

DYNAMIC AND STRATEGIC ISSUES OF INDUSTRIAL POLICY
ESSAYS FROM THE PERSPECTIVE OF JAPANESE EXPERIENCE

by

SADAO NAGAOKA

M. S. Management, MIT

(1980)

SUBMITTED TO THE DEPARTMENT OF ECONOMICS
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Doctor of Philosophy in Economics

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

January 1990

Copyright Sadao Nagaoka, 1990. All rights reserved.

The author hereby grants to MIT permission to reproduce and to distribute copies of this thesis document in whole or in part.

Signature of Author _____

Department of Economics
January 10, 1990

Certified by _____

Paul R. Krugman
Professor of Economics
Thesis Advisor

Accepted by _____

Peter Temin
Chairman, Departmental Graduate Committee
Department of Economics
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FEB 28 1990

LIBRARIES

ARCHIVES

DYNAMIC AND STRATEGIC ISSUES OF INDUSTRIAL POLICY
ESSAYS FROM THE PERSPECTIVE OF JAPANESE EXPERIENCE

by

SADAO NAGAOKA

Submitted to the Department of Economics on January 10, 1990, in partial fulfillment of the requirements for the Degree of Philosophy of Doctor in Economics.

ABSTRACT

Both theoretical and empirical investigations were carried out on the effects of industrial policy upon technical efficiency and welfare in the environment where technical progress plays an important role.

It is found that whether industrial policy restricting actual or potential degree of market competition positively affects technical efficiency depends upon the relative strength of strategic effect and market fragmentation effect of competition. If strategic effect dominates, industrial policy limiting competition reduces technological effort.

A small change in industrial policy can cause a large change in technological efforts, since it may cause a strategy switch between status-quo and undertaking large investment and among entry accommodation, entry deterrence and exit. Even if industrial policy intervention looks to be harmful to consumers' interest, it may in fact be Pareto-welfare improving when it strongly encourages technical progress.

Industrial policy in practice is often endogenous with respect to industry behavior due to various constraints faced by the government. One such constraint is dynamic inconsistency of the optimal intervention. Thus, industrial policy creates incentive distortion even if externality justifies policy intervention. It is found, however, that active domestic competition can reduce such distortion by diluting policy endogeneity as well as by creating a competitive threat that liberalization is forced due to better performance of competitors.

Japanese industry has achieved remarkable productivity improvement for the last three decades, which has been one major source for substantial real appreciation of Yen during this period. It is found, however, that each industrial sector, including its workers, has been unable to significantly appropriate the gain from its own technical progress. Technical progress in Japan has generated significant externalities. It is also found that the industrial subsectors targeted in the 1950s and 1960s did achieve above average total factor productivity growth, while the opposite conclusion holds for the agriculture sector of Japan.

Thesis Supervisor: Dr. Paul R. Krugman

Title : Professor of Economics

ACKNOWLEDGEMENT

I would like to deeply thank for invaluable guidance and encouragement provided by Professor Paul Krugman of MIT and by Associate Professor Kala Krishna of Harvard University.

TABLE OF CONTENTS

	Page
Introduction.	6
A. Objectives	6
B. Methodology and Analytical Framework	8
C. Outline and Major Findings	11
References	15
I. Competition, Strategic Effect and Technology Catchup	16
A. Introduction - Market Fragmentation Effect and Strategic Effect of Competition.	16
B. Domestic and Import Liberalizations in a Duopoly Model	23
C. Domestic Competition, Technology Catchup and Welfare in a N-firm Model	
Appendix	70
References	78
II. Temporary Protection and Technology Catchup.	80
A. Introduction - Potential Competition and Industry Behavior	80
B. Technology Catchup under Permanent and Temporary Protection.	83
C. Impact of Temporary Protection on Technical Efficiency	92
D. Impact of Temporary Protection on Welfare.	102
Appendix	110
References	121
III. Policy Endogeneity, Incentive Distortion and A Strategic Role of Domestic Competition	
A. Policy Endogeneity in Practice	122
B. Consequences of Policy Endogeneity	126

C.	Causes of Policy Endogeneity and Control Mechanism	132
D.	A Strategic Role of Domestic Competition in a Dynamic Framework	
E.	A Strategic Role of Domestic Competition in a Static Framework.	
	Appendix	174
	References	183
IV.	Productivity, Competitiveness and Industrial Policy of Japan .	185
A.	Introduction	185
B.	Productivity, Competitiveness and Real Exchange Rate	188
C.	Technical Change, Capital Accumulation and Productivity Growth	207
D.	Price Competitiveness and Trade Performance of the Manufacturing Sector	
E.	Technical Progress and Returns to Labor and Capital.	228
F.	An Assessment of Industrial Policy	238
	Data Appendix.	248
	Technical Appendix	251
	References	267

INTRODUCTION

A. Objective

The objective of this study is to examine some dynamic and strategic issues of industrial policy in the environment where technical progress is important. Specifically, major issues addressed in this study are the following:

- Is liberalization allowing more domestic and import competition beneficial to technical efficiency and welfare?
- Is temporary protection more conducive to technical efficiency and welfare than permanent protection?
- What is the implication of policy endogeneity on industrial policy? How can the distortion caused by policy endogeneity be controlled?
- How important technical progress has been in determining competitiveness and real exchange rate of Japan? Was industrial policy a success in terms of its effect on the economy-wide technical progress?

These issues are very important, since clearly the primary concern of industrial policy authorities in many countries is to achieve better industrial performance in terms of technical efficiency and productivity. In fact technical progress often accounts for a major part of the growth of those countries with successful development records.

Addressing these issues require both substantial theoretical and empirical work. First of all, existing theoretical literature does not pay

adequate attention on the linkage between industrial policy and technical progress in open economy. The rapidly growing international trade literature on strategic policy depends mostly on the static framework.^{1/} Most industrial organization literature on technology development has remained closed-economy focused. Consequently most diagnosis of industrial policies in practice done by economists remain incomplete and often unpersuasive, due to the absence of coherent theoretical framework. For an example, although there exist many empirical literature attempting to evaluate industrial policy experiences of Japan in the 1950s and 1960s, they often provide more puzzles than answers. Most fundamentally a logical explanation has not been offered for why Japan "succeeded," when in many developing countries similar industrial policies have led to dismal consequences? Existing literature sometimes do suggest seemingly persuasive answers: active domestic competition and temporary protection. But they do not provide consistent logical framework supporting these suggestions.

Furthermore, most existing empirical literature on productivity and competitiveness issue neglect to take a general equilibrium perspective. Consequently it has not been examined whether sectoral bias in productivity change, which has been substantial in the industrial sector of Japan and of successful developing countries, has caused real exchange rate change. It has been rarely addressed whether industrial policy has not just ended up in helping one sector at the expense of others. This study attempts to fill some of these gaps.

^{1/} Helpman and Krugman (1989, Chapter 9) identifies incorporating real dynamics into the analysis of trade policy under imperfect competition as one of the four main areas for future research.

B. Methodology and Analytical Framework

The study consists of the four distinct chapters, each of which addresses different theoretical or empirical issues. The first three chapters investigate theoretical issues of industrial policy, especially focusing on its effect on the development of industry with a substantial potential for cost reduction. The fourth chapter investigates empirically the performance of the Japanese industry and attempts to assess the impact of productivity change on real exchange rate as well as the impact of industrial policy on technical efficiency from a general equilibrium perspective.

(a) Theoretical Part

The major assumptions of the theoretical chapters are the following. First, competition is formulated as two stage game in most of the study. In the first stage enterprises compete in investment for cost reduction. In the second stage they compete in quantity or price. Since the main focus of this study is technical progress and investment in technology has a commitment value in product market competition, the above formulation seems to be the minimal analytical framework.

Second, Nash noncooperative sub-game perfect solution is used to characterize the market equilibrium. It is assumed that enterprises cannot sustain explicit nor tacit collusion. This assumption may be unsatisfactory for analyzing industry with a large potential of cost reduction, since cooperation among enterprises generate not only the standard monopoly rent but also the efficiency gain of avoiding duplicative investments in cost reduction. There may be a strong pressure for

cooperation and collusion in such industry. I simply leave this question open for future research.^{2/}

Third, in the first two chapters the government is assumed to set its policy before industry decides its investment. The government has the first mover advantage over industry. This assumption is very strong and its reality can be questioned. Often the government can act only after industry has committed its investment. Such timing structure may be even rational or dynamically consistent for the government with discretionary power for intervention. Therefore, the third paper investigates the implications of policy endogeneity.

Fourth, quantity competition and strategic substitutes are assumed for the second stage product market competition in most of the study. It has been known since Kreps and Scheinkman (1983) that quantity competition can be interpreted as a reduced form of the two-stage game where each enterprise chooses capacity in the first stage and engages in Bertrand price competition subject to capacity constraint in the second stage. Since the main theme of this study is technical progress and it is likely that investment for capacity expansion takes less time than investment for cost reduction, it seems to me that formulating the second stage competition as quantity competition seems to be a natural one.^{3/}

^{2/} Itoh (1988) offers an interesting interpretation of the behavior of the Japanese automobile industry before liberalization that competitive threat from foreign producers seems to have induced the Japanese automobile industries to avoid extreme price competition, which might have negatively affected their investments.

^{3/} If the foreign enterprise has no capacity constraint in supplying its good to the domestic market, import liberalization may trigger price competition. Such case is also considered in Chapter III (Section D).

Enterprises first compete in technology, then in capacity and finally in price. Although quantity competition can be compatible with strategic complement, the assumption of strategic substitute has a close relationship with the "stability" condition of the equilibrium under quantity competition.^{4/} In the case of duopoly the Hahn's condition is equivalent to the condition for strategic substitute. Therefore it seems to me that strategic substitute is a natural companion of quantity competition.

Fifth, the study focuses on domestic market competition. The main reason is that protection has been the main instrument of industrial policy in many countries. Adding competition in the export market is straight forward and most conclusions of this study will go through except for the welfare analysis. In fact the effects of policy on technical efficiency would be amplified by the presence of export market competition, if strategic substitute in export market is assumed.

Sixth, the study assumes that the unilateral action by the domestic government is feasible. Such action is often not feasible today since it invites countervailing actions by foreign governments, especially when it is taken by large developed countries. The consequences of reciprocal actions and the possibilities and limitations of international cooperative solutions are the subjects of future research.

(b) Empirical Part

The theoretical framework for empirical analysis is a monopolistic competition model. It is also assumed that industry determines price so

^{4/} It has to be noted, however, that the "stability" condition of the Nash equilibrium has not yet got real economic foundation.

that it has a constant markup over marginal cost. Although constant markup assumption is empirically questionable and theoretical models developed in this study also predict changing markup as industry improves its competitiveness, it is necessary for me to use this simpler framework due to various constraints including the availability of data.

The study also utilizes the standard growth accounting framework to estimate total factor productivity growth of each industrial subsector, except for the fact that it takes into account the possible divergence of price from marginal cost due to market power. The most fundamental assumption of this approach is constant returns to scale with respect to labor and capital. Although this assumption is still compatible with technological opportunities for cost reduction, the problem is that empirical data available does not easily allow the decomposition of labor and capital into those for production and those for cost reduction. In the empirical analysis I simply have to assume that all labor and capital reported for each period are used for production under constant return to scale for that period.

C. Outline and Major Findings

The first chapter analyzes the effect of competition on technology catchup and welfare. The government is assumed to affect the degree of market competition through entry and trade regulations. Section B focuses on the asymmetric equilibrium in a duopoly model, while Section C focuses on the symmetric equilibrium in a general N- firm oligopoly model. It is found that liberalization has a favorable effect on technical efficiency when strategic effect of competition dominates market fragmentation effect

of competition. It is also found that reducing tariff can cause a Pareto inferior change by increasing domestic price, especially when it causes a discrete decline in investment for cost reduction by the domestic enterprise due to nonconvexity of such investment.

The second chapter analyzes the effect of potential competition on technology catchup and welfare. The government is assumed to set the length of protection before the domestic enterprise invests. It is found that shortening protection has a favorable effect on technical efficiency, again if the strategic effect of increased competition dominates its market fragmentation effect. Quite independently from this it is found that shorter protection may induce a large jump in technological effort, since it may trigger a switch in the technology development strategy from entry accommodation to entry deterrence. It is also found that the tradeoff between static welfare effect and dynamic welfare effect of protection is neither absolute nor stable.

The third chapter analyzes the implication of policy endogeneity. The first three sections discuss the endogeneity of industrial policy in terms of its causes, consequences and countermeasures. The last two sections analyzes the role of domestic competition as a control mechanism. It is found that policy endogeneity can be caused by dynamic inconsistency of the optimal industrial policy. It is also found that domestic competition can substantially reduce the incentive distortion due to policy endogeneity by diluting its effect as well as by creating the competitive threat that liberalization is forced by the faster technological catchup of competitors.

The fourth chapter empirically analyzes the linkage between productivity, competitiveness and industrial policy of Japan. Section B analyzes the linkage between productivity and real exchange rate. It is confirmed that significantly faster productivity growth of the industrial sector of Japan over that of the USA has caused real appreciation of Yen in terms of broad price index. Section C analyzes the sources of productivity growth of the Japanese industry. It is also found that both the total factor productivity growth and rapid capital deepening have been significant contributing factors. It is also found that price and quantity measures of the total factor productivity growth yield similar results, suggesting relatively small markups by industries at least in the long run. Section D analyzes the linkage between price competitiveness and trade performance. It is found that the sectoral shift in price competitiveness has affected significantly the structural change of the trade and industry of Japan. Significant evidence has not been found for the view that the productivity performance biased in favor of high price elasticity sectors in Japan has caused the puzzling tendency for real appreciation of Yen even in terms of the price of industrial sector.

Section E of the fourth chapter analyzes the linkage between technical progress and factor returns. It is found that each industrial sector including its workers cannot significantly appropriate the gain from its own technical progress, implying that most gain are absorbed by price fall of that sector and the increase in factor returns in the economy as a whole. Section F attempts to make an assessment of industrial policy from the general equilibrium perspective. It is found that the industrial subsectors targeted in the 1950s and 1960s on average did achieve higher

total factor productivity growth and faster decline of their output prices, even measured relative to the performance of the U.S. industries. However, the opposite conclusion holds for the agriculture sector of Japan.

REFERENCES

- Helpman, E. and Krugman, P. (1989), Trade Policy and Market Structure, The MIT Press: Cambridge.
- Itoh M. (1988) "Growth Competition in Greenhouse: Impact of Industrial Policy," in Itami, H., Kagono, T., Kobayashi, T., Sakakibara, K., and Itoh, M. (1988), Competition and Innovation: Growth of the Japanese Automobile Industry, (In Japanese), Toyokeizai.
- Kreps D. V. and J. S. Scheinkman, (1983), Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes, Bell Journal of Economics 14, 2, 326-37.

CHAPTER I
COMPETITION, STRATEGIC EFFECT
AND TECHNOLOGY CATCHUP

A. Introduction - Market Fragmentation Effect
and Strategic Effect of Competition

It is widely believed among pro-reform policy makers and their economic advisors that competition is beneficial to technology development. For an example, the recent OECD report on structural adjustment and economic performance identifies competition as the first "golden rules for success" for industrial adjustment and policy after reviewing the experiences of major industrialized countries.^{1/} It is also conjectured that major "success" factors for the good technological performance of some East Asian economies especially Japan under the circumstance of import protection is active domestic competition in these economies.^{2/} Consequently, it is even suggested sometimes that domestic competition

^{1/} OECD (1987), Chapter 6.

^{2/} Balassa and Noland (1988) note that "One might ask how the Japanese steel and automobile industries could become internationally competitive in the context of protection from imports and from foreign investment, when in the developing countries protective measures have generally led to the establishment of high-cost industries. The answer to this question may lie in the fact that MITI promoted the simultaneous development of several firms; fostering competition among them...." (Chapter 2, p. 38)..

becomes more important in those developing countries where competition from import is heavily restricted.

Conventional theories, however, tend to offer opposite conclusions. In their influential paper Dasgupta and Stiglitz (1980) concluded that "If the number of firms is increased, each firm in equilibrium spends less on R&D, and so unit cost of production in equilibrium is higher" in their seminal paper analyzing the interlinkage between market structure and investment for cost reduction.^{3/} Within the same framework, it is conjectured by Tandon (1984) that free entry is generally harmful to both welfare and technical efficiency.^{4/}

Although it has been well known since Arrow (1962) that the competitive market structure can be more conducive to R&D than the monopolistic one due to the absence of incumbent rent, this Arrow effect applies more to drastic R&D (drastic meaning causing the shift of the market structure to monopoly) rather than to investments for cost reduction

^{3/} Dixit and Stern (1982) derived a concise formula linking the speed of cost reduction, the number of enterprises and concentration within the Dasgupta and Stiglitz framework (1980): The speed of cost reduction can be given by $-dc/dt = (kR/n)(1 - H/\epsilon)$ for the case of Cournot equilibrium, where c is the average industry cost, n the number of enterprises, R the value of industrial output, H Herfindahl index of concentration, and ϵ the elasticity of market demand. n affects R and H ($H = 1/n$ in the case of symmetric equilibrium). It is possible to show that $\partial/\partial n (-dc/dt) < 0$. Thus, a larger number of enterprises decelerates the speed of cost reduction.

^{4/} I prove this conjecture under very general conditions in the section C of this paper. Tandon (1984) compared numerically the technical efficiency and welfare of the free entry equilibrium and those of the optimal equilibrium with the number of entries being selected so as to conform to the national welfare maximization, by assuming specific functional forms for demand and cost reduction functions.

which continuously take place within the environment of a given market structure. The latter seems to be far more important in practice.

Krugman (1984) derived a result similar in spirit to that of Dasgupta and Stiglitz (1980) for an open economy. He has demonstrated that import protection can help industry achieve higher technical efficiency and thus can enhance its export, given such technological opportunities as scale economy, learning by doing and R&D.^{5/} His result has also been surprising and discomfoting to those many who believe in the virtue of competition.

The driving force for the above negative relation between competition and competitiveness is the market fragmentation effect of competition.^{6/} Higher domestic and foreign competition reduces the share of the market served by each enterprise and thus reduces the incentive for higher technical efficiency. This is because the profit which can be obtained by the enterprise from cost reduction is proportional to the output of that enterprise.

However, these theories ignore another aspect of competition: the possibility that higher competition strengthens strategic motive of the enterprises to undertake investment for higher technical efficiency (I call it as strategic effect of competition). It is important to consider this second aspect of competition, since the investment for higher technical

^{5/} Rodrik (1989) has also shown that import liberalization is inimical to technical progress of the liberalized sector.

^{6/} I prove the market fragmentation effect of competition under much general conditions than those assumed by Dasgupta and Stiglitz (1980) in the section E of the third Chapter (also see the section C of this Chapter). They assumed constant elasticity demand and constant elasticity cost-reducing functions in deriving this proposition.

efficiency generally has a commitment value to product market competition, in addition to its direct effect on cost saving. In fact casual observation suggests that one of the major motives for an enterprise to invest in technology is to secure its competitive position in the future product market competition. An enterprise successful in enhancing its technical efficiency can increase its market share at the expense of the others by aggressive capacity expansion and price undercutting. The monopoly enterprise protected from competition does not have this strategic motive for investment, so that it may well invest less than those enterprises competing among each other, even if it has a larger captive market.

There exists a large volume of industrial organization literature now, which has analyzed investment enhancing effect of competition especially in the context of R&D. In particular, Barzel (1968) in his seminal paper demonstrated that competition could cause excessive investment in R&D when the winner in the patent race could obtain the exclusive right on the patented technology. Brander and Spencer (1983) have demonstrated that strategic motive for cost-reducing investment increases the total amount of industrial R&D and can potentially improve welfare in the model of symmetric duopoly.^{7/} Similarly, Fudenberg and Tirole (1983) have demonstrated that strategic motive accelerates learning

^{7/} They have also demonstrated that the equilibrium under the strategic motive coincides with the second-best optimum (the optimum obtained under the constraint that market power in product market cannot be directly affected) when the two firms produce homogenous product under constant marginal cost for the linear market demand. This does not generalize to the case with more than two firms, however (See the section C.2 and the Appendix section 5).

by doing for the case of linear demand and linear learning. They (1986) have also demonstrated that competitive threat forces the incumbent monopolist to adopt technology more quickly than the timing optimal when such threat is absent.

However, the primary concerns of these literature have been the effect of patent system, the difference between precommitment and perfect equilibrium for a given market structure, and the existence of incentive bias for the innovation by either incumbent or entrant, and not the effect of industrial policy intervention on the market structure, in spite of its practical importance.^{8/} This paper attempts to analyze the effect of such a policy. In doing that, I evaluate the effects of competition on technical efficiency and welfare comprehensively, considering both market fragmentation effect and strategic effect of competition.

The structure of the game analyzed here is the following. In the stage 0 the government decides whether it allows an entry of either domestic or foreign enterprise in the industry which has been protected by the government entry and trade regulations.^{9/} In the stage 1 the enterprises which have opportunities to undertake cost-reducing investments decide their levels. We assume that these investments are sunk in the

^{8/} The governments in both developed and developing countries often intervene to regulate competition in industrial sectors through investment licensing, quota and other non-tariff barriers and regulation of foreign direct investment. One of their major objectives has been to create "national champion" enterprise to accelerate the national technology development in a certain sectors (See Flam (1988) for European industrial policy for computer industry as an example of such intervention).

^{9/} We reverse the order of the moves by the government and enterprises in Chapter 3.

stage 2 so that they have commitment values, while they cannot precommit their stage 2 output levels in the stage 1. In the stage 2 the enterprises compete among themselves in product market through their choices of outputs. We depend on the Nash equilibrium in determining market equilibrium.

The analysis consists of the two distinct parts. In the section B I analyze how import and domestic liberalizations affect technical efficiency and welfare in the simplest possible setup, in order to demonstrate the market fragmentation effect and the strategic effect of competition. I use a simple duopoly model with a linear demand and an exponential cost reduction function so that I can explicitly solve for the perfect equilibrium involved. I also discuss the possible asymmetry of the impacts of domestic and import liberalizations in developing countries.

The major findings of this section are the following:

- (1) Import liberalization (removal of ban or quota) can cause a positive technological response by the domestic enterprise, since strategic effect of import competition can dominate its market fragmentation effect. However, import liberalization in the sense of tariff reduction always cause the negative technological response by the domestic enterprise in this model.
- (2) Strategic effect of import competition provides a new and potentially most important case for tariff against quota. Tariff always induces higher technical efficiency. Tariff can also be Pareto superior to quota.
- (3) Stronger import competition (improved cost competitiveness of the foreign enterprise or reduction of tariff) can cause a

Pareto inferior change in the domestic economy. Paradoxically consumers can also get hurt, since stronger competition may have a disproportionately large negative effect on the competitiveness of the domestic enterprise, so that the market price can actually go up. Stronger import competition can worsen the existing distortion (i.e. underinvestment in technology) substantially, especially when the profit function of the domestic enterprise is nonconvex with respect to investment due to high initial cost.

- (4) Domestic liberalization can be still beneficial to technical efficiency even when import liberalization is harmful to it. They may have asymmetric effects on technical efficiency in developing countries.

In the section C I extend the analysis to N-firm competition but limit my focus to symmetric equilibrium and domestic competition. I analyze the effects of increased competition on technical efficiency and on welfare. The major findings of this section are the following:

- (1) Increased domestic competition (larger N) induces higher technical efficiency, if its strategic effect dominates its market fragmentation effect. It can even cause the expansion of the output of each enterprise.
- (2) If there exists no strategic effect, free entry results in both lower welfare and lower technical efficiency than those under the social optimum (I prove this proposition under fairly general conditions).

- (3) Given strategic effect, entry regulation can become counter-productive both to welfare and technical efficiency.

B. Domestic and Import Liberalizations
in a Duopoly Model

This section analyzes explicitly the impact of import and domestic liberalization within the framework of duopoly. A linear demand and an exponential cost reduction function are assumed. The objectives of the analysis are to evaluate the effect of liberalization both on technical efficiency and on welfare and to assess the potential difference between import and domestic liberalizations. I first analyze the investment decision of a monopoly enterprise protected from both domestic and foreign competition in the subsection 1, then analyzes the impact of import liberalization (i.e. liberalization of the entry of a foreign enterprise), and the impact of domestic liberalization (i.e. liberalization of the entry of a second domestic enterprise) respectively in the subsections 2 and 3, and finally discusses policy implications in the subsection 4.

1. A Domestic Monopoly Shielded
from Competition

This subsection presents the basic structure of the model and points out the possible nonconvexity of profit function. It also demonstrates that a monopoly enterprise not only produces less than the social optimum for a given technology but also underinvests in technology itself.

I assume a linear demand:

$$(1) \quad P(Q) = 1 - Q$$

I also assume production technology of constant marginal cost (C). The marginal cost however is assumed to decline exponentially as investment for cost reduction (k) increases:

$$(2) \quad C(k) = C_0 \exp(-vk),$$

where $C_0 (>0)$ is the marginal cost when no investment is done and $v (>0)$ represents the effectiveness of investment. It can be interpreted as the technological capability of the domestic enterprise. We have $C' < 0$ and $C'' > 0$.

The domestic monopoly enterprise determines the size of output and the level of cost-reducing investment, so as to maximize its profit $\pi(q;k)$:

$$(3) \quad \pi(q;k) = P(q)q - C(k)q - k.$$

Since the enterprise is shielded from competition, cost-reducing investment has no commitment value and the precommitment and perfect equilibrium coincide. The equilibrium output q_M for a given k or equivalently C is given by

$$(4) \quad \partial\pi/\partial q = 1 - 2q - C = 0$$

or

$$(4') \quad q_M = (1 - C/2)$$

The profit maximizing k (k_M) or equivalently C (C_M) is in turn determined by

$$(5) \quad \partial\pi/\partial k - (\partial C/\partial k)(\partial\pi/\partial C) - 1 = (\partial C/\partial k)(-q_M) - 1 = 0$$

by the envelope theorem, assuming the presence of the interior maximum and convexity of $f(k) = \pi(q(k), k)$. From equation (2), we get

$$\partial C/\partial k = -vC$$

Substituting this equation into equation (5), we get the following equation:

$$(6) \quad \begin{aligned} \partial\pi/\partial k &= -(v/2)C^2 + (v/2)C - 1 \\ &= -(v/2)(C^2 - C + 2/v) = 0 \end{aligned}$$

The profit maximizing solution to this equation is

$$(7) \quad C_M(v) = (1/2)\{1 - (1 - 8/v)^{0.5}\}$$

since the second order condition requires that

$$\begin{aligned} \partial^2\pi/\partial k^2 &= (\partial C/\partial k)(\partial/\partial C)(\partial\pi/\partial k) \\ &= (\partial C/\partial k) v (1/2 - C) < 0 \end{aligned}$$

or

$$C_M < 1/2$$

given that $\partial C/\partial k < 0$. It is clear from equation (7) that high v induces low C_M . If $v < 8$ or efficiency of cost reducing investment is very low, no investment takes place.

$f(k) = \pi(q(k); k)$ can be nonconvex, since

$$(8) \quad f''(k) = -(\partial^2 C/\partial k^2)q_M + (-\partial C/\partial k)(\partial q_M/\partial k)$$

becomes positive when the second positive term dominates the first term. In the current model it is clear from equation (8) that if $C_0 < \frac{1}{2}$, $f(k)$ is convex for $k \geq 0$, so that equation (5) does give the condition for the global maximum.

On the other hand if $C_0 > \frac{1}{2}$, $f(k)$ is concave for $k < k_*(C(k_*) = \frac{1}{2})$ and convex for $k > k_*$. In this case the enterprise generally has to compare $f(k=0)$ and $f(k_M)$, in order to get the global maximum, as illustrated in Figure 1. Nonconvexity of f implies that a small reduction in v can precipitate investment to zero, when it causes a switch from the interior local maximum k_M to another local maximum $k=0$.

Consequently investment for cost reduction can be lumpy. The intuition behind this is the following. Although the net profit from marginal investment by a high cost firm may be negative due to the small output to which cost reduction applies, discretely large investment by such

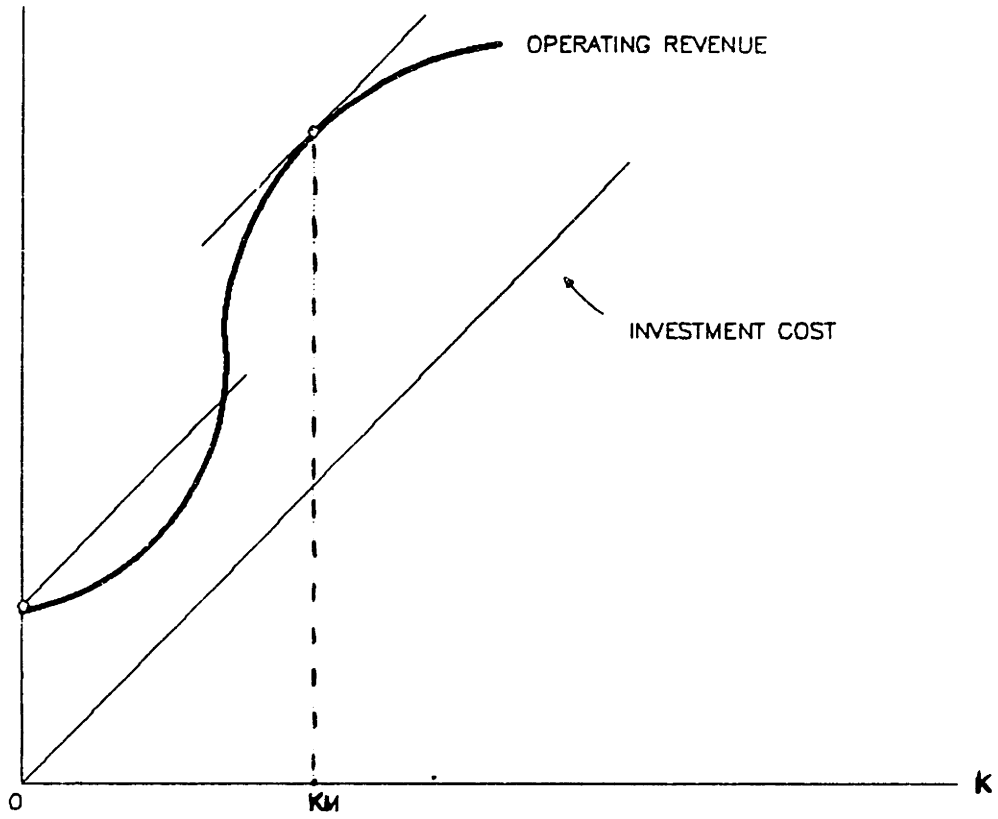


Figure 1: DETERMINATION OF THE COST-REDUCING INVESTMENT
($C_0 > \frac{1}{2}$)

firm can be still profitable since it enlarges the market served by the enterprise itself. There can be an increasing return from investment for cost reduction, so that a small parametric change can cause discrete changes in investment for cost reduction, output and price.

It is clear that the monopoly enterprise underinvests in technical progress, since it cannot appropriate the increase in consumers' surplus due to price fall. If we differentiate welfare $W^M(k)$ ¹⁰ (the sum of consumers' surplus CS and producers' surplus) at the monopoly level of investment we get the following:

$$(9) \quad \partial W^M / \partial k = \partial CS / \partial k + \partial \pi / \partial k = \partial CS / \partial k - (\partial CS / \partial q)(\partial q / \partial k) > 0$$

2. Impact of Import Liberalization

Import liberalization is assumed to cause the entry of a foreign enterprise either through its export or through its direct investment.¹¹ For simplicity we assume that technology of the foreign enterprise is exogenous to the equilibrium analyzed in this section. Specifically the marginal cost of the foreign enterprise is assumed to be a parameter. This

¹⁰/ The explicit formula for investment is given by

$$k_M = 1/V \log C_O / C_M = (1/V) \log [2C_O / (1 - (1 - 8/V)^{0.5})]$$

The welfare (W^M) is given by

$$\begin{aligned} W_M &= 1/2q_M^2 + (P - C_M)q_M - k_M \\ &= (3/32)(1 + (1 - 8/V)^{0.5})^2 (1/V) \log [2C_O / (1 - (1 - 8/V)^{0.5})] \end{aligned}$$

¹¹/ We use the term import liberalization for this specific policy change in this section, unless otherwise specified.

assumption is not critical to most points of this section and would be reasonable for most industries in developing countries in their catchup process.

The competition resulting from liberalization is assumed to take place through the following two stages: determination of the cost-reducing investment in the first stage and determination of output in the second stage. The Nash equilibrium of the second stage game is given by

$$(10) \quad q_D(C_D, C_F) = (1 - 2C_D + C_F)/3 \text{ and}$$

$$(11) \quad q_F(C_D, C_F) = (1 - 2C_F + C_D)/3$$

where q_D (q_F) is the output of the domestic (foreign) enterprise and C_D (C_F) is the marginal cost of the domestic (foreign) enterprise. The comparison with equation (4) suggests that competition reduces the output of the domestic enterprise (i.e., $q_D < q_M$) for a given level of production cost.^{12/}

In the first stage only the domestic enterprise has the option to undertake cost reducing investment by assumption. We assume the same cost-reducing function as equation (2). The enterprise determines its cost-reducing investment (k) so as to maximize

$$(12) \quad \pi_D(k_D) = (1 - q_D - q_F)q_D - C_D q_D - k_D$$

^{12/} $q_D - q_M = -q_F/2 < 0$ if $C_D = C_M$, given equation (11). This result is general and follows directly from the fact that the competition through quantity under the linear demand has the characteristic of strategic substitute.

subject to equations (10), (11) and

$$(13) \quad C_D = C_0 \exp(-v_D k_D)$$

We get

$$(14) \quad \partial \pi_D / \partial k_D = (\partial C_D / \partial k_D) \{-q_D + q_D (\partial P / \partial Q) (\partial q_F / \partial C_D)\} - 1$$

where $q_D (\partial P / \partial Q) (\partial q_F / \partial C_D) = -q_D / 3$ represents the strategic effect of cost reducing investment, while the first term in the bracket represents the direct effect of cost reduction. The comparison with equation (5) demonstrates that competition reduces the incentive for cost reduction by its market fragmentation effect ($q_D < q_M$) for a given k but increases it by creating the strategic motive ($q_D / 3 > 0$). The second effect can dominate the first effect as shown later.

If we assume the existence of the interior maximum and convexity of $\pi_D(k_D)$, we have the following equation determining k_D or equivalently C_D ¹³:

$$(15) \quad C_D^2 - (1 + C_F)C_D/2 + 9/(8v_D) = 0 \quad \text{or} \quad (2C_D - 1) + 9/(4v_D C_D) = C_F$$

The profit maximizing solution to this equation is

^{13/} A major implicit assumption is that the domestic enterprise accommodates the entry of the foreign enterprise. As is clear from figure 2, the domestic enterprise cannot deter the entry of the foreign enterprise, if $C_F < \frac{1}{2}$. We assume that this is the case. See the third paper for entry deterrence.

$$(16) \quad C_D = (1 + C_F)/4 - ((1 + C_F)^2/16 - 9/(8v_D))^{0.5}$$

since the second order condition for profit maximization requires that

$$(17) \quad \partial^2 \pi_D / \partial k_D^2 = \partial C_D / \partial k_D (4/9) v_D (1 + C_F - 4 C_D) < 0 \quad \text{or} \quad C_D < (1 + C_F)/4$$

given that $\partial C_D / \partial k_D < 0$.

Equation (16) tells us the following two key findings. First, higher efficiency of cost reducing investment (larger V_D) induces lower marginal cost of the domestic enterprise, as in the case of a domestic monopoly. If V_D is very large, $C_D \approx 0$ irrespective of C_F . Second, higher competitiveness of the foreign enterprise (i.e. lower C_F) prevents the domestic enterprise from achieving lower marginal cost. Stronger foreign competition limits the size of domestic market available to the domestic enterprise, so that the incentive for cost reduction becomes smaller, since both of the cost-reducing effect and the strategic effect are proportional to the size of the market served by the domestic enterprise, as shown in equation (14).

This negative effect becomes larger as C_F becomes smaller, since C_D is a convex function of C_F as is clear from equation (15) and (17). C_D as a function of C_F is illustrated in Figure 2. $-\partial C_D / \partial C_F$ can exceed one and can become infinitely large as C_F approaches $(18/v_D)^{0.5} - 1$, when $v_D < 18$. Furthermore, a marginal reduction in C_F can cause a discrete increase in C_D to C_0 as illustrated in Figure 2, when C_0 is relatively high. This is

because the profit function $\pi(k_D)$ becomes concave for small k_D when C_0 is relatively high, as is clear from equation (17).

The fact that stronger foreign competition reduces the technological effort of the domestic enterprise does not imply that the absence of foreign competition is most conducive to technical efficiency. If the domestic enterprise is completely shielded from foreign competition, it loses the strategic incentive for cost reduction completely and can become more reluctant to make investment than the enterprise exposed to competition. I then compare the incentive for cost reduction of the enterprise shielded from foreign competition (M for brevity) relative to the enterprise exposed to foreign competition (D for brevity) in the following.

We can rewrite equations (5) and (14) in the following manner.

$$(5') \quad MB^M = q^M = (1 - C)/2 = -1/(\partial C/\partial k) = 1/(vC) = MC$$

and

$$(14') \quad MB^D = (4/3)q^D = (4/9)(1 - 2C + C_F) = MC$$

where MB^M (MB^D) stands for the marginal benefit of cost reduction for the enterprise M(D) and MC for its marginal investment cost. Figures 3-A and 3-B show the two distinct possibilities for the relationship between MB^M and MB^D . If MB^D is located below MB^M for all relevant level of C as in Figure 3-A, we have $C_M < C_D$ for any v where C_M (C_D) is the level of

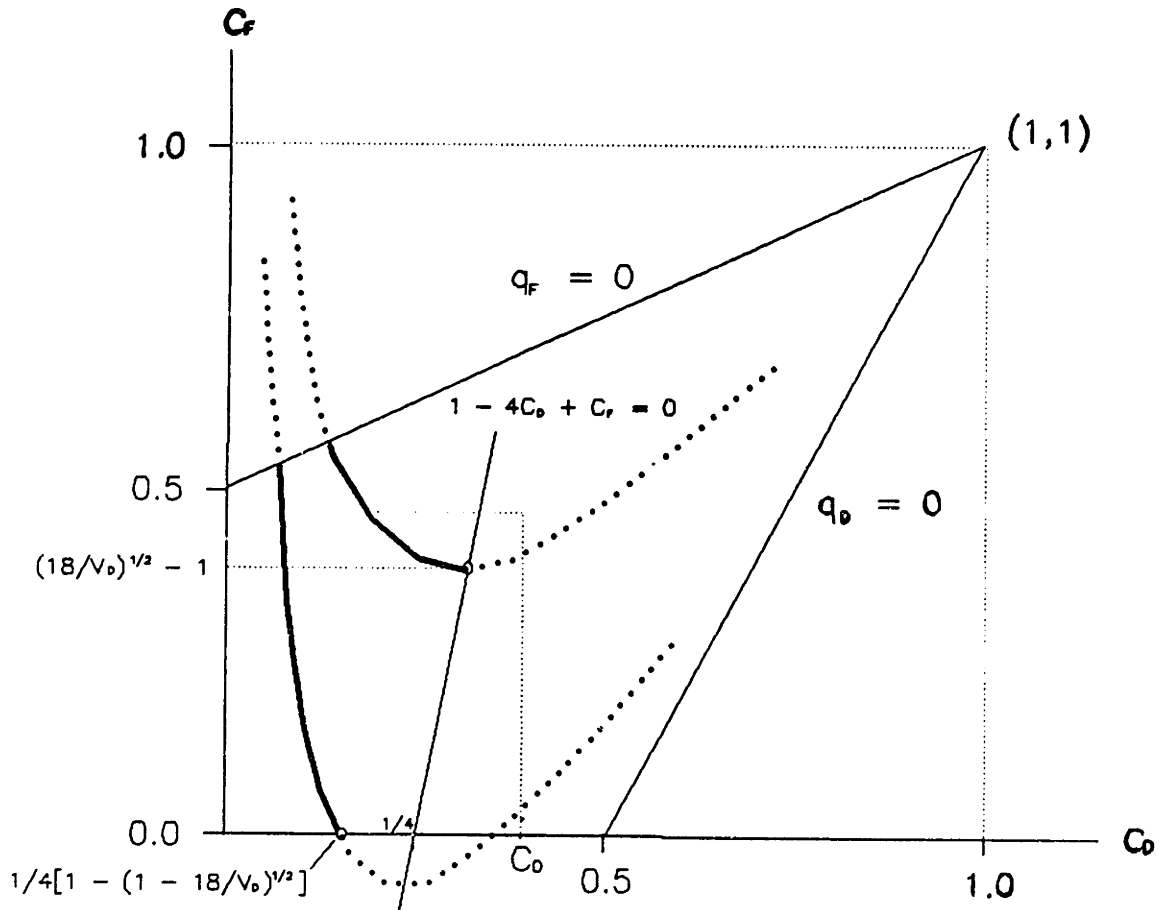


Figure 2: REACTION OF C_D TO C_F

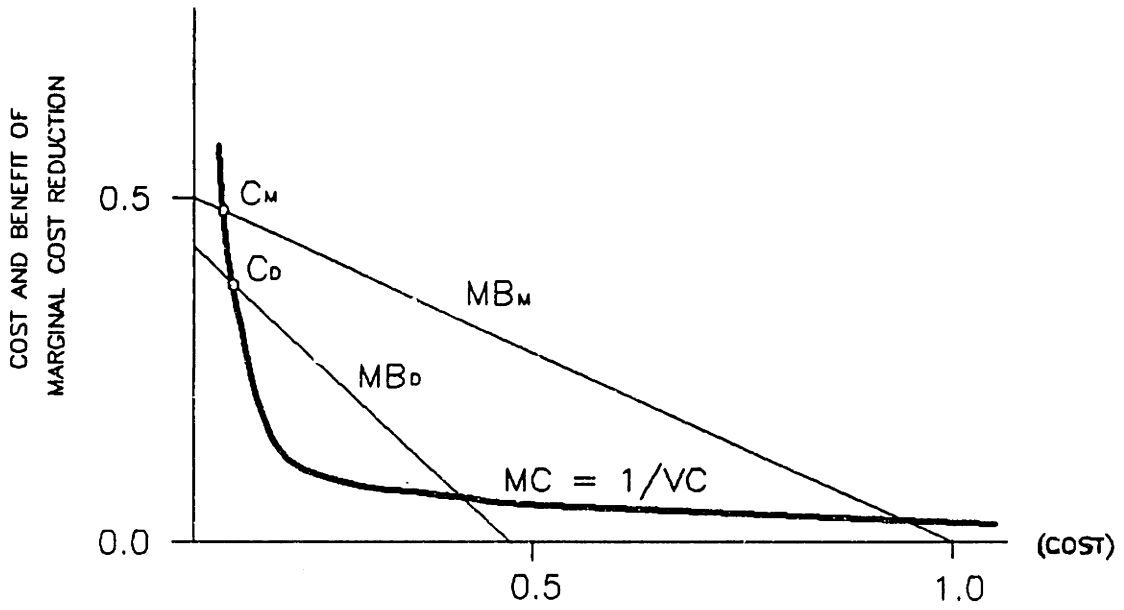


Figure 3-A: NEGATIVE RESPONSE TO LIBERALIZATION

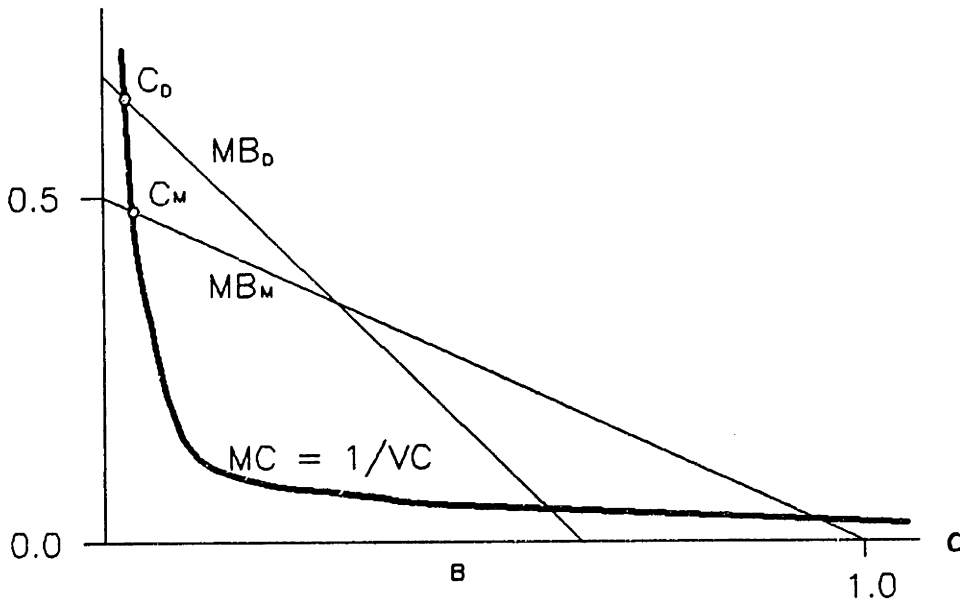


Figure 3-B: POSITIVE RESPONSE TO LIBERALIZATION

technical efficiency optimally chosen by the enterprise $M(D)$. In this case liberalization reduces the investment for cost reduction and increases marginal cost of production, no matter how high the efficiency of cost reducing investment (v) is.

However, MB^D can be located above MB^M for a certain range OB of C as shown in Figure 3-B. In this case if v is sufficiently large, we have $C^D < C^M$ as shown in the Figure. MB^D can cross MB^M , if

$$MB^D |_{C=0} = (4/9)(1 + C_F) > 1/2 = MB^M |_{C=0} \text{ or}$$

$$(18) \quad C_F > 1/8$$

since MB^D has a sharper slope than MB^M . Consequently, the positive response to liberalization is possible. This obtains even though the marginal increase of the competitiveness of the foreign enterprise always causes the reduction of the investment for cost reduction by the domestic enterprise.

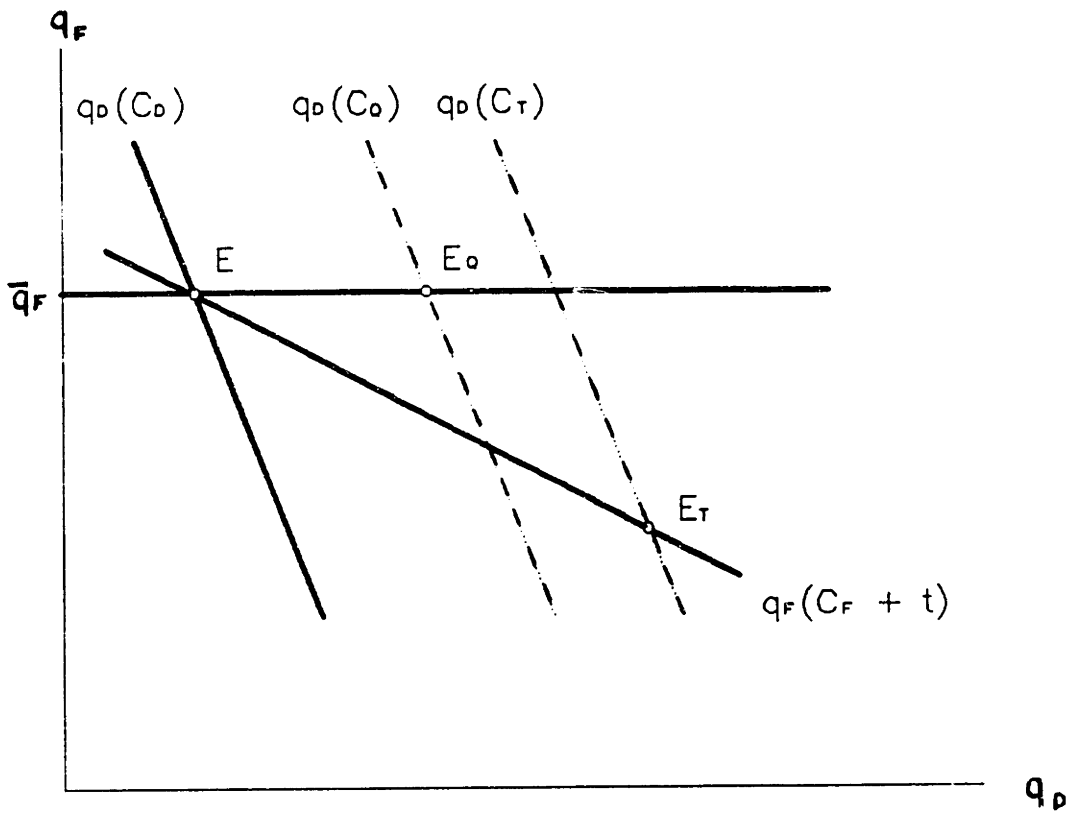
The intuition for the second case is clear: In the case of monopoly the effect of cost reduction on the profit of the domestic enterprise is equal to its output. Although the output of the domestic enterprise becomes smaller for a given C due to import liberalization (fragmentation effect), the profit effect of cost reduction after liberalization also depends on the negative output response of its competitor to its cost reduction (strategic effect) as shown in equation (14). When the domestic enterprise has high capability of technological development, the incentive

for cost reduction can be larger in the case of duopoly than in the case of monopoly, since strategic effect dominates fragmentation effect.

Based on the above result let us compare the effects of tariff and quota on technical efficiency and on welfare. I consider the following situation. Tariff and quota are set so as to bring about identical domestic output and import, before a technological opportunity for cost reduction becomes known. This can be done simply by setting the import quota identical to the level of observed import subject to tariff in the case of Cournot equilibrium (See Figure 4).

Then what will happen if the domestic enterprise suddenly perceives a certain technological opportunity? The investment decision of the firm subject to tariff is exactly identical to that for the enterprise D, while the investment decision of the firm subject to quota is exactly identical to that for the enterprise M, except for the fact that the two firms have identical outputs when their investments for cost reduction are zero. Consequently, it is clear that the firm protected by tariff achieves higher technical efficiency and larger domestic output than the firm protected by quota, since the firm protected by tariff still has a strategic motive to displace import. (Compare C_Q and C_T in Figure 5).

It is important to note that the profit of the domestic enterprise is also higher under tariff protection than under quota, since quota deprives the domestic enterprise of the opportunity to use its first mover advantage in product market competition by making preemptive investment. In fact quota protects the foreign enterprise rather than the domestic enterprise from potentially stronger competition.



t	: tariff
q_F	: quota
E	: original equilibrium before innovation
E_T	: equilibrium under tariff after innovation
E_0	: equilibrium under quota after innovation

Figure 4: TARIFF VS. QUOTA

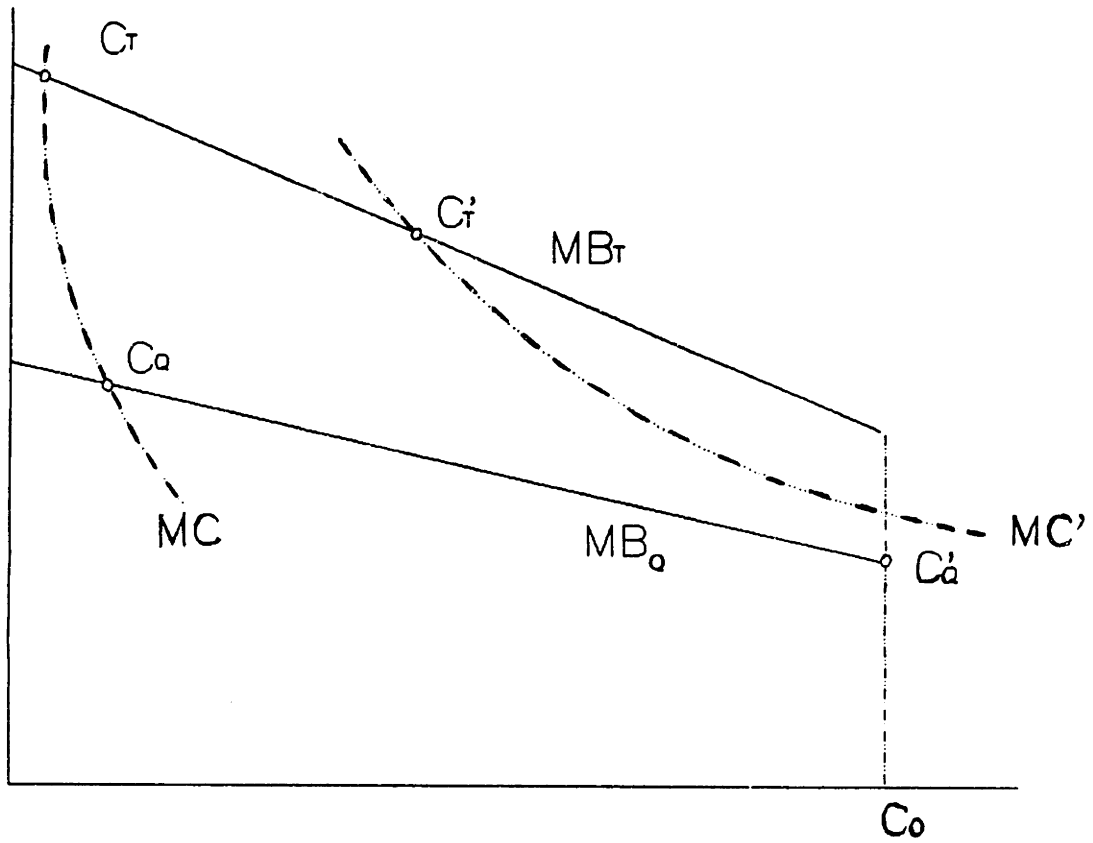


Figure 5: TARIFF vs. QUOTA

The response of total supply in the domestic market depends upon the technological capability of the domestic enterprise. If it is very high, $C_T \approx C_Q$ as illustrated in Figure 5. This in turn implies that the reaction curve under quota protection almost coincides with that under tariff protection in Figure 4. If such is the case, it is obvious from Figure 4 that total supply is larger under quota protection than under tariff protection. On the other hand if the technological capability of the domestic enterprise is relatively low, we can have $C'_T < C'_Q \approx C_0$ as illustrated in Figure 5. In this case, the total supply under tariff protection is larger than that under quota protection. All domestic entities (consumer, domestic industry and the government) gain from the switch from quota to tariff.

The standard cases for tariff against quota are larger domestic output and larger government revenue.¹⁴ The above analysis provides a new and potentially more important case for tariff, since tariff is found to be more conducive to dynamic efficiency. If strategic effect is essential in inducing the domestic enterprise to start investment in cost reduction, tariff also leads to higher welfare in a Pareto sense. The above analysis might be criticized on the ground that it does not properly compare tariff and quota, since import declines under tariff. However, that criticism may be off the point, since import restrictions are often introduced to protect domestic enterprises at prevailing cost conditions, so that import

^{14/} See Helpman and Krugman (1989), Chapters 3, 4 and 6. An exception may be the case where the level of the domestic output is determined by the domestic cartel to control the enforceability of the agreement (explicit and implicit), since quota then can force such a cartel to increase domestic output to offset the increased incentive for defection (Rotemberg and Saloner (1988)).

replacement due to the improved technical efficiency of the domestic enterprises is not likely to be a cause of concern.¹⁵

Next I analyze the welfare effect of stronger import competition (lower foreign cost or lower tariff). Stronger import competition can cause Pareto-inferior change in the economy, as demonstrated below. First it is convenient for us to develop a general formula for evaluating the welfare change due to parametric changes. The welfare (W^D) is given by the sum of the consumers' surplus ($CS(q)$) and the producer's surplus $PS(q_D, k_D)$:

$$(19) \quad W^D = CS(q = q_D + q_F) + PS(q_D, k_D)$$

Totally differentiating this relation, we get

$$(20) \quad dW^D = -q_F dP + (P - C_D)dq_D + \{-(\partial C_D/\partial k)q_D - 1\}dk_D$$

where $dP = P'dq$.

This formula suggests that we have to take into account the three effects in evaluating the welfare effect of any parametric change. First, terms of trade effect. Any increase in the domestic price implies terms of trade deterioration, as long as q_F (import or sales of the subsidiary of

^{15/} Since the domestic enterprise makes more profit under tariff than under quota, it "should not" complain. It is also important to recall that the traditional welfare comparison of tariff and quota has been rather add hoc, since the rationale for restricting the amount of import itself has not been clearly specified.

the foreign enterprise) is positive. Second, efficiency in the composition of supply. Since the price which domestic consumers pay to the foreign enterprise is above the marginal cost of the domestic enterprise, the shift of supply from the foreign enterprise to the domestic enterprise benefits the domestic economy. Third, efficiency of investment. Due to the strategic motive of investment, the enterprise invests over what cost minimization requires. That is

$$- (\partial C_D / \partial k_D) q_D - 1 = - (\partial C_D / \partial k_D) (\partial P / \partial Q) (\partial q_F / \partial C_D) q_D < 0$$

or the benefit of the reduction of marginal cost falls short of its marginal investment cost. Consequently the expansion of the investment for cost reduction itself is welfare reducing, although its total effect is still positive in the case of the domestic monopoly enterprise.

Using the above framework let's analyze the welfare effect of the marginal increase of the competitiveness of the foreign enterprise ($dc_F < 0$). The negative technology response of the domestic enterprise tends to reduce the positive terms of trade effect of stronger foreign competition and to amplify its negative effect on the composition of supply. We have already seen that $\partial C_D / \partial C_F < 0$, so that $dc_D > 0$ and $dk_D < 0$. $dc_F < 0$ and $dc_D > 0$ also implies that $dq_D < 0$ and $dq_F > 0$. $dc_D + dc_F$ can become positive,

since the technological response of the domestic enterprise can exceed one.¹⁶ If $dC_D + dC_F > 0$, we have $dq_D + dq_F < 0$ and $dp > 0$, since we have $q = q_D + q_F = (2 - (C_D + C_F)) / 3$ and $p = 1 - q$.

If $dq_D + dq_F < 0$, it is clear that stronger import competition reduces both consumers' welfare and industry profit. We can derive the following formula from equation (20) (See the Appendix for its derivation).

$$(21) \quad dW^D = -q_D P + q_D P' (\partial q_F / \partial C_F) dC_F$$

where the first term represents the change in the consumers' surplus and the second term represents the change in the profit of the domestic enterprise. The second term is always negative for $dC_F < 0$. The first term also becomes negative if $dC_F < 0$ causes $dp > 0$.

The above unconventional result can occur, since higher foreign competitiveness can have an amplified effect on the competitiveness of the domestic enterprise, when the output of the domestic enterprise is already small. The reason is the following. Since the incentive for cost reduction is proportional to the size of output, the small output allows the domestic enterprise to exploit only highly effective opportunities for cost reduction. Hence, a further decline of output caused by stronger import competition causes the domestic enterprise to forgo even these

^{16/} When V_D is very large relative to $1 + C_F$, it is not possible. Approximation of equation (16) gives $C_D = (9/16)(1/V_D)(1/(1 + C_F))$. Consequently,

$$|dC_D| = | (9/16)(1/V_D) \{-dC_F/(1 + C_F)^2\} | \geq (9/16)(1/V_D) |dC_F| > |dC_F|$$

opportunities. The above amplified effect on the production cost of the domestic enterprise in turn leads to the rise of the market price in the oligopoly environment. Consequently, tariff can cause a Pareto-superior change: lower domestic price, higher industry profit and higher government revenue. Conversely import liberalization in the sense of tariff reduction can be a Pareto-inferior policy.

The negative response of the domestic price to tariff sounds very paradoxical, but its possibility has been pointed out by Venables (1985, 1987), although based on the grounds different from that of the above analysis. First, tariff can reduce domestic price by shifting the location of the industries with large economies of scale to the home country and thereby saving transportation cost (Venables (1987)). Second, tariff can reduce domestic price by increasing the number of firms competing in the domestic market and thereby reducing markup in the environment of segmented markets (Venables (1985)). My analysis is closer to this second possibility identified by Venables, since the negative response of domestic price is caused by the negative effect of tariff on the markup by the foreign enterprise although not by increasing the number of enterprises but by strengthening the competitiveness of the domestic enterprise. While tariff is necessarily immiserizing for the foreign country in the Venable's framework (1985) since it is anticompetitive abroad, that is not necessarily the case in my analysis. If we consider the possibility of export by the domestic enterprise, tariff can also lower the price abroad.

How general is my result? Increasing the number of foreign enterprises does reduce the possibility of the negative response of domestic price to tariff but does not eliminate it. Increasing the number

of domestic enterprises again has no qualitative effect. Switching from quantity to price competition is not likely to change the result qualitatively, as long as marginal tariff can have a discrete effect on the level of the cost of domestic enterprise, by influencing the decision whether to undertake investment for cost reduction or not. On the other hand, the analysis here does not say that tariff always reduce the domestic price, unlike the analysis by Venables (1985, 1987).

Figure 6-A illustrates the discrete welfare effect of liberalization (removal of ban or quota). The area A represents the gain from the reduction of monopoly underconsumption, when $q_D + q_F > q_M$. The area B represents the profit loss of the domestic enterprise due to the loss of the market, when $q_D < q_M$. The area C represents the gain from production cost saving when C_D responds positively to liberalization and the area D represents its investment cost. The welfare effect of import liberalization is generally ambiguous, since it depends on these conflicting effects. When V_D is large, $W^D \rightarrow (2 + C_F^2)/6 \leq 3/8$ for $C_F \leq 1/2$, while $W^M \rightarrow 3/8$.¹⁷ Consequently, the welfare effect is negative, when V_D is large. This is essentially the same result which can be obtained from a

^{17/} The welfare function can be explicitly derived as follows:

$$(21) \quad W^D = (1/2)(q_D + q_F)^2 + (P - C_D)q_D - k_D \\ = -(5 + C_F) C_D/12 + (2 + C_F^2)/6 - (9/16)(1/V_D) - (1/V_D) \log(C_O/C_D), \text{ where}$$

$$C_D = (1 + C_F)/4 - [((1 + C_F)/4)^2 - 9/(8V_D)]^{0.5}$$

$$\lim W^D \rightarrow (2 + C_F^2)/6, \text{ since } \lim (1/V) \log V = 0 \text{ as } V \rightarrow \infty.$$

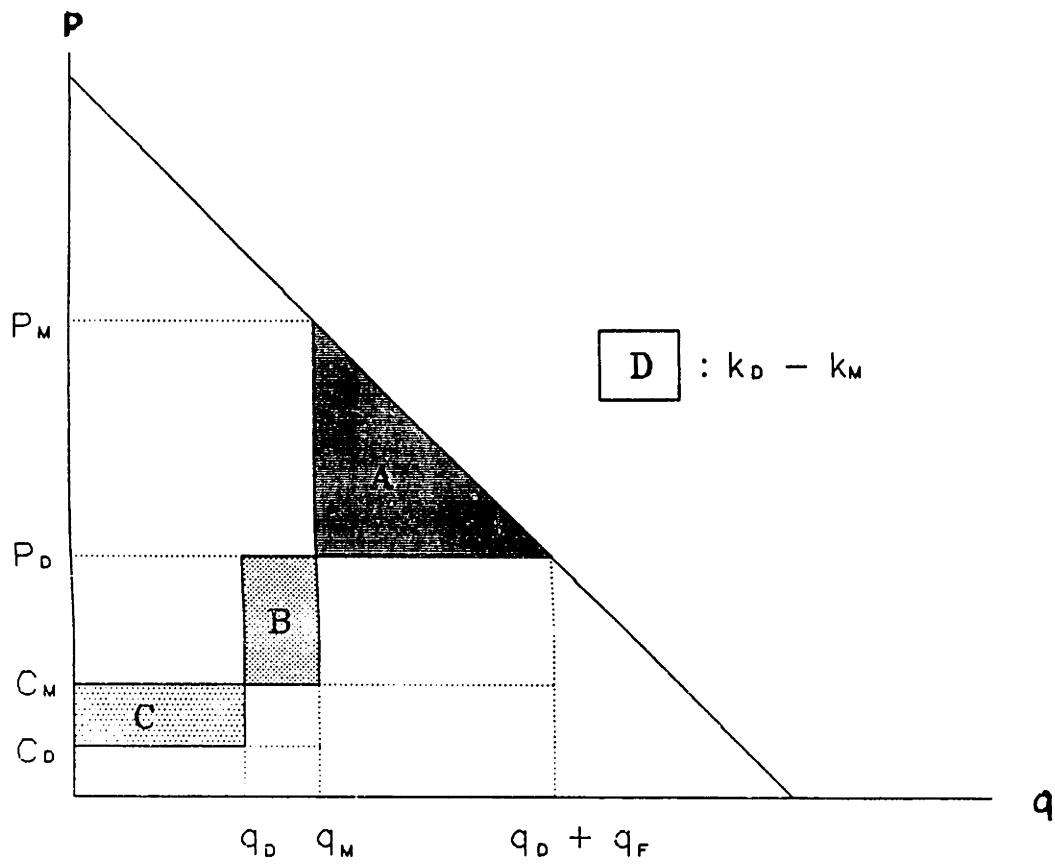


Figure 6-A: WELFARE EFFECTS OF IMPORT LIBERALIZATION

conventional static model of Cournot competition, since high V_D implies that $C_D \approx 0$ irrespective of C_F .

3. Impact of Domestic Liberalization

Domestic liberalization is assumed here to cause an entry of another domestic enterprise, a challenger. First we analyze the case where the challenger has no opportunity to improve production technology and then the case where both enterprises have technological opportunities for making cost-reducing investment, which has commitment or strategic value for product market competition.

When the challenger has no opportunity to improve cost, the analysis is exactly the same as that for the last section except for welfare. Domestic liberalization can stimulate the domestic incumbent enterprise to undertake more investment for cost reduction. Whether it does so depends on the balance between the market fragmentation effect and the strategic effect of increased competition. Since it is likely that the foreign enterprise has lower cost than the domestic challenger in developing countries, domestic liberalization is likely to be less harmful to technical efficiency than import liberalization in these countries.

The welfare change in response to a marginal parametric change is given by

$$dW = (P - C_1) dq_1 + (P - C_2) dq_2 + \{(-q_1)(\partial C_1 / \partial k_1) - 1\} dk_1,$$

and for a parametric change of dC_2 , it is given by

$$(23) \quad dW = - P'q_1dq_1 - P'q_2dq_2 - q_2dC_2$$

where q_1 (q_2) is the output of the incumbent (challenger), C_1 (C_2) is the marginal cost of the incumbent (challenger), k_1 is the cost reducing investment of the incumbent and V_1 is its efficiency. When the challenger has similar technical efficiency compared with the incumbent (consequently $q_1 \sim q_2$), then the net welfare effect of stronger domestic competition is positive, as long as industry output expands. On the other hand, if the challenger has only low efficiency (consequently $q_2 \approx 0$), marginally stronger domestic competition is welfare reducing.

The overall welfare effect of domestic liberalization (the discrete change from monopoly to duopoly) is illustrated in Figure 6-B. The area A represents the reduction of both monopoly underconsumption and undersupply, when $q_1 + q_2 > q_M$. The area B represents the loss due to the shift of production from a more efficient incumbent to a less efficient challenger when $q_1 < q_M$. The area C represents the reduction of production cost and D for the additional investment cost. It is tempting to say that the net welfare effect is positive, if $C_2 \approx C_M$, since $B = 0$. However, it is not necessary the case, since investment is not cost minimizing due to the strategic effect.¹⁸ It is also clear that domestic liberalization has higher welfare effect than import liberalization if the domestic challenger has identical cost with the foreign enterprise.

^{18/} If the incumbent enterprise ignores the strategic value of cost-reducing investment, cost minimization implies that $C_1q_1 + k_1 < C_Mq_1 + k_M$ so that $(C_M - C_1)q_1 - (k_1 - k_M) > 0$.

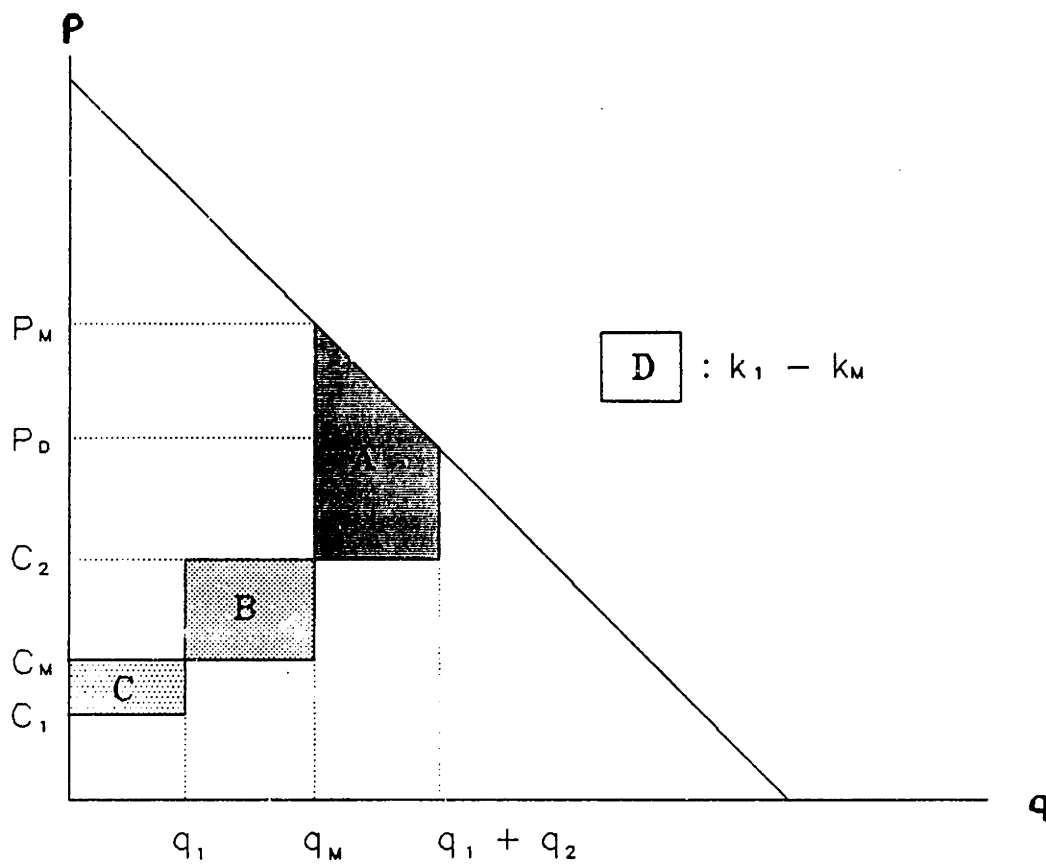


Figure 6-B: WELFARE EFFECTS OF DOMESTIC LIBERALIZATION

Next we analyze a more realistic case where the challenging enterprise also has the opportunity for cost-reducing investment. The perfect equilibrium of the two stage game is given by the following set of equations derived from equation (15):

$$(24) \quad 2C_1 + (9/(4V_1))(1/C_1) = 1 + C_2$$

$$(25) \quad 2C_2 + (9/(4V_2))(1/C_2) = 1 + C_1$$

where V_2 is the efficiency of cost-reducing investment by the challenger enterprise. The resulting equilibrium is illustrated in Figure 7 for a symmetric case.

It is clear from this figure that the relative increase in the efficiency of cost-reducing investment of the first enterprise reduces the marginal cost of production of the first enterprise and increases the marginal cost of production of the second enterprise, since it causes the relative downward shift of the reaction curve I-I. It is also clear that $C_1 + C_2$ declines around the symmetric equilibrium as either of V_1 or V_2 increases.

However, $C_1 + C_2$ can increase in the asymmetric equilibrium, since both of the reaction curves can have slopes larger than one, as is clear from Figure 7. Consequently, higher investment efficiency of one of the enterprises can cause the decline of industry output and thus can reduce the consumers' welfare. Asymmetric equilibrium can thus bring about unconventional result. One implication is that investment subsidy for cost

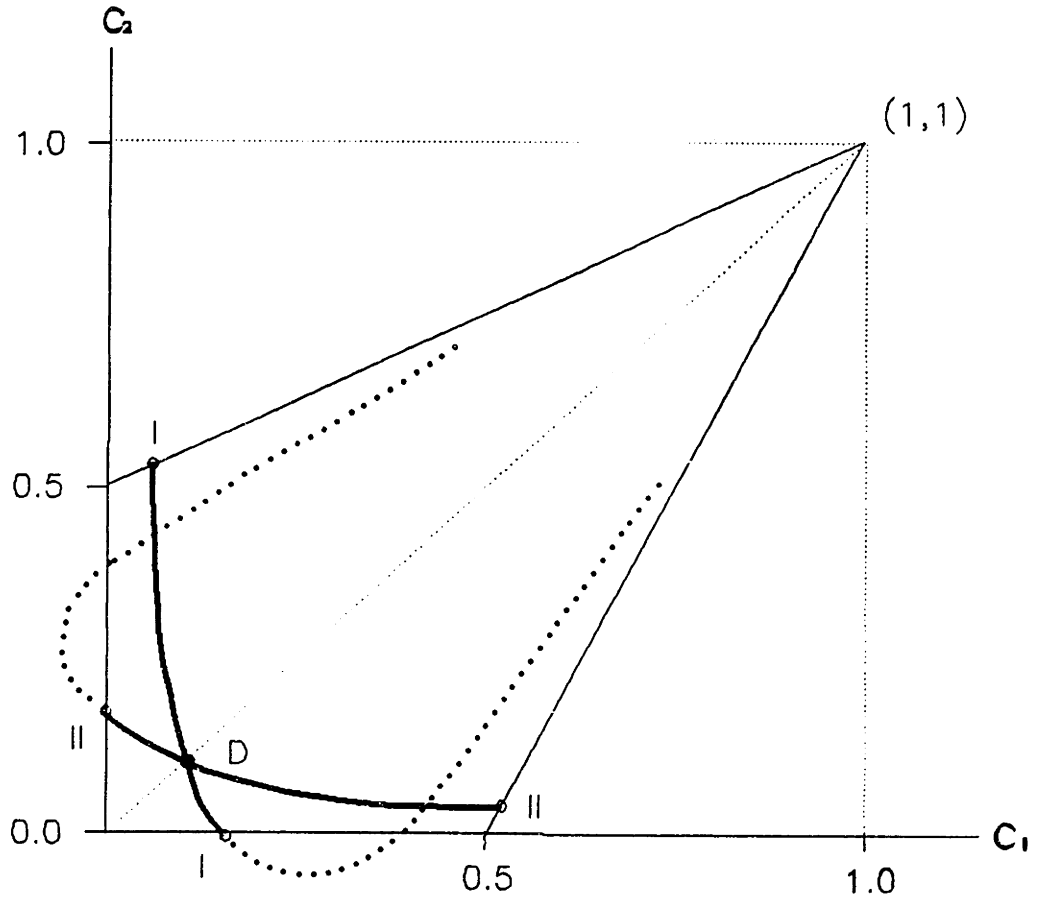


Figure 7: PERFECT EQUILIBRIUM

reduction can lead to higher market price, if it is provided only to the dominant enterprise with low cost.

The welfare effect of marginal parametric change is given by

$$(26) \quad dW^D = (P-C_1)dq_1 + (P-C_2)dq_2 + \{-q_1(\partial C_1/\partial k_1)-1\} \\ + \{-q_2(\partial C_2/\partial k_2)-1\}$$

The larger V_2 ($dV_2 > 0$) brings about $dq_1 < 0$, $dq_2 > 0$, $dk_1 < 0$ and $dk_2 > 0$, so that net effect is not clear as in the other cases.

Finally, we analyze the impact of domestic liberalization (the discrete change from monopoly to duopoly). We focus only on the symmetric case. It is possible to show in this case that, although the effect on technical efficiency is negative, the effect on welfare is positive when the efficiency of cost-reducing investment is high. In the symmetric case we have

$$(27) \quad C_1^2 - (1 + C_1)C_1/2 - 9/(8v_1) = 0$$

$$(28) \quad C_1 = \{1 - (1 - 9/V)^{0.5}\}/2$$

The comparison with equation (8) immediately suggests that $C_M < C_1$. The negative effect on technical efficiency, however, critically depends on linear demand, which implies relatively strong market fragmentation effect.

The welfare (W_D)¹⁹ in this case is higher than in the case of monopoly, when v is large. It is possible to show that $W^D \rightarrow 4/9$ and $W^M \rightarrow 3/8$.

4. Policy Implications

In this subsection I briefly discuss some policy implications which can be derived from the above analysis, admitting its simplicity.

First, even if import competition makes the domestic enterprise suffer market loss and the consequential decline of the investment for cost reduction, it does not imply that instituting a ceiling on import competition by, e.g., introducing a quota system can induce higher investment for cost reduction. As demonstrated in the above analysis, such policy can actually have a negative effect on the technical efficiency of the domestic enterprise.

Second, strategic effect provides a new and potentially most important reason why tariff is likely to be superior to quota when some protection is unavoidable. The standard cases for tariff are higher domestic output and higher revenue. In addition to these two favorable

^{19/} It is possible to derive the following formula:

$$W^D = (1/2)(2q_1)^2 + 2(P - C_1)q_1 - 2k_1$$

$$= \frac{(2 + 2(1 - 9/V_1)^{0.5} - 9/V_1)/9 + (2/V_1) \log \{ [1 - (1 - 9/V_1)^{0.5}] / (2C_0) \}}$$

effects, tariffs also keeps alive the strategic effect of investment and therefore is likely to cause higher dynamic efficiency than quota.²⁰

Third, domestic liberalization can still improve technical efficiency even when import liberalization hurts it. Domestic competition is likely to have smaller market fragmentation effect for a domestic enterprise in developing countries than import liberalization since production cost of the domestic challenger is likely to be more similar to the incumbent enterprise than that of the foreign competitor. Domestic and import competition can thus have asymmetric effects on the technical efficiency of domestic industry.

Fourth, however, it is not necessarily the case that the welfare effect of domestic liberalization is larger than that of import liberalization, since there exist two opposing forces. Import liberalization in developing countries on the one hand can significantly reduce the underconsumption due to monopoly distortion. On the other hand, it can also transfer significant part of the domestic monopoly rent to the foreign enterprise. The welfare effect of the slow down of technology development is generally ambiguous, although its marginal decline is welfare reducing since the domestic monopoly enterprise underinvests in technology.

Fifth, tariff may lower the domestic price, if it helps the domestic enterprise substantially increase its investment for cost reduction. This result may provide some support for infant industry protection in

^{20/} An important condition for this conclusion is that the domestic enterprise is more blessed with investment opportunities for higher technical efficiency, which are focused on the domestic market competition. If the opposite happens to be true, then the ranking can be reversed.

developing countries, which is regarded to be legitimate by the GATT. However, it is important to note that the result depends critically on the asymmetric opportunities for cost reduction as well as on the market power of the foreign enterprise. Furthermore, active use of tariff policy is still costly in terms of consumption distortion compared with, e.g., investment subsidy and may also generate cost due to policy endogeneity just as the other sector-specific government interventions.

C. Domestic Competition, Technology Catchup and Welfare in an N-Firm Model

In this section I demonstrate that in the general framework of N-firm competition increased domestic competition can potentially accelerate technology catchup when its effect on the strategic motive for investment dominates its market fragmentation effect. I use a model of dynamic competition where enterprises determine their levels of investments for cost reduction in the first stage and their output levels in the second stage. I limit my focus on a symmetric Nash equilibrium in this section.

1. Market Equilibrium in the Presence of Strategic Effect

The profit of the i th domestic enterprise (π_i) is given by

$$(29) \quad \pi_i = P(\sum^N q_i)q_i - C_i(k_i)q_i - k_i$$

where $P(Q = \sum^N q_i)$ is the inverse market demand function, Q is aggregate output, q_i is the output of the i th firm, C_i is constant marginal cost of production, and k_i is cost reducing investment. We assume that

$$(30) \quad P' < 0, \text{ and}$$

$$(31) \quad C' < 0 \text{ and } C'' > 0.$$

The second stage equilibrium is given by

$$(32) \quad \partial \pi_i / \partial q_i = P' q_i + P - C_i = 0.$$

since investments for cost reduction are sunk in the second stage. Each firm determines its output so as to maximize its profit, taking marginal cost as given.

The second-order conditions are

$$(33) \quad \partial^2 \pi_i / \partial q_i^2 = P'' q_i + 2 P' < 0$$

I assume that the Hahn's condition holds globally 21:

21/ Hahn (1962). The condition (34) assures the stability of a myopic adjustment process to a Cournot equilibrium. As is well known (Dixit (1986) and Tirole (1988)), myopic adjustment process lacks real economic foundation. However, given the current absence of a real alternative, I depend on the stability condition of such process in order to derive comparative static results, as most existing oligopoly theories do.

$$(34) \quad P'' q_i + P' < 0$$

It is clear that the second-order conditions hold when equation (34) is satisfied. The Hahn's condition (34) also implies strategic substitute in the product market competition as well as the response coefficient less than one in absolute value:²²

$$(35) \quad 0 > \partial q_i / \partial q_i \mid (\partial \pi_i / \partial k_i = 0) > 1$$

The second stage equilibrium depends on the choice of investments for cost reduction already made in the first stage, so that the equilibrium output q_i can be written as

$$(36) \quad q_i = q_i(k_1, \dots, k_1, \dots, k_N)$$

Given the assumption (33), (34) and (35), around a symmetric equilibrium we have

$$(37) \quad \partial q_j / \partial k_i < 0 \text{ for } i \neq j \text{ and } \partial q_i / \partial k_i > 0 \text{ and}$$

$$(38) \quad \sum^N (\partial q_j / \partial k_j) > 0$$

^{22/} Bulow, Geanakoplos and Klemperer (1985) defined strategic substitutes and strategic complements in oligopolistic competition. In the case of linear demand product market competition always has the characteristic of strategic substitute. In the case of the demand curve with a constant elasticity it is not always the case.

(See the Appendix) ²³.

In the first stage of the game each firm determines its level of investment, recognizing the dependence of the second-stage equilibrium output q_i on the investment levels of all firms. The profit of each firm can be written as the function of investments:

$$(39) \quad \pi_i = \pi_i(q_1(k_1, \dots, k_i, \dots), \dots, q_j(k_1, \dots, k_i, \dots), \dots) \\ - g_i(k_1, \dots, k_i, \dots, k_N)$$

The perfect equilibrium is therefore given by

$$(40) \quad \partial g_i / \partial k_i = P' [\sum_{j \neq i} \partial g_j / \partial k_i] q_i - q_i \partial C_i / \partial k_i - 1 = 0,$$

where the first term represent strategic effect of the investment for cost reduction. Since $\partial q_j / \partial k_i < 0$ from equation (37), the first term is positive, suggesting that each enterprise has an incentive for implementing cost-reducing investment more than justified by the cost minimization.

The second order condition is given by

$$(41) \quad \partial^2 g_i / \partial k_i^2 = P'' (\partial Q / \partial k_i) (\sum_{j \neq i} \partial q_j / \partial k_i) q_i \\ + P' [(\sum_{j \neq i} \partial^2 q_j / \partial k_i^2) q_i + (\sum_{j \neq i} \partial q_j / \partial k_i) \partial q_i / \partial k_i] \\ - (\partial q_i / \partial k_i) (\partial C_i / \partial k_i) - q_i (\partial^2 C_i / \partial k_i^2) < 0$$

^{23/} If we assume the diagonal dominance of the coefficient matrix for the myopic adjustment process in the second stage product market competition, it is possible to show that equations (37) and (38) hold even for asymmetric equilibrium (see Dixit (1986)).

It is satisfied if C_i is sufficiently convex. I assume that such is a case.²⁴

If we focus on the symmetric equilibrium, we get $k_i = k$ for all i as a solution to equation (40). We further have

$$(42) \quad q = q_i(k_1, \dots, k_i, \dots, k_N) = q_i(k, \dots, k, \dots, k) = h(k) \text{ and}$$

$$(43) \quad \partial q_i / \partial k_j = \partial q_j / \partial k_i = U(k) < 0$$

for all i and j except for $i = j$. k and q satisfy the following equation derived from equation (40).

$$(44) \quad P'(Nq) \cdot [(N-1)U(k)] \cdot q - q \partial C / \partial k(k) - 1 = 0$$

The determination of the equilibrium (q, k) is illustrated by Figure 8. Here the q curve corresponds to equation (42) and the k curve corresponds to equation (44). The q curve has a positive slope. This can be demonstrated as follows: Since we have $\partial q_i / \partial k_j = \partial q_j / \partial k_i$ for the symmetric equilibrium,

$$(45) \quad \left. \frac{dq}{dk} \right|_{q\text{-curve}} = \frac{dh}{dk} = \sum_{j=1-N} \partial q_i(k, \dots, k) / \partial k_j = \sum_{j=1-N} \partial q_j(k, \dots, k) / \partial k_i > 0$$

^{24/} It can be violated, if for an example $-(\partial q_i / \partial k_i)(\partial C_i / \partial k_i)$ is positive sufficiently, as I analyzed in the section B.

from equation (38). Higher investments for cost reduction by all enterprises make production costs lower and the market price lower, so that the outputs of all enterprises increase.

The k-curve corresponding to equation (44) generally has a positive slope, unless dU/dk is not strongly negative (or strategic effect does not become excessively strong as k increases). High level of output, on the one hand, makes investment for cost reduction more profitable, since its effect on cost reduction is proportional to the size of output. High level of output also strengthens strategic effect, unless the market demand curve is strongly convex, since it is again proportional to the size of output (see the firm term of the equation (44)). I assume that the k curve has a positive slope in the following analysis.

I further assume the following stability condition: the coefficient matrix of the myopic adjustment process in the first stage investment competition has the characteristic of diagonal dominance. The diagonal dominance is a sufficient condition for the stability of such adjustment process. It is possible to show that the diagonal dominance requirement in symmetric equilibrium assures that the k curve is steeper than the q curve (See Appendix). Consequently we assume that

$$(46) \quad dq/dk | k \text{ curve} > dq/dk | q \text{ curve}.$$

We assume that this holds globally for all N .

Using this framework I can first demonstrate that strategic effect increases equilibrium output and the size of cost reducing investment in the N -firm case. In the nonstrategic equilibrium the first term in

equation (44) vanishes, so that the k curve shifts to the right (the k' curve) as shown in Figure 8. Thus strategic incentive induces higher technical efficiency. Consequently, equilibrium output and investment are larger in the perfect equilibrium than in nonstrategic or open loop equilibrium.

The increase in domestic competition (increase in N) shifts the q curve down due to market fragmentation. Since I assume that product market competition constitutes strategic substitute, entry of a new firm makes incumbent enterprises reduce their sizes. Consequently, increase in domestic competition shifts the q curve down as in Figure 9. Since this is the only effect in the case of nonstrategic equilibrium, the increase in domestic competition fragments the market and reduces the size of cost reducing investment ($E \rightarrow B$)²⁵.

Under the perfect equilibrium, however, the increase in domestic competition tends to shift the k curve to the right due to increased strategic effect. Although the increase in N also tends to reduce $U(k)$, the increase of $(N-1)$ tends to dominate it,²⁶ unless the market demand curve is strongly concave. Consequently the effect of the increase in domestic competition on technical efficiency becomes ambiguous. If strategic effect is strong and dominates market fragmentation effect, increased domestic competition can induce higher investment for cost reduction, as shown by E' or A in Figure 9. Output of each enterprise can also become larger (A) as a result of increased domestic competition. If

^{25/} See the section E of the third paper for more details and for an exception.

^{26/} This is certainly the case for a linear demand (See Appendix).

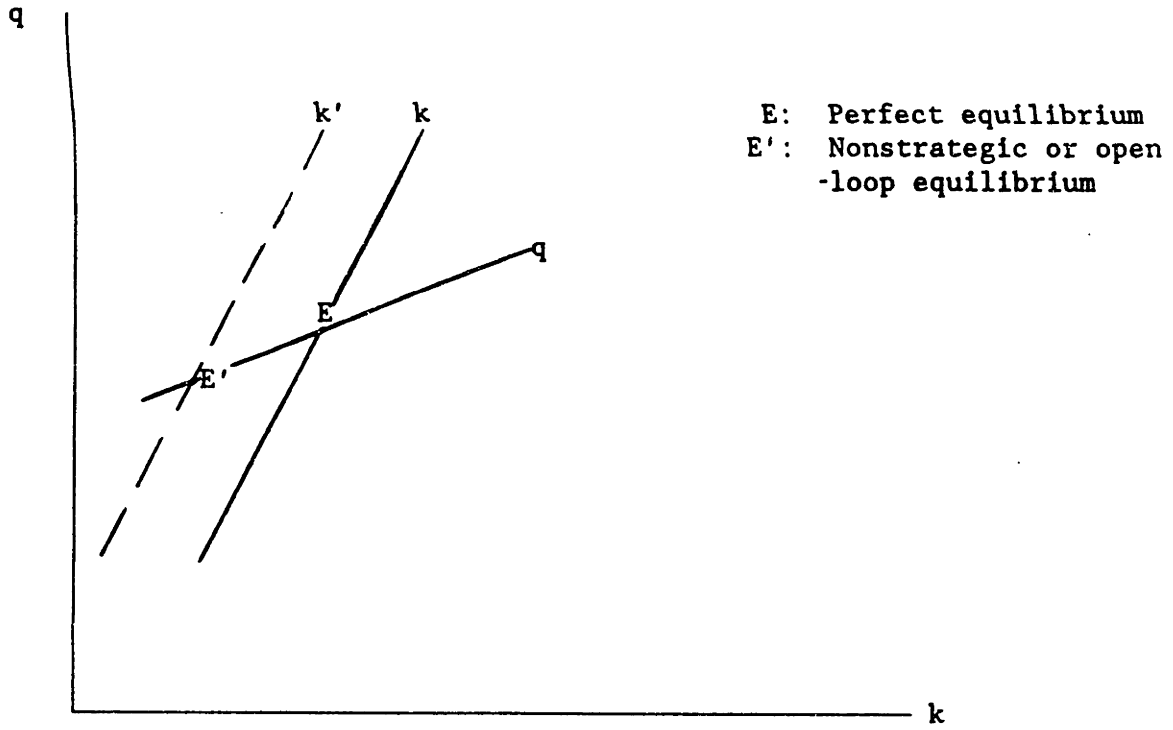


Figure 8: DETERMINATION OF q AND k

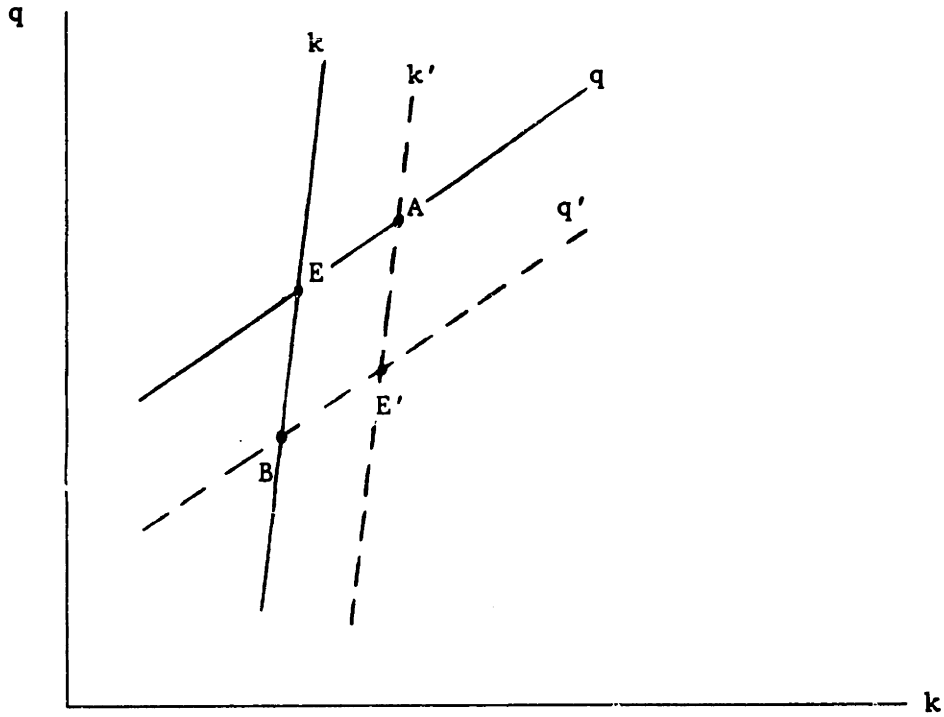


Figure 9. IMPACT OF THE INCREASE IN DOMESTIC COMPETITION

strategic effect is negligible, increased domestic competition reduces both the size of domestic enterprise and the size of cost reducing investment (B in Figure 9).

2. Strategic Effect and Economic Efficiency

a. Investment

Since the strategic effect is based on the motive of each enterprise to secure market at the expense of others, investment tends to become excessive on this account. However, on the other hand, the price responsiveness of demand tends to make investment deficient in oligopolistic market as in the case of monopoly, since each enterprise cannot fully appropriate the gain from cost reduction (part of the gain accrues to consumers). Therefore strategic effect can compensate the tendency for underinvestment in the oligopolistic market, but it can overdo it. I demonstrate this more formally below.²⁷

The social welfare is given by

$$(47) \quad W(k_1, \dots, k_N) = \int_0^{z_{qi}} P(s) ds - \sum C(k_j) q_j - \sum k_j$$

For the symmetric equilibrium we get

$$(48) \quad \partial W / \partial k_1 = (P - C)(\partial Q / \partial k_1) + (-q(\partial C_1 / \partial k_1) - 1)$$

^{27/} The following analysis is similar to that by Itoh, Kiyono, Okuno, and Suzumura, (1988), Chapter 14.

The first term represents the effect of increased investment for correcting monopoly distortion of undersupply and therefore positive. The second term represents the strategic effect (i.e. the effect of higher market price due to the induced contraction of the output of the competitors) and is negative for social welfare (see equation (40)). If the first effect dominates the second, the marginal increase of the investment for cost reduction at the market equilibrium can increase welfare. However if the second term dominates, investment for cost reduction is excessive.

Given equation (40), equation (48) can be rewritten to

$$(49) \quad \begin{aligned} \partial W / \partial k_i &= (P-C) [\partial Q / \partial k_i + \sum_{j \neq i} \partial q_j / \partial k_i] \\ &= (P-C) [\partial q_i / \partial k_i + 2(N-1)U] \end{aligned}$$

It is more likely that strategic effect dominates the effect of correcting monopoly underinvestment as domestic competition (or N) increases,²⁸ since U tends to decrease less than $1/(N-1)$.

b. Entry

In this subsection I demonstrate that the presence of strategic effect can potentially make excessive entry problem less severe or even reversed, since it makes market fragmentation by increased domestic competition less severe.

^{28/} It can be shown that equation (49) has a negative value in the case of Cournot competition and a linear demand, when $N > 3$. In this case $U \propto 1/(N+1)$ (See the Appendix).

I focus only on the symmetric equilibrium. The social welfare is given as the sum of consumers' surplus and profit:

$$(50) \quad W(N) = \int_0^{Nq} P(s)ds - NC(k)q - Nk$$

If we also ignore the integer constraint on N , we get

$$(51) \quad W'(N) = (q + N \partial q / \partial N) P(Nq) - Cq - NC \partial q / \partial N \\ - N(q \partial C / \partial k + 1)(\partial k / \partial N) - k$$

Since $\pi = P(Nq)q - cq - k$, we get

$$(52) \quad W'(N) = \pi + N [P(Nq) - C] \partial q / \partial N + [-N \{(q(\partial C / \partial k) + 1)\}(\partial k / \partial N)]$$

The coefficients of $\partial q / \partial N$ and $\partial k / \partial N$ are positive and negative respectively, since from equations (32) and (44) we get

$$(53) \quad P(Nq) - C = -P'(Nq)q > 0 \text{ and}$$

$$(54') \quad -(q\partial C / \partial k + 1) = -P'(Nq)(N-1)Uq < 0 \text{ with strategic substitutes.}$$

The expansion of the output of each enterprise has a positive effect on the social welfare, since marginal cost of production is below the market price under oligopolistic equilibrium. On the other hand the expansion of the cost reducing investment of each enterprise has a negative effect on the

social welfare, since private incentive for investment exceeds its social benefit (i.e. cost reduction) due to the presence of strategic effect.

We assume that the response of profit to increased domestic competition is negative:

$$(55) \quad \partial\pi/\partial N = (P - C) \partial q/\partial N + qP' \partial(Nq)/\partial N - (C'q + 1) \partial k/\partial N < 0.$$

This would be the case if $P' \partial(Nq)/\partial N$ is sufficiently negative.

If the strategic effect is negligible, we have $U \approx 0$, so that

$$(56) \quad W'(N) = \pi + N (P - C) \partial q/\partial N \text{ and } \partial\pi/\partial N < 0.$$

As discussed by Mankiw and Whinston (1986) this relation shows that there exists negative externality for entry, since $\partial q/\partial N$ is negative. The change in social welfare due to a marginal entry falls short of private profit to the marginal entrant. Consequently free entry leads to socially excessive entries. The free entry number of firms (N_e) exceeds the socially optimal number of firms (N^*), as illustrated in Figure 10. Furthermore, if there exists no strategic effect we know that the technical efficiency at the free entry equilibrium is lower than that of the social optimal equilibrium ($k_e < k^*$) from Figure 9 (compare E and B). Consequently, we can conclude

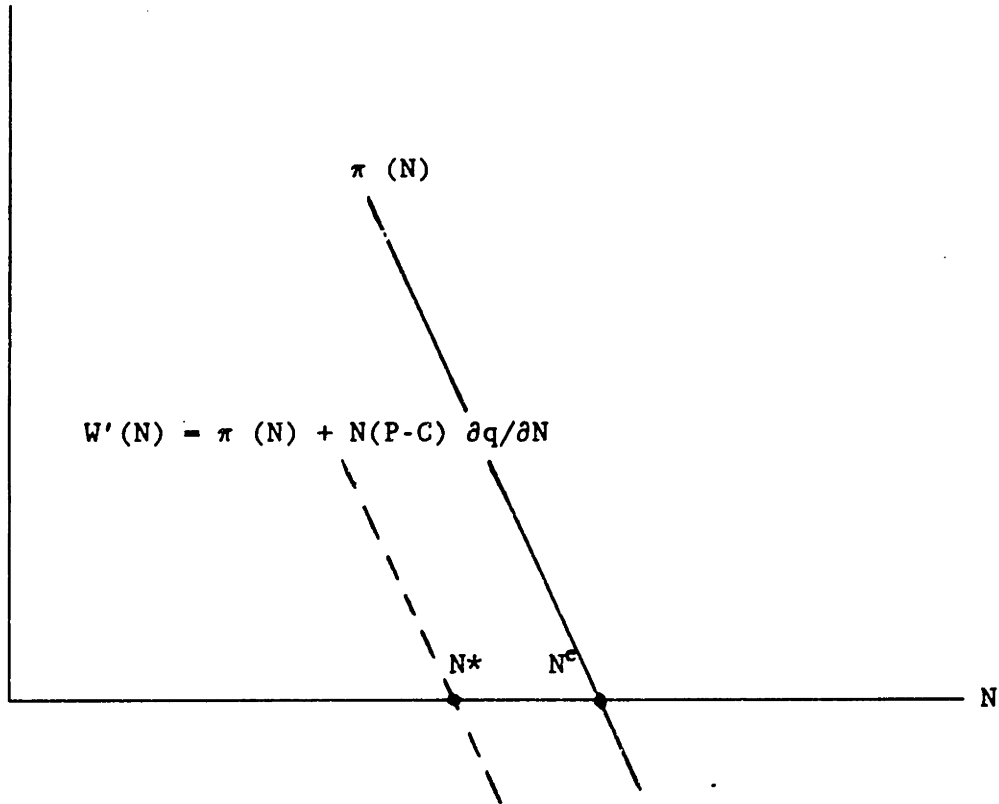


FIGURE 10:

that both welfare and technical efficiency are inefficiently low at the free entry equilibrium when strategic effect is negligible.²⁹

The existence of strategic effect affects excess entry problem through the following two channels (Compare B and E' in Figure 9). First strategic effect weakens the fragmentation of the output caused by a new entrant (i.e. $\partial q/\partial N$ becomes larger and can have a positive sign). Consequently the gap between the private gain from entry and its social benefit becomes smaller on this account. The sign itself may become positive. Second, however, strategic effect increases investment for cost reduction by incumbent enterprises (i.e. $\partial k/\partial N$ becomes also larger and can have a positive sign), which does not have a social benefit of itself. If the strategic effect is very strong ($\partial q/\partial N > 0$), free entry can result only in a deficient number of enterprises. Therefore, strategic effect can at least potentially completely reverse the conclusion by Tandon (1984). Entry regulation can be harmful to both welfare and technical efficiency.³⁰

3. Conclusions and Policy Implications

The main conclusions of this section are the following. Increased domestic competition can potentially accelerate technological catchup by enhancing the strategic effect of the investment for cost reduction.

^{29/} Recall that Tandon (1984) derived the same conclusion only through numerical simulation by assuming highly specific demand and cost-reducing functions.

^{30/} As discussed by Mankiw and Whinston (1986) the contribution of competition to product diversity is another beneficial effect which can upset the conclusion by Tandon. As discussed in the section E of the third chapter the contribution of competition to diluting policy endogeneity can also upset the conclusion.

Although the strategic motive for investment is not based on the national efficiency consideration, it can potentially improve the national welfare by correcting the tendency for underinvestment for cost reduction in monopoly or oligopolistic markets. The tendency for excessive entry in the oligopolistic market can also be potentially ameliorated or even become reversed by the strategic effect.

The most important policy implication is that entry regulation exercised very widely for industrial sectors in developing countries can be counterproductive to the stated objective, i.e., higher technical efficiency. In particular a monopoly enterprise protected both from foreign and domestic competition can show very poor dynamic efficiency gain due to the loss of strategic incentive for investment. Liberalization can result in both higher welfare and higher technical efficiency.

APPENDIX

$$1. (a.1) \quad dW^D = - P' q dq + q_D P' \partial q_F / \partial C_F dC_F:$$

If we totally differentiate the profit of the domestic enterprise,

$$\begin{aligned} (a.2) \quad d\pi^D &= d((P - C_D)q_D - k_D) \\ &= (P - C_D) dq_D + q_D dP - (q_D dC_D + dk_D) \\ &= (P + q_D \partial P / \partial Q - C_D) dq_D + q_D \partial P / \partial Q dq_F - (q_D \partial C_D / \partial k_D + 1) dk_D \\ &= q_D \partial P / \partial Q (\partial q_F / \partial C_F dc_F + \partial q_F / \partial C_D dC_D) - q_D \partial P / \partial Q \partial q_F / \partial C_D dC_D \\ &= q_D \partial P / \partial Q \partial q_F / \partial C_F dC_F \end{aligned}$$

given the following profit maximizing conditions:

$$(a.3) \quad P + q_D \partial P / \partial Q - C_D$$

and

$$(a.4) \quad q_D \partial C_D / \partial k_D + 1 = \partial C_D / \partial k_D q_D \partial P / \partial Q \partial q_F / \partial C_D$$

Therefore we get equation (a.1).

2. $\sum_{j=1}^{N-1} \partial q_j / \partial k_i > 0$ for a symmetric equilibrium:

I show the equivalent condition: $\sum_{j=1}^{N-1} \partial q_j / \partial C_i < 0$. Totally differentiating equation (32), we get

$$(a.5) (P''q_i + 2P')dq_i + (P''q_i + P')dq_{-i} = dC_i$$

and

$$(a.6) (P''q_j + 2P')dq_j + (P''q_j + P')dq_{-j} = dC_j \text{ for } j \neq i$$

For a symmetric equilibrium we have $q_i = q_j = q_E$, $dq_j = dq_i / (N - 1)$ for $j \neq i$, and $dq_{-j} = dq_i + \{(N - 2) / (N - 1)\}dq_i$. Consequently, we can rewrite equations (a.5) and (a.6) into

$$(a.7) \begin{vmatrix} P''q_E + 2P' & P''q_E + P' \\ P''q_E + P' & ((P''q_E + 2P') + (N - 2)(P''q_E + P')) / (N - 1) \end{vmatrix} \begin{vmatrix} dq_i \\ dq_i \end{vmatrix} = \begin{vmatrix} dC_i \\ 0 \end{vmatrix}$$

From the Hahn's condition all the coefficients of the matrix are positive. Furthermore, the diagonal element dominates in each row in absolute value, since

$$(a.9) 0 > P''q_E + P' > P''q_E + (N / (N - 1)) P'$$

Consequently, we have

$$(a.10) \quad \partial q_i / \partial C_i < 0 \quad \text{and} \quad \partial q_{-i} / \partial C_i > 0$$

$$(a.11) \quad \partial q_i / \partial C_i + \partial q_{-i} / \partial C_i < 0$$

as demonstrated in Figure A.1.

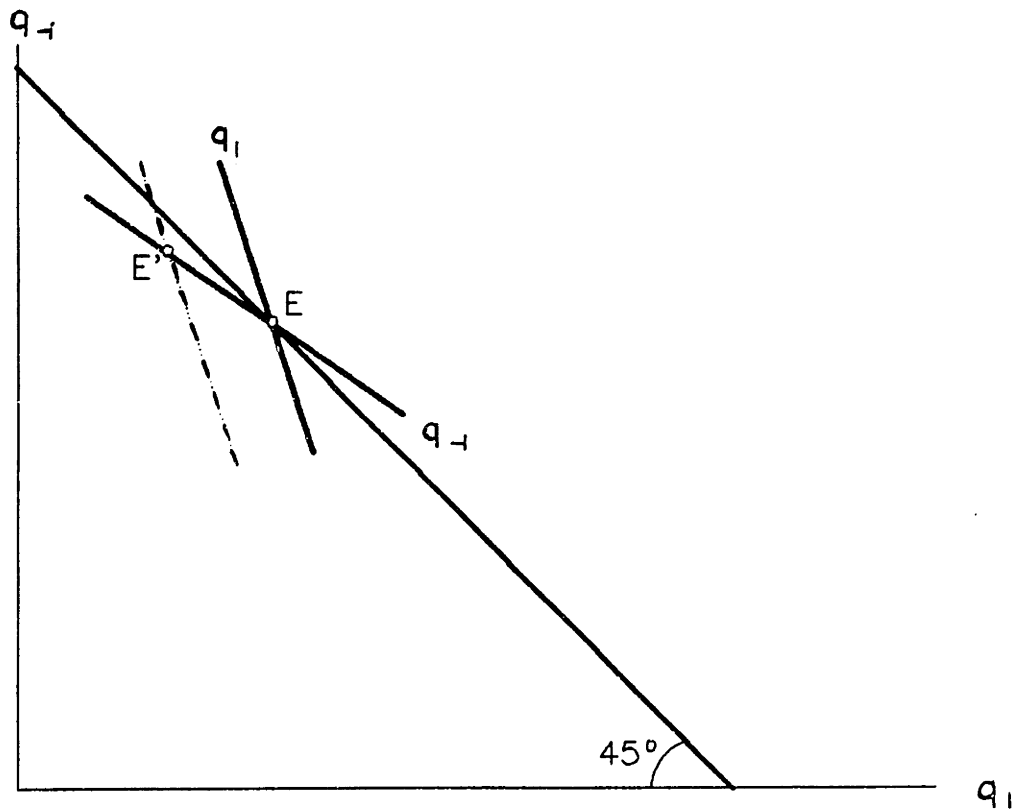


Figure A.1: N-FIRM NASH EQUILIBRIUM (SYMMETRIC CASE)

3. The relative slope of the q curve and k curve:

The total differentiation of equations (42) and (44) with respect to q and k around a symmetric equilibrium gives

$$(a.12) \begin{vmatrix} 1 & -(D + (N - 1)U) \\ -(NP''q + P')(N - 1)U + \partial C/\partial k & -P'(N - 1)q \partial U/\partial k + q\partial^2 C/\partial k^2 \end{vmatrix} \begin{vmatrix} dq \\ dk \end{vmatrix} = \begin{vmatrix} 0 \\ 0 \end{vmatrix}$$

where $D = \partial q_i/\partial k_i$. The determinant of this matrix is positive, as shown below, which implies that k curve is steeper than the q curve.

I consider the following myopic adjustment process, where each firm increases its investment if marginal profit is judged to be positive.

$$(a.13) \dot{k}_i = A_i \partial g_i/\partial k_i, A_i > 0$$

Linearization around the symmetric equilibrium gives

$$(a.14) \begin{matrix} \dot{k}_1 = & A_{1g11} & A_{1g12} & \dots & A_{1g1N} & k_1 - k^* \\ \dot{k}_2 & A_{2g21} & A_{2g22} & \dots & A_{2g2N} & k_2 - k^* \\ & & & & & \\ & & & & & \\ & & & & & \\ \dot{k}_N & A_{NgN1} & A_{NgN2} & \dots & A_{NgNN} & k_N - k^* \end{matrix}$$

A sufficient condition for the stability of this adjustment process is diagonal dominance:

$$(a.15) |g_{ii}| > \sum_{j \neq i} |g_{ij}| - (N - 1) |b_i|$$

where $g_{ij} = b_i$ for all $j \neq i$, given the symmetry of equilibrium.

Given the second order condition (equation (41)), $a_i = g_{ii} < 0$.

Consequently, equation (a.15) implies that

$$(a.16) \quad a_i + (N - 1)b_i < 0$$

If we denote $\partial^2 q_i / \partial k_j \partial k_i = E$ for all i and j except for $i = j$, we have the following equality, given the symmetry of equilibrium:

$$(a.17) \quad \sum_{j \neq i} \partial^2 q_j / \partial k_i^2 = \partial / \partial k_i \sum_{j \neq i} \partial q_j / \partial k_i = \partial / \partial k_i \sum_{j \neq i} \partial q_i / \partial k_j \\ = \sum_{j \neq i} \partial^2 q_i / \partial k_i \partial k_j = (N-1)E$$

We also get the following equality: For any $i \neq j$,

$$(a.18) \quad \sum_{j \neq i} \partial^2 q_j / \partial k_i \partial k_j = \partial / \partial k_i (\sum_{j \neq i} \partial q_j / \partial k_i) = \partial / \partial k_i (\sum_{j \neq i} \partial q_i / \partial k_j) \\ = \sum_{j \neq i} \partial^2 q_i / \partial k_i \partial k_j = U / \partial k - E$$

since $\partial U / \partial k = \sum_{j=1}^N \partial / \partial k_j \partial q_i / \partial k_j = E + \sum_{j \neq i} \partial^2 q_i / \partial k_i \partial k_j$

Given equations (a.17) and (a.18),

$$a_i = g_{ii} \\ = P''(D + (N - 1)U)(N - 1)Uq + P'((N - 1)Eq + (N - 1)UD) \\ - D \partial C / \partial k - q \partial^2 C / \partial k^2$$

and

$$\begin{aligned}
 b_1 &= g_{11} \\
 &= P''(D + (N - 1)U)(N - 1)Uq + P'((\partial U/\partial k - E)q + (N - 1)U^2) \\
 &\quad - U \partial C/\partial k
 \end{aligned}$$

Given these equations, equation (a.16) implies that the determinant of the coefficient matrix of equation (r.12) is positive.

4. $\partial/\partial N [(N - 1)(-U(k))] > 0$ for linear demand case:

We assume the following market demand function:

$$(a.12) \quad P = a - bQ \quad \text{and}$$

In this case

$$(a.14) \quad U = \partial q_i/\partial k_i = \partial q_i/\partial C_j \partial C/\partial k = (1/b)(1/(N+1))C'(k) < 0$$

Consequently,

$$\begin{aligned}
 (a.15) \quad \partial/\partial N [(N - 1)(-U(k))] &= - (1/b)C'(k) \partial/\partial N \{(N - 1)/(N + 1)\} \\
 &= - (2/b) C'(k)/(N + 1)^2
 \end{aligned}$$

Thus higher domestic competition strengthens strategic incentive for investment.

5. $\partial W/\partial k_1 < 0$ for $N \geq 3$ for a linear market demand:

Since

$$(a.16) \quad \frac{\partial q_i}{\partial k_1} \frac{\partial C}{\partial k} \frac{\partial q_i}{\partial C} \frac{\partial C}{\partial k} (-1/b)N/(N+1) > 0,$$

we get the following result corresponding to equation (49) in the text:

$$\begin{aligned} (a.17) \quad \partial W/\partial k_1 &= (P - C)\{- (1/b)N/(N+1) + (2/b)(N-1)/(N+1)\} \partial C/\partial k \\ &= (P - C)(1/b)\{(N-2)/(N+1)\} \partial C/\partial k < 0 \quad \text{for } N \geq 3 \text{ and} \\ &= 0 \quad \text{for } N = 2. \end{aligned}$$

The latter result is consistent with the result obtained by Brander and Spencer (1983).

REFERENCES

- Arrow, K. J. (1962), "Economic Welfare and the Allocation of Resources of Invention," in Nelson, R. R. ed., The Rate and Direction of Inventive Activity, Princeton University Press: 619-622.
- Balassa B. and M. Noland (1988), Japan in the World Economy, Institute of International Economics.
- Barzel, Y. (1968), "Optimal Timing of Innovations," Review of Economics and Statistics, 50, August: 348-355.
- Brander, J. A. and Spencer, B. J. (1983), "Strategic Commitment with R&D: The Symmetric Case," Bell Journal of Economics, Spring: 225-235.
- Bulow, J. I., Geanakoplos, J. D. and Klemperer P.D. (1985), "Multimarket Oligopoly: Strategic Substitutes and Complements," Journal of Political Economy, 93, pp. 488-511.
- Dixit, A. and Stern, N. (1982), "Oligopoly and Welfare: A Unified Presentation with Applications to Trade and Development," European Economic Review, 19, 123-143.
- _____. (1986) "Comparative Statics for Oligopoly," International Economic Review, Vol. 27, No. 1, February.
- Flamm, K. (1988), Creating the Computer: Government, Industry and High Technology, The Brookings Institution.
- Fudenberg, D. and Tirole, J. (1983), "Learning by Doing and Market Performance," Bell Journal of Economics, 14, 522-530.
- _____. (1986), Dynamic Models of Oligopoly, Harwood Academic Publishers.
- Hahn, F. H. (1962), "The Stability of the Cournot Oligopoly Solution," Review of Economic Studies, vol. 32, pp. 329-331.
- Helpman, E. and Krugman, P. (1989), Trade Policy and Market Structure, The MIT Press: Cambridge.
- Itoh, M., Kiyono, K., Okuno, M. and Suzumura, K. (1988), Economic Analysis of Industrial Policy, the University of Tokyo Press.

- Krugman, P. R. (1984), "Import Protection as Export Promotion," in H. Kierzkowski (ed.), Monopolistic Competition and International Trade, Oxford: Blackwell.
- Mankiw, N. and Whinston, M. D. (1986), "Free Entry and Social Inefficiency," Rand Journal of Economics, vol. 17, No. 1 Spring, pp. 48-58.
- O.E.C.D. (1987), Structural Adjustment and Economic Performance.
- Rodrik, D. (1989), "Closing the Productivity Gap: Does Trade Liberalization Really Help?," in G. K. Helleiner (ed.) Trade Policy, Industrialization and Development: A Reconsideration, the Oxford University Press.
- Rotemberg, J. J., and Saloner (1988), "Tariffs vs. Quotas with Implicit Collusion," Canadian Journal of Economics, forthcoming.
- Tandon, P. (1984) "Innovation, Market Structure and Welfare," American Economic Review, vol. 74, No. 3, pp. 394-403.
- Tirole, J. (1988), The Theory of Industrial Organization, the MIT Press, Cambridge, Massachusetts.
- Venables, A.J. (1985), "Trade and Trade Policy with Imperfect Competition: The Case of Identical Products and Free Entry." Journal of International Economics 19: 1-20.
- _____. (1987), "Trade and Trade Policy with Differentiated Products: A Chamberlinian-Ricardian Model." Economic Journal. 97: 700-717.

CHAPTER II

TEMPORARY PROTECTION AND TECHNOLOGY CATCHUP

A. Introduction -- Potential Competition
and Industry Behavior

The standard presumption among policy advisors for industrial policy is that protection, if granted for industrial development, should be temporary. The major reason is that the threat of import liberalization is believed to spur a domestic enterprise for active technological effort. Temporary nature of protection from import and direct foreign investment is often regarded to be one of the major "success" factors of the activist Japanese industrial policy in the 1950s and 1960s.^{1/}

However, there exist only a few theoretical studies which have examined the linkage between temporary protection and industrial development rigorously.^{2/} Quite recently, Matsuyama and Itoh (1987) have

1/ See Itami and others (1988), Chapter 7, for such view in the case of the industrial policy for the development of the Japanese automobile industry. However, the actual causality between temporary protection and industrial development could have been reverse. Successful industrial development of Japan could have allowed the government to remove protection. See the Chapter on policy endogeneity.

2/ There exists a large volume of theoretical literature analyzing the rationale for infant industry protection (See Corden (1974, Chapter 9) for a good review). However, most of these literature focuses its analysis on the optimality of trade interventions, making no substantive distinctions between temporary and permanent protection. A major exception is Grossman and Horn (1988), who have shown that when infant industry faces informational or reputational barriers to entry, temporary protection reduces the welfare by exacerbating moral hazard and adverse selections, while permanent protection might enhance it.

shown that temporary restriction of import and direct foreign investment may accelerate industrial development, while permanent protection might lead to industrial stagnation. Utilizing the dynamic oligopoly model developed by Spence (1979), they have demonstrated that protection can grant the first mover advantage to the domestic enterprise over its foreign competitor in the domestic market. When protection is believed to be temporary, the threat of future foreign competition gives the domestic enterprise strategic incentive to accumulate its domestic market specific capital, thereby preempting the investment opportunities by its foreign competitor in the market. They suggest that the model fits well with the Japanese experiences in the 1960s.

Although their analysis is highly insightful and in the same spirit as this paper is in emphasizing strategic investment, the scope of their analysis is limited to the role of market-specific investment such as investments in distribution network and customer reputation, since the critical assumption of their analysis is the location specificity of capital. Consequently, it does not have direct relevancy to technology development, which I regard as the central element of industrial development.

Rodrik (1989) has shown recently that protection accelerates technology catchup but temporary protection weakens this effect by reducing profitability of catchup. He, thus, questioned the conventional wisdom that temporary protection is conducive to technology development. However, since he treats import as an exogenous parameter in his model, he ignores the strategic motive for investment by the domestic enterprise. Since investment in cost reduction constitutes a sunk cost and thus has a

commitment value in product market competition, his analysis is substantially incomplete. He also does not analyze the welfare effect of policy interventions. This paper attempts to provide a systematic analysis of the linkage between the length of protection period and technology catchup.

The basic conclusions of the paper are the following: the response of the technology effort of the domestic enterprise to the change in the length of the protection period depends critically on (1) whether the strategic effect of increased competition due to import liberalization dominates its effect on market fragmentation and (2) whether increased competition causes the switch in the industrial strategy from entry accommodation to either entry deterrence or exit. Stronger technical capability of the domestic enterprise makes the positive response to shorter protection more likely. Reducing length of protection can induce a large jump in technological effort by such enterprise, if it triggers a switch in the strategy from entry accommodation to entry deterrence. On the other hand, reducing the length of protection tends to reduce technological effort by the enterprise with only weak technical capability.

As for welfare, the above response of the technology effort plays an important role, since there exists a tendency for underinvestment in cost reduction by the domestic enterprise.^{3/} When the domestic enterprise under permanent protection can achieve only a similar level of technical

^{3/} Underinvestment in technology is, however, substantially dependent on the assumption of the analysis below that there exists only one domestic enterprise. Overinvestment may arise for more competitive domestic market structure (See the chapter on Competition, Strategic Effect and Technology Catchup).

efficiency as the foreign enterprise, temporary protection is likely to reduce investment for cost reduction. Thus it has both negative dynamic welfare effect as well as negative static welfare effect. In this case to strengthen potential competition by reducing the length of protection may lead to a Pareto inferior equilibrium. This is a specific example in international trade field of the paradoxical effect of potential competition suggested by Stiglitz (1981).

B. Technological Catch-up Under Permanent and Temporary Protections

1. Analytical Framework

I use a two-stage duopoly model: there exist a single domestic enterprise and a single foreign competitor.^{4/} The structure of the game analyzed is the following. In the stage zero the government decides the length of protection period (T_L). In the stage one the domestic enterprise determines its investment for cost reduction. It is assumed that the foreign enterprise does not have the opportunity for investment in the first stage, either because it has already exhausted technological opportunities or because the market in question is too small to influence his investment decision. In the stage two, the domestic enterprise and the foreign enterprise compete in the product market. However, it is assumed that the government grants protection for the domestic enterprise from import competition (complete ban of export or direct foreign investment by

^{4/} Increasing the number of foreign competitors does not materially affect the result of the paper. Increasing the number of domestic enterprises can, however, substantially affect the welfare analysis, as explained in the footnote 3.

the foreign competitor) for the period T_L , to encourage technology development. It is further assumed that product market competition has the characteristic of strategic substitute in terms of quantity.^{5/}

I assume the existence of a technological opportunity by which the domestic enterprise can reduce its production cost linearly during the catchup period $[0, T_R]$ until a certain limit C_R as illustrated in Figure 1. I assume that C_R is a choice variable but T_R is constant for simplicity.

After import liberalization the two enterprises compete in the domestic market. The market equilibrium depends upon how much cost reduction the domestic enterprise has made. Lower production cost of the domestic enterprise increases its market share, as illustrated in Figure 2 for the case of quantity competition and strategic substitute in the domestic market. When the cost of the domestic enterprise declines below a certain critical value C_{ED} , it can maintain its monopoly position even after liberalization, given the existence of a fixed cost for the entry by the foreign enterprise in the domestic market.

2. Domestic Enterprise Under Permanent Protection

The domestic enterprise permanently protected from import chooses the level of technological catchup so as to maximize the net present value of its profit ($V(C_R)$):

$$(1) \quad V(C_R) = \int_{t=0}^{\infty} \exp(-rt) \pi_M(t; C(t)) dt - K(C_R)$$

^{5/} This condition is equivalent to the stability condition of the Cournot equilibrium proposed by Hahn (1962).

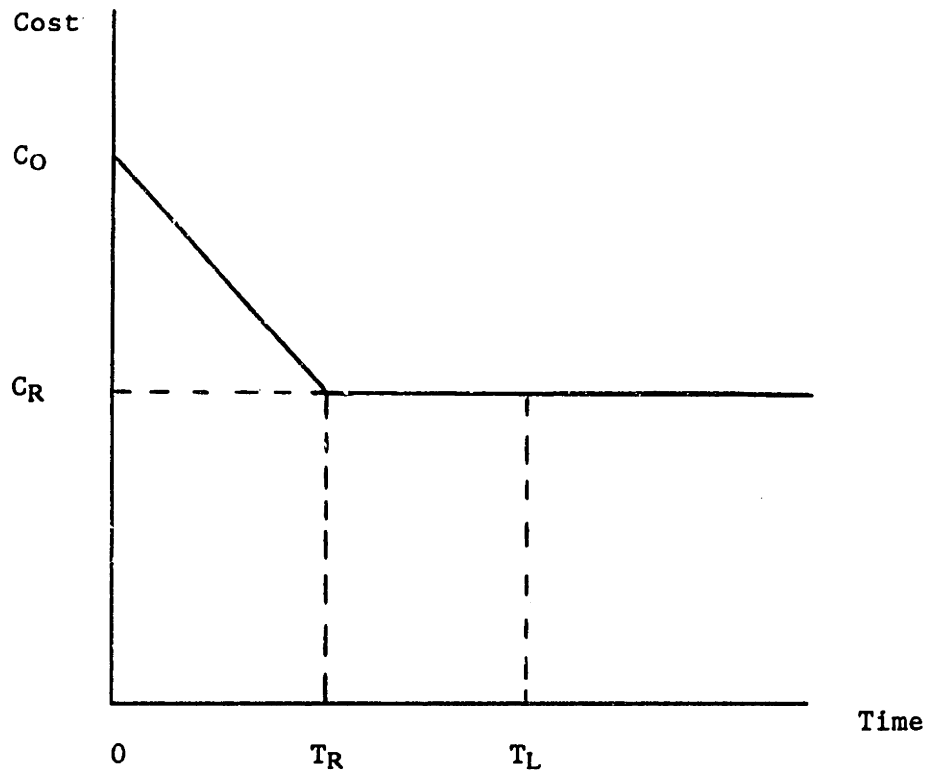


Figure 1: COST REDUCTION OPPORTUNITY FOR A DOMESTIC ENTERPRISE

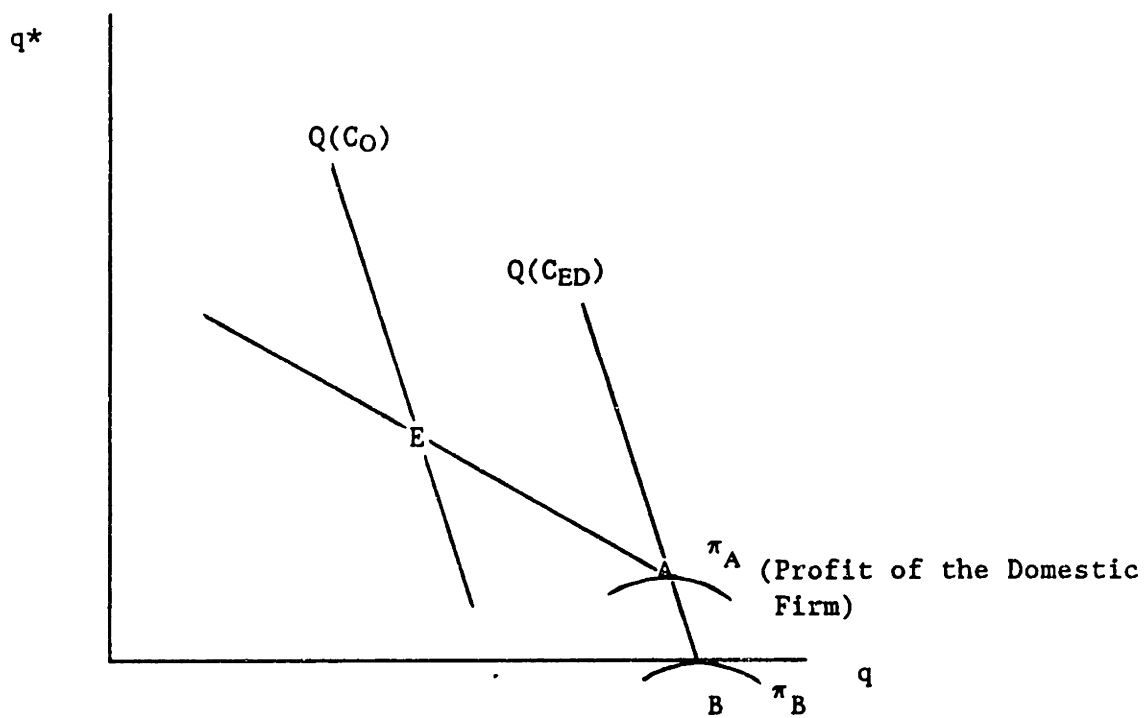


Figure 2: MARKET EQUILIBRIUM AFTER IMPORT LIBERALIZATION

where r stands for the discount rate of a firm, π_M stands for the monopoly profit and can be written as follows:

$$(2) \quad \pi_M (t, C(t)) = \text{Max}_Q (P(Q) Q - C(t) Q)$$

where $P(Q)$ is the inverse demand function faced by the domestic enterprise, Q is industry output and $C(t)$ is the cost at time t . $C(t)$ is given by

$$(3) \quad C(t) = C_0 - t/T_R (C_0 - C_R) \quad \text{for } t \leq T_R \\ = C_R \quad \text{for } t \geq T_R$$

$K(C_R)$ is the investment cost to be incurred to achieve the cost reduction from C_0 to C_R . We assume that

$$(4) \quad K'(C_R) < 0 \quad \text{and} \quad K''(C_R) \geq 0.$$

I denote the discounted revenue by $R(C_R)$:

$$(5) \quad R(C_R) = \int_{0-\infty} \exp(-rt) \pi_M(t; C(t)) dt$$

The value-maximization condition is

$$(6) \quad V'(C_R) = R'(C_R) - K'(C_R) \\ = \int_{0-\infty} \exp(-rt) \partial \pi_M / \partial C_R dt - K'(C_R) \\ = 0$$

The first term is negative, since higher production cost reduces instantaneous profit of the domestic enterprise. C_R is determined so as to balance the marginal gain from improved cost condition and the increased investment cost. I denote the value C_R maximizing V by C^P . Figure 3 illustrates the determination of C^P .

I assume that the second order condition $V''(C_R) < 0$ holds globally.

3. Domestic Enterprise Under Temporary Protection

Next I consider the behavior of the domestic enterprise under temporary protection. I assume that the protection period T_L is longer than T_R for simplicity in the main paper.^{6/} The domestic enterprise chooses C_R so as to maximize:

$$(7) \quad V(C_R; T_L) = \int_{0-TL} \exp(-rt) \pi_M(t; C(t)) dt + \int_{TL-\infty} \exp(-rt) \pi(t, C_R) dt - K(C_R)$$

where $\pi(t, C_R)$ is the instantaneous profit after liberalization. We have to distinguish the two cases in specifying $\pi(t; C_R)$, monopoly case and duopoly case:

$$(8) \quad \pi(t; C_R) = \begin{cases} \pi_M(t; C_R) & \text{if } C_R \leq C_{ED} \\ \pi_D(t; C_R, C^*) & \text{if } C_R > C_{ED} \end{cases}$$

^{6/} Since the main objective of the analysis of this paper is to compare temporary protection and permanent protection, this assumption does not materially constrain the analysis. This assumption simplifies the analysis since no change in the market structure takes place after liberalization. See the section 3 of the Appendix for the analysis of the case for $T_L < T_R$.

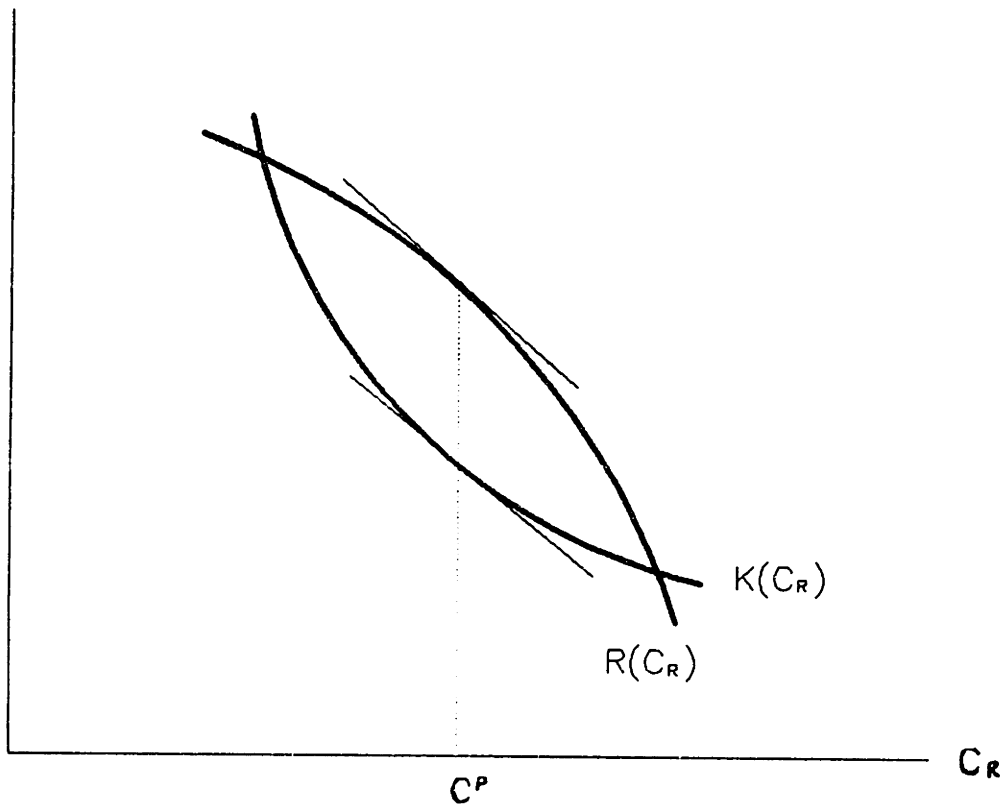


Figure 3: DETERMINATION OF THE LEVEL OF TECHNOLOGY
UNDER PERMANENT PROTECTION

where $\pi_D(t; C_R, C^*)$ is the profit of the domestic enterprise in the duopoly equilibrium in the domestic market and C^* is the production cost of the foreign enterprise. We assume that C^* is an exogenous parameter. Remembering that $R(C_R; T_L)$ denotes the discounted revenue, $R(C_R; T_L)$ declines by a discrete amount at $C_R = C_{ED}$ as C_R increases, since $\pi_M(t; C_R) > \pi_D(t; C_R, C^*)$ for $t > T_L$, as shown in Figure 4.

Due to the discontinuity of the value function, the domestic enterprise is confronted with the following strategic decision:

(I) Entry Accommodation. The domestic enterprise accommodates the entry of the foreign enterprise and chooses the most profitable technology level within this framework. The value-maximization condition in this case is

$$(9) \quad \frac{\partial V(C_R; T_L)}{\partial C_R} = \int_{0-T_L} \exp(-rt) \frac{\partial \pi_M}{\partial C_R} dt + \int_{0-T_L} \exp(-rt) \frac{\partial \pi_D}{\partial C_R} dt - K'(C_R) = 0 \text{ for } C_R > C^{ED}$$

I denote the solution of this equation as C^A , as shown in Figure 4.

(II) Entry Deterrence. The domestic enterprise deters the entry of the foreign enterprise by achieving significant cost reduction. The value maximization requires

$$(10) \quad V(C_{ED}; T_L) \Big|_{\text{monopoly}} > V(C^A; T_L) \Big|_{\text{duopoly}} \text{ if } \frac{\partial V}{\partial C_R}(C_{ED}; T_L) \Big|_{\text{monopoly}} \geq 0$$

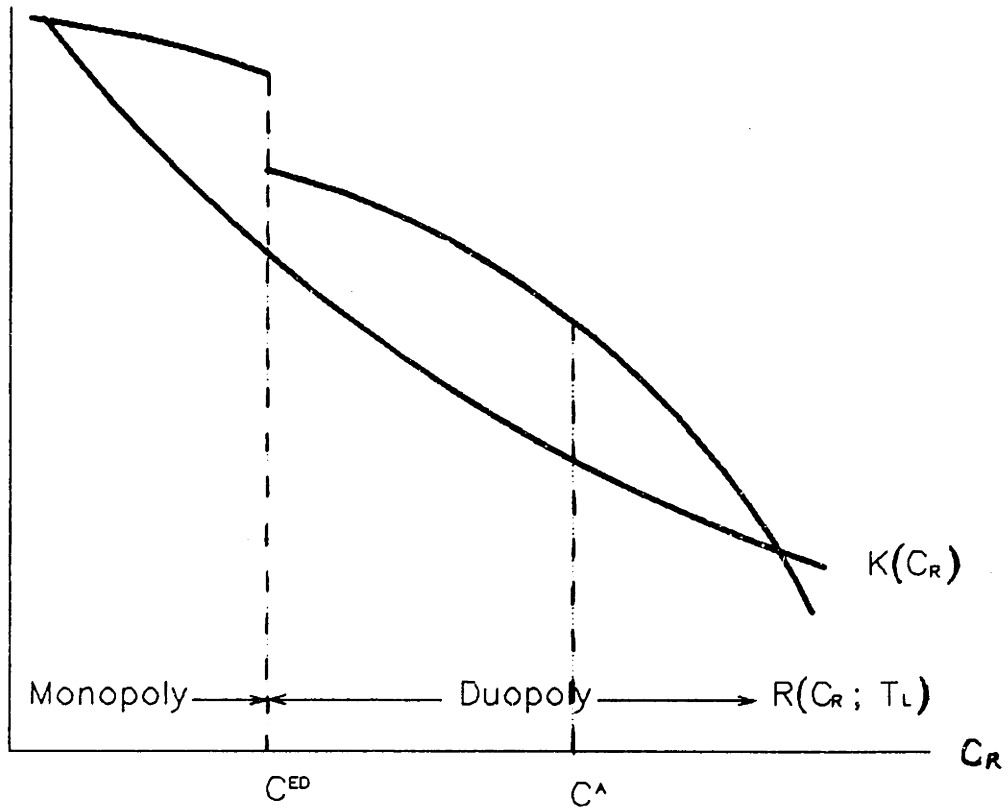


Figure 4: DETERMINATION OF THE TECHNOLOGY LEVEL UNDER TEMPORARY PROTECTION

It is the same as equation (6) for the enterprise under permanent production, if $V'(C_R; T_L)|_{\text{monopoly}} = 0$ and $V(C_R; T_L)_{\text{Monopoly}} > V(C^A; T_L)$

Duopoly.

C. Impact of Temporary Protection on Technical Efficiency

1. Effects on the Discounted Profit

Here I examine the effect of the length of protection on the technology development achieved by the domestic enterprise based on the analytical framework developed in the section B. The striking point is that shortening the length of protection can accelerate technology development significantly if it can trigger the shift of the strategy of the domestic enterprise from entry accommodation to entry deterrence.

First, I analyze the effect of the length of protection (T_L) on the level of the value function $V(C_R; T_L)$. The partial derivative of equation (7) gives us

$$(11) \quad \partial V / \partial T_L(C_R; T_L) = \exp(-rT_L) [\pi_M(T_L; C_R) - \pi(T_L; C_R)]$$

$$= \begin{cases} \exp(-rT_L) [\pi_M(T_L; C_R) - \pi_M(T_L; C_R)] = 0 & \text{if } C_R < C_{ED} \\ \exp(-rT_L) [\pi_M(T_L; C_R) - \pi_D(T_L; C_R)] > 0 & \text{if } C_R \geq C_{ED} \end{cases}$$

since the monopoly profit is larger than the profit of the domestic enterprise under duopoly. The value function does not shift once $C_R < C_{ED}$

as long as $T_L > T_R$, since the highly competitive position of the domestic enterprise prevents the entry of the foreign enterprise independent of the existence of the import protection. Figure 4 illustrates the effect of shortening protection from infinity to a finite period $T_L > T_R$.

Shorter protection period can make the domestic enterprise prefer not to enter. As shown in Figure 5, when the revenue function $R(C_R; T_L)$ shrinks beyond the level of R^E , the domestic enterprise prefers not to enter.

The effect on the slope of $V(C_R)$ is given by differentiating equation (9):

$$(12) \quad \frac{\partial^2 V(C_R; T_L)}{\partial T_L \partial C_R} = \exp(-rT_L) \{ (-\partial \pi_D(T_L; C_R) / \partial C_R) - (-\partial \pi_M(T_L; C_R) / \partial C_R) \}$$

for $C_R > C_{ED}$. The sign of this equation depends on the following two effects. First, the difference in the size of the market served by the domestic enterprise (market fragmentation effect). If the entry of the foreign enterprise reduces the size of the market served by the domestic enterprise, the profit effect of cost reduction declines by that amount. Second, the response of the output or price of the foreign enterprise to the cost reduction of the domestic enterprise (strategic effect). Import competition creates strategic incentive for cost reducing investment. In the case of strategic substitute the market fragmentation effect of import liberalization is negative but its strategic effect is positive,^{7/} so that the sign of $\frac{\partial^2 V}{\partial T_L \partial C_R}$ depends on the balance of these two effects. If

^{7/} In the case of strategic complement strategic effect is negative, since the aggressive behavior (e.g., price cut) by the domestic enterprise invites a similar behavior by its competitor (e.g., price cut).

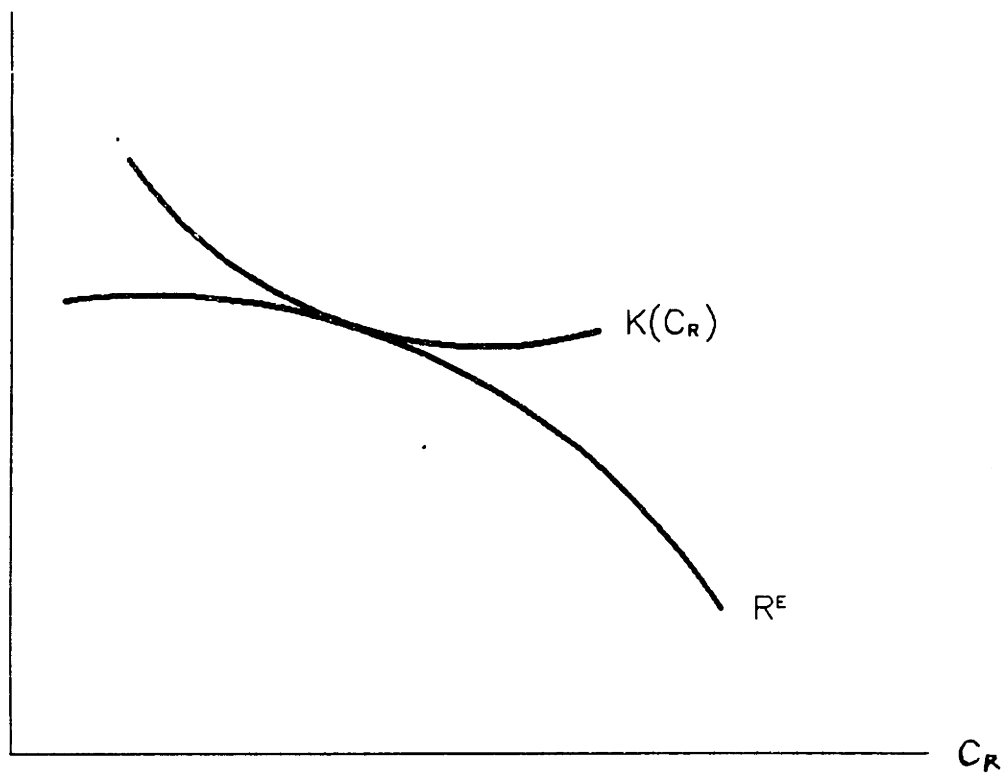


Figure 5: EXIT OF THE DOMESTIC ENTERPRISE

strategic effect of import competition dominates its market fragment effect, equation (12) has a positive sign.

2. Change in the Entry Accommodation Strategy

Let's investigate what will happen to the optimal C_R as T_L is adjusted when the entry accommodation remains the best strategy. I assume that the domestic enterprise under permanent protection does not achieve the technology level necessary to deter the entry of the foreign enterprise. I also assume that the entry accommodation strategy remains the best strategy for any T_L . Totally differentiating equation (9), we get the following equation:

$$(13) \quad \partial C^A / \partial T_L = (\partial^2 V / \partial T_L \partial C_R) / (-V''(C_R))$$

The second order condition requires that $V''(C_R) < 0$, so that $\partial C^A / \partial T_L$ has the same sign as $\partial^2 V / \partial T_L \partial C_R$. Consequently, if the strategic effect of import competition dominates its market fragmentation effect, shorter protection or more imminent import competition results in lower production cost. If the opposite is true, shorter protection results in higher production costs. In the latter case, stronger potential competition from import reduces technological effort by the domestic enterprise.

The causal relation between T_L and C_R is bi-directional, since the balance between the market fragmentation effect and the strategic effect of import competition depends on the competitiveness of the domestic enterprise at the time of liberalization or C_R . In order for us to obtain an

explicit expression for the effect of the change in C_R on the balance of the market fragmentation and strategic effects, let us focus our analysis on linear demand and Cournot-Nash competition. In this case, it is possible to obtain the following equation (see appendix):

$$(14) \quad \partial^2 V(C_R, T_L) / \partial T_L \partial C_R = \exp(-rT_L) (8C^* - 7C_R - 1)$$

According to this equation, relatively high competitiveness of the domestic enterprise at the time of import liberalization results in the dominance of strategic effect. When the domestic enterprise has only low competitiveness, market fragmentation effect dominates. Let us denote the boarder line competitiveness by C_B , which is a function of the competitiveness of the foreign enterprise.

$$(15) \quad C_B = C^* - (1 - C^*)/7 < C^*$$

As illustrated in Figure 6, the technological response of the domestic enterprise to the length of protection period can have the following two patterns in the case of linear demand and Cournot-Nash competition. When $C_R(T_L = \infty)$ or the production cost level under permanent protection is below C_B , shortening the length of protection from infinity to a finite period encourages increasingly higher technological effort.^{8/} This is because shorter protection strengthens the competitiveness of the

^{8/} If $V''(C_R)$ is constant, equation (13) implies that C_R is concave for $C_R < C_B$ and convex for $C_R > C_B$ when T_L is large.

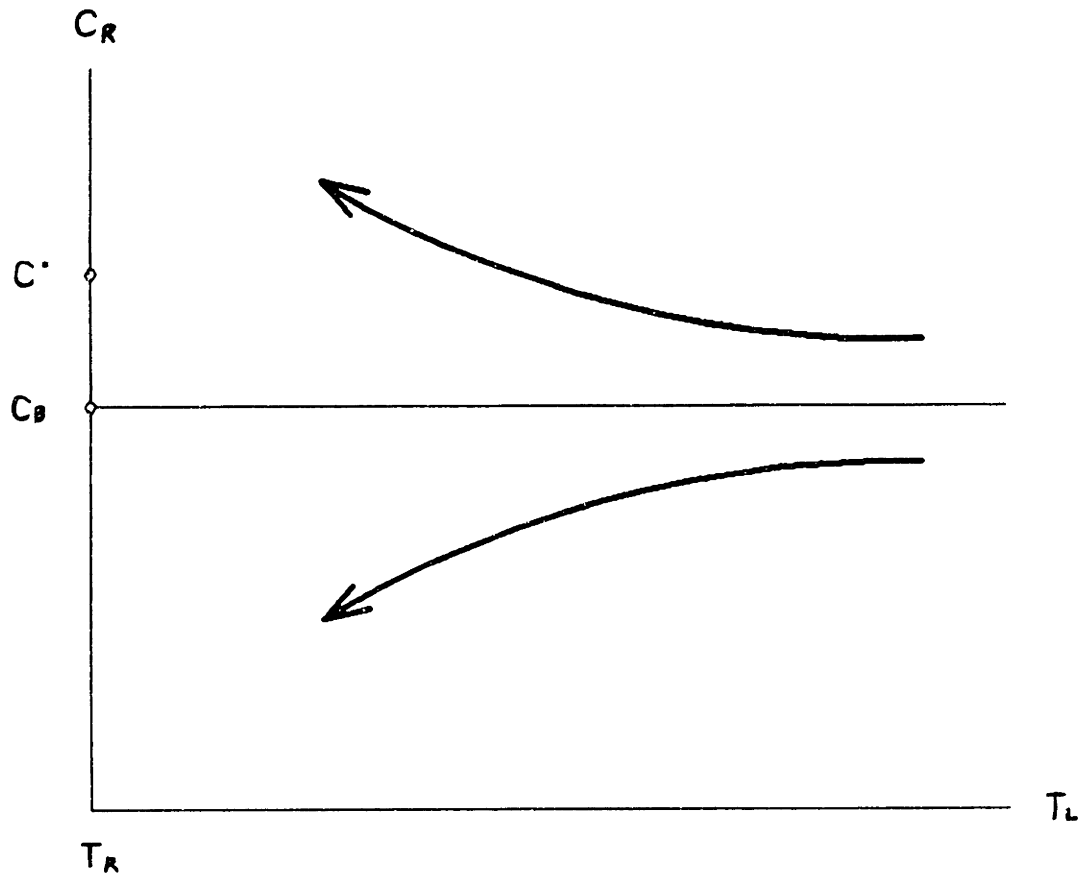


Figure 6: Technological Response to the Length of Protection
(Entry Accommodation Case)

domestic enterprise once C_R is below C_B , which in turn tends to strengthen the positive effect of further shortening protection on technology. On the other hand, when $C_R(T_L = \bullet)$ is above C_B , temporary protection is more detrimental to the technical efficiency, the shorter the protection period is.

3. Switch from Entry Accommodation Strategy to Entry Deterrence Strategy and to Exit

When the length of protection is shortened, it can trigger the change in the technology development strategy from entry accommodation to either entry deterrence or exit. As is shown by equation (11), as the protection period (T_L) becomes shorter, the curve $R(C_R; T_L)$ shrinks only for $C_R > C_{ED}$ and can cause such changes.

I first consider the switch to entry deterrence. I assume that the domestic enterprise under permanent protection does not choose the technology level necessary to deter the entry of foreign enterprise, as in the last subsection. However, I also assume that entry deterrence by domestic enterprise is feasible, given $T_L \geq T_R$.^{9/} The assumed situation is illustrated in Figure 7. In this case temporary protection can force the domestic enterprise to deter the entry of the foreign enterprise as follows.

As T_L becomes shorter, the curve $R(C^R; T_L)$ shrinks for $C_R > C_{ED}$. Let us assume that at a certain length of the protection period (T_L^S),

$$(15) \quad V(C^A; T_L^S) = V(C_{ED})$$

^{9/} If achieving the technical efficiency necessary for the entry deterrence is feasible under some length of protection ($T_L > T_R$), then it is also feasible for any $T_L > T_R$. However, it may become infeasible for $T_L < T_R$ (see the section 3 of Appendix).

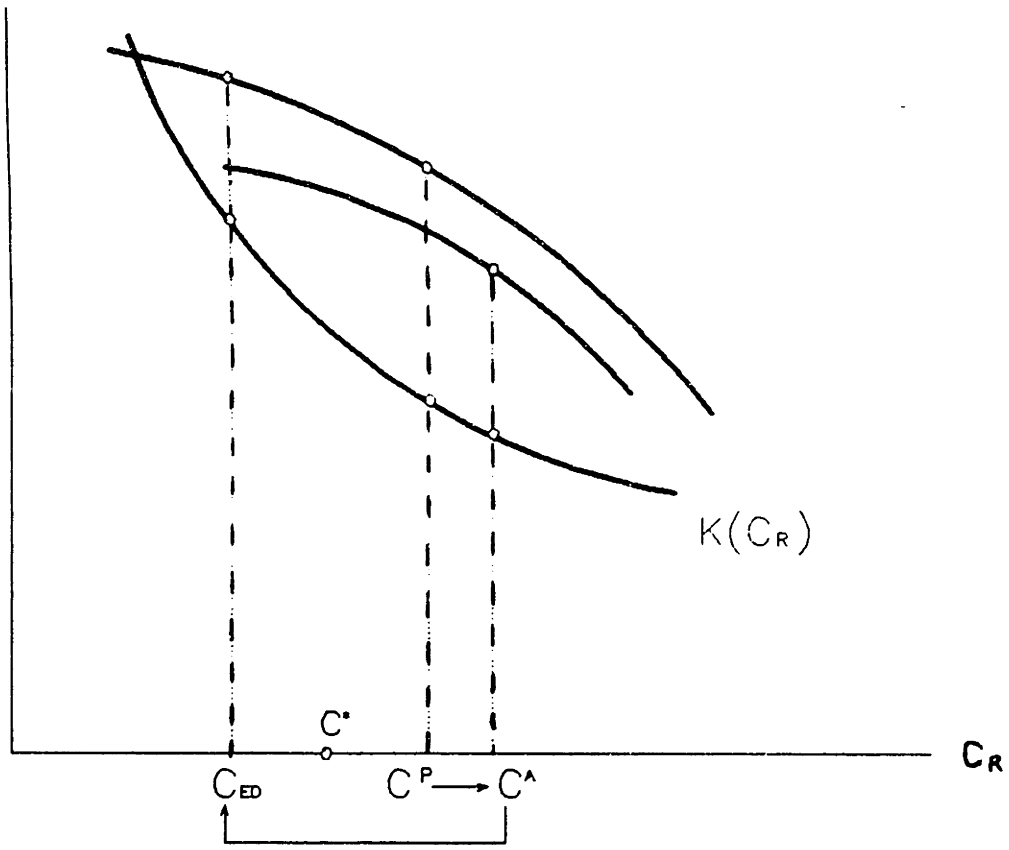


Figure 7: SWITCH IN THE STRATEGY
AS THE PROTECTION PERIOD BECOMES SHORTER

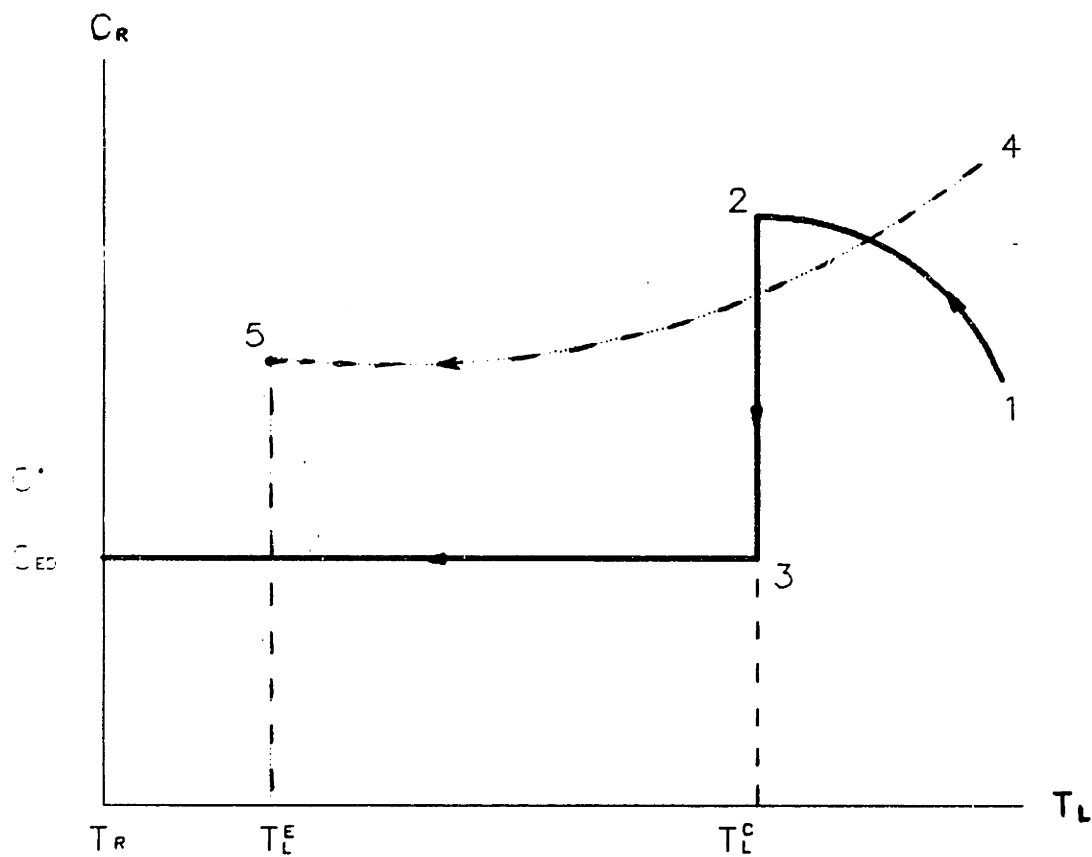
and

$$(16) \quad V(C^A; T_L) < V(C_{ED}) \text{ for } T_L < T_L^S.$$

At T_L^S , the technology development strategy switches from entry accommodation to entry deterrence. The domestic enterprise is induced to make a large jump in technology development as the fine tuning of entry accommodation fails to yield a larger profit than the drastic switch of strategy to entry deterrence.

As shown in the section C.2 in the case of linear demand and Cournot competition, the shorter protection period results in smaller technological effort when the domestic enterprise chooses technology level inferior to the boarder line competitiveness under permanent protection, as shown in Figure 7. If we take into account the possibility of entry deterrence, the relation of the protection period and technological catchup may not be monotonic. The shorter protection period can induce initially a smaller technological effort but if it is further shortened it can trigger a discrete increase in such an effort. Such response is illustrated as the line 123 in Figure 8.

Finally we consider the switch of the strategy to exit. Reduced protection period can invite monotonic increase in the technological effort due to the dominance of strategic effect of competition, until the domestic enterprise decides not to enter in the market. Such possibility is illustrated as the line 45 in Figure 8. In this case, although protection helps the domestic enterprise enter the market, longer protection beyond the minimum level (T_L^E) retards its technology effort.



**Figure 8: TECHNOLOGICAL RESPONSE TO THE CHANGES
IN THE PROTECTION PERIOD
(Cases Involving Strategy Switch)**

The main conclusions of this section can be summarized as follows:

- (a) The relation between the length of protection period and technology catchup depends critically on the balance of strategic effect and fragmentation effect of increased competition and on the potential switch in the technology strategy taken by the domestic enterprise. High technical capability of the domestic enterprise tends to make the relation between protection period and technological investment negative, i.e. shorter period of protection encourages more technological catchup, even if the switch of the business strategy does not happen.
- (b) The reduction in the protection period can trigger a large jump in technological effort, when the domestic enterprise switches its technology development strategy from entry accommodation to entry deterrence.
- (c) The reduction in the protection period can also trigger exit of the domestic enterprise. In this case temporal protection helps the domestic enterprise enter into the market.

D. Impact of Temporary Protection on Welfare

1. Underinvestment in Technology Development

In this subsection I show that the domestic monopoly enterprise underinvests in cost reduction, so that marginal increase of the investment in cost reduction benefits the economy. The national welfare is represented by

$$(17) \quad W(C_R; T_L) = V(C_R; T_L) + CS(C_R; T_L)$$

where $CS(C_R; T_L)$ is the consumers' surplus. $CS(C_R; T_L)$ can be written as

$$(18) \quad CS(C_R; T_L) = \int_{0-T_L} \exp(-rt) f(q_M(C(t))) dt \\ + \int_{T_L-\infty} \exp(-rt) f(q(C_R, C^*) + q^*(C_R, C^*)) dt$$

where $q_M(q)$ is the output of the domestic enterprise before the liberalization (after the liberalization), q^* the output of the foreign enterprise after the liberalization (zero if its entry is deterred), and f is the instantaneous consumers' surplus function.

Differentiating (17) with respect to C_R , we have

$$(19) \quad \partial W / \partial C_R = \partial V / \partial C_R + \partial CS / \partial C_R \\ = \partial CS / \partial C_R \\ = \int_{0-T_L} \exp(-rt) f'(\partial q_M / \partial C(t)) (\partial C(t) / \partial C_R) dt \\ + \int_{T_L-\infty} \exp(-rt) f'(\partial q / \partial C_R + \partial q^* / \partial C_R) dt$$

since $\partial V / \partial C_R = 0$ by the profit maximization condition for the domestic enterprise.

Since we assume the strategic substitute in product market competition, we get

$$(20) \quad \partial q / \partial C_R + \partial q^* / \partial C_R < 0$$

Since $\partial q_M / \partial C(t) < 0$, $f' > 0$ and $\partial(C(t) / \partial C_R) \geq 0$, we definitely have

$$(21) \quad \partial W / \partial C_R < 0.$$

However, if the change in C_R is non-marginal, $\Delta W / \Delta C_R$ can be positive, since such change is accompanied by the change in market structure. In particular, if shorter protection causes the switch of technology development strategy from entry accommodation to entry deterrence, C_R declines discretely but market supply after liberalization can also decline discretely. (In Figure 2, E (entry accommodation) can lie above the 45° line through B (entry deterrence)). Since domestic enterprise itself is indifferent to such switch, the net welfare may decline, even though the economy still enjoys the discrete expansion of supply before liberalization. On the other hand, the switch from entry accommodation to exit can be welfare reducing, since supply declines after liberalization and the domestic enterprise itself is indifferent to such switch even though elimination of protection brings about initial expansion of supply.

Therefore we can conclude that the domestic enterprise underinvests in cost reduction, possibly except when further cost reduction causes the switch in technology development strategy from entry accommodation to entry deterrence. The level of production cost is generally too high from the national point of view in this model, so that policy interventions

encouraging investment in cost reduction are welfare improving. Protection can be potentially justified on this ground, as seen in the next subsection, although it is not the first best instrument.

2. Impact of Temporary Protection

Let us analyze the impact of the length of protection on the welfare. I concentrate in the case where entry accommodation remains the best strategy.^{10/} Totally differentiating equation (17) with respect to T_L we get

$$(22) \quad dW/dT_L = \partial W/\partial T_L + (\partial W/\partial C_R)(\partial C_R/\partial T_L)$$

The first term represents the standard tradeoff between the loss in consumers surplus and the gain in the producer's profit due to postponed liberalization in the oligopolistic domestic market for a given level of the competitiveness of the domestic enterprise. I call it a static welfare effect of longer protection. In the case of a linear demand and a Cournot-Nash competition it is possible to derive

$$(23) \quad \partial W/\partial T_L = \exp(-rT_L) (1 - 2C^* + C_R) (1 + 2C^* - 3C_R)/24$$

The second term represents the welfare effect due to the change in the competitiveness of the domestic enterprise induced by longer

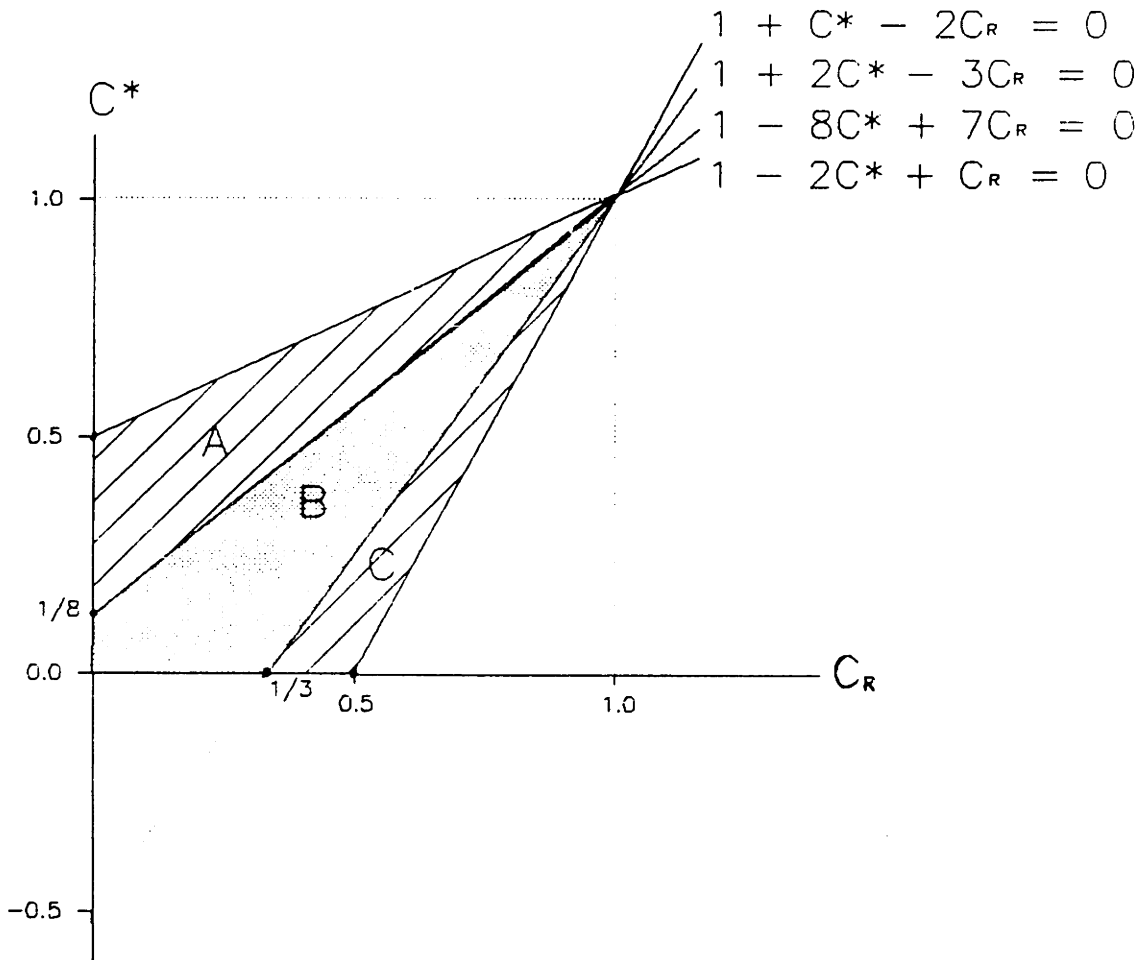
^{10/} As shown in the Appendix, it is possible to relax the assumption of $T_L > T_R$ for the entry accommodation case.

protection. I call it as a dynamic welfare effect of longer protection. Since the domestic enterprise underinvests in cost reduction, the dynamic welfare effect is positive if longer protection encourages investment in cost reduction. In the case of linear demand and Cournot-Nash competition, it is possible to derive

$$(24) \quad (\partial W/\partial C_R)(\partial C_R/\partial T_L) - (-\partial W/\partial C_R)(-1/V''(C_R; T_L)) \\ \exp(-rT_L)(1 - 8C^* + 7C_R)/18$$

It is possible to identify the three regions in the (C_R, C^*) space by the signs of the static and dynamic welfare effects of longer protection, as illustrated in Figure 9. In the area B (the domestic enterprise has a similar level of efficiency as the foreign enterprise) both static and dynamic welfare effects are positive, so that longer protection benefits the economy. If the dynamic welfare effect is strong (this would be the case when K'' is small), consumers can also gain from the longer protection, since the dynamic welfare effect accrues to consumers. Longer protection moves the economy from E to E' in the area B horizontally but keeps it in the area B. Consequently, the optimal policy is permanent protection among all protection programs ($T_L > T_R$). Conversely, temporary protection reduces welfare. It can also lead to a Pareto-inferior equilibrium, hurting both consumers and producers.

If the economy is in the area A or C (there exists relatively large efficiency gap between the domestic and foreign enterprises), there exists a tradeoff between static and dynamic welfare effects of protection. When



Area	Static Welfare Effect	Dynamic Welfare Effect	Total
A	+	-	?
B	+	+	+
C	-	+	?

Figure 9: STATIC AND DYNAMIC WELFARE EFFECTS OF LONGER PROTECTION

the domestic enterprise has high efficiency, longer protection generates positive static welfare effect, the gain in the producer's operating profit dominating the loss in the consumers' surplus. However, it also generates the loss in dynamic welfare, since longer protection makes the domestic enterprise more conservative for investment in cost reduction due to weaker threat from import competition. The net welfare effect is ambiguous.

If the economy is in area C, longer protection helps the domestic enterprise to achieve higher production efficiency by preserving the domestic market longer for the domestic enterprise. However, the government can do that only by incurring increasingly larger static welfare cost. However, if the government protects the domestic enterprise long enough, it may be able to move the economy from the point E" to E (although not necessarily). In this case marginal static welfare effect of longer protection becomes positive, although the cumulative welfare effect can still remain negative. Consequently, there is a possibility that marginal protection is welfare-reducing but long-enough protection is welfare-enhancing.

3. Some Policy Implication

Admitting the simplicity of the analysis, I try to draw some policy implication. It is important to bear in mind that the welfare analysis significantly depends on the assumption of a single domestic enterprise and the consequential underinvestment in technology.

(a) Under the circumstance where technology development is

important, the standard presumption that increasing actual and potential competition increases welfare can fail very easily. As demonstrated in Figure 9, strengthening potential competition from import can generate negative static welfare effect as well as negative dynamic welfare effect (area B).

- (b) The tradeoff of protection between static welfare effect and dynamic welfare effect is not absolute nor stable. There may be no such tradeoff at least at the margin of the length of protection (area B). Even if such trade off exists, longer protection can cause both positive and negative dynamic welfare effects, depending on the circumstance.
- (c) As the traditional literature on infant industry protection suggests, protection is not the first best instrument to correct underinvestment in technology. Although investment subsidy cannot correct the distortion due to the market powers in product market, it is still likely to be superior to protection, since it can increase technical efficiency without hurting consumers.

APPENDIX

1. Response of monopoly and duopoly profits to cost reduction (the case of Cournot-Nash competition and a linear demand):

I assume a linear demand $P = 1 - Q$ and a linear cost cq . In this case the monopoly profit π_M is given by

$$(a.1) \quad \pi_M = \text{Max}_q \{ (1 - q)q - Cq \}$$

The profit maximizing q is given by

$$(a.2) \quad q_M = (1 - C)/2 > 0$$

By the envelope theorem

$$(a.3) \quad \partial\pi_M/\partial C = -q_M < 0$$

When the domestic firm (the production cost C_R) is confronted with a foreign competitor (the production cost C^*), the profit of the domestic firm is given by

$$(a.4) \quad \pi_D = \text{Max}_q \{ [1 - (q + q^*)]q - C_R \cdot q \}$$

Assuming the Cournot-Nash equilibrium, the profit maximizing q and q^* are given by

$$(a.5) \quad q = (1 - 2C_R + C^*)/3$$

and

$$(a.6) \quad q^* = (1 - 2C^* + C_R)/3$$

Given these relations, the response of the profit (π_D) of the domestic enterprise to the change of its cost is given by

$$(a.7) \quad \partial \pi_D / \partial C_R = -q + q(\partial P / \partial Q)(\partial q^* / \partial C_R) = -4q/3$$

From (a.3) and (a.7), equating $C=C_R$, we get

$$(a.8) \quad \Delta(C, C_F) = (-\partial \pi_D / \partial C_R) - (-\partial \pi_M / \partial C_R) = -(7C_R - 8C^* + 1)/18$$

2. Static Welfare Effect of Longer Protection:

I derive the result under the same assumption as the section 1 in the appendix. The effect on the producers' surplus of longer protection (a unit increase in the protection period) is given by

$$(a.9) \quad \exp(-rT_L)(\pi_M - \pi_D) = \exp(-rT_L)[(1 - C_R)q_M - q_M^2 - ((1 - C_R - q^*)q - q^2)]$$

The effect on the consumers' surplus is given by

$$(a.10) \exp(-rT_L) (q_M^2/2 - (q + q^*)^2/2)$$

Consequently, the static welfare effect of longer protection (a unit increase in the protection period) is given by

$$\begin{aligned} (a.11) \exp(-rT_L) & \{ (1 - C_R)q_M - q_M^2/2 - (1 - C_R)q + 1/2 q^2 - 1/2 q^{*2} \} \\ & - \exp(-rT_L) \{ (q_M - q) \{ (1 - C_R) - (q_M + q)/2 \} - q^{*2}/2 \} \\ & \approx \exp(-rT_L) (q^*/2) \{ (1 - C_R) - (q_M + q)/2 - q^* \} \\ & = \exp(-rT_L) (1 - 2C^* + C_R)(1 + 2C^* - 3 C_R)/24 \end{aligned}$$

3. Analysis of the case where $T_L < T_R$:

When $T_L < T_R$, it is possible for the market structure to change over time even after T_L , since the domestic enterprise experiences continuous cost reduction until T_R . The most general case is illustrated in Figure A.1. In this Figure liberalization forces the domestic enterprise to make a temporary exit, since its cost at the time of liberalization (C_L) is too high to have non-negative profit. At time T_D , however, the domestic enterprise comes back to the market, since its cost has fallen to the level C_E , which allows the domestic enterprise to make non-negative profit. Further decline of the cost to C_{ED} forces the competitor out of the market.

The domestic enterprise thus chooses C_R so as to maximize

$$\begin{aligned}
 \text{(a.12) } V(C_R; T_L) - R(C_R; T_L) - K(C_R) &= \int_{0-T_L}^{\infty} \exp(-rt) \pi_M(t, C(t)) dt + \int_{T_D-T_M}^{\infty} \exp(-rt) \pi_D \\
 &\quad (t, C(t), C^*) dt \\
 &+ \int_{T_M-\infty}^{\infty} \exp(-rt) \pi_M(t, C(t)) dt - K(C_R)
 \end{aligned}$$

subject to

$$C_0 - (t/T_R)(C_0 - C_R) \quad \text{for } t \leq T_R$$

$$\text{(a.13) } C(t) =$$

$$C_R \quad \text{for } t \geq T_R$$

It is important to note that T_D and T_M are positively and linearly dependent on C_R , except when $T_D = T_L$ or $T_D = T_M = T_L$. Larger cost reduction makes both the period of temporary exit and the period of duopoly shorter, as illustrated in Figure A-1.

There exist three critical values of C_R , which cause shifts in the observed market structures. Let us denote by C_{RE} the cost level of C_R , which makes T_D equal to T_L . Similarly, C_{RD} represents the cost level of C_R , which makes T_M equal to T_R , C_{RM} represents the cost level of C_R , which makes T_M equal to T_L . It is obvious that $C_{RM} < C_{RD}$, since faster entry deterrence requires faster cost reduction. I assume that $C_{RD} < C_{RE}$ for the purpose of simplicity of exposition. Then it is possible to identify the four ranges of C_R , which have different pattern of the shift in market structure over time, as shown in Table A.1. C_{RE} and C_{RM} are positively and linearly dependent on T_L but C_{RD} is independent of T_L .

$R(C_R; T_L)$ is continuous with respect to C_R , except at $C_R = C_{RD}$. When $C_R > C_{RD}$, the domestic enterprise accommodates the entry of foreign

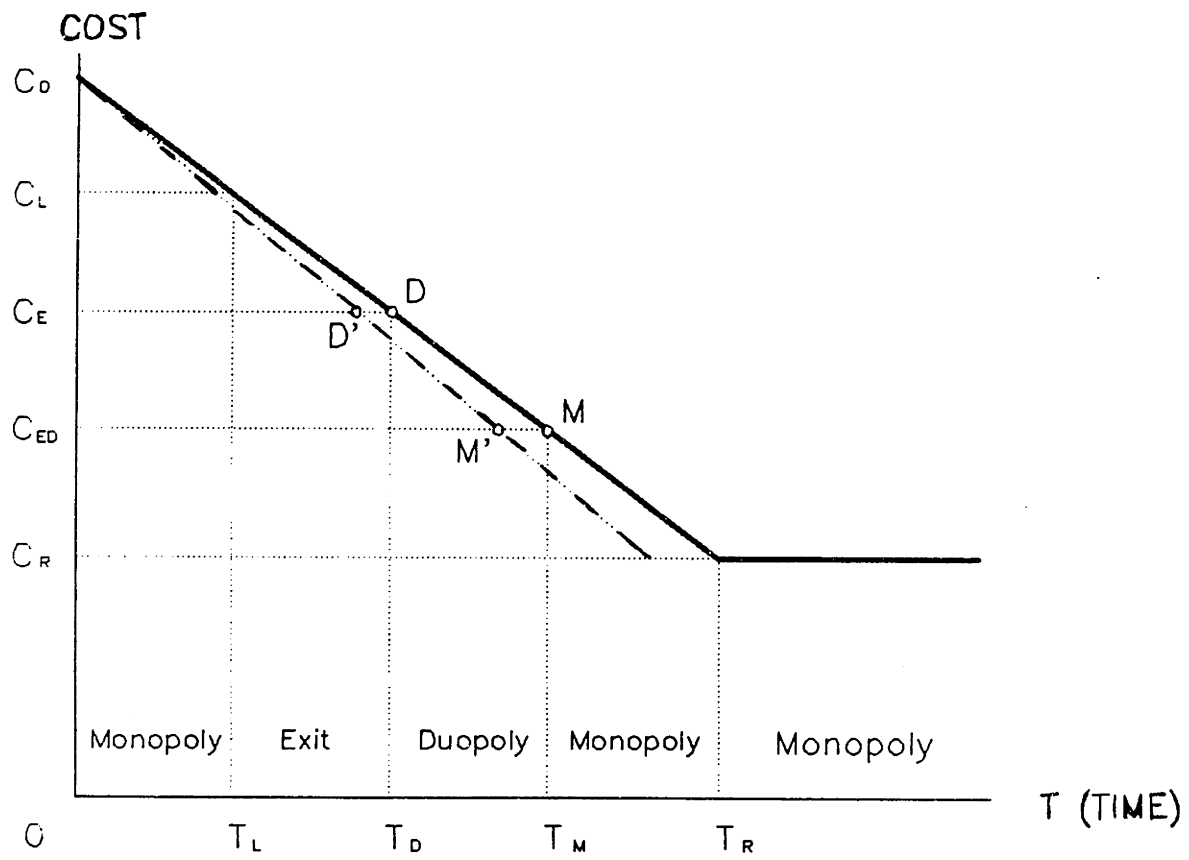


Figure A-1: CHANGE IN MARKET STRUCTURE

Table A.1: RESPONSE OF REVENUE TO COST CHANGE

Shift in Market Structure	$\partial R / \partial C_R$
(I) Monopoly ($C_R < C_{RM}$)	$\int_0^{\infty} \exp(-rt) \partial \pi_M / \partial C_R dt$
(II) Monopoly --> Duopoly --> Monopoly	$\int_0^{TL} \exp(-rt) \partial \pi_M / \partial C_R dt + \int_{TL}^{TM} \exp(-rt) \partial \pi_M / \partial C_R dt + \int_{TM}^{\infty} \exp(-rt) \partial \pi_D / \partial C_R dt$
($C_{RM} < C_R < C_{RED}$)	$dt - \partial TM / \partial C_R \exp(-rTM) (\pi_M - \pi_D)$
(III) Monopoly --> Duopoly	$\int_0^{TL} \exp(-rt) \partial \pi_M / \partial C_R dt + \int_{TL}^{\infty} \exp(-rt) \partial \pi_D / \partial C_R dt$
($C_{RED} < C_R < C_{RE}$)	$\partial \pi_D / \partial C_R dt$
(IV) Monopoly --> Exit --> Duopoly	$\int_0^{TL} \exp(-rt) \partial \pi_M / \partial C_R dt + \int_{TD}^{\infty} \exp(-rt) \partial \pi_D / \partial C_D dt$
($C_{RE} < C_R$)	

enterprise after T_R . Since profit of the domestic enterprise under duopoly is lower than that under monopoly and this shift in market structure takes place for more than infinitesimal period (i.e., the period for $T_R - \epsilon$), $R(C_R; T_L)$ declines by a discrete amount at $C_R = C_{RED}$ as C_R increases.

$R(C_R; T_L)$ is also continuously differentiable with respect to C_R , except when the change in C_R causes the shift in market structure.^{1/} Given the above critical values of C_R , it is possible to derive $\partial R/\partial C_R$ as in Table A.1 for the four ranges. It is clear that $\partial R/\partial C_R$ declines discretely at C_{RM} as C_R increases, since monopoly profit is larger than the profit under duopoly. On the other hand $\partial R/\partial C_R$ is continuous at C_{RE} .

Consequently $R(C_R; T_L)$ has the shape as illustrated in Figure A.2. There exist five distinct possibilities for the C_R maximizing $V(C_R; T_L)$.

- (a) Interior maximum for $C_R > C_{RED}$ (entry accommodation)
- (b) Corner maximum : $C_R = C_{RED}$ (entry deterrence)
- (c) Interior maximum for $C_{RM} < C_R < C_{RED}$ (entry deterrence)
- (d) Corner solution : $C_R = C_{RM}$ (absolute entry deterrence) and
- (e) Interior maximum for $C_R < C_{RM}$ (absolute entry deterrence),

where absolute entry deterrence implies that even temporary entry of the competitor during the catchup period is deterred.

The change of $R(C_R; T_L)$ in response to the change of T_L is shown in Table A.2. Shorter T_L reduces R and V except for $C_R < C_{RM}$. The first difference from the case where $T_L > T_R$ is that the value function shifts down even for $C_R < C_{RED}$, since the competitor makes a temporary but

^{1/} It is important to note that $\pi_D(T_D, C(T_D), C^*) = 0$, which allows us to get the simplified formula as in Table A.1.

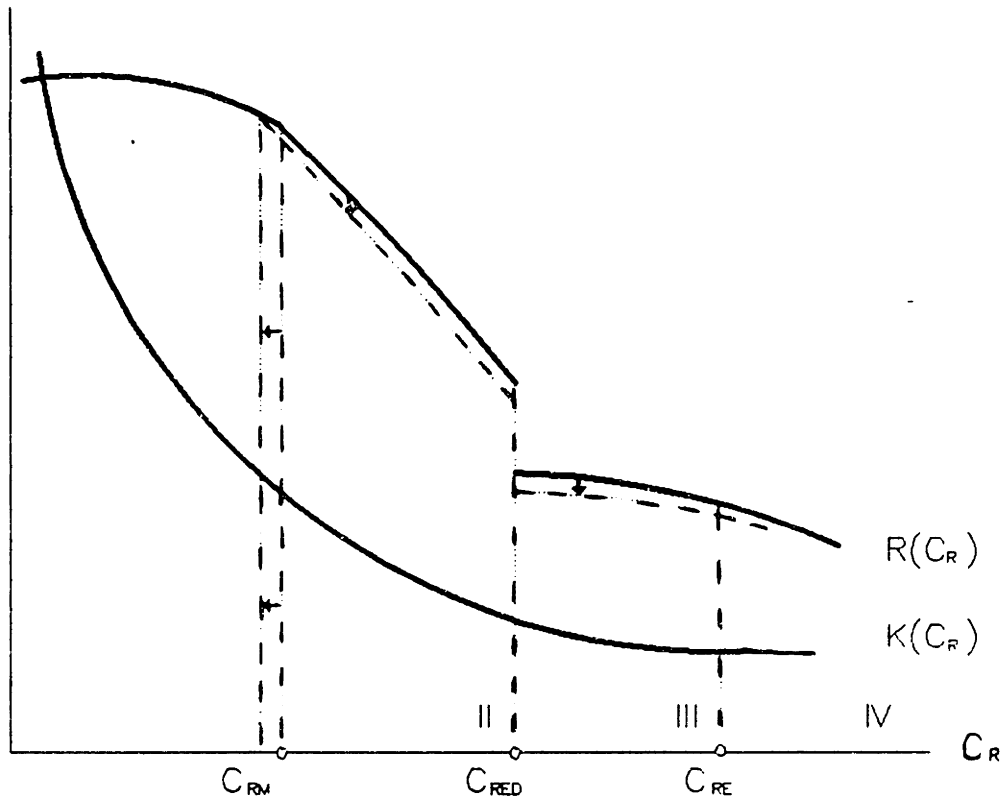


Figure A-2: REVENUE AND COST FUNCTIONS

successful entry in the market when $T_L < T_R$ as long as $C_R > C_{RM}$. The second difference is that C_{RM} declines as T_L becomes shorter while C_{RED} remains unchanged, since C_{RM} depends on T_L while C_{RED} depends only on T_R as long as $T_R < T_L$.

The above differences allow more variety of strategy shifts than the analysis in the main paper. For an example, shortening protection can cause the shift from absolute entry deterrence to entry deterrence, simply because the former becomes infeasible. It can cause the shift from entry accommodation to entry deterrence like the analysis presented in the main paper as well as the reverse shift. The shift from entry accommodation to entry deterrence is more likely than the reverse shift when C^* is high, since the difference between the excess of monopoly profit over the profit under duopoly tends to become larger, as C_R increases, when C^* is high (equation (14) does not change sign as long as $C_R > C_B$).

Table A.2 also shows $\partial^2 V / \partial T_L \partial C_R$. If strategy shifts do not take place, the response of the technological effort to shorter protection depends on the balance between the market fragmentation and strategic effects of increased competition as in the analysis of the main paper for the ranges II and III ($C_{RM} < C_{RED} < C_{RED}$). For $C_R < C_{RM}$, the technological effort is not influenced by the marginal change in the length of protection. For $C_R > C_{RE}$, the technological effort becomes smaller as protection becomes shorter, since shorter protection only reduces the opportunity from gaining profit from cost reduction by accelerating the timing of temporary exit of the domestic enterprise.

It is also clear from this Table A.2 that, if cost and revenue conditions are such that CRED is not feasible but CR remains below CRE, then the analysis presented in the entry accommodation case in the main paper also applies to the case for $TL < TR$ without any substantive modifications.

Table A.2: RESPONSE OF V AND $\partial V/\partial CR$ TO THE LENGTH OF PROTECTION

Shift in Market Structure	$\partial V/\partial TL$	$\partial^2 V/\partial TL \partial CR$
(I) $CR < CRM$ Monopoly	0	0
(II) $CRM < CR < CRE$ Monopoly-Duopoly-Monopoly	$\exp(-rTL) [\pi_M(TL) - \pi_D(TL)] > 0$	$\exp(-rTL) [(-\partial\pi_D(TL)/\partial CR) - (-\partial\pi_M(TL)/\partial CR)]$
(III) $CRE < CR < CRE$ Monopoly-Duopoly	"	"
(IV) $CRE < CR$ Monopoly-Exit-Duopoly	$\exp(-rTL)\pi_M(TL) > 0$	$-\exp(-rTL) \left\{ -\frac{\partial\pi_M(-TL)}{\partial CR} \right\} < 0$

REFERENCES

- Corden, W. M. (1974), Trade and Economic Welfare, Oxford: Oxford University Press .
- Grossman, G. M., and Horn, H. (1988), "Infant-Industry Protection Reconsidered: The Case of Informational Barriers to Entry," Quarterly Journal of Economics.
- Hahn, F. H. (1962), "The Stability of the Cournot Oligopoly Solution," Review of Economic Studies, Vol. 32, pp. 329-331.
- Itami, H., Kagono, T., Kobayashi, T., Sakakibara, K., and Itoh, M. (1988), Competition and Innovation: Growth of the Japanese Automobile Industry, (In Japanese), Toyokeizai.
- Matsuyama, K. and Itoh, K., 1987, "Protection Policy in a Dynamic Oligopoly Market," Discussion paper, University of Tokyo.
- Rodrik, D., (1989), "Closing the Productivity Gap: Does Trade Liberation Really Help?" in G. K. Helleiner (ed.), Trade Policy, Industrialization, and Development: A Reconsideration, New York: Oxford University Press, forthcoming.
- Spence, A. M. (1979), "Investment Strategy and Growth in a New Market." Bell Journal of Economics 10 (Spring 1979), 1-19.
- Stiglitz, J. E. (1981). "Potential Competition May reduce Welfare," American Economic Review, Vol. 71, No. 2, 184-189.

CHAPTER III

POLICY ENDOGENEITY, INCENTIVE DISTORTION AND A STRATEGIC ROLE OF DOMESTIC COMPETITION

Introduction

In this chapter I discuss the implications of endogenous industrial policy and a strategic role of domestic competition in reducing the negative incentive distortion caused by policy endogeneity.

In the first three sections, I discuss the general issue of endogenous industrial policy: its causes, consequences, and counter-measures in order to place the subsequent analysis in perspective. In the sections D and E, I formally demonstrate that domestic competition can positively contribute to solving the policy dilemma.

A. Policy Endogeneity in Practice

1. Endogeneity of Industrial Policy

In the earlier chapters, I assumed that the government policy was exogenous. It was assumed that the government had the first mover advantage over industry and the industry took the government policy as a given parameter in deciding its activity. However, this assumption is extreme, since the government in reality is often constrained from maintaining its first mover advantage over industry.

The endogeneity of industrial policy is most clearly observed in infant industry protection in developing countries. In many cases the

schedule of protection is not preannounced. Even if such announcement is made, the government is often unwilling to withdraw protection which can jeopardize the viability of the protected industry. Consequently, in many cases the removal of protection is contingent on the successful development of industry. I discuss a Japanese case of endogenous protection in the 1960s in some detail in the next subsection, to demonstrate the point that even "successful" protectionist policy had at least some endogeneity (here "success" meaning that temporary protection did not lead to permanent protection and industrial stagnation).

The policy endogeneity is also frequently observed in adjustment assistance for the industries having difficulties in coping with foreign competition. Although most adjustment assistance programs stipulate temporary nature of assistance, there exist many examples where temporary relief from import has become permanent or quasi-permanent. The US import protection of textile and steel sectors are good examples. In both cases protection starting as temporary import relief has become now almost institutionalized. Their full removal seems to be possible only when protection becomes substantially unnecessary for their survival.

2. An Example of Endogenous Import Liberalization

Here I describe the comprehensive import liberalization program of Japan announced in 1960. In this year the Japanese Government issued a general guideline for liberalizing its stringent foreign trade and exchange control system, which had been used to tightly control the import regime. The guideline governed whole liberalization measures in the 1960s and the

early 1970s. Although there have been no major reversals of liberalization in Japan, the timing of liberalization was significantly contingent on the development of each protected industry, as seen below.

The general guideline classified traded goods in the following four categories:^{1/}

- (A) Goods to be liberalized immediately
- (B) Goods to be liberalized in the near future (within around three years)
- (C) Goods to be liberalized at an appropriate future time by providing necessary time (to industries)
- (D) Goods the liberalization of which are deemed to be difficult for a considerable time in the future.

The category A includes mainly raw materials for industry. The objective of immediate liberalization was to reduce input cost of the industry.

Imports which do not compete with domestic industries or goods for which domestic industries could already competitively supply (such as textile, sundries, and steel) were included in either category A or B.

The category C included infant industries e.g. industries which were under the process of technology development or which were deemed to merit nurturing as critically important industries for the development of machinery sector. Liberalization of several emerging industries proceeded in a phased manner after 1963: automobiles (1965), machine tools (1970), color film (1971), integrated circuits (1974), electronic computers (1975).

^{1/} Based on Yamazawa, I. (1984).

Liberalization of these industries was postponed until they gained international competitiveness.^{2/}

Category D mainly included agricultural goods.

Given the clear endogeneity of import protection for infant industries in Japan, the question was why it had not apparently caused inefficiency due to incentive distortion. Two possibilities are conceivable. The first possibility is that import protection was still regarded to be temporary by the industries, given the determination of the government to liberalize industrial import and international pressure for liberalization. In fact the guideline mentioned the following three reasons for liberalization: request from foreign countries, improved trade balance and positive effect of international competition on the rationalization efforts by industry. Credibly temporary protection can not only avoid the incentive distortion caused by policy endogeneity but also may potentially accelerate technology development compared with permanent protection, as analyzed in the second chapter. The second possibility is active domestic competition in Japan. Domestic competition can reduce or even eliminate incentive distortion caused by endogenous protection. I will demonstrate this strategic role of domestic competition more formally in sections D and E. Before doing that, I discuss the general issue of the causes and consequences of policy endogeneity and countermeasures and put the formal analysis in sections D and E in perspective.

^{2/} When the automobile import was liberalized in 1965, the Japanese automobile industry already exported 17% of its production. When the direct foreign investment was liberalized in 1971 (still under the condition of minority status), the export output ratio was 38%. When the import of electronic computers was liberalized in 1975, the export output ratio was 4.5%.

B. Consequences of Policy Endogeneity

Endogeneity of protection causes incentive distortion. The protected industry can take advantage of the endogeneity by reducing or neglecting its effort for technological advance or for adjustment. Consequently, policy intervention can not only lose its effectiveness substantially but also can cause welfare loss even under the circumstances where significant market failures warrant government intervention.

The welfare effect of policy endogeneity, however, depends on the specific economic circumstance in which it is impinged upon. When another distortion is present, smaller policy endogeneity can reduce economic welfare, if the negative welfare effect of the second distortion is sufficiently amplified as a result.^{3/} In fact, it is demonstrated by Carmichael (1987) in the context of export credit subsidies that adopting subsidy rate ceiling reduces welfare of the exporting country. The reason is the following. When such ceilings are binding, enterprises can no longer expect that the loss of competitiveness due to artificial inflation of their export prices is compensated by subsidies, so that effective export prices (i.e., gross export prices minus export subsidies) decline. However, export prices are too low under the circumstance of export price rivalry as analyzed by Carmichael (i.e., price competition and strategic complement), so that adopting subsidy rate ceiling is welfare reducing.^{4/}

^{3/} It is well known from Bhagwati (1971) that reductions in the degree of a distortion will not necessarily be welfare increasing if there is another distortion in the system.

^{4/} The optimal intervention by first-mover government for export price rivalry is tax (Eaton and Grossman (1986)). However, the optimal intervention by second-mover government can be subsidy (Gruenspecht (1988)).

The existence of the second distortion (oligopolistic price rivalry) makes the reduction of policy endogeneity (endogenous subsidy) a losing proposition in this case.

Given the above caveat, let us analyze the welfare consequence of policy endogeneity in the case deemed to be typical in actual industrial policy practices. The effect of policy endogeneity is illustrated in Figure 1. In this figure S stands for the government support and I for industrial investment for higher efficiency. The utility function of the government is assumed to be $U(I, S)$. I assume that $\partial U/\partial S$ is positive for small S but turns negative as S becomes larger. This would be the case if the government were concerned with the size (output or employment) of the assisted industry as well as the distortion caused by intervention, since S (import protection for an example) increases the size of the industry only with diminishing return and increasing distortion (e.g., consumption distortion) (See Appendix for an exact formulation). Investment for higher efficiency is assumed to enhance U but reduce $\partial U/\partial S$. The latter assumption $\partial^2 U/\partial I \partial S < 0$ is justified, since higher investment by the protected enterprise causes the expansion of its size and consequently reduces the marginal utility from its further expansion induced by higher protection. Finally it is assumed that U is quasi-concave. Under these assumptions the government reaction curve (GG) and indifference curve (U) have the shapes as illustrated in Figure 1.

The enterprise is assumed to maximize its profit $\pi(I, S)$. It is assumed that there exists a positive level of profit maximizing I for any S .

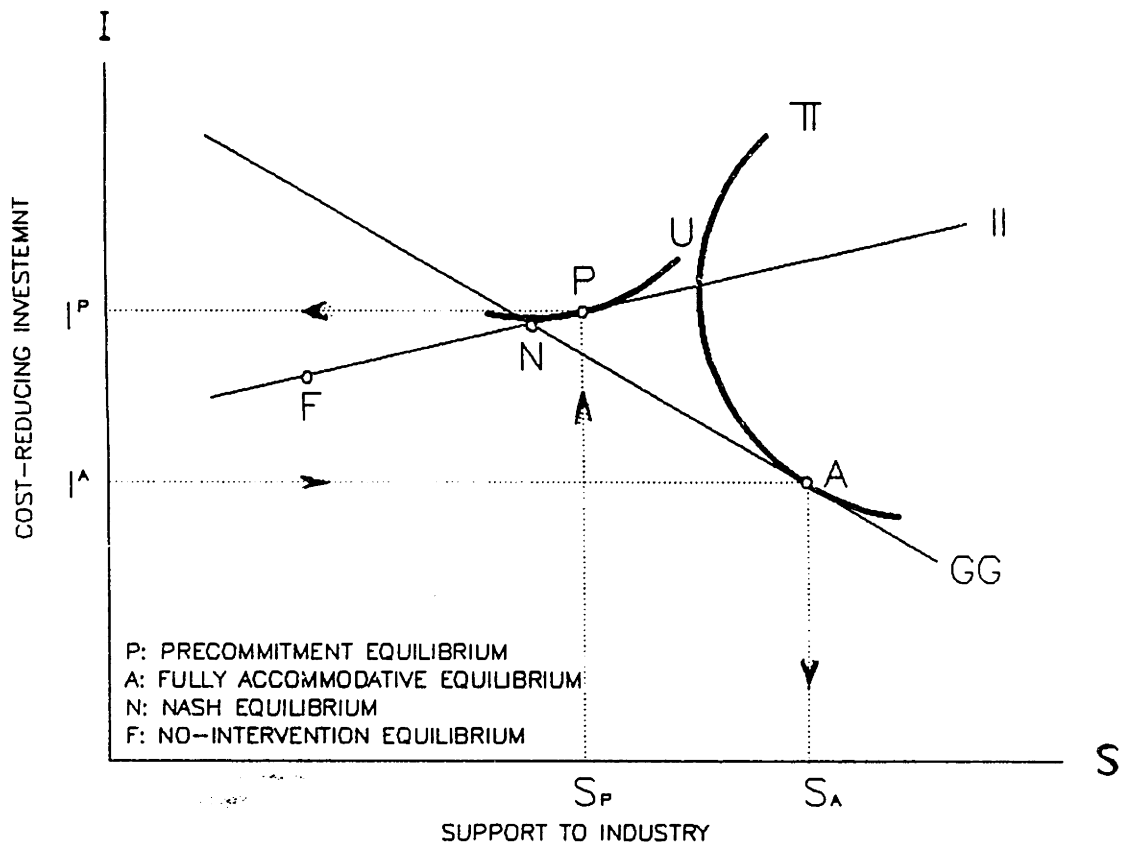


Figure 1: IMPLICATION OF POLICY ENDOGENEITY

Higher S is assumed to increase both π and $\partial\pi/\partial I$.^{5/} It is further assumed that the isoprofit curve π is quasi-concave. Under these assumptions the reaction curve (II) and isoprofit curve π of the enterprise have the shapes as illustrated in Figure 1.

Now I consider three alternative equilibria: precommitment equilibrium (P), fully accommodative equilibrium (A) and Nash equilibrium (N). First, if the government can precommit itself to the optimal level of support S^P , industry will respond by undertaking the "nationally" optimal level of technological effort I^P .^{6/} In this case, the government has the first mover advantage and chooses its best equilibrium on the reaction curve of the industry (II).

Second, however, if industry has the first mover advantage, it expects that the government will respond to the actual technological effort in a compensatory manner along the reaction curve GG (e.g. faster technological development triggers import liberalization or conversely slower technological development delays import liberalization). The industry chooses its best equilibrium on the reaction curve of the government (GG). Consequently, industry will undertake only lower technological effort ($I^A < I^P$) and also necessitates larger government support to

^{5/} The latter assumption $\pi_{IS} > 0$ is justified, when higher protection increases the size of market available to the domestic enterprise and makes cost-reducing investment more profitable.

^{6/} However, even I^P is too low under the circumstance where the government and the enterprise can make a contract binding S and I . This is because marginal increase of investment from P increases U , while it does not affect π .

the industry ($S^A > S^P$). The consequences of policy endogeneity are smaller investment, higher industry support and lower "national" welfare.^{7/}

Third, if neither of the government nor industry can precommit itself, I expect that the economy will get settled in the Nash equilibrium. Nash equilibrium is a natural outcome under such a circumstance, since in Nash equilibrium neither party wishes to change its strategy given the strategy of the other. The Nash equilibrium also entails policy endogeneity. As demonstrated in Figure 1, investment and welfare are lower than in the precommitment equilibrium but higher than in the fully endogenous equilibrium. Industry support becomes smaller than in the two equilibria. The consequences of policy endogeneity in the case of Nash equilibrium are smaller investment, smaller industry support and lower national welfare.

The degree of distortion caused by endogenous policy can be highly significant. The welfare effect of full accommodation can be decomposed as the sum of the effect due to the shift from P to N and the effect due to the shift from N to A. The welfare effect of the first shift (from P to N) is relatively small, since the government can economize its excessive use of S (P lies at the rightward of the GG line) in exchange for the reduced level of investment. A small deviation from P along the curve II results in no corresponding first order change of the government utility due to the envelope theorem. However, the welfare effect of the second shift (from N to A) is relatively large, since the government is not compensated for the

^{7/} The government utility may not exactly coincide with the national welfare in this model, since it is generally not rational for the government to target the size of industry. However, imperfect information may justify such practice.

loss due to the further decline of investment (the increase in S has no net welfare effect along the line GG). Compared with the equilibrium under no intervention (F), not only the level of S and resulting distortion are higher at A but investment level at A itself can be lower than that at F , as illustrated in Figure 1. In this case the government intervention is clearly welfare-reducing, in spite of the fact that no intervention equilibrium is not efficient.

The negative welfare effect of policy endogeneity is further amplified, if it exacerbates another existing distortion. To illustrate the point let us assume that there is positive externality from investment either technically (e.g., knowledge spillover) or pecuniarily. In this case the strategic underinvestment by industry has a negative multiplier effect on the welfare of the national economy.

Consequently, the welfare loss due to the policy endogeneity may well be very large, which may offer one potential explanation for why the consequences of industrial policy interventions have been often dismal. It also offers a potential explanation for the simple fact that high protection often coincides with low investment, which is hard to be explained by a conventional analysis taking protection as exogenous. Moreover, the snap shot analysis of policy regime often used to identify non-uniformity of protection does not reveal adequately the true cost of protection. In this sense the traditional focus of the trade policy reform on making protection low and uniform may well be significantly incomplete.

C. Causes of Policy Endogeneity and Control Mechanism

In this section, I review major causes of policy endogeneity with a special focus on dynamic inconsistency and discuss potential mechanisms to control policy endogeneity. There exists five causes of industrial policy endogeneity, which seem to be important in reality: industry lobbying, equity or income distribution concern of the government, prior commitment to targeted industries, information asymmetry and dynamic consistency.

Industry can affect government policy by its lobbying activities in the political and administrative processes. There already exists extensive theoretical and empirical literature analyzing lobbying activities and their welfare consequences.^{8/} An important insight from this literature is that cost of protection is not adequately measured by the deadweight loss derived from the assumption of taking protection as a parameter, since lobbying and counter-lobbying absorb real economic resources. Another important point is that the existence of lobbying opportunity can fundamentally affect welfare rankings of alternative policies, since a particular policy instrument (e.g., tariff) has a larger free-rider problem for lobbyists than the other (e.g., subsidy) and as a result can upset the traditional welfare ranking (trade intervention is inferior to domestic intervention in dealing with domestic distortions).^{9/}

Although industry lobbying theory has many valuable insights, it also has major limitations. First, most fundamentally, the government and

^{8/} Baldwin (1982) offers an excellent review. Posner (1975), Findlay and Wellisz (1982) and Tullock (1967) demonstrated the importance of understanding the policy formation process.

^{9/} Rodrik (1986).

political institutions do act (although may not always) to pursue policies which are deemed to improve national welfare. Second, industrial lobbying per se does not explain why infant industries and industries having adjustment difficulties fail to improve efficiency in spite of seemingly favorable conditions created by the policy intervention.

Second, industrial policy can become endogenous when it is driven by ex post income redistribution or equity concern. Under such a circumstance the policy intervention can become contingent on the enterprise behavior. The enterprise can expect larger support from the government when it performs relatively poorly so that the situation similar to the model as analyzed in the last section emerges. Although no government would like to penalize efforts nor to compensate the shortage of efforts, asymmetric information for the government can cause such outcome. Industrial policy does seem to be strongly motivated by the objective of distributional equity especially in some developing and socialist countries. In those countries industrial policy often serves as an inefficient social policy, partly because policy instruments targeted to individuals (e.g., income taxation and unemployment compensation scheme) are not well developed.

Third, industrial policy becomes endogenous when the government is constrained by its prior commitment to targeted industries. Although its rationality can be questioned, industrial policy in practice often consists of the following three stage game. In the first stage, the government decides whether a particular industry is to be targeted. Targeting decision may involve the decision of the cabinet or even parliament. The government itself may invest in the industrial ventures in such targeted sectors. In many cases, however, targeting implies strong government

commitment to the development or survival of the industry, which is not accompanied by clear conditionalities. In the second stage, the protected industry decides how much to invest, given protection. In the third stage the government decides whether to liberalize. But due to the existence of the prior government commitment to the industry, liberalization may take place only if industry is judged to withstand international competition. Liberalization threat is not very credible,^{10/} since the government has also high stake on the development or survival of the protected industries.

Fourth, information asymmetry can be another cause for the policy endogeneity. Often the government has only imperfect information concerning the necessary level of support beforehand, so that commitment to the preannounced protection schedule is very difficult to make. After all there exist a lot of uncertainties in the market, technologies and competition. However, if the government has the same information as industry, uncertainty per se does not necessarily cause policy endogeneity. It would cause only unanticipated therefore nondistortionary policy changes when dynamic inconsistency issue is negligible. On the other hand, if industry has private information concerning its technological effort not available to the government, reducing technological effort may induce longer protection and benefit industry under certain circumstances.^{11/}

^{10/} See the discussion of dynamic inconsistency below.

^{11/} Whether smaller technological effort can induce longer protection depends on the government objectives. If equity concern of the government is strong, such would be the case. However, if the objective is to compensate pecuniary externality due to technical change, slower technical progress may be interpreted as evidence for shorter protection, since it may represent poorer technological opportunities.

Fifth, industrial policy can become endogenous due to dynamic inconsistency of the optimal intervention. Dynamic inconsistency arises, when the government cannot credibly precommit itself to future policy actions, since it does not serve the national interest to implement such actions in the future. I review the major issues in some detail below mainly in the context of industrial policy.

Although dynamic consistency has been subject to most extensive research in the context of macroeconomic policy,^{12/} it is also highly relevant to industrial policy.^{13/} The effectiveness of industrial policy critically depends on its credibility, since industry would not like to commit large investment resources if industry believes that it is most rational for the government to reverse the announced policy in the future. Furthermore industry may be able to precommit itself more easily through investment than the government.

Figure 1 can be used to illustrate the point. Let us assume that investment takes time to generate productive capacity, so that only S (let us interpret S to be tariff) in the future after investment is realized matters for both industry and the government. Consequently, the game

^{12/} The seminal paper is Kydland and Prescott (1977). See Blanchard, and Fisher (1989) Chapter 11 for a brief review of dynamic consistency issues in macroeconomics.

^{13/} Although there has not been many literature, Maskin and Newbery (1986) have found that the optimal import tariff on an exhaustible resource is not generally dynamically consistent. Staiger and Tabellini (1987) has found that the optimal redistributive trade policy (free trade) is dynamically inconsistent and has also pointed out that dynamically consistent tariff can dominate dynamically consistent production subsidies due to its additional social cost. Matsuyama (1987) and Tornell (1989) have analyzed the dynamic consistency of temporary protection. Their results are discussed in some detail later in the paper.

consists of the following three stages: in the first period the government announces S expected to be applied in the third period, in the second period the industry decides I and in the third period the government decides the actual S to be applied. In the first period the government may announce S^P . But it is not credible to industry, since industry knows that in the third period the government is better off by choosing S^A rather than S^P if industry invests I^A in the second period. Therefore, industry invests only I^A . In the third period, the government has no choice other than providing S^A , since it maximizes the national welfare, given I^A . Therefore, the industrial policy providing the optimal support S^P is not dynamically consistent in this case.

In the case of Figure 1, industry is better off at the expense of the government due to the absence of the credible commitment by the government. However, it is easy to construct an example where both are worse off. In Figure 2, the government is concerned only with the divergence of investment from the nationally optimal level (I^*) ^{14/} and with the distortion (e.g., fiscal cost) caused by intervention (S). The enterprise has the same profit function as in Figure 1. In this case, the government reaction curve coincides with the vertical axis, since the government is best off with no distortion by intervention once investment is given. Consequently, the Nash equilibrium (N) and the accommodative equilibrium (A) coincide with each other and both lie on the vertical axis. As is clear from the Figure, both the government and industry are better off at the precommitment equilibrium (P), but end up at the inferior equilibrium

^{14/} It is not concerned with the size of industry per se as the government in Figure 1.

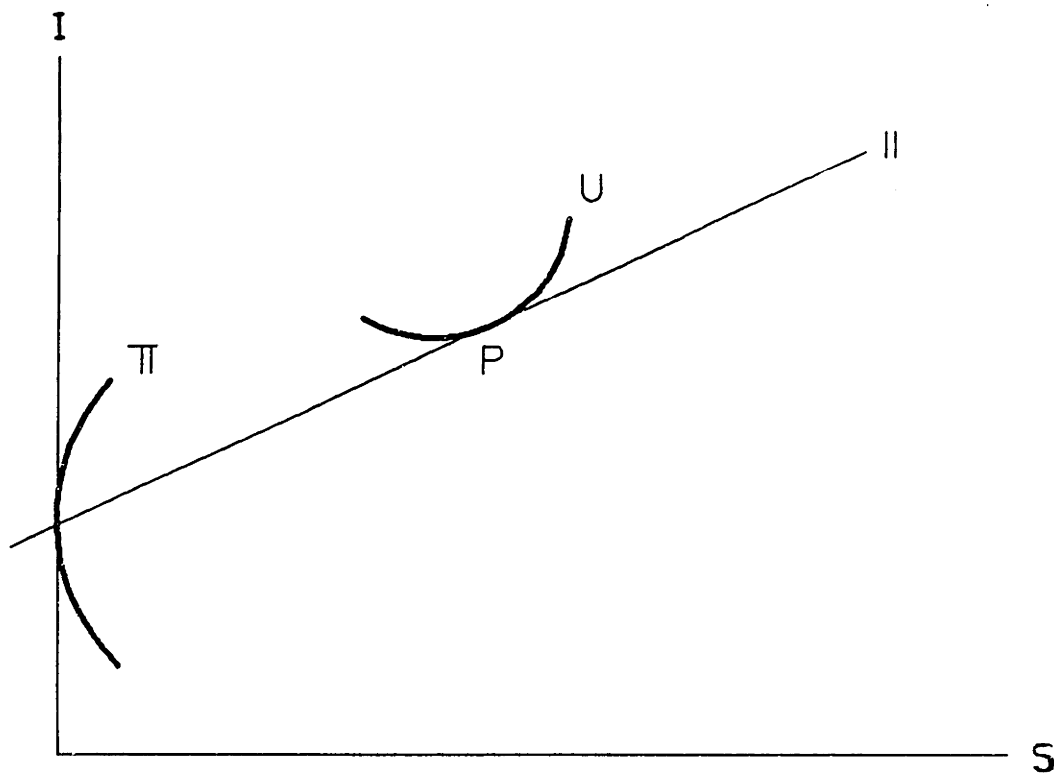


Figure 2: IMPLICATION OF THE ABSENCE OF CREDIBLE COMMITMENT (II)

if the government cannot make a credible precommitment. Although this model may be relevant to industrial stagnancy under certain circumstances (e.g., small investment in debt ridden countries in recent years), it does not explain the coexistence of high protection and low investment.

As shown by Matsuyama (1987), the inability of the government to make a credible commitment can imply that there exists no pure equilibrium strategy of temporary protection when time horizon of the game is not limited. In his model the government is willing to provide temporary protection if industry invests. Industry, however, has an incentive to invest only if it is credibly threatened by liberalization. He has demonstrated that only a mixed strategy exists in this game, if both industry and the government are restricted to take the same actions when they are confronted with the same situation. In particular temporary protection strategy (i.e., protection ---> invest ---> liberalization) cannot be supported as a pure strategy, since liberalization threat is not credible.^{15/}

Next, I discuss various mechanisms to control policy endogeneity. The mechanisms analyzed by the existing literature include reputation, bonding, the law, and investment contingent incentive.

If the government has a good reason to build up and maintain its reputation of keeping its commitment, its commitment may become credible

^{15/} If industry does not invest (industry is assumed to be better off by not investing if protection persists), the government faces the same situation as it does at the beginning of the game, so that the government is bound to provide another "temporary" protection. The industry can again refrain from investment to induce another temporary protection, etc. Clearly temporary protection strategy cannot work under the constraint of Markov equilibrium (i.e., each player chooses the same move whenever he faces the same situation).

even if breaking the commitment in the future is judged to serve the narrow interest of the government. In the context of industrial policy, the government may have strong incentive to buildup its reputation when the potential number of industries to be dealt with is indefinitely large,^{16/} as pointed out by Matsuyama (1987). The consolidation of sectoral industry ministries into one ministry of industry, which has taken place in some socialist and developing countries, makes sense in this context.

The government can also make breaking the commitment costly by posting a bond. A bond can be the penalty which is imposed when breaking a contract with a third party such as the GATT, the World Bank and a foreign government. Breaking international contract will cause the loss of international reputation, difficulty in the access to finance and retaliatory punitive duties on the home country export, so that the government commitment may become more credible.

The government can also reduce its discretionary power by making its intervention bound by law. If the government does not have the power to change its policy the enterprise can not expect to induce policy shift by changing its behavior. The tariff binding under the GATT is an example for reducing the discretion of the government to change trade policy.

Investment contingent incentive is a potential mechanism to ameliorate the strategic distortion caused by the absence of credible commitment, as analyzed by Tornell (1989). In terms of Figure 1 the basic idea is to provide investment subsidy in the first period (S can be interpreted as investment subsidy), so that the enterprise has sufficient

^{16/} It is known that a prisoner's dilemma can be solved if the same game is repeated infinitely (Folk Theorem, see Tirole (1988), Chapter 6).

incentive to invest I^P . If time horizon is limited to two periods, the government can induce the enterprise to invest adequately in the first period by providing investment subsidy, the value of which is slightly greater than the value of protection in the second period which the government is forced to provide in the case of underinvestment ("bail out" as called by Tornell). However, the problem is that time horizon is not limited to two periods, so that it is difficult for the government to precommit not to use investment subsidy in the future. It was shown by Tornell that considering the opportunity available for the industry to enjoy both protection and investment subsidy just by postponing investment, the rate of subsidy must be very high to overcome the distortion caused by the possibility of bail out.

Another potentially important control mechanism is to have active domestic competition. The literature does not seem to have paid adequate attention to the possibility that domestic competition can reduce the distortion caused by policy endogeneity. In the rest of the paper, I focus on the role of domestic competition in this regard. Although active domestic competition can help industrial development in many ways, policy makers in many developing countries tend to suppress it through investment licensing and other means due to their concern over fragmentation and resulting loss of dynamic efficiency. The point which I would like to demonstrate here is that increased domestic competition can potentially improve dynamic efficiency by better controlling the incentive distortion caused by policy endogeneity.

In section D, I depend on the dynamic framework where an enterprise chooses investment for technology catchup in the first stage and output in the second stage. In this framework domestic competition can potentially significantly stimulate investment by diluting the effect of policy endogeneity and by creating the threat that his competitor's faster technological progress triggers import liberalization.

In section E, I depend on the static framework which have been often used to demonstrate that increased entries of domestic enterprises fragment the market and reduce investment for cost reduction. I show that domestic competition can potentially stimulate investment for cost reduction by diluting the endogeneity of import protection.

D. A Strategic Role of Domestic Competition in a Dynamic Framework

1. Introduction

In this section I demonstrate the potential role of domestic competition in accelerating technology development in the dynamic environment where the timing of import liberalization is contingent on the technological catch-up of a domestic enterprise. I assume that the liberalization decision of the government depends on the technological catch-up of the most efficient domestic enterprise in this section, which can be shown to be dynamically consistent under certain circumstances.

2. Technological Catch-up by a Monopoly Enterprise

I assume the existence of a technological opportunity where a domestic enterprise can reduce its production cost to the level of a

foreign enterprise (from C_0 to C^*).^{17/} A domestic enterprise, which is assumed to be a monopoly in this subsection, can reduce its production cost linearly over time to the level of C^* as in Figure 3. Investment decision for cost reduction is made once and for all at the beginning of the whole process. I also assume that the government prohibits foreign competition during the catchup process but liberalizes it once the domestic enterprise achieves a cost parity with a foreign enterprise, in order to capture the effect of policy endogeneity.^{18/}

The domestic monopoly enterprise chooses the timing of catchup (t_M) so as to maximize the net present value of its profit ($V(t_M)$):

$$(1) \quad V(t_M) = \int_{0-t_M} \exp(-rt)\pi_M(t;t_M)dt + \int_{t_M-\infty} \exp(-rt)\pi_F(t)dt - k$$

where r stands for the discount rate of the domestic enterprise. π_M stands for the monopoly profit and can be written as follows:

$$\pi_M(t;t_M) = \text{Max}_Q\{P(Q)Q - C(t;t_M)Q\}$$

where $P(Q)$ is the market demand faced by the domestic enterprise, Q is its output and $C(t;t_M)$ is the cost at time t . $C(t;t_M)$ is given by

$$(2) \quad C(t;t_M) = C_0 - (t/t_M)(C_0 - C^*) \text{ for } t \leq t_M$$

^{17/} I adopt the same analytical framework as utilized by Rodrik D. (1988).

^{18/} Such a government behavior can be shown to be dynamically consistent under the circumstance of Bertrand price competition (See the subsection 3).

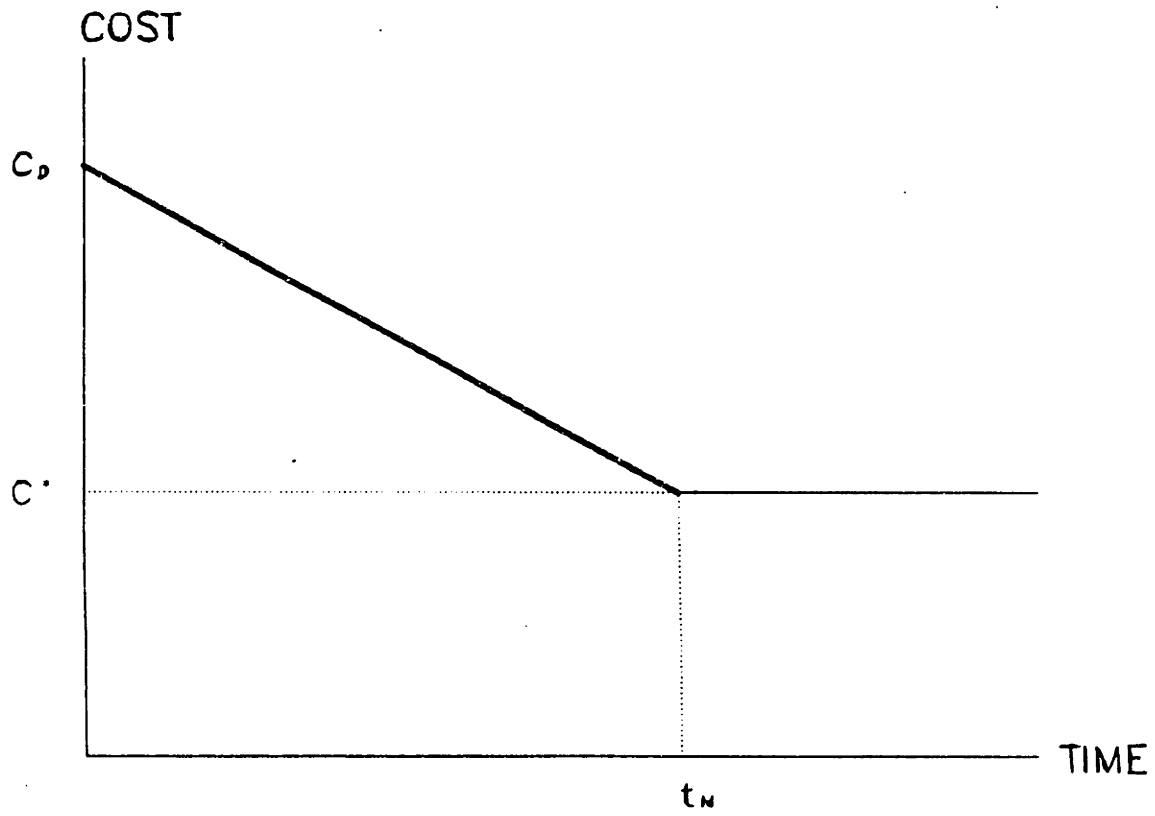


Figure 3: TECHNOLOGICAL CATCHUP

π_F is the profit of the domestic enterprise after import is liberalized. I assume that

$$(3) \quad \pi_F(t) < \pi_M(t; t_M)$$

$k(t_M)$ is the investment cost for technological catchup. I assume that

$$(4) \quad k'(t_M) < 0 \text{ and } k''(t_M) \geq 0.$$

The value-maximization condition is

$$(5) \quad \begin{aligned} V'(t_M) - \int_{0-t_M} \exp(-rt)(\partial\pi_M/\partial t_M)dt + \exp(-rt_M)(\pi_M(t_M; t_M) - \\ \pi_F(t_M)) \\ - k'(t_M) \\ = 0 \end{aligned}$$

The first term is negative since slower technological catchup increases the cost of production and thus reduces the instantaneous profit of the enterprise for a given t until t_M . The second term is positive since slower technological catchup reduces the negative effect on the discounted profit of the import liberalization by delaying its timing. The third term is also positive since slower technological catchup saves investment cost. The domestic monopoly enterprise chooses t_M so that these three effects balance. I denote the interior solution to this condition by T_M .

When import liberalization is not endogenous, the value maximization condition becomes:

$$(6) \quad V'_{NC}(t_M) = \int_{0-t_M} \exp(-rt) \partial \pi_M / \partial t_M dt - k'(t_M) = 0$$

I denote the solution to this condition by T_{NC} . Assuming that the second order condition (i.e., $V''_{NC}(t_M) < 0$) holds globally, we know that

$$(7) \quad T_{NC} < T_M,$$

since the second term of equation (5) is positive. The endogenous import liberalization dilutes the incentive for the domestic monopolist to innovate, so that the time necessary for catching up becomes longer.

3. Dynamic Consistency of Endogenous Liberalization

This subsection discusses the rationality of the liberalization strategy assumed in this section. It can be justified as dynamically consistent if liberalization is expected to cause severe price competition between the domestic and foreign enterprises, as demonstrated below.

I assume that Bertrand price competition takes place after liberalization. Under Bertrand price competition, the domestic enterprise can expect to earn only negative profit if it continues to operate, when import is liberalized before the domestic enterprise achieves the cost parity with the foreign enterprise. Thus the threat of exit by the domestic enterprise is credible. The exit of the domestic enterprise also reduces national welfare, since the foreign enterprise can now exercise the monopoly power indefinitely. Therefore, it is to the advantage of the

government to postpone liberalization. However, on the other hand, once the domestic enterprise has achieved the cost parity with the foreign enterprise, the threat of exit becomes no longer credible. The government itself prefers the presence of foreign competition, since it forces marginal cost pricing by the domestic enterprise.

Consequently, dynamic consistency requires the government to liberalize just when the domestic enterprise achieves the cost parity with the foreign enterprise, once investment decision by the domestic enterprise for cost reduction is made. Therefore the government, which cannot credibly precommit the timing of liberalization before the domestic enterprise makes its investment decision, is forced to accommodate the investment decision of the enterprise by adjusting the liberalization program.

In the more general product market competition the assumed liberalization strategy is not necessarily dynamically consistent. Therefore, generally we have to take it as a positive behavior assumption, which may not be rational but may have some empirical validity.

4. Technological Catch-up by Duopoly Enterprises

In this section I assume the existence of domestic competition. For a simplicity I assume the existence of the two identical domestic enterprises. The market equilibrium assumption is Nash noncooperative solution both in technological competition and product market competition. Enterprises first choose the timing of catch-up t_1 and t_2 . In the second

stage they choose variables (price or output) relevant to product market competition.

The government is assumed to liberalize import as soon as one of the domestic enterprises achieves the cost parity with the foreign enterprise. This behavioral assumption is again dynamically consistent, if we further assume that only import liberalization triggers Bertrand price competition. Bertrand price competition among domestic enterprises is incompatible with their investments for cost reduction. The best import liberalization strategy for the government with no capacity of precommitment is to wait until one of the enterprises achieve the cost parity with the foreign enterprise. This is because liberalization before that makes both domestic enterprises exit and liberalization after that allows the domestic enterprise which has achieved the cost parity to continue pricing above marginal cost. The government does not care the survival of the second enterprise, since the existence of one domestic competitive enterprise is sufficient to force the marginal cost pricing by the foreign enterprise under the Bertrand price competition.

The domestic enterprise (the first enterprise) maximizes the following value functions:

$$(8.1) \quad V^1(t_1, t_2) = \int_{0-t_1} \exp(-rt) \pi_D(t; t_1, t_2) dt \\ + \int_{t_1-\infty} \exp(-rt) \pi_F(t; t_1, t_2) dt - k(t_1) \quad \text{for } t_1 \leq t_2$$

and

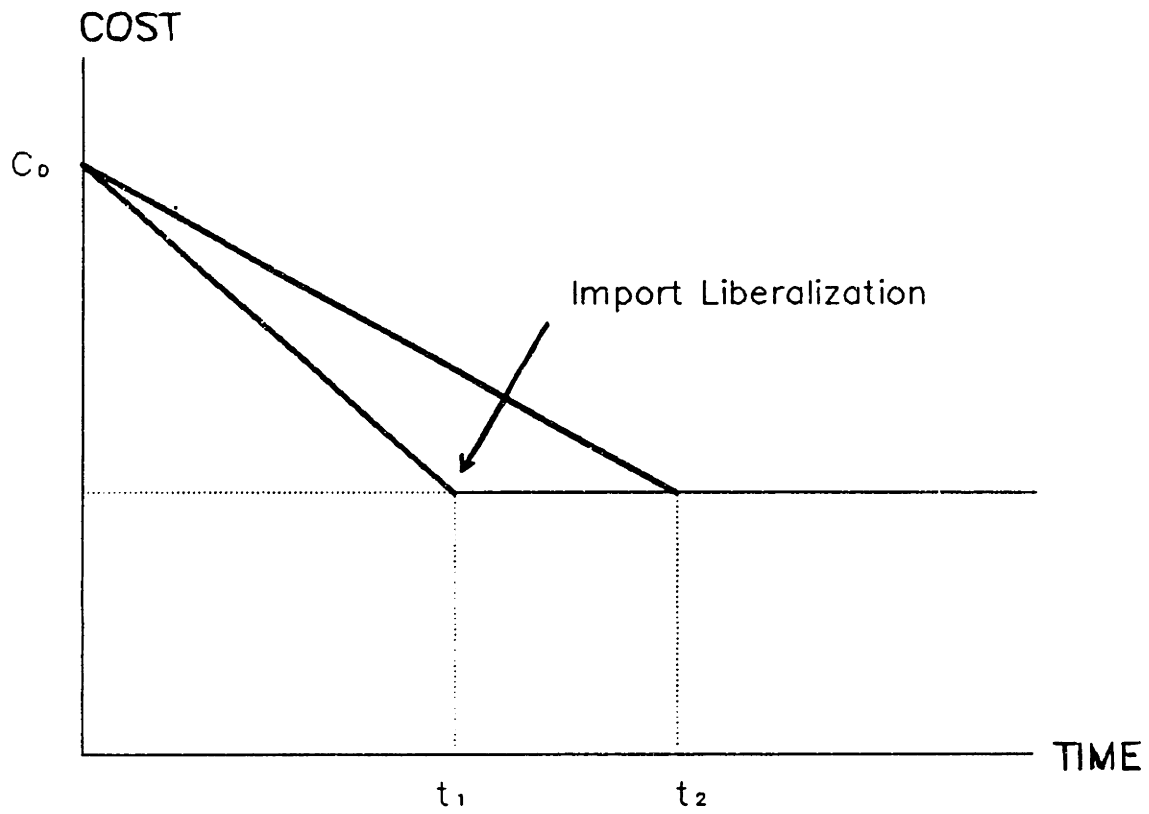


Figure 4: TECHNOLOGICAL CATCHUP (Duopoly)

$$(8.2) \quad V^1(t_1, t_2) = \int_{0-t_2} \exp(-rt) \pi_D(t; t_1, t_2) dt \\ + \int_{t_2-\infty} \exp(-rt) \pi_F(t; t_1, t_2) dt - k(t_2) \quad \text{for } t_1 \geq t_2$$

where $\pi_D(t; t_1, t_2)$ is the profit of the first enterprise before import is liberalized. $\pi_F(t; t_1, t_2)$ stands for its profit after import is liberalized. It is zero in the case of Bertrand price competition.

Since I assume that no further cost reduction takes place after an enterprise has achieved cost parity with the foreign enterprise, I have

$$(9) \quad \partial \pi_F / \partial t_1 = 0 \text{ if } t > t_1 \quad \text{and} \quad \partial \pi_F / \partial t_2 = 0 \text{ if } t > t_2$$

Given equation (9), the first order derivatives of $V^1(t_1, t_2)$ are given by

$$(10.1) \quad \int_{0-t_1} \exp(-rt) \partial \pi_D / \partial t_1 dt + \exp(-rt_1) (\pi_D(t_1) - \pi_F(t_1)) \\ - k'(t_1) \text{ for } t_1 \leq t_2$$

$$(10.2) \quad \int_{0-t_2} \exp(-rt) \partial \pi_D / \partial t_1 + \int_{t_2-t_1} \exp(-rt) \partial \pi_F / \partial t_1 dt \\ - k'(t_1) \text{ for } t_1 \geq t_2$$

There exists a negative discontinuity of the value of the derivative at $t_1 = t_2$:

$$(11) \quad \partial V^1 / \partial t_1 (t_1 = t_2 +) - \partial V^1 / \partial t_1 (t_1 = t_2 -) \\ = - \exp(-rt_2) (\pi_D(t_2) - \pi_F(t_2)) < 0$$

This is because the positive effect on the discounted profit of delayed import liberalization exists only when the first enterprise innovates faster than the second enterprise.

I further assume that the following relations hold globally:

$$(12) \quad \partial^2 V^1 / \partial t_1^2 < 0$$

Given this assumption there exist the following three possibilities for the determination of the optimum t_1 (I denote it by T_1) for a given t_2 , as illustrated in Figure 5. In particular, $T_1 = t_2$ if $\partial V^1 / \partial t_1 (t_1 = t_2 -) > 0$ and $\partial V^1 / \partial t_1 (t_1 = t_2 +) < 0$. Since a small change in t_2 brings about only correspondingly small changes in $\partial V^1 / \partial t_1 (t_1 < t_2)$ and $\partial V^1 / \partial t_1 (t_1 > t_2)$ ^{19/}, there exists a range of t_2 where $T_1 = t_2$.

Next I consider the market equilibrium. Since I assume the existence of the two identical enterprises, the optimal choice of technological catchup (T_2) by the second firm given the choice of the first firm is exactly the same as above. Consequently the market equilibrium is given by Figure 6. The stability condition requires that the reaction curve of the first enterprise T_1 has a greater positive slope than that of the second enterprise T_2 .

^{19/} As is clear from the equations (10.1) and (10.2), $\partial V^1 / \partial t_1$ is differentiable with respect to t_2 for both $t_1 < t_2$ and $t_1 > t_2$, as long as both enterprises stay in the market.

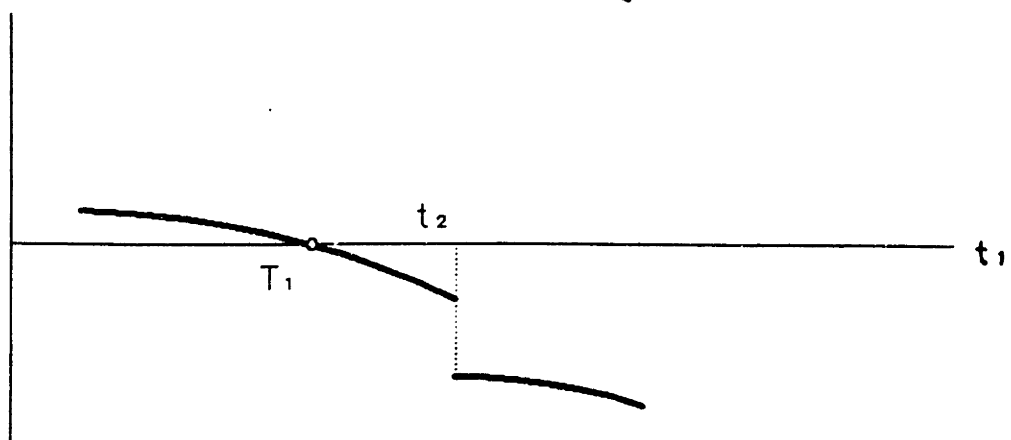
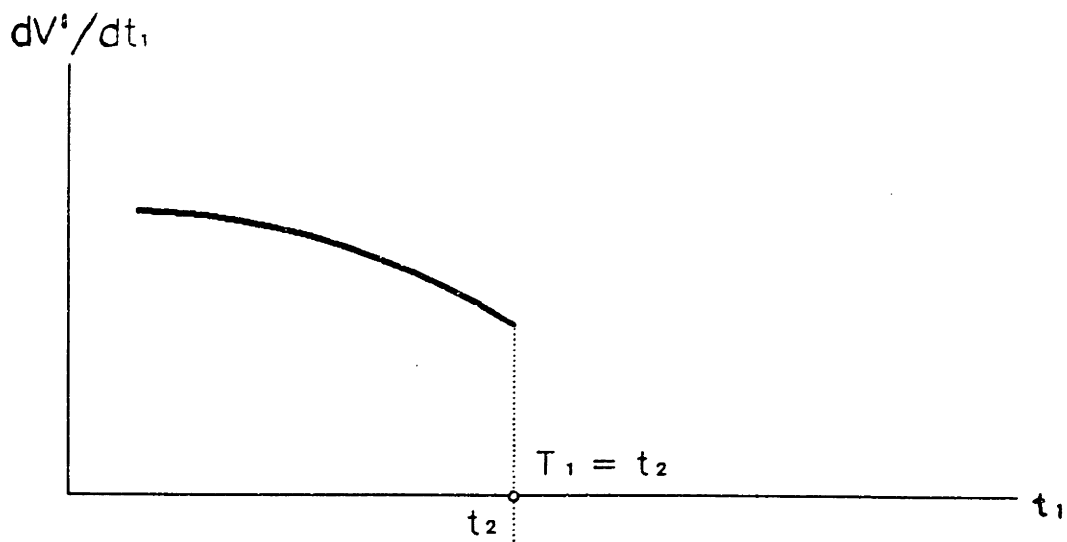
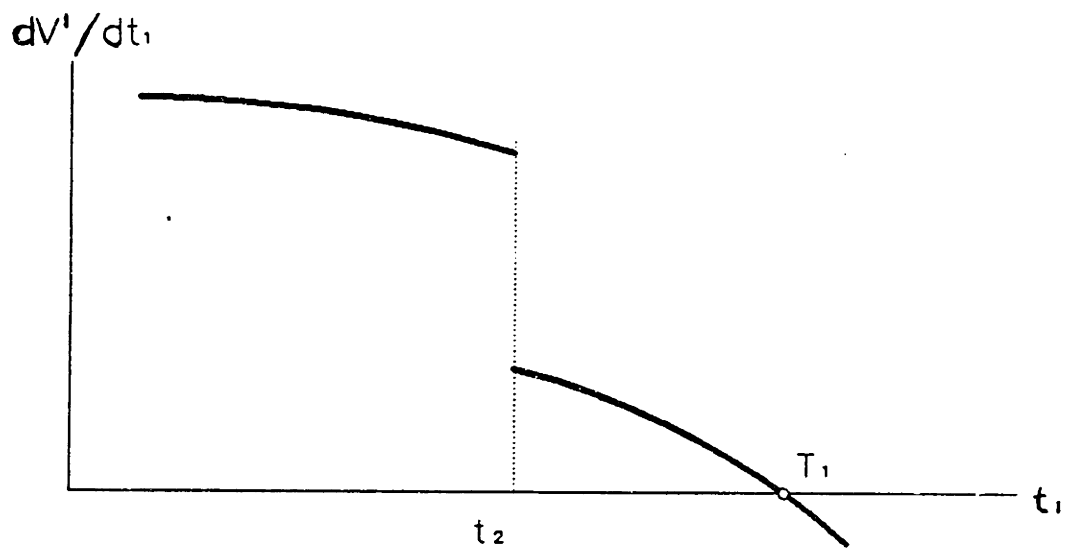


Figure 5: THE OPTIMUM TECHNOLOGICAL CATCHUP

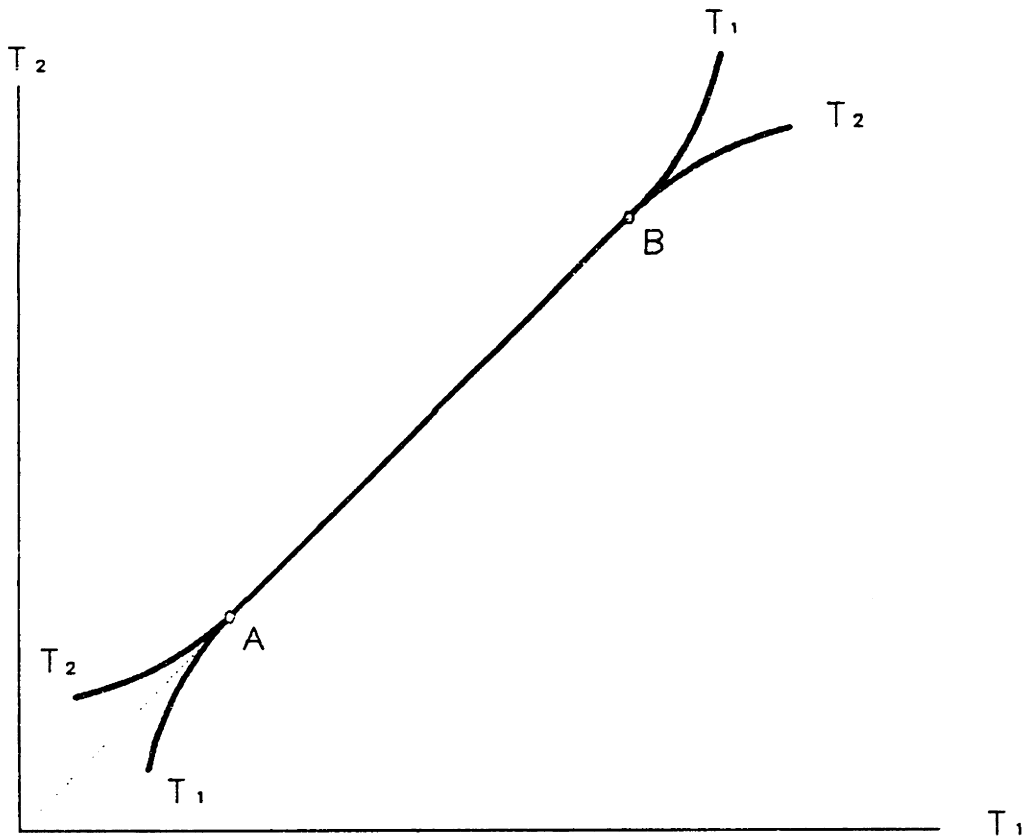


Figure 6: MULTIPLE EQUILIBRIA IN TECHNOLOGICAL CATCHUP

Consequently there exist multiple equilibria in this framework. Since the matching strategy (i.e., to choose the same speed of technological catchup as its competitor) is the optimum strategy for each enterprise for some range, the market equilibrium becomes indeterminate.

First, we focus on the equilibrium with the shortest catchup time (i.e., A in Figure 6). This would be the case when both enterprises are concerned with the threat that his competitor wins the race for technological catchup. This equilibrium is given by the following condition: Since $T_1 \geq T_2$ for the first enterprise, denoting the catchup time by $T^A = T_1 - T_2$,

$$(13.2) \quad \partial V^1 / \partial t_1(T^A, T^A) = \int_{0-T^A} \exp(-rt) \partial \pi_D(t; T^A, T^A) / \partial t_1 dt - k'(T_A) = 0$$

from equation (10.2).

Compared with equation (5) of the monopoly case, we realize the two differences. First, the monopoly profit is replaced by the profit under duopoly in equation (13.2). The negative profit effect by slowing catchup can become larger in the case of duopoly than in the case of monopoly, since domestic competition creates strategic effect of the investment for cost reduction, ^{20/} which can dominate fragmentation caused by domestic competition. Second, the positive effect due to the delayed import liberalization has vanished in equation (13.2), since the expectation at

^{20/} An enterprise expects that his investment for cost reduction will improve his cost competitiveness and will force his competitor to reduce output.

the equilibrium A is that timing of import liberalization is determined by the competitor. Consequently, it is possible that both effects are positive. In this case the technological catchup under duopoly becomes sharply accelerated than in the case of monopoly. Even if the first effect is negative for technology development it can be still dominated by the second effect, so that increased domestic competition can still accelerate technology development in spite of its fragmentation of the domestic market.

Next, I analyze the equilibrium with the longest catchup time (i.e., B in Figure 6). This would be the case when neither enterprise is concerned with the threat that his competitor wins the race for technological catchup. This equilibrium is given by the following equation:

$$\begin{aligned}
 (13.1) \quad \partial V^1(T^B, T^B)/\partial t_1 &= \int_{0-T_B}^{\infty} \exp(-rt) \partial \pi_D(t_1; T^B, T^B) / \partial t_1 dt \\
 &\quad + \exp(-rT_B) (\pi_D(T_B) - \pi_F(T_B)) - k'(T_B) \\
 &= 0
 \end{aligned}$$

from equation (10.1).

The comparison with equation (13.2) suggests that the direct positive profit effect of the delayed import liberalization accounts for the difference between T_A and T_B . T_B can be still smaller than T_M , since the effect of the endogeneity is still smaller in the case of duopoly than

in the case of monopoly.^{21/} Consequently, if $-\partial\pi_D/\partial t_1 > -\partial\pi_M/\partial t_M$ (strategic effect dominates fragmentation effect), we definitely have $T_B < T_M$ (i.e., domestic competition accelerates technology development).

5. Impact of Uncertainty

In this subsection I examine the impact of uncertainty on the dynamic competition analyzed in the last section. The multiple equilibria phenomenon vanishes but the favorable effect of the domestic competition on reducing incentive distortion remains, as shown below.

For a simplicity I assume that the timing of catchup follows a uniform distribution. t_1 has the mean m_1 and uniformly distributed between $[m_1 - w, m_1 + w]$. Similarly t_2 has the distribution with the mean m_2 and with the range $[m_2 - w, m_2 + w]$. Investment for technological catchup is assumed to affect the mean catchup time:

$$(14) \quad m_1' (k_1) < 0 \text{ and } m_1'' (k_1) > 0 \text{ and}$$

$$(15) \quad m_2' (k_2) < 0 \text{ and } m_2'' (k_2) > 0.$$

^{21/} Let's denote the profit of the industry consisting N symmetric firms by I_N . We generally have $I_1 \geq I_2 \geq I_3$, since increased number of firms makes collusion more difficult. Consequently, we have

$$(I_1 - I_2/2) - (I_2/2 - I_3/3) = (I_1 - I_2) + I_3/3 \geq 0$$

so that the effect of policy endogeneity (i.e., the second terms in equations (5) and (13.1)) is smaller in the case of duopoly than in the case of monopoly.

I assume that firms are risk neutral, so that they maximize expected present value of the profits. The firm 1 chooses k_1 so as to maximize

$$\begin{aligned}
 (16) \quad V^1(k_1, k_2) = & \frac{1}{(4w^2)} \int_{m_1 - w - m_1 + w}^{dt_1} \int_{m_2 - w - m_2 + w}^{dt_2} \\
 & [A(t_2 - t_1) \left(\int_{0-t_1}^{\exp(-rt)\pi_D dt} + \int_{t_1-\infty}^{\exp(-rt)\pi_F dt} \right) \\
 & + A(t_1 - t_2) \left(\int_{0-t_2}^{\exp(-rt)\pi_D dt} + \int_{t_2-\infty}^{\exp(-rt)\pi_F dt} \right)] - k_1 \\
 & = 0
 \end{aligned}$$

where $A(t_2 - t_1) = 1$ if $t_2 \geq t_1$ (the firm 1 is a winner) and $A(t_2 - t_1) = 0$ if $t_2 < t_1$ (the firm 2 is a winner). $V^1(k_1, k_2)$ is differentiable with respect to k_1 and k_2 , since the integrand is continuous with respect to t_1 and t_2 . Consequently, the first-order condition for the value maximization for the firm 1 becomes

$$(17) \quad \partial V^1(k_1, k_2) / \partial k_1$$

$$\begin{aligned}
&= 1/(4w^2) \partial m_1 / \partial k_1 \int_{m_2 - w - m_2 + w} dt_2 \\
&\quad [A(t_2 - (m_1 + w)) \left(\int_{0 - m_1 + w} \exp(-rt) \pi_D dt + \int_{m_1 + w - \infty} \exp(-rt) \pi_F dt \right) \\
&\quad + A(m_1 + w - t_2) \left(\int_{0 - t_2} \exp(-rt) \pi_D dt + \int_{t_2 - \infty} \exp(-rt) \pi_F dt \right) \\
&\quad - A(t_2 - (m_1 - w)) \left(\int_{0 - m_1 - w} \exp(-rt) \pi_D dt + \int_{m_1 - w - \infty} \exp(-rt) \pi_F dt \right) \\
&\quad - A((m_1 - w) - t_2) \left(\int_{0 - t_2} \exp(-rt) \pi_D dt + \int_{t_2 - \infty} \exp(-rt) \pi_F dt \right)] \\
&\quad - 1 \\
&= 0
\end{aligned}$$

We focus on the symmetric equilibrium: $m_1 = m_2 = M$ and $k_1 = k_2 = K$. As seen from Figure 7, in this case the first firm is always a loser at $t_1 = M + w$ and always a winner at $t_1 = M - w$, so that the first order condition becomes

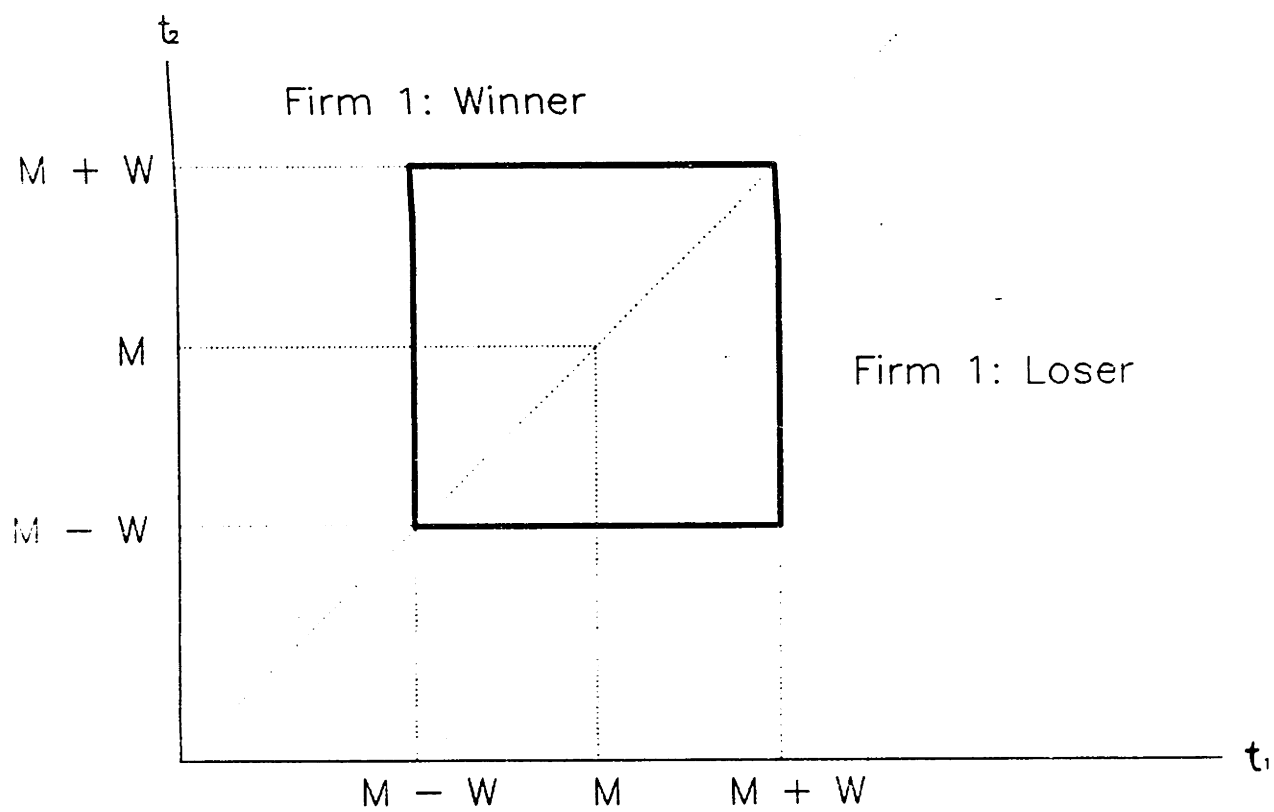


Figure 7: SYMMETRIC EQUILIBRIUM

$$(18) \quad \partial V^1(K, K) / \partial k_1$$

$$\begin{aligned}
 &= 1/(4w^2) \partial m_1 / \partial k_1 \int_{M-w-M+w}^{dt_2} \\
 & \quad \left[\int_{0-t_2} \exp(-rt) \pi_D(t; M+w, t_2) dt + \int_{t_2-\infty} \exp(-rt) \pi_F(t; M+w, t_2) dt \right. \\
 & \quad \left. - \left(\int_{0-M-w} \exp(-rt) \pi_D(t; M-w, t_2) dt + \int_{M-w-\infty} \exp(-rt) \pi_F(t; M-w, t_2) dt \right) \right] \\
 & \quad - 1 \\
 & = 0
 \end{aligned}$$

Equation (18) can be rewritten in the following manner:

$$(19) \quad \partial V^1(K, K) / \partial k_1$$

$$\begin{aligned}
 &= 1/(4w^2) (\partial m / \partial k_1) \int_{M-w-M+w}^{dt_2} \\
 & \quad \left[\left(\int_{0-\infty} \exp(-rt) \pi_D(t; M+w, t_2) dt - \int_{0-\infty} \exp(-rt) \pi_D(t; M-w, t_2) dt \right) \right. \\
 & \quad + \left(\int_{M-w-\infty} \exp(-rt) (\pi_D(t; M-w, t_2) - \pi_F(t; M-w, t_2)) dt \right. \\
 & \quad \left. - \int_{M+w-\infty} \exp(-rt) (\pi_D(t; M+w, t_2) - \pi_F(t; M+w, t_2)) dt \right) \\
 & \quad \left. + \left(- \int_{t_2-M+w} \exp(-rt) (\pi_D(t; M+w, t_2) - \pi_F(t; M+w, t_2)) dt \right) \right] \\
 & \quad - 1 \\
 & = 0
 \end{aligned}$$

A similar condition can be derived for a monopoly firm subject to uncertainty:

$$(20) \quad 1/(2w) \partial m / \partial k$$

$$\begin{aligned} & \left[\left(\int_{0-\infty} \exp(-rt) \pi_M(t; M+w) dt - \int_{0-\infty} \exp(-rt) \pi_M(t; M-w) dt \right) \right. \\ & + \left(\int_{M-w-\infty} \exp(-rt) (\pi_M(t; M-w) - \pi_F(t; M-w)) dt \right. \\ & \left. \left. - \int_{M+w-\infty} \exp(-rt) (\pi_M(t; M+w) - \pi_F(t; M+w)) dt \right) \right] \\ & - 1 \\ & = 0 \end{aligned}$$

The comparison of the two conditions reveal the following conclusions:

- (1) The first bracket of both conditions is negative and represents the effect of delaying the catchup when protection from import is permanent. If import liberalization is not endogenous, we have only this term. As in the certainty case, if the strategic effect of domestic competition dominates its market fragmentation effect, we have a larger negative value in the case of duopoly than that in the case of monopoly.
- (2) The second bracket of both conditions represent the effect of policy endogeneity: profit effect of the postponement of import liberalization accompanying the slowdown of the technological catchup of the first enterprise. It is positive for the monopoly enterprise just as in the certainty case, since it can

expect to enjoy monopoly profit due to import protection for a longer period on average. It is also positive in the case of duopoly. However, it is likely to be smaller than in the monopoly case, since the increased number of firms tends to dilute the effect of import liberalization.^{22/}

- (3) The third bracket of the first condition (equation (19)) represents the threat effect of domestic competition and is negative. Slower technological catchup by the first enterprise implies larger possibility that import is liberalized due to the faster technological catchup of the second enterprise. The domestic enterprise shielded from competition does not have this threat.

Consequently, I can state that the domestic competition can reduce the incentive distortion caused by endogenous import protection in the uncertainty case too both due to the dilution effect and the threat effect. The threat effect of domestic competition will become further amplified when firms are risk-averse, since they will become more concerned with reducing the probability that import is liberalized when they are "unprepared."

On the other hand the multiple equilibrium result as discussed in the last subsection is found not to be robust to the introduction of uncertainty.

^{22/} If import liberalization reduces the profit of the domestic monopoly enterprise below that of the domestic competitor (the second enterprise) under duopoly before liberalization, the profit effect of postponed liberalization is smaller in the case of duopoly than in the case of monopoly. In particular, this obtains if import liberalization causes Bertrand price competition.

6. Conclusion

In this section I have demonstrated that domestic competition can potentially accelerate technology development due to its favorable effect on the incentive distortion caused by endogenous import protection. The incentive distortion can be largely eliminated if a domestic enterprise is substantially threatened by the chance that his competitor's faster technological progress triggers import liberalization.

E. A Strategic Role of Domestic Competition in a Static Framework

1. Introduction

In this section I demonstrate that increased domestic competition can potentially accelerate technology development by diluting the endogeneity of import protection within the static framework where investment for cost reduction and output are simultaneously chosen by competing enterprises.

2. Is Increased Domestic Competition Beneficial to Technical Efficiency-Conventional Analysis-?

Conventional economic theories, which ignore strategic role of investment and policy endogeneity, tend to suggest that increased competition, both domestic and foreign, fragments domestic economy, thus discouraging investment by domestic enterprises in cost reduction and preventing the achievement of the economy of scale in technical

progress.^{23/} Increased domestic competition therefore can make infant industry protection from import unworkable in this framework.

I first illustrate the results of the conventional analysis using the framework of Cournot-Nash competition with output and investment for cost reduction as choice variables. Let's assume the following:

$$(1) \pi^i (q_i, k_i) = p (\sum_{j=1}^N q_j, M) q_i - c(k_i) q_i - k_i$$

π^i profit of the i th enterprise

q_i output of the i th enterprise

$Q = \sum_{j=1}^N$ output of the sector (N the number of enterprises)

k_i investment for cost reduction of the i th enterprise

P market price

M the size of competing import ($\partial P / \partial M < 0$) determined by the quota policy of the government, and

$C(k_i)$ cost of the i th enterprise, $C' < 0$ and $C'' > 0$

I further assume that investment and output are decided simultaneously and each firm takes output and investment decisions of all the other firms as given. Under these assumptions, the profit maximizing conditions of each firm imply that

^{23/} See Dasgupta, P. and Stiglitz, J. (1980) and Tandon, P. (1984) for the negative affect of increased domestic competition on the investment for cost reduction. See Dani Rodrik (1989) and Krugman (1984) for a skeptical view of the effect of trade liberalization on technical efficiency and export.

$$(2.1) \quad (\partial P / \partial Q) q_i + P - C(k_i) = 0, \text{ and}$$

$$(3.1) \quad -C'(k_i) q_i - 1 = 0,$$

where M is exogenous for each firm.

If we focus our attention only on the symmetric equilibrium ($q = q_i$ and $k = k_i$), we get

$$(2.2) \quad (\partial P / \partial Q) (Nq, M) q + P(Nq, M) - C(k) = 0 \text{ and}$$

$$(3.2) \quad -C'(k) q - 1 = 0$$

The Nash equilibrium is given by the intersection of the two curves k and q in Figure 8, corresponding to equations (2.2) and (3.2) respectively.

Given the second order conditions of profit maximization of each enterprise it is possible to show that both curves have positive slopes and that the k curve is steeper than the q curve, unless the demand curve is strongly convex (See the appendix).^{24/}

We can assess the impacts of increased domestic competition (increase in N) and import competition (increase in M). Generally both of these changes cause the curve corresponding to equation (2.2) to shift

^{24/} The k curve is steeper than the q curve, if the marginal revenue faced by each enterprise declines as the output of any other firm increases. This condition is equivalent to the sufficient condition for stability of a Cournot equilibrium suggested by Hahn (1962). See the appendix.

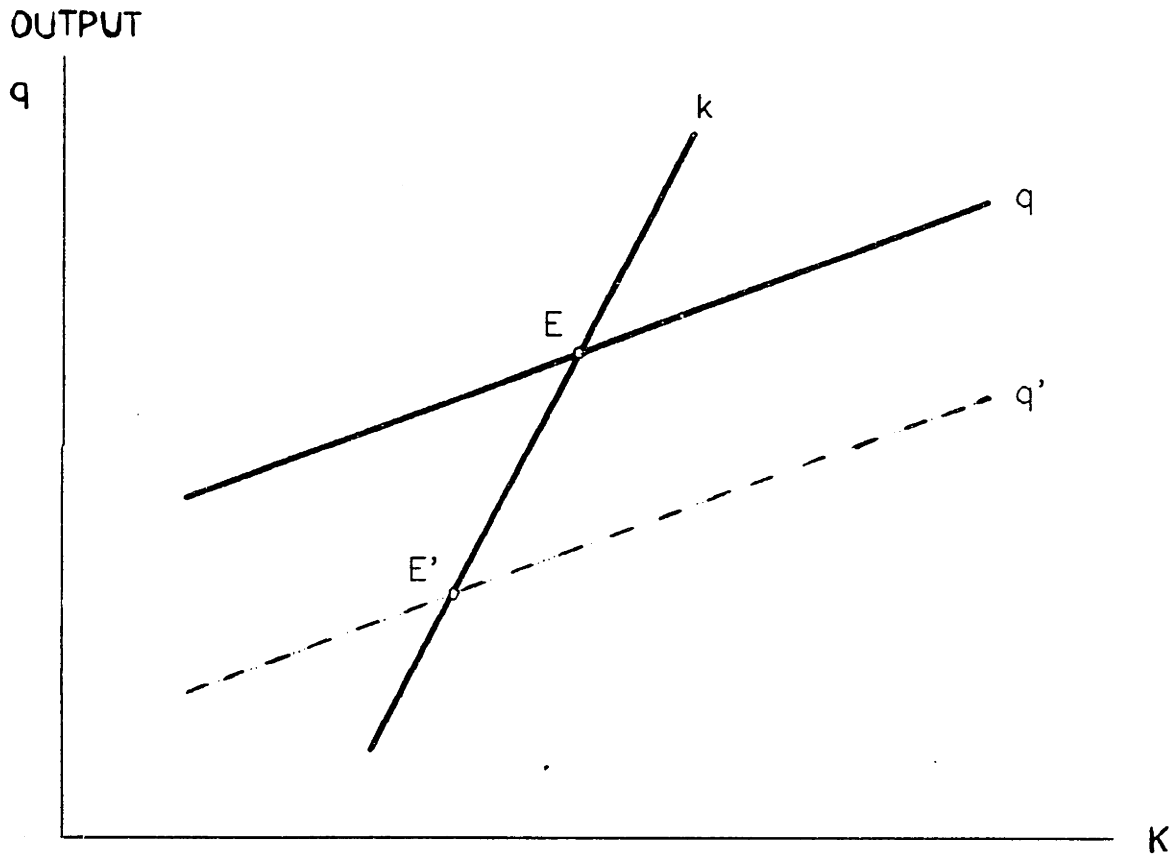


Figure 8: DETERMINATION OF q AND k

downward since the domestic market becomes more crowded.^{25/} Consequently, both of the size and investment of each domestic enterprise decline. We name this effect as fragmentation effect. Both import competition and domestic competition tend to harm technology development. The intuition is that both forms of competition fragments domestic market and reduces the financial profitability of innovation by each enterprise.

The above analysis assumes that the import protection policy is exogenous for each firm. However, as discussed in the first three sections of this paper, protection policy actually often depends on the ex post technology development of the protected sector. This endogeneity of the policy substantially affect the merit of domestic competition as seen in the next section.

3. Endogenous Protection, Incentive Distortion and Domestic Competition

In this section I analyze the effect of the endogeneity of import protection and the relation with domestic competition. Let's assume that the government is expected to act according to the following reaction rule:

$$(4.1) \quad M = M(\sum_{i=1}^N c(k_i)/N), \quad M' < 0$$

^{25/} The necessary and sufficient condition is that the marginal revenue of each enterprise declines as N increases in the case of large N or as M increases (See Appendix). There exist exceptions to the fragmentation effect of competition. As shown in the appendix, the shift from monopoly to duopoly can shift the q curve upward.

which states that improved cost condition of the sector leads the government to relax the quota control. Therefore protection is endogenous. The difference from the assumption of the last section D is that the government decision is influenced by the average of technical efficiency of the industry not by the technical efficiency of the most efficient firm.

The profit maximizing condition (3) is now modified to

$$(5.1) \quad \left(1 - \frac{P_M \cdot M'}{N} \right) * q_i * c'(k_i) + 1 = 0$$

It is now seen that part of the effect of the decrease of the marginal cost due to the cost reducing investment is offset by the increase of import and its depressing effect on the market price. However, its effect is diluted as N becomes larger. I call this effect as dilution effect of domestic competition.

If we focus only on the symmetric equilibrium as before,

$$(2.2) \quad (\partial P / \partial Q) (Nq, M) q + P (Nq, M) - C(k) = 0$$

$$(5.2) \quad \left(1 - \frac{P_M (Nq, M) M'}{N} \right) * q * C'(k) + 1 = 0$$

$$(4.2) \quad M = M(C(k))$$

The equilibrium is again given by the intersection of the two curves k and q in Figure 9. The policy endogeneity shifts the k curve to the left,

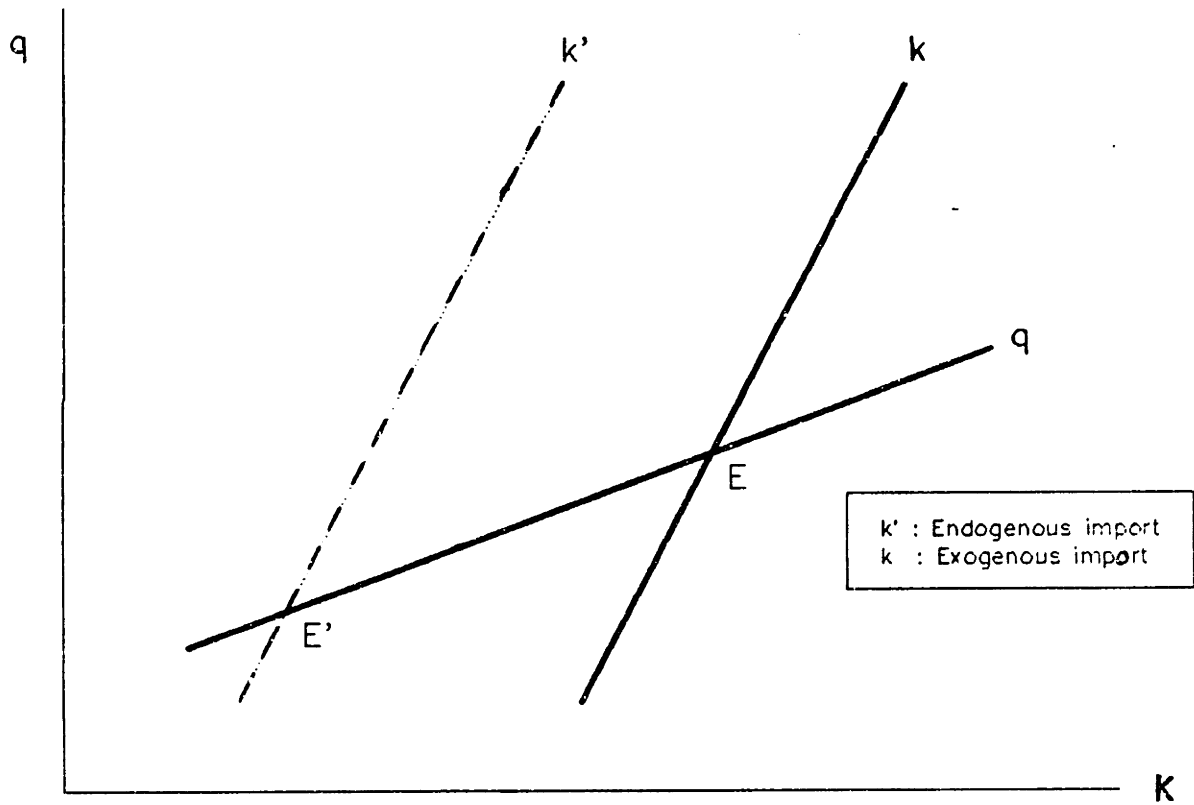


Figure 9: EFFECT OF THE POLICY ENDOGENEITY

since the incentive for investment declines for given q . Consequently, both the incentive for cost reduction and the output level are negatively affected. In fact, the policy endogeneity triggers the following vicious cycle: smaller investment \rightarrow high cost \rightarrow smaller market \rightarrow smaller investment, etc. The slope of the k curve is also affected by the policy endogeneity. If $P_{M0} < 0$ (or if the market demand curve is concave for the case of perfect substitutability between import and domestic output), the slope of the k curve becomes sharper or investment becomes less sensitive to the output change, since the favorable direct incentive for investment of larger output is offset by its effect of strengthening the price-depressing effect of the given import. When $P_{M0} > 0$, if the degree of policy endogeneity is very high, it is possible that the k curve becomes less flat than the q curve. But I rule out such a possibility by simply assuming that the degree of policy endogeneity is not so high as to cause such a reversal, since it might lead to a potential instability.

Let us analyze the impact of increased domestic competition. The increase in the domestic competition shifts both curves (See Figure 10). In particular, the increase of domestic competition dilutes the effect of policy endogeneity, so that investment for cost reduction increases for a given q , as N increases, unless P_{M0} has a very large negative value ^{26/}: The k curve shifts to the rightward. The effect on the investment and on

^{26/} In the case of a linear demand P_M is constant, so that the k curve definitely shifts to the right. In the case of a constant elasticity demand curve and homogenous import and domestic output,

$$P_{M0} = \left\{ \left(\frac{1}{g} \right) \left(1 + \frac{1}{g} \right) \right\} (Nq + M) \cdot \left(- \left(2 + \frac{1}{g} \right) \right)$$

where g is the elasticity of demand, so that the k curve shifts to the right.

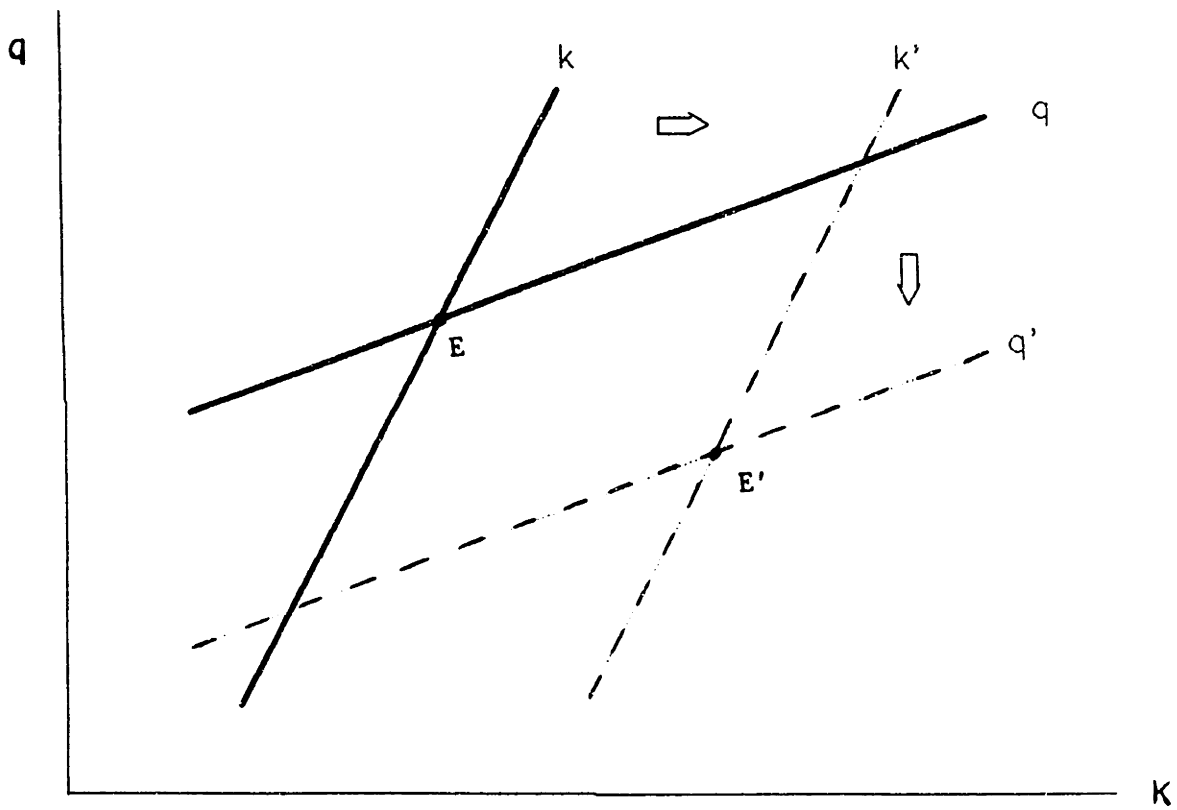


Figure 10: EFFECT OF HIGHER DOMESTIC COMPETITION

the size of a firm depends on whether the increase in dilution effect is larger than the increase in fragmentation effect. If the former effect dominates the latter, both of the investment and the size of a firm increase as a result of increased domestic competition.

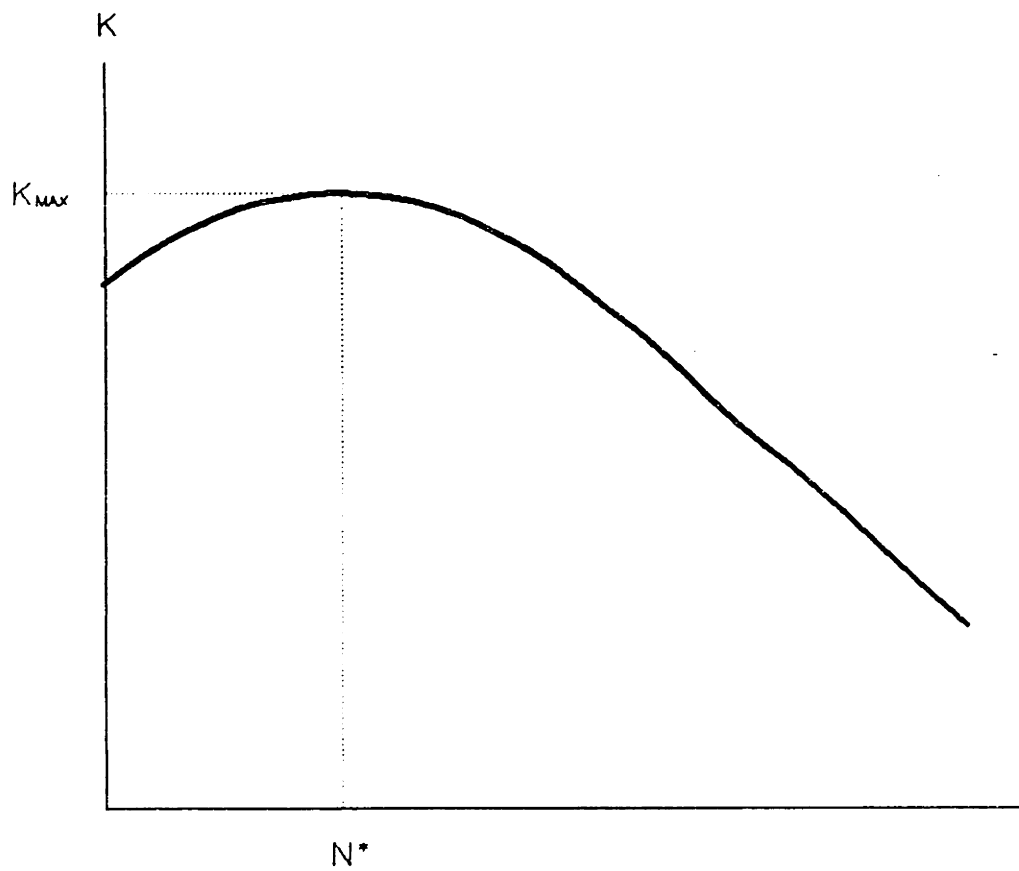
The dilution effect tends to be larger when the domestic market is more concentrated since it is proportional to the term of $1/N$. It becomes negligible when the domestic market is already competitive. The fragmentation effect of domestic competition depends critically on the price responsiveness of demand. When the demand curve is linear, the fragmentation effect is stronger when the market is more concentrated just as the dilution effect. When the demand curve is isoelastic, the fragmentation effect can be relatively small when the market is concentrated.^{27/}

In this latter case, it is quite possible that the relation between domestic competition and investment for cost reduction follows a curve with a hump as in Figure 11. Increased level of domestic competition up to a certain point increases technology development. "Medium" level of domestic competition induces most active R&D investment by domestic enterprises and allows most quick import liberalization.

4. Conclusion

The main conclusions of this section are the following: When protection from import is endogenous and contingent on the technological development of domestic enterprises, increased domestic competition can

^{27/} See the appendix, in particular Table A.1.



**Figure 11: RELATION BETWEEN DOMESTIC COMPETITION,
AND TECHNICAL EFFICIENCY**

potentially accelerate technology development, due to the positive effect on reducing the incentive distortion. This effect is particularly strong for highly concentrated industries. This may provide one important case for reducing policy-induced barriers to domestic entry, especially in monopoly or highly concentrated market even at some cost of fragmentation.

APPENDIX

1. Reaction curves of government and industry (Section B)

I assume that the government is concerned with the size of domestic industry (Q) and the level of protection (S), so that its utility function U is given by

$$(a.1) \quad U = f(Q) + g(S)$$

where f' is positive since the government wants this particular industry to expand, while g' is negative since the government is also concerned with distortion due to protection. I assume that $g'(0) = 0$ and f'' and g'' are negative.

The scale of domestic output depends positively on the level of investment for cost reduction as well as on protection but with diminishing returns:

$$(a.2) \quad Q = Q(I, S) \text{ with } Q_I > 0, Q_S > 0, Q_{II} < 0 \text{ and } Q_{SS} < 0$$

Consequently we have

$$(a.3) \quad \partial U / \partial S = f' Q_S + g'$$

$$(a.4) \quad \partial^2 U / \partial S^2 = f'' (Q_S)^2 + f' Q_{SS} + g'' < 0$$

Since $\partial U / \partial S (S = 0) = f' Q_S > 0$, given the assumption that $g' (0) = 0$, it is positive for small s . I assume that $\partial U / \partial S$ becomes zero for large enough S .

Furthermore,

$$(a.5) \quad \partial U / \partial I = f' Q_I > 0$$

$$(a.6) \quad \partial^2 U / \partial I^2 = f'' Q_I^2 + f' Q_{II} < 0$$

$$(a.7) \quad \partial^2 U / \partial I \partial S = f'' Q_S Q_I + f' Q_{IS}$$

I assume that equation (a.7) is negative with the first term dominating the second term, even if the latter is positive, which implies together with equation (a.4) that the government reaction function $\partial U / \partial S = 0$ has a negative slope.

The domestic industry's profit is

$$(a.8) \quad \pi = P(Q, S) Q - c(I) Q - I$$

where P is price and C is marginal cost. I assume that $C' < 0$ and $C'' > 0$.

The profit maximization output for given S and I is given by

$$(a.9) \quad \partial\pi/\partial Q = \partial P/\partial Q Q + P - C(I) = 0$$

which implies equation (a.2).

Given the envelope theorem, we have

$$(a.10) \quad \pi_I = -C' Q - 1$$

$$(a.11) \quad \pi_{II} = -C'' Q - C'$$

I assume that there exists a positive profit maximizing I for any given S , so that $\pi_{II} < 0$.

Furthermore we have

$$(a.12) \quad \pi_S = P_S \cdot Q > 0$$

$$(a.13) \quad \pi_{SS} = P_{SS} \cdot Q + P_S \cdot Q_S$$

$$(a.14) \quad \pi_{SI} = -C' \cdot Q_S > 0$$

Equation (a.14) implies together with the second order condition $\partial^2\pi/\partial I^2 < 0$ that the reaction curve of industry ($\partial\pi/\partial I = 0$) has a positive slope.

2. The slopes of the q curve and the k curve (Section E):

The total differentiation of equations (2.2) and (3.2) with respect to q and k give

$$(a.15) \quad \begin{vmatrix} N(\partial^2 P/\partial Q^2)q + (N+1)\partial P/\partial Q & -C' \\ -C' & -C''q \end{vmatrix} \begin{vmatrix} dq \\ dk \end{vmatrix} = \begin{vmatrix} 0 \\ 0 \end{vmatrix}$$

It is obvious that the k curve has a positive slope, given $C' < 0$ and $C'' > 0$. We can rewrite the coefficient of dq in the first row of the matrix as follows:

$$(a.16) \quad N\partial^2 P/\partial Q^2 q + (N+1)\partial P/\partial Q \\ = (\partial^2 P/\partial Q^2 q + 2\partial P/\partial Q) + (N-1)(\partial^2 P/\partial Q^2 q + \partial P/\partial Q)$$

From equations (2.1) and (3.1) the second order conditions for profit maximization of each enterprise are

$$(a.17) \quad \partial^2 P/\partial Q^2 q_i + 2\partial P/\partial Q < 0$$

and

$$(a.18) \quad \begin{vmatrix} \partial^2 P/\partial Q^2 q_i + 2\partial P/\partial Q & -C'(k_i) \\ -C'(k_i) & -C''(k_i)q_i \end{vmatrix} > 0$$

Consequently, if we assume that equation (a.17) holds globally, we know that the first term of equation (a.16) is negative. Further, if we

assume the stability condition for the Cournot equilibrium in the product market as suggested by Hahn (1962), we have

$$(a.19) \quad \partial^2 P / \partial Q^2 q + \partial P / \partial Q < 0$$

Given these conditions we know that equation (a.16) has a negative value, so that the q curve has a positive slope.

The comparison of the two matrices (a.15) and (a.18) also suggest that under the same assumptions, we have

$$(a.20) \quad \begin{vmatrix} N\partial^2 P / \partial Q^2 q + (N + 1)\partial P / \partial Q & -C' \\ -C' & -C''q \end{vmatrix} > 0$$

Consequently, the k curve is steeper than the q curve.

3. Effects of Higher Domestic and Foreign Competition on the q Curve (Section E)

The total differentiation of equation (2.2) with respect to N, M and q gives

$$(a.21) \quad (\partial^2 P / \partial Q^2 q + \partial P / \partial Q) q dN + (\partial MR / \partial M) dM \\ + (N\partial^2 P / \partial Q^2 q + (N + 1)\partial P / \partial Q) dq = 0$$

where MR is marginal revenue of each enterprise and is identical to $\partial P / \partial Q$ q + P. $N\partial^2 P / \partial Q^2 q + (N + 1)\partial P / \partial Q < 0$ from the second section of the Appendix.

Therefore, it is clear that if we can ignore the integer constraint, the Hahn's condition assures that higher domestic competition ($dN > 0$) shifts the q curve down or reduces q given k.

It is also clear that if import reduces marginal revenue of the enterprise, higher import also shifts the q curve down.

4. Here I demonstrate that higher domestic competition can shift the q curve upward for the change from monopoly to duopoly (Section E).^{1/}

I assume a demand function with constant elasticity E^{-1} :

$$(a.22) \quad P = aQ^{-E} \quad , \quad a > 0 \quad \text{and} \quad 0 < E < N.$$

I discuss only the case where import is negligible and exogenous.

I assume the following investment opportunity for cost reduction:

$$(a.23) \quad C(k) = Bk^{-d} \quad , \quad 0 < d$$

$$C'(k) < 0 \quad \text{and} \quad C''(k) > 0.$$

In this case the symmetric equilibrium (defined by equations (2.2) and (3.2) in the text) is given by

$$(a.24) \quad a[(-E) N^{(E+1)} + N^E] q^{-E} = Bk^{-d} \quad \text{and}$$

$$(a.25) \quad d * (Bk^{-d}) * q^{-1} = 0$$

^{1/} The formulation of demand and cost reduction functions here are the same as utilized by Dasgupta P. and Stiglitz J. (1980).

Rewriting the equations,

$$(a.24') \quad q = (a/B) \{N^{-E} - E * N^{-(E+1)}\}^{(1/E)} k^{d/E}$$

$$(a.25') \quad k = (d*B*q)^{1/(1+d)} \text{ or } q = 1/(d*B)k^{1+d}$$

Increased domestic competition (larger N) shifts down the q curve if $N \geq 1 + E$ since

$$(a.26) \quad \partial(N^{-E} - E*N^{-(1+E)})/\partial N \\ = -E*N^{-(1+E)} * (1 - (1+E)/N) < 0 \text{ for } N > 1 + E$$

The exception for $E < 1$ (or elastic demand) is the shift from monopoly to duopoly. In fact the shift from monopoly to duopoly can increase both the size of firm and the investment for cost reduction. When $E=0.5$ (or the elasticity is two), $N^{-E} - EN^{-(E+1)} = 1-E = 0.5$ for monopoly while the same function has a value of 0.53 for duopoly (See the Table A.1). Competition thus have market enhancement effect.^{2/}

The shift of the q curve can be also relatively small when N is small. For an example when $E=0.5$ (or the elasticity of demand is 2), $N^{-E} - EN^{-(E+1)}$ declines only from 0.5 to 0.4 as N increases from 1 to 5. Under this demand condition the fragmentation effect of higher competition is negligible when the market is relatively concentrated. However, such is not always the case. When the demand curve is linear, fragmentation effect

^{2/} This possibility was not pointed out by Dasgupta and Stiglitz (1980).

is strong even for small N since the demand becomes less price elastic as price falls.^{3/}

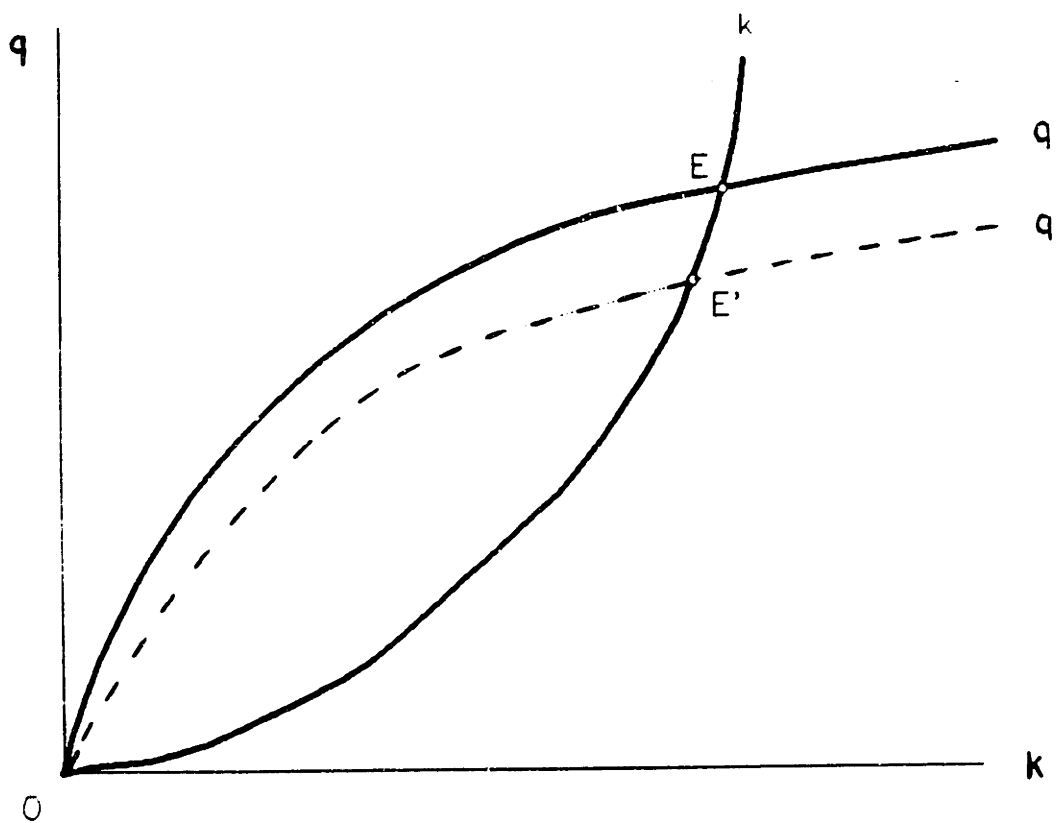


Figure A.1: EFFECT OF INCREASED DOMESTIC COMPETITION
($N > 1 + E$)

^{3/} In the case of a linear demand, equation (a.24') becomes
 $q = (1 - C(k))/(N+1)$

**Table A.1: EFFECTS OF HIGHER DOMESTIC COMPETITION ON FRAGMENTATION
CONSTANT ELASTICITY DEMAND**

		E = 0.7			E = 0.5			E = 0.3		
N	N ^E	N ^{0.7}	N ^{E-E.N^{0.7}}	N ^E	N ^{0.5}	N ^{E-E.N^{0.5}}	N ^E	N ^{0.3}	N ^{E-E.N^{0.3}}	
1	1	1	0.3	1	1	0.5	1	1	0.7	
2	0.61	0.31	0.39	0.71	0.35	0.53	0.81	0.41	0.69	
3	0.46	0.15	0.35	0.58	0.19	0.48	0.72	0.24	0.64	
4	0.38	0.09	0.31	0.5	0.13	0.44	0.66	0.16	0.61	
5	0.32	0.06	0.27	0.45	0.09	0.41	0.62	0.12	0.58	

REFERENCES

- Baldwin, R. E. (1982), "The Political Economy of Protectionism," in Import Competition and Response edited by Bhagwati, J. N., the University of Chicago Press: Chicago.
- Bhagwati, J. N. (1971), "The Generalized Theory of Distortions and Welfare," in J. Bhagwati et al., Trade, Balance of Payments and Growth, North Holland.
- Blanchard, O. J. and Fischer, S. (1989), Lectures on Macroeconomics, the MIT Press: Cambridge.
- Carmichael, C. M. (1987), "The Control of Export Credit Subsidies and Its Welfare Consequences," Journal of International Economics 23 1-19.
- Dasgupta, P. and Stiglitz, J. (1980), "Industrial Structure and the Nature of Innovative Activity," Economic Journal, June.
- Eaton, J. and G. M. Grossman (1986), "Optimal Trade and Industrial Policy under Oligopoly," Quarterly Journal of Economics 10, 383-406.
- Findlay R. and Wellisz, S. (1982), "Endogenous Tariffs, the Political Economy of Trade Restrictions, and Welfare," in Import Competition and Response edited by Bhagwati, J. N., the University of Chicago Press: Chicago.
- Gruenspecht H. K. (1988), "Export Subsidies for Differentiated Products," Journal of International Economics 24, 331-344.
- Hahn, F. H. (1962), "The Stability of the Cournot Oligopoly Solution," Review of Economic Studies, vol, 32, pp. 329-331.
- Krugman, P. R. (1984), "Import Protection as Export Promotion: International Competition in the Presence of Oligopoly and Economies of Scale." In Monopolistic Competition in International Trade (ed. H. Kierzkowski), Oxford: Blackwell.
- Kydland, F. E. and E. C. Prescott (1977), "Rules Rather than Discretion: The Inconsistency of Optimal Plans," Journal of Political Economy vols. 85, 3, pp. 475-492.
- Maskin, E. and D. Newbery (1986), "Disadvantageous Oil Tariffs and Dynamic Consistency," Harvard Institute of Economic Research Discussion Paper No. 1219.

- Matsuyama, K. (1987), "Perfect Equilibria in a Trade Liberalization Game," Northwestern University Discussion Paper No. 738.
- Posner, R. A. (1975) "The Social Costs of Monopoly and Regulation," Journal of Political Economy, August, 807-27.
- Rodrik, D. (1986), "Tariffs, Subsidies and Welfare with Endogenous Policy," Journal of International Economics, pp. 285-299.
- _____. (1989), "Closing the Productivity Gap: Does Trade Liberalization Really Help?," in Gerald K. Helliner (ed.), Trade Policy, Industrialization, and Development: A Reconsideration, New York: Oxford University Press, forthcoming.
- Staiger, R. and Tabellini, G. (1987), "Discretionary Trade Policy and Excessive Protection," American Economic Review, vol. 77, No. 5, pp. 823-837.
- Tandon, P. (1984), "Innovation, Market Structure and Welfare," American Economic Review, June.
- Tirole, J. (1988), The Theory of Industrial Organization, the MIT Press, Cambridge, Massachusetts.
- Tornell, A. (1989), "Time Inconsistency of Protectionist Programs," Columbia University Mimeo.
- Tullock, G. (1967), "The Welfare Costs of Tariffs, Monopolies and Theft," Western Economic Journal, June.
- Yamazawa, I. (1984), Economic Development of Japan and International Division of Labor (in Japanese), Toyokeizai.

CHAPTER IV

PRODUCTIVITY, COMPETITIVENESS AND INDUSTRIAL POLICY

A. Introduction

This paper examines industrial performance of Japan for the last 30 years, focusing on productivity growth and on competitiveness and attempts to make an assessment of industrial policy exercised in the 1950s and the 1960s. The motivations of this paper are the following: First, most existing empirical studies on competitiveness issue fail to provide a comprehensive picture linking productivity, competitiveness and real exchange rate. In particular they do not address the implication of differential improvement of productivity across industrial sectors on real exchange rate change. Second, most empirical studies on trade adjustment have yielded fairly low estimates for price elasticities of demand. This is especially true for Japan. This macroeconomic evidence is not consistent with the industry level perception that price competitiveness does matter significantly. Third, most existing empirical studies on productivity growth at the sectoral level take the total factor productivity growth as exogenous and does not address the following critical issue: whether industry can significantly appropriate gain from the total factor productivity growth. Fourth, there exist no empirical studies addressing whether industrial targeting in Japan was a success in terms of their effect on economy-wide technical progress.

In order to address these issues I have developed a database which cover thirteen industrial subsectors from 1955 to 1987 for Japan and the United States. Most data are from National Income and Product Accounts (see the data appendix for the sources of statistics). Based on this database disaggregated analysis has been performed on productivity growth, its linkage with the shift in price competitiveness, sources and determinants of productivity growth, the linkage between price competitiveness and international trade, returns to labor and capital from productivity growth and potential impact of industrial targeting.

Six major findings from this empirical analysis are the following:

1. Real exchange rate of Japan has appreciated not only in terms of broad price index but also in terms of the price of tradable sector. I put forward the following hypothesis which can potentially explain this puzzling tendency: real exchange rate of the countries under the process of fast technological catchup appreciates over time, since there exist sectoral bias in technical progress in favor of high price elasticity sectors. This is due to favorable incentive for fixed cost investment in those sectors. Econometric evidence testing this hypothesis is presented.
2. Price elasticity of export demand are likely to be much higher than conventional trade equations suggest. Disaggregation and the use of instrumental variable estimation have allowed me to get estimates which often exceed two. Consequently the shift in productivity growth and the change in price competitiveness does

seem to matter significantly in determining trade flow and real exchange rate.

3. There exist high correlations between quantity measure and price measure of total factor productivity growth. There exist both macro and micro implications: First, supply side development seems to dominate demand shocks in even shortrun productivity changes. This view, however, has to be qualified somewhat since I have found some evidence indicating that wage has profit component. Second, market power may not be very important at least in the longrun. Markup affects the quantity measure of the total factor productivity growth but does not affect its price measure, as long as it stays constant over time. Small difference between the two measures implies small market power.
4. Each industry including its workers does not significantly appropriate the gain from its own technical progress. The efficiency gain seems to be absorbed mostly by the decline in industry price and by economy-wide increase in factor returns, i.e., general wage and real interest rate. Consequently technical progress does produce significant externality.
5. Industrial subsectors targeted in Japan in the 1950s and the 1960s did achieve faster technical progress than nonassisted industrial subsectors. This holds even if we take technical progress of the corresponding subsectors in the U.S.A. as a standard.

6. Hall's method of estimating markup does not seem to be a robust method. It is vulnerable to the shortrun mismatch between recorded input and output and to cyclicalities of markups.

B. Productivity, Competitiveness and Real Exchange Rate

1. Productivity Performance

In this subsection, I briefly review the productivity growth performance of the Japanese economy in comparison to the U.S. economy for the period from 1955 to 1987. The objective of this review is to demonstrate that long-term productivity performance of the manufacturing sector of Japan has been remarkable and has had a close correlation with the increase in real product wage.

Table 1 presents summary information on the labor productivity performance of Japan and the United States for the period from 1955 to 1987. Labor productivity is defined as the ratio of real value added and employment. Labor productivity growth of the Japanese economy has been much higher than that of the United States. The trend annual growth rate of the labor productivity of Japan was 5.9% for the economy as a whole for 1955-1970, compared with 1.7% of the U.S. It was 3.0% for 1970-1987, compared with 0.7% of the U.S. The productivity growth differential between the two countries has been much larger for the manufacturing sector and mining sector. It was 6.6% for the manufacturing sector for 1955-1970 and 3.1% for 1970-1987 in favor of Japan.

The cumulative effect of this productivity differential is enormous. Figure 1 shows the development of normalized labor productivity growth of the manufacturing sectors of the two countries with 1955 as the base year.

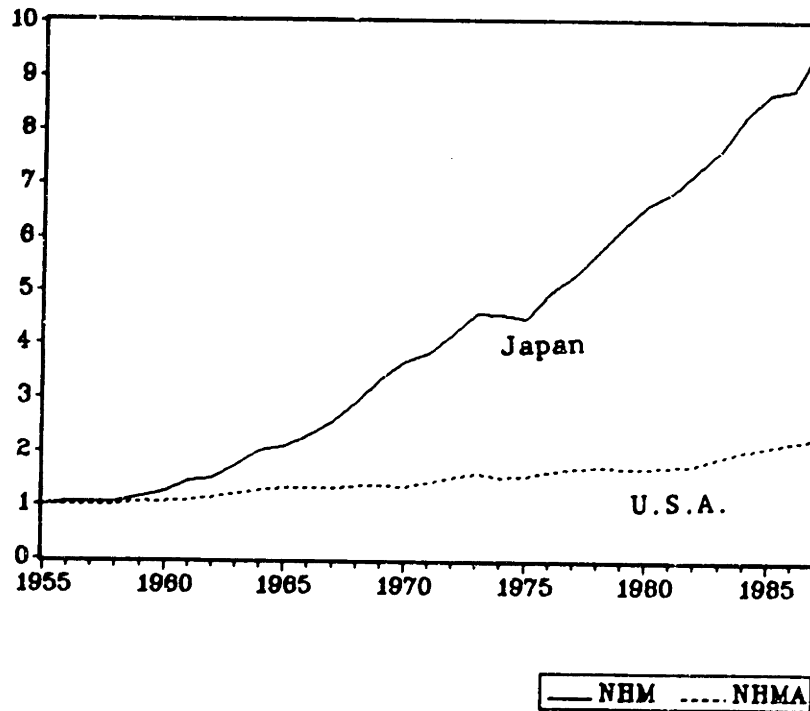
Table 1: PRODUCTIVITY PERFORMANCE (TREND ANNUAL RATE, JAPAN vs. U.S.A.)

	J A P A N		U. S. A	
	1955-1970	1970-1987	1955-1970	1970-1987
Economy as a whole	5.9%	3.0%	1.7%	0.7%
Agriculture sector	4.9	2.3	3.6	1.4
Mining sector	11.2	4.6	4.8	-2.8
Manufacturing sector	9.2	5.7	2.6	2.6
Nontradable sector	5.7	2.0	1.4	0.2
Sources of the economy-wide productivity change				
Productivity change in the manufacturing sector	38(23) ^{a/}	58 (32)	31 (21)	77 (22)
Productivity change in the non-manufacturing sector	64	40	63	19
Structural change	-2	2	7	30
Others	0	0	-1	1
Increase in real product usage				
Economy as a whole	5.9	4.2	2.0	0.6
Manufacturing sector	8.6	7.3	2.7	2.7

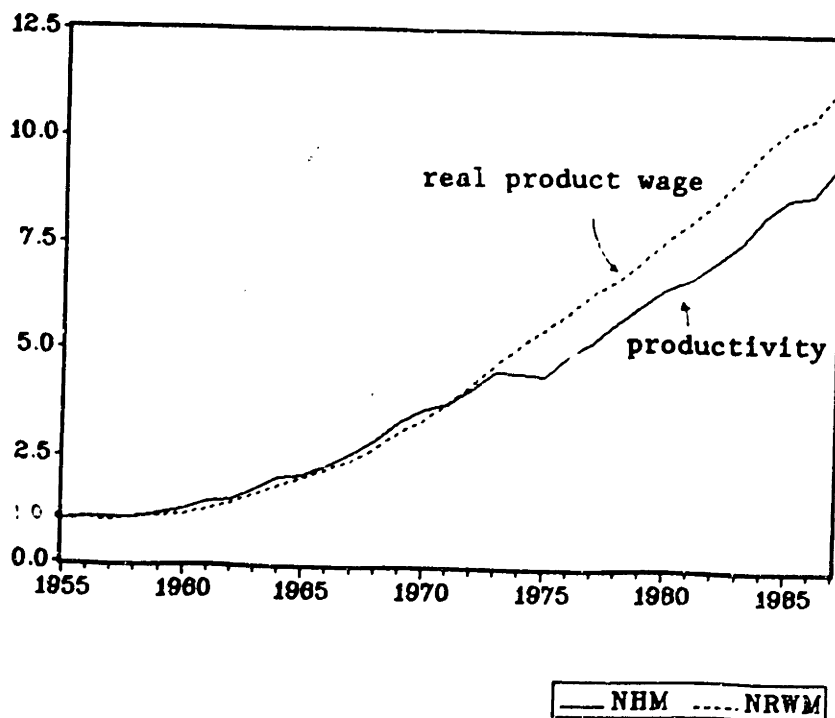
^{a/} Average share of the manufacturing sector in real value added of the economy.

Figure 1: LABOR PRODUCTIVITY GROWTH OF THE MANUFACTURING SECTOR

(A) JAPAN vs. USA



(B) LABOR PRODUCTIVITY vs. REAL PRODUCT WAGE



The labor productivity of Japan in 1987 became almost 10 times as high as that of 1955, while the labor productivity of the U.S. in 1987 was only 2.3 times as high as that of 1955. As Table 1 shows, the labor productivity growth of the manufacturing sector contributed more than proportionately to the labor productivity growth of the economy as a whole, due to its faster speed.

As shown in Figure 1, labor productivity growth is closely related to the increase in real product wage in Japan. It is also true in the U.S. As Table 1 suggests, the real product wage of the manufacturing sector increased almost at the same speed as its labor productivity growth in the United States. In the manufacturing sector of Japan the increase in real product wage fell slightly short of the productivity growth for 1955-1970. For 1970-1987 it exceeded the productivity growth but not substantially (I later discuss and test one possible explanation for this divergence). The correlation between annual increase in real product wage and labor productivity growth is 0.49 for Japan and 0.64 for the United States for 1955 to 1987. The time series regression of real wage increase on labor productivity increase gives a coefficient of 0.88 for Japan and 0.70 for the U.S.

2. Productivity Approach to Real Exchange Rate

The considerably larger productivity growth differential of Japan in favor of the industrial sector should have caused real appreciation of Yen in terms of broad price indexes such as GDP deflator and CPI, if the exchange rate is determined to equalize the price of tradables across countries. It has been well known since Balassa (1964) and Samuelson

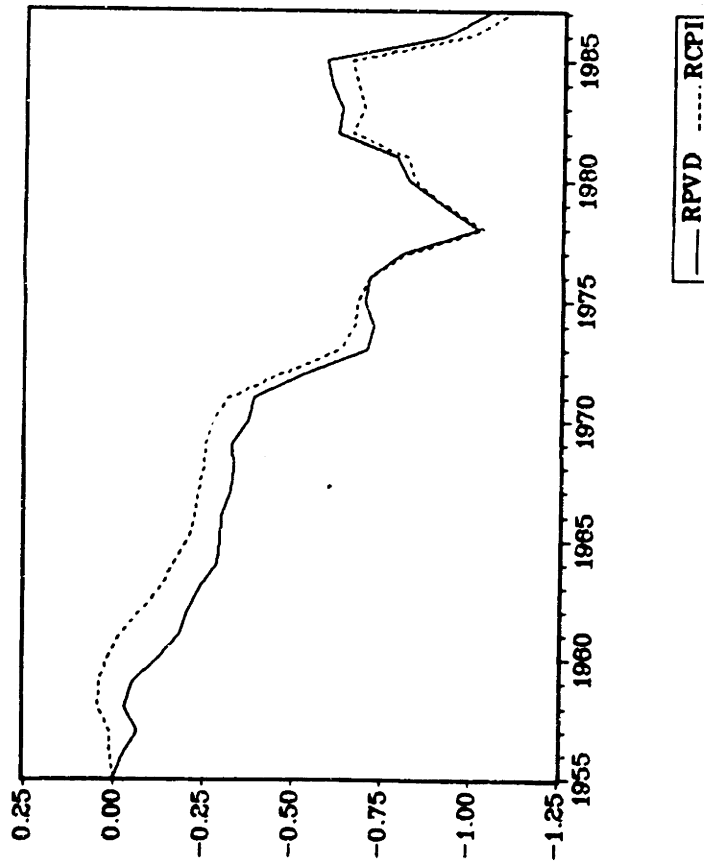
(1964) that exchange rate diverges from purchasing power parity (PPP) if productivity differential between tradable and nontradable sectors differ across countries. Although empirical testing of this productivity approach had produced mixed results, Hsieh (1982) found strong evidence for the role of intersectoral productivity differential in determining the annual change in the real exchange rates of West Germany and Japan from 1954 to 1976.^{1/} More recently Marston (1986) has found that the exchange value of Yen as it stood in 1983 required significant adjustment (around 40% appreciation of Yen) to restore the competitiveness of the U.S. traded goods, even though the real exchange rate in terms of the GDP deflator was at the same level as it was one decade ago (1973), due to much larger productivity growth differential in favor of tradable sector in Japan. In fact, Yen has appreciated significantly since 1985.

In the rest of this subsection, I first report the extended empirical evidence favorable to the productivity approach to real exchange rate. Second, I point out that Yen looks to have appreciated more than justified by the aggregate price of the manufacturing sector or by the relative unit cost of labor of the manufacturing sector and discuss alternative explanations.

As shown in Figure 2, real exchange rate of Japan in terms of GDP deflator and CPI has shown persistent tendency for appreciation since 1955. The major exception was only the period from 1978 to 1982, which was marked by the second OPEC major price hike and the onset of the U.S. deflationary policy. For the whole period from 1955 to 1987, Yen has appreciated by

^{1/} Most studies prior to Hsieh (1982) depended on cross-section data.

Figure 2: REAL EXCHANGE RATE IN TERMS OF GDP DEFLATOR AND CPI



a/ the vertical axis is in natural log.

180% (3.3% annually on average) in real terms as measured by GDP deflator, and by 200% (3.5% annually on average) in real terms as measured by CPI.

This persistent real appreciation can be significantly accounted for by the differential productivity performance of tradable sector (manufacturing sector) and nontradable sector. I have estimated the following equations (all variables are the first differences in logs):

$$(1) \quad r_v = C_0 + C_1 (h_M - h_{NM}) + C_2 (h_{MA} - h_{NMA}) + C_3 \text{rulct}$$

$$(2) \quad r_v - r_{VM} = D_0 + D^1 (h_M - h_{NM}) + D_2 (h_{MA} - h_{NMA})$$

Where r_v (r_{VM}) is the real exchange rate (the U.S. prices relative to the prices in Japan) based on the value added deflator of the economy as a whole (the manufacturing sector), rulct is the relative unit labor cost of the manufacturing sector of the U.S. over Japan, h_M (h_{NM}) is the labor productivity of the manufacturing sector (the nonmanufacturing sector) of Japan, and h_{MA} (h_{NMA}) is the labor productivity of the manufacturing sector (the nonmanufacturing sector) of the U.S.^{2/} In the first equation we expect C_0 to be zero, C_1 to be negative but larger than minus one and C_2 to be positive but less than one, and C_3 to be close to be one. Since wage change is unlikely to be completely exogenous with respect to price change, I estimate equation (1) both by OLS (ordinary least squares) and IV (instrumental variables method). In the second equation we expect D_0 to be

^{2/} I classify only the manufacturing sector as tradable sector. There has been extensive quantitative restrictions on import of agricultural goods in Japan and export of agricultural products has been limited.

zero, D_1 to be negative but larger than minus one, and D_2 to be positive but less than one.

Table 2 presents results from regressions. For both equations constant term was found to be insignificant as expected. All of the productivity differential terms were found to have statistically significant coefficients with correct signs. The coefficient of the relative unit labor cost was found to be significant and to be close to one. These results confirm the findings by Hsieh (1982) and Marston (1986).

Although productivity differentials between tradable and nontradable sectors have been found to have significant effects on real exchange rate, they can explain only about 40% of the real appreciation of Yen in terms of the GDP deflator which has taken place during this period. If we assume that the relative unit labor cost of the manufacturing sector has stayed constant, productivity differentials between tradable and nontradable sectors should have caused the appreciation of Yen only to the level of 270 Yen per \$ in 1987, while the exchange value of Yen stood at 145 Yen per \$. A significant part of the real appreciation of Yen in terms of the GDP deflator has to be accounted for by the appreciation of Yen in terms of the price of the tradable good sector.

In fact Figure 3 shows clearly that real exchange rate of Yen in terms of the value added deflator or the competitiveness of the manufacturing sector has also tended to appreciate. From 1955 to 1987 Yen has appreciated by 84% (1.9% annually on average) in terms of the value added deflator of the manufacturing sector and by 107% (2.3% annually on

Table 2: DETERMINANTS OF REAL EXCHANGE RATE

	Productivity differential in Japan	a/ Productivity differential in U.S.A.	C ₁	C ₂	C ₃	R ²	S.E.	D.V.
OLS	0.0007	- 0.80	1.05	0.89	0.85	0.036	1.86	
(1956-1987)	(0.010)	b/ (0.23)	(0.37)	(0.068)				
IV <u>z</u> /	0.005	- 0.90	1.17	0.96	0.84	0.038	1.88	
(1956-1987)	(0.013)	(0.34)	(0.57)	(0.21)				
	d ₀	d ₁	d ₂	R ²	S.E.	D.V.		
OLS	- 0.012	- 0.25	0.48	0.01	0.024	1.64		
(1956-1987)	(0.007)	(0.14)	(0.23)	0.01	0.024	1.64		

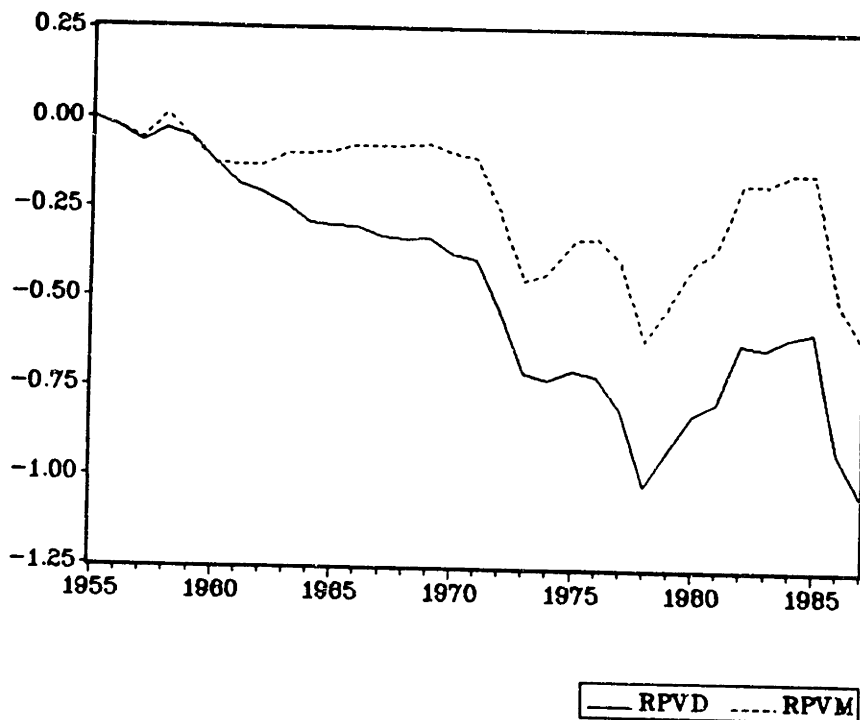
a/ Productivity = Real value added / (employment work hour)

b/ The numbers in the brackets are standard errors of coefficients.

c/ Instruments: labor productivity growth of the manufacturing sectors of Japan and the U.S.A. of the previous year.

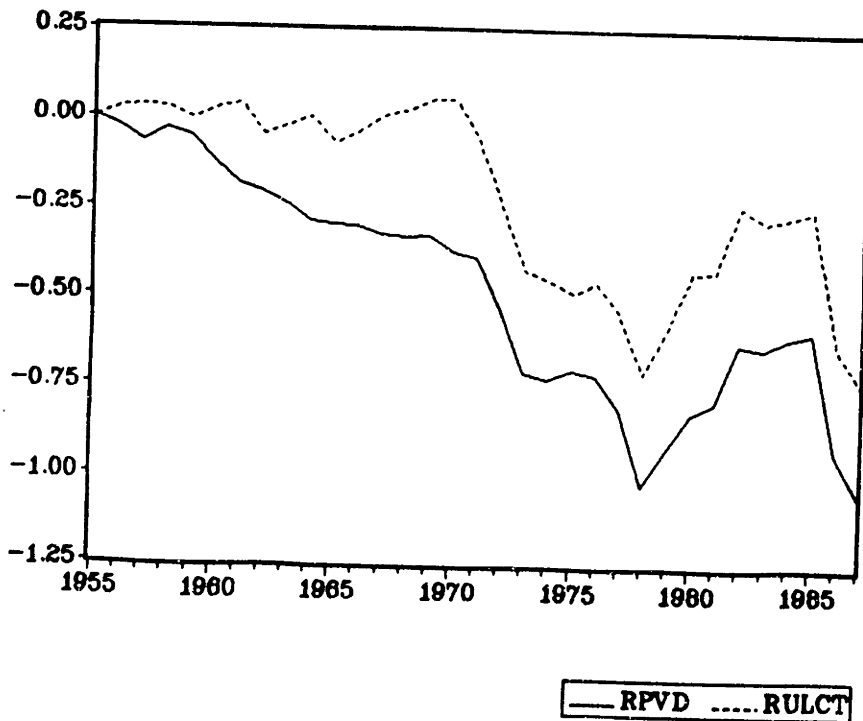
Figure 3: REAL APPRECIATION OF EXCHANGE RATE OF JAPAN

(A) GDP DEFLATOR vs. MANUFACTURING VALUE ADDED DEFLATOR



(B) GDP DEFLATOR vs. RELATIVE UNIT LABOR COST

OF THE MANUFACTURING SECTOR



average) in terms of the relative unit labor cost of the manufacturing sector.

There exists a possibility that the recent level of Yen is overvalued and the real exchange rate in terms of the price of tradable sector in fact remains constant over the long run.^{3/} In fact, Krugman (1989) has recently offered an ingenious theoretical model which can explain the broad empirical fact among industrialized countries that fast-growing countries have systematically high income elasticity of their exports and have not experienced secular real devaluations. However, the above evidence on the degree of divergence from the purchasing power parity as well as the persistence of the large trade surplus of Japan even at current exchange rate do seem to indicate that real exchange rate of Yen in terms of the price of the tradable good has had to appreciate in order to equalize the aggregate competitiveness of the tradable good sector internationally.

Several distinct (can be complementary to each other) explanations for the tendency for real appreciation in terms of the price of tradable good sector are conceivable:

- (a) Extension of the Balassa - Samuelson model to the "tradable" sector... Some of the manufacturing subsectors produce nontradable products (e.g., consumption goods catered to the consumers' needs specific to the country). If these subsectors have smaller technological opportunities for productivity

^{3/} Another possibility is undervaluation of Yen in 1955. However, this is quite unlikely since Japan was still in the state of dollar shortage in 1955.

improvement than the rest of the manufacturing sector,
industrial development leads to real appreciation.

- (b) Industrial diversification... As analyzed by Krugman (1979) within the context of Ricardian model of international trade, if a country in question has diversified its industrial structure faster than the rest of the world, its real exchange rate should appreciate, since the aggregate expenditure pattern shifts to its advantage.
- (c) Systematic correlation between the price elasticity of demand and improvement of price competitiveness (see the technical appendix for more detail presentation)... It is possible to derive the following formula for real exchange rate determination. Assuming the absence of productivity growth bias for export sector,

$$(3) \quad dr/r = \{a(dP/P - (dP/P)^E)\}^E + \{(a-b)(dP/P - (dP/P)^M)\}^M \gamma_A$$

where r is real exchange rate, P_i is the price of industrial sector i of the home country, a_i is the price elasticity of export demand for sector i , b_i is the price elasticity of demand of sector i products as a whole, and upper superscript E (M) implies that variables with those superscripts are averages with the export value (import value) weights. Since high price elasticity is conducive to investment in cost reduction, it is possible that there exists a positive correlation between price

elasticity and improvement of price competitiveness for the countries under rapid technological catchup, leading to real appreciation.

- (d) High export income elasticity relative to import income elasticity... If the home country is blessed with high export income elasticity and if its favorable effect on trade balance is not fully offset by high import income elasticity nor by growth, the real exchange rate of the home country should appreciate. In fact the elasticity ratio for export and import of Japan is above the "45# line" with respect to growth ratio as named by Krugman (1989).^{4/} However, there exists a conceptual problem to this view: it is not clear why a particular country (Japan) can systematically win in identifying high income elasticity sectors.

Although full empirical testing of these hypotheses is beyond the scope of this paper, I will attempt to test the third hypothesis in the section D, since it is newly proposed in this paper.

3. Productivity and Price Competitiveness of the Manufacturing Subsectors

This subsection examines the productivity and price competitiveness of the manufacturing sector in detail. Marston (1986) has found that there exists considerable variation in productivity growth and competitiveness among the subsectors of manufacturing industry in the United States and

^{4/} For the period from 1970 to 1986, the income elasticity ratio (export over import) was 2.06, while the growth ratio (home over foreign) was 1.75 (Krugman (1989)). .

Japan, and that variation of productivity growth has significant correlation with that of competitiveness across the subsectors. I extend his analysis by disaggregating the manufacturing sector further and by extending the time framework.^{5/}

Industrial classification utilized in the analysis is presented in Table 3, together with value added data for both Japan and the United States. The nominal value added of the manufacturing sector of Japan was only one 15th of that of USA in 1955, while it became 80% of that of USA in 1987. In terms of industrial structure the share of traditional industries such as food and textile industries were much higher in Japan than in USA in 1955, while the share of machinery sector was significantly lower. By 1987 industrial structure of the two countries have become quite similar to each other, (the correlation coefficient between the industrial structures of the two countries went up from 0.43 in 1955 to 0.87 in 1987).

Figure 4 shows trend labor productivity growth of each manufacturing subsector for the periods from 1955 to 1970 and from 1970 to 1987. Not only the trend productivity growth is much higher in Japan than in the U.S., but also there exists much higher variation in productivity growth among sectors in Japan. From 1955 to 1970 the trend productivity growth of the three subsectors of chemical products, petroleum and coal products and electrical machinery exceeded 15% per year, compared with 5 to 7% of food

^{5/} I disaggregate the machinery sector into four subsectors: general machinery, electrical machinery, transportation machinery and instruments and other precision machinery. The time framework is extended from 1973-1983 to 1955-1987.

Table 3: INDUSTRIAL STRUCTURE OF JAPAN AND UNITED STATES

	Value added (Japan)		Value added (USA)	
	1970	1987	1955	1970
1. Manufacturing sector as a whole	8.2b\$	689b\$	121b\$	252b\$
2. Food	22%	11%	13%	12%
3. Textile	12	5	4	3
4. Pulp and paper	3	3	4	4
5. Chemical products	8	8	4	4
6. Petroleum & coal products	3	5	3	3
7. Stone, clay & glass products	4	4	4	3
8. Primary metal	15	11	9	7
9. Metal products	4	6	7	7
10. General machinery	5	11	9	11
11. Electrical machinery	4	11	6	9
12. Transportation machinery	7	11	15	12
13. Precision machinery	1	2	2	3
14. Other manufacturing sectors a/	12	13	18	18

a/ Other manufacturing sectors consist of apparel and other textile products, printing and publishing, rubber and miscellaneous plastic products, leather and leather products, lumber and wood products, furniture and fixtures, and miscellaneous manufacturing industries.

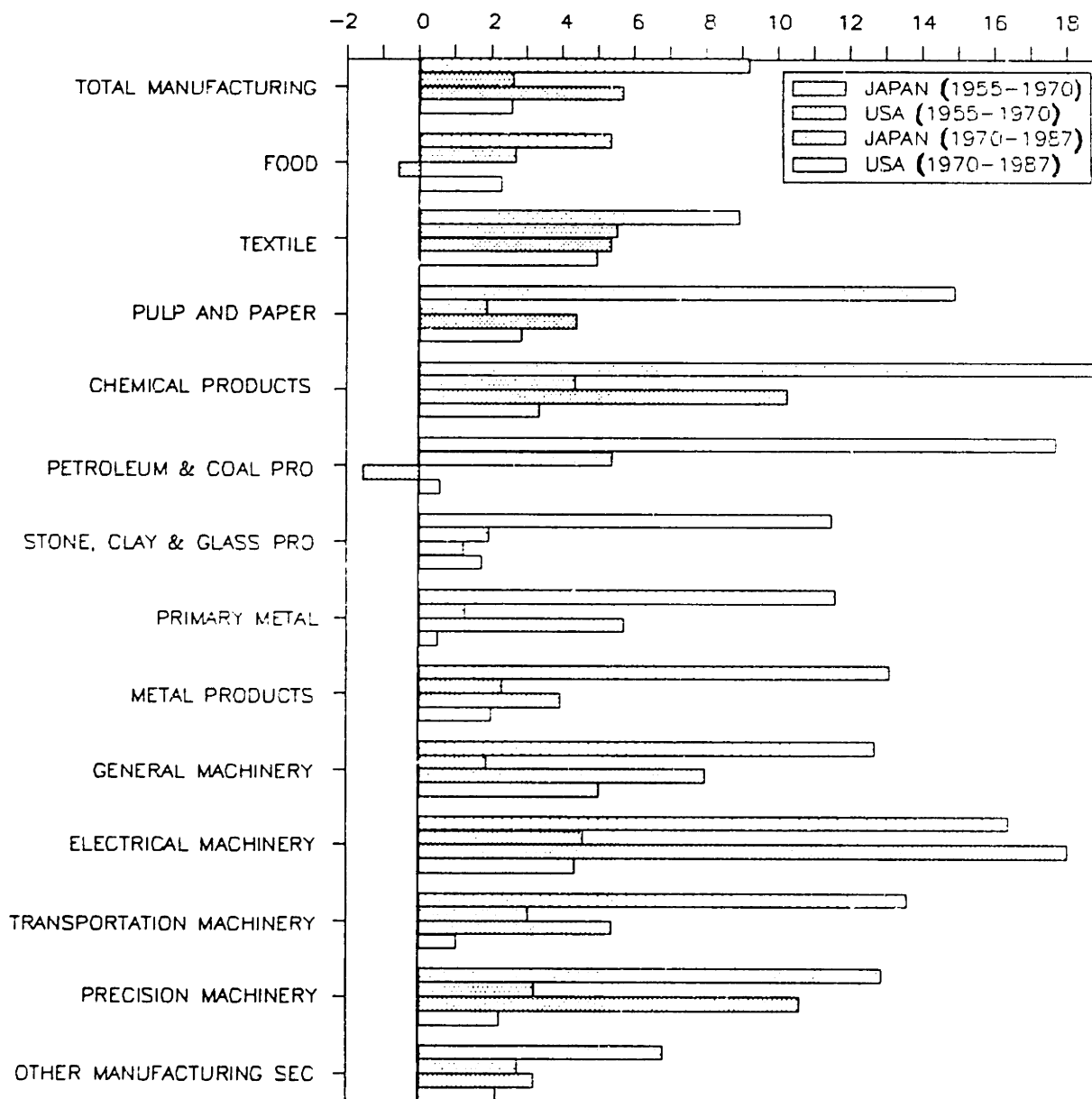


Figure 4: TREND PRODUCTIVITY GROWTH (JAPAN vs. USA)

and other manufacturing sectors. From 1970 to 1987 the electrical machinery sector recorded the trend productivity growth exceeding 18% per year, while food sector and petroleum and coal product sectors recorded negative productivity growth. The productivity growth of the United States has been much more uniform across sectors.

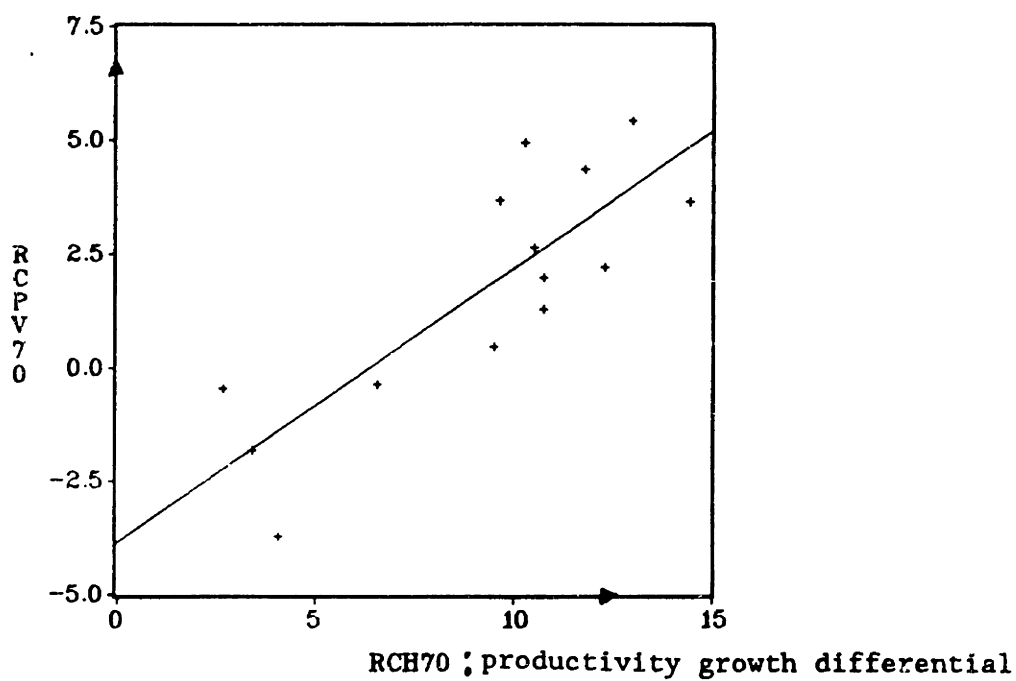
The productivity growth differential between U.S. and Japan has high correlation with the shift of price competitiveness, as we expect from a simple production and pricing model based on the Cobb-Douglas function and constant markup assumptions (see the Technical Appendix). Figure 5 gives clear evidence for this correlation. In this figure price competitiveness is measured as the ratio of the nominal value added deflator of each subsector of Japan and United States. The vertical axis represents the trend change of price competitiveness of the 13 manufacturing sectors of Japan with respect to United States while the horizontal axis represents the trend change in productivity growth differential in favor of Japan.

Table 4A presents results from the cross section regression of the shift in price competitiveness on the productivity growth differential. It is estimated by OLS. In both periods the coefficient of the productivity growth differential are found to be highly significant. For the period from 1970 to 1987 we cannot reject the hypothesis implied by the Cobb-Douglas function and constant markup assumption i.e., the coefficient of the productivity growth differential is one. On the other hand the same coefficient estimate is found to be significantly less than one while the constant term is found to be significant for 1955-1970, which may signify a specification error (e.g. elasticity of substitution between capital and labor > 1). Next, I turn to the evidence from time series.

Figure 5: PRODUCTIVITY GROWTH AND PRICE COMPETITIVENESS

competitiveness

(A) 1955-1970



competitiveness

(B) 1970-1987

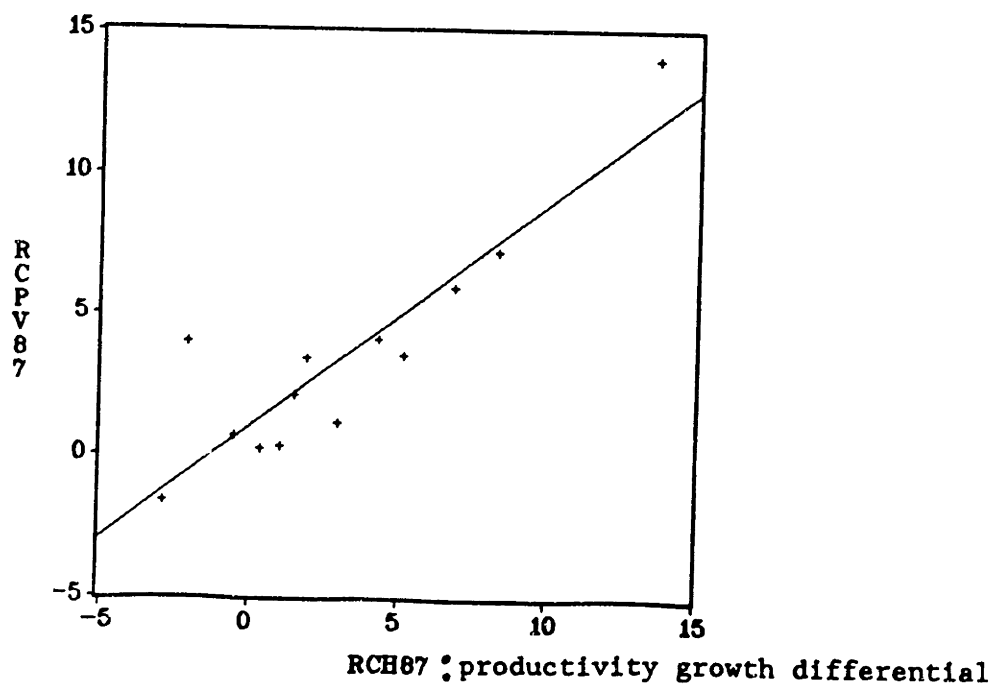


Table 4A: PRODUCTIVITY GROWTH AND PRICE COMPETITIVENESS
(Cross Section Estimates)

		Constant	Coefficient of the productivity growth differential	R ²	S.E.
1955-1970	OLS	-3.7 (1.3)	0.59 (0.13)	0.64	1.63
1970-1987	OLS	0.98 (0.64)	0.79 (0.12)	0.78	1.89

Table 4B: PRODUCTIVITY GROWTH AND PRICE COMPETITIVENESS
(Time Series Estimates)

	Coefficient of productivity growth \underline{a} /			
	OLS		IV	
1. Manufacturing sector as a whole	- 0.37	(0.14) \underline{b} /	-0.41	(0.32) \underline{b} / (F)
2. Food	- 0.53	(0.11) (A)	-1.20	(0.52)
3. Textile	- 0.53	(0.19)	-1.38	(0.72)
4. Pulp and paper	- 0.83	(0.17)	-1.03	(0.30)
5. Chemical products	- 0.40	(0.08)	-0.38	(0.20)
6. Petroleum & coal products	0.59	(0.34)	-0.23	(0.44)
7. Stone, clay & glass products	- 0.43	(0.11)	-0.48	(0.16)
8. Primary metal	+ 0.18	(0.17) (A)	-0.33	(0.23) (F)
9. Metal products	- 0.52	(0.08)	-0.51	(0.12)
10. General machinery	- 0.51	(0.12)	-0.26	(0.52)
11. Electrical machinery	- 0.59	(0.11) (A)	-0.38	(0.18) (F)
12. Transportation machinery	- 0.57	(0.08)	-0.46	(0.24)
13. Precision machinery	- 0.47	(0.05)	-0.43	(0.14)
14. Other manufacturing sectors \underline{a} /	- 0.47	(0.13)	-0.29	(0.38)

\underline{a} / The estimated equation is $d \log P^i = C_0 + C_1 d \log h^i + C_2 d \log w$, where P is the value added deflator h is the labor productivity (real value added/employment) and w is the average labor compensation of the manufacturing sector. The time period for estimation is from 1956 to 1985, except for the manufacturing sector (1956-1987) and the petroleum and coal products (1956-1973).

\underline{b} / Standard error of the estimated coefficient.

\underline{c} / (A) Stands for the use of Cochrane-Orcutt method and (F) stands for the use of the Fair's method of estimation.

Table 4B presents results from time series regression for the Japanese manufacturing sector, to test the relation between labor productivity and price. Labor productivity here is measured as real value added divided by total labor hours. Estimation has been done both by OLS and IV (instruments are GNP growth of Japan and of U.S.A.). In most subsectors the productivity growth is found to significantly reduce output price in the same year, although the coefficients were found to be significantly smaller than unity in most sectors and R2 was low.

I therefore conclude that labor productivity performance differential between Japan and United States can significantly explain the long run sectoral shift of competitiveness between the two countries as a production and pricing model based on the Cobb-Douglas function and constant mark-up assumptions predicts, although its short run predictive power is not high.

C. Technical Change, Capital Accumulation and Productivity Growth

This subsection examines the contributions of technical change and capital accumulation to the massive labor productivity growth of the manufacturing sector of Japan which we have observed in the previous two sections. The analytical framework utilized for this purpose is a standard growth accounting (see the appendix). There already exist a number of empirical studies which have estimated the total factor productivity (TFP) growth of the Japanese economy at sectoral level.^{6/} The main contribution of this section is to take into account the potential bias due to market

^{6/} The most comprehensive study available is the one by Jorgenson, Kuroda, and Nishimizu (1987).

power in product market, and to estimate price measure of the TFP growth. All existing studies on Japan which I am aware of assume perfect competition in factor markets as well as in product markets, and utilizes quantity measure of the TFP growth.

The divergence of price from marginal cost causes a bias in the standard measure of TFP growth. Hall (1986a) has shown that TFP growth is procyclical when such divergence exists. It is also evident that such divergence makes even TFP growth averaged over the business cycles biased: it underestimates the true TFP growth, when capital deepening takes place (see the technical appendix).

This study attempts to deal with the potential bias by estimating price measure of TFP growth. It can be shown that price measure of TFP growth does not suffer any bias even if price is divergent from marginal cost, as long as markup ratio is constant (see the appendix). Price measure of TFP growth utilized in this study is the following:

$$(4) \quad d\hat{H} = s_L d\log(W/P) + (1 - s_L)\log(V/K)$$

where $d\hat{H}$ is price measure of TFP growth, s_L labor share, W hourly compensation to labor, P value added deflator, V real value added and K capital stock. This relation holds for the Cobb-Douglas production function. This equation assumes that labor use is adjusted annually so as to equate its marginal product to wage. It does not presume unrealistically that capital stock is adjusted optimally so that marginal product of capital is equal to interest rate. This equation is not

affected by market power as long as markup ratio is constant. I utilize the calculated price measure of the TFP growth as an instrument for measuring coefficients in pricing and demand equations in time series regression in section D, since it is less vulnerable to market power than the quantity measure of TFP growth.

Table 5 presents the results from calculation. We can make several observations. First, contribution of technical progress to labor productivity improvement is high: 60% for 1955-1970 and 54% for 1970-1985. In particular it is found that most of the improvement in labor productivity has come from technical progress for the textile sector during the 1955-1970 period and for electrical and precision machinery sectors during the 1970-1985 period. Second the speed of technical progress slowed down significantly after 1970. In 9 out of the 13 sectors the growth of TFP became less than half. The energy-intensive sectors recorded negative TFP growth after 1970. The major exceptions are electrical machinery sector and precision machinery sector, which actually increased their TFP growth after 1970.

Third, there exists a significant correlation between quantity and price measures of productivity growth. The cross-section correlation between the two measures are 0.915 for 1955-70 and 0.998 for 1970-1985

Table 6 presents time series evidence confirming the above correlation. The estimated equations are:

$$(5) \quad d\hat{H}_Q = C_0 + C_1 d\hat{H}$$

$$(6) \quad d\hat{H}_Q = C_0 + C_1 d\hat{H} + C_2 (dY/Y)$$

Table 5: CONTRIBUTION OF TECHNICAL PROGRESS TO LABOR PRODUCTIVITY IMPROVEMENT

	1955-1970 Average			1970-1985 Average			(%)
	Labor productivity growth (A)	Technical progress (Q)	Technical b/ progress (P)	Labor productivity growth (A)	Technical a/ progress (Q)	Technical b/ progress (P)	
Manufacturing sector as a whole	9.2	5.8	5.3	5.7	2.6	3.6	54
food	5.4	- 0.8	0.5	- 0.6	- 2.4	- 1.0	-
Textile	8.9	8.0	8.3	5.5	2.7	3.8	59
Pulp and paper	14.9	10.7	9.8	4.4	1.2	1.5	31
Chemical products	18.8	11.0	10.1	10.3	6.9	7.4	69
Petroleum and coal products	17.7	5.7	4.8	- 1.5	- 5.3	- c/	-
Stone, clay & glass products	11.5	7.1	6.3	1.3	- 1.2	0.1	-
Primary metal	11.6	4.2	4.5	5.7	1.5	2.4	34
Metal products	13.1	7.0	6.2	4.0	1.1	2.5	45
General machinery	12.7	7.4	5.4	8.0	5.1	6.1	70
Electrical machinery	16.4	10.8	7.7	18.0	16.9	17.7	96
Transportation machinery	13.6	9.4	6.7	5.4	2.1	3.3	50
Precision machinery	12.9	7.3	7.6	10.6	8.3	9.7	85
Others	6.8	4.8	5.4	3.2	0.8	1.5	36

a/ Quantity measure of TFP growth.

b/ Price measure of TFP growth.

c/ Petroleum and coal products sector had negative value added in some years after the oil crisis.

**Table 6: QUANTITY AND PRICE MEASURES OF TECHNICAL CHANGE
(1956-1985)**

	c_1	S.E.	R^2 a/	$t d_2$ b/	R^2 c/	$M d/$
Manufacturing sector as a whole	1.10	(0.17)	0.61	3.17	0.09	1.06
Food	0.99	(0.08)	0.85	- 1.10	0.0	1.57
Textile	0.78	(0.10)	0.66	0.55	0.01	1.21
Pulp and paper	0.95	(0.07)	0.88	1.93	0.01	0.93
Chemical	1.25	(0.08)	0.90	0.98	0.0	0.95
Petroleum and coal products e/	1.04	(0.06)	0.95	0.05	0.0	0.49
Stone, clay and glass products	1.13	(0.11)	0.80	2.08	0.02	1.06
Primary metal	1.30	(0.14)	0.76	0.66	0.0	1.19
Metal products	1.08	(0.10)	0.82	2.12	0.02	1.04
General machinery	0.87	(0.10)	0.71	1.55	0.03	0.90
Electric machinery	0.99	(0.08)	0.85	2.79	0.03	0.66
Transportation machinery	1.06	(0.09)	0.83	1.93	0.02	0.83
Precision machinery	1.26	(0.10)	0.85	0.12	0.0	1.12
Others	0.96	(0.09)	0.81	1.57	0.02	1.18

a/ R^2 of equation 5.

b/ The t-value for the coefficient of the GNP growth rate.

c/ The difference of R^2 of equation 5 and of equation 6.

d/ Markup ratio estimated.

e/ Estimation period for 1956-1973.

where $d\hat{H}_Q$ is the quantity measure of TFP growth, $d\hat{H}$ the price measure of TFP growth and Y the GNP of Japan. The estimation period is from 1955 to 1985. As shown in Table 6 the estimate of C_1 is very close to one in most of the sectors. Furthermore the coefficient of GNP growth is not significant in 9 out of the 13 sectors, so that the divergence of the quantity and price measures of TFP growth are not strongly procyclical either. The third and fifth columns show that including GNP growth into the equation adds very little to explaining the variance of the quantity measure of TFP growth, once the equation has the price measure of TFP growth.

The above result is highly consistent with the finding by Shapiro (1987) for the U.S. economy. There exist two important implications. First, a macroeconomic implication: as suggested by Shapiro (1987), the annual variation of the total factor productivity change comes mostly from supply side. If the demand shock is a driving force, the real wage should not increase as the quantity measure of TFP goes up, since it is not caused by the real increase of the productivity of labor. Consequently the price measure of TFP is expected to move much less than the quantity measure of TFP and the divergence of the two measures is expected to be procyclical, if the demand shock is dominant.^{7/} Consequently the econometric finding in Table 6 suggests that the demand shock has not been a major driving force

^{7/} It is important to note that investment rate has been very high and variable in Japan, so that demand shock has not dominated the fluctuation of productivity even in the shortrun.

of the productivity fluctuation in Japan. This view, however, has to be qualified somewhat by the fact that wage has some profit component.^{8/}

The second implication is microeconomic: the close correlation of quantity and price measures of TFP growth across sectors as observed in Table 6 suggests that market power is not important at least in the longrun and does not vary very much across sectors. It is possible to have an estimate of markup ratio $M(\text{price/marginal cost})$, if we assume that price measure of TFP growth represents the true TFP growth:

$$(7) \quad M = (\hat{dH}_Q - \hat{dH}) / (s_L \text{dlog}(L/K)) + 1 \\ = (\text{dlog}(V/L) - \text{dlog}(W/P)) / \text{dlog}(L/K) + 1$$

where S_L is labor share in value added, K capital and L labor. The last column in Table 6 presents a result of such calculation. It suggests that the divergence of price and marginal cost in value added basis is only around 10% for the manufacturing sector as a whole, and the highest divergence is only around 60% in the food sector. This result, however, is highly tentative, especially because 4 sectors out of 13 sectors pricing below marginal cost.

I also applied the method as proposed by Hall (1986a). However, I could not get satisfactory results. The estimated markup are highly

^{8/} As pointed out by Shapiro (1987), if labor can share profit with capital, the divergence between the two measures becomes smaller. Since profit sharing through labor compensation is more likely to be prevalent in Japan than in the United States, there exists a possibility that the above econometric finding is still consistent with a Keynesian view. See section E for some evidence of rent sharing.

variable and take negative values in a number of sectors (see appendix). The four potential explanations for this failure are the following.^{9/}

First, mismatch between investment and output, due to lumpiness of investment for capacity creation. It is likely that a substantial part of investment has been made for discrete increase in capacity in anticipation of future longterm demand growth when Japan was in high growth phase. This causes mismatch between capital stock and output and a positive bias for the estimate of markups, as long as some correlation exists between investment and instruments used for estimation. Second, countercyclical markups. More extensive labor hoarding in Japan is likely to cause larger variation in markups over business cycle, even if average markups are the same between the two countries. As shown by Hall (1988), the combination of countercyclical markup and capital deepening causes a positive bias in the estimation of average markup. Third, the combination of price rigidity and labor hoarding. As discussed by Rotemberg and Summers (1988), the combination of shortrun price rigidity (rationing in boom) and labor hoarding causes procyclical total factor productivity change without the presence of market power. Fourth, unrecorded change in the labor input. The statistics on labor input is quite likely to underestimate its actual change in relation to output, since workers hoarded during recession are put to work for repairs and maintenance, training, etc. which do not contribute to current output.

^{9/} See Appendix for more detail.

D. Price Competitiveness and Trade Performance of the Manufacturing Sector

1. Structural Transformation of the Japanese International Trade

This section examines how the shift in price competitiveness has caused the transformation of the export structure of Japan. It also attempts to estimate price elasticity of demand in disaggregated level for the total demand and export demand. These estimates are then utilized to evaluate the hypothesis put forward in section B.2.

Table 7 presents a summary data of the significant structural change of the Japanese trade, especially its export. In 1950 machinery export accounted for only a little more than 10% of the total export, while textile, food and miscellaneous export accounted for around 40%. In 1970 the share of machinery export went up to 40% and became about 67% in 1987. On the other hand, the share of textile, food and miscellaneous export declined to around 17% in 1970 and further down to 6% in 1987.

The rapid structural transformation is more clearly recognized when we look at the change in the bilateral trade structure between Japan and U.S.A. (see Table 8). In 1956 the Japanese export to the U.S. was only half of its import from the U.S. and textile and other light manufactured goods accounted for most of its export to the U.S. In 1971 more than 70% of the Japanese export to the U.S. was accounted for by metal, metal products and machinery and exceeded its import from the U.S. by 30%.

Table 7: EXPORT GROWTH AND TRADE STRUCTURE

	Average Export Growth [%]		Share in Total Export [%]			Share in Total Import [%]		
	1955-1970	1970-1987	1955	1970	1987	1955	1970	1987
Manufacturing sector as a whole	13.6	6.0	74.8	82.8	88.0	36.7	40.2	52.7
Food	7.5	- 2.6	4.1	2.0	0.6	16.1	5.9	8.9
Textile	6.4	- 1.3	24.7	7.2	2.0	2.0	1.8	3.0
Pulp and paper	12.8	2.7	0.8	0.8	0.6	0.8	1.0	1.4
Chemical products	17.2	4.6	4.2	6.5	5.5	3.5	4.7	6.2
Petroleum and coal products	23.8	1.0	0.2	0.7	0.6	3.5	3.5	5.6
Stone, clay & glass products	8.6	1.5	3.6	1.8	1.2	0.2	0.2	0.7
Primary metal	14.1	1.3	11.9	13.2	5.9	4.1	8.1	7.7
Metal products	15.0	0.2	2.5	3.3	1.4	0.2	0.3	0.5
General machinery	19.0	9.0	3.7	8.8	13.9	3.4	4.5	2.2
Electrical machinery	26.3	14.3	1.8	12.0	24.5	0.9	3.2	4.2
Transportation machinery	22.1	8.8	4.9	15.8	25.1	0.9	2.3	3.1
Precision machinery	21.3	7.4	1.1	3.1	3.2	0.4	1.3	1.5
Others	8.3	- 0.3	11.3	7.6	3.6	0.7	3.2	7.6

Table 8: CHANGE IN THE BILATERAL TRADE STRUCTURE (U.S.A. vs. JAPAN)

	1956			1971		
	Export from Japan (E) <u>b/</u>	Import from USA (M) <u>b/</u>	M/E	Export from Japan (E) <u>b/</u>	Import from USA (M) <u>b/</u>	M/E
Food and beverages	58	134	2.3	160	937	5.9
Crude materials	23	645	28.0	41	2,514	61.3
Textiles	182	0	0	808	0	0.0
Chemicals and medicines * <u>a/</u>	5	72	14.4	207	410	1.9
Metals and metal products *	60	56	0.9	1,570	0	0.0
Machinery and instruments *	47 <u>c/</u>	111	2.4	4,516	1,437	0.3
Others	168	47	0.3	1,070	684	0.6
TOTAL	543	1,065	2.0	8,372	5,982	0.7

a/ * : Sectors with the decline in M/E from 1956 to 1971.

b/ Million US\$.

c/ Major export items: Sewing machine (13 m\$), camera (9 m\$), other optimal instrument (9 m\$)

Source: Foreign Trade of Japan, JETRO (1960 and 1973).

2. Significance of Price and Income Elasticities in the Structural Change

The above structural transformation is closely related to the shift of price competitiveness across sectors, as shown below, although income elasticity is also found to remain highly significant.

First, I estimate price elasticity of demand from a cross-section data of the longrun average of export growth and the shift in price competitiveness. A major merit of this approach is that we can sidestep the difficulty of estimating the lag structure by using the longrun average data. However, there also exist two potential problems: First, the sectoral difference in export income elasticity can cause an upward bias in the estimate, if it is positively correlated with the improvement of price competitiveness. Second, the sectoral difference in export price elasticity also causes an upward bias in the estimate, if high price elasticity is favorable to larger cost reduction and faster improvement in price competitiveness as hypothesized in the section B.2. If not, we can get an average of price elasticities of all subsectors.^{10/} I later examine both of these correlations.

Given the working assumption that the improvement of the price competitiveness is uncorrelated with income elasticity nor with price elasticity, I set the following equation for estimation.

$$dE_i/E_i = C_0 + C_1 S_i (dRP_i/RP_i) + U_i$$

^{10/} The degree of bias is proportional to $\{R (C_i - C)(dP_i/dP - dP/P)\}(dP/P)$, where C_i is the price elasticity of sector i , C is its weighted average and dP_i/P_i is the change of price competitiveness of sector i and dP/P is its arithmetic average.

where E_i is the export of the sector i , C_i the average price elasticity of export demand of all subsectors, s_i the share of value added in the gross output, RP_i relative price in terms of the value added deflator of the sector i , and U_i the sector specific disturbance.

I estimate C_i for the two periods: 1955-1970 and 1970-1985. Since no comprehensive sectoral output price data consistent with the industrial classification used here is readily available for the U.S., it is necessary for me to use the value added deflator.^{11/} s_i is the average of the 1955 value added share and the 1970 value added share of Japan for the estimation for the period of 1955-1970, and the average of the 1970 value added share and the 1985 value added share of Japan for the estimation for the period of 1970-1985. I further assume that the sector specific innovation in the value added deflator is independent of the sector specific innovation in the price of intermediate input.

Ideally we should include as an independent variable the relative price of this sector in the foreign economy (i.e., the U.S.A.), the coefficient of which represents intersectoral price elasticity (see Appendix). However, since output price data of the U.S.A. for this

^{11/} The percentage change of the output price P is given by

$$dP/P = (1/P)(\partial C/\partial P^V)dP^V + (1/P)(\partial C/\partial P^I)dp^I$$

where C is the marginal cost, P^V the value added deflator and P^I the input price. This obtains as long as markup is constant. Since $\partial C/\partial P^V$ is equal to the value added requirement of unit output (v), we get

$$(1/P)(\partial C/\partial P^V)dP^V = (VP^V/P)(dP^V/P^V) = S(dP^V/P^V)$$

where s is the share of value added.

sectoral classification is not readily available, I simply omit this variable which can cause a downward bias. Utilizing the total factor productivity change as an instrumental variable would eliminate the bias due to this omission to the extent that productivity changes in the two countries are uncorrelated. The instrumental variable approach also safeguards the estimation from potential bias caused by sectoral demand shocks.

Table 9 presents results from regressions. It is found that the coefficient of the price elasticity of demand is highly significant except for the IV estimate for 1955-1970 (although still significant). The estimates for 1955-1970 are very high and far exceed most of the existing estimates of price elasticity. The estimates for 1970-1985 are more modest but still much higher than most of the estimates obtained from time series regressions.^{12/} The shift in price competitiveness among sectors can explain around 50% of the variation in export. This result, although with many qualifications, indicates a possibility that the conventional price elasticity estimate may significantly understate the effect of the change of price competitiveness on trade flow. Next I provide further evidence from time series regression to support this view.

My approach to time series regression is again to use the total factor productivity shock as an instrument. This approach has been recently applied to the U.S. industries by Shapiro (1987). Elasticities

^{12/} Goldstein and Khan (1985) summarizes the results of the recent empirical studies estimating price elasticities. According to them, 9 out of the 10 studies have long-run price elasticity estimates of export less than 2.0. Similarly Deppler and Ripley (1978) reports that 11 out of 12 industrialized countries have long-run price elasticity of their exports less than 2.0.

Table 9: PRICE ELASTICITY OF EXPORT
(Cross-Section Estimate)

	C_0	C_1	R^2	R^2 (Adjusted)	S.E.
(1955-1970) OLS	11.9 (1.6) ^{a/}	-6.05 (1.63)	0.55	0.51	4.65
IV	11.2 (2.4)	-7.12 (3.20)	0.54	0.50	4.74
(1970-1985) OLS	3.18 (1.31)	-2.20 (0.71)	0.46	0.42	3.89
IV	1.98 (1.60)	-3.36 (1.02)	0.33	0.27	4.34

^{a/} Standard error of the coefficient estimate.

of both total demand and export demand are estimated. For total demand the equation estimated is

$$(8) \quad dD_i/D_i = C_0 - C_1(dP_i/P_i) + C_2 (dY/Y) + U_i$$

where D_i is total demand, P_i the value added deflator of the sector i relative to domestic value added deflator, Y the GNP and U_i the sector specific disturbance.^{13/} Since there exists an obvious simultaneity problem between P_i and U_i , I utilize the total factor productivity shock (the price measure of the TFP growth of sector i) as an instrument, which should be independent of sector specific demand shock.

For export demand the equation estimated is

$$(9) \quad dE_i/E_i = K_0 + K_1(dRP_i/RP_i) + K_2(dY^A/Y^A) + T_i$$

where E_i is export demand, RP_i the international competitiveness of the sector i , Y^A the GNP of the United States and T_i the sector specific disturbance. Although simultaneity problem is likely to be less serious than the case for total demand, I utilize the total factor productivity shock (the price measure of the TFP growth) and the exchange rate change as instrumental variables.

In estimating both equations the Fair's method is used when there exists a significant serial correlation in the residuals.

^{13/} As pointed out by Shapiro (1987), this equation may be misspecified for durable goods sectors, since demand also depends on the expected future price in these sectors. I simply ignore this potential problem.

Table 10 presents estimated results. I could obtain fairly tight estimates for price elasticities. Estimated price elasticities are again much higher than the conventional estimates. For total demand 11 out of the 13 subsectors have price elasticities exceeding 3. For export demand 8 out of the 13 subsectors have price elasticities exceeding 2. This high price elasticities suggest that the shift of price competitiveness has also been a major cause for the structural change in industry and trade. The following Table illustrates this point by decomposing export growth into income effect and price effect. Although income effect is still highly significant, the change in the price competitiveness also plays a major role.

Next I examine the hypothesis put forward in section B.2. My hypothesis is that there exists a positive correlation between price elasticity and the speed of cost reduction across sectors, since industry has larger incentive for cost reduction in high price elasticity sector. I test this hypothesis by estimating the following equation on the cross section data (13 subsectors). Variables are the averages over the period from 1955 to 1985.

$$(10) \quad S^i \text{ or } H^i = C_0 + C_1 E_{pi} + C_2 E_{li}$$

where S is TFP growth, H labor productivity growth, E_p price elasticity of demand and E_l income elasticity of demand. E_l is included since incentive for cost reduction depends positively on the future size of the market. I expect both C_1 and C_2 to be positive and significant. Estimations are done separately for total demand and export demand.

Table 10: INCOME AND PRICE ELASTICITIES

	Total demand			Export demand		
	Price elasticity (output basis)	(V.A. basis)	Income Elasticity	Price elasticity (output basis)	(V.A. basis)	Income Elasticity
Manufacturing sector as a whole	4.0	1.3 (0.51)	1.4 (0.51)	2.5	0.8 (0.27)	2.1 (0.82)
Food	3.4	1.2 (0.26)	- 0.1* (0.36)	2.0	0.7 (0.23)	1.3* (0.79)
Textile	2.5	0.7 (0.16)	1.0 (0.36)	1.6	0.5* (0.27)	0.9* (1.3)
Pulp and paper	3.2	0.9 (0.17)	0.9* (0.48)	1.5	0.4* (0.28)	0.0* (0.0)
Chemical products	5.8	2.1 (0.47)	0.8* (0.60)	3.3	1.2 (0.35)	3.1 (1.1) (F)
Petroleum and coal products	4.4	2.1* (1.4)	- 1.8* (2.7)	2.8	1.4* (1.6)	- 2.7* (3.8)
Stone, clay and glass products	3.6	1.4 (0.41)	1.4 (0.43)	1.6	0.6 (0.18)	1.2 (0.59)
Primary metal	7.1	1.5 (0.65)	2.3 (0.32)	3.6	0.8 (0.38)	0.8* (1.6)
Metal products	2.4	1.0 (0.33)	1.9 (0.49) (F)	1.1	0.5 (0.41)	- 0.04* (1.0) (F)
General machinery	6.7	2.2 (0.68)	0.8* (0.73) (F)	1.1	0.4 (0.24)	1.4 (0.76) (F)
Electrical machinery	4.9	1.8 (0.26)	2.1 (0.61) (F)	2.5	0.9 (0.26)	4.7 (1.0) (F)
Transportation machinery	3.3	1.2 (0.17)	1.4 (0.36)	2.1	0.8 (0.26)	1.2* (0.97) (F)
Precision machinery	4.3	1.7 (0.19)	1.0 (0.35)	0.8	0.3 (0.20)	2.4 (0.67) (F)
Others	3.8	1.3 (0.23)	1.2 (0.27)	2.7	0.9 (0.25)	1.5 (0.82)

a/ The value in the bracket is the standard error of the coefficient. The coefficient with * is not statistically significant. (F) stands for the estimation by the Fair's method.

b/ Estimation period is from 1955 to 1985 except for the petroleum and coal products (1955-1973).

c/ The output based price elasticity is obtained by dividing the estimated value added based elasticity by the share of the value added (inclusive of indirect tax) in the gross output in 1970.

Table 11: INCOME AND PRICE EFFECTS ON EXPORT GROWTH

	1955-1970			1970-1985		
	Export Growth	Price Effect	Income Effect	Export Growth	Price Effect	Income Effect
Manufacturing sector as a whole	13.6	-0.5	6.7	7.7	-0.3	5.2
Chemical Products	17.2	4.6	9.9	5.1	4.9	7.7
Electrical Machinery	26.3	3.3	15.0	16.4	11.1	11.8

Table 12 presents the results of estimation. It is found that both price and income elasticities are significant and have expected signs in the equation for total demand. They explain around 50% of the variation of the TFP growth and of the labor productivity growth. As for the equation for export demand, income elasticity term still has a significantly positive coefficient. However, price elasticity term is found to be insignificant, although it has a correct sign. This result may not be surprising, since export, although significant, is only a small part of total demand.

The significant correlation between price elasticity of total demand and productivity changes across sectors, however, does not necessarily imply real appreciation. If it is relevant only to domestic demand (since the correlation between price elasticity for export demand and productivity change is found not to be strong), it may actually imply real devaluation, since more domestic price reduction in the sectors with high sectoral price elasticities leads to significantly larger expenditures for the products of these sectors, including imports, which may substantially offset substitution effects between domestic goods and imports (See Appendix). Therefore, I have to conclude that the hypothesis put forward in section B does not have statistically significant supporting evidence from the Japanese experience. However, further research covering developing countries will be useful to test the robustness of my result.

Table 12: DETERMINANTS OF PRODUCTIVITY GROWTH
(Cross-Section)

	Constant	Price Elasticity of Demand	Income Elasticity of Demand	R ²	R ² (Adjusted)	S.E.
(I) Total Demand						
TFP Growth	-2.4 (2.6) ^{a/}	4.0 (1.4)	2.4 (0.92)	0.49	0.39	2.9
Labor Productivity Growth	1.4 (2.9)	4.0 (1.6)	2.4 (1.0)	0.45	0.31	3.1
(II) Export Demand						
TFP Growth	2.8 (2.3)	1.3 (2.8)	1.3 (0.53)	0.38	0.26	3.2
Labor Productivity Growth	6.1 (2.5)	2.2 (3.0)	1.3 (0.57)	0.35	0.22	3.4

^{a/} Values in the brackets are the standard errors of the coefficient estimates.

E. Technical Progress and Returns to Labor and Capital

This subsection examines returns to labor and capital. The primary objective is to examine whether industry can significantly appropriate the gain from its own technical progress. If strategic effect of competition drives enterprises to undertake investment for cost reduction, industry as a whole may not gain significantly from cost reduction. Instead, we expect that the first major beneficiary group from technical progress is consumers. Furthermore, if a large segment of industries in the economy invest heavily in technology and price elasticity of demand is relatively large for these industries, aggregate output, employment and investment expands rapidly, which in turn cause rapid increase in real wage and real interest rate. Therefore, the second major beneficiary group are workers and investors as a general. However, industry which actually implements investment for technical progress may gain only a little or even lose from such investments. I hypothesize that the above view is an important aspect of the industrial development of Japan. As a first step to test this view I examine whether industry can significantly gain from its own technical progress.

I approach the problem from the two angles. First a test will be conducted to see whether wage increase in a particular sector reflect TFP growth of that sector. If workers can get some share of industry profit, wage can be a better measure of profit than accounting profit, since the latter may have only weak systematic relation with economic profit.^{14/} I

^{14/} Fisher and McGowan (1983) expressed a very pessimistic view about the usefulness of accounting profit as a measure of economic profit, since accounting profit does not correctly match investment and its return.

examine the two propositions: whether wage reflects industry profit and whether wage increase of the sector i reflects the TFP growth of the same sector. Second, I examine whether industry accounting profit is systematically related to the TFP growth.

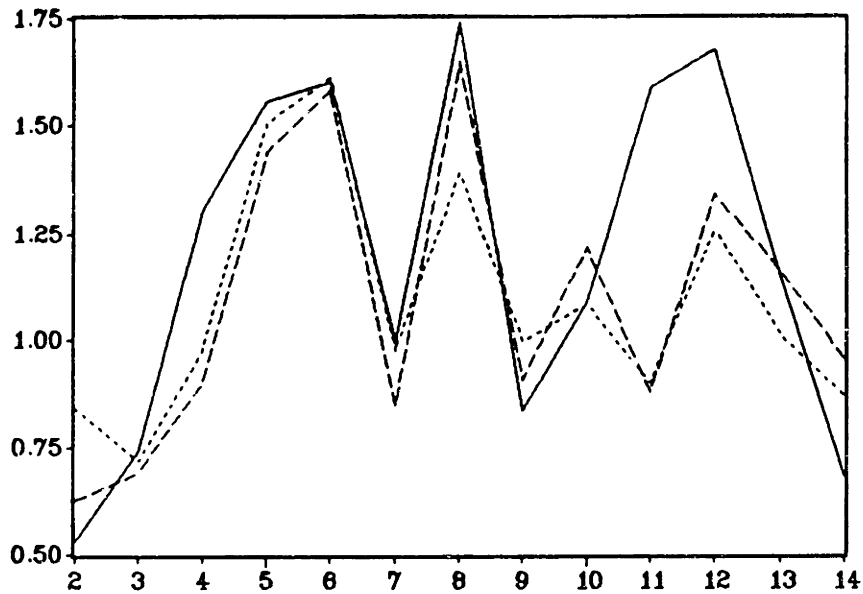
Average real product wage of the manufacturing sector has gone up almost at the same speed as the labor productivity growth, as shown in Table 1 and Figure 1. This largely holds true for each manufacturing subsector. In fact this is equivalent to say that the price measure of the TFP growth based on the Cobb-Douglas specification yields roughly the same result as the quantity measure of the TFP growth, which we ascertained in the section C. However, this does not imply that wage is determined so as to make this relation obtain or industry specific TFP growth is fully reflected in the wage of that industry. The more likely causality is that wage is determined in the market and each industry determines its price so as to make this relation obtain. In fact we have already seen in the section B.3 that sectoral labor productivity improvement has been significantly absorbed by the decline in the output price of that sector (Table 4). In the following, I examine the determinants of the shift of industry wage profile to directly test the linkage between technical progress and wage.

Figure 5 presents industry profile of average hourly labor compensation in 1955, in 1970 and in 1985. The industry wage profile has been highly stable despite differential productivity performance across sectors, which itself suggests that wage is not dependent on sector specific shocks. A conspicuous and interesting exception is electrical machinery sector, which used to be among the sectors with the highest wage

in 1955 but paid less than industry average wage in 1987. As we have observed, this subsector has achieved the highest or one of the highest TFP growth for the whole period from 1955 to 1987. This example suggests strongly that sectoral productivity performance is not reflected in sectoral wage, although we have to make a more systematic test as done below before reaching this conclusion.

Figure 5: INDUSTRY WAGE PROFILE

(a) 1955 - 1970 - 1985



— W55 W70 - - - W85

- | | | |
|----------------------|---------------------------------|---------------------------------|
| 2. Food | 6. Petroleum & coal products | 11. Electrical machinery |
| 3. Textile | 7. Stone, clay & glass products | 12. Transportation machinery |
| 4. Pulp and paper | 8. Primary metal | 13. Precision machinery |
| 5. Chemical products | 9. Metal products | 14. Other manufacturing sectors |
| | 10. General machinery | |

(b) Correlation with Capital Labor Ratio (1985)

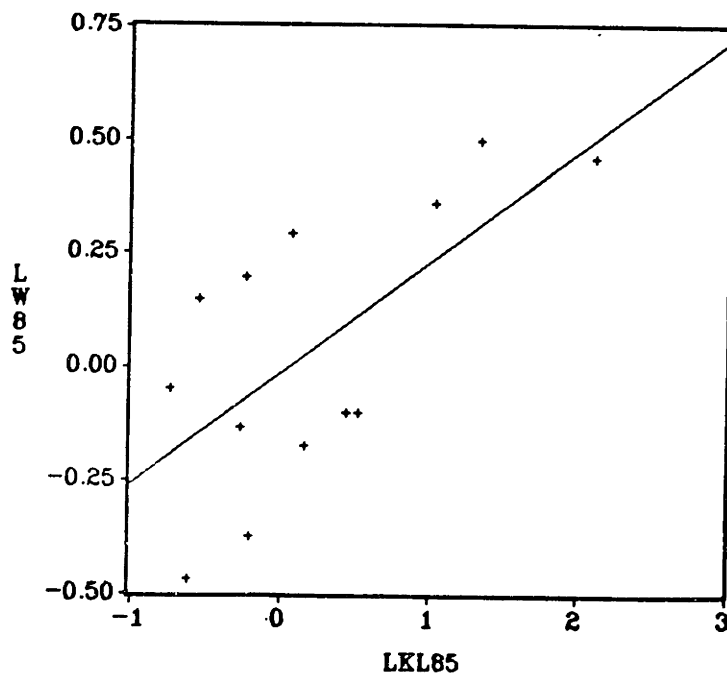


Figure 5 also shows the correlation of the sectoral wage profile with the capital labor ratio. There exists a close correlation between the two variables (the correlation coefficient is 0.68). This result confirms the finding by Katz and Summers (1989) for the U.S. industry, which is interpreted by them that workers compensation have a significant component of industry rent. There also exists a close correlation in industry wage profile between Japan and the United States (the correlation coefficient is 0.82).

In order to test the effect of technical progress on the wage, I estimate the following equation from cross section data:

$$(11) \quad W_{it} = C_0 + C_1W_{i(t-1)} + C_2d\hat{H}_i + C_3(K/L)_i$$

where W_{it} is wage of the sector i at the time t , $d\hat{H}_i$ the total factor productivity growth during the period from $t-1$ to t of sector i , and $(K/L)_i$ is the capital labor ratio of sector i at time t . If workers can get some share of profit based on their bargaining power, we expect C_3 to be positive and significant, as long as there exists some variation in $(K/L)_i$ over time. Furthermore, if industry can appropriate gain from technical progress of its sector, we expect C_2 to be also positive and significant, since workers should also get benefitted from efficiency gain, if they have sufficient bargaining power.

Table 13 presents results from regressions. Capital labor ratio is found to be significant for 1955-1970, even given the past wage profile. It is not significant for 1970-1985. However, this is presumably due to the high correlation between the capital labor ratio in 1970 and that in

Table 13: DETERMINANTS OF INDUSTRY WAGE PROFILE
(Cross-section Estimate)

	C_0	Past Wage Profile C_1	TFP Growth C_2	Capital Labor Ratio C_3	R^2	SEE
OLS (1955-1970)	0.61 (0.13) ^{a/}	0.39 (0.14)	-1.0 (1.6)	0.052 (0.020)	0.73	0.142
OLS (1970-1985)	-0.26 (0.22)	1.26 (0.25)	0.55 (0.81)	-0.017 (0.034)	0.84	0.135

^{a/} Standard error of the coefficient.

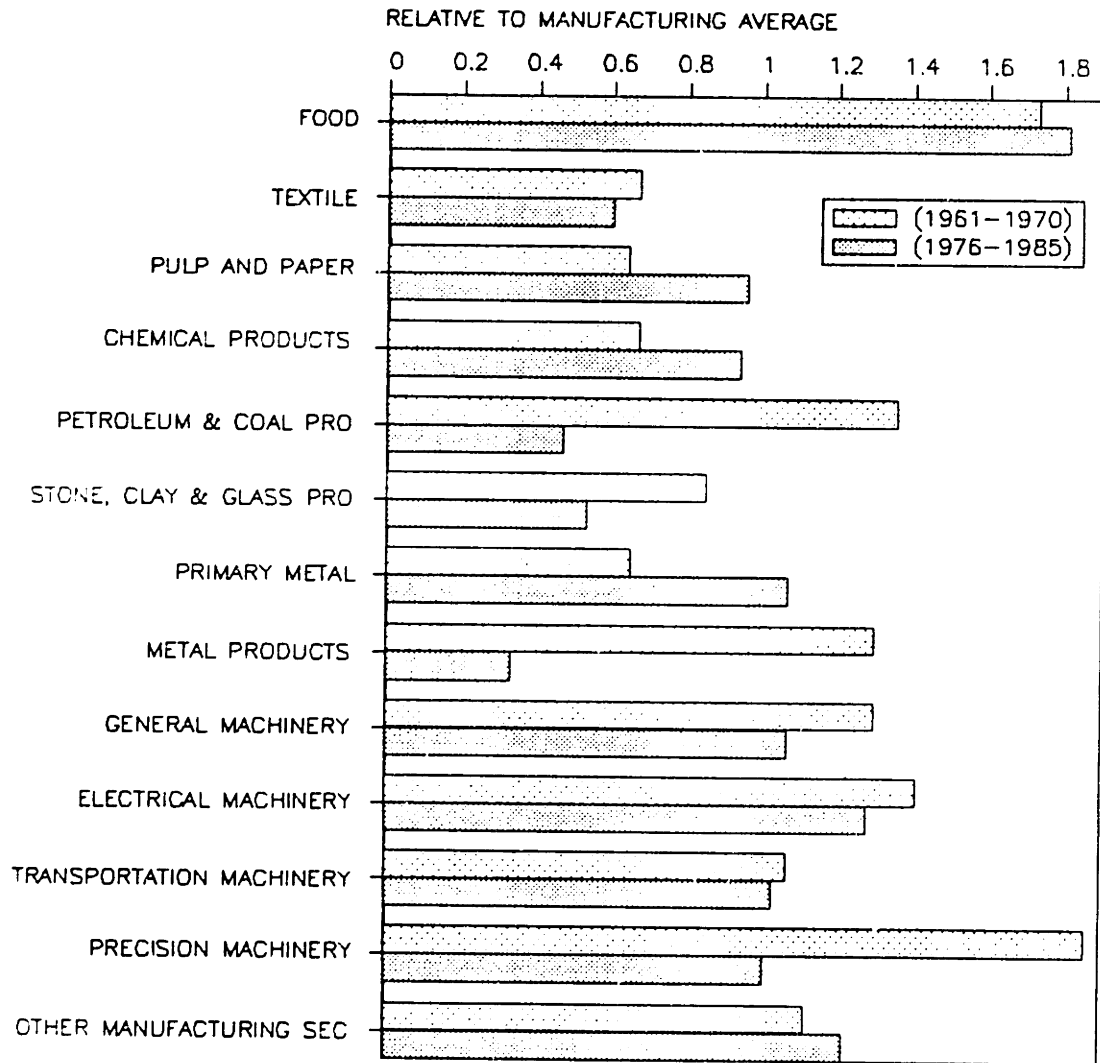
1985 (the correlation coefficient is 0.99). Consequently, there exists some evidence that workers can get some share of profit. On the other hand, the coefficient of TFP growth is found to be insignificant in both periods. It even has a wrong sign for 1955-1970. Therefore, the evidence supports the view that industry cannot appropriate gain from technical progress in a significant manner.

Next I examine return to capital. Return to capital is constructed by dividing the accounting profit (i.e. value added - indirect tax - depreciation - labor compensation) by the capital stock estimate.^{15/} As is well known, accounting profit is a very treacherous measure of economic profit. Most importantly high growth sector has low accounting rate of return simply due to larger depreciation charge. In the following estimation I attempt to correct this bias by introducing the growth rate of capital as an explanatory variable of the return to capital. Another problem is that depreciation data of the National Account of Japan which this paper depends on is not inflation adjusted.

Figure 7 shows return to capital profile. It represents the longrun average of the return of each sector normalized by the return of the manufacturing sector as a whole for 1961 to 1970 and for 1976 to 1985. There exist a large variation in relative return to capital, which does not allow an easy interpretation. Return to capital profile is not stable as wage profile is, although there exists some positive correlation in the profiles of the two periods.

^{15/} Capital stock estimate is obtained from Professor M. Kuroda of Keio University. The Japanese Government (the Economic Planning Agency) reports only gross capital stock estimate.

Figure 7: RETURN TO CAPITAL PROFILE
(1961-1970 vs. 1976-1985)



In order to test the effect of technical progress on industry profit, I estimate an equation similar to equation (11):

$$(12) \quad \text{ROK}_{it}/\text{ROK}_{i(t-1)} = C_0 + C_1 \hat{dH}_i + C_2 ((dK/K)_t / (dK/K)_{(t-1)})$$

where ROK_{it} is relative accounting rate of return to capital of the sector i at time t , \hat{dH}_i the TFP growth from the period $t-1$ to the period t , dK/K the speed of capital growth up to period t .^{16/} If industry can significantly appropriate the gain from TFP growth, we expect C_1 to be positive and significant. dK/K is introduced to correct for the possible bias for the estimate of C_1 due to the negative effect of accounting depreciation on profit, since investment is likely to be positively correlated with TFP growth. We expect C_2 to be negative and significant, since the sector with rapid capital growth experiences relative reduction of accounting profit due to relatively large depreciation cost.

Table 14 presents estimated results. It is found that both coefficients are insignificant. In particular there is no statistically significant evidence that sectors experiencing rapid technical progress have higher returns on capital. The growth of the capital stock has a wrong sign. One possible source of bias is sector specific demand shock. However, adding relative growth of value added has not improved the estimation at all. Therefore I conclude, although tentatively, that returns on capital data also support the view that industry does not substantially gain from its own technical progress.

^{16/} See appendix for the procedure used to construct data for equation (12). I basically used longrun average data.

Table 14: DETERMINANTS OF RETURN TO CAPITAL PROFILE
(Cross-section Estimate)

	C_0	Total Factor Productivity Growth C_1	Acceleration in the Growth of Capital Stock C_2	R^2	$\overline{R^2}$	S.E.
Change in the Relative Return to Capital	-0.114 (0.58)	0.018 (0.032)	0.174 (0.597)	0.042	-0.149	0.594

F. An Assessment of Industrial Policy

1. Evaluating Industrial Targeting

This section attempts to make an assessment of industrial policy of Japan, focusing on targeting. Given the resource constraint of the economy, government support to one sector even if justified due to externality, automatically implies taxing all the other sectors and can still end up with national welfare loss.^{17/} Furthermore, a government intervention tends to create new distortions. In the case of industrial policy of Japan in the 1950s and 1960s protection was the main intervention tool, so that it definitely caused consumption distortion including distortion in the user industries. Therefore it is necessary that assisted sectors generate significantly more positive externalities than unassisted sectors, in order for industrial policy to be judged as a success.

In spite of the fact that many developed countries and probably most developing countries target industries explicitly or implicitly, there has been almost no systematic empirical study whether such interventions have been beneficial or not. A major exception is the study by Krueger and Tuncer (1982). They evaluated industrial targeting in Turkey from 1963 to 1976 by examining whether the TFP growth of the highly protected sectors had been more rapid than those of discriminated sectors. Their conclusions were negative.

In this section, I basically take the same approach for evaluating Japanese industrial policy. There exist three major potential problems to

^{17/} See Dixit and Grossman (1986). If resources are internationally mobile, this consideration does not apply. However, such was not the case for Japan in the 1950s and 1960s, as well as for most developing countries today.

this approach. First, the TFP growth does not immediately imply externality. The gain from it may be appropriated by industry. However, I have already presented evidence in the last section that industry cannot significantly gain from its own technical progress.

The second major problem is the fact that the government intervention is only one of the many and probably minor determinants of technical progress. Consequently, even if a protected sector achieves rapid technical progress, we cannot a priori attribute it to protection. If protection were absent, industry may achieve faster technical progress. Similarly, when a protected sector achieves only below average technical progress, it may not be due to protection. Removal of protection may reduce the speed of technical progress further. Contrary to the assertion made by Krueger and Tuncer (1982) higher TFP growth of the protected sectors is neither sufficient nor necessary condition for the success of industrial targeting.

Furthermore the effect of the government policy on technical progress depends upon many factors, including market structure and the type of intervention. For examples, protection may be harmful to technical efficiency of a monopoly enterprise but can be beneficial to more competitive industry. Quota may have much smaller effect on encouraging investment for cost reduction than tariff, even if they yield the same level of effective rate of protection. Exogenous protection may encourage cost reduction but endogenous protection is likely to discourage cost reduction, again even if they yield the same level of effective rate of protection. Consequently the effect of government policy cannot be summarized by the level of effective rate of protection.

One partial remedy to the second problem is to conduct international comparison. It would help control determinants of technical progress other than policy interventions. I take this approach by using the U.S. as a control, although ideally we should have a country similar to Japan in the 1950s and 1960s in terms of technological conditions but with a neutral policy regime. As for the effect of policy interventions, I simply assume in this section that effective rate of protection represents adequately the degree of industry support.

The third major problem is that TFP growth is only one determinant of welfare and its contribution to welfare itself depends upon many factors including elasticity of demand and external trade position. Consequently, we cannot put the same welfare value to the same degree of TFP growth of different sectors. One sector might incur marginal investment cost larger than the marginal benefit from additional TFP growth, due to excessive degree of strategic rivalry. The opposite story might hold for another sector. TFP growth improves terms of trade if it occurs in import substituting sector but worsens it if it occurs in export sector. Moreover, external trade position of a particular sector changes over time. The exact evaluation of the welfare consequence of TFP growth can therefore be done only by explicit modelling of the technical progress of each sector. In the following examination, I simply assume that there exist no systematic bias between assisted sectors and unassisted sectors in the relation between TFP growth and welfare.

2. Industrial Policy Interventions

I take here as a working assumption that the heavy and chemical industries in addition to agriculture and mining were assisted during the 1950s and 1960s as the official statement of the Japanese Government proclaimed. In terms of the industrial classification of our study, I identify assisted sectors and nonassisted sectors as follows:^{18/}

- (a) assisted sectors (AI)...agriculture and mining
- (b) assisted sectors (AII)...petroleum and coal products, chemicals, primary metals, metal products, general machinery, electric machinery, transportation machinery and instruments and other precision machinery
- (c) unassisted sectors (UA)...food, textile, paper, stone & clay & glass products and other miscellaneous industries (wood, furniture, apparel, printing, leather, rubber, etc.).

We have the following supporting evidence for this identification:

- (a) It is well known that the agriculture sector of Japan has been tightly protected from import. Most remaining quantitative restrictions on import apply to agriculture products. The government also assisted heavily the mining sector (mainly coal sector).
- (b) Major quantitative restrictions which remained after the abolition of the foreign exchange budget system in 1963

^{18/} What matters is only relative degree of assistance. I call more assisted sectors as assisted sectors and less assisted sectors as unassisted sectors for simplicity.

concentrated mostly on machinery and food sector:

representative machinery products are color TV, automobile, machine tool, integrated circuit and electronic computers. Food industry was, on the other hand, burdened by the import restrictions on agricultural products.

- (c) Effective rate of protections calculated from the tariff structure (see Table 15) show relatively low protection for traditional industries such as wood products, paper and pulp and publishing and printing. Although textile (fabrics) has relatively high effective rate of protection, it is likely that it did not represent real incentives, considering its high competitiveness and large export during that period. Export subsidies played only a small role in Japan.

I do not examine a separate targeting issue: targeting tradable sector especially manufacturing sector against nontradable sector, since I believe that it was not an important aspect of targeting in Japan in the 1950s and 1960s. Protection, which was a main instrument for industrial policy at that time, clearly cannot assist the tradable sector as a whole, since it is offset by either exchange rate appreciation or by domestic price increase.

3. Relative Performance of Assisted Sectors and Unassisted Sectors

Table 16 provide summary information. The data presented in the upper part is based on the author's calculation. It is value added based and covers the period up to 1970, since sector specific interventions had

**Table 15: EFFECTIVE RATE OF PROTECTION IN JAPAN
(1963-1973)**

	1963	1973
Manufacturing	32.3	14.4
Textiles	54.3	18.6
Spinning	27.1	15.0
Fabrics	44.6	15.5
Garments	72.8	22.4
Wood Products	14.0	16.1
Paper and Pulp	9.7	11.0
Publishing and Print	-16.7	-0.9
Leather and Rubber	30.9	12.3
Chemicals	33.4	8.8
Oil and Coal Products	19.5	7.1
Ceramics	22.2	8.1
Steel	30.1	17.1
Non-ferrous Metals	30.4	22.1
Metal Products	13.8	9.9
Machinery	36.7	7.7
General Machinery	23.0	8.7
Electrical Machinery	30.9	5.4
Transportation Machinery	61.5	9.2
Precision Machinery	34.9	10.4

Note: Calculation is based on tariff, not on the direct price comparison.

Source: Shouda Y., "Effective Rates of Protection in Japan," April 1982, Nihon Keizai Kenkyu, No. 11.

Table 16: RELATIVE PERFORMANCE OF ASSISTED SECTORS AND NONASSISTED SECTORS IN JAPAN
(1955-1970) & (1960-1979)

	Assisted Sector (I)	Assisted Sector (II)	Nonassisted Sectors
(I) Value Added Basis (1955-1970) <u>a/</u>			
Technical progress	N.A.	8.2	4.8
Productivity growth	5.5 (3.7) <u>b/</u>	14.0 (3.1)	8.0 (3.1)
Relative productivity growth <u>c/</u>	1.8	11.0	5.0
Price	5.5 (2.5)	-2.1 (1.1)	2.4 (1.1)
Relative price <u>c/</u>	3.0	-3.2	1.3
Output growth (Real)	1.5	20.0	11.0
Output share (1955) <u>d/</u>	22.0	12.0	17.0
Output share (1970) <u>d/</u>	7.0	23.0	13.0
Export growth (Real)	3.6	20.0	7.1
Export share (1955) <u>d/</u>	3.1	30.0	45.0
Export share (1970) <u>d/</u>	1.3	63.0	19.0
Compensation to labor <u>e/</u>			
1955		1.39	0.73
1970		1.13	0.85
Return to Capital <u>e/</u>			
1960		1.04	0.94
1970		1.01	0.97
Capital labor ratio (1970) <u>e/</u>		1.24	0.71
(II) Gross Output Basis (1960-1979) <u>f/</u>			
Technical progress	-0.48 (0.88)	1.55 (0.55)	0.16 (0.50)
Relative technical progress	-1.36	1.00	-0.34
Output share (1970)	10.0	56.0	34.0

a/ Aggregation over subsectors by the value added (net of indirect tax) in 1962, except for the capital labor ratio. The latter is aggregated by the capital stock in 1970.

b/ The number in the brackets are the values of the corresponding U.S. industries.

c/ The difference between Japan and the U.S.A.

d/ The shares are in terms of nominal values of each year. The denominators are those for the national economy.

e/ Normalized by the average value of the manufacturing sector as a whole.

f/ Calculated from Jorgenson, Kuroda and Mishimizu (1987). Aggregation over subsectors is done by the 1970 gross output.

diminished substantially by that time. The data presented in the lower part is taken from Jorgenson, Kuroda and Nishimizu (1987). Their study is gross output based. They also conducted highly detailed statistical work in order to construct capital and labor input data which adequately reflects quality and composition changes. Their study, therefore, provides a useful check. The data up to 1979 is taken also for the purpose of check. It also provides estimates of TFP growth of the United States, which can be used to judge the policy effectiveness in Japan.

Major findings are the following:

- (a) Technical progress of the assisted manufacturing sectors (AII) was almost double over the unassisted manufacturing sectors (UA) on the value added basis. Although the difference becomes smaller,^{19/} we have the same conclusion on the gross output basis: Assisted sectors achieved much higher technical progress than unassisted sectors in the manufacturing sector. This finding is in sharp contrast with the finding by Krueger and Tuncer (1982) for Turkey. Furthermore, controlling technical progress by the technical progress of the United States does not affect the conclusion at all.
- (b) On the other hand technical progress of the assisted sectors AI was smaller than that of UA. The difference becomes larger if I take the technical progress of the United States as a standard.

^{19/} The TFP growth estimate based on the gross output basis is equal to the share of value added in gross output multiplied by the TFP growth estimate based on the value added basis (Nishimizu (1974)). In addition my calculation does not take into account the quality change of labor. Furthermore, data presented in Table 16 covers different time spans for the two estimates.

- (c) Labor productivity growth of the assisted sectors AII was also substantially higher than that of the unassisted sectors. Price of the assisted sectors AII fell significantly relative to the price of unassisted sectors. Competitiveness positions of the assisted sectors AII with respect to the United States also improved significantly, while that of the unassisted sectors as a whole actually worsened. The exact opposite story holds for the performance of assisted sector AI relative to unassisted sectors as well as to the corresponding sectors of the U.S.
- (d) Output and export of the assisted sectors AII rose much more sharply than those of the unassisted sectors. Consequently, the share of these sectors in the economy expanded sharply (value added share from 12% to 23% and export share from 30% and 63%). The exact opposite story hold for the assisted sectors AI. Their share in the economy dropped dramatically.
- (e) Average labor compensation were considerably higher in assisted sectors AII in 1955 than the nonassisted sectors, but the difference became considerably smaller by 1970.
- (f) There exists no material difference in returns to capital between the assisted sectors (AII) and unassisted sectors (UA).

The above evidence shows that the assisted sectors AII did achieve fast technical progress and labor productivity growth. Moreover efficiency gains in these sectors looks to have been substantially absorbed on the one hand by the faster economy-wide wage increase and on the other by the significant decline of their output prices, contributing to the fast expansion of these sectors. Industry nor its workers could significantly

appropriate the gain from productivity improvement. Therefore, I conclude that industry targeting applied to the manufacturing sector was at least not a gross failure. If we believe that international difference in the TFP growth in a specific sector (Japan over USA) was mainly caused by policy difference, that consumption distortion produced by the protection was not significant, and that industries underinvest in cost reduction unless some support are provided (of course all of these assumptions can be easily questioned), we might conclude that it was a success. On the other hand, the opposite story holds for the assisted sectors AI.

Then why did industrial targeting practiced in many developing countries and in quite a few developed countries apparently fail? Why did agricultural protection apparently fail in Japan? Although resolving these questions are beyond this study, I can now speculate possible answers. First, protection and intervention in industrial sector in Japan was not so intensive that the government could avoid making large mistakes. It is noteworthy that industrial policy of Japan is often characterized as being market conformative. Second, active domestic competition in Japan created strong strategic motive for industries to invest in cost reduction. Third, active domestic competition as well foreign pressures helped industrial policy from becoming endogenous and accommodative of the inefficiencies of industries. Fourth, there was no major artificial regulatory barriers against efficient use of resources in industrial sector.

DATA APPENDIX

The main data source and data limitations are the following:

A. Japan

Except for exchange rate, consumer price index, employment, work hour and capital, all data are from the Reports on National Accounts published by Economic Planning Agency. National accounts have been recently revised with 1980 as the base year. I have utilized revised series, as reported in 1985, 1988 and 1989 issues.

Exchange rate is from the Economic Report of the President (1989). Consumer price index is from the Annual Report on consumer Price Index by the Prime Minister's Office (1985 and 1988).

Employment figures from 1955 to 1969 which are consistent with the national income account was directly obtained from the Economic Planning Agency. The rest of employment figures are from the Reports on National Accounts. Data on work hour is obtained from Monthly Labor Survey by the Ministry of Labor (various years).

Capital service (the division index of capital input) and capital stock data were obtained from the database developed by Mieko Nishimizu, the World Bank, in her study of the Japanese productivity for 1955 to 1959 period, and from Professor M. Kuroda of Keio University for 1960 to 1985. It covers not only depreciable assets but also land and inventory. Capital stock of each year is evaluated at the beginning of each calendar year.

Since the National Wealth Survey, which provides benchmarks for their estimations (the most recent survey was done only in 1970), is based on the accounting information, the capital input estimated by them reflects accounting depreciation. The capital stock estimate published by the Economic Planning Agency provides only gross capital which disregards completely depreciation except for retirement.

B. U.S.A.

All data are from the National Income and Product Accounts 1929-82, BEA, 1986 September and from the recent issues of the Survey of Current Business, except for consumer price index. The latter is from the Economic Report of the President (1989).

C. Data Used in Equation (12)

Return on capital (1961-1970 period and 1976-1985 period) is a simple average of the return on capital of each year for 1961 to 1970 and for 1976 to 1985.

As for total productivity growth (from 1961-1970 period to 1976-1985 period), I first calculated the average TFP growth for the recent 10 years with an arithmetically declining weight (1, 0.9, 0.8, 0.7, ..., 0.2, 0.1) for each year from 1976 to 1985. The idea behind this is that more recent technical progress has larger effect on profit. Second I took a simple average of these growth rates. All TFP growth used are price-based measures except for the petroleum and coal products.

As for the speed of capital growth, I first calculated the average growth rate for the recent 5 years with arithmetically declining weights

(1, 0.8, 0.6., 0.4 and 0.2). Then I took a simple average for each period (1961 to 1970 and 1976 to 1985).

TECHNICAL APPENDIX

ANALYTICAL FRAMEWORK FOR THE EMPIRICAL ANALYSIS

1. Labor Productivity and Price Competitiveness

Here I present a simple production and pricing model,^{1/} which serves as an analytical framework for the section B.

If the production function can be approximated by the Cobb-Douglas form,^{2/} it can be represented by

$$(1) \quad \log v = \hat{H} + S_L \log L + (1 - S_L) \log K$$

where V is value added, \hat{H} technical level or total factor productivity, S_L labor share, L labor and K capital. I assume that price (P) is determined by the enterprise facing demand with constant elasticity. I further assume that labor market is competitive and labor is paid its marginal product. Under these conditions we get

$$(2) \quad \begin{aligned} P &= M^* MC \\ &= M^* W / (\partial V / \partial L) \\ &= (M / S_L) W / (V / L) \end{aligned}$$

^{1/} This model is exactly identical to the one used by Marston (1986).

^{2/} By linearization of the constant elasticity of substitution production function we get a Cobb-Douglas production function (Marston and Turnovsky (1985)).

given equation (1), where MC is marginal cost, M markup ratio and W wage.

Consequently, since labor productivity is given by $H = V/L$, we have the following pricing equation:

$$(3) \quad \log P = \log(M/S_L) + \log W - \log H$$

If we further assume that wage is determined nationally (rather than sectorally) and M and S_L remain constant over time, then

$$(4) \quad \Delta \log P_i = \Delta \log W - \Delta \log H_i$$

for each sector i .^{3/} If we take the difference of equation (4) across countries, we get the following key equation linking the change in price competitiveness and the change in the labor productivity.

$$(5) \quad (\Delta \log P_i)_{\text{country A}} - (\Delta \log P_i)_{\text{country B}} \\ = \Delta \log (W_A/W_B) - ((\Delta \log H_i)_A - (\Delta \log H_i)_B)$$

where prices and wages are measured in a common currency. Since the first term of the right hand side of the equation is common across sectors if our

^{3/} For a general production function, we have

$$\Delta \log P_i = \Delta \log W - (1/f_i) \Delta \log H_i - (1-1/f_i) \widehat{dH}_i,$$

where f_i is elasticity of substitution. H_i can predict P_i well only if $(1 - 1/f_i) \widehat{dH}_i \approx 0$.

assumption of the national determination of wage is correct, we should observe a close correlation between the proportional change in price competitiveness and the proportional change in labor productivity growth differential across sectors.

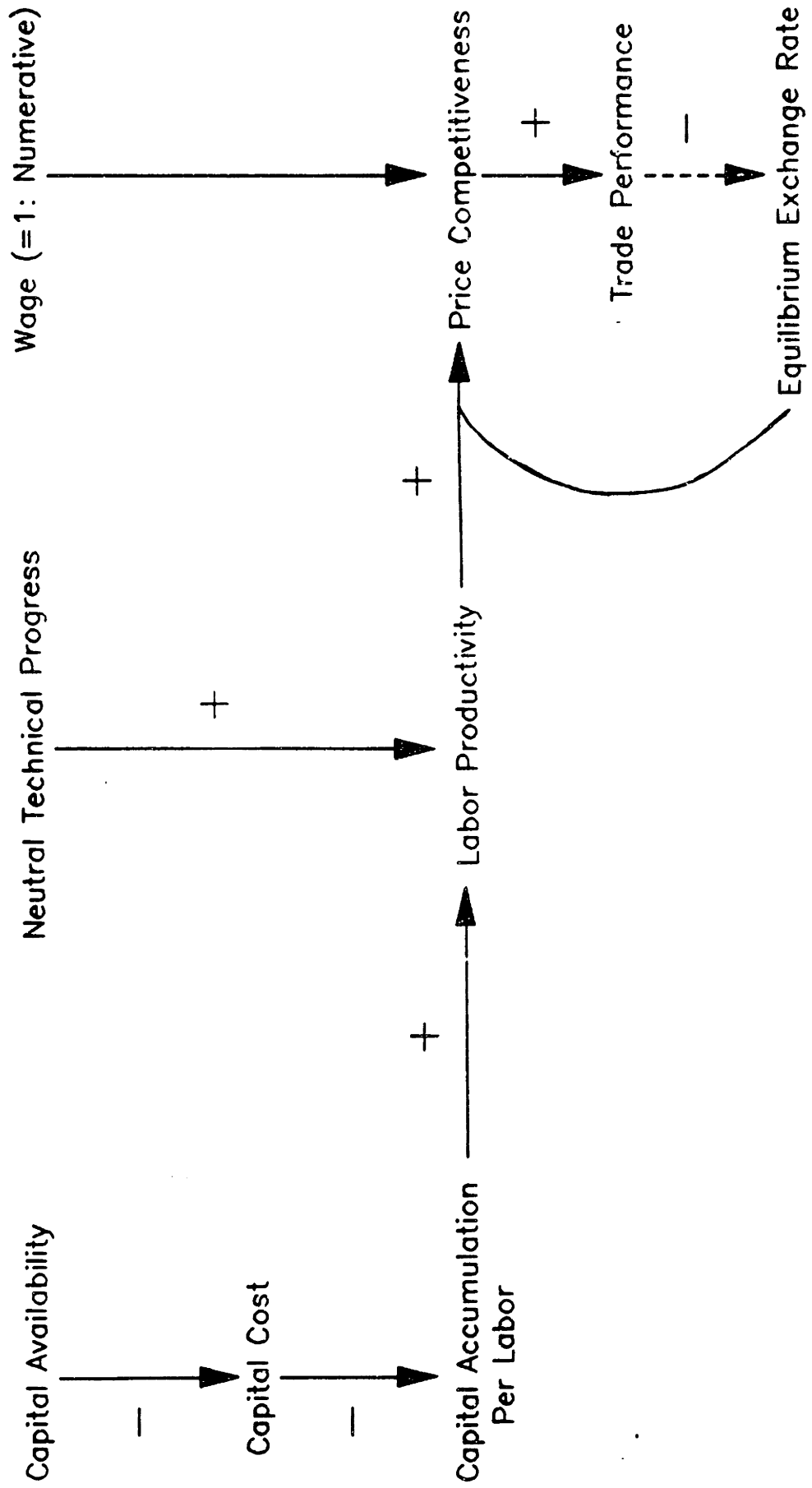
Labor productivity is in turn determined by the capital labor ratio and total factor productivity:

$$(6) \quad \Delta \log H_i = (1-S_L) \Delta \log (K/L)_i + \hat{dH}_i$$

If relative factor prices are identical across countries, then $\Delta (K/L)_i$ should be identical across countries. In this case labor productivity performance differential across countries and in turn price competitiveness depend only on the differential in total factor productivity changes.

However, since factor markets are internationally segmented, labor productivity performance differential also depends on the differential movements in the capital labor ratio. For an example in the countries faced with capital shortage due to international debt problem, capital costs should have increased, so that the growth of the capital labor ratio should have declined, resulting in slower labor productivity growth. The overall linkage between productivity and competitiveness is illustrated in Figure 1.

Figure 1



2. Price Competitiveness and Real Exchange Rate

This subsection develops a simple formula linking price competitiveness of industrial subsectors and equilibrium real exchange rate. The objective is to demonstrate how the real exchange rate index can be biased when there exists a systematic correlation between the shift in competitiveness and price elasticities of demand across industrial sectors. I completely omit income effects.^{4/}

The trade balance T is given by the difference between aggregate export and import:

$$(7) \quad T = RP_iE_i - RP_{fj}M_j = 0$$

where P_i (P_{fj}) is the price of output of the sector i of the home country (the sector j of the foreign country), E_i the quantity of export of the sector i , and M_j is the quantity of import from the sector j of the foreign country. The total differentiation of equation (7) gives the following equation:

$$(8) \quad dT = RP_iE_i (dP_i/P_i + dE_i/E_i) - RP_{fj}M_j (dP_{fj}/P_{fj} + dM_{fj}/M_{fj}) = 0$$

The following specifications for export and import demand are assumed.

^{4/} A general-equilibrium analysis gives a similar result (see Nagaoka (1989)).

$$(9) \quad dE_i/E_i = -a_i(dP_i/P_i) + (a_i - b_i)(dP_{fj}/P_{fj}) + b_i(dP_{fA}/P_{fA})$$

$$(9') \quad dM_j/M_j = -a_j(dP_{fj}/P_{fj}) + (a_j - b_j)(dP_j/P_j) + b_j(dP_A/P_A)$$

where a_i is the price elasticity of demand for the domestic products of sector i , b_i is intersectoral price elasticity of demand for sector i products as a whole and $P_A(P_{fA})$ is general domestic (foreign) price level with expenditure weights. We assume that $a_i > b_i > 1$.

Given equations (7), (9) and (9'), equation (8) becomes

$$(8') \quad (dP/P)^E - (a dP/P)^E + \{(a - b)(dP_f/P_f)\}^E + (b)^E dP_{fA}/P_{fA} \\ - (dP_f/P_f)^M - (adP_f/P_f)^M + \{(a - b)(dP/P)\}^M + (b)^M dP_A/P_A$$

where upperscript E (M) implies that the term with that upperscript is the weighted average by export value shares (import value shares).

If we further assume that domestic and foreign expenditure patterns on domestic goods are proportional, we get

$$(10) \quad dP_A/P_A = C(dP/P)^E + (1 - C)(dP_f/P_f)^M$$

$$(10') \quad dP_{fA}/P_{fA} = C(dP_f/P_f)^M + (1 - C)(dP/P)^E$$

where C is expenditure share for domestic goods.

Given these assumptions, equation (8') can be solved for real exchange rate.

$$\begin{aligned}
(11) \quad & A((dP/P)^E - (dP_f/P_f)^M) \\
& - (a-b)^M \{ (dP/P)^E - (dP/P)^M \} - (a-b)^E \{ (dP_f/P_f)^M - (dP_f/P_f)^E \} \\
& - \{ a(dP/P - (dP/P)^E) \}^E - \{ (a-b)(dP/P - (dP/P)^M) \}^M \\
& + \{ a(dP_f/P_f - (dP_f/P_f)^M) \}^M + \{ (a-b)(dP_f/P_f - (dP_f/P_f)^M) \}^M
\end{aligned}$$

where $A = a^E + a^M - (1 - C)(b^M + b^E) - 1$. I assume that A is positive, which holds when the difference between a_i and b_i is sufficiently large or when C is close to unity.

If we focus on the changes in the home country and assume that there is no bias in productivity changes between export and import-competing sectors (i.e., $(dP/P)^E = (dP/P)^M$), we have

$$(12) \quad A(dP/P)^E = -\{ a(dP/P - (dP/P)^E) \}^E - \{ (a-b)(dP/P - (dP/P)^M) \}^M.$$

We can derive the following observations from this formula:

- (a) If the home country experiences across-the-board improvement of its competitiveness, then it has to have the corresponding amount of appreciation in its currency or wage increase to have the trade balance. The equilibrium real exchange rate however does not change.^{5/} Elasticity difference across sectors do not play a role.

^{5/} Since I ignore income effects, there exist no terms of trade effect of growth or technical change.

- (b) If all industrial sectors have identical price elasticities, then the shift of competitiveness across sectors does not affect the equilibrium real exchange rate.
- (c) However, if there exist a correlation between dP_i/P_i and a_i , then we expect that the equilibrium real exchange rate has to change. In particular if the country in question suffers a loss in its competitiveness in the sectors with relatively high elasticity of substitutions, then the equilibrium real exchange rate must go up (or the home country has to undertake real devaluation). We should observe the divergence from the purchasing power parity.
- (d) If the country in question gains international competitiveness in the sectors with relatively high b_i , equilibrium real exchange rate may decline. This is because the improvement of competitiveness in those sectors expands demand for these sectors proportionately more, including demands for imports, which can significantly offset substitution effect.

Is there any presumption for the correlation between a_i and dP_i/P_i ? Internationally asymmetric opportunities for technology development cause systematic correlations. We know that high price elasticity of market demand is conducive to investment in cost reduction, since a small reduction of cost can expand sales substantially.^{6/} Furthermore, developing countries with high technical capability would have more

^{6/} See Nagaoka (1989) for an exposition.

opportunities for cost reduction than developed countries during their catchup periods. Consequently I can formulate the following hypotheses:

Hypothesis 1: Developing countries with high capacity for technology absorption should experience real appreciation of their currencies, even measured by the prices of tradable sectors,^{7/} since they will experience faster productivity growth in the sectors with high price elasticities.

Hypothesis 2: Given the existence of these developing countries, developed countries will experience real devaluation of its currency, since they will experience stronger competitive pressures from these countries in the sectors with high price elasticities.

3. Quantity and Price Measures of Total Factor Productivity

If we assume competitive product market, the pricing equation becomes

$$(2') \quad P = W/(\partial V/\partial L)$$

^{7/} It is important to note that these hypotheses are completely independent from and complementary with the celebrated Samuelson (1964) - Balassa (1964) analysis of why the purchasing power parity fails. Their analysis focuses on the systematic difference in the relative price of nontradables between developed and developing countries. The proposed hypotheses state that the purchasing power parity fails even for the tradable sector, due to systematic bias in productivity change within the tradable sector.

for a general production function V ($M = 1$ for the equation (2)). Given this equality, technical progress can be measured by

$$(13) \quad d\hat{H} = (dV/V - dK/K) - s_L (dL/L - dK/K)$$

for any $V(L, K)$ with constant returns to scale (CRS). Equation (13) gives the quantity measure of technical progress or the Solow's residual.^{8/}

When there exists market power ($M > 1$), the estimate of M is necessary to measure technical change from the changes in quantities:

$$(14) \quad d\hat{H} = (dV/V - dK/K) - MS_L(dL/L - dK/K)$$

Defining the Solow's residual by $d\hat{H}^Q$ (i.e. the right-hand-side of equation (13)), we have

$$(15) \quad d\hat{H}^Q = (M-1)S_L(dL/L - dK/K) + d\hat{H}$$

As is clear from this equation, $d\hat{H}^Q$ overestimates $d\hat{H}$ when the economy experiences unanticipated boom (i.e. $dL > 0$ & $dK = 0$), if there exists market power ($M > 1$). Conversely, $d\hat{H}^Q$ underestimates $d\hat{H}$ when the economy experiences unanticipated recession (i.e. $dL < 0$ & $dK = 0$). Therefore $d\hat{H}^Q$ is procyclical and biased in the shortrun. $d\hat{H}^Q$ is also biased in the longrun unless $dL/L = dK/K$. Since most economies experience longrun rise in the capital labor ratio, $d\hat{H}^Q$ underestimates $d\hat{H}$ in the longrun.

^{8/} Solow (1957).

When V takes the Cobb-Douglas form as equation (1), equation (2)

becomes

$$(16) \quad \log(W/P) = \log(S_L/M) + \hat{H}/S_L + (1 - S_L)/S_L \log(K/V)$$

The differentiation over time gives

$$(17) \quad d\log(W/P) = d\hat{H}/S_L + \{(1 - S_L)/S_L\}d\log(V/K)$$

if S_L and M stay constant over time. Rewriting equation (17), we have

$$(18) \quad d\hat{H} = S_L d\log(W/P) + (1 - S_L) d\log(V/K)$$

Technical progress can thus be estimated as a weighted average of real wage growth and capital productivity change. This is price measure of productivity change.^{9/} It is important to note that equation (18) still holds even if $M \neq 1$, as long as M stays constant over time, unlike equation (13).

^{9/} In the case of a more general production function of constant elasticity of substitution form, we get $d\hat{H} = [S_L d\log(W/P) + \{(1 - S_L)/f\}d\log(V/K)] / (1 - (1 - 1/f)(1 - S_L))$, where f is elasticity of substitution between capital and labor (See Shapiro (1987)).

4. Measurement of Markups

I utilize the following two approaches. The first approach is proposed by Hall (1986a) and has been applied to the U.S. industries.^{10/} It essentially utilizes equation (15). If we have instruments correlated with labor input L but uncorrelated with technical change \hat{dH} , we can estimate M from equation (15) consistently, since all variables are directly observable except for M . Equivalently, the Lerner's index of market power or price cost margin can be directly estimated. Equation (15) can be rewritten by using equation (14) in the following manner.

$$(19) \quad \hat{dH}^Q = ((M-1)/M)(d\log(V/K) - \hat{dH}) + \hat{dH} \\ - g d\log(V/K) + (1-g)\hat{dH}$$

where $g = (M-1)/M$ (Lerner's index of market power). This equation can be used to estimate g .

^{10/} Hall (1986a, 1986b, 1988) applied his approach to U.S. industries (26 industries and value-added basis) and found evidence of significant market power. Domowitz, Hubbard and Peterson (1987) utilized more detailed U.S. industry data with gross-output and materials input and confirmed Hall's finding. Shapiro (1987) further extended the analysis by estimating market price elasticity and by comparing it with the perceived elasticity implied by the markup. He also confirmed significant market power in many U.S. industry. However, Rotemberg and Summers (1988) offers an alternative theoretical framework, where labor cannot be adjusted in the shortrun as assumed in equation (2), which implies the procyclical productivity even if market power is absent.

The second approach could be to directly compare the price measure and quantity measure of total factor productivity change.^{11/} From equation (15), we have

$$(20) \quad M = (\hat{dH}^Q - \hat{dH}) / (S_L d \log (L/K)) + 1 \\ - (d \log (V/L) - d \log (W/P)) / d \log (L/K) + 1$$

where we use equation (18) to estimate \hat{dH} . This approach requires stronger assumptions (Cobb-Douglas technology in addition to constant markup) than the first approach, but does not require instruments. Furthermore, it is not vulnerable to cyclical errors of data or of specifications if we take averages over business cycles, unlike the Hall's method.

5. Application of the Hall's Method

I applied the Hall's method to the Japanese manufacturing industries. The estimation period is from 1956 to 1985. The instruments used are the GNP growth rate of the United States, the GNP growth rate of Japan and the combination of the change in exchange rate and the change in wholesale price index of fuel and energy in Japan.^{12/} Among these the exogeneity of the GNP growth rate of the United States is likely to be the highest, so that the estimate based on that instrument is considered as a standard.

^{11/} No one has taken this approach to my knowledge.

^{12/} Whole sale price index of fuel and energy is from the Annual Report on Price Index by the Bank of Japan.

Table A.1: ESTIMATES OF MARKUPS AND LERNER'S INDEX
(Hall's method applied for 1956-1985)

	B1 a/	B11 b/	B111 c/	B111 d/	M1A e/
Manufacturing sector as a whole	0.81	(3.4) f/	(6.1) f/	(3.7) f/	3.1
Food	1.23	(0.8)	(1.8)	(1.0)	5.0
Textile	1.10	(3.3)	(0.39)	(3.5)	2.6
Pulp and paper	0.80	(3.9)	(8.8)	(9.5)	3.7
Chemical	0.99	(4.8)	(2.5)	(6.8)	20.1
Petroleum and coal products	1.50	(0.1)	(12.0)	(12.0)	-
Stone, clay and glass products	0.80	(4.0)	(7.7)	(7.2)	5.0
Primary metal	1.04	(11.1)	(13.9)	(0.85)	2.2
Metal products	1.02	(5.7)	(4.8)	(6.6)	1.6
General machinery	0.28	(0.30)	(2.2)	(- 0.03)	1.4
Electric machinery	0.70	(2.1)	(1.5)	(2.9)	3.1
Transportation machinery	0.67	(2.5)	(3.3)	(0.51)	3.0
Precision machinery	0.80	(3.9)	(2.3)	(2.8)	5.0
Others	0.24	(0.34)	(4.8)	(5.6)	1.3

a/ Instrument: Current GNP growth rate of the U.S.A.

b/ Instrument: Current GNP growth rate of Japan.

c/ Instruments: Current change in exchange rate and in the wholesale price for fuel and energy of Japan.

d/ The estimate of markup ratio $M_1 = 1 / (1 - B_1)$.

e/ The estimate of markup ratio for the U.S. industries as reported by Hall (1988). The estimates for food and transportation machinery sectors are the averages of subsectors by the 1970 nominal value added. The estimate for the manufacturing sector as a whole is the average of the estimated markups for durable and nondurable goods.

f/ The numbers in the brackets are t values.

Table A.1 presents estimated results. It is found that the three sets of instruments give similar results. The GNP growth rate of Japan gives the highest estimate of the Lerner's index in most cases. This seems to be brought about by larger bias caused by its higher correlation with the growth rate of capital stock (see the discussion below). Even the estimate of the Lerner's index based on the GNP growth rate of the United States is higher than one in 5 out of the 13 subsectors, causing negative estimates for markups. I consider this to be a very unsatisfactory result.

I think that the estimates presented are substantially biased in the upward direction due to the following reasons. First, mismatch problem between investment and output. Investment for capacity creation is often lumpy and made in anticipation of future longterm demand growth. This is the case especially when economy is in the rapid growth process as Japan was in the 1950s, 1960s and early 1970s. Capacity created is used fully only after several years. If instrument used has no correlation with this component of investment, it may not cause a large bias. However, since instrument has to be selected among those which can cause output and employment changes, it is difficult to avoid this correlation. This is because investment is forward-looking. For the instruments used in my estimation, the growth rate of capital stock has the following sample correlations: 0.07 with the growth rate of GNP of the U.S., 0.39 with the growth rate of GNP of Japan, 0.06 with the exchange rate change and -0.16 with the change in the wholesale price index for fuel and electricity.

Second, counter-cyclical markup. It is shown by Hall (1988) that if markup ratio is negatively correlated with the instrument which causes upward change in employment and output, the estimated markup ratio becomes positive, even if the average markup ratio is zero. The degree of bias depends upon the degree of the countercyclicality of markup as well as on the speed of capital deepening. This bias is again likely to be much larger in Japan on both reasons. Since labor is more like a fixed cost in Japan in the shortrun than in the USA, the divergence between price and marginal cost during recession is likely to be much larger in Japan than in the U.S.A. Capital deepening has been much more rapid in Japan.

Third, price rigidity and labor hoarding. As discussed by Rotemberg and Summers (1988), the combination of shortrun price rigidity (rationing of customers in boom) and labor hoarding can cause procyclical total factor productivity change, even if market power is absent. More extensive labor hoarding in Japan then causes another positive bias to the estimate of the markup ratio.

Fourth, unrecorded change in the labor input. The statistics on labor input is quite likely to underreport its actual change. This is because workers who are put to work for maintenance and repairs, training, development work, during ressession are still counted as produciton workers, even though they do not contribute to current output.

REFERENCES

- Balassa, B. (1964) "The Purchasing-power Parity Doctrine: A Reappraisal," Journal of Political Economy, 72 (December), 584-96.
- Deppler, M. C. and Ripley, D. M. (1978), "The World Trade Model Merchandise Trade," IMF Staff Papers, 25: 147-206.
- Dixit, A. and Stern, N. (1982), "Oligopoly and Welfare: A Unified Presentation with Applications to Trade and Development," European Economic Review, 19, 123-143.
- _____ and Grossman, G. M. (1986), "Targeted Export Promotion with Several Oligopolistic Industries," Journal of International Economies, 21: 233-250.
- Fisher, R. M. and McGowan, J. J. (1983), "On the Misuse of Accounting Rates of Return to Infer Monopoly Profits," American Economic Review, Vol. 73 No. 1, 82-97.
- Goldsten M., and M. S. Khan, (1985), "Income and Price Effects in Foreign Trade," in R. W. Jones and P. B. Kenen edited, Handbook of International Economics, Vol. 2, 1041-1105, North-Holland.
- Hall, Robert E. (1986a) "Market Structure and Macro Fluctuation," Brookings Papers on Economic Activity (2) 285-322.
- _____ (1986b) "Chronic Excess Capacity in U.S. Industry," NBER Working Paper No. 1973.
- _____ (1988) "The Relation Between Price and Marginal Cost in U.S. Industry," Journal of Political Economy, October.
- Jorgenson, D. W., Kuroda, M., and Nishimizu, M. (1987), "Japan-U.S. Industry-Level Productivity Comparisons, 1960-1979," Journal of the Japanese and International Economies 1, 1-30.
- Katz, L. F. and Summers, L. H. (1989), "Industry Rents: Evidence and Implications," Brookings Papers on Economic Activity, Macroeconomics Issue, 209-290.

- Krugman, P. (1979), "A Model of Innovation, Technology Transfer, and the World Distribution of Income," Journal of Political Economy, Vol. 87; 253-266.
- Marston, R.C. and Turnousky S.J. (1985), "Imported Materials Prices, Wage Policy and Macroeconomic Stabilization," Canadian Journal of Economics, 18: 273-84.
- Marston, Richard C. (1986) "Real Exchange Rates and Productivity Growth in the United States and Japan," NBER Working Paper No. 1922, May.
- Nagaoka, S. (1989), "Productivity, Competitiveness and Real Exchange Rate in a Monopolistic Competition Model," World Bank Mimeo.
- Nishimizu, M. (1974), Total Factor Productivity Analysis: A Disaggregated Study of the Post-War Japanese Economy with Explicit Consideration of Intermediate Inputs, and Comparison with the United States, Unpublished Ph.D. dissertation, the Johns Hopkins University.
- Rotemberg, J.J. and Summers, L.H. (1988) "Labor Hoarding, Inflexible Prices and Procyclical Productivity," NBER Working Paper No. 2591, May.
- Shapiro, Matthew D. (1987) "Are Cyclical Fluctuations in Productivity Due More to Supply Shocks or Demand Shocks?" American Economic Review Proceedings 77 118-124.
- _____ (1987) "Measuring Market Power in U.S. Industry," NBER Working Paper No. 2212, May 1987.
- Solow, Robert M. (1957) "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, 39, 312-320.
- Samuelson, P.A. (1964) "Theoretical Notes on Trade Problems," Review of Economics and Statistics, 46 (May), 145-54.