market-share" arguments. The introduction of costs of gaining export share gives a clue to theoretically interpret the behavior which has often been explained by the firm's serious concern about export market share. As was formalized by Froot and Klemperer (1989), and as is claimed by many businessmen, export market share is an important factor in exporter's decisions especially when reputation matters. Froot and Klemperer, however, introduce the market share variable directly into the profit function. Our model can analyze the same issue by a more standard model of dynamic optimization behavior of a rational firm.

2.3. Implications: effects of expectations

By rewriting (11) being explicit about the firm identity and timing, the export quantity during currency appreciation chosen by the firm i at time t is given by

$$q_{it} - \alpha((c - \delta\lambda_t b_{it}) / e_t)^{-\theta} \qquad (12)$$

where we assume no private information in expectations ($\lambda_{it} = \lambda_t$ for all i).

The most interesting question would be the effect of adjustment costs on dynamic export decisions. We will study it in detail in Section 3 by investigating the cross-section data of Japanese firms. Before moving to the empirical study about cross-sectional variations, let us discuss other implications: the effects of expectations in our dynamic export adjustment model.

First, the effect of *dynamic* changes in expectations (λ_t) should be crucial. Expectations about future exchange rate (for example, whether current appreciation is permanent or temporary) play an important role in exit decisions from export operations, but the expectations held by exporting firms often change quickly over time especially during   exchange rate adjustment process.[13] This dynamic changes in expectations cannot leave export decisions untouched.

To obtain information about the effects of expectations on export decisions during exchange rate appreciation, the comparison of the relations of export quantity and exchange rate during currency depreciation phase with that during appreciation phase is useful. The intuition behind it is that the export quantity choice during currency depreciation is independent of dynamically changing expectations ($q - \alpha((c+b)/e)^{-\theta}$ (10)). Then, we can infer the effect of expectations (λ_t) by comparing the actual export level during currency appreciation with the

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[13] Frank(1988) interprets the similar observation from a different perspective. He focuses on another aspect of sunk entry cost : as a reflection of belief held by a firm. If a firm sunk larger cost on entry then, his anticipation about profitability should be higher and hence the firm stays in the market longer.

export level obtained by extrapolating, into the currency appreciation periods, the relation (10) estimated over the currency depreciation period.[14]

Figure 1 illustrates the case in Japanese machinery industry during the yen appreciation after 1985. Here, we define the rate as the percentage deviation of actual export quantity from the level which is obtained from (10) with parameters estimated for the preceding yen depreciating period(1979:11 - 1985:1).[15] At the peak (mid-1986) which is about one year after the exchange rate adjustment process began, thus defined rate is as high as 17%.[16]

Although this estimation procedure is far from perfect, this magnitude of rate at least suggests that the role of expectations is not negligible. Since the export adjustment costs (or the discount rate) themselves are not supposed to be drastically changing monthly under stable inflation as in the 1980s, the quick changes in Figure 1 should be mainly due to the dynamic changes in expectations. Figure 1 is also consistent with the learning process because exporting firms may have spent one year to gradually revise their belief about

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[14] Easily seen from the definition ((11) divided by (10)), thus defined rate is equal to $((c-\delta\lambda b)/(c+b))-\theta$. Hence, we can infer the effect of "$\delta\lambda$" from this rate. In other words, higher rate implies higher λ, ceteris paribus.

[15] We conduct a linear regression of log q on constant term, and log c/e from 1979:11 to 1985:1, assuming b/c stable. Then, we calculate the "estimated" export with estimated coefficients in this regression and actual "e" and "c" from 1985:2 to 1988:12. The rate in Figure 1 is actual export quantity divided by this estimated export quantity minus one (expressed in percentage). Export quantity is defined as the export value in trade statistics divided by export price index, as in Chapter One and Two. Exchange rates are monthly closing rates (yen/dollar). Cost index is from the Input-Output table.

[16] Our result of "too large" export quantity during yen appreciation phase (larger than that for the same yen rate during depreciation phase) is rather puzzling since the effect of entry costs must be stronger on entry during depreciation phase than on exit during appreciation phase. We should interpret the estimated rate with reserve because production technology and/or preference(θ), which we assume constant, may happen to change before and after the yen appreciation. Especially, productivity growth may not be negligible for the Japanese machinery industry.

reversion to yen depreciation after facing a sudden change in 1985. In other words, they kept relatively high export level during the drastic yen appreciation process (especially in the early stage (1986)) because they expected the appreciation to be temporary. This interpretation receives empirical support because many studies about various survey data show that Japanese exporting firms actually expected that the drastic yen appreciation since 1985 would not persist and that their expectations were only gradually revised over time.

Second, since an exporting firm in the real world seems to need relatively long time to recognize whether or not ongoing exchange rate adjustment is permanent, suppose that a firm forms its expectation based on the Bayesian learning process. Assume that the conditional probability of reversion to depreciation is either λ_L or λ_H ($\lambda_L < \lambda_H$) and let the subjectively assessed probability of λ_H be π_t which is updated over time by the following Bayes rule where initial optimism (quick recovery to depreciation) is gradually replaced by grim reality (long-lasting appreciation)[17]:

$$d\pi_t/dt = - (\lambda_H - \lambda_L) \pi_t (1-\pi_t)$$

By solving this differential equation,

$$\lambda_t = [\pi_0\lambda_H + (1-\pi_0)\lambda_L \exp((\lambda_H - \lambda_L)t)] / [\pi_0 + (1-\pi_0)\exp((\lambda_H - \lambda_L)t)] \qquad (13)$$

We have conducted simulations about the case of Japanese machinery industry.[18] As a benchmark, the export quantity deviation from the "frictionless"

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[17] This specification of updating is the same as that in Saint-Paul (1990), where he examines the impact of business pessimism on European sluggish employment recovery

[18] We set $\delta = 0.9$ and b_t/e_t (the dollar-base export expansion costs) = 0.1. The export demand elasticity(1.068) is estimated as the coefficient in the log-linear regression on export price. The sample period is from February 1985 to December 1988. In our cost index, b/e = 0.1 corresponds to the case where roughly one-quarter of marginal production costs is necessary for one unit of export expansion.

level (i.e. the export quantity chosen under no expected adjustment costs) will be useful.[19] By (11), if $\delta\lambda b = 0$, the export quantity during currency appreciation is given by $\underline{q} - \alpha(c/\underline{e})^{-\theta}$. Then, it will be informative to see the export "excess" rate $(\Delta q_t/q_t - (1 - \delta b_t\lambda_t/c_t)^{-\theta} - 1)$ which measures how many percent the export quantity is kept higher during currency appreciation compared with the "frictionless" case

Simulation results are as follows. As the initial belief of quicker recovery (π_0) rises from 0.5 to 0.7, the difference in initial belief of this magnitude persistently affects the export adjustment for about one year.[20] Next, as λ_L increases from 0.3 to 0.5 keeping the gap between λ_H and λ_L constant, the export excess rate is almost doubled.[21]

None of the results obtained here should be exaggerated because we have no reliable data of the export expansion costs and the expectations about future export expansion. Quite often it is almost impossible to distinguish the export expansion costs from export production costs in corporate accounting data and to measure the assessment of future export expansion possibility taking account of exchange rate forecasts as well as of international prospect of technological progress which affects competitiveness. Next, we move to the study of the exchange rate pass-through which we have reliable estimates.

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[19] The terminology "frictionless" is used to refer to the no-adjustment-cost case in Bertola and Caballero (1990), for example

[20] We set $(\lambda_L, \lambda_H) = (0.4, 0.8)$. The export excess rate in each case is not substantially different if we take the mean over three years after the start of the appreciation (7.84%, 8.21%)

[21] We set $(\lambda_L, \lambda_H) = (0.3, 0.9)$ and $(0.5, 0.7)$. π_0 is fixed at 0.5. The export excess rate increases from 5.94% to 9.79% evaluated at the mean

Third, we will discuss the implications of our model to the pass-through from exchange rate changes into dollar export prices. Since our model is focused on the determination of export quantity (not pricing), the linkage is indirect. However, since the exchange rate pass-through has been an important research topic with complicated policy implications, we will analyze this issue in our framework.

Since the export quantity decision is influenced by the expectations λ_t which is usually updated over time, the pass-through should also change over time.[22] Figure 2 illustrates the observed dynamic patterns of pass-through changes for the case of Japanese machinery and textiles industries.[23] Let us examine it in what follows:[24]

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[22] In our model, once we obtain the export quantity, the corresponding export price is determined by the inverse export demand function. Then, given the exchange rate changes, we can calculate the pass-through elasticity (defined as percentage rise in the dollar export price with respect to one-percent yen appreciation). Naturally, the higher the expected adjustment cost becomes, the more sluggish exports are reduced, the lower the dollar export prices is realized.

[23] Here, the pass-through elasticity is calculated as the percentage export price change rate (in terms of dollars) since February 1985 divided by the percentage exchange rate change rate during the same period.

[24] The pass-through of the metal industry shows a different pattern (not shown in Figure 2). The pass-through stays quite low (around 0.3) for nearly two years and then increases to one after that. This observation seems to be more consistent with Dixit's prediction than with ours. If we suppose that the exit-inducing exchange rate for firms in this industry was passed at early 1987, his model can explain the metal industry case. This may be rather reasonable because our assumption of per-unit export expansion costs might be more suitable for some consumer goods and the metal industry might be better characterized by fixed entry costs with negligible additional per-unit export expansion costs. However, this may be a matter of degree because there remains a problem of aggregation. If the cost dispersion among firms is large, Dixit's model might be consistent with gradually rising pass-through as in the machinery and textiles industries. But this interpretation would be unrealistic at least for the machinery industry where "exits" are quite rare.

The pass-through elasticity increases gradually over time and it takes nearly two years to reach perfect pass-through in the machinery industry. The level of pass-through is almost always lower than that of the textiles industry. Our model attributes this to higher export adjustment costs and/or higher expectations of future export expansion possibility in the machinery industry. Although the exchange rate applied to exports is the same for all industries, the technical progress or changes in international competitiveness quite differs among industries. Therefore, even if the exchange rate expectations held by firms show no industrial differences the assessed future possibility of export expansion can be different depending on the industry. In this sense, the extremely high pass-through in the textiles industry may be the reflection of the pessimistic expectations about the competitiveness of this industry in the export market, which may be consistent with other anecdotal evidence [25]

Finally, in our model, the "entry costs" significantly affect "exit decisions" through expectations, i.e., firms keep exports higher during currency appreciation as the export expansion costs get higher because re-expanding once-reduced export in the future is anticipated to be more costly. On the other hand, Dixit (1989b) reports, by numerical simulations, that[26] the number of firms staying in the foreign market after appreciation decreases from 64 to 57 as the entry cost is doubled. Although he shows that a firm exits later during exchange rate

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[25] As will be discussed later in Section 3 the different market structure may be another factor for different degree of pass-through in these two industries. As Table 3 will show, industry concentration in the textiles industry is much lower than any machinery industries. Less oligopolistic, or more perfect competition in the textiles industry compared with the machinery industry may explain the almost perfect pass-through in the textiles industry

[26] He considers an industry which is consisted of n firms each producing one unit with fixed sunk cost of entry

appreciation process (wider inertia band), the export level is on average lower within plausible range of exchange rate (150 - 122 yen/dollar) as the entry costs get higher. This result is due to the Brownian motion assumption because changes are always likely to be gradual within that stochastic process. As a result, higher entry costs hinder entry strongly but retard exit only insignificantly.[27] Our assumption of Markov process makes the stochastic process more like mean reversion and, as a result, the effect of entry costs on exit becomes so strong that the absolute export level during currency appreciation is actually higher as entry costs get higher.[28] Although the differences between these two models are rather a matter of degree than a matter of kind, the expectation effect of entry costs on exit decision is now more explicit.

3. A cross-section study of firm-level export adjustments

In this section, we will focus on cross-sectional variations in export adjustments across firms. After reviewing the related industrial organization literatures, the actually observed export adjustment patterns at individual firm level will be investigated in the case of Japanese companies in the late 1980s during the drastic yen appreciation.

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[27] Bentolila and Bertola (1990) argue that "the firm knows that firing costs will have to be paid, but this possibility is heavily discounted since hiring occurs in good times, and bad times are far into the future." (pp. 393)

[28] On the other hand, in Dixit's model, the absolute export level (the number of surviving firms) is lower as entry costs get higher. However, this difference becomes rather subtle if we look at the export reduction rate because benchmark or starting points may differ between the two models.

3.1. Previous results

In industrial organization, the exit decision from declining industries is one of the well-researched topics.[29] Ghemawat and Nalebuff (1985) prove, by the logic of backward induction, that the larger firm exits earlier in the subgame-perfect Nash equilibrium in duopoly under monotonically declining deterministic demand. Ghemawat and Nalebuff (1990) relax the assumption of all-or-nothing exit decision in their previous paper and consider continuous adjustment of capacity. They conclude that larger firms reduce capacity first until they shrink to the same size as smaller firms.[30] In both papers, they predict decline in industry concentration.

Baden-Fuller (1989), by investigating the case of U.K. steel casting during 1977 - 1982, reports that more diversified firms reduce more production capacity because of their lower labor reallocation costs.[31] His work might suggest us that a firm more highly dependent on export stick to export operation longer even after drastic currency appreciation because it has higher "stake" in the export market.[32]

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[29] Even before the formal introduction of game theory and dynamic optimization techniques, the same issue had been traditionally studied in industrial organization For example, Caves and Porter (1976) argued that diversification could deter or prompt exits due to conflicting managerial effects: easier internal employee replacement and higher power to average loss with profits from other lines of firm's business.

[30] The intuitive reason for this can be found in that marginal revenue is a declining function of quantity, in the absence of strong economies of scale. In other words, larger firms tend to receive higher pressures to shrink during declining demand.

[31] In a different context of spatial differentiation, Judd (1985) theoretically proves earlier exits by multiproduct incumbent because his preemptive threat in differentiation space is incredible in that he faces conflict from keeping substitutes markets. This theory is consistent with the disproportionate capacity reduction by more diversified firms

[32] We could interpret this by the model of Dixit (1989b) if we assume that exit costs are significantly large and depend on a firm's diversification. More diversified to domestic

This story, however, may contradict the conventional wisdom which suggests that a firm with lower export dependence has more stable profit under fluctuating exchange rates and thus can endure the loss from keeping the export market share during appreciation.

This traditional "deep-pocket / long-purse" idea is theoretically formalized by Fudenberg and Tirole (1985).[33] Although their interest is in predation or entry deterrence, they conclude that a firm with higher internal wealth can undertake more projects because of lower interest payment under capital market imperfection.[34]

Lieberman (1990) examines whether "shakeout" or "stakeout" characterizes exit decisions in the chemical industries.[35] He concludes that smaller firms are more likely to exit, while the probability of plant closure increases with the firm's capacity share after controlling for plant size.[36] Based on extensive study of plant-level panel data about U.S. manufacturing industries, Dunne, Roberts, and Samuelson (1988) find that diversifying firms who enter an industry through new-plant construction have lower exit rate compared with new firms.

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sales, the exporting firm is more likely to exit from export business because of his lower exit costs.

[33] They consider a one-period problem about finance for a project with pre-fixed size.

[34] Related to this issue, Scherer(1980) reminds us that more diversified firms have lower capital cost because their stable intertemporal profits lower the risk premium required by risk-averting investors.

[35] We share the same motivation with Lieberman: to analyze the effect of firm size on exit decisions. However, he refers to scale economies as the advantage of larger firms, while we will study the deep-pocket effect. Since detailed cost data are necessary to test scale-economy effect, we exploit company financial data and study the larger firm's advantage from that perspective. Lieberman employs engineering cost data to study the chemical industries in which economy of scale is crucial.

[36] On the other hand, Deily (1991) studies plant-closing decisions of 19 steel firms by logit regressions and finds that both the firm-size effect and the diversification effect are small, compared with the strong plant-characteristics effect.

In international context, Doi (1991) reports that concentration in Japanese exports decreased during the yen appreciation in the late 1980s, although his study is based on aggregate data.[37]

3.2. Theoretical predictions

Before starting empirical investigations, we will introduce the effect of financial constraint to fill the gap between the prediction from adjustment cost model and the conventional "deep-pocket" argument.

Consider a case where a firm faces a constraint that it has to earn at least some fixed level $(\underline{\Pi})$ per period, for example, for interest payments. On the other hand, the short-term (per-period) export profit during currency appreciation $(e = \underline{e})$ is not necessarily maximized if the firm follows the dynamic decision rule (11). Then, it is possible that a firm can attain the minimum level of per-period profit $(\underline{\Pi})$ by giving up the dynamically optimal level of export quantity. Further, a firm may be forced to do so especially if external borrowing is very costly because of capital market imperfection.

An exporting firm with large domestic sales, however, may be able to attain the relatively high dynamically optimal export by subsidizing profits from domestic operations which is stable under exchange rate changes.[38]

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[37] According to Doi's study, concentration in Japanese export (defined as the share held by top 50 firms) declined from 62.5% in 1983 to 60.5% in 1988. Although his paper presents no formal model, he argues that this declining concentration may be a result of surge in overseas production mainly led by large automobile companies.

[38] Besides, firms which have close ties with financial institutions also can endure the loss from keeping high export by obtaining the loan without satisfying the financial constraint. We will discuss this possibility in the Japanese "Keiretsu" group case later.

The export dependence of a firm might affect its dynamic export decision not only through the direct mechanism mentioned above but also through the export expansion cost determination in the following way:

Although export expansion costs have been so far assumed to be constant for all firms and for all levels of exports, it could be an oversimplification. The main source of the difference will be the home-market sales of a firm. Since some of the production technologies for domestic goods can be used for exports production and since goodwill of a firm will spill over across markets, a firm with substantial domestic sales faces lower entry costs than a firm with no experience in the domestic market. In other words, firms with large home market base benefit from scope economies in expanding exports and firms with larger initial export may find it more difficult to increase their already saturated exports.[39] Once it enters the foreign market, a firm with no home-market base tends to stick to exports even under drastic currency appreciation because it has nowhere to retreat. Put another way, firms highly depending on exports have higher "stake" in exports because it will be quite difficult for them to resume export operation once they loose their position in the foreign market.

Then, if we consider the case where the export expansion costs of a firm increases with its export dependence, then, our adjustment cost model predicts higher export level under currency appreciation for firms with higher initial export dependence because of their higher export adjustment costs. However, the

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[39] One reserve should follow the *average* adjustment costs might be decreasing for some range of exports, especially at low level. This is because there could be *fixed* costs in export adjustments in addition to the variable costs "b". It seems quite common to assume either fixed or variable adjustment costs but not both. Hamermesh (1989) analyzes the structure of labor adjustment costs in the case of U.S. manufacturing plants by switching regressions allowing both fixed and variable adjustment costs and concludes that fixed portion of adjustment costs is large.

discussion of deep-pocket effect tells us that the very firms whose financial constraints are binding are likely to be those highly export-dependent firms. Hence, if this deep-pocket effect is actually strong, the relevancy of our model will be limited for the firms with binding financial constraints.[40]

Let us briefly formalize the deep-pocket argument within our framework of the theory section. By explicitly introducing the constraint to dynamic optimization, a firm's behavior is expressed as

$$V_t = \max(\Pi x(e_t) + \Pi h) + \delta E_t(V_{t+1}) + \eta_t (\Pi x(e_t) + \Pi h - \Pi) \qquad (14)$$

where η is the Lagrange multiplier for the financing constraint. Suffixes h and x denote home sales and exports. Since the home market profit does not directly depend on exchange rate by assumption[41], the financial constraint is less likely to bind under currency appreciation for those firms with low export dependence.

After similar manipulations in section 2.2., we obtain the counterpart of (11) by[42]

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[40] If increasing returns in export expansion are significant, firms with higher export dependence will face lower export expansion costs and reduce exports more and are less likely to have binding financial constraints. Then, the prediction of our adjustment cost model will not be erased, but rather strengthened. Therefore, to check the relevancy of our adjustment cost model, all that we have to test is the case of increasing marginal export expansion costs.

[41] This assumption itself is worth examining independently. Intuitively, in the macroeconomy highly depending on exports, home sales should also drop after currency appreciation due to the fall in income in exporting industries. In general equilibrium, on the other hand, currency appreciation is beneficial for all sectors including exporters through falling price of imported materials.

[42] Here, we assume that the financial constraint can be binding only in the currency appreciation state.

$$q - \alpha([c - \delta\lambda b/(1+\eta)] /e)^{-\theta} \tag{15}$$

If the financing constraint is not binding $(\eta = 0)$, (15) coincides with the previously obtained dynamic export choice (11) $[q - \alpha((c-\delta\lambda b)/e)^{-\theta}]$. On the other hand, if the constraint is binding, the export quantity (q) is smaller than the level determined by (11) because $\eta > 0$. Thus, the equality (15) implies that firms who face financing problem by export decrease due to currency appreciation have to keep higher profitability by abandoning higher export level which is dynamically optimal (11). Since η can be interpreted as the marginal value of the financial constraint, (15) means that the export reduction gets larger as the financial problem becomes severer.[43]

Then, a firm with low initial export dependence can support high export during exchange rate appreciation, while a firm heavily depending on export sales has to reduce exports more because the firm is more likely to face binding financial constraint.

3.3. Description of the data

This section describes the data which we employ in the empirical study The appendix to Chapter Three will provide additional explanations about them in detail.

The firms we will investigate in this chapter are those firms which operated any export business before the yen appreciation triggered by the G5-Plaza accord

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[43] η is equal to the extra profit which would result from the relaxation of the constraint by one unit. In other words, if the financial constraint were relaxed by one unit, a firm could keep export higher and, as a result, the profit of the firm would rise by η. Then, the tighter the constraint, the larger η, and the smaller "q" in (15).

in 1985 in the sixteen export-oriented manufacturing industries (of which the definition will be in the appendix). By restricting our attention to export-oriented industries, we can examine the variations among firms within each industry. As a result, 309 exporting companies are collected as our sample. Table 1 shows our industrial classification with distribution of firms to each industry.

The available data for us are the total sales value, or revenue level (in million yen) and the export ratio "R" (%) defined as the share of export sales values in the total sales values:

$$R = P_x Q_x / (P_x Q_x + P_h Q_h)$$ (16)

The higher export ratio of a firm before exchange rate appreciation means that the firm is more vulnerable to the appreciation. To check the robustness, we will report the results both in terms of export ratio (R) and export revenue level $(P_x Q_x)$ [44]

Table 2 summarizes the basic statistics for all 309 firms combined.[45] As expected, both the export level and export ratio decline after the yen appreciation. However, the rate of reduction is quite small. 14.6% in export ratio, 0.2% in export level while the yen exchange rate appreciated almost double (from 250 to 125 yen/dollar). As is suggested by large standard errors, the cross-sectional variations are so substantial that we should not satisfy with statistics at

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[44] The export ratio R may not be a good measure of firm's "dependence" on (or "burden" of) exports in some cases. A high export ratio before currency appreciation could be consistent with high export profitability during appreciation, for example, when a firm can charge high export price due to inelastic demand or to non-price competitiveness based on product differentiation. In another case, low initial export ratio could merely be a reflection of low competitiveness of the firm in the export market irrespective of currency depreciation and, then, this firm could be severely further damaged by currency appreciation if its home-market demand is not strong.

[45] Although the data are available on quarterly basis, we will concentrate on the cross-sectional variations rather than constructing the panel data set because the export ratio of most firms changes only gradually over time in the exchange rate adjustment process during the late 1980s.

this aggregate level. Therefore, in the next section, we will analyze this data by dividing into industries or into subgroups based on financial relations.

3.4. Empirical results

As was studied in Section 2, the i-th firm chooses its export quantity during currency appreciation by

$$q_i = \alpha((c-\delta\lambda b_i)/\underline{e})^{-\theta} \qquad (11)'$$

If the export adjustment costs are zero, one percent appreciation brings about θ percent export reduction for all firms (at least for all firms in the same industry). However, if the export adjustment costs differ across firms, export reduction rate is lower for firms with higher adjustment costs as long as the financial constraint is not binding. In this section, we will examine the cross-section data of firm-level export adjustments by various descriptive statistics approaches.

3.4.1. Concentration in industry

The most straightforward question will be in the industrial organization context: the change in concentration or who exits earlier, larger firm or smaller firm? Table 3 reports the concentration index of each industry before the yen appreciation and its change rate (%) compared with after the appreciation. Here, we measure the concentration in an industry by the most standard index: Herfindahl index, or the squared sum of each firm's export market share.[16]

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[16] We will focus on the change, not on the absolute level of the concentration index because we have calculated it by using our sample of firms which exclude companies *not* listed on the First Section of the Japanese stock markets.

Exactly speaking, we should consider the effect of exits on the concentration changes. In other words, we should have reported the concentration index for limited cohort of surviving firms, as Lieberman (1990) pointed out. However, since only four

If we look at the concentration in all 309 firms combined, it declines by 1.8% after the appreciation, as Doi (1991) find in his study of top-50 firm concentration ratio at aggregate level. However, it is too early to conclude that larger firms have strategic liability under declining demand because changes in concentration index substantially differ across industries so that aggregate level concentration is almost meaningless. Concentration should be discussed within relevant range of well-defined industry.

Actually, in ten out of sixteen industries, the concentration rises after the yen appreciation. Among them, rising concentration is observed in the textiles industry where export reduction is enormous. Although the automobiles industry which occupies major share in Japan's total exports decreases its concentration, this may be due to this industry's specific factor: the surge of overseas production mainly led by larger firms. Therefore, we cannot support the hypothesis that larger firms reduce exports more during currency appreciation.

We need to analyze the data from another perspective because the concentration index can rise either by expansion of larger firms or by shrinkage of smaller firms.[47] Since some of the firms expand export scale amid the drastic currency appreciation in our case, distinguishing these two possibility will be important. Hence, we classify firms by export reduction rate *and* initial firm size in the export market. The industrial classification will be added as the third dimension.

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out of 309 firms exit in our case, this effect is negligible. If we calculate the concentration for only surviving firms, its change rate will be revised to +12.41% (textiles), -9.14% (auto), -9.06% (miscellaneous), -1.81% (all industries).

[47] Lieberman (1990) finds the cause of the increased concentration index in the chemical industries is exits of smaller producers, not increased firm-size variations among surviving firms.

3.4.2. Distribution of firms and industrial differences

Table 4A reports the export reduction rate (%) of 309 firms with their initial export level.[48] Table 4B reports the export *ratio* reduction rate(%).[49] Tables 5A and 5B are the counterparts of Tables 4A and 4B at industry level. Export revenue levels (in yen terms) are standardized (mean = 10) to make comparison easier.[50]

First, as Tables 4A and 4B show, all the firms who exited from export market are small (only one percent of average export level) and with quite low initial export ratio (2.25% compared with 25.58% (average)).[51] Their small size may imply some kind of increasing returns in export operations. Their low export dependence is consistent with our adjustment cost model in that stronger home-market base (relative to the export) lowers export expansion costs.

Exiting firms are small and with low initial export dependence even by each industry's standard, as is clear from Tables 5A and 5B. Textile firms are generally smaller than automobile firms but exiting firms in both industries are the same relative size in each industry (one percent of the industry average).

These interpretations cannot be exaggerated because the number of exiting firms is only four even if all sixteen industries are combined. This may be a result of high expectations about exchange rate reversion to yen depreciation

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[48] The mean of export reduction rate is 39% for firms not increasing exports and 0.2% for all firms. Therefore, we choose 0% and 40% as threshold levels in classifying firms

[49] The mean of export ratio reduction rate is 32% for firms reducing export ratio and 15% for all firms. Hence, we choose 15% and 32% as threshold levels

[50] If the export level figure in the tables is larger than one, the firm's export revenue is larger than average of the industry

[51] This is a common finding. For example, Lieberman (1990) and Dunne et al (1988) also find that smaller firms exit at disproportionately higher rate

(strong perception that ongoing yen appreciation is temporary) Or one could argue that the observation of few exits may rather be consistent with the sunk entry/exit cost model [52]

Second, Table 4B reports that the export ratio reduction rate decreases with initial export ratio for firms reducing their export ratios. Similar observation is found in export level in Table 4A. If the export expansion costs increase with export size or export dependence of a firm, then, these observations of export divergence are predicted by our dynamic adjustment model because larger export or higher export dependence means higher stake for an exporting firm. As a result, export size or export dependence of firms diverges after yen appreciation, although, at the aggregate level, this trend is partly canceled out by expanding firms which started from low export level (or dependence) before the appreciation.

After disaggregation in Tables 5A and 5B, e.,uₗt ratio divergence across firms is observed in many industries although the industrial machinery industry seems far from it. Export level divergence is not found in the industrial machinery and electric machinery industries.[53]

Finally, in Table 4A, those who expand their exports against the drastic yen appreciation are firms smaller than average (17% below the average export

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[52] The firms who kept their export ratio unchanged have quite low initial export ratio (9.76%). This may imply the existence of lower limit on the export ratio due to fixed cost for establishing export operation section within a firm but there remains a doubt whether export *ratio* (not export sales or quantity) is a control variable for a firm and industrial variations are huge

[53] Lieberman (1990) finds "a strong trend" toward firm-size convergence in declining chemical products due to exits of small firms and disproportionate shrinkage of large firms

level). Table 4B shows that firms raising export ratio have initial export ratio lower than average (18.6% < 25.6%). By studying the micro-disaggregated firm-level data, we can discriminate two scenarios both of which could be consistent with declining aggregate concentration . "large firms' withdrawal" v.s. "withdrawal or exit by some small firms coupled with disproportionate expansion by other small firms". Our evidence clearly supports the latter. Assuming that all firms reduce their exports is oversimplification even for our case of drastic currency appreciation because some firms (typically small) could increase export due to particular demand growth for their products, technological breakthrough or catching the market niche in product differentiation space.

The wide variation or less stability of small firms is also consistent with the observation by Dunne, Roberts, and Samuelson (1988) about U.S. manufacturing industries. Firms with initial export level lower than average are likely to be divided into two groups who reduce export drastically (more than 60% or even complete exit) and who expand export against currency appreciation, while all the large firms tend to reduce export at relatively modest pace. We can also see this by changes in the standard deviation of export levels among firms before and after the yen appreciation as follows:

[Change in the standard deviation of firm's export level]

| [among large firms] | -11.06 % |
| [among small firms] | +8.25 % |

where the threshold for "large/small" is the mean of export revenue level before the appreciation. During the currency appreciation, large firms became more alike while small firms traced divergent paths one another

At industry level, too, export-expanding firms are smaller than average in most of the industries, although the dominant firms further raise their share in the

precision machinery industry. Firms raising export ratio have low initial export ratio in all industries in the Table 5B.

Since substantial industrial variations are rather natural, we should contend ourselves without generalization. At least what becomes clear is that assuming constant export reduction rate for all firms is an oversimplification even within an industry. A drastic exchange rate change brings about drastic change not only in aggregate export level but also in market structure of each industry. Dominant firms further raise their market share in some industries, while the deviation of market shares among firms gets narrowed in other industries. Firms highly depending on export are reluctant to reduce export in some industries, while the initial difference in export ratio diminishes in other industries. Discrimination of various hypothesis about adjustment costs will be possible only after extensive studies of narrowly-defined industry possibly by case studies.[54]

3.4.3. Effects of financial affiliations

Following Hoshi, Kashyap and Scharfstein (1991) about the effect of financing constraint on corporate investment, we can test our constraints by dividing the entire sample into subsets of firms and assuming that the constraint is binding for firms in one subsample but not for those in the others. As Hoshi et. al did, Japanese firms are expected to provide a good sample in this regard because firms affiliated with "Keiretsu" (industrial group) keep close tie with the member

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[54] Harrigan (1980) is an example of industrial case studies of exits from seven U.S. declining industries, each of which is chosen from her category of industries (based on concentration, product differentiation, and exit barriers). Among the industries she studied, the baby-food industry case might be instructive for us because the considerable gap between actual outcome and expectations (forecasts about future birth rates after a sudden birth decline in the late 1950s) dictated exits from the once-profitable oligopolistic industry

bank of the group and can avoid being exposed to the capital market imperfection.[55] Then, we can assume that financing constraints can be binding for "independent" firms but not for "Keiretsu-affiliated" firms, which in turn implies that the high export dependence means high burden during the exchange rate appreciation only for independent firms.[56]

Table 6 compares the subgroups of firms in their export adjustment behaviors.

Within "big firms" (firms with higher stock aggregate values), the effect of financial affiliation is significant. The export ratio reduction rate rises as a firm's financial viability gets stronger. While Keiretsu-affiliated big firms and independent big firms have about the same level of export dependence before the yen appreciation, Keiretsu-affiliated big firms reduce their export ratio more than independent big firms do. This result holds true even if we include "other big firms" (firms neither classified as Keiretsu-affiliated nor independent) between these two subgroups. This observation is consistent with our dynamic adjustment cost model in that Keiretsu-affiliated firms do not have to keep high level of exports during currency appreciation because their strong ties with financial institutions may decrease adjustment costs which will be required for the future export expansion.

Within small firms, however, similar evidence is not clear because "other (quasi-affiliated) firms" are the outlier. In terms of export level, a test of our

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[55] The detailed definition of our sample separation which follows Hoshi et al (1991) will be found in the appendix

[56] When panel data are available, another approach could be taken. We can estimate directly the Euler equation of dynamic export decision of a firm with/without financing constraint by instrumental variable method. See, for example, Whited (1990) studying the effect of liquidity constraints on corporate investment.

prediction about export reduction pattern is difficult because many firms actually expand their export size during the yen appreciation.

Next, we will move from the comparison between subgroups to the comparison of firms within each subgroup

Tables 7A and 7B report the export reduction rate and export ratio reduction rate for independent small fir s and other firms. The independent small firms are ex-ante regarded to be the firms who are exposed (or vulnerable) to the capital market imperfection Therefore, we expect significant deep-pocket effect only for independent small firms Figures 3A and 3B graphically illustrate the same results by scatterplots

Table 7A shows that, within independent small firms, larger firms reduce exports more; the average of initial export levels of firms reducing exports by more than 40% is twice as large as that of firms reducing by less than 40% (1.26 > 0.69) The same table shows that the opposite is true for other firms: larger firms reduce exports less This implies that the expectation-stake effect works for all firms but the deep-pocket effect clearly dominates it for independent small firms.

As for the export ratio, Table 7B reports consistent evidence Within other firms, firms with high initial export ratio tend to reduce export ratio only a little, while, within independent small firms, firms nearly keeping their initial export ratio are likely to be relatively less export-dependent The initial export ratio of other firms reducing their ratio by less than 20% is about twice as high as that of independent small firms in the same category (42 9 > 21 4), although the overall average and the average of other categories are almost the same between these two groups of firms

Combining these observations, we have confirmed the theoretical prediction about the deep-pocket effect. Our prediction goes like the following: For those firms which are presumably rather free from capital market monitoring because of their affiliation with Keiretsu banks, larger firms or more highly export-dependent firms can keep their exports higher during yen appreciation without being forced by financing problems. On the other hand, within independent small firms, since the deep-pocket effect may dominate or partly offset the expectation-stake effect, larger firms or more highly export-dependent firms are forced to reduce exports more because of their higher sensitivity to liquidity or to loss from export operation.[57]

4. Conclusions

A dynamic model of export decisions under exchange rate changes has been constructed and cross-sectional variations of export adjustments across firms have been examined.

First, the case where entry costs retard exit decisions has been considered. By assuming a two-state Markov process, our model concludes that the reason for the persistent exports after the exchange rate appreciation can be found in the high costs of export expansion (not reduction) and in their high expectations about future recovery possibility (anticipating current appreciation to be temporary).

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[57] Within our 309 firms, three out of four exiting firms are independent firms. Out of three firms reducing export sales more than 80%, two firms are Keiretsu-affiliated. This evidence is consistent with the result about deep-pocket effect because the financial availability will determine which firm at the edge of the market to finally exit.

Our dynamic export adjustment model makes more explicit the expectation effect of entry costs on exits already predicted by the sunk entry/exit cost model under Brownian motion assumption.

Second, the effect of dynamic evolution of expectations over time upon export decision has been studied. During drastic exchange rate adjustment process, export decisions are likely to be strongly dictated by quickly updated expectations about future exchange rates (e.g. anticipated persistence of current exchange rate). Dynamic changes in expectations substantially alter the dynamic patterns of export level and, as a result, those of exchange rate pass-through of Japanese industries in the late 1980s.

Third, the cross-sectional variations of export adjustments among firms have been examined. The statistics of actual observation from 309 Japanese firms have been summarized. The individual firm-level data could enrich the previous representative firm model of entry/exit decisions. As was found in industrial organization studies of domestic cases, exiting firms are small in size and the variation of exports across firms are large within small firms. The market structure of each export industry drastically changes after the appreciation and the concentration rises in many industries, although industrial variations are enormous and the aggregate concentration declines.

Finally, the case where firms may face financial constraint under capital market imperfection has been considered to formalize the conventional wisdom that firms with strong home-market base tend to keep high exports during currency appreciation. Then, firms with large domestic sales, which are stable even under exchange rate fluctuations, can sustain loss from keeping high export during appreciation. We find evidence consistent with the deep-pocket effect by splitting firms depending on firm's affiliations with Keiretsu groups.

Although the extensions such as assuming more realistic stochastic processes will enrich the theoretical contents of this chapter, our model has yielded valuable insights about the roles of firm-specific expected adjustment costs in dynamic export decisions. Investigations of more episodes of export adjustments ,especially with panel data in hand, should follow to cement the validity of our model. Since some of the results obtained here can also be explained by the previous other models, explicit formal tests discriminating them will be desirable. The most difficult task left for future work will be, however, the explicit aggregation of our microeconomic model distinguishing idiosyncratic shocks from firm-specific adjustment costs

Appendix

Japan Company Handbook (Toyo Keizai Inc., Tokyo; quarterly publication written in English) contains financial and sales information on all 1194 Japanese companies listed on the First Section of the Tokyo, Osaka and Nagoya stock exchange. We employ this data set for the basis of our study.

1. Industrial classification

The firms we investigate in this chapter are the firms which operated any export businesses in the manufacturing industry where the export ratio of at least one firm exceeds 50% before the yen appreciation.

Industrial classifications are shown in Table 1. The corresponding code number of *Japan Company Handbook* are in parentheses.

2. Exports

The export ratio (%) and total revenue (sales) of each firm "before" the yen appreciation are taken as the values at the time of the autumn of 1984 and those "after" the appreciation are the autumn of 1988. Exact timing (month) reported as "autumn" may slightly differ across firms. (Source : *Japan Company Handbook* Spring issue of 1985 and Spring issue of 1989)

3. Keiretsu/Independence

Following Hoshi, Kashyap,and Scharfstein(1991), we classify all firms into three categories depending on their relations with financial institutions. Main source of information about firms of our study are *Nihon no Kigyo Shudan* (Japanese Enterprise Groups, vol 1 - 7, Sangyo-Doko Chosa-kai, Tokyo, published in Japanese)

The corporate groups, most of which have their origin in pre-war "Zaibatsu",
play a key role in defining the firm's vulnerability in financing. Six largest
industrial groups which are usually recognized and which we use in our
definition are Mitsubishi, Mitsui, Sumitomo, Fuyo(Fuji), Sanwa, and Daichi-Kangyo.

The definition of "Keiretsu-affiliated" firms is given by the following:

--- The member bank of the group should be the biggest lender to the firm.

or

--- The shareholdings within the group must exceed 20 %.

or

--- The member bank should be lending more than 40 % of the firm's total
debt.

and

--- The firm must experience no merger or separation with other firms. The
firm must not change the affiliation to the group during sample period.

If the firm satisfy none of the above, and if the firm is *not* a member of a
group's President's Council which is rather prestigious, the firm is classified as
"independent". Firms which are not classified as either Keiretsu-affiliated or
independent are classified as "other firms." These "other firms" could be called as
"quasi Keiretsu-affiliated firms" which are supposed to possess characteristics
between Keiretsu-affiliated firms and independent firms.

The current aggregate value of the firm is also made use of in classifying
firms. The threshold level of the stock value is 100 billion yen. (Source , *Japan
Company Handbook*)

Thus, we classified all 309 firms into six subgroups: Keiretsu-affiliated big
firms, Keiretsu-affiliated small firms, other big firms, other small firms,

independent big firms, and independent small firms. The distribution of firms
across these six categories is shown in Table 6.

TABLE 1   INDUSTRIAL CLASSIFICATION

INDUSTRY	NUMBER OF FIRMS	(CODE No.)
A. TEXTILES	36	(No. 3002 - 3580)
B. DIESEL ENGINES	3	(No. 6011 - 6041)
C. MACHINE TOOLS	13	(No. 6101 - 6141)
D. INDUSTRIAL MACHINERY	48	(No. 6201 - 6407)
E. MISCELLANEOUS MACHINERY & PARTS	18	(No. 6436 - 6498)
F. HEAVY ELECTRIC MACHINERY	22	(No. 6501 - 6645)
G. COMMUNICATIONS EQUIPMENT	12	(No. 6701 - 6751)
H. CONSUMER ELECTRONICS & PARTS	35	(No. 6752 - 6814)
I. MEASURING INSTRUMENTS	10	(No. 6841 - 6859)
J. MISCELLANEOUS ELECTRIC MACHINES	28	(No. 6901 - 6999)
K. SHIPBUILDING	8	(No. 7003 - 7020)
L. ROLLING STOCK	6	(No. 7201 - 7282)
M. AUTOMOBILES & TRUCKS	28	(No. 7201 - 7282)
N. BICYCLES	2	(No. 7305 - 7309)
O. PRECISION MACHINERY	20	(No. 7701 - 7769)
P. MISCELLANEOUS MANUFACTURING	20	(No. 7905 - 7999)
TOTAL	309	

(NOTE)

1. See Appendix 1. for the selection of industries and firms.

2. In Tables 5A and 5B, industries B - E are combined as "industrial machinery" and industries F - J are combined as "electric machinery."

TABLE 2   AGGREGATE STATISTICS

	MEAN	STD. ERROR	MINIMUM	MAXIMUM
EXPORT LEVEL (BEFORE)	77089	253680	143.26	2770600
EXPORT LEVEL (AFTER)	69254	225670	0.00	2408900
EXPORT LEVEL REDUCTION	0.00207	0.63632	-4.4576	1.00
EXPORT RATIO (BEFORE)	25.579	20.585	1.00	100.0
EXPORT RATIO (AFTER)	20.644	18.014	0.00	84.00
EXPORT RATIO REDUCTION	0.14564	0.43552	-2.50	1.00

(NOTES)

1. "Export level" is measured in terms of the export revenue. [100 million yen]

2. "Export ratio" is defined as the share of export in revenue. [%]

3. "Reduction" is defined as the rate $(z_0 - z_1)/z_0$ ("negative" = increase).

TABLE 3   CONCENTRATION IN INDUSTRIES

INDUSTRY	INITIAL CONCENTRATION	CHANGE IN CONCENTRATION
A Textiles	0 0884337	+12.59%
B. Diesel engines	0.487673	+10.63%
C. Machine tools	0 130162	+10.82%
D. Industrial machinery	0.146813	-21.14%
E. Miscel. machinery	0.116315	+3.37%
F. Heavy electric machine	0.269618	-2.84%
G. Communication equip	0.371203	-4.13%
H. Consumer electronics	0.122797	+20.05%
I. Measuring instruments	0.254817	-10.07%
J. Miscel. electric mach.	0 113642	+7.70%
K. Shipbuilding	0.204259	+19.88%
L. Rolling stock	0.417820	-29.88%
M. Automobiles & trucks	0.196603	-9.10%
N. Bicycles	0.768940	+17.14%
O. Precision Machinery	0.164160	+8.61%
P. Miscel. manufacturing	0 221076	+9.63%
16 industries combined	0.0381684	-1.78%

(NOTES)

1. The figures in the center column represent the sum of squared export market share of firms in each industry before the yen appreciation.

2. The figures in the right column are the change rate (%) of the concentration from before to after the yen appreciation.

3. See the appendix for the industrial classification

TABLE 4A

EXPORT CHANGE(%)	NUMBER OF FIRMS	INITIAL EXPORT LEVEL
100 (exit)	4	0.010
60 - 100	34	0.297
40 - 60	44	1.262
20 - 40	43	1.180
0 - 20	49	1.655
increasing export	135	0.826
TOTAL	309	1.000

(NOTE) "INITIAL EXPORT LEVEL" is the export revenue (pq, yen) before the yen appreciation relative to the average.

TABLE 4B

EXPORT RATIO CHANGE (%)	NUMBER OF FIRMS	INITIAL EXPORT RATIO (%)
100 (exit)	4	2.25
50 - 100	43	22.53
32 - 50	56	25.68
15 - 32	69	32.00
0 - 15	44	39.45
0	21	9.76
raising ratio	72	18.60
TOTAL	309	25.58

TABLE 5A

EXPORT CHANGE(%)	TEXTILES	INDUSTRIAL MACHINERY	ELECTRIC MACHINERY	AUTOMOBILE & TRUCKS	PRECISION MACHINERY
100	(2,001)	---	---	(1,001)	---
60 - 100	(7,045)	(12,089)	(6,027)	---	(2,015)
40 - 60	(9,095)	(11,069)	(14,093)	(3,230)	(2,012)
20 - 40	(11,162)	(13,226)	(12,181)	(3,023)	---
0 - 20	(5,125)	(13,098)	(18,141)	(5,216)	(3,079)
- 0	(2,006)	(33,065)	(57,079)	(16,060)	(13,132)
TOTAL	(36,100)	(82,100)	(107,100)	(28,100)	(20,100)

TABLE 5B

EXPORT RATIO CHANGE (%)	TEXTILES	INDUSTRIAL MACHINERY	ELECTRIC MACHINERY	AUTOMOBILE & TRUCKS	PRECISION MACHINERY
100	(2,30)	---	---	(1,20)	---
50 - 100	(5,158)	(14,256)	(12,207)	(1,140)	(3,183)
32 - 50	(14,135)	(16,262)	(12,346)	(6,307)	(2,175)
15 - 32	(10,252)	(19,323)	(27,360)	(3,213)	(2,375)
0 - 15	(1,70)	(9,211)	(19,392)	(8,450)	(7,550)
0	(3,37)	(2,250)	(10,128)	(2,45)	(1,10)
- 0	(1,20)	(22,171)	(27,185)	(7,123)	(5,390)
TOTAL	(36,150)	(82,242)	(107,281)	(28,257)	(20,373)

(NOTES) The figures in parentheses are (number of firms,
initial export revenue level (yen) relative to industry's average(TABLE 5A) or
initial export ratio (% TABLE 5B))

TABLE 6

SUBGROUP	NUMBER OF FIRMS	EXPORT LEVEL	EXPORT RATIO
KEIRETSU/BIG	43	(28.2, 6.83)	(29.9, 17.1)
OTHER/BIG	29	(17.0, -1.66)	(29.4, 10.8)
INDEPENDENT/BIG	59	(8.51, -17.2)	(31.0, 5.84)
KEIRETSU/SMALL	30	(0.98, 26.7)	(17.9, 33.6)
OTHER/SMALL	36	(1.33, -16.6)	(21.0, 0.83)
INDEPENDENT/SML	112	(0.89, 5.66)	(23.6, 18.5)
TOTAL	309	(6.93, 0.21)	(25.6, 14.6)

(NOTE) The figures in parentheses are

(initial value, reduction rate in percentage)

The initial export level is the revenue in terms of trillion yen and the initial export ratio is in percentage. (Negative reduction rate means "increases".) See the appendix for classification of firms.

TABLE 7A

EXPORT CHANGE(%)	INDEPENDENT SML FIRMS	OTHER FIRMS
100 (exit)	(3, 0.09)	(1, 0.01)
60 - 100	(18, 1.29)	(16, 0.31)
40 - 60	(12, 1.22)	(32, 1.12)
20 - 40	(17, 0.68)	(26, 1.26)
0 - 20	(15, 0.71)	(34, 1.56)
increasing export	(47, 1.10)	(88, 0.80)
TOTAL	(112, 1.00)	(197, 1.00)

TABLE 7B

EXPORT RATIO CHANGE(%)	INDEPENDENT SML FIRMS	OTHER FIRMS
100 (exit)	(3, 2.7)	(1, 1.0)
50 - 100	(22, 23.1)	(21, 21.9)
15 - 50	(44, 30.2)	(81, 28.6)
0 - 15	(7, 21.4)	(37, 42.9)
0	(8, 8.1)	(13, 10.8)
raising ratio	(28, 20.7)	(44, 17.3)
TOTAL	(112, 23.6)	(197, 26.7)

(NOTE)

Figures in parentheses are (number of firms, initial export revenue level relative to the subgroup's average (TABLE 7A) or initial export ratio (TABLE 7B)) See the appendix for the definition of "independent small firms."

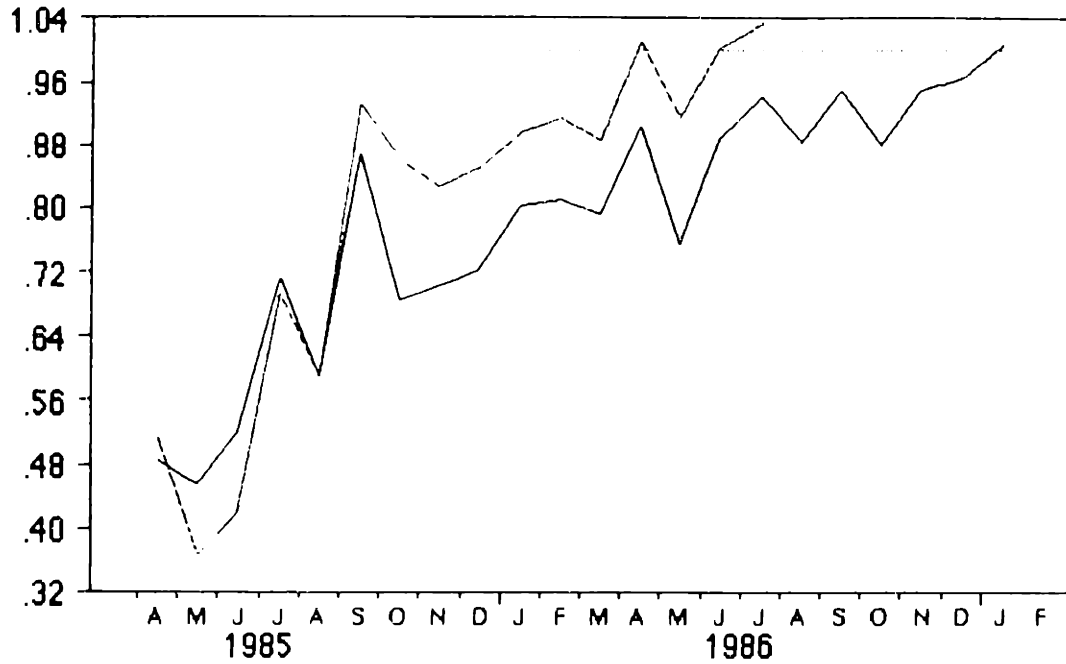FIGURE 1   EXPORT QUANTITY ADJUSTMENT (MACHINERY)

Δq/q (%)
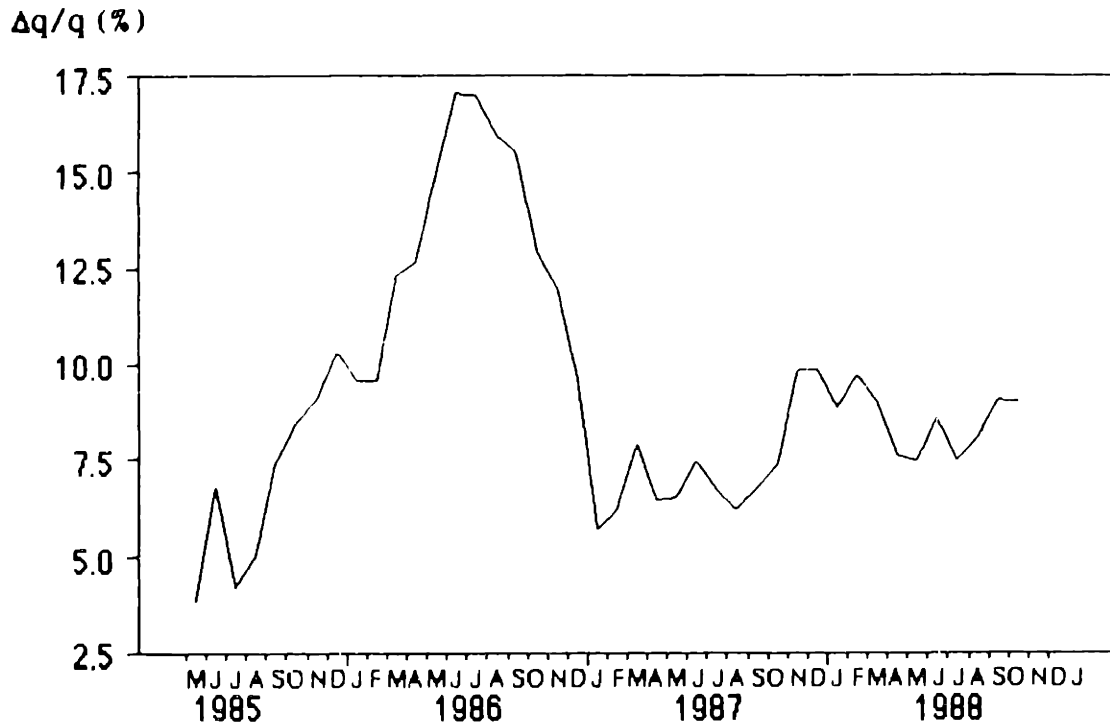
(NOTE)

Δq/q (%) = (actual export / estimated export) - 1

The "estimated export" is obtained by extrapolating (10) estimated over 1979:11 - 1985:1.

FIGURE 2   PASS-THROUGH ELASTICITY

(NOTE)

The thick line is the pass-through elasticity of the machinery industry and the dotted line is that of the textiles industry. The pass-through elasticity in each month is defined as the dollar export price change rate(%) divided by the exchange rate change rate(%) between the month and February 1985.
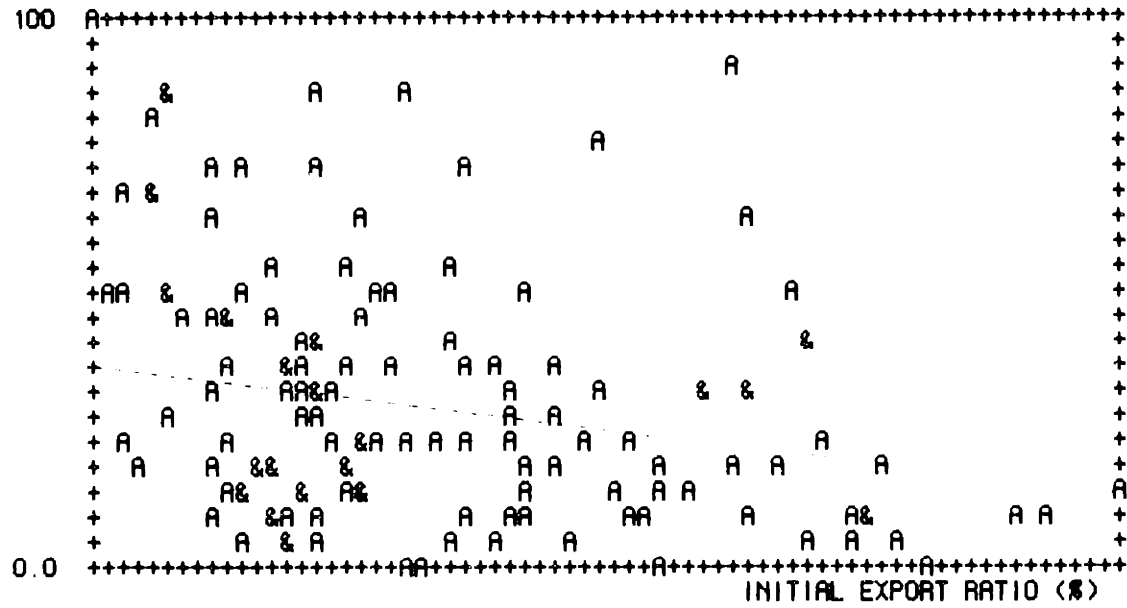
FIGURE 3A

[INDEPENDENT SMALL FIRMS]

[OTHER FIRMS]

FIGURE 39
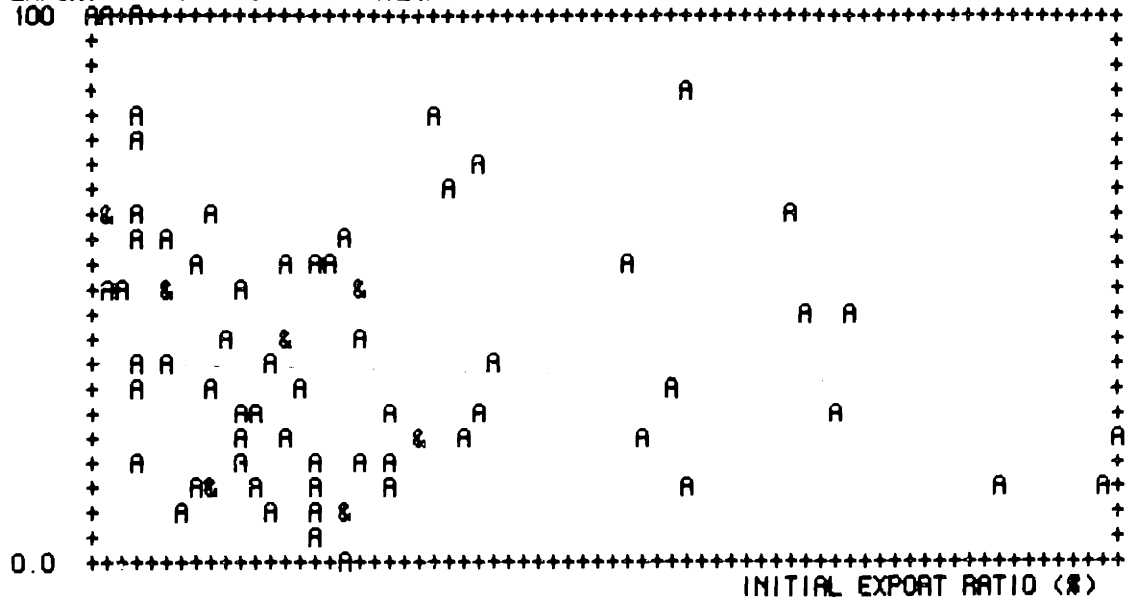
[INDEPENDET SMALL FIRMS]

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