

Essays in Real-Financial Linkages

by

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Abstract

Chapter 1 develops a model which views financial development as a process of accumulating information through learning by doing. A country that has limited experience with industrial economies has limited knowledge of opportunities to invest in industrial projects. Financial intermediary has to find out good investment opportunities by actually making loans to industrial projects. Accumulation of information by financial intermediary leads to financial deepening. The pattern of financial development depends on the way accumulated information is managed within financial intermediation sector.

In chapter 2, the relation between the market concentration and pass-through is investigated empirically. Partial pass-through, observed at least in U.S. import prices, implies that the shift in the real exchange rate caused by a shock in the financial market can affect the international prices. Theoretically, partial pass-through is the optimal response of firms operating in imperfectly competitive international markets. This paper, using Korean industry data, tests one implication of the theory which has not been investigated previously: pass-through elasticity should be smaller for more concentrated industries. A strong and robust negative correlation between concentration and pass-through is established.

In chapter 3, the pricing to market behavior is investigated empirically. The pricing to market of a small country is peculiar because price discrimination is caused by the asymmetry of market power between the export and the domestic markets. The firm is quite often more of a price taker in the large foreign market than in the small domestic market. A simple model of the pricing to market of a small country is proposed and its implication is tested using Korean export data. The pricing to market effect is found to be statistically significant. At the same time, the pricing to

market effect is stronger in the industries that export into the U.S., vindicating one implication of the model.

Thesis Supervisor: Stanley Fischer
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A thousand thanks are due for my wife, Soyeon, and my daughter, Jeesu Clarice, whose collaborations were indispensable to my work.

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I dedicate this dissertation to my father and my late mother.

Chapter 1

Financial Development

1.1 Introduction

Although an efficient financial intermediation sector is regarded as an important requirement for economic growth, it is a common symptom of developing countries to suffer from inefficiencies in the intermediation sector. I present a model which views this as coming from the underdevelopment of the financial sector itself. The financial sector develops by learning about the projects into which it has channelled the savings of the country.

Establishing a financial intermediary business in a country with little experience of a successful capitalist/industrial economy, which is true for most developing countries and the post-communist countries, is different from establishing the business in a country which has learned a lot through past loan experiences. As well as dealing with many problems of everyday risks existing in developed countries, financial intermediaries have to address big risks which arise from the uncertainty of project types.

While there is a detailed credit history for the borrowers in developed countries, credit history needs to be established from the scratch in many developing countries. In this sense, financial development is a process of learning by doing for a substantial period of time during its early stage of development.

I develop a model which views financial development as a process of accumulating information. An underdeveloped financial system is regarded as a state devoid of effective informational networks between lenders and borrowers. Financial intermediaries develop this network by accumulating information on borrowers.

In the model, financial intermediation contributes to growth by enhancing information about project types. There is a technology whose rate of return is high when a 'good' project is operated by a large scale investment that cannot be financed by individual savings. It is possible to invest in that technology with the aid of financial intermediaries. At the same time, the operations of projects financed by intermediaries reveal the types of financed projects. A larger pool of good projects yields better intermediation which attracts more investment. As more investment is directed to projects, more good projects are identified. Aggregate output increases as the pool of identified good projects expands.

The dynamics of financial development depends on how the knowledge of project types is managed within the intermediation sector. This depends on the institutional structure of the financial intermediation sector. In this paper, I propose two alternative structures of financial intermediation sector without exploring the primitive institutional backgrounds that can produce the proposed structures as equilibrium outcomes. The dynamics of financial development and the implication on the potential role of government are discussed under each structure of financial intermediation. In one structure, the dynamics of financial deepening is illustrated. In the other, it is illustrated how inertia against change builds up as a side effect of financial development.

The discussion on finance and development has a long history. The discussion of the previous works is in order to appropriately place this paper in the vast literature of finance and development. Financial intermediation has been regarded as one of the crucial requirements for economic development, at least since Schumpeter(1934) and Gerschenkron(1962) attributed to banking an important role in the economic growth of Germany. More recently, there was research initiated by McKinnon and Shaw and an independent series of works by Goldsmith.

Schumpeter and Gerschenkron perceive economic development as involving a change in the mode of economic activity. Schumpeter mentions the change introduced by innovative entrepreneurs. Gerschenkron mentions widespread distrust of industrial activities in economically backward countries. It is then critical to allocate credit to the economic activities most conducive to economic development. Given the importance of credit allocation, an institution that specializes in credit allocation is needed. The role of financial intermediation in the allocation of credit is thus regarded to be integral in economic development.

Goldsmith uncovers a solid fact as a result of a series of research into financial development of many countries. Financial interrelations ratio, which is calculated as the value of financial assets over the value of tangible assets and net foreign balance, increases rapidly at an early stage of growth and stabilizes later on.¹ He documents the prevalence of the high correlation between 'financial deepening'² and economic growth, without proposing a particular model that can produce this correlation, nor without being assertive about the causality between the financial deepening and economic growth. Goldsmith's work points toward a transitional character of financial development.

McKinnon and Shaw³ look at the situations facing financially repressed devel-

¹ Refer to *Financial Development and Economic Growth, 1969* and *Comparative National Balance Sheets, 1986*

² This is author's expression borrowed from Shaw. This term was not adopted by Goldsmith.

³ Look at the books by McKinnon and by Shaw. Fry(1988) has a good discussion of works in this

oping countries and argue that national savings can be mobilized more effectively by liberalizing the financial system. Financial liberalization eliminates the pressure to maintain low private interest rates to expedite sales of government bonds. Conversely, it is also important to control the tendency to finance government deficits by printing money, which increases inflation and lowers real interest rate. Direct control of private interest rates and inflationary money supply were identified as two major symptoms of financial repression resulting from excessive government deficits. Financial liberalization aims at eliminating these symptoms of undesirable distortion.

As summarized in Fry(1988) and in World Development Report(1989), the interest in finance and growth has been steady since the studies mentioned above. Most recently, there has been theoretical research linking financial intermediation and growth. This research relies on the works of Goldsmith to highlight the importance of issue of finance and growth, but does not relate to the discussion of financial repression *à la* McKinnon. It is justifiable to bypass the issue of money and inflation because inflation is an issue even when the financial development, in the sense of efficient credit allocation, has been achieved to a satisfactory extent.

Most theories of financial intermediation concentrate on the comparative advantage in the provision of liquidity and monitoring technology. The link between finance and growth was studied in quantity effect in the sense that liquidity insurance mobilizes bigger savings for investment, as exemplified by Bencivenga and Smith(1991) and Levine(1990). This increases growth rate in endogenous growth models. Another aspect of the link was studied in quality effect in the sense that more efficient intermediation increases the efficiency of investment. Greenwood and Jovanovic(1990), for example, describes financial intermediation as an investigation technology which requires a fixed participation cost. As consumers get wealthier by accumulating the factor of production, more consumers can afford the cost of participating in financial intermediation. 'Financial deepening' accompanies the growth driven by factor

line of research.

accumulation and creates Kuznets-like dynamic evolution of income distribution.

This paper presupposes the importance of financial intermediation in economic development *à la* Schumpeter and Gerschenkron. The model analyzes dynamics of financial development as a structural transition that can be observed as 'financial deepening' identified by Goldsmith. In these two aspects, this paper has much in common with the work of Greenwood and Jovanovic(1990). However, this paper analyzes financial development as a process of accumulating information through learning by doing. This paper also illustrates different paths of financial development and different implications on government intervention according to different configurations of financial sector.

As well as performing the role of providing liquidity insurance and minimizing the monitoring cost by pooling large numbers of deposits, financial intermediaries work as providers of information.⁴ The accumulation of information in financial development has not been previously analyzed in models of finance and growth. The process of financial development has been suppressed into the expenditure of a fixed start-up cost. Understanding information accumulation in financial development is important especially in an economy at the inception of economic development, because such an economy is plagued not only by lack of physical capital but also by lack of an 'informational capital'.⁵ As a model of growth, in comparison to the recent papers combining banking model and endogenous growth models,⁶ this paper is more explicit about the process of financial development and less so about the process of technological progress and growth. The steady state in this model is not one of a higher growth rate but one of a higher output. The interaction between saving(supply of deposits) and learning by financial intermediaries leads to financial development.⁷

⁴Stiglitz and Weiss(1988) emphasize the role of banks in the acquisition and dissemination of information. See also Stiglitz(1991), and Lewis and Davis(1987).

⁵Lamoreaux(1986) for the case of New England banking. Gerschenkron(1962) for the view that there is widespread mistrust of entrepreneurial activity in the backward economy.

⁶Bencivenga and Smith(1991), Greenwood and Jovanovic(1990), Saint-Paul(1990)

⁷The growth effect of financial development will be magnified by various complementarities between financial intermediation and other sectors of the economy, but I am focusing on the interaction within

Section 1.2 presents the model and basic relations determining an equilibrium. Section 1.3 looks at the dynamics of financial deepening under the first assumption on the financial sector. Section 1.4 considers the second assumption on the financial sector. The inertia buildup can impede financial development even after financial deepening has proceeded sufficiently. This case offers a rationale for a prolonged government intervention. Section 1.5 concludes.

1.2 Model

1.2.1 An Economy

The economy is populated by overlapping generations of two period lived consumers, indexed by the unit interval $[0,1]$. A young consumer has one unit of endowment which can either be consumed directly when young, or be invested to be consumed when old. Consumers are risk averse.

There are two kinds of investment technologies in the economy. One is liquid technology which is constant returns to scale with a certain rate of return a . It can be employed at any scale desired and is accessible to anyone in the economy. Another is an industrial technology which is of a large scale and risky. It is risky in the sense that there are two types of projects. Good projects turn out the rate of return A and bad projects turn out 0. A good project has a higher rate of return than a liquid technology.

$$a < A$$

One can interpret the difference between 0 and a as coming from the difference in the ease with which the technologies can be collateralized or liquidated.

the financial sector.

Ex ante, λ of industrial projects are good, but it is unknown which are good. As a simplification, I assume λ of unknown projects are always good.⁸ It is like fishing in a lake where the number of fish is kept constant by self-reproduction. I also abstract from the existence of uncertainty in outcomes.⁹ It is of a large scale because it requires a minimum input of \mathcal{F} to be operative. However, input exceeding \mathcal{F} doesn't increase output. An industrial technology, when it is a good project, exhibits increasing returns to scale initially and decreasing returns to scale in the end. This precludes an unlimited dependence on a single project and makes the continuation of learning necessary for financial development.

Output from both technologies are not storable, excluding the growth effect by factor accumulation. The output has to be consumed in the period in which it is produced. It is also assumed that there is an abundant supply of good industrial projects.

$$\lambda\mathcal{F} > 1.$$

The condition implies that there are enough opportunities of investment in industrial technologies, and the actual investment is bounded by the willingness of the investors, not by the technological limit. This assumption is certainly to focus the paper on the analysis of the role of financial intermediation in the adoption and implementation of investment opportunities.

There is another breed of agents who are infinite lived bankers indexed by $[0, \kappa]$. The basic assumption on the number of bankers is

$$\kappa\mathcal{F} > 1.$$

They are risk neutral.¹⁰ The assumption on the number of bankers imply that there

⁸Some failed projects are improved to become good ones.

⁹I assume the outcome is observable and verifiable. Thus, I don't discuss issues of ex post monitoring, which is studied in detail by Sussman(1990) in the context of financial development.

¹⁰This is a place to discuss briefly the link to the more conventional models of banking. One can say there is additional *raison-d'etre* for banks coming from the static gains from banking. For example,

are sufficient supply of potential bankers and that the dynamics of financial development depends on how they are put into business. A banker collects consumers' savings in the form of deposit and invests it in industrial technology. Depositors are paid interest R_t contingent on the outcome of investment by a banker. Individual depositors go to bank due to the physical impossibility of investment in the required large scale. From this point on, investment in industrial technology occurs through banks, and consumers choose either to deposit in the bank or to invest directly in the liquid technology. The primary role of banks is the repository of knowledge on investment opportunities.

Capacity constraint is imposed on the the number of projects to be handled by an individual banker and the number of banks with which each consumer transacts. The constraint is imposed at a finite number, implying that perfect diversification of risk is not available. Because there is no loss of generality in restricting them to one, I only allow single investment by each bank to avoid the inconvenience of dealing with an arbitrary finite number. The number of banks in which each consumer deposits is specified later. This assumption is to analyze the gains from financial development in terms of risk bearing.

1.2.2 Banking

In this section, I propose two scenarios of equilibrium in banking sectors. They result in different implications on financial development. These two alternative scenarios are intended to illustrate the implication of the different market conditions in financial intermediation.

they save on the bankruptcy cost due to scale economies: each one files a separate bankruptcy proceeding, wants to make sure he got the fair share, and so on, if liquidation is performed individually. This cost advantage of financial intermediation from scale economies is discussed in Diamond(1984) and we include it in a highly condensed form because this is not the major issue of our discussion.

The quality of an industrial project is completely revealed once it is financed and tried by a bank. By investing in an industrial project, a bank uncovers the quality of a project. A good project keeps on being financed once it is identified.

(Banking A) Good project discovered by a bank is separable from the bank without any restriction. Each bank can accept deposit only of the size of the optimal scale of investment(\mathcal{F}). The information as to the project quality is shared by bankers. In other words, the quality of an industrial project is publicly observable (to bankers) once investment of \mathcal{F} was made in the project. At each round, bankers compete among themselves to get hold of the good projects which are revealed up to now. The deposit rate is the ex post average rate of return from the investment. Each consumer deposits in only one bank.

(Banking B) Good project discovered by a bank is not separated from the bank. A bank(established bank) which has discovered a good project can accept deposit of the size in excess of the optimal scale of investment, but they can still invest only in one project. The deposit rate is determined to be the average rate of return from the investment. On the other hand, a bank(new bank) which has not discovered a good project cannot accept deposit of the size in excess of optimal scale of investment, and can invest only in one project. The deposit rate is the ex post average rate of return from the investment. Each consumer deposits in one established bank and one new bank.

The two alternative structures of banking market are assumed here. The critical difference lies in the ease with which the customer relationship between the bank and the borrower can be switched. If the banking practice is such that the customer relationship is long lasting, (Banking B) is a more appropriate description. If the banking practice is such that the customer relationship is not very long lasting and if the cut-throat competition among banks is prevalent, (Banking A) is a more appropriate description. Although it is clear that the two alternative structures should

be derived from the more primitive observation of the banking market, it is not attempted in this paper.

If a good project is separable without friction from a bank of previous allegiance, there is no advantage of incumbency on the part of banks which had discovered a good project in the past. All the banks are symmetrical. In **(Banking A)**, the symmetry is pushed to extreme. The banks are completely symmetric with respect to the portfolio decision of consumers, which is the decision relevant to financial intermediation in the model. The restriction that banks take deposit only of the size of the optimal scale of investment simplifies the model.

If a good project is not separable from a bank of previous allegiance due to some friction, there is some advantage of incumbency on the part of banks which had discovered a good project in the past. In **(Banking Market B)**, the advantage of incumbency is picked up as the guarantee of good investment and the capability to take in deposit bigger than the size of the optimal scale of investment.

It should be noted that I am suppressing the relation between the projects and the banks, which is the relation between the firms and the banks more realistically. If one considers what can happen in the relation between the firms and the banks, the disparity which the advantage of incumbency brings about will take different shapes from the assumptions **(Banking A)** and **(Banking B)**. The two assumptions of banking structure contrast the existence vs. the inexistence of the advantage of incumbency in a manner tailored to the model of this paper where the portfolio decision of consumers is the key decision in the working of financial intermediation.

1.3 Financial Deepening

To discuss dynamics of financial deepening under (Banking A), we first look at the portfolio decision of consumers.

1.3.1 Consumer Equilibrium

Young consumers decide how to allocate their endowment among consumption when young, investment in liquid technology, and investment in industrial technology. Investment in industrial technology runs the risk of producing only 0, as the deposit increases beyond the amount which can be invested in identified good projects.

pool of good projects

Let D be the amount of deposit to be invested in industrial technology, and G_t/\mathcal{F} be the pool of good projects identified up to the period $t-1$, therefore pre-determined at period t . G_t is the amount of deposit which can be invested in identified good projects.

p_t , the probability of having deposit invested in good projects, is a function of G_t and D . For deposit which exceeds the amount that can be invested in identified good projects, i.e. $D - G_t$, the probability of investment in good projects is λ .

$$p_t = 1 \quad \text{if } D < G_t$$

$$p_t = \frac{1}{D} \{G_t + \lambda(D - G_t)\} \quad \text{if } D > G_t$$

This can be summarized as follows.

$$p_t = p(G_t, D) = \min\left\{1, \lambda + (1 - \lambda)\frac{G_t}{D}\right\} \quad (1.1)$$

p_t as a function of D shifts rightward as G_t increases. Refer to figures.

Let D_t be the equilibrium amount of deposit at period t . If D_t is bigger than G_t , G_{t+1} is bigger than G_t and function p_t is shifted rightward to become p_{t+1} .

$$G_{t+1} = G_t + \lambda(D_t - G_t) = \lambda D_t + (1 - \lambda)G_t \quad (1.2)$$

When D_t is smaller than G_t ,

$$G_{t+1} = G_t \quad \text{and} \quad p_{t+1} = p_t.$$

To summarize:

$$p_{t+1} > p_t \quad \text{as far as} \quad D_t > G_t \quad (1.3)$$

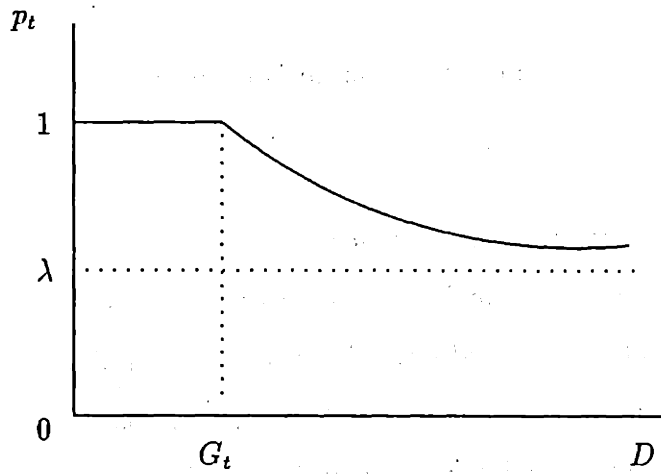
choice of consumption and portfolio

A young consumer at period t consumes c_{1t} in period t and saves $1 - c_{1t}$ for the consumption in period $t + 1$. Fraction ν_t out of the saving is deposited in the bank to be invested in industrial technology. Next period's consumption c_{2t+1} depends on the terms of deposit.

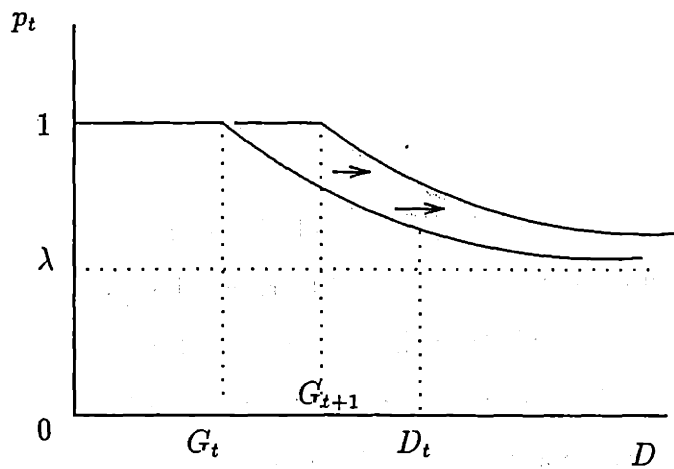
A young consumer's optimization problem is written as follows.

$$\max_{c_{1t}, \nu_t} u(c_{1t}) + \beta E\{u(c_{2t+1})\} \quad (1.4)$$

$$u' > 0, \quad u'' < 0, \quad \lim_{c \rightarrow 0} u'(c) = +\infty$$



probability of good investment as
a function of deposit



shift in p_t

Relevant probability distribution in assessing the expected utility of the second period depends on the banker's equilibrium. If we have the optimal value of ν_t for a given deposit rate, we can get the level of deposit D_t .

$$D_t = \nu_t(1 - c_{1t}). \quad (1.5)$$

Equations (1.1) and (1.5), together with the conditions of consumer's optimum, determine a static equilibrium.

Equilibrium ν_t shows how much of consumer's saving is deposited at period t . If this ratio increases, the importance of financial intermediation increases. I interpret this ratio as a measure of degree of financial intermediation. This ratio is both the ratio of deposit in total saving and the share of investment in industrial technology in total investment. Increase in the degree of financial intermediation in this sense does not imply that the *level* of deposit increases accordingly. The level of deposit is affected also by the level of saving, as is clear in equation (1.5).¹¹

1.3.2 Financial Deepening

We are prepared to discuss the dynamics of the model. The accumulation of pool of good projects is the process of financial development as a process of learning the type of borrowers.¹² It depends on the initial condition whether this process can take off spontaneously. Dynamics are traced in detail for the case of a log utility function, and the same dynamics is shown to be at work for a general utility function.

log utility function

¹¹Empirical evidence is that the share of bank deposit increases with the interest increase, while the sign of interest elasticity of total saving is ambiguous.

¹²Type of projects in my model.

Assume first that

$$u(c) = \log c$$

in equation (1.4). This case fosters intuition, because saving decisions are inelastic to interest rate, making it easy to trace the dynamics. We derive demand and supply curve in the (p_t, ν_t) plane and follow their movement over time.

Given p_t , the optimization of a young consumer is as follows, using the fact that the deposit rate from the bank with good investment is A under **(Banking A)**.

$$\max_{c_{1t}, \nu_t} \log c_{1t} + \beta \{ p_t \log((1 - \nu_t)a + \nu_t A)(1 - c_{1t}) + (1 - p_t) \log(1 - \nu_t)a(1 - c_{1t}) \} \quad (1.6)$$

First order conditions are:

$$\frac{1}{c_{1t}} = \frac{\beta}{1 - c_{1t}} \quad (1.7)$$

$$\frac{p_t(A - a)}{(1 - \nu_t)a + \nu_t A} = \frac{(1 - p_t)a}{(1 - \nu_t)a} \quad (1.8)$$

Equilibrium is determined by equations (1.1), (1.5), (1.7), and (1.8). Substituting equation (1.7) into equation (1.5),

$$D_t = \nu_t \frac{\beta}{1 + \beta}$$

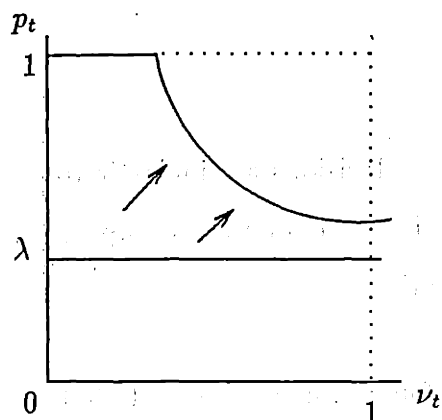
One can thus rewrite equations (1.1), (1.5), and (1.7) into equation (1.9).

$$p_t = \min \left\{ 1, \lambda + (1 - \lambda) \frac{G_t(1 + \beta)}{\nu_t \beta} \right\} \quad (1.9)$$

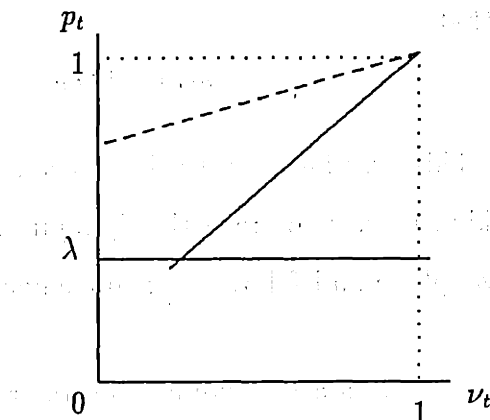
This is a demand curve, which shows the level of deposit needed to finance enough number of projects to realize a given probability of success.

Equation (1.8) is rewritten into equation (1.10).

$$p_t = \frac{A - a}{A} \nu_t + \frac{a}{A} \quad (1.10)$$

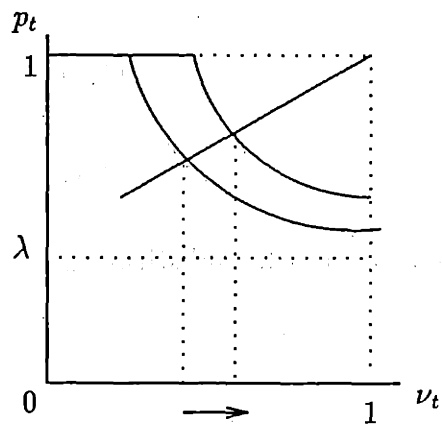


$G_t = 0$ vs. $G_t > 0$

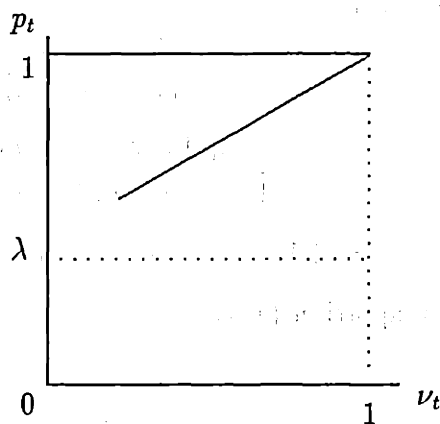


$\lambda A < a$ $\lambda A > a$

first period



increase in ν_t



stationary state

This is an implicit supply curve. Given the probability of success, the supply of the deposit is determined.

When there is no good projects already identified, the demand curve is a straight line horizontal at λ , because there is no accumulated information. Once we have some pool of identified good projects, the graph changes into a curve which combines a straight line and a hyperbolic curve. As the pool of good projects increases, the curve shifts northeast.

Let period 1 be the first period when intermediation starts. Because there is no

pool of identified good projects, the probability of investment in good projects is λ . If industrial technology is so rewarding as to induce some investment under this probability, investment in industrial technology occurs. The condition is:

$$\lambda A > a \quad (1.11)$$

In that case, the supply curve intersects the demand curve at positive value of ν_t . If condition (1.11) does not hold, there is no deposit in equilibrium and no investment in industrial technology. It takes an exogenous event to generate initial investment in industrial technology.

If there occurs a positive investment in industrial technology in the first period, fraction λ of the investment is directed into good projects. In the second period, then, the demand curve contains a hyperbolic part that starts at $p_t = 1$ and heads toward the asymptote $p_t = \lambda$. Investment in the first period produced the information to shift the demand curve. The fraction of the flat part of demand curve represents the depth of accumulated information. Once there was acquisition of information, the equilibrium level of deposit is always positive thereafter.

Equation (1.3) says that the pool of identified good projects grows as far as deposit exhausts current pool of good projects and finances some new projects. Some investment in new projects occurs if p_t is less than 1. Until the horizontal part of the demand curve extends up to $(\nu_t, p_t) = (1, 1)$, the two curves intersect at p_t less than 1. Therefore, p_t and ν_t keep on increasing toward 1.

As the probability of investment in good projects increases, consumers deposit a bigger part of saving. Because only small number of good projects are identified at the beginning, some investment in new projects occurs and the pool of identified good projects grows. The degree of intermediation, i.e. the ratio of deposit to total saving, increases accordingly. The degree of intermediation is also the share of industrial technology in total investment. This share increases as the involved risk shrinks as

banks get more experienced.

Finally, the pool of identified good projects grows large enough to absorb all saving. Consumers put the whole saving into deposit to be invested in industrial technology, because they will get a high rate of return with certainty.

Financial development is the process of learning the qualities of industrial projects. The risk of investment in industrial technology, which is daunting initially, is diminished as the economy accumulates knowledge of projects. In our model with only banker and consumer, this benefit goes to consumers allowing them bigger investment and bigger consumption.¹³

general utility function

As a generalization of log utility function, I will first consider a utility function of constant relative risk aversion and then an arbitrary concave utility function satisfying conditions listed in equation (1.4). All the results for log utility carry over to CRRA utility straightforwardly. I begin with stating consumer's optimization problem. Given p_t , (1.4) can be written as follows.

$$\max_{c_{1t}, \nu_t} u(c_{1t}) + \beta \{ p_t u(((1 - \nu_t)a + \nu_t A)(1 - c_{1t})) + (1 - p_t) u((1 - \nu_t)a(1 - c_{1t})) \} \quad (1.12)$$

Put R_g equal to $(1 - \nu_t)a + \nu_t A$ and R_b equal to $(1 - \nu_t)a$. First order conditions are the following.

$$\frac{u'(c_{1t})}{\beta} - p_t R_g u'(R_g(1 - c_{1t})) - (1 - p_t) R_b u'(R_b(1 - c_{1t})) = 0 \quad (1.13)$$

$$p_t (A - a)(1 - c_{1t}) u'(R_g(1 - c_{1t})) - (1 - p_t) a(1 - c_{1t}) u'(R_b(1 - c_{1t})) = 0 \quad (1.14)$$

¹³In principle, the same mechanism can be discussed in a model where the benefit is absorbed by banks.

The equilibrium is determined by equations (1.1), (1.5), (1.13), and (1.14).

We learn two things immediately by looking at equation (1.14). ν_t equals 0, if $p_t A \leq a$. ν_t is smaller than 1 as far as p_t does not equal 1, because we assumed the marginal utility is infinitely large at zero consumption. At the same time, p_t is smaller than 1 as far as ν_t is smaller than 1. Consumers put aside some part of their saving for investment in liquid technology because they should bear some risk if they invest all their saving in the industrial technology. When p_t is smaller than 1, it means that there is some investment in new technologies. The expected probability of good investment is smaller than one because consumers deposit more than can be invested in identified good projects.

p_t keeps on increasing as far as banks finance some new projects. banks do not diversify away risk completely but reduces risk little by little with the accumulation of knowledge. The risk is dissipated finally resulting in p_t equal to 1. Then, consumers deposit all the saving in the banks and investment in industrial technology explains the whole investment. The performance of intermediation improves in the sense that investment in industrial technology becomes less risky. I need to show that

$$\frac{d\nu_t}{dp_t} > 0. \quad (1.15)$$

It is straightforward to show inequality (1.15) for the utility function of constant relative risk aversion.

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}, \quad \gamma > 0$$

Separation between consumption decision and portfolio decision in CRRA utility enables us to do straightforward comparative statics.

Equation (1.14) is written as:

$$p_t(A - a)((1 - \nu_t)a + \nu_t A)^{-\gamma} = (1 - p_t)a((1 - \nu_t)a)^{-\gamma}$$

Given the probability of investment in good projects, the equilibrium degree of intermediation is determined solely in this equation.

$$\frac{d\nu_t}{dp_t} = \frac{(A-a)R_g^{-\gamma} + aR_b^{-\gamma}}{\gamma(A-a)^2R_g^{-\gamma-1} + \gamma a^2R_b^{-\gamma-1}} > 0.$$

We already know that the probability of investment in good projects increases monotonically. Positiveness of the above derivative shows that the degree of intermediation increases monotonically, too.

A comparative statics to prove inequality (1.15) for an arbitrary concave utility is in the following.

$$U(c_{1t}, \nu_t, p_t) =$$

$$u(c_{1t}) + \beta[p_t u\{(1-\nu_t)a + \nu_t A\}(1-c_{1t}) + (1-p_t)u\{(1-\nu_t)a(1-c_{1t})\}]$$

First order conditions are:

$$U_1 = 0$$

$$U_2 = 0$$

Standard argument for comparative statics gives:

$$\frac{d\nu_t}{dp_t} = \frac{\begin{vmatrix} U_{11} & -U_{13} \\ U_{21} & -U_{23} \end{vmatrix}}{\begin{vmatrix} U_{11} & U_{12} \\ U_{21} & U_{22} \end{vmatrix}}$$

$$\frac{d\nu_t}{dp_t} = \frac{-U_{11}U_{23} + U_{13}U_{21}}{U_{11}U_{22} - U_{12}U_{21}}$$

The second order condition for maximization says

$$U_{11}U_{22} - U_{12}U_{21} > 0.$$

I want to show that

$$-U_{11}U_{23} + U_{13}U_{21} > 0.$$

Calculation substituting first order conditions yields the following.

$$\begin{aligned} -U_{11}U_{23} + U_{13}U_{21} = & \\ & -\frac{1}{\beta}(A-a)(1-c_{1t})u'(R_g(1-c_{1t}))u''(c_{1t}) - \frac{1}{\beta}a(1-c_{1t})u'(R_b(1-c_{1t}))u''(c_{1t}) \\ & -[(A-a)R_gR_b + aR_g^2]p_t(1-c_{1t})u''(R_g(1-c_{1t}))u'(R_b(1-c_{1t})) \\ & -[aR_bR_g + (A-a)R_b^2](1-p_t)(1-c_{1t})u''(R_b(1-c_{1t}))u'(R_g(1-c_{1t})) \end{aligned}$$

Because consumers are risk averse, the above is positive.

1.3.3 Government Intervention

Having seen the process of financial development by learning, I discuss the implication on government intervention of this approach. For analytic convenience, the case of log utility is discussed.

It has been shown the inequality

$$\lambda A < a \tag{1.16}$$

is critical in determining whether the financial development starts spontaneously. If this inequality holds, no first generation is willing to invest in the industrial technology. It is potentially possible for the banks to bear the cost making up for the risk

for the first generation with a view to the future profit for themselves. However, each bank finds it preferable to wait until other banks have made the initial investment, as far as the information is publicly available and a good project is completely separable from the bank who discovered the project.

This is an underdeveloped financial system. Although there are potentially useful projects, risk is big because it is not clear which one is the right project to finance. On the other hand, there are less productive but highly liquid project. These have little uncertainty. Investment does not occur even if initial attempt at the risky industrial projects starts the transitional process of financial development. An intervention which reverses the inequality (1.16) can take the economy out of the trap of financial underdevelopment. Specific policies can be considered by alternative interpretations of the model.

credit subsidy

Government can subsidize the investment in the industrial project financing the subsidy by taxing the next generation. The old are at least guaranteed the same rate of return as that from liquid technology. The young are more than compensated for the tax burden by the increase in the rate of return from the industrial investment. The young generation is compensated by the accumulation of information. If the compensation to the young in the next generation is not big enough to justify the subsidy, government can issue a debt and roll it over until it can be paid back. It is possible to do this with a balanced budget because some generation can invest all the saving in the industrial technology and gets a return of A , once enough degree of information has been accumulated. It is possible for the government to implement a Pareto improving transfer program across generations, because some generation can invest all the saving in the industrial technology rather than in the liquid technology. For whatever level of loss to be compensated for the initial generation, it is possible

to implement the net transfer between the initial generation and the generation in the stationary state by transferring the amount corresponding to the required compensation from the adjacent posterior generation to the adjacent anterior generation until the generation in the stationary generation is reached. Government makes the inter-generational transfer work, because it is not in the interest of the *last generation involved* to fulfill the promised transfer once the stationary state has been reached.

It is not possible to change the structure of returns between technologies within the same generation and to start financial development in a Pareto improving way. Two such schemes are shown not to work.

An easy experiment is transfer within industrial technology reducing the risk. Transfer within industrial technology cannot take the economy out of the trap

$$\lambda A < a,$$

without discussing the welfare implication. Maximum that can be attained by redistribution within industrial technology is $u(\lambda A)$.

$$u(a) > u(\lambda A) > E_{\lambda} u(\tilde{r}) = \lambda u(A) + (1 - \lambda)u(0)$$

An alternative is for the government to try to distort the returns from the two alternative investment opportunities. It is possible to let the initial investment happen but not possible to implement a Pareto improving policy by this transfer across projects within the same generation. At the sacrifice of the first generation, however, all the later generations are better-off. Government taxes income from investment in liquid technology at the rate of τ and subsidizes income from investment in industrial technology at the rate of $\hat{\tau}$. The rate of return for liquid technology is $a - \tau$ and the rate of return for industrial technology is $(A + \hat{\tau}, \hat{\tau})$.

When $\tau = \hat{\tau} = 0$, utility of a consumer is

$$U = \log \frac{1}{1+\beta} + \beta \log \frac{\beta}{1+\beta} + \beta \log a.$$

When government intervenes in the financial market, it is possible to induce consumers to invest in industrial technology. We normalize for \mathcal{F} to be 1. Subscript 0 refers to period 0.

Balanced budget condition says:

$$(1 - c_{10})(1 - \nu_0)\tau - (1 - c_{10})\nu_0\hat{\tau} = 0$$

$$\hat{\tau} = \frac{1 - \nu_0}{\nu_0}\tau$$

Utility of consumer under financial repression is as follows.

$$\begin{aligned} \hat{U} &= \log \frac{1}{1+\beta} + \beta \lambda \log \frac{\beta}{1+\beta} [(A + \hat{\tau})\nu_0 + (a - \tau)(1 - \nu_0)] \\ &\quad + \beta(1 - \lambda) \log \frac{\beta}{1+\beta} [\hat{\tau}\nu_0 + (a - \tau)(1 - \nu_0)] \\ &= \log \frac{1}{1+\beta} + \beta \log \frac{\beta}{1+\beta} + \beta \lambda \log(\nu_0 A + (1 - \nu_0)a) + \beta(1 - \lambda) \log(1 - \nu_0)(a + \tau) \end{aligned}$$

$$F(\nu_0) = \hat{U} - U = \beta \lambda \log[\nu_0 A + (1 - \nu_0)a] + \beta(1 - \lambda) \log(1 - \nu_0)a$$

We ask whether there is a range of tax and subsidy which improves welfare of the young generation at period 0.

$$F(0) = \beta \log a$$

$$F'(\nu_0) |_{\nu_0=0} = \frac{\beta}{a} [\lambda(A - a) - (1 - \lambda)a]$$

$$F'(\nu_0) |_{\nu_0=0} = \frac{\beta}{a} (\lambda A - a) < 0$$

capital control

If the model is interpreted as the situation of a small open economy, the implication of capital control can be discussed. For an underdeveloped economy in an international capital mobility, liquid technology can be interpreted as a profitable and safe investment in the advanced countries, while the industrial technology is risky domestic investment. The assumption of A bigger than a comes from the fact that domestic investment contributes to the economy more than a simple capital income. Thus, there is a natural tendency for capital outflow, which is optimal for individual but not for the whole economy. Either by taxing foreign investment or by prohibiting capital export, the government helps to get the economy out of the trap.

It is another question whether the capital control can be implemented in a Pareto improving fashion. One direction is for the government to raise debt in the international capital market and to channel the fund in the investment in the industrial project via domestic financial sector. Pareto improvement is possible when the debt can be paid back by the later generations who benefit from having the necessary initial investment made ahead of their own generations. The inter-generational transfer is made with the aid of government through the foreign debt instead of tax/subsidy. The net transfer of wealth across generations is equivalent to that in the previous program of tax and subsidy. The role of government is to be a guarantor for the domestic banks in front of foreign lenders. It is important not to spend the foreign debt so raised on the government's agenda which should abide by the feasible revenue constraint. The reasoning is comparable to that of infant industry protection, while it is different in that there is nobody – not even foreign banks – to make the necessary initial investment because of the free-rider problem.

comparison with financial repression

The case for a government intervention arises from the free-rider problem among banks. In contrast to the common criticism of the government intervention in the

financial market, it can contribute to promoting information accumulation aspect of financial development. However the specific recommendation for policy is different from what happens under financially repressed economy. The comparison can be attained by interpreting the liquid technology as the government bond which should be sold each period to finance government expenditure. In the financially repressed economy, the credit condition will be distorted in favor of the liquid technology in opposition to the policy recommended in this model. This model agrees with the contention against financial repression of the type identified by McKinnon and Shaw.

1.4 Inertia

In this section, I discuss the dynamics of financial development under **(Banking B)**. In the previous section, the information as to the qualities of projects was assumed to be public and projects were assumed to be separable from the banks with former allegiance, to abstract away from the different saving opportunities provided by banks with and without good investment opportunities learned from the previous experience. In this section, I consider the case where the good projects stay with the banks and ask what different implication it has on financial development.

When a bank which had discovered a good project keeps the project under its control, consumers naturally want to deposit saving in the banks that had already discovered a good project. Call the banks that had already discovered a good project 'established' banks and the banks that had not done so 'new' banks. For simplicity, let banks pay deposit interest rate by average return on their deposit. Lending to only one project, the deposit in excess of the optimal scale of investment (\mathcal{F}) reduces the available interest rate on deposit. It will be driven down to the interest rate from the liquid technology, as far as there is positive investment in the liquid technology. The investment going to the liquid technology diminishes as the pool of good projects

expands.

At some stage, the pool of good projects becomes large enough to absorb all the savings that used to be invested in the liquid technology. The allocation of saving is now only between the deposit in an established bank and the deposit in a new bank. Because the pool of established banks expands, more saving is deposited in the established bank *and the deposit rate from the established bank increases*. This works against the deposit in new banks and the investment in new projects. The economy gains from the expansion of the established banks but also loses some opportunity due to the buildup of inertia driven by the expansion of the established banks. It becomes less attractive to invest in new opportunities. Finally, learning stops before the full potential of the economy is realized. The resulting stationary state is characterized by the rate of return lower than the rate of return A that would have prevailed with full learning. Government policy can be implemented to settle the economy in a more desirable stationary state.

I illustrate inertia buildup by focusing on the case of log utility function.¹⁴ At the same time, the optimal scale of investment \mathcal{F} is normalized to be equal to 1 for the ease of derivation. Let \hat{R}_t be the interest rate from the established bank.

Because the consumption decision and the portfolio decision are separable, one can safely focus on the portfolio choice problem. The consumer decides how much of saving ($\hat{\eta}_t$) to deposit in the established banks, and how much of saving (μ_t) to deposit in the unestablished banks. The rest of saving ($1 - \hat{\eta}_t - \mu_t$) is invested in the liquid project.

$$\lambda \log(\hat{\eta}_t \hat{R}_t + (1 - \hat{\eta}_t - \mu_t)a + \mu_t A) + (1 - \lambda) \log(\hat{\eta}_t \hat{R}_t + (1 - \hat{\eta}_t - \mu_t)a) \quad (1.17)$$

Because the λ of the unestablished banks succeed in discovering a good project and

¹⁴The same logic carries through qualitatively for the more general utility function, but is difficult to illustrate as explicitly as in the case of log utility function.

get established, the law of motion for the number of the established banks is:

$$G_{t+1} = G_t + \lambda S_t \mu_t.$$

The amount of aggregate saving is S_t .

1.4.1 Financial Development

Financial sector develops in three separate phases in this model.

phase I: financial deepening

When consumers recognize the established banks, the deposit in the established banks bears no risk in contrast to the deposit in new banks. Consumers will increase their deposit in the established banks as far as the deposit rate from the established banks is higher than the rate of return from the liquid investment. The first order condition with respect to $\hat{\eta}_t$ is

$$\lambda \frac{\hat{R}_t - a}{\hat{\eta}_t \hat{R}_t + (1 - \hat{\eta}_t - \mu_t)a + \mu_t A} + (1 - \lambda) \frac{\hat{R}_t - a}{\hat{\eta}_t \hat{R}_t + (1 - \hat{\eta}_t - \mu_t)a} = 0.$$

Consumers want to increase the deposit in the established banks if

$$\hat{R}_t > a.$$

Consumers want to diminish the deposit in the established banks if

$$\hat{R}_t < a.$$

When G_t of established banks (thus, good projects) are available in the economy, the

deposit rate from the established banks is:

$$\hat{R}_t = \frac{G_t A}{S_t \hat{\eta}_t}$$

Finite optimum is obtained only if $R_t = a$. When that condition holds, $\hat{\eta}_t$ is indeterminate from the first order condition. The level of deposit is determined at the market equilibrium. This reasoning holds true at whatever value of the deposit in new banks ($\hat{\eta}_t$). Once the pool of established banks is given, there is only one level of deposit which brings about the equilibrium. The only possible equilibrium deposit rate is

$$\frac{G_t A}{S_t \hat{\eta}_t} = a$$

$$\hat{\eta}_t = \frac{G_t A}{S_t a}. \quad (1.18)$$

In log utility,

$$S_t = \bar{S} \equiv \frac{\beta}{1 + \beta} \text{ for all } t.$$

Thus,

$$\hat{\eta}_t = \frac{G_t A}{\bar{S} a}.$$

With respect to μ_t ,

$$\lambda \frac{A - a}{\hat{\eta}_t \hat{R}_t + (1 - \hat{\eta}_t - \mu_t)a + \mu_t A} + (1 - \lambda) \frac{A - a}{\hat{\eta}_t \hat{R}_t + (1 - \hat{\eta}_t - \mu_t)a} = 0$$

Imposing the condition

$$\hat{R}_t = a$$

I get

$$\lambda \frac{A - a}{(1 - \mu_t)a + \mu_t A} = (1 - \lambda) \frac{a}{(1 - \mu_t)a}.$$

$$\lambda = \frac{A - a}{A} \mu_t + \frac{a}{A}$$

$$\mu_t = \frac{\lambda A - a}{A - a} \equiv \bar{\mu}$$

This is positive as far as

$$\lambda A - a > 0.$$

The number of established banks follows

$$G_{t+1} = G_t + \lambda \bar{S} \bar{\mu}.$$

The degree of financial intermediation is

$$\hat{\eta}_t + \mu_t.$$

As the number of established banks increases, the degree of financial intermediation increases, yielding financial deepening. The financial deepening proceeds as the established banks attract more saving which used to be invested in the liquid technology.

phase II: buildup of inertia

When the number of established banks is large enough, consumers deposit all the savings in the banks. The deposit in the established banks dominates investment in liquid technology. The financial deepening has proceeded to fruition. The choice is between the established banks and new banks now. Let T be the start of the Phase II. Phase II starts when the deposit rate from the established banks is higher than or as high as than the rate of return from the liquid investment, when all the savings other than the deposit in the new banks have been deposited in the established banks.

$$\hat{R}_t = \frac{G_T A}{S_T (1 - \mu_T)} \geq a$$

$$G_T \geq \frac{a}{A} \bar{S} (1 - \bar{\mu}) = \frac{a \beta (1 - \lambda)}{(1 + \beta)(A - a)}$$

Because the rate of increase of the number of established banks is constant during

Phase I, T is the smallest integer satisfying

$$T \geq \frac{a}{\lambda A} \left(\frac{1}{\bar{\mu}} - 1 \right).$$

The portfolio decision in Phase II is made with the condition

$$1 - \hat{\eta}_t - \mu_t = 0 \quad (1.19)$$

imposed on the decision problem of equation (1.17). The restriction is imposed because the effective portfolio choice occurs only when this equilibrium condition holds for the allocation of saving between the established banks and the liquid investment. Consumers choose how much to deposit in the new banks and deposit the rest in the established banks. The portfolio decision in phase II is given by

$$\max_{\mu_t} \lambda \log[(1 - \mu_t)\hat{R}_t + \mu_t A] + (1 - \lambda) \log[(1 - \mu_t)\hat{R}_t]$$

after substituting equation (1.19) into equation (1.17). The first order condition is

$$\lambda \frac{A - \hat{R}_t}{(1 - \mu_t)\hat{R}_t + \mu_t A} = (1 - \lambda) \frac{\hat{R}_t}{(1 - \mu_t)\hat{R}_t}$$

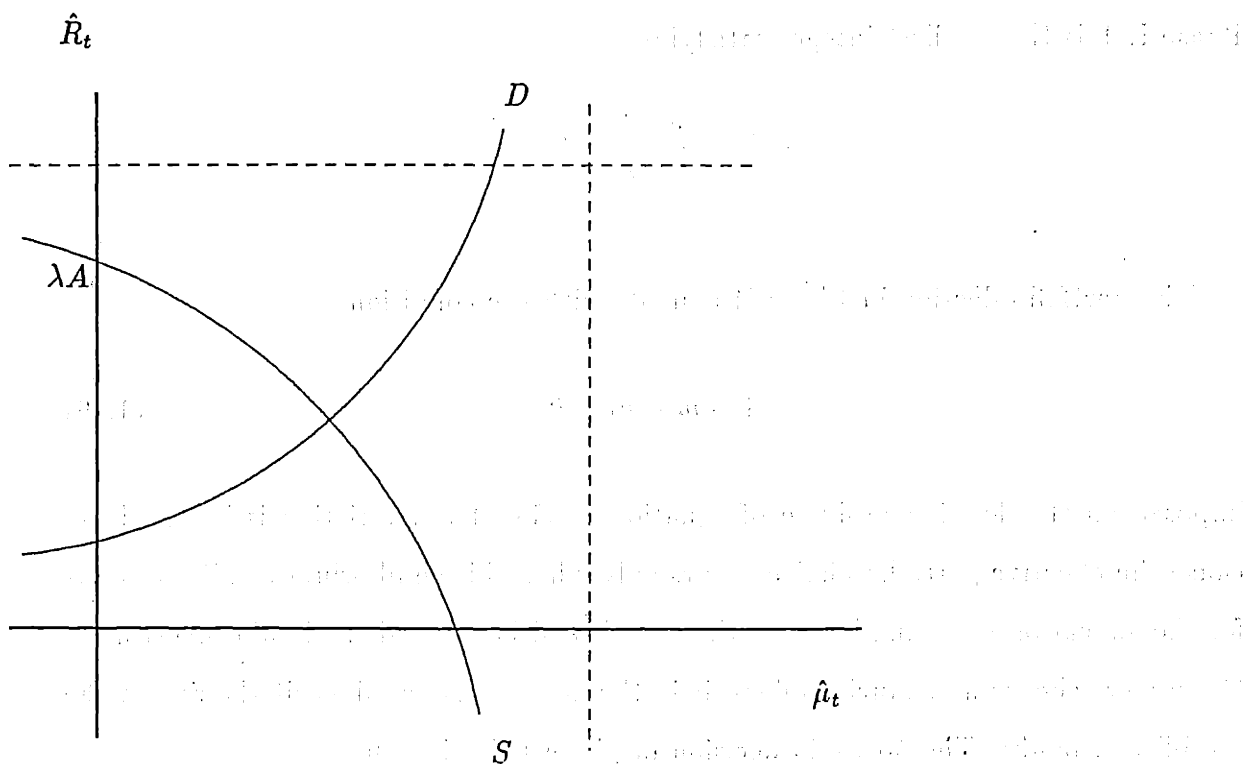
$$\lambda = \frac{A - \hat{R}_t}{A} \mu_t + \frac{\hat{R}_t}{A}$$

$$\hat{R}_t = \frac{A(\lambda - \mu_t)}{1 - \mu_t} = A + \frac{A(1 - \lambda)}{\mu_t - 1}$$

The market is equilibrated by this condition and the equilibrium condition

$$\hat{R}_t = \frac{G_t A}{\bar{S}(1 - \mu_t)}$$

In diagram, as the number of established banks expands, the D curve shifts upward until the vertical intercept coincides with the vertical intercept of the S curve. Once



$$D : \hat{R}_t = \frac{G_t A}{S(1-\hat{\mu}_t)}$$

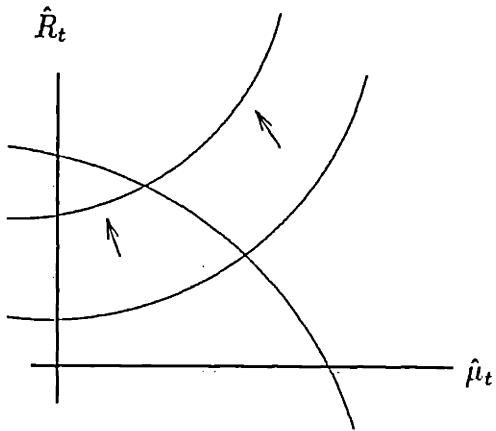
$$S : \hat{R}_t = A + \frac{A(1-\lambda)}{\hat{\mu}_t - 1}$$

the vertical intercepts of the two curves meets, the stationary state is reached. Because the vertical intercept of the S curve is λA , the degree of learning in stationary state is always incomplete.

The number of established banks follows

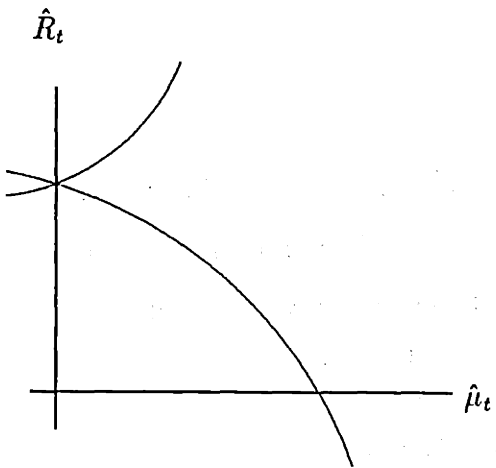
$$G_{t+1} = G_t + \lambda \bar{S} \mu_t.$$

The deposit rate from the established banks increases. Because the deposit in new banks should fight a more and more difficult fight, the rate of growth of the number of established banks diminishes. As the number of established banks increases, the inertia against new banks increases. In the end, no deposit is available to new banks and the economy reaches the stationary state.



D curve shifts up as G_t increases.

\hat{R}_t increases and $\hat{\mu}_t$ decreases.



Stationary State

$$\hat{R}_\infty = \lambda A$$

phase III: stationary state

The stationary state (the end of the growth in the number of established banks) starts at the interest rate \hat{R}_∞ satisfying

$$\frac{\lambda(A - \hat{R}_\infty)}{(1 - \mu_\infty)\hat{R}_\infty + \mu_\infty A} = \frac{(1 - \lambda)\hat{R}_\infty}{(1 - \mu_\infty)\hat{R}_\infty}$$

at

$$\mu_\infty = 0.$$

The interest rate of the stationary state is

$$\hat{R}_\infty = \lambda A.$$

The number of the established banks is

$$G_\infty = \lambda \bar{S}.$$

The number of the established banks does not grow any more because the inertia has become strong enough to preclude the entry of new banks. The expansion of the established banks and the increase of the deposit rate of the economy works against financial development by building up inertia against change.¹⁵

¹⁵Whoever is the residual claimant bearing the risk builds up inertia preventing it to take a risky but promising action as the status quo becomes more attractive. In this paper, the consumers are described to bear the ultimate burden of risk taking. If the bank and the entrepreneur, who is suppressed as a project in this paper, share the risk, the arrangement between them affects the incentive to learning and adventurous investment. This should be the agenda of the research subsequent to this paper.

1.4.2 Government Intervention

The condition for government intervention in Phase I is the same as in Section 1.3. In this model, however, government intervention is required all through Phase I.

Even if no government intervention is required in Phase I, it can be possible to push the economy to the stationary such that

$$G_{\infty} = \bar{S}$$

by government intervention that represses the interest rate from the established banks during Phase II. Again the intervention is called for all through Phase II.

Under **(Banking B)**, government intervention is called for at a bigger scale than under **(Banking A)**. Pareto improving government intervention is possible by implementing inter-generational transfer.

1.5 Conclusion

Degree of intermediation increases as more experience is accumulated in the banks. Intermediation reduces the risk to be borne by consumers. "Financial deepening" goes on as banks get more experienced. The aggregate performance of the economy also improves.

When industrial technology is not very profitable and there is no pool of already known good projects, it is necessary to initiate financial deepening somehow. Once it is triggered, financial deepening proceeds by itself. Government can intervene in the financial sector to stimulate initial development.

If the project is not separable from the bank, financial deepening is accompanied by buildup of inertia. Accumulation of inertia to a large enough extent impedes further financial development. A prolonged government intervention can move the economy to a stationary state with more learning and higher rate of return.

The extent of beneficial government intervention is enlarged as less accumulated information is retained within the financial sector to promote learning. Depending on how the market configuration is affected by government policy, the model can be interpreted as a case for non-interventionist policy. Without exploring the specific determinants of market configuration, the model provides a rationale for the necessity of government intervention.

The two results of the paper, gains from learning and the buildup of inertia to block learning are more general than the specifics of this paper. In this paper, the role of banks and projects in the decision of interest rates were suppressed to the extreme for the ease of derivation. If they are allowed to play more explicit roles, the implications will be qualified but not destroyed. It is a worthwhile future research agenda to introduce more explicit description of banks and projects. They will allow one to think about more specific institutional issues in financial development.

Chapter 2

Pass-Through

2.1 Introduction

The slow and apparently partial adjustment of import prices in the U.S. to both the appreciation of the dollar in the first half of the eighties and the depreciation of the dollar that started in 1985, put the issue of the pass-through of exchange rate changes to the prices of traded goods firmly on the research agenda. As well as being helpful in understanding the experience of the U.S., the question has a significant implication for the link between nominal and real exchange rates.¹

Before 1980, the pass-through elasticity for import prices had been estimated to be stable at between 50 and 80 percent.² The dramatic experience of the 1980s rekindled interest in the issue. The existence of partial rather than complete pass-

¹In other words, it is an important part of price responses in open-economy macroeconomics. (Dornbusch, 88)

²The U.S. Treasury's Office(1974) and references in Mann(1986).

through can be accounted for by models of imperfect competition in which exchange rate movements affect the profit possibilities of foreign firms.

In this paper, I investigate empirically the relation between market concentration and pass-through. My main empirical result, derived using Korean data, is that the pass-through elasticity varies systematically with concentration: the more concentrated the industry, the smaller the pass-through elasticity.

The use of Korean data provides some advantages. The Korean data is more comprehensive in its coverage of individual industries than those for the United States – the focus of most previous empirical work. At the same time, the data is more precise than industry-level data of other countries in that it consists of fixed weight price indices rather than unit price indices. There have been empirical works on industry-level data, attempting to gather evidence on the pricing to market effect. Except for Marston's work on Japanese export prices(90,JIE), however, all these works use unit prices. They are vulnerable to bias from the change in the composition of trade volumes, which does not arise in the data used in this paper. In addition, because the United States economy bulks large in international trade, shifts in U.S. demand conditions would be expected to affect equilibrium prices of imports even if the world were perfectly competitive. This problem does not arise in the case of Korea, a relatively small open economy.

The results presented in this paper are interesting both because they provide information on the determinants of the extent of pass-through, and also because they provide empirical support for the use of an explicitly imperfectly competitive model of international trade. The new trade theory has so far been an area in which theory has moved well ahead of empirical evidence, so that these results are among the first that provide explicit support for such theories.

This work also makes a valuable contribution as an inter-industry study. The

usefulness of inter-industry study is summarized by Schmalensee³.

Cross-section studies ... can produce useful stylized facts to guide theory construction and analysis of particular industries. ... Inter-industry research can complement industry studies by describing robust relations that hold across large samples of markets.

Although there are works on pass-through which use disaggregate data at various levels of disaggregation, there has been no previous attempt to test an inter-industry restriction.

This paper is organized as follows: In section 2.2, I briefly survey various theories and previous empirical work. In section 2.3, the empirical framework of the paper is set forth, followed by the discussion of the data in section 2.4. The results are reported in section 2.5, and the summary and conclusion is in section 2.6.

2.2 Theories and Evidence

There are two major issues in the discussion of pass-through: first, the magnitude and channel of pass-through; and second, the stability of pass-through. The magnitude of pass-through has been measured at least since 1974.⁴ The estimate then was in the range of 50% to 70%. In the 1980s, both theoretical and empirical research arose in response to the wide variation in the dollar exchange rate. Partial pass-through can be explained theoretically by allowing markets to be imperfectly competitive, as in the works of Dornbusch(1987) and Krugman(1987). In the empirical investigation of the issue for the U.S., Mann(1986) finds partial pass-through. At the same time,

³Chapter 15 in *Handbook of Industrial Organization*.

⁴*The Effects of Exchange Rate Adjustments, 1974*, The Proceedings of a Conference sponsored by the United States Treasury's Office of the Assistant Secretary for International Affairs.

however, Mann's work raises the issue of stability of pass-through by uncovering an unusual movement in the profit margins of foreign exporters. During a big swing in the dollar exchange rate, she observed that import prices moved little, resulting in a big change in the foreign profit margin. This anomaly led some economists to question the stability of pass-through. In response, a number of theoretical models have proposed an explanation of the structural break in pass-through based on the existence of fixed cost of entry. See Baldwin(88), Krugman and Baldwin(87), and Dixit(89).

This paper investigates empirically one implication of the models of partial pass-through based on imperfect competition. In section 2.2.1, I survey various theories to clarify the relation of this paper to the general question of pass-through. In section 2.2.2, I discuss the implication on the relationship between concentration and pass-through, and propose the empirical framework of this paper.

2.2.1 Models of Pass-Through

Models of pass-through can be grouped into three categories. The first type of models attempt to explain the possibility of structural break after a big movement in the exchange rate. The second type tries to explain partial pass-through as a short-run response to exchange rate change. The final group focuses more on the strategic interaction as the source of partial pass-through, formally using a static model. These three categories of models are surveyed in sequence.

Hysteresis

When there is fixed cost of entry, firms behave differently once they have paid the entry cost. Because the cost is sunk, firms are not concerned about it once it has

been incurred. If there is a large appreciation in the exchange rate, as in the dollar in the early eighties, foreign firms find it attractive to enter the U.S. market incurring the fixed cost of entry. Having entered the market, however, foreign firms do not exit even if the exchange rate depreciates to the pre-appreciation level, because the cost of entry has been sunk and possibly even reclaimed during the period of appreciation. Now that there are more foreign firms in the import market, the pass-through relation is different from the one that existed before the foreign firms entered. This change in equilibrium relation is observed as a structural break.

This idea is shown for different specifications of the exchange rates. Baldwin(1988) assumes that the path of exchange rate is known in advance, Baldwin and Krugman(1990) assume an i.i.d. process, and Dixit(1989) specifies the exchange rate as Brownian Motion. Baldwin and Krugman(1990) go one step further and show that the equilibrium exchange rate can be different after a swing, which is caused by a large temporary shock to the capital flow.

Baldwin(1988), Krugman and Baldwin(1987), Hooper and Mann(1989), and Melick(1990) test the stability of the pass-through equation and get inconclusive results. Ait-Shalia(1991) looks for the possibility of the structural break for the automobile industry of the U.S.⁵

Dynamic Model

Models of partial pass-through without structural break can be classified into two groups depending on how dynamic elements are treated. Partial pass-through can be observed when firms do not respond fully to what they consider to be short-run shocks. There are various channels by which short-run adjustment becomes partial.

⁵Korean currency experienced a depreciation followed by an appreciation during the sample period. Hysteresis by entry is quite unlikely. Furthermore, if the fixed cost itself is not dependent on the country size, the reward allowed by the appreciation in Korean currency is not big enough to induce entry by foreign firms.

When firms care about the effect on the market share of their pricing decisions, they respond more sensitively to the expected exchange rate than to the current exchange rate (Froot and Klemperer, 1988). Krugman (1987) comments briefly on the possibility of short-run price smoothing due to the consideration of the effect on consumer search activity, or due to a convex adjustment cost. There are also a number of papers following a macroeconomic approach, relying on menu costs.⁶ The basic idea in this type of model is that, as long as there is some form of adjustment cost, firms will respond differently to shocks they believe are temporary than they do to shocks they believe are permanent. In this paper, however, I do not pursue short-run dynamics of import price responses. Instead, I investigate static/long-run response; this is set forth in the next section.

Static Model

Partial pass-through can also be explained by concentrating only on the strategic decisions of firms. When the exchange rate moves for a reason exogenous to the domestic market, it becomes a cost shock to foreign firms who export to that market, but not to the domestic firms. This situation is unique to international economics in the sense that this is a shock which prevails across all the industries but which affects only a part of the firms in each industry. In other words, the shock is homogeneous across the industries but heterogeneous across domestic and foreign firms within each industry. Since this static model is also useful in contrasting the small vs. the large open economy and in deriving the implication on market concentration and pass-through, I will describe it in detail.

A perfectly competitive foreign firm pricing at its marginal cost tries to pass all the shock to the price. The final effect on import prices depends also on the relative size of the importing country. If the country is large enough to affect world market

⁶Gulde (1989) contains a survey.

price, exchange rate movement for the country results in a partial pass-through, even if each firm attempts a complete pass-through. If the exchange rate for a large country depreciates, its demand for foreign goods diminishes, resulting in reduced world equilibrium price. When converted into domestic currency at the depreciated exchange rate, import price does not rise in proportion to the depreciation in its currency. For a small open economy which cannot influence world equilibrium price, pass-through is complete when the market is perfectly competitive.

With imperfect competition, however, a partial pass-through is a norm even for a small open economy. Each firm is conscious of the effect of its own price/quantity change on its own revenue. When there is a shock in exchange rate, foreign firms do not pass all the cost shock to price, since they also consider the strategic effect of price increases.

I draw on a model of Cournot competition with linear demand from Dornbusch(87) to illustrate these ideas. Suppose the demand function is linear:

$$Q_d = a - bp.$$

There are n domestic firms and n^* foreign firms that export to domestic market. If q and q^* denote the sales of domestic and foreign firms, aggregate sales is given as:

$$Q = nq + n^*q^*.$$

Each firms maximizes its profit taking the sales of other firms as given. Assume constant cost of c and c^* for domestic and foreign firms, and denote the exchange rate by e . The objective functions of the typical domestic and foreign firms in the domestic market are:

$$\pi = (p - c)[a - bp - (n - 1)q - n^*q^*],$$

$$\pi^* = \left(\frac{p}{e} - c^*\right)[a - bp - nq - (n^* - 1)q^*].$$

The equilibrium price is

$$p = \frac{nc + n^*ec^*}{N} + \frac{a}{bN} \quad (2.1)$$

$$N = n + n^* + 1.$$

The formula for pass-through elasticity is given as follows.

$$\varphi = \frac{n^*ec^*}{Np}$$

Pass-through depends on the ratio of the number of domestic and foreign firms and the mark-up enjoyed by a representative foreign firm.

This model sheds additional light on the pass-through of a small open economy. For a small country in a perfectly competitive market, the number of foreign firms is close to the number of total firms. The pass-through is almost one except for the mark-up term. Because the mark up is zero in a perfectly competitive market, the pass-through is complete for a small open economy under perfect competition. If the market is imperfectly competitive, the mark-up is positive and it diminishes the magnitude of pass-through.

If this model is embedded in a dynamic context, it can be interpreted as a model of long-run pass-through because firms expect the prevailing exchange rate today to remain steady in the future. In other words, this static expectation of the exchange rate is rational when that rate prevails in the long run. At the same time, there is no consideration of adjustment cost, which matters in the short-run pricing dynamics. It requires an explicit consideration of expectation formation and short-run adjustment costs to fully characterize the dynamics. Again, this paper does not pursue the short-run dynamics.

There are many empirical studies of pass-through in the U.S.⁷ Pass-through of U.S. import prices was estimated to be between 50% and 80%. Most recently, Hooper and Mann obtain the estimate between 50% and 75%.⁸

2.2.2 Concentration and Pass-Through

It is plausible to think that strategic consideration becomes more acute as the market gets more concentrated, and thus to conclude that pass-through will be smaller in a more concentrated market. The first two models, however, can be pursued by an entry cost or an adjustment cost orthogonal to market concentration. The first two groups of models – hysteresis and dynamic models – do not have direct implication on the relation between concentration and pass-through. Nevertheless, this paper's results shed light on the prevalence and importance of imperfect competition which is the common base of all the categories of models. As such, the results of this paper lend empirical support to the use of explicitly imperfectly competitive model in the issue of pass-through.

The static linear model is useful for thinking about the effect of market concentration on pass-through. When an industry is more concentrated, the mark-up is larger and the pass-through is smaller. Foreign firms absorb more of exchange rate variation in the variation of mark up and less in the variation of prices/quantities, because they care more about the negative effect from production increase. The more concentrated an industry, the less elastic the demand for an individual firm in the industry. This paper tests the negative correlation between pass-through and market concentration.

⁷The earliest exhaustive work is in the conference by the Treasury in 1974: *The Effects of Exchange Rate Adjustments*

⁸There are many more works on the pricing to market effect based on various industry-level data. Gulde(1989) has an exhaustive survey.

To establish the relationship, I return to the linear model. The mark-up term in the pass-through elasticity can be expressed in terms of the parameters of the model:

$$\frac{ec^*}{p} = \frac{bN}{bnc + bn^*ec^* + a} \quad (2.2)$$

To see the effect on pass-through when the market becomes more concentrated, we reduce the number of firms, keeping the proportion between foreign and domestic firms constant. Because three-firm concentration ratio is $\frac{3}{N}$ in the symmetric model, reducing the number of firms is increasing market concentration ratio. We see that the pass-through elasticity φ is reduced as we reduce the number of firms. Or, the pass-through elasticity can be written explicitly in the concentration ratio. In this conceptual experiment, the whole industry becomes more monopolistic. The ratio between the numbers of domestic and foreign firms is kept constant.

$$\alpha \equiv \frac{n^*}{N} \quad CR_3 = \frac{3}{N}$$

$$\varphi = \frac{3\alpha b}{3(1 - \alpha)bc + 3\alpha bec^* + aCR_3}$$

This result, however, is sensitive to the choice of models of imperfect competition. For example, Fisher(89) investigates pass-through when the firms engage in Bertrand competition and reaches the conclusion that pass-through is bigger for the monopolistic industry than for the competitive industry. Nonetheless, I believe that Cournot competition is the most desirable framework for this analysis. First, Cournot competition is the appropriate way of thinking about imperfect competition in a static model.⁹ Second, Cournot competition generates a smooth transition from imperfect competition to perfect competition.¹⁰ Finally, the actual results of this paper argue for the use of Cournot competition.

⁹Chapter 6 of *Handbook of Industrial Organization* for more discussion.

¹⁰See the work by Novshek, referenced in Chapter 6 of *Handbook of Industrial Organization*.

2.3 Empirical Framework

The discussion in section 2.2 implies the following relation in each industry.

$$pm_t^i = a_1^i + a_2^i e_t^i + a_3^i c_t^{*i} + a_4^i c_t^i + \epsilon_t^i \quad (2.3)$$

Here, pm_t^i refers to import price index, e_t^i to the effective nominal exchange rate, c_t^{*i} to foreign costs, and c_t^i to domestic costs, in industry i . Because the log value of each variable is used, the estimate of a_2^i is the pass-through elasticity.

The next step is to investigate the correlation of the pass-through elasticity and market concentration by the following simple regression.

$$\text{estimate of } a_2^i = \text{constant} + \beta(\text{concentration ratio})^i \quad (2.4)$$

This regression is designed to estimate the correlation and does not bear a direct structural interpretation. In terms of estimation, an ordinary least squares regression of the second equation retrieves a consistent estimate of β which follows the standard t -distribution.¹¹

A number of issues arise in applying these two equations to the data. The first question is the contrast between nominal prices and relative prices. Past empirical work has used nominal price indexes.¹² This is justifiable if one conceives of a producer trying to decide the mark-up over the cost of production which is expressed in nominal variables and if inflation and the exchange rate are not strongly correlated. If one conceives of a producer who calculates profit in terms of relative prices, the use of nominal prices is inappropriate and results in a bias in the estimate. This bias, however, is less worrisome in estimating β for equation (2.4) than in estimating a_2

¹¹There are errors in variables on the left hand side of the regression equation, which does not affect the estimation of the coefficient.

¹²Hooper and Mann(1989) and others.

for equation (2.3), as long as the bias is similar across all industries. Because the use of nominal prices yields biased estimates of pass-through, if the correlation between the exchange rate and inflation is strong, use of relative prices should be seriously considered. Here, I first proceed with nominal prices, both because the bias to the estimation of cross-industry correlation β is not worrisome, and because it eases comparison with past work. I also perform the same estimation using relative prices, and get the same qualitative result for the cross-industry correlation. But, the estimate of pass-through elasticity exhibits slight upward shifts when relative prices are used, implying that the correlation between the exchange rate and inflation is not negligible for Korea.

The choice of appropriate cost variables emerges as the second question. It is most desirable to use industry specific cost measures including both labor cost and materials cost. Because such a comprehensive data are not available, this paper works with manufacturing unit labor costs and materials prices. The choice of trade weights is also a question. Because the weights that correspond exactly to the classification of industries in the data for import price indexes are not available, I construct a conversion table. Both of these data problems are discussed in more detail in section 2.4.

Finally, unit root discussion and interpretation of the result is an issue. Statistical tests do not reject the existence of a unit root in each series. Although unit root interpretation adds to the accuracy of my calculation of cross-industry correlation, it is disputable whether one should believe in the description of exchange rates and relative prices as random walks. The interpretation in terms of unit roots is discussed in section 2.5.3.

2.4 Data

Bank of Korea compiles import prices. The data I use comes from the data of the Bank. The indexes are calculated for the period of 1980 to 1990 by the Laspeyres formula using weights derived from the trade statistics of 1985. A weight for each commodity was assigned in proportion to its trade value in the whole basket, which includes 178 commodities. Contract prices are collected to obtain the prior-to-market price of import commodities. Import prices are on a CIF basis and are not affected by the variation in the tariff rates. One or two trading partners controlling a greater portion of trade in an item are selected to survey the price data. Price data are obtained on a monthly basis. The original data was a dollar based index and was converted into a won based index using the monthly average exchange rate.¹³ Quarterly averages of the won based index are used in this work.

Imports are classified into 3 one digit groups: agricultural, forest & marine products, mineral products, and manufactured products. Manufactured products are, again, divided into 9 two digit groups, and each two digit groups are again divided into three digit and four digit groups. Some subgroups are further divided into smaller groups. In this paper, I use the price index for the whole manufacturing sector, and 28 three or four digit subgroups belonging to manufacturing. To recover maximum information from the data on market concentration ratio, a finer classification is desirable. On the other hand, an index with some degree of aggregation is desirable to avoid getting bogged down in trying to explain price movements of individual commodities. I chose three or four digit classification to strike a balance between these opposing needs.

To translate the data into the framework of Korea versus the rest of the world, it is necessary to construct foreign variables weighted by the trade weights. As a first approximation, aggregate import data from U.N. trade statistics were used. Accord-

¹³Korean currency is won. In 1985, on annual average, 870 won is exchanged with one dollar.

ing to U.N. statistics, Japan, U.S., Germany, Canada, and U.K. were Korea's largest trade partners. Applying weights based on aggregate import data to the manufacturing industry is problematic, but was attempted as a first look at the data. Cross industry comparisons based on these weights are reported later, together with the primary results, to see how sensitive our estimate might be to the potential error in the choice of weights.

To obtain a more accurate estimate of industry specific pass-through elasticities, industry specific trade statistics are needed. Korean imports from six OECD countries were acquired from OECD trade series C. Statistics for 1985 were used because the import price series from the Bank of Korea uses weights based on imports of the same year.

OECD data is available in one, two, three, and five digit SITC codes. Looking at one digit data, major sources of manufacturing imports were Japan, U.S., Germany, France, U.K., and Canada. Although a conversion table between SITC and SIC is available, classification of Korean import price data is similar but not identical to SIC. The same was true for the conversion table between SITC and KSIC. Lists of commodities, used in the survey for Korean import prices, and lists of SITC codes were compared to identify a match between the two series. Even SITC five digit codes, however, are more aggregated than the individual commodity lists of Korean import prices survey. To minimize the likelihood of omitting a commodity, I adopted a more aggregated SITC code when there was ambiguity as to which SITC code a commodity belongs to. As a result, the actual match is between imports groupings and SITC two or three digit codes for most of the industries. The conversion table so constructed is in table 2.7.

In each industry, trade weight was calculated as follows. I first get the imports from the six countries, and add them up. The weight for a country is the share of the import from that country in total imports. In each industry, there are six weights for the six trade partners. The sum across selected SITC codes was used to construct

weights for manufacturing total. Trade weights were applied to all foreign variables, to construct the data for the rest of world as a trading partner. Foreign variables include the exchange rate, unit labor cost, and materials price.

Monthly average nominal exchange rates were taken from the International Financial Statistics of the IMF. They were weighted by trade weights into the effective nominal exchange rate. Manufacturing or aggregate unit labor cost indexes for the six trading partner countries come from OECD main economic indicator data. This aggregate data is weighted by trade weights. I do not have the information for industry specific unit labor cost, thereby missing one aspect of industry specificity. Unit labor cost for Korea is also aggregate.

I constructed several different indexes for materials prices. One that is most frequently used is the trade weighted average of wholesale price indexes of materials for the trading partner countries. The price indexes were from OECD main economic indicators, except for France where the producer price index from International Financial Statistics was used. For some industries with high material content, commodity price series from International Financial Statistics were used. The indexes from IFS are: wholesale price index of food, wholesale price index of all commodities, and wholesale price index of metals. It is reported later for which industries these price indexes were used.

Relative prices were defined as nominal prices relative to the consumer price index. The consumer price index for each country from IFS was used to obtain the relative price for each price series. The same criterion was applied to produce the weighted indexes.

I use the three firm concentration ratio as an index of market concentration. The index is available at five digit classifications from unpublished data of Korea Development Institute. The original data is annual from 1983 to 1987, and the average was used in this work. This index does not perfectly fit our conceptual framework. The

index is the share of the sales by the biggest three firms in total sales of the industry, with both domestic and export sales combined. In contrast to a hypothetical measure, which looks at domestic sales of both domestic and foreign firms, the index captures only part of the information I need on market structure. Another source of bias is in the treatment of multi-product firms. A firm is classified into an industry to which its major product belongs. Then, the firm's total production is used as its sales in the industry to which its major product belongs. This bias, however, is reduced because I use an index of concentration averaged across a number of five digit industries belonging to an industry in import prices data. Because the imports classification does not match Korean Standard Industrial Classification(KSIC), two lists were compared and corresponding KSIC codes were identified to calculate averages. Concentration ratio for imports grouping is taken as an average of concentration ratios for KSIC five digit industries.

Two industries among three or four digit classifications of Korean import price data were excluded in our work. Glass products(code number 361) had time series starting only in 1985. Other electrical appliances(code number 3834) consisted of one commodity; carbon electrode. I look at 28 industries belonging to three or four digit classifications of Korean import price data.

2.5 Results

2.5.1 Nominal Prices

To estimate the pass-through elasticity, equation (2.3) was estimated. In contrast to past empirical literature using U.S. data, lagged coefficients were not statisti-

cally significant.¹⁴ I adopt the estimates of ordinary least squares estimation without lagged variables as the appropriate estimates. This result is also interpretable as a cointegrating regression, which I will discuss in section 2.5.3.

The estimate of pass-through elasticity and market concentration is reported in table 2.8. The elasticity shows a wide variety from zero to one, although it is substantially less than one for most industries. There are two industries for which the estimate is outside the range between zero and one: leathers and furs, and foods. Large material content, which is subject to the volatile fluctuations in commodity prices, seems to be the reason for the poor estimates of both industries.

Although the weighted average of raw materials price was used for materials price in most industries, indexes of commodity prices from International Financial Statistics were used for some industries. The IFS price index of food was used for foods industry(311). It brought the pass-through coefficient closer to one. The IFS price index of all commodities was used for the leathers and furs industry(322). The estimate was still unsatisfactory. IFS price index of metals was used for a number of industries related to metal(371-372); this tended to produce reasonable estimates.

Calculation of correlation between the estimate of pass-through elasticity and the concentration ratio serves as the test of the hypothesis of partial pass-through predicted by imperfect competition. If one plots the pass-through coefficients against the concentration ratio, as is done in Fig. 1 at the end of the paper, one can see a clearly negative correlation. The negative correlation is still strong even if I exclude leathers & furs industry and foods industry which happen to strengthen the negative correlation. The coefficient from regression (2.4) is in Table 2.1.

A regression which includes time as a right hand side variable in the estimation of

¹⁴Hooper and Mann(1989) is the prime example using polynomial distributed lag structure. When I added up the lagged coefficients in spite of their statistical insignificance, the estimate of pass-through coefficient were well outside the range between zero and one.

Table 2.1: cross-industry correlation; nominal prices

	coefficient	stand. error	dof
(1)	-1.027	0.342	27
(2)	-0.824	0.318	25
(3)	-0.671	0.449	27

$$(\text{pass-through elasticity})^i = \text{constant} + \beta(\text{concentration ratio})^i$$

(1) all industries. unit labor cost and materials price; (2) industries excluding 311 and 322. unit labor cost and materials price; (3) all industries. unit labor cost, materials price, and time.

equation (2.3) was also tried. This is the suggested procedure if a deterministic trend in the data is suspected, which is plausible in the nominal price data. The graph of the estimates of pass-through obtained by this procedure and the concentration ratio is in Fig. 2. The correlation between the pass-through estimate and the concentration ratio for various cases is in table 2.1.

Including both unit labor cost and materials prices separately without restriction is not the best thing to do. The construction of a cost measure with appropriate weights to labor cost and materials price is preferable. The unrestricted use of two cost measures is adopted only because of the limitations of the data. For this reason, I tried to vary the cost measures included in the estimation of equation (2.3) within the limits of my data. The correlation between the pass-through elasticity and concentration is in Table 2.2. Negative correlation is exhibited in all the cases.

I also present Table 2.3 which reports the pass-through estimate obtained when the effective exchange rate based on total imports was used. The corresponding plot is in Fig. 3. The variables for cost are also different. Instead of unit labor cost indexes from OECD, relative unit labor costs from IFS were used, and the materials price index was omitted. Although the negative relation is weaker than that of the primary estimates, this shows that my choice of weights and data is not driving the results of Tables 2.1 and 2.2.

Table 2.2: cross-industry correlation; nominal prices; robustness check

	coefficient	stand. error	dof
(1)	-0.987	0.391	27
(2)	-1.553	0.570	27
(3)	-0.027	0.537	27
(4)	-0.228	0.575	27
(5)	-0.476	0.659	27

$$(\text{pass-through elasticity})^i = \text{constant} + \beta(\text{concentration ratio})^i$$

(1) all industries. foreign unit labor cost and materials price; (2) all industries. foreign materials price; (3) all industries. foreign unit labor cost; (4) all industries. Korean and foreign unit labor cost; (5) all industries. no cost variables, i.e. regression of import prices on a constant and the exchange rate.

Table 2.3: cross-industry correlation using aggregate imports weight; nominal prices

coefficient	stand. error	dof
-0.709	0.589	27

$$(\text{pass-through elasticity})^i = \text{constant} + \beta(\text{concentration ratio})^i$$

all industries. Korean and foreign unit labor cost. Foreign unit labor cost comes from IFS.

Table 2.4: cross-industry correlation; relative prices

	coefficient	stand. error	dof
(1)	-0.652	0.511	27
(2)	-0.659	0.379	26

$$(\text{pass-through elasticity})^i = \text{constant} + \beta(\text{concentration ratio})^i$$

(1) all industries. unit labor cost and materials price; (2) industries excluding 352.

2.5.2 Relative Prices

In the spirit of microeconomic models, relative prices are the relevant concept to be used in this empirical investigation. Again, equation (2.3) was estimated using only the current values of the variables, because the lagged variables did not yield significant coefficients. The correlation between pass-through and concentration is reported in Table 2.4, and the corresponding graph is Fig. 4. But, the regression with inclusion of a time trend as a right hand side variable was not attempted, because it usually is not expected in the relative prices and the plot of each relative price series did not show a trend.¹⁵ For the same reason as in the case of nominal prices, cost measures in the regression were varied, and the results are in table 2.5.

The investigation using relative prices also produces a strong negative correlation between the pass-through elasticity and market concentration. However, the estimate of the pass-through elasticity for individual industries is not identical. Table 2.8 also contains estimates of the pass-through elasticities when relative prices were used. Differences between the estimates using nominal prices and the estimates using relative prices are in Fig. 5.¹⁶

¹⁵The estimation of equation (2.3) with weights from U.N. statistics was not attempted, either.

¹⁶As a reference of comparison, standard errors for the coefficients of pass-through are centered around 0.2. Note that most of the differences between the two estimates have absolute value less than 0.2.

Table 2.5: cross-industry correlation; relative prices; robustness check

	coefficient	stand. error	dof
(1)	-1.013	0.424	27
(2)	-1.204	0.493	27
(3)	-0.768	0.448	27
(4)	-0.520	0.446	27
(5)	-0.827	0.552	27

$$(\text{pass-through elasticity})^i = \text{constant} + \beta(\text{concentration ratio})^i$$

(1) all industries. foreign unit labor cost and materials price; (2) all industries. foreign materials price; (3) all industries. foreign unit labor cost; (4) all industries. Korean and foreign unit labor cost; (5) all industries. no cost variables, i.e. regression of import prices on a constant and the exchange rate.

2.5.3 Unit Root Representation

It is a stylized fact in macroeconomics that many time series can be described as containing unit roots. If one adopts a unit root representation, the statistical interpretation of the results in sections 2.5.1 and 2.5.2 changes, too. I discuss this issue analyzing the nominal price data by unit root representation.

Unit roots in each variable are not rejected by the Dickey-Fuller tests. When a first order autoregressive process was fitted, the coefficient for each series is very close to 1.

The interpretation relying on unit roots adds to the accuracy of the estimation of the cross-industry correlation. If individual series have unit roots and equation (2.3) characterizes the long-run equilibrium relation among the series, the series will be cointegrated. The estimate of a cointegrating vector for non-stationary data is consistent with a finite sample bias of order $1/T$, while the estimate for stationary data has a finite sample bias of order of $1/\sqrt{T}$. In two stage modelling of cointegration and error correction, this rapid convergence guarantees the consistency of the error correction estimation, although the asymptotic variance of the cointegrating vector

itself is a random variable. By the same argument, the regression of the estimated cointegrating vector on the concentration ratio brings us a consistent estimate of the correlation between pass-through and concentration ratio.

Long-run pass-through can be estimated by the regression of current variables without being impeded by the disputes concerning the correct short run dynamics. Short-run dynamics governs the second stage of Engle's and Granger's two stage approach¹⁷, and theoretically depends on the various theories of price rigidities and the expectation of the exchange rate movement. When firms take some part of exchange rate change to be permanent and the other part to be temporary, the effect of the part which they consider permanent will be captured by the co-integrating vector and the effect of the part which they consider temporary will be captured by the error correction part. Even if the theory of short-run dynamics is not resolved, I can obtain the estimate of long-run pass-through by estimating the cointegrating vector. In fact, Melick(1990) estimates the long-run pass-through to be 0.586 for U.S. manufacturing import prices by estimating the cointegration regression. This conforms with other earlier estimates of long-run pass-through estimate based on lagged coefficients.

The cointegrating regression is nothing other than the ordinary least squares regressions that was performed in sections 2.5.1 and 2.5.2. To confirm the existence of cointegration, however, one needs to show that the residual series are stationary. When plotted, the residual series show a strong tendency of mean reversion, suggesting the stationarity of the process. When a first order autoregressive process was fitted, they are autocorrelated quite strongly, but are stationary(table 2.9).

To be more formal, one should test the stationarity of the residual series. It is preferable to test the null hypothesis of co-integration rather than to test that of no co-integration, which is what presently available tests of cointegration are about. In spite of the wide need, however, the test has not been formulated. I perform an augmented

¹⁷Engle and Granger(1987).

Dickey Fuller test of the residuals from the ordinary least squares estimation by industry, following conventional method of testing the null of no cointegration:

$$\Delta u_t^i = b_0 u_{t-1}^i + \sum_{n=1}^{L_i} b_n \Delta u_{t-n}^i$$

To choose an optimal lag structure, the Akaike criterion was applied according to the suggestion by Engle and Yoo(89). For all industries, t statistics for the coefficient b_0 is lowest for the lag length that Akaike criterion chooses. This, again, suggests that the residual series are stationary. For a number of industries, calculated t statistics, in table 2.10, do not reject the null of no cointegration at 10% significance level based on the simulation results in Engle and Yoo(89) cited in table 11. These simulations, however, have a small sample bias when the residual series has a relatively high autocorrelation coefficient. In Engle and Yoo(89), the critical region for the null of no-cointegration shrinks for sample size of 50 when the autocorrelation coefficient is put equal to 0.8. Also, the poor power of the various co-integration tests are well recognized as is exposed in Campbell and Perron(91).

I conclude that there is cointegration in spite of the mixed result of residual based test, because the power of the test is low and other characteristics of the series suggest the stationarity of the data. The t statistics are quite close to Engle and Yoo's 10% critical value even in industries which do not reject the null of no cointegration.

According to the cointegration interpretation, the estimates of the pass-through in sections 2.5.1 and 2.5.2 are long-run pass-through elasticities. Although the statistical accuracy of individual estimate cannot be established, the statistical interpretation of the cross-industry correlation is tight.

2.6 Summary and Implications

The negative correlation between the pass-through elasticity and the market concentration is fairly robust. Considering that the cost measures and the trade weights used were, of necessity, imperfect proxies, I find this negative correlation convincing support for the models of imperfect competition. It seems clear that market structure is one factor that should be considered when thinking about the effect of exchange rate movement on international prices.

What do the results of this paper imply for alternative models of pass-through? For one, there is a non-negligible systematic difference in different industries. This calls attention to industry specific details which are linked to the market concentration of each industry. For another, the evidence presented in this paper provides broad support for the use of models of imperfect competition.

A change in the nominal exchange rate caused by a shock in financial markets causes a change in real exchange rate. The shock to financial markets can come from a source with no relation to the determinants of purchasing power. Our finding is, therefore, more evidence against a rigid interpretation of purchasing power parity.

A directly related macroeconomic implication concerns the inflationary effect of exchange rate fluctuation. Devaluation is believed to cause domestic inflation especially strongly in small open economies. If the pass-through is less than one and it is because of imperfect competition, we expect that the inflationary effect of depreciation is smaller in an economy with more concentrated industries. Rodrik argues that smaller economies are more concentrated¹⁸. In that case, the inflationary effect of depreciation is smaller in smaller economies.

A generic lesson of the paper lies in the usefulness of international data. The data

¹⁸Table 12 is cited from his work.

from different countries is useful because different characteristics and situations of various countries allow us more diverse experiments. This paper is an example that illustrates the usefulness of such an experiment. In terms of the price dynamics in open economy macroeconomics, a data set which allows one to inspect short-run dynamics will be complementary to this paper. An accumulation of such empirical regularities will both provide valuable information for policymakers and lay a foundation for further theoretical work.

Appendix

Data Sources

Characteristics of Market Concentration Ratio

SERIES	OBS	MEAN	STD ERROR	MINIMUM	MAXIMUM
CR3	29	0.60453	0.15457	0.22899	0.87731

Materials Price

WPI of raw materials(OECD): Germany, Japan, USA, UK

PPI of manufacturing(OECD): Canada

PPI of intermediate goods(IMF): France

WPI of all commodities(IMF)

WPI of food(IMF)

WPI of metals(IMF)

Unit Labor Cost

index of relative unit labor cost(IMF): Canada, Germany, Japan, UK, USA

index of manufacturing unit labor cost(OECD): Canada, Germany, Japan, UK, USA

index of aggregate unit labor cost(OECD): France

Table 2.6: mnemonics of industry classification

311	foods
321	textile products
3211	processed yarns & threads
3212	textile fabrics
322	leathers & furs
3401	pulp & paper
351	chemical products
3511	organic chemicals
3512	dyestuffs & pigments
3513	other chemical products
352	petroleum & coal products
362	other nonmetallic mineral products
371	iron, steel & related primary products
3711	iron & steel
3712	steel rolling mill products
3713	other primary iron & steel products
372	nonferrous metals & related primary products
381	metal products
382	general machinery
3821	metal working machinery
3822	special industrial machinery
3823	office machines
3824	other general machinery
383	electrical & electronic appliances
3831	industrial electrical apparatus
3832	sound, image & communication equipment apparatus
3833	electronic components
384	transportation equipment
385	precision instruments

Table 2.7: conversion to SITC

industry	SITC
311	01, 06, 08,09, 22
321	65
3211	651
3212	652-657
322	61
3401	251, 64
351	51-53, 55-56
3511	512
3512	53
3513	55, 561
352	32-34
362	662-663
371	67
3711	671-672, 282
3712	673-677
3713	678, 6731(67311-67315)
372	68
381	692, 698
382	71
3821	715
3822	717, 718
3823	714
3824	711, 712, 719
383	72
3831	722, 723
3832	724, 725, 726
3833	77220, 77230, 77630, 77640, 77681, 77689, 71610, 71621
384	73
385	86

Table 2.8: pass-through coefficients and concentration ratio

industry	pass-through		concentration CR3
	nominal	relative	
311	-0.356	-0.044	0.657
321	0.727	0.874	0.474
3211	0.555	0.859	0.587
3212	0.897	0.915	0.360
322	1.118	0.852	0.229
3401	0.317	0.015	0.628
351	0.532	0.773	0.755
3511	0.565	0.782	0.762
3512	-0.013	0.651	0.621
3513	0.876	0.887	0.692
352	0.900	2.111	0.607
362	0.635	0.868	0.766
371	0.294	0.176	0.735
3711	0.325	0.246	0.841
3712	0.278	0.191	0.665
3713	0.500	0.361	0.676
372	0.291	0.410	0.877
381	0.690	0.842	0.382
382	0.704	0.719	0.534
3821	0.764	0.704	0.346
3822	0.543	0.814	0.426
3823	0.377	0.968	0.792
3824	1.044	0.406	0.573
383	0.383	0.403	0.543
3831	0.642	0.497	0.555
3832	0.359	0.776	0.644
3833	0.356	0.074	0.596
384	0.53	1.115	0.525
385	0.687	0.503	0.684

Table 2.9: AR for residuals: nominal prices

residual	AR1 coefficient (sum of AR2 coefficient)	standard deviation for coefficient
U3	0.874	0.110
(AR2)	0.796	0.110
U311	0.657	0.137
U321	0.663	0.134
U3211	0.746	0.145
U3212	0.500	0.149
U322	0.640	0.131
U3401	0.773	0.115
U351	0.854	0.099
(AR2)	0.751	0.091
U3511	0.865	0.096
(AR2)	0.757	0.084
U3512	0.502	0.151
U3513	0.416	0.156
U352	0.767	0.139
U362	0.747	0.118
U371	0.695	0.140
U3711	0.728	0.125
U3712	0.740	0.131
U3713	0.352	0.170
U372	0.487	0.154
U381	0.651	0.136
U382	0.767	0.128
U3821	0.669	0.122
U3822	0.593	0.137
U3823	0.413	0.165
U3824	0.778	0.129
U383	0.819	0.120
(AR2)	0.731	0.125
U3831	0.650	0.152
U3832	0.478	0.160
U3833	0.885	0.104
(AR2)	0.771	0.095
U384	0.555	0.181
U385	0.749	0.129

Table 2.10: Cointegration Test: nominal prices

residual	lags	coeff.	s.d.	t value
U3	8	-1.260	0.256	-4.909
U311	1	-0.389	0.160	-2.421
U321	4	-0.577	0.168	-3.415
U3211	8	-1.513	0.406	-3.721
U3212	5	-0.735	0.223	-3.296
U322	4	-0.549	0.176	-3.106
U3401	4	-0.541	0.159	-3.388
U351	4	-0.533	0.154	-3.462
U3511	5	-0.655	0.169	-3.878
U3512	1	-0.636	0.150	-4.236
U3513	1	-0.697	0.192	-3.629
U352	4	-0.541	0.151	-3.569
U362	1	-0.316	0.121	-2.603
U371	4	-0.613	0.175	-3.491
U3711	7	-0.585	0.180	-3.238
U3712	2	-0.490	0.132	-3.693
U3713	1	-0.641	0.209	-3.068
U372	5	-0.915	0.213	-4.293
U381	6	-0.524	0.183	-2.863
U382	1	-0.352	0.131	-2.686
U3821	1	-0.296	0.148	-1.991
U3822	1	-0.527	0.144	-3.664
U3823	1	-0.890	0.171	-5.207
U3824	4	-0.515	0.153	-3.361
U383	5	-0.762	0.208	-3.658
U3831	8	-1.073	0.378	-2.837
U3831	1	-0.396	0.179	-2.208
U3832	1	-0.679	0.179	-3.785
U3833	8	-1.425	0.261	-5.442
U384	1	-0.633	0.214	-2.959
U385	2	-0.521	0.138	-3.762

Table 2.11: critical values for cointegration test from Engel and Yoo

sample size	AR in residual	significance level		
		1%	5%	10%
50	none	5.41	4.76	4.42
50	first order(0.8)	4.80	4.15	3.85

Number of variables is five.

Table 2.12: four-firm concentration ratios in industry

country	year	unweighted average of four-firm concentration ratios	number of industries
Brazil	1972	0.72	68
Chile	1979	0.50	41
India	1968	0.55	22
Mexico	1972	0.73	73
Pakistan	1968	0.66	51
Turkey	1976	0.67	125
U.S.	1972	0.40	323
France	1969	0.28	48

Table 5.1 in "Imperfect Competition in Developing Countries" by Dani Rodrik

FIG. 1: nominal pass-through

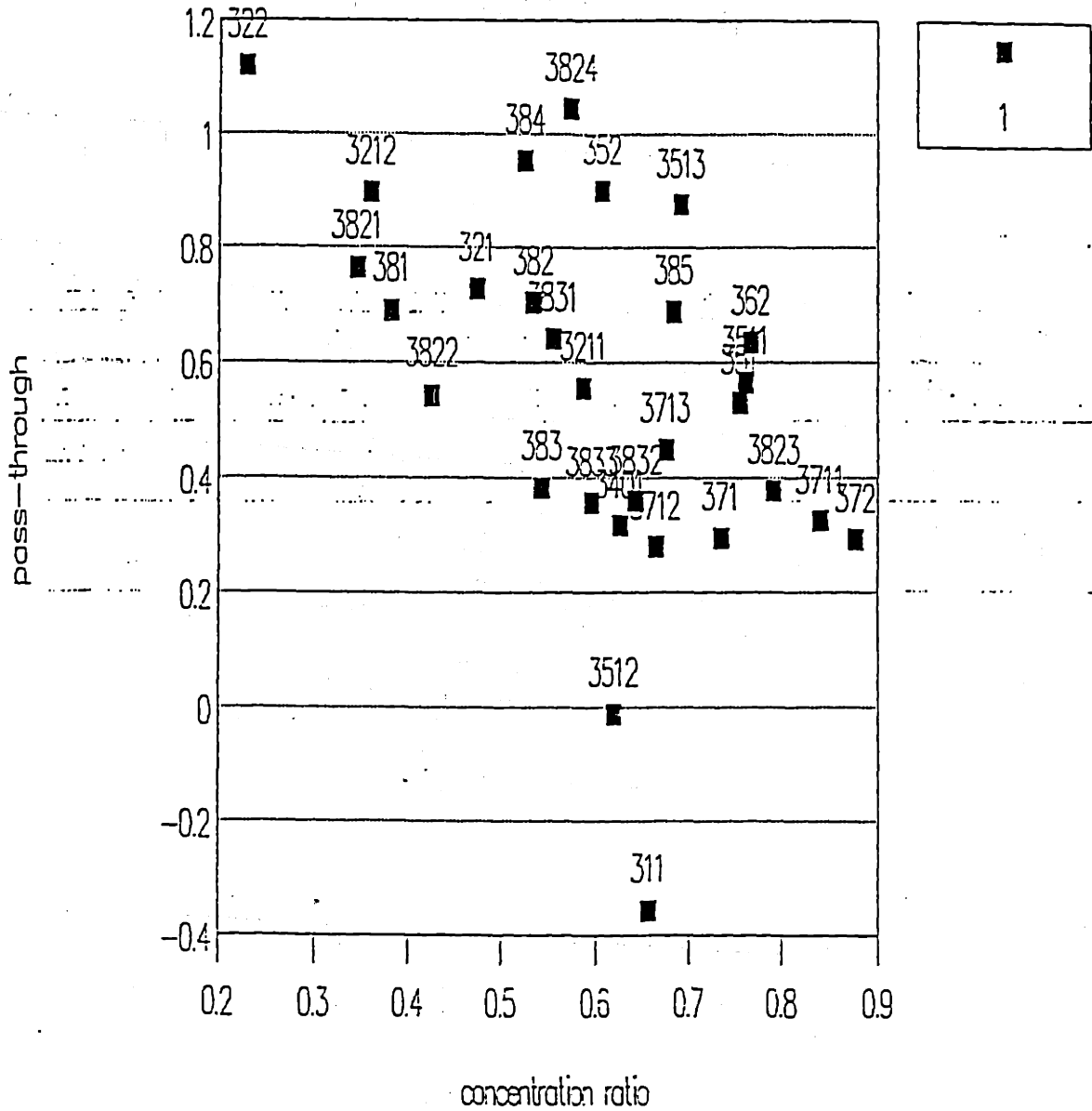


FIG. 2: nominal pass-through
time as a RHS variable

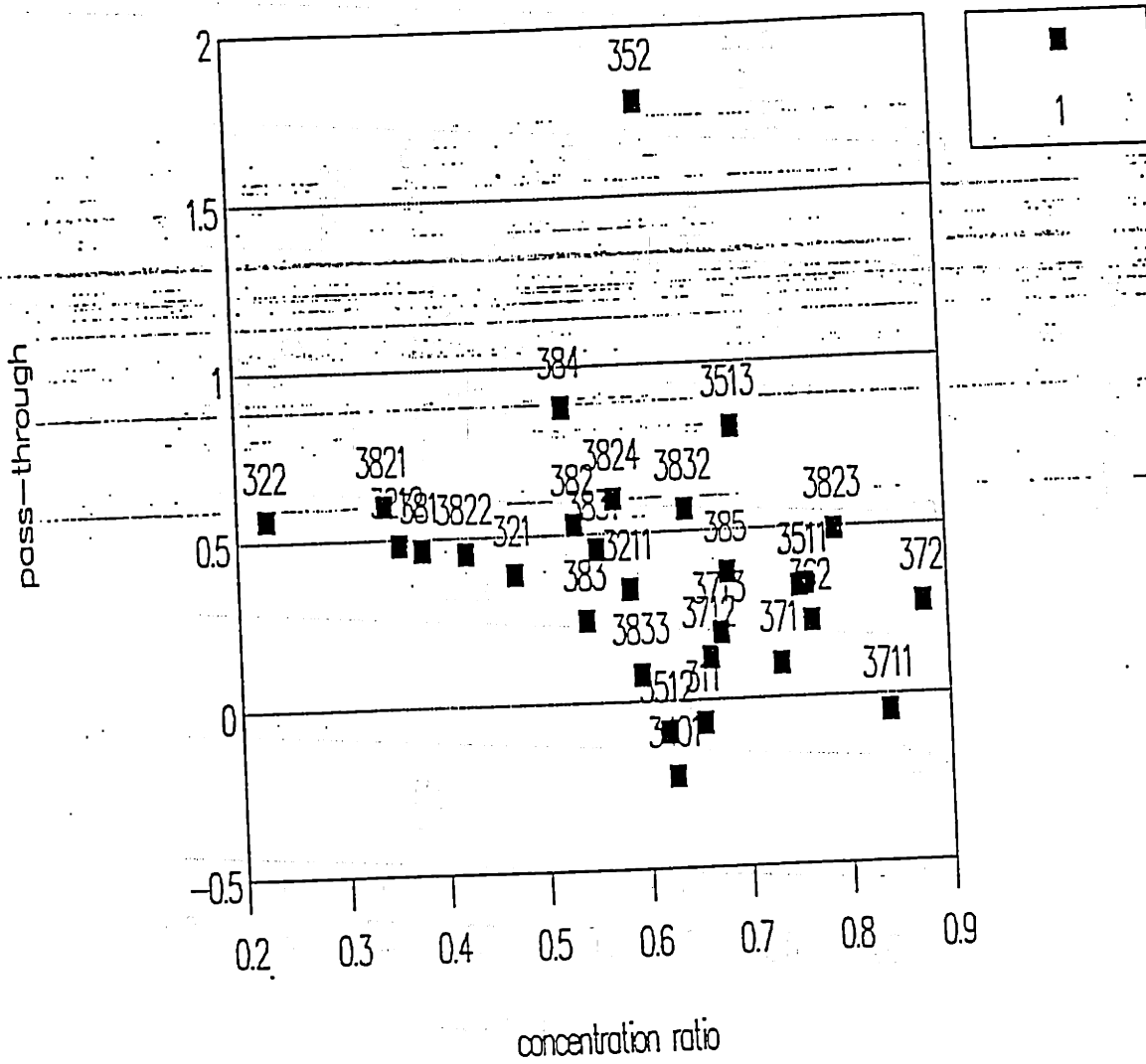


FIG. 3: nominal pass-through

weights based on U.N. statistics

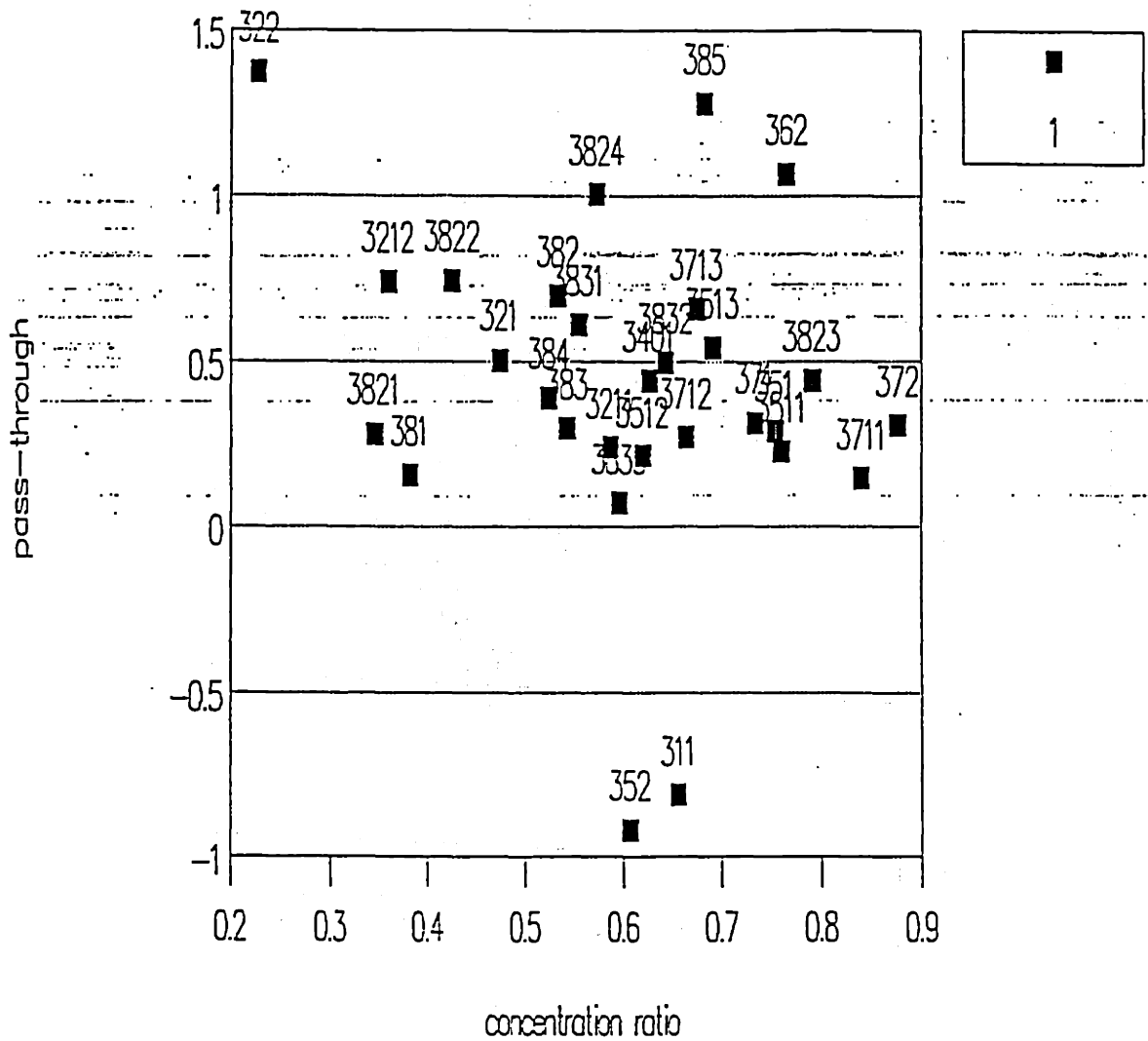


FIG. 4: real pass-through

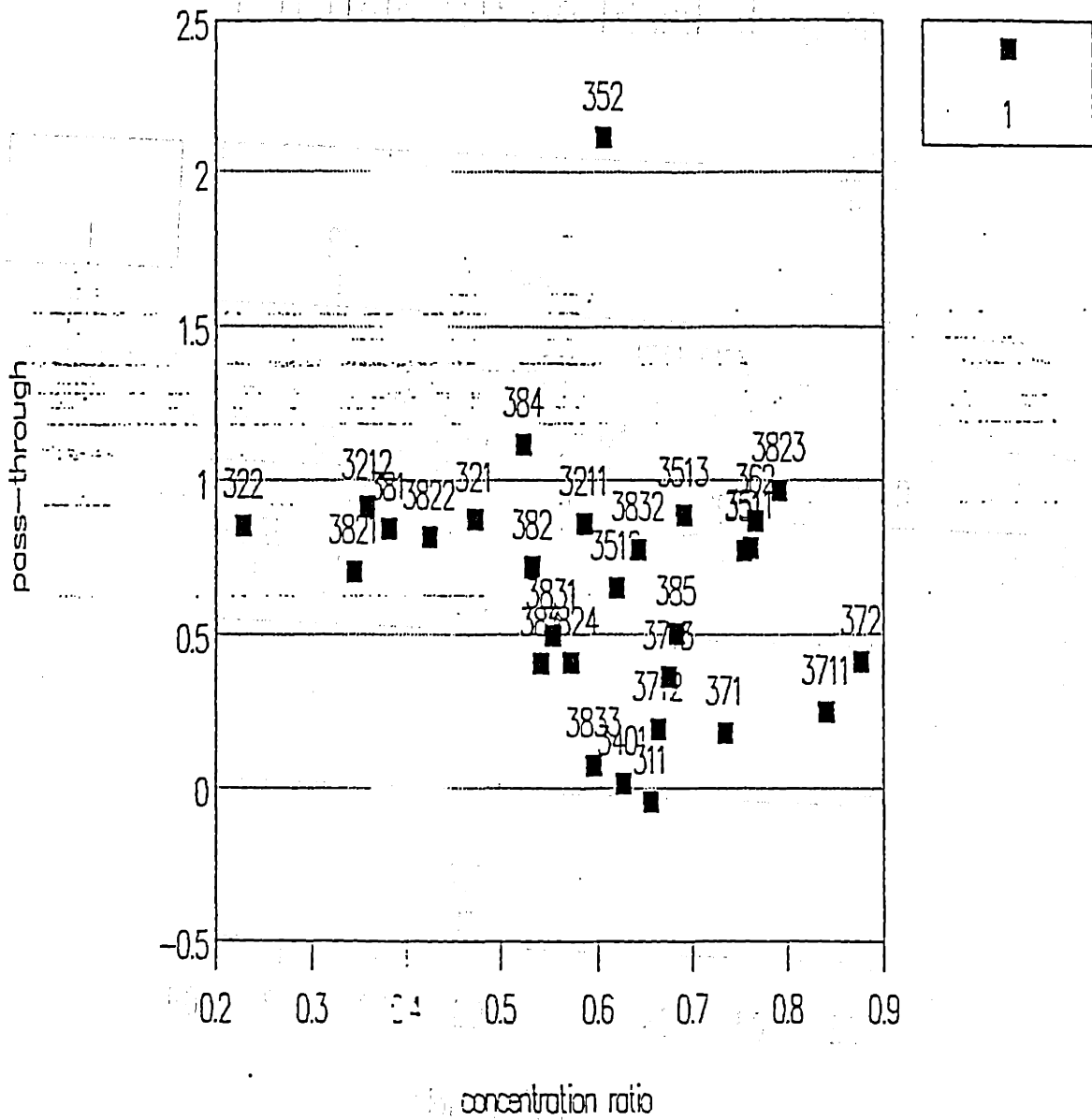


FIG. 4A: real pass-through
 subsample excluding 352

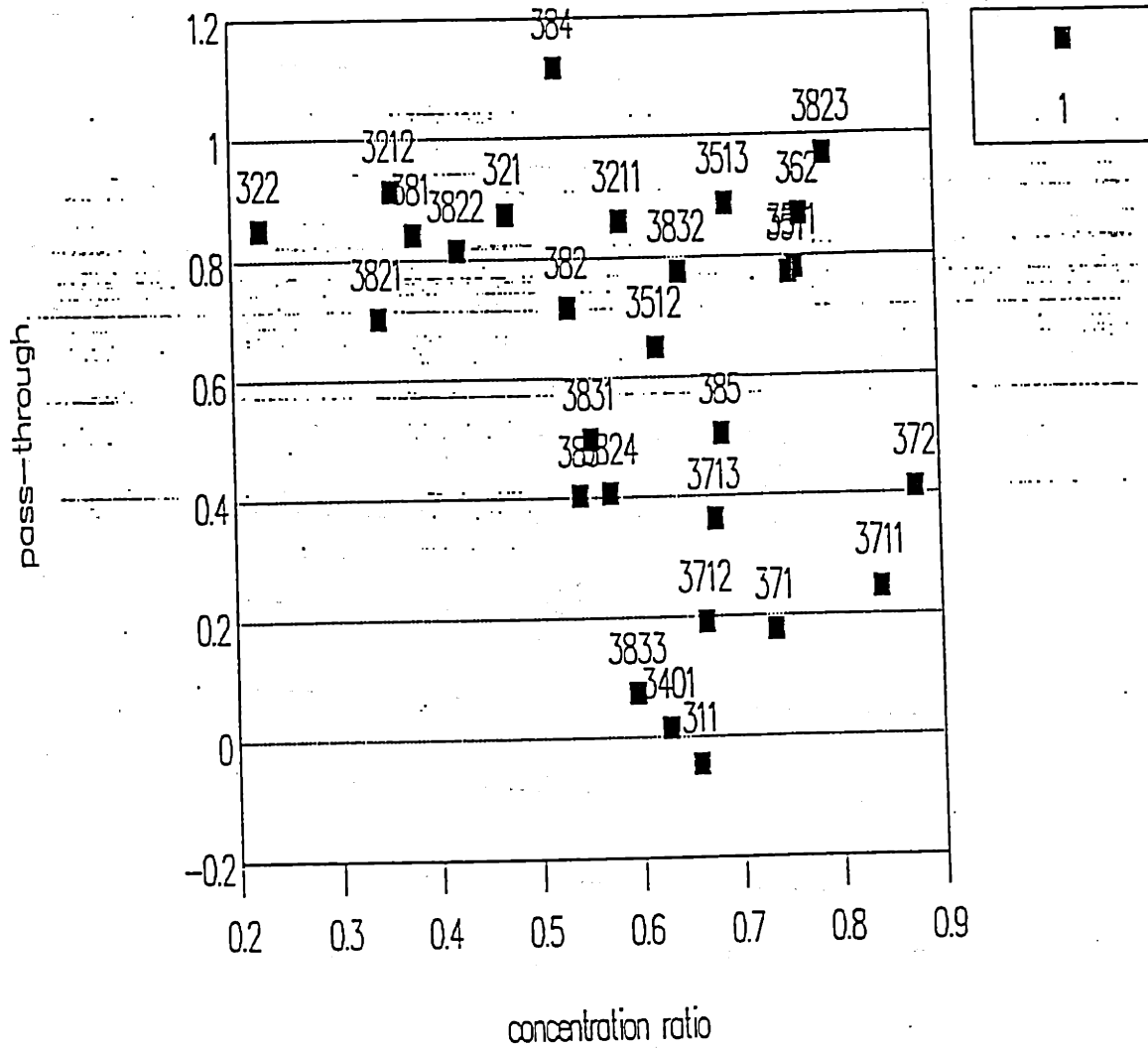
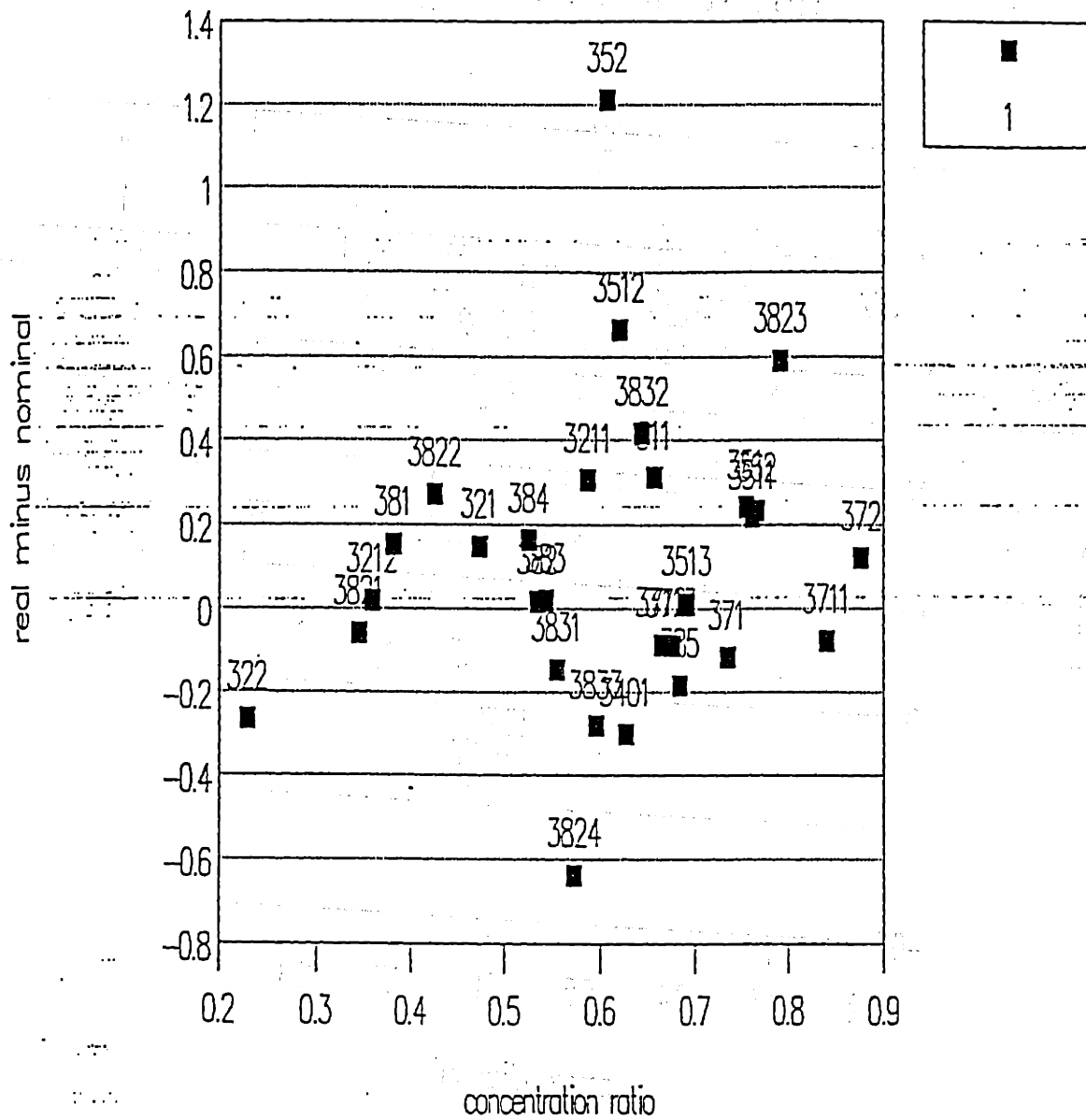


FIG. 5: nominal vs. real pass-through



Chapter 3

Pricing to Market

3.1 Introduction

A firm operating in international markets is subject to the shocks in the nominal and the real exchange rates. In addition to the risks posed by the surprises in the nominal exchange rate, the shift in the real exchange rate confronts a firm operating in international markets with different market situations in domestic and foreign markets. When the home currency appreciates, for example, the international firm is put at a cost disadvantage relative to its competitors in the export market, while it is at the same cost condition relative to its competitors in the domestic market. Faced with different cost conditions relative to its competitors in domestic and foreign markets, the firm finds it optimal to discriminate prices between the two markets.

Under the perfect competition, because there is no asymmetry in the response of relative cost conditions, the shift in the real exchange rate causes no change in the ratio between the domestic and the export prices denominated in domestic currency

unit. When the market is imperfectly competitive, the shift in the real exchange rate produces the change in the ratio between the domestic and the export prices. This effect arises as the result of the optimal response of a firm operating in both the domestic and the foreign markets.

This price discrimination resulting from the real exchange rate change is named as pricing to market effect in international economics.¹ This term emphasizes the price discriminating aspect of international pricing. If one looks only at the export price and the real exchange rate, without caring about the domestic price, the question is posed as the elasticity of the export price with respect to the real exchange rate. The firms do not reflect the exchange rate change completely into their export price when the market is imperfectly competitive. The term pass-through is used to refer to the degree by which the exchange rate change is reflected in the export price. In this paper, the pricing behavior of international firms is studied by the prism of pricing to market rather than by the prism of pass-through.

The pricing to market effect is a building block of the adjustment mechanism of the trade balance in response to the movement in the real exchange rate. The role of the real exchange rate in the adjustment of the trade balance has always been an important question in international economics. In the 1980's, it was one of big questions in international economics whether the real exchange rate adjustment is necessary for the adjustment of the U.S. trade balance. Apparent insensitivity of trade balance figures to the real exchange rate raised doubt on the role of the real exchange rate in the adjustment of trade balance. The inquiry into the cause of the apparent insensitivity started the research of the pass-through relation.

The real exchange rate is also closely related to competitiveness. The issue of competitiveness is all the more important for small developing countries relying heavily on international trade. Because the international trade is much more significant in small

¹Krugman(1987)

countries than in the country like the U.S., the role of the real exchange rate extends beyond the adjustment mechanism of trade balance and reaches the implication on long-term growth performance of the economy.

Pricing to market effect is important in itself as a discussion of the effect of the real exchange rate on international pricing. Export price of one country is the import price of the other country. In the viewpoint of importing country, pricing of foreign exporting firms has an implication on the link between the exchange rate and inflation. If all foreign exporting firms engage in pricing to market and absorb a substantial fraction of the exchange rate change in their profit margins, the depreciation of the currency of the importing country has smaller effect on domestic inflation than it would have if the foreign exporting firms did not discriminate prices in different markets.

The possibility of pricing to market was proved theoretically in a number of papers. Empirically, Marston(1990a) verifies the effect in Japanese export prices. In the international economic scene, however, Japan is a fairly large country which obviously commands a substantial market power in its export market. For example, the market power of Japanese firms in the automobile market of the U.S. is domineering. This paper, using Korean industry data, investigates the pricing to market effect of a small country which is not so prominent as Japan in the international economic scene. A work dealing directly with the case of a small country is worthwhile not only because it is a slightly different type of pricing to market but also because it is in the case of small countries that more concern is directed to the real exchange rate, trade balance, and competitiveness.

The third country effect is a question which arises uniquely in the case of a small country, because the dominant third country has a significant market power while the small country has virtually no control over its own export price. It is possible that the export price responds more sensitively to the exchange rate of the dominant third country than to the exchange rate of its own currency.

I propose a simple model that captures the pricing to market effect of a firm in a small country which is an oligopolistic firm in the domestic market but is almost a price taker in the foreign market. The prediction of the model is then tested using the export and the domestic price data of Korea. In the process, the possibility of lagged effect is also investigated. The lag structure is interesting considering the attention given to the slow response of the U.S. trade balance to the real exchange rate. But the lag structure is more important for small developing countries because the slow adjustment of trade balance can require that additional attention be paid to short-run financing problem even when the real exchange rate realignment (depreciation, devaluation) can be expected to restore trade balance equilibrium after sufficiently long lags. Finally, the third country effect is investigated with respect to the Japan-U.S. exchange rate for the six industries whose primary export destination is the U.S.

The pricing to market effect is found to be prominent in the sixteen export industries of Korea. This implies that pricing to market is significant also in small countries such as Korea. The pricing to market effect is found to be bigger in the industries being exported into the U.S. than in the industries being exported into other countries. This finding conforms to one implication of the model: the pricing to market effect is not only significant in small countries but is bigger for the industries in whose export market the small country exporters in fact have weak market power. As for the speed, the effect appears to occur fast, typically within a quarter, and there is little evidence for the additional lagged effects. According to this result, most of the effect of pricing to market is realized fast, whether the pricing to market is conducive to the specific desiderata of the time or not. Contrary to the prior conjecture, there is no evidence of the third country effect relative to Japan, in the industries which are exported primarily into the U.S.. The third country effect in this paper, however, is in a very specific sense of pricing to market, and the appropriate interpretation is discussed in the relevant section.

3.2 Model

The market situation for the exporting firms in many small countries, and especially in Korea, is slightly different from that in large countries such as Japan or Germany. The domestic market in small countries is characterized by a high degree of market concentration which is caused not only by the restrictions on import but also by the fact that the market is not large enough to 0 many producers. On the other hand, the important export market of small countries is quite often large countries like the U.S. or Germany, where the market power of the exporter from small countries is much more limited than its market power in its own domestic market. In this case, pricing to market 0 primarily due to the asymmetry in the market situation between the domestic market and the foreign market.

I set up a simple model of an exporting firm in a small country which operates in an oligopolistic market in the home market, but has limited market power in the foreign market. The limited market power in the foreign market can arise either because the world market is perfectly competitive or because there are foreign firms exercising strong market power forcing the firm from small 1 to acquiesce in their lead. For the purpose of illustration, the model deals with the case when the international market is closer to perfect competition than the domestic market. The alternative interpretation for the lack of market power of the domestic firm is no less plausible.

There are two firms in the domestic market. One firm sells only in the domestic market and the other sells both in the domestic market and foreign market. In foreign market, there are N foreign firms. There are no foreign exporters into the domestic

market.² The demand in the domestic market is:

$$p = a - bq$$

The demand in the foreign market is:

$$p = A - Bq^*$$

The domestic firm selling in both markets sells q_1 in home market and sells q_1^* in foreign market. The domestic firm selling only in home market sells q_2 . Each foreign firm sells q_2^* supplying Nq_2^* in total. Thus, the supply in the domestic market is $q_1 + q_2$ and the supply in the foreign market is $q_1^* + Nq_2^*$. All the firms incur constant marginal cost: w for domestic firms and w^* for foreign firms.

The objective of the firms are as follows. E is the foreign currency per unit of the domestic currency. The domestic firm selling in both the domestic market and the foreign market maximizes:

$$\max_{q_1, q_1^*} q_1(a - b(q_1 + q_2)) + q_1^* \frac{1}{E} (A - B(q_1^* + Nq_2^*)) - w(q_1 + q_1^*)$$

The domestic firm selling only in the domestic market maximizes:

$$\max_{q_2} q_2(a - b(q_1 + q_2)) - wq_2$$

A foreign firm maximizes:

$$\max_{q_2^*} q_2^* (A - B(q_1^* + (N - 1)q_2^* + q_2^*)) - w^*q_2^*$$

²This assumption is primarily for simplicity. In addition, the industries to be investigated in this paper import little foreign products. In most of the sixteen industries, the imports were not allowed for the sample period. Major import liberalization in these industries are very recent. Import restrictions in these industries create the image of Korea as a highly closed economy, while aggregate import volume is substantial because of the imports in the industries studied in Chapter 2.

The first order conditions are as follows. For the domestic firm selling both in the domestic market and in the foreign market,

$$a - b(q_1 + q_2) - bq_1 = w$$

$$A - B(q_1^* + Nq_2^*) - Bq_1^* = wE$$

For the domestic firm selling only in the domestic market,

$$a - b(q_1 + q_2) - bq_2 = w$$

For a foreign firm,

$$A - B(q_1^* + Nq_2^*) - Bq_2^* = w^*$$

The symmetry among foreign firms was imposed.

Equilibrium price in the home market is

$$p = \frac{a + 2w}{3}.$$

Equilibrium price in the foreign market is

$$p^* = \frac{A + wE + Nw^*}{N + 2}.$$

The extent of pricing to market is summarized by the ratio of the export price to the domestic price.³ The export price is denominated in domestic currency unit as p^*/E .

The price ratio between the export price and the domestic price is given:

$$X = \frac{p^*}{Ep}.$$

$$X = \frac{3(A + Nw^*)}{E(a + 2w)(N + 2)} + \frac{3w}{(a + 2w)(N + 2)}. \quad (3.1)$$

³Marston(1990a) proposed this measure originally.

The elasticity of the price ratio with respect to the exchange rate is negative.

$$\frac{\partial X}{\partial E} \frac{E}{X} = \left(-X + \frac{3w}{(a+2w)(N+2)} \right) \frac{1}{X} = -1 + \frac{9w(A+wE+Nw^*)}{E(a+2w)^2(N+2)^2}$$

$$-1 < \frac{\partial X}{\partial E} \frac{E}{X} < 0$$

There is no pricing to market, when the elasticity $\frac{\partial X}{\partial E} \frac{E}{X}$ is equal to 0. It is possible if the exporter is a price taker in both the foreign market and the domestic market. In the context of this model, it is when both the number of home firms and the number of foreign firms get sufficiently large, although the number of firms selling in the domestic market is not endogenized in this model.⁴

As N gets large, $\frac{\partial X}{\partial E} \frac{E}{X}$ approaches -1. This is the case when domestic firm has no market power in the foreign market and behaves as a price taker in the foreign market. As N decreases, $|\frac{\partial X}{\partial E} \frac{E}{X}|$ decreases.⁵ Note that an extreme pricing to market is possible when the exporter is a price taker in the export market and a price setter in the domestic market. In this case, however, the exporting firm is not actively discriminating prices between the export market and the domestic market. Instead, the exporting firm is relying on the market power in the domestic market to preserve profit in the face of adverse pricing situations in the export market. It is observed as the price differential.

The price differential comes not so much from the exploitation of the market power in the foreign market as from the asymmetry in the market situation between the home and the foreign market. The monopolistic decision of a firm plays a much smaller

⁴Foreign exporters into the domestic market need to be introduced, resulting in trade in both directions. There is no pricing to market when the world market is completely integrated and is in perfect competition.

⁵The bounds of -1 and 0 are the result of linear demand. If one considers non-linear demand, the boundaries can move (for examples, Dornbusch(1987)). This is not formalized in this paper. Nevertheless, 0 represents no pricing to market, and the pricing to market gets severer as the asymmetry between the two markets gets deeper.

role. This is a more appropriate interpretation of the pricing to market behavior of firms from small countries like Korea, while the case with the explicit oligopolistic pricing decision in the foreign market is a more appropriate interpretation of the pricing to market behavior of firms from a large economy like Japan or Germany. For the exports into the U.S., this certainly is the descriptions of the exporting firms from small countries. On the other hand, Korea might be a big hand in some export markets. In export markets to the small developing countries, Korea might be a big firm in the marketplace. This contrast offers one potential experiment. The degree of pricing to market by Korean firms can be bigger in the industries exported into the U.S. than in the industries exported into small countries. In the model, one can contrast the case with $N = \infty$ and the case with $N = 2$. The absolute value of the pricing to market elasticity is bigger when $N = \infty$.

Looking at the equation (3.1), the variables that shift the demand and supply curves in the home and the domestic market affect the elasticity $\frac{\partial X}{\partial E} \frac{E}{X}$. These are represented by A, a in demand and w, w^* in supply. The presence of the other independent variables contradict Marston(1990b)'s claim that the ratio between the domestic price and the export price is a sufficient statistic for the pricing to market effect. Marston(1990b) notes that the domestic firm bases both its decision for the domestic sales and its decision for the foreign market on the same cost function. The repercussion of the real exchange rate change on the cost conditions is thus argued not to affect the degree of price discrimination. This is not completely true. The question is whether the repercussion from the real exchange rate affects the relative cost condition in the domestic and the foreign market differentially or not. As such, it can be settled only by an empirical investigation.

Finally, the third country effect can be explained by the above model, too. One of the interesting questions in international trade in an imperfectly competitive market is that of the third country effect. If the exchange rates of all the competing countries appreciate, and if the export prices of those countries rise, the domestic exporter can

also ride the tide and increase its export price keeping its own profit or even still having a larger profit. As a special case, if there is a dominating competitor, the appreciation in its exchange rate followed by the increase in its export price can provide a good opportunity to increase the export price of domestic exporter. It is possible that the export price, in the currency unit of the export market, does not change in response to the change in its own exchange rate, but does change in response to the change in the dominant country's exchange rate.

In terms of the model in this paper, the exchange rate of the dominant country can be interpreted as a cost shifter of some foreign firms. Without actually writing down the algebra, the implication is clear. If the real exchange rate of the dominant country appreciates, some of the foreign firms suffer from cost increase and the new equilibrium price tends to increase. If the exporter of a small country is a complete price taker, its export price increases in both the currency unit of the export market and the currency unit of its home market. As the result, there is an increase in the price ratio between the export price and domestic price of the small country. While the conventional pricing to market occurs because the export price in foreign currency unit does not change enough in response to the change in the exchange rate of the home currency, the pricing to market induced by the third country occurs because the export price in foreign currency unit changes without a change in the θ rate of the home currency.

I set out four implications of the model: pricing to market effect as a negative coefficient, bigger pricing to market in the industries being exported into the bigger market, insufficiency of the simple elasticity calculation, and the third country effect. These implications will be investigated in turn.

3.3 Specification and Data

Linearization of the equation (3.1) by Taylor expansion leads to the following specification.⁶

$$\Delta x_t = C + a\Delta e_t + b\Delta w_t + c\Delta w_t^* \quad (3.2)$$

Korean real wage is used to take care of the independent determinants of pricing to market in Korean market. Foreign real wage is used to care of the independent determinants of pricing to market in foreign markets. In countries for which wages are not available, the wholesale price is substituted for the wage. All the variables are included in log, denoted by a lower-case letter. All the variables are relative prices, acquired by dividing the nominal indexes by the consumer price index of each country.

Wages, exchange rates, and various aggregate price indexes come from the International Financial Statistics. The export price indexes of sixteen Korean industries are from the Bank of Korea. The indexes are the Laspeyres price indexes using the fixed weight of the export of 1985. Each index is investigated with respect to the specific trading partners, in dollar units. The industries are listed in Table 3.1 with specific trading partners specified. For industries with † in front, however, the countries listed are selected by the author as the biggest trading partners in the region that are designated by the original data. The domestic prices are domestic wholesale price indexes also from the Bank of Korea.⁷ The domestic wholesale price is preferable to

⁶An alternative route to this specification starts with the linear representation of the equation(3.1).

$$x_t = C + ae_t + bw_t + cw_t^*$$

Then, based on the existence of unit root in each of these variables, first differenced equation is estimated. This leads us to the specification of equation (3.2). The difference lies in the interpretation of the estimated coefficient of equation (3.2) in terms of the persistence of the effect. It is clearer to think about the persistence of the effect when the specification is acquired by the unit root approach. Nevertheless, this approach is not explicitly adopted because the unit root representation of relative prices is not indisputably adopted in international economics. It is far beyond the scope of this paper to settle this dispute.

⁷Because the survey baskets of the domestic wholesale price index would have been different from the survey baskets of export price, there are some data flaws.

Table 3.1: trading partner for the export price index

canvas sports shoes	U.S.
wire rope	U.S.
color TV	U.S.
tape recorder	U.S.
passenger car	U.S., Canada
toy	U.S.
pure silk fabric	Japan
cold-rolled sheet	Japan, U.S.
† polyester fabric	Thailand, Singapore
† PVC resin	Malaysia, Singapore, Indonesia
passenger car tire	U.S., Saudi A.
† glass tableware	Philippines, Malaysia, Thailand, Nigeria
† black and white TV receiver	U.S., Germany, Netherlands, United Kingdom
electric refrigerator	U.S., Canada, HongKong
† transistor	Philippines, Singapore
† I.C.	Philippines, Malaysia, Singapore

the retail price for the purpose of this paper because the retail price already contains large local content due to the service in the distribution stage. The industries covered do not belong to a specific sector of manufacturing but belong to a broad spectrum of manufacturing industries.

Because export price index is dollar based index, Won based index was constructed by using the dollar-to-Won exchange rate. Won based index is necessary in considering the industries whose primary trading partners are other countries than the U.S.. Finally, according to the trading partners corresponding to the price index of each commodity, effective exchange rate was created appropriately. The specific trading volumes were based on the Korea Trade Annual 1985. All the exchange rates are represented as the amount of foreign currencies available per unit of Korean currency. As the result, the increase in the algebraic value of the exchange rate is appreciation of the Korean currency.

The sample period is from the first quarter of 1980 to the fourth quarter of 1990.

3.4 Evidence of Pricing to Market

The price ratio and the real exchange rate are plotted in Fig. 1A and Fig. 1B. The real exchange rate is the foreign currencies available per unit of domestic currency, its decrease is depreciation of home currency. For example, in canvas sport shoes exported to the U.S., the real exchange rate depreciates during the period 1980 to 1986. During the same time period, the price ratio in the canvas sport shoes has increased. If the export price in the U.S. market is unchanged in dollar unit, the export price in Korean domestic currency is higher. The graphs in Fig. 1A suggest the pricing to market effect, while the graphs in Fig. 1B provide less hope.

3.4.1 Short-Run Effect

The following equation is estimated to get the short-run elasticities as discussed in equation (3.2).

$$\Delta x_t = C + a\Delta e_t + b\Delta w_t + c\Delta w_t^* + \epsilon_t$$

The result of estimation is reported in Table 3.2. In most of the industries, the conventional pricing to market effect is discovered. The coefficient on the real exchange rate is negative and significantly different from 0 in all the six industries exported into the U.S.. Among the other ten industries exported to more diverse destinations, six industries yield negative and statistically significant coefficient, two industries yield negative but statistically insignificant coefficient, and two industries yield positive coefficient. The degree of pricing to market in the industries with negative coefficient is substantial. In the case of color TV, the price charged on the export price into the U.S. is decreased by 50% relative to the change in the domestic price in Korean market. The overall evidence supports the existence of pricing to market. The coefficients for the other variables are not statistically significant. The insignificance of the coefficients on the other variables lends support to the claim that the incentive for

pricing to market is not very sensitive to the variables other than the real exchange rate.

The model in section 3.2 implies that the elasticity is bigger for the industry in which the domestic firm is more of a price taker in the foreign market. A point to note is that the elasticities are bigger for the commodities exported into the U.S. than for the commodities exported to other destinations. As far as Korean color TV producer has a much weaker market power in the color TV market of the U.S. than in glass tableware market in Nigeria, the result also conforms with the prediction of the model. This observed difference between the pricing to market effect in the exports into the U.S. and the pricing to market effect in the exports into the other countries is evidence for the peculiarity of the pricing to market effect of a small country.

Although the evidence of the pricing to market is evident, the anomalies of the positive coefficients are worthy of some speculations. The positive coefficient is conceptually possible if the demand function is non-linear allowing a much bigger zone of demand elasticities. If the demand for the firm in the foreign market is very inelastic, the firm can decide to shrink the export volume a little and charge a much higher price as the result of the real exchange appreciation. This is more plausible when the exporting firm is more of a price-setter in the foreign market, unlike the model of section 3.2. Two industries with positive coefficient are cold-rolled sheet, exported to Japan, and PVC resin, exported to Malaysia, Singapore, and Indonesia. It is more plausible to conceive of Korean exporter exercising market power in the PVC resin market in Malaysia than to conceive of Korean exporter exercising market power in Japan. The alternative explanation is required for the positive coefficient on the real exchange rate in the export of cold-rolled sheet to Japan. It seems necessary to investigate industry-specific shocks independent of the real exchange rate, but the issue is not pursued any more.

Table 3.2: short-run elasticities

industry	e	wk	wf	R^2 , D.W.
canvas sports shoes	-0.88 (0.37)	0.25 (0.13)	-0.23 (0.23)	0.17, 1.74
wire rope	-0.38 (0.21)	0.10 (0.08)	0.16 (0.13)	0.14, 1.86
color TV	-0.53 (0.21)	-0.08 (0.08)	0.29 (0.13)	0.29, 1.88
tape recorder	-0.63 (0.20)	-0.07 (0.07)	0.08 (0.13)	0.27, 1.15
passenger car	-0.64 (0.13)	0.02 (0.05)	-0.12 (0.08)	0.39, 1.34
toy	-0.65 (0.17)	0.01 (0.06)	-0.01 (0.10)	0.29, 2.20
pure silk fabric	-0.01 (0.13)	0.15 (0.12)	0.43 (0.27)	0.12, 1.68
cold-rolled sheet	0.76 (0.28)	0.33 (0.15)	-0.19 (0.50)	0.19, 1.97
polyester fabric	-0.34 (0.18)	-0.00 (0.07)	0.58 (0.32)	0.15, 1.53
PVC resin	0.55 (0.43)	-0.13 (0.18)	-0.13 (0.79)	0.06, 1.28
passenger car tire	-1.12 (0.24)	0.02 (0.09)	-0.12 (0.16)	0.38, 0.57
glass tableware	-0.25 (0.09)	-0.03 (0.06)	0.15 (0.27)	0.19, 1.22
black and white TV	-0.38 (0.23)	-0.00 (0.08)	0.41 (0.15)	0.24, 2.02
refrigerator	-0.42 (0.17)	-0.05 (0.06)	0.29 (0.11)	0.31, 2.21
transistor	-0.41 (0.19)	0.08 (0.09)	0.07 (0.27)	0.12, 1.60
I.C.	-0.32 (0.28)	0.07 (0.13)	-0.47 (0.55)	0.07, 2.24

3.4.2 Long-Run Effect

Is it enough to look only at a single quarter for the pricing to market effect of the real exchange rate? There might be lagged effect because of the contractual lengths. At the same time, the works on pass-through using aggregate data tend to find some lagged effects. Of course, the discovery of lagged effects does not necessarily imply the existence of lagged effects in the pricing to market effect. While the pass-through is the elasticity of the export price or the import price with respect to the real exchange rate, the pricing to market effect is the elasticity of the ratio of two prices with respect to the real exchange rate.

The following equation is estimated to acquire the long-run elasticity.

$$\Delta x_t = C + \sum_{j=0}^{j=L} a_j \Delta e_{t-j} + \sum_{j=0}^{j=L} b_j \Delta w_{t-j} + \sum_{j=0}^{j=L} c_j \Delta w_{t-j}^* + \sum_{j=1}^{j=L} d_j \Delta^2 s_{t-j} + \epsilon_t$$

The real exchange(e), Korean wage(w), and Foreign wage(w^*) are log values of the relative prices. The new variable s is the surprise in the nominal exchange rate.

$$\Delta^2 s_{t-j} = \Delta s_{t-j} - \Delta s_{t-j-1}$$

This is introduced because the surprise in the nominal exchange rate will also be considered in setting the export price in dollar, which is the denominating currency for the contracts.

Given the fact that the longest lags identified in the previous works is eight quarters⁸, I first run the regression with $L = 8$. There is no convincing evidence for the existence of pricing to market effect after two years. The long-run elasticities in Table 3.4 are the sum of all the current and lagged response to the change in the real exchange rate. For example, the coefficient of -1.03 of passenger car implies that

⁸Hooper and Mann

the ratio between export price and domestic price of passenger car has decreased by 100% for the eight quarters. The standard error of 0.83, however, makes this interpretation statistically inappropriate. It is more appropriate to conclude that there is little effect on the price ratio after eight quarters. The coefficient on the real exchange rate exhibits a negative coefficient in five out of six industries exported into the U.S. and in six out of the other ten industries. All the industries show the long-run elasticity different from 0, but with standard error so large as not to reject the hypothesis that the long-run elasticity is zero. The large standard error of the estimate leads one to conclude that the pricing to market effect is not likely to be conspicuous after two years.

A natural question is if this reflects inexistence of the pricing to market effect at every point in time, or if this is the result of the initial pricing to market effect being dissipated after two years. The lagged responses of the price ratio to the real exchange rate are graphed in Fig. 2. There is a typical pattern for the lagged responses in the industries exported into the United States. In the exports to the United States, there is initially negative pricing to market effect but there is no additional effect after eight quarters. In the meantime, there is slowly decreasing effects. For the exports to other countries, the dynamic pattern of response is very diverse. Up to the data problem of different countries, the following interpretation is possible. In the case of the export to the United States, the Korean firms are very defensive about their market share, reflecting the dollar depreciation (Won appreciation) in the profit margin of their exports initially. As a result, the trade volume will be affected little. As the exchange rate appreciation is prolonged, the customer goodwill is slowly diluted, and the exporter needs to engage in additional pricing to market to compensate for the loss in the customer goodwill. But, the strategic response is not permanent, because this implies profit squeeze, which cannot go on indefinitely. In due time, the ratio of export price to domestic price and profit margin in exports is restored to the normal level, and trade volume would have adjusted, too. The graph of the lagged response of passenger car suggests that the strategic response is

dissipated after approximately five quarters. The graph of passenger car even suggests that export price is more expensive relative to the domestic price in response to the dollar depreciation after eight quarters(not the accumulated effect). It is possible if the Korean firm is selling relatively more in the domestic market than in the export market because the appreciation of Won(depreciation of dollar) made the competition in the export market tougher after it has persisted for the eight quarters. Because it is more profitable to sell more at the domestic market at a cheaper price and to sell less at the export market at a higher price than to preserve the foreign market share, the adjustment on both markets results in the price ratio between the export price and domestic price higher than pre-appreciation level.

Some unappealing responses which show positive response at the beginning with declining response over time can also be understood by the adjustments in both domestic and export market.⁹ If the initial response to the depreciation is the shrinkage in the export volume and the expansion of the domestic sales, it is possible for the price ratio to increase after the appreciation of Won(depreciation of the currency of the export market). The competitiveness in the export is regained gradually, decreasing the price ratio between the export and domestic price. This sequence is more plausible when the sales in the export market is less lucrative and less important. It seems plausible that the exporting firms will be less worried about sales of the black and white TV in Europe or about the sales of passenger car tire in Saudi Arabia than the sales of passenger car in the United States. On the other hand, it is possible to interpret this as a result of the combination of two data flaws: The poor data for foreign variables and the inappropriate choice of trade partners. For example, although the major export market of passenger car tire is Saudi Arabia, no cost variable was found for Saudi Arabia. The market situation in Saudi Arabia is not addressed. In the case of black and white TV, not only is it possible that the choice of trade partners are misleading, but is it possible that the domestic price index for TV receivers is

⁹The explanation attempted in this part of the paper tries not to rely totally on the inelastic demand attempted as an explanation for the positive coefficient in the regression without lags.

explained mostly by the price of color TV. Thus, the price ratio between export price and domestic price is inappropriate for the black and white TV. Second, the results for the other countries raise the possibility of an interesting sequence of responses. If the short-run adjustment occurs mostly in the shrinkage in export volume, it will be verified by the short-run response identical to the result suggested in the lagged regression.

At what frequency does the additional short-run pricing to market effect disappear? This is investigated for the six commodities which are exported into the United States, because the lagged responses in the other industries are not credible from the beginning. The same regression as in Table 3.4 is run varying the lags from 2 to 8.¹⁰ In five industries other than wire rope, the sign of the elasticity is negative for all lags, but the standard error gets so large as to make the estimate insignificant around four to five quarters. This conforms roughly with the finding of Athukorala of four to five quarters. Marston(1990a), on the other hand, finds that price-setting lags range from one to three months.¹¹ In light of the result of this paper, Marston's result explains why the regression without lags provides most sensible result. Although it is possible that the pricing to market effect dissipates in about a year in the industries which are exported primarily into the United States, it seems possible that most of the effect occurs in the first quarter. At least, one can say that the effect is strongest in the first quarter. And in other industries, both the result of this paper and Marston's result suggest that more relevant time horizon is a much shorter period of about a quarter. The results of the previous section and this section leads to the interim conclusion: the pricing to market effect occurs most strongly within a single quarter.

¹⁰One lag is not feasible due to the second degree PDL.

¹¹In six out of eight transport and tractor equipments, price-setting lags of one to three months are identified. In three out of nine consumer goods, lags of one to three months are identified. No lags are found in the remaining commodities.

3.4.3 A Simple Measure?

Marston(1990b) applies the simple elasticity calculation of the price ratio with respect to the real exchange rates to contrast the pricing to market behavior of the Japanese and the American firms. If this measure can be successfully applied to other countries, it will be very convenient. The approach seems justifiable in treating the elasticity without lags given that I just argued that the pricing to market effect occurs most strongly within a single quarter. Another question is whether it is also justified in treating the elasticity as depending only on the real exchange rate.

The series of X and the effective exchange rate are shown in Fig. 1, and the implied elasticities as the ratio of the slope of two curves during the depreciatory period(usually from 1980 to 1986) and the appreciatory period(usually from 1986 to 1990) are calculated in Table 3.6.

$$\frac{\log(X_{1986}) - \log(X_{1980})}{\log(E_{1986}) - \log(E_{1980})}$$

The values during depreciation are different from those during appreciation, but both are different from 0. The values for the Japan and the U.S. in are both reasonable in Marston's work. The values of this paper, however, is not very persuasive. Because the values show large divergences from the estimate in Table 3.2, it is not recommendable to base inference on the calculation of simple elasticities even if there were prolonged period of uni-directional movement of the exchange rate.

3.5 Third Country Effect

In case of Korea, Japan is a prime candidate for the dominant competitor. Korea is known to be a marginal exporter, relative to Japan, in many industries. I investigate

the possibility of the third country effect relative to Japan in the six industries which are exported into the U.S.. These industries are studied for two reasons. First, the prominence of Japan and the marginality of Korea is most conspicuous in the U.S. market. In the remaining industries, say in PVC resin exported to Malaysia, the other trading partners should first be investigated. At the same time, it is unlikely that there is such a conspicuous leader as Japan in the U.S. market if one looks at other market. Second, the regression results of the six industries exported into the U.S. are most reliable. By using the result without the third country as a frame of reference, one can get a more accurate understanding of the third country effect.

The effect can be investigated as follows.

$$\Delta x_t = C + a\Delta e_t + b\Delta e_t^* + c\Delta w_t + d\Delta w_t^* + \epsilon_t$$

The non-zero coefficient of e^* attests to the existence of the third country effect. The exchange rate between Japan and the U.S. e^* is defined as the units of Yen available per unit of dollar. With the exchange rate so defined, the coefficient b is expected to be of positive sign. The definition of the other variables is the same as in the regression for Table 3.2. The lag is not used because the results up to now suggest that pricing to market effect is most prominent in the first quarter.

The result of this regression is reported in Table 3.3. The coefficients are both small in absolute value and insignificant statistically. The small absolute value relative to the coefficient of dollar-to-Won exchange rate is not itself problematic. If the Japanese firm reflects 20% of the Japanese exchange rate appreciation in its own export price in dollar unit, and if a unit increase in the Japanese export price increases the price ratio of Korean exporters again by 20%, then the coefficient of the Japanese exchange rate in the regression is expected to be 0.04. However, the statistical insignificance works against the existence of the third country effect. At the same time, the result of regression of other variables in Table 3.3 is surprisingly identical to the result of Table 3.2.

Table 3.3: third country effect

industry	e	e*	w	w*	R ² , D.W.
canvas sports shoes	-0.88 (0.38)	-0.00 (0.02)	0.24 (0.14)	-0.26 (0.38)	0.17, 1.75
wire rope	-0.35 (0.22)	-0.009 (0.01)	0.09 (0.08)	0.03 (0.21)	0.16, 1.79
color TV	-0.56 (0.21)	-0.008 (0.01)	-0.07 (0.08)	0.40 (0.21)	0.30, 1.83
tape recorder	-0.62 (0.20)	-0.004 (0.01)	-0.07 (0.08)	0.03 (0.20)	0.27, 1.17
passenger car	-0.64 (0.13)	0.0006 (0.007)	0.02 (0.05)	-0.11 (0.13)	0.39, 1.34
toy	-0.64 (0.17)	-0.0004 (0.009)	0.01 (0.06)	-0.06 (0.17)	0.30, 2.21

In terms of the price ratio between the export price and domestic price of Korea, there is no evidence of third country effect from the Japan-U.S. real exchange rate. Even if the order of magnitude of this effect can be much smaller than that of the effect of Korea-U.S. exchange rate, the statistical insignificance implies the effect is not strong. Two interpretations are possible. First, Korean firms are not in direct competition with Japanese firms because they belong to separate market habitat. Second, Korean firms absorb all of the opportunity provided by the the appreciation of the Japanese exchange in increasing its sales because of such considerations as investment in market share. This explanation, however, is difficult to push in the period of the depreciation of the Japanese exchange rate.

3.6 Conclusion

The exporters in small countries can engage in pricing to market due to the differential market condition in home and foreign market. The pricing behavior of Korean export firms show the evidence of pricing to market, verifying the relevance of pricing to market effect for the exporting firms in small countries. The pattern is strong

especially in the export prices of the industries that export primarily into the U.S..

The effect of pricing to market occurs also quite fast within a single quarter. The pricing to market effect can be investigated effectively by focusing on a single quarter. At the same time, it is not enough to simply calculate the elasticities to estimate pricing to market effect, even if it is a period of prolonged uni-directional exchange rate change. When the third country effect on pricing to market is investigated with respect to Japan in industries that are exported into the U.S., no significant evidence is discovered.

Table 3.4: long-run elasticities

industry	elast.	s. e.	R^2 , D.W.
canvas sports shoes	-5.78	(3.48)	0.52, 2.00
wire rope	1.26	(1.63)	0.69, 2.34
color TV	-1.81	(1.86)	0.61, 2.15
tape recorder	-1.93	(1.80)	0.55, 1.20
passenger car	-1.03	(0.83)	0.73, 2.36
toy	-0.24	(1.58)	0.38, 2.04
pure silk fabric	-1.17	(0.76)	0.88, 2.30
cold-rolled sheet	-4.60	(3.88)	0.57, 2.55
polyester fabric	-1.14	(2.08)	0.38, 1.68
PVC resin	-3.51	(2.73)	0.82, 2.59
passenger car tire	1.77	(1.03)	0.85, 2.83
glass tableware	-0.04	(0.24)	0.71, 1.64
black and white TV	4.29	(3.25)	0.61, 3.03
electric refrigerator	0.24	(1.99)	0.66, 3.04
transistor	1.24	(0.88)	0.51, 1.97
I.C.	-1.09	(1.20)	0.75, 2.94
poly. fabric(ar1)	1.51	(3.05)	0.48, 2.04
PVC resin(ar1)	-3.99	(2.33)	0.84, 2.24
pass. car tire(ar1)	2.33	(0.84)	0.88, 2.60
tableware(ar1)	2.73	(1.17)	0.81, 2.94
B & W TV(ar1)	5.81	(2.13)	0.76, 2.49
refrigerator(ar1)	0.68	(1.62)	0.76, 2.49
I.C.(ar1)	0.17	(0.45)	0.89, 2.59

Table 3.5: elasticities according to varying lags under PDL

industry	lags	elast.	s.e.	R^2 , D.W.
canvas sports shoes	0	-0.88	(0.37)	0.17, 1.74
	2	-1.53	(0.66)	0.52, 1.76
	3	-1.00	(0.87)	0.53, 2.07
	4	-0.82	(1.13)	0.55, 2.37
	5	-1.21	(1.36)	0.59, 2.09
	6	-1.01	(1.39)	0.62, 2.02
	7	-4.66	(2.33)	0.53, 1.93
	8	-5.78	(3.48)	0.52, 2.01
	wire rope	0	-0.38	(0.21)
2		0.47	(0.39)	0.51, 1.75
3		-0.59	(0.49)	0.58, 1.87
4		0.01	(0.68)	0.55, 1.91
5		-0.52	(0.77)	0.62, 1.96
6		0.34	(0.78)	0.66, 2.19
7		1.15	(1.10)	0.70, 2.32
8		1.26	(1.63)	0.70, 2.34
color TV		0	-0.53	(0.21)
	2	-0.12	(0.44)	0.38, 1.77
	3	-0.99	(0.56)	0.45, 1.94
	4	-1.32	(0.77)	0.41, 1.82
	5	-1.39	(0.97)	0.41, 2.11
	6	-0.08	(1.00)	0.45, 2.36
	7	-0.41	(1.20)	0.64, 2.53
	8	-1.81	(1.86)	0.61, 2.16

tape recorder	0	-0.63	(0.20)	0.27, 1.15
	2	-1.04	(0.37)	0.47, 1.32
	3	-1.24	(0.46)	0.53, 1.41
	4	-1.13	(0.60)	0.55, 1.19
	5	-1.28	(0.70)	0.61, 1.39
	6	-1.11	(0.72)	0.64, 1.48
	7	-0.96	(1.21)	0.55, 1.33
	8	-1.92	(1.80)	0.54, 1.20
	passenger car	0	-0.64	(0.13)
2		-0.58	(0.17)	0.68, 1.57
3		-0.41	(0.23)	0.69, 1.99
4		-0.37	(0.31)	0.67, 2.25
5		-0.26	(0.39)	0.66, 2.26
6		-0.47	(0.40)	0.69, 2.20
7		-0.14	(0.62)	0.68, 2.22
8		-1.03	(0.83)	0.73, 2.36
toy		0	-0.65	(0.17)
	2	-0.36	(0.32)	0.29, 1.90
	3	-0.46	(0.43)	0.27, 2.00
	4	0.06	(0.48)	0.49, 2.03
	5	-0.38	(0.62)	0.47, 2.11
	6	-0.75	(0.63)	0.51, 2.32
	7	-1.53	(0.95)	0.52, 2.10
	8	-0.24	(1.58)	0.38, 2.04

Table 3.6: elasticities during the depreciation and appreciation

industry	division	X(depr)	X(appr)
canvas sports shoes	86:2	-1.25	-1.17
wire rope	86:2	-0.40	0.05
color TV	86:2	-0.52	-0.15
tape recorder	86:2	0.73	0.38
passenger car	86:2	-0.26	-0.33
toy	86:2	2.03	-1.01
pure silk fabric	87:2	-0.02	0.03
cold-rolled sheet	86:1	-1.81	0.07
polyester fabric	86:1	-3.84	-1.29
PVC resin	85:2	-5.78	-0.84
passenger car tire	85:2	-2.90	-0.55
glass tableware	85:2	-1.47	-0.03
black and white TV	86:2	-0.36	-0.96
electric refrigerator	86:2	-1.04	-0.96
transistor	86:2	6.52	-2.79
I.C.	85:2	4.98	-1.06

FIG. 1A

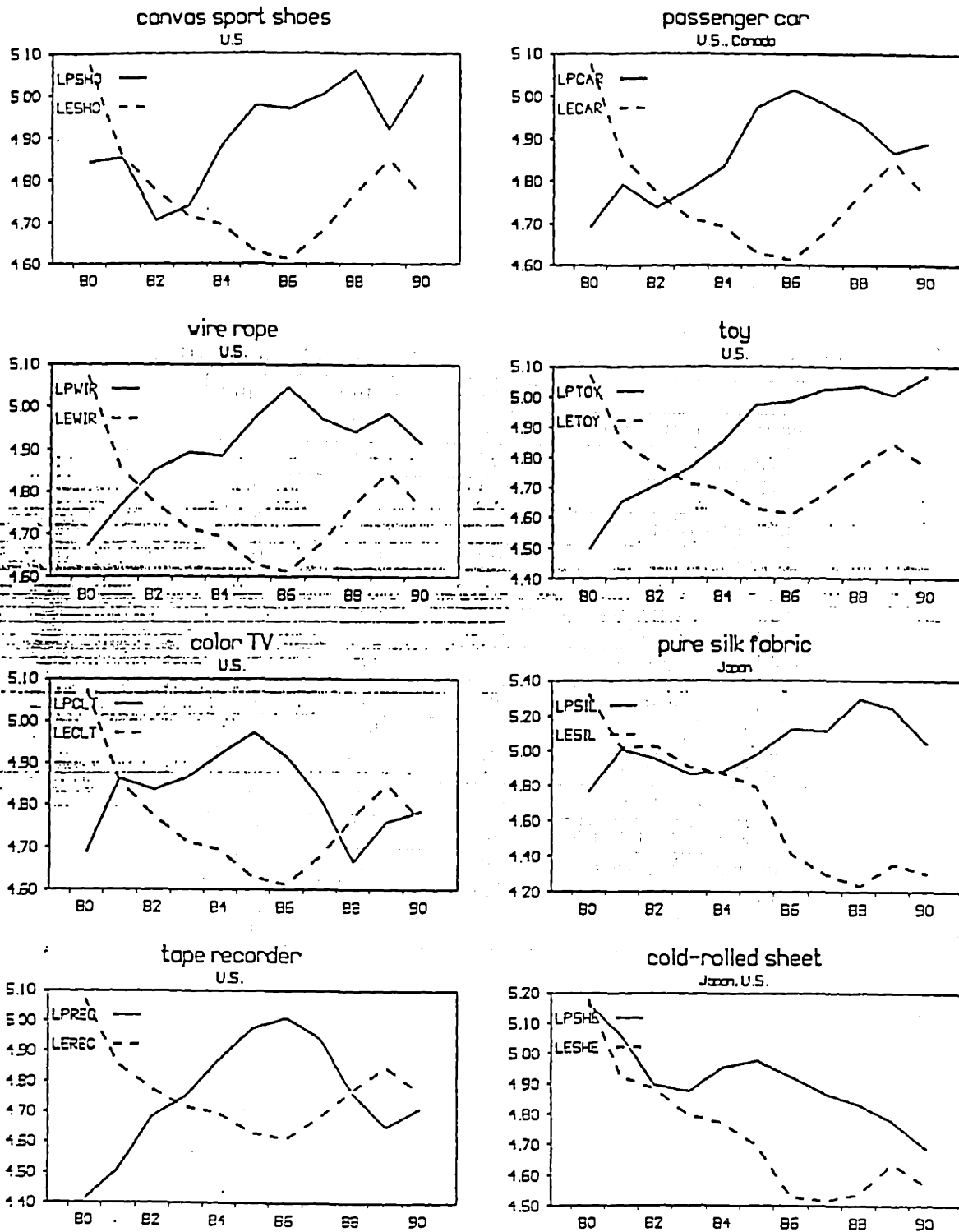


FIG. 1B

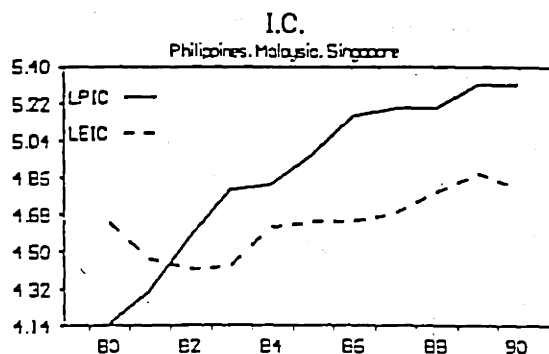
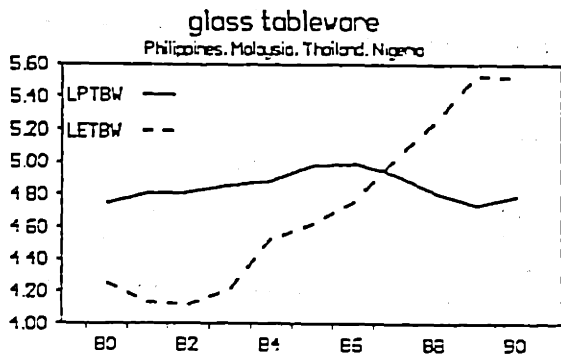
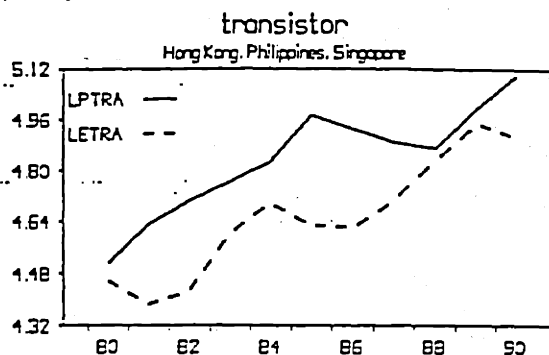
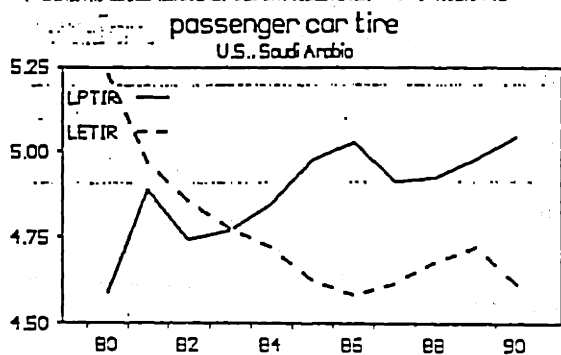
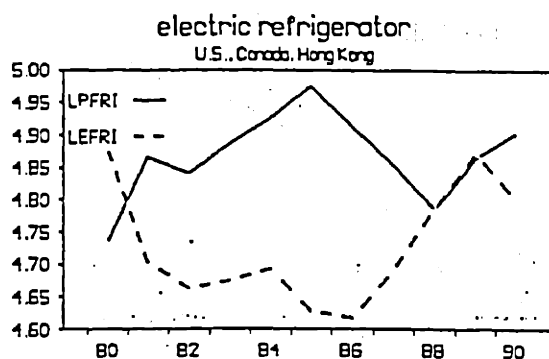
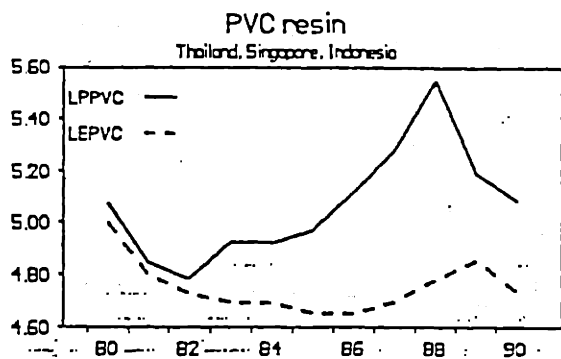
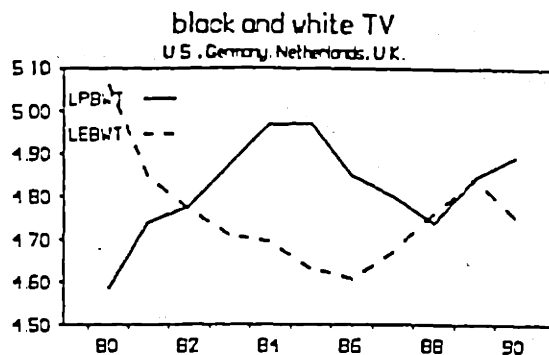
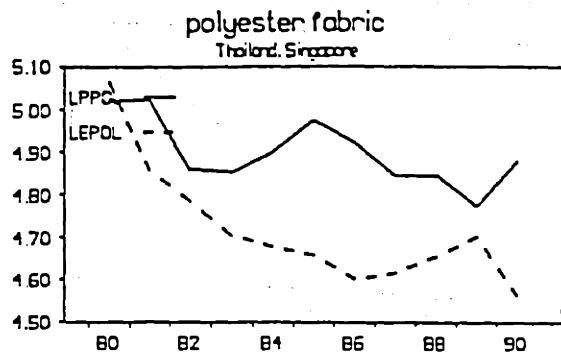


FIG. 2A

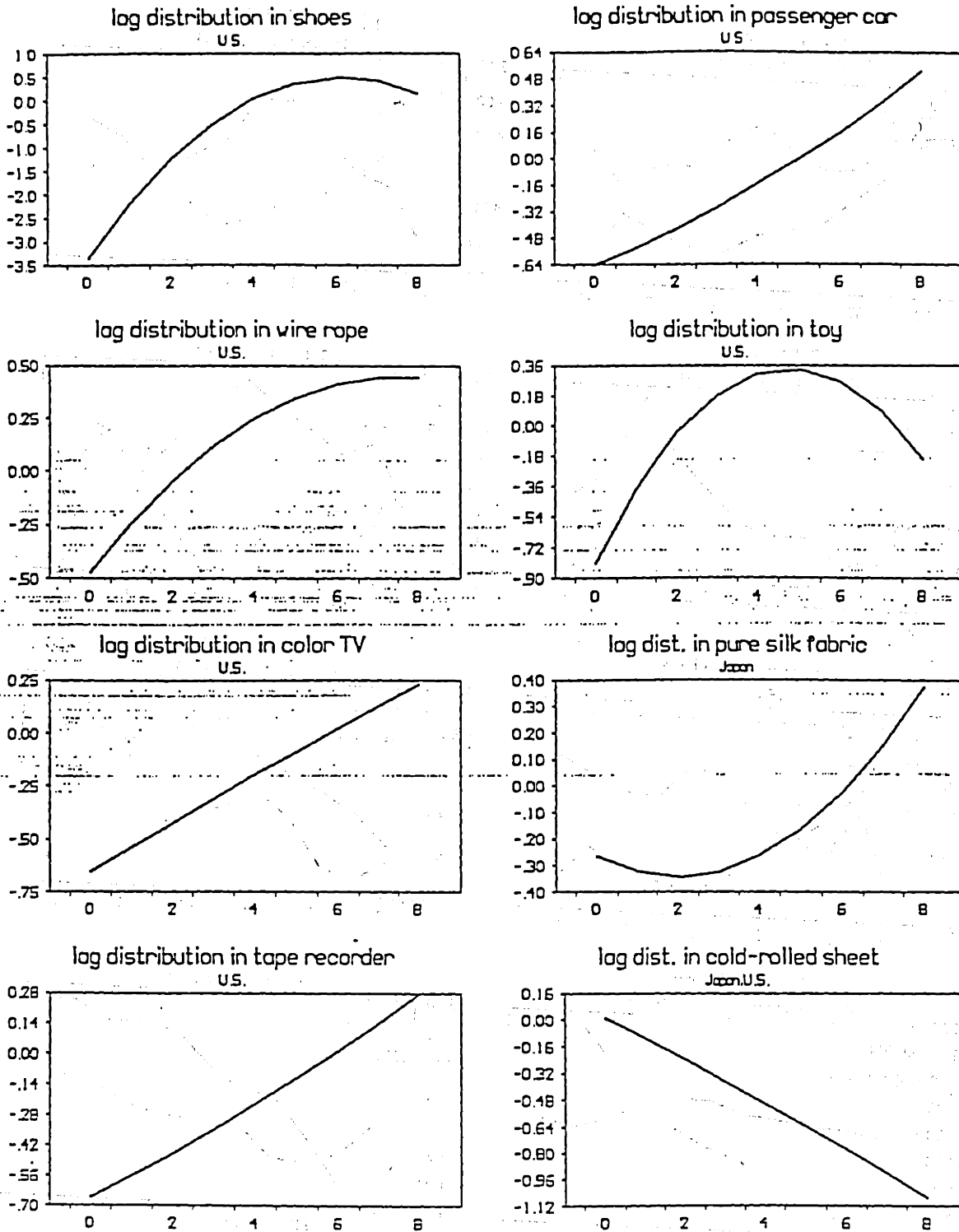
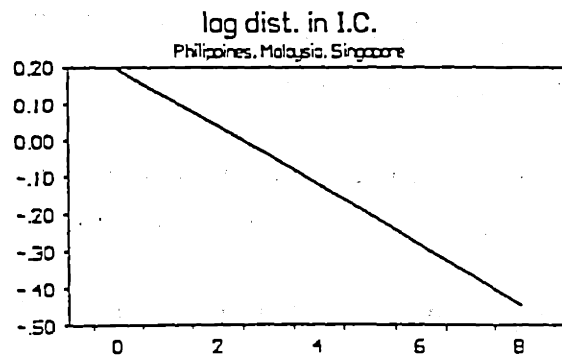
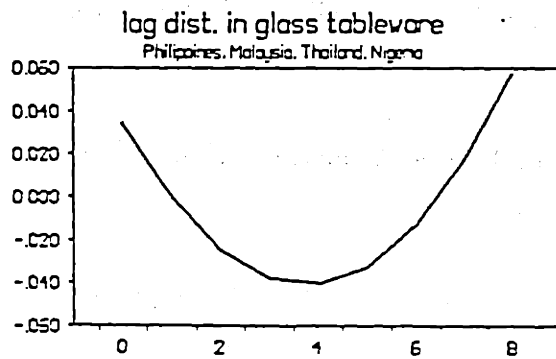
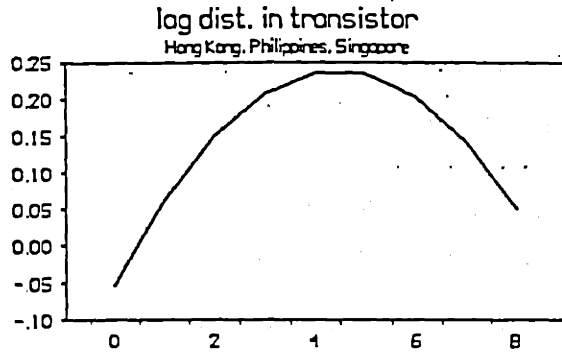
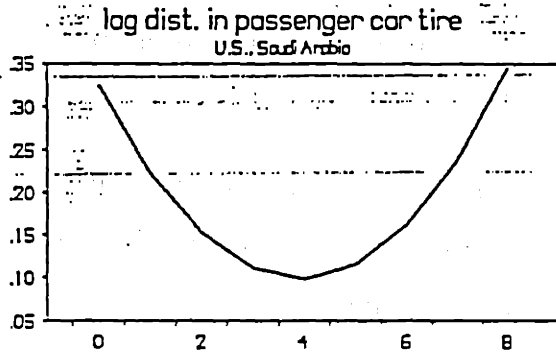
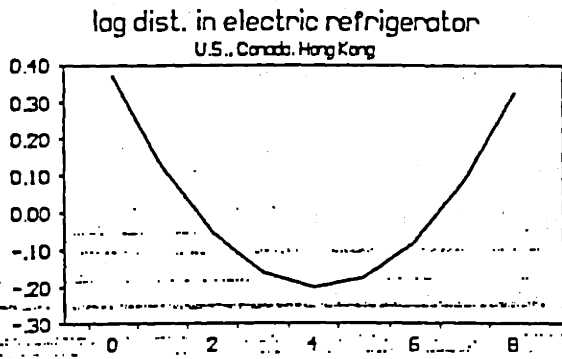
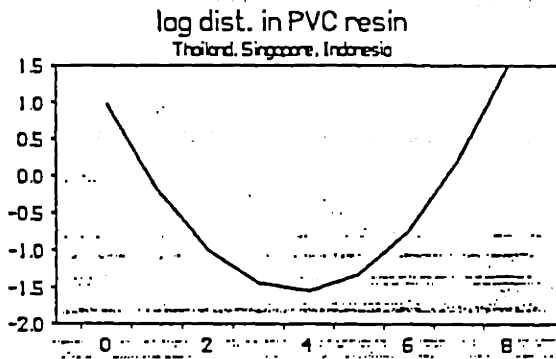
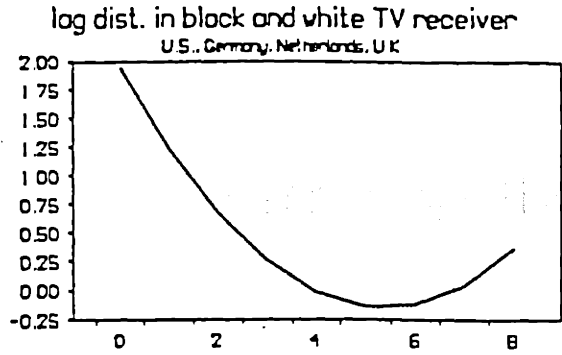
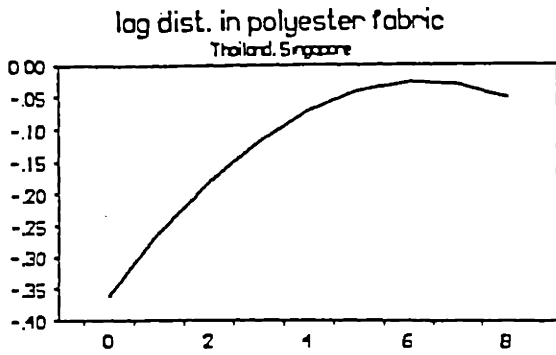


FIG. 2B



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