INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic print: are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.
SELECTIVE CREDIT ALLOCATION AND INDUSTRIAL DEVELOPMENT IN SOUTH KOREA

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ECONOMICS

DECEMBER 1995

By
Hee-Sik Kim

Dissertation Committee:
Chung H. Lee, Chairperson
James E. T. Moncur
Seiji F. Naya
Marcellus S. Snow
Karl E. Kim
ACKNOWLEDGEMENTS

I started this study with curiosity about the fundamental discrepancy between the Korean experience and the neoclassical theories of economic development. The question was how the Korean economy could develop rapidly in spite of the financially repressed system. It was possible for me to resolve the question to my intellectual satisfaction with the help of my teachers, my colleagues, and many others.

First of all, I am greatly indebted to my academic adviser, Professor Chung H. Lee. He inspired me throughout this study. Without his guidance, based on his in-depth understanding of economic development issues, I would not have been able to launch this study, not to mention complete it.

I am also grateful to Professor Douglas Holz-Eakin at Syracuse University for answering my questions about the methodology for testing causality with panel data and to Professor Kwang-Soo Cheong at the University of Hawaii for helping me to refine the empirical results. Comments on the empirical chapter by Professor Hyo-Soo Lee and heart-felt encouragement by Professor Yong-Wook Lee at the Yeungnam University in South Korea are also appreciated.

Acquisition of data was possible with the help of Kyu-In Lee and Ku-Sik Sin, my colleagues at the Bank of Korea. Shirley Ym and other consultants at the computing center of
Shirley Ym and other consultants at the computing center of the University of Hawaii helped me use the mainframe IBM computer. Changsuk Kim, a fellow student, helped me handle many computer-related problems. Many thanks go to them. I deeply appreciate Leonard Greer, Lynn Graybeal, and Mark Deweaver for proofreading and editing the last draft.

I am grateful to Byung-Ju Lee, Hongbum Jang, and Kang-Jin Lee, my classmates, and Dong-Goo Chang, Wook-Heon Song, and Jong-Kyu Lee, my fellow students and colleagues in the Bank of Korea, for their innumerable help during my stay in Hawaii. I also thank Sung-Soo Eun, a fellow student, for encouraging me while I was in a difficult stage of my study. I am also grateful to Rene and Stephen Latimer, and Rosemary Casey for sharing a warm friendship with me and my family.

The financial support for the first four years from the East-West Center is acknowledged. I also appreciate the Bank of Korea for allowing me a study leave. My brother, my mother, and my families-in-law encouraged and financially supported the rest of my stay at Hawaii. My deep thanks are extended to them.

I have two sons, Kun-Woo and June-Woo, born while I was writing this dissertation. Their sacrifice due to their daddy's being always busy with his study can never be fully acknowledged. I thank Fran Fiust for taking care of my sons while I attend mass in the Newman Center, a Catholic church in the University of Hawaii at Manoa, every Sunday since
September 1994. Last but not least, I do not know how to thank Young-Hyun. Without her sharing hardship, this study might not have been brought to completion.
ABSTRACT

In spite of financial repression, the Korean industries have been able to develop rapidly. The superb performance of Korean industries casts doubt on the argument that the presence of financial repression in itself necessarily leads to inefficient resource allocation and economic stagnation. In fact, this study posits that the presence of strong influence of the government in credit allocation indicates that a hierarchical mechanism of economic coordination was in operation, using selective credit allocation as the main instrument for interactively implementing its industrial policies with firms in order to achieve dynamic efficiency.

Government intervention may be warranted when there are externalities and economies of scale amidst underdeveloped financial markets. In addition, in order to be efficient in promoting industrial development, the government’s selective credit allocation should be implemented effectively. These two implications are examined through empirical tests.

First, representing the selective credit allocation by the interindustrial variations in incremental loans and cost of borrowing, this study tests whether the selective credit allocation caused in the Granger sense interindustrial variations in investment. Second, it tests whether there were economies of scale and externalities among industries in the manufacturing sector of Korean economy during 1966-83.
period by pooling industrial cross-section and time-series data.

The causality tests are carried out for two periods--from 1977 to 1979 and from 1981 to 1983--by estimating vector autoregression models with panel data. The results from the models for the earlier period suggest that the selective credit allocation was effective in changing industrial investment patterns. However, the results for the later period suggest that the intertemporal interrelationship between incremental loans and investment underwent a change, implying that the industries gained their own momentum in investment decisions.

The other test shows that as economies of scale having been realized over time, externalities originating from customer industries have been important for rapid industrial growth. The results are consistent with the argument that a combination of export promotion and aggressive investment was Korea's primary developmental strategy. But there was no indication that externalities originated from supplier-industries, implying that Korean industrial expansion depended on imported inputs and technology.
TABLE OF CONTENTS

ACKNOWLEDGEMENT.................................................................iv
ABSTRACT......................................................................................vii
LIST OF TABLES .................................................................xii
LIST OF FIGURES .................................................................xiv
CHAPTER I. INTRODUCTION .........................................................1

CHAPTER II. FINANCIAL SYSTEM AND INDUSTRIAL DEVELOPMENT 
IN SOUTH KOREA .................................................................6
  2.1. Financial System of Korea before Liberalization...6
  2.2. Industrial Development in Korea .....................23
  2.3. Literature Review .................................................................27
    2.3.1. Theory of Financial Deepening .....................28
    2.3.2. Neo-structuralist Criticism of Liberalization..........32
    2.3.3. Critiques of Financial Deepening ..................37
    2.3.4. Theory of Neutral Incentives ...................43

CHAPTER III. SYSTEMIC APPROACH ...........................................53
  3.1. Coordination Problem in Late Industrialization ..54
    3.1.1. Pecuniary External Effects and Big Push ...55
    3.1.2. Learning-by-Doing ..................................................57
    3.1.3. Sectoral Difference in Productivity Growth...63
  3.2. Credit-Based Systemic Approach to Industrial Development ...........................................67
    3.2.1. Government-Business Relationship .............68
    3.2.2. Selective Credit Allocation ..................70
    3.2.3. Consensus Formation .............................................74
    3.2.4. Operation of the Systemic Approach ..........76
    3.2.5. Intra-group Spillovers ...............................78
  3.3. Theoretic Rationale For Selective Credit Allocation ..................................................80
    3.3.1. Static Efficiency-Based View of Selective Credit Allocation ........................................82
    3.3.2. Dynamic Efficiency-Based View of Selective Credit Allocation ........................................85
    3.3.3. Costs and Benefits of Selective Credit Allocation ..................................................93
    3.3.4. Implication for Empirical Work ................94
3.4. Economies With and Without Selective Credit Allocation ..........................95
   3.4.1. The Case of Manufacturing Firms in the U.S.A. .........................96
   3.4.2. Pecularity of Korean Corporate Financing ..........................102

CHAPTER IV. EFFECTIVENESS OF SELECTIVE CREDIT ALLOCATION:
CAUSALITY TESTS BETWEEN INCREMENTAL LOANS AND INVESTMENT ...............108
   4.1. Empirical Question About the Effectiveness of Selective Credit Allocation .....................108
   4.2. Previous Empirical Studies about the Issue ..............112
   4.3. Causality Test: Methodology ..................114
   4.4. Hypothesis Testing .................................................130
      4.4.1. Test of Overidentifying Restrictions ...............130
      4.4.2. Test of Linear Restriction on Parameters ..........131
         4.4.2.1. Testing Stationarity of Individual Effect ..........132
         4.4.2.2. Testing Causality ..............................140
   4.5. Data ..........................................................141
   4.6. Estimation and Test Results ..................................144
      4.6.2. Determination of Investment Patterns during 1981-1983 Period ...............155
      4.6.3. Implications ..............................................165

CHAPTER V. EMPIRICAL TESTS OF EXTERNALITIES AND ECONOMIES OF SCALE IN KOREAN MANUFACTURING SECTOR ....................171
   5.1. Methodology ...................................................172
   5.2. Data ..........................................................174
   5.3. Results ......................................................177
   5.4. Profiles of Estimates ......................................178
   5.5. Implications ..................................................183
      5.5.1. Innovation Capabilities of Korean Manufacturing Sector ..................183
      5.5.2. Half-fullness of Korean Industrial Development ......................187
      5.5.3. Intra-industry Differentials in Productivity Growth .................189
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. The Share of Loans and Discounts in the Financial Survey</td>
<td>7</td>
</tr>
<tr>
<td>2.2. Loans and Rediscounts of the Bank of Korea</td>
<td>11</td>
</tr>
<tr>
<td>2.3. Proportion of Loans Accounted for by Government's Policy Loans, Japan and Republic of Korea</td>
<td>17</td>
</tr>
<tr>
<td>2.4. Weighted Average Net Financing of Private Physical Investment by Enterprises in France, Germany, Japan, the U.K., the U.S.A., and Korea: 1970-85</td>
<td>19</td>
</tr>
<tr>
<td>2.5. Industrial Composition of Employment and Output</td>
<td>22</td>
</tr>
<tr>
<td>2.6. Labor, Capital Stock, and DMB Loans and Discounts Used by and Value Added Generated in the Manufacturing Sector</td>
<td>24</td>
</tr>
<tr>
<td>3.2. Investment and Finance Indicators for Manufacturing Firms in the U.S.A., averages over the period of the 1970-84 period</td>
<td>101</td>
</tr>
<tr>
<td>3.3. Investment and Finance Indicators for Manufacturing Firms in Korea</td>
<td>102</td>
</tr>
<tr>
<td>4.1. Test Results for Investment Equation ( I_t, \ t = 1977-79 ) with 4 Variables: ( I, S, \Pi ) and ( dL )</td>
<td>149</td>
</tr>
<tr>
<td>4.2. Test Results for Investment Equation ( I_t, \ t = 1977-79 ) with 4 Variables: ( I, S, DC ) and ( dL )</td>
<td>152</td>
</tr>
<tr>
<td>4.3. Test Results for Investment Equations ( I_t, \ t = 1977-79 ) with 4 Variables: ( I, S, DC ) and ( dL )</td>
<td>154</td>
</tr>
<tr>
<td>4.4. Test Results for Investment Equations ( I_t, \ t = 1981-83 ) with 4 Variables: ( I, S, \Pi ) and ( dL )</td>
<td>157</td>
</tr>
<tr>
<td>4.5. Test Results for Investment Equations ( I_t, \ t = 1981-83 ) with 4 Variables: ( I, S, DC ) and ( dL )</td>
<td>159</td>
</tr>
<tr>
<td>4.6. Test Results for Investment Equations ( I_t, \ t = 1981-1983 ) with 4 Variables: ( I, \Pi, DC ) and ( dL )</td>
<td>161</td>
</tr>
</tbody>
</table>
4.7. Test Results for Investment Equations
\( (I_t, t = 1981-83) \) with 5 Variables:
I, S, II, DC, and \( dL \) .................................................163

4.8. Contemporaneous Correlations Between Interindustrial Variations in Incremental Loans and Costs of Borrowing........................................166

5.1. Estimation Results for the Manufacturing Sector of Korea........................................176

5.2. Estimation Results for the Manufacturing Sector of the U.S.A. ........................................176

A3.1. Prices of Caprolactam and AN Monomer.................202

A4.1. Industry Classification Used in this Study........203

A4.2. Parameter Estimates of the Four-Variable Investment Model Including \( I, S, DC, dL \) for the 1977-1979 period..................................................205


A5.1. Rates of Growth of Labor Productivity, Capital Intensity and TFP in Korean Manufacturing Industries, 1963-79.................................207
### LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2. Effects of Selective Credit Allocation: Static Efficiency-Based View</td>
<td>83</td>
</tr>
<tr>
<td>3.3. Effects of Selective Credit Allocation: Dynamic Efficiency-Based View</td>
<td>87</td>
</tr>
<tr>
<td>3.4. Pecking-Order Theory of Corporate Finance</td>
<td>99</td>
</tr>
<tr>
<td>5.1. Profiles of Economies of Scale</td>
<td>180</td>
</tr>
<tr>
<td>5.2. Profiles of Externalities: Externalities from Customers</td>
<td>181</td>
</tr>
<tr>
<td>5.3. Profiles of Externalities: Externalities from Input Suppliers</td>
<td>182</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

Korea is now a well-known success story. Her performance, read from macroeconomic indicators, is superb. According to the Penn World Table (Mark 5), the real GDP per worker in the Republic of Korea (henceforth, Korea), measured in U.S. dollars at 1985 international prices, more than quintupled between 1960 and 1988. On a relative scale, Korea has been catching up with the U.S.A., jumping from 9.8 percent to 28.1 percent of the per capita GDP in the U.S.A.

This study has its origin in this question raised by Chung H. Lee (1992): "How has South Korea been able to develop so rapidly with a repressed financial system..." (189). Lee's question contains two factual components—that Korea developed rapidly, and that during its development, the financial system was repressed. It also challenges the theory which predicts that financial repression necessarily deters economic development. In the recent literature, there appears an alternative theory which argues that financial repression (or, selective credit allocation) may be "beneficial" (Stiglitz, 1994, 19) when capital markets fail. In other words, when the capital market is underdeveloped, the presence of economies of scale and interdependent investments warrants government intervention in credit allocation. But, there is little empirical evidence to support this alternative argument.
The present study attempts to provide an empirical test for the validity of the alternative argument.

It is possible that the government can also fail to bring about efficient coordination due for example to rent-seeking activities. The question critical to effectiveness of selective credit allocation is then: Is there any mechanism available on which the government may rely for efficient coordination that the market fails to bring about? Some theorists answer positively, mostly referring to new institutional economics. If this is so, potential efficiency of such a mechanism may provide an answer to the seemingly contradictory coexistence of financial repression and industrial development in Korea during rapid transitional period.

The study here approaches the issue by asking whether selective credit allocation can effectively influence the pattern of industrial investments so that problems contained in late-industrialization, i.e., economies of scale and interindustrial externalities, can be well taken care of. In practice, the question is divided into two parts: First, can selective allocation of credits effectively influence the pattern of industrial investment? The present study addresses this question by transforming it into a test of causality. The technique is to set up an investment function in terms of incremental bank loans (or, the cost of borrowing) as a proxy for selective credit allocation and
check whether the interindustrial variations in the ratio of incremental loans to capital stock caused the variations in investment-to-capital ratios. The test of causality uses a panel data vector autoregression model.

The second question is: Has the manufacturing industries in Korea in fact been overcoming the problems arising from economies of scale in profitable investment opportunities and from interdependence of investments? This question is addressed with a model explaining the growth rates of industrial outputs in terms of growth of own inputs and customers' and suppliers' outputs. According to the model, the coefficient for the growth rates of own inputs represents economies of scale and other coefficients of external effects from expansion of customers or input suppliers. Both the causality test and the test of economies of scale and externalities give results consistent with affirmative answers to the two questions.

The study consists of six chapters. Chapter II describes the characteristics of (1) the Korean financial system before it was liberalized in the 1980s and (2) industrial development in Korea. The chapter also reviews the literature on the finance-development nexus: the financial liberalization theory and neutral incentives theory. Chapter III attempts to derive a theoretical rationale for selective credit allocation. It is posited that (1) a systemic approach is required for a backward
economy to achieve a dynamic efficiency and (2) selective credit allocation, as well as a "mechanism through which business and government could exchange information and coordinate investment decisions," is an essential ingredient in such an approach. Two views about the effect of selective credit allocation are discussed: static efficiency-based and dynamic efficiency-based views. Chapter IV and Chapter V carry out empirical tests. A causality test on the effectiveness of selective credit allocation is performed in chapter IV. Chapter V reports the results of empirical tests of economies of scale and externalities in the Korean manufacturing sector. Chapter VI concludes the discussion.
NOTES

1. The data, reported by Summers and Heston (1990), are comparable across countries as well as over time. In terms of RGDPCH (real GDP per worker in chain index), the real GDP per worker in Korea was $923 in 1960 and $5,156 in 1988.

2. The same question is raised by Patrick and Park (1994, 365).


4. The theory for rent-seeking behavior is pioneered by Krueger (1974).

5. They include Ha-Joon Chang (1993), Chung H. Lee (19921), and Cho and Hellman (1993).

6. The bank credit allocation and pricing were in almost complete control of the government in Korea during the Park regime (1963-1979).

CHAPTER II

FINANCIAL SYSTEM AND INDUSTRIAL DEVELOPMENT IN SOUTH KOREA

This chapter reviews both the financial system and the industrial development of Korea. It will show that while the financial system had been a repressed one, industries could develop rapidly. Then it will review the literature on the finance-development nexus.

2.1. Financial System of Korea Before Liberalization

After reviewing the financial system of Korea, this section will explain the nature of the financial system before it was partly liberalized in the early 1980s. The impacts of liberalization on financial institutions and firms are described.

A financial system is a set of institutions and organizations that provide payment services, mobilize savings, and allocate credits in an economy. In Korea, the regulated financial institutions consist of the Bank of Korea (BOK), which is the central bank; deposit money banks (DMB), including commercial banks and special banks; securities market; and non-bank financial institutions (NBFI), which are subdivided into development institutions, savings institutions, life insurance companies, and investment companies.¹
## Table 2.1. The Share of Loans and Discounts in Financial Survey

<table>
<thead>
<tr>
<th>Year</th>
<th>Deposit Money Banks</th>
<th>Korea Develop Bank</th>
<th>Others&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>0.612</td>
<td>0.105</td>
<td>0.283</td>
</tr>
<tr>
<td>1975</td>
<td>0.730</td>
<td>0.145</td>
<td>0.124</td>
</tr>
<tr>
<td>1977</td>
<td>0.699</td>
<td>0.150</td>
<td>0.151</td>
</tr>
<tr>
<td>1978</td>
<td>0.700</td>
<td>0.153</td>
<td>0.147</td>
</tr>
<tr>
<td>1979</td>
<td>0.675</td>
<td>0.161</td>
<td>0.165</td>
</tr>
<tr>
<td>1980</td>
<td>0.664</td>
<td>0.169</td>
<td>0.167</td>
</tr>
<tr>
<td>1981</td>
<td>0.656</td>
<td>0.157</td>
<td>0.187</td>
</tr>
<tr>
<td>1982</td>
<td>0.652</td>
<td>0.151</td>
<td>0.197</td>
</tr>
<tr>
<td>1983</td>
<td>0.641</td>
<td>0.141</td>
<td>0.218</td>
</tr>
<tr>
<td>1986</td>
<td>0.599</td>
<td>0.115</td>
<td>0.286</td>
</tr>
</tbody>
</table>


Note: a. "Others" include non-bank financial institutions.
The KDB has been the most important specialized financial institution for channeling foreign funds (foreign aid and loans), government funds, and financial funds into strategic industries. Its share in loans purveyed by financial institutions has been significant, as shown in Table 2.1.² The government funds were generated from foreign aid and they became an important source of funds in financial institutions during 1960s. Naturally, the government had a strong influence on the allocation of those funds. In the first half of the 1960s, the ratio of the government loans purveyed to banks to the banks' loans supplied to the private sector was 37.0 percent per year. In the last half of the period, it decreased to 17.7 percent. Thereafter, the ratio dropped to less than 10 percent per year.³

The activities of the Bank of Korea reveal a peculiarity of Korean financial system. The Bank of Korea Act (1950) was drafted by two American specialists, Bloomfield and Jensen. Reflecting the drafters' view, the act stressed political neutrality and the independence of the central bank's financial activity from fiscal needs. But, with the military coup d'état in 1961, and the beginning of a series of government-led five-year economic plans in 1962, the act was amended to accommodate industrial needs for finance.⁴ Whatever the formal organization of the monetary authority, the MOF came to exercise strong
influence on the monetary and credit policies. The nationwide commercial banks were nationalized. The monetary authority reserved the right to set maximum interest rates on deposits and loans of banks and to set ceilings on the volume of bank credits. Relying on this law and laws promoting individual industries, the government—the Economic Planning Board, the Ministry of Trade, the MOF, and the BOK taking on different responsibilities—exercised selective influence on credit allocation.

The main instruments used to provide incentives for investment were control of nominal interest rates and selective credit allocation through the government's influence on financial institutions. According to Wontack Hong and Yung Chul Park (1986), the difference between the nominal interest rate on one-year time deposits and the rate of change in GNP deflator was about -10.7 percent per annum on average between 1954-65. It was 10 percent per year during 1965-71 and -3.4 percent between 1972-81. Under such circumstances, access to bank loans becomes a privilege. And the performance of the system relies greatly on the capacity of the financial institutions (including the government's financial authority) to allocate credit efficiently.

The mainstay of direct control of credit allocation has been the discount window of the Bank of Korea. The central bank rediscounts commercial bills. This was considered as a
means to control aggregate liquidity in the economy, until 1968, when the regulation pertaining to the commercial bill discounts was revised to extend the maturity and the quantity limit that one person could borrow through commercial bill discounts. Since then, it had been considered as an instrument of selective credit allocation. The BOK introduced new regulations on qualifications for firms to be selected and it expanded the range of firms qualified for the rediscount. Moreover, it made loans to commercial banks using as collateral qualified securities that the commercial bank had handled. Loans for exports were introduced in 1961. The regulations of export loans stipulated that (1) financial institutions lend funds to those who had received a letter of credit or holders of export contracts within the necessary amounts for discharging the export contract and (2) the Bank of Korea should rediscount the bill within the amount of loans made to the exporters. Among the general funds, "A funds" were used to support industrial policies that promoted key industries and small enterprises and investments elsewhere. The rest of the general funds, or "B funds," were used to control liquidity by replenishing reserve shortages of commercial banks.

The importance of rediscounts and loans by the central bank to the deposit monetary banks is reflected in the asset structure of the central bank. Loans, rather than
Table 2.2. Loans and Rediscounts of the Bank of Korea  
(shares of total at the end of each period in percentage)  

<table>
<thead>
<tr>
<th></th>
<th>General Loans^a</th>
<th>Bills Discounted</th>
<th>Loans For Trade</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>0.04</td>
<td>0.16</td>
<td>0.23</td>
<td>0.57</td>
</tr>
<tr>
<td>1975</td>
<td>0.21</td>
<td>0.13</td>
<td>0.47</td>
<td>0.20</td>
</tr>
<tr>
<td>1977</td>
<td>0.14</td>
<td>0.08</td>
<td>0.49</td>
<td>0.28</td>
</tr>
<tr>
<td>1978</td>
<td>0.32</td>
<td>0.06</td>
<td>0.55</td>
<td>0.28</td>
</tr>
<tr>
<td>1979</td>
<td>0.30</td>
<td>0.08</td>
<td>0.41</td>
<td>0.21</td>
</tr>
<tr>
<td>1980</td>
<td>0.17</td>
<td>0.11</td>
<td>0.48</td>
<td>0.25</td>
</tr>
<tr>
<td>1981</td>
<td>0.21</td>
<td>0.16</td>
<td>0.44</td>
<td>0.19</td>
</tr>
<tr>
<td>1982</td>
<td>0.28</td>
<td>0.21</td>
<td>0.37</td>
<td>0.14</td>
</tr>
<tr>
<td>1983</td>
<td>0.39</td>
<td>0.17</td>
<td>0.30</td>
<td>0.14</td>
</tr>
<tr>
<td>1986</td>
<td>0.60</td>
<td>0.13</td>
<td>0.19</td>
<td>0.08</td>
</tr>
<tr>
<td>1990</td>
<td>0.51</td>
<td>0.33</td>
<td>0.08</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Sources: Economic Statistics Yearbook, The Bank of Korea, various years.  
Note: a. General loans include "A funds" for policy loans and "B funds" for liquidity control. By the end of 1987, the share of "B funds" was 4 percent (Oh, et. al., July 1994, 19 Table 7).
securities, are the most important asset for the Bank of Korea. The BOK extends loans to banks via commercial paper rediscount, loans for imports and export activities, small and medium industry promotion funds and so on. Most of these loans have been extended in relation to the government's industrial policy rather than in relation to liquidity control (see Table 2.2). In fact, the proportion of assets lent was 55.6 percent of the total assets of the Bank of Korea by the end of 1984. In contrast, the proportion of assets lent in the consolidated Federal Reserve Banks accounts as of March 28, 1984, was 3 percent. On the one hand, this shows that monetary and financial policies in Korea are implemented through "discount windows." On the other hand, the proportion of assets of the central bank held in domestic securities was zero for Korea, and 81.8 percent in the U.S.A., respectively, which shows that the Federal Reserve influenced the amount of reserves mainly through open market operations. 

The monetary authority's criteria for selection are dictated indirectly by industry-specific legislation and other governmental regulations. Banks, mostly owned by the government until the early 1980s, made loans or discounted bills mainly in accordance with governmental decisions and directions. Regulations pertaining to the uses of funds in the financial sector, laid down by the Monetary Board in 1962, required the specialized banks to finance preferential
sectors such as chemical, and heavy industry; and small and medium industry. The regulation also controlled the fund allocation of commercial banks to make loans to strategic industries.\textsuperscript{10}

The government's industrial policies included financial support for industrial development at preferential terms, as well as fiscal supports. Industry specific legislation included the Industrial Machinery Promotion Act (1967), the Shipbuilding Industry Promotion Act (1967), the Electronic Industry Promotion Act (1969), the Steel Industry Fostering Act (1970), the Petrochemical Industry Fostering Act (1970), the Non-ferrous Metal Smelting Industry Act (1971), and the Textiles Industry Modernization Promotion Act (1974). These laws on individual industries were relinquished and integrated into a comprehensive law, the Industry Development Act, in 1986. The 1986 law also included the financial and fiscal support for rationalization programs. Other governmental regulation of industrial development that stipulated priority industries in credit allocation include five-year economic plans, temporary decrees, and plans from ministries such as the Industry Rationalization Funds Use Plan (1972) by the Economic Planning Board (according to this plan, the funds will be used to transform the current high interest rate, short-term, corporate debts into long-term loans at a low interest rate.) and the Fine Chemistry Industry Five-Year Plan (1972) by the MTI. Most of the laws
stipulated support of investment with preferential finance. For example, the Decree on Textile Industry Equipment (1967) required textile industrialists to register their equipment and the Minister of Trade and Industry to notice the plan for equipment adjustment each year. According to it, the MTI had to subsidize investment from fiscal funds or to mediate financial funds for the purchase of the equipment.¹¹

The dual regulations, i.e., the industrial laws and the regulations pertaining to loans, limited the ability of financial institutions to make selective decisions at their own discretion. The BOK was bound by the regulations to provide automatic rediscount of bills to banks. The banks were required to provide loans according to the industrial laws.

In short, the selective credit allocation has been implemented within the boundaries set by industrial policies and the financial regulations that accommodate them. The automaticity of the rediscount provision procedures jeopardized control of aggregate liquidity by expanding high-powered money. Depending on the scope and intensity of industrial promotion policies, credits were provided beyond the capacity to maintain price stability. Because of the difficulties in downsizing the total amount of rediscounts and the de facto absence of open markets, the only available means of controlling the aggregate liquidity was to
manipulate the reserve ratio. Thus, the reserve requirement ratios of deposit money banks were kept at the inflated level of 20-27 percent from 1973 to 1980 (and 3.5-7.0 percent level during 1980-1987). These measures were insufficient to keep real interest rates positive.

Hong and Park (1986) summarize the magnitude of government influence in terms of the composition of bank loans. "Discretionary policy loans provided through the DMB" (167) accounted for about 20 percent of total loans in 1967-81. "Non-discretionary policy loans" such as short-term export credits and loans for agriculture, fisheries, and housing was about 17 percent of total loans on average from 1967 to 1981. Discretionary loans such as commercial bills discounted and loans based on general banking funds were about 30 percent of total loans on average from 1967 to 1971 and about 20 percent on average from 1977 to 1981. Thus policy loans made up around 60 percent of the total loans outstanding.

As a natural consequence of the biased credit allocation policy in support of industrial policies, the technologies of the banks for screening risks and monitoring the behavior of borrowers did not develop as fast as the real economic growth. The main source of the bank funds were borrowed reserves. To hedge default risks, the banks relied heavily on collateral, especially real estates. Large firms belonging to chaebols, the diversified business
groups in Korea, were extended loans without being required of collateral, because the other firms within the same group could guarantee the repayment of loans to one of its members. In order to give the banks incentives to lend to policy-related projects, the monetary authority allowed a relatively large interest rates spread between the interest rates on deposits and those on loans. In 1985, the interest rate spread between loans and savings in commercial banks was 4.6 percentage points. During the same period, it was 1.1 in Japan and 3.7 in the U.S.A. The large spread may indicate the degree of inefficiency in financial intermediation in Korea, it does not tell whether the industrial projects supported by the large spread are productive enough to offset the loss in efficiency. This leads to the issue of dynamic efficiency of an economic system (It is the theme of Chapter III).

Compared to Japan’s policy loans, which were about 10 percent of total loans, the proportion of Korea’s policy loans seems extremely high (see Table 2.3). But the Korean financial system is not the only one that has a high proportion of policy loans. For example, before its liberalization in 1988, the French financial system was also based on credits and interest rate control rather than on the pure market mechanism. The most telling evidence is that, in 1979, 43 percent of all credits to the economy in
Table 2.3. Proportion of Loans Accounted for by Government’s Policy Loans, Japan and Republic of Korea

<table>
<thead>
<tr>
<th>Year</th>
<th>Japan</th>
<th>Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>13.2</td>
<td>47.41</td>
</tr>
<tr>
<td>1960</td>
<td>11.0</td>
<td>52.43</td>
</tr>
<tr>
<td>1965</td>
<td>9.6</td>
<td>59.78</td>
</tr>
<tr>
<td>1970</td>
<td>9.8</td>
<td>52.77</td>
</tr>
<tr>
<td>1975</td>
<td>10.6</td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>14.1</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>13.7</td>
<td></td>
</tr>
</tbody>
</table>

Sources: The World Bank, 1993, 281 Table 6.5; For Japan, JDB/JERI (1993); and for Korea, Stern and others (1992).

Notes: a. Policy loans as a share of loans and discounts. Policy loans pertains to all loans made under Japan’s Fiscal Investment Loan Program. Outstanding loans are of all financial institutions.

b. Policy loans include under some kind of explicit preferential credit program, that is, loans extended preferentially in terms of interest rate and availability or supported by the BOK’s automatic rediscounts. Outstanding loans are the value of all loans and discounts to the private sector made by the BOK, DMB, and all loans by the Korean Export-Import Bank.

France were made with some kind of privilege or subsidy and 25 percent of corporate lending was subsidized directly.\(^{15}\) The relation between MOF and BOK in Korea resembles that between the Trésor and Banque de France; that is, the Trésor molds the industrial policy framework for selective credit allocation which Banque de France implements.

Government control of credit allocation engendered a widespread belief that the government would not allow any bank or other financial institutions to go bankrupt; in other words, the risks involved in industrialization had been socialized. The government was aware that this belief could pave the way for various risky financial practices,
such as that business would undertake overly ambitious projects and the banks would not monitor entrepreneurial behavior adequately. Therefore, investment behavior of the main debtors was monitored using various measures, including tax examination and secret police. By and large, the implicit rules and agreements between government and business had been enforced effectively through incentives and threats during the Park regime.

The government’s ability to keep close communication with business society has been important in designing industrial policy and modifying it. Thus, in a sense, the task of risk management relating to loan provision in Korea has been performed by the government in close relationship with the business sector. Such a close relationship underlies the high external finance ratio of Korean corporations. It implies the provision of large subsidized loans to firms. And it suggests that the investment decisions by firms depend greatly on the government policies.

Table 2.4 shows the average financing of private enterprises in six countries over the period 1970-1985 (for Korea, it is over 1971-1985). The table reveals how the capital stock in existence in 1985 had been financed.\textsuperscript{16,17} As shown, internal funding of investment is extremely low in Korea. The high proportion of the loans minus deposit reflects that the Korean financial system has
been controlled by the government through the government-owned banks. Most external financing continue to be influenced by the government.

Table 2.4. Weighted Average Net Financing of Private Physical Investment by Enterprises in France, Germany, Japan, the U.K., the U.S.A., and Korea: 1970-1985 (in percentages)

<table>
<thead>
<tr>
<th>Retentions</th>
<th>Loans-Deposits</th>
<th>Net Trade Credit</th>
<th>Net Bonds</th>
<th>Net Shares</th>
<th>Others(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>62</td>
<td>37</td>
<td>-1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Germany</td>
<td>73</td>
<td>12</td>
<td>-3</td>
<td>-2</td>
<td>1</td>
</tr>
<tr>
<td>Japan</td>
<td>65</td>
<td>42</td>
<td>-10</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>U.K.</td>
<td>107</td>
<td>5</td>
<td>-2</td>
<td>-2</td>
<td>-4</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>90</td>
<td>26</td>
<td>-1</td>
<td>12</td>
<td>-3</td>
</tr>
<tr>
<td>Korea(^b)</td>
<td>42</td>
<td>33</td>
<td>-5</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Mayer, 1988, 1174, Fig.2. Numbers for Korea are calculated from the Flow of Funds in National Accounts (1987 and 1990), the Bank of Korea.

Note: a. "Others" include capital transfers, others, and statistical adjustments.

b. For Korea, the periods covered are from 1971 to 1985.

Net bond and equity issues are gaining importance in financing Korean industrial investment. To a large extent, this reflects the efforts of the government, rather than the spontaneous growth of capital markets. The government has fostered the capital market to help large firms finance those investment needs which are consistent with government policies. The government attempted to foster it because the
banks' capacity to finance the investment projects was limited. Indeed, the government spurred firms to go open by restraining bank lending to deviant firms. The 1968 Act on Fostering the Capital Market gave strongly encouraged public offering of equity issues for highly-leveraged privately-owned firms. The increase in bond issues resulted from the government's control of the loans-to-equity ratios of large corporations beyond a certain level. But most of the bonds are guaranteed by the banks; they are mostly another form of bank loans. Thus, the high numbers for both bonds and equities for Korea reflect not so much market initiatives as the responses of firms to initiatives by the government. They thus may be seen as results rather than as the causes of the growth of Korea's economy.

In conjunction with governmental control of credit allocation, the financial markets had a dualistic structure. Unregulated private financial markets were sizable and played an important role in resource mobilization and allocation. Sogang University (1970) estimated that the volume of the private loan market totaled 22.2 billion won (the Korean currency) as of 1963, while the loans and discounts by deposit money banks totaled 49.1 billion won (Cole and Park, 1983 127 Table 27). According to Cole and Park, informal loans declared by business enterprises under this August 3 Decree (1972) amounted to "345.6 billion
won...equivalent to 34 percent of the then-outstanding domestic credit of the banking sector..."(127).

The role of this market is controversial. Some argue that it has been efficient. The efficiency of the curb market may imply inefficacy of the selective credit allocation, as Hong and Park contend. Cole and Park maintain that the curb money market was complementary to long-term bank loans. All views seem to have partial validity. The question is the degree of efficacy of the government’s selective intervention with credit controls.

Korea’s financial system had many elements that were alien to a market system such as industrial policy, interest rate ceilings, and selective credit allocation. Some economists (mostly neoclassical) may consider these elements to be causes of inefficiency. Others may regard them as a corrective of the market mechanism in economic development. Theorists who define the market mechanism in terms of the free determination of prices will see the Korean system as a repressed one. The latter theorists, who recognize the difficulties in industrial development by a lagging economy, will reserve a final judgement on the efficiency of the economic system until they look into the actual relationship between industrial and financial development in the economy. From their point of view, a good financial system is one that serves industrial development, regardless of the
Table 2.5. Industrial Composition of Employment and Output

<table>
<thead>
<tr>
<th></th>
<th>Agriculture(^a)</th>
<th>Manufacturing</th>
<th>Total</th>
<th>(\text{B}/\text{A})</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Employment(^b), percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>76.5</td>
<td>7.9</td>
<td>100</td>
<td>1.0</td>
</tr>
<tr>
<td>1986</td>
<td>23.6</td>
<td>24.7</td>
<td>100</td>
<td>1.0</td>
</tr>
<tr>
<td>B. GDP in current prices, percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>32.8</td>
<td>13.8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>12.3</td>
<td>29.9</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>C. The ratio of sectoral to aggregate labor productivity (\text{B}/\text{A})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>0.43</td>
<td>1.75</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>0.52</td>
<td>1.21</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

Notes: a. Agriculture, forestry, and fisheries.
       b. Employment includes self-employment.
regulating mode. Section 2.2 will explore the nature of industrial development in Korea.

2.2. Industrial Development In Korea

The change in industries in Korea has been dramatic. It can be surmised from the data in Table 2.5. Initially, the manufacturing activity was scanty; that is, in 1960, the proportion of gross domestic product (GDP) generated by manufactures was 13.8 percent of GDP in current prices. In the course of economic development, value added in manufacturing sector increased to 29.9 percent in current prices in 1986. The expansion of manufacturing sector which has higher per person productivity and shrink of agriculture whose labor productivity is low imply an improvement in aggregate labor productivity. From dividing the sectoral product shares with respective labor shares, a measure of labor productivity relative to the aggregate labor productivity is derived. The labor productivity has been higher in manufacturing sector than in agricultural sector all the time.

Table 2.6 suggests that the structural changes in labor and capital employment might have resulted from the industrial policies that favor the manufacturing sector. It shows that preponderance of loans are provided to manufacturing sector. The deliberate efforts (whether
Table 2.6. Labor, Capital Stock, and DMB Loans and Discounts Used by and Value Added Generated in the Manufacturing Sector (share of the total industry in percentage)

<table>
<thead>
<tr>
<th>Year</th>
<th>Labor</th>
<th>Capital Stock</th>
<th>DMB Loans &amp; Discounts</th>
<th>Value-Added</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974</td>
<td>17.4</td>
<td>21.5</td>
<td>58.8</td>
<td>26.0</td>
</tr>
<tr>
<td>1980</td>
<td>21.6</td>
<td>28.1</td>
<td>54.7</td>
<td>29.7</td>
</tr>
<tr>
<td>1983</td>
<td>22.5</td>
<td>27.5</td>
<td>45.5</td>
<td>29.9</td>
</tr>
<tr>
<td>1986</td>
<td>24.7</td>
<td>29.4</td>
<td>46.0</td>
<td>31.7</td>
</tr>
</tbody>
</table>

discretionary or non-discretionary) to promote manufacturing industries may have been the driving force behind the rapid industrial expansion. It also implies that the rest of the economy may have suffered from a shortage of funds.

Industrial development may reveal itself not only in expansion of manufacturing sector as a whole but also increased transactions among firms within the sector. The intensity of interindustrial transactions among domestic industries can be calculated following Pasinetti's (1981) concept of "vertical integration." Seiyama (1988) estimated the measure of Pasinetti's vertical integration for physical capital (in fact, variable capital represented by intermediate inputs for an industry) in Korea for 1978 and 1983. A unit of vertically integrated productive capacity is defined as

\[ S_j^i = A(I-A)^{-1}Y_j, \]

where \( Y_j \) is a vector with \( j \)-th element being one and other elements all being zeros; \( A \) is a matrix in which \((i,j)\)-th element represents the amount of \( i \)-th products directly required to produce one unit of \( j \)-th product. \( S_j^i \) represents the intermediate inputs directly and indirectly required to produce one unit of \( j \)-th final good. Let \( S \) be the matrix comprised of \( S_j^i \) for all \( j \). The \( i \)-th row of \( S \) represents the vector comprised of the amount of \( i \)-th
product as direct and indirect intermediate inputs for each industry, $j$, for all $j$.

According to Sejiyama, the vertical integration of Korean industry had increased during 1978-1983 period.\textsuperscript{22} That is, most elements of the $S$ matrix increased to levels similar to those of Japan. For example, the amount of domestically produced steel products directly and indirectly required for one unit of secondary metal was 0.452 units in 1978 and increased to 0.561 units in 1983. For notation, let's denote this by

"(steel, secondary metal) = 0.452 \rightarrow 0.561."

Then, some of his calculations can be reported as:

(steel, car) = 0.155 \rightarrow 0.289,

(Steel, other transportation equipments) = 0.255 \rightarrow 0.304,

and

(Steel, general machinery) = 0.333 \rightarrow 0.283.

Thus, the unit structure of major steel-using industries changed toward a greater use of steel, except for general machinery.

For another example, the amount of domestically produced chemical products directly and indirectly required for one unit of fiber yarn increased from 0.444 units to 0.524 units in 1983. Using the same notation as above,

(chemicals, textile products) = 0.19.2 \rightarrow 0.231,

(chemicals, gum products) = 0.166 \rightarrow 0.148,

(chemicals, wood products) = 0.051 \rightarrow 0.081,
and
(chemicals, paper products) = 0.064 -> 0.101.
Thus, except for the gum products, the unit structures of
the major chemical-using industries changed toward a greater
use of chemicals.

The fattening of the $S$ matrix reported by Sejiyama
proves neither presence of interindustrial externalities nor
improvement of competitiveness of domestic supplying
industries (in the above examples, steel and chemicals).
But, at least, it represents increased interaction among
domestic industries. To the extent that expansion of
industrial production requires technological capabilities,
the increased interindustrial interactions will represent
increased technological capabilities in the industrial
sector and increased division of labor in the economy as a
whole.

The issue of how Korean industries were able to improve
technological capabilities relates to the institutional
framework for rapid transition. Theoretical framework is
discussed in Chapter III.

2.3. Literature Review

The previous two chapters have shown that, despite the
non-market elements in the Korean financial system, the
Korean industrial sector developed. How a non-market
element could blend with a market economy and help the
economy perform well in industrial development is rarely addressed in the literature, especially that for the development of a lagging economy. The neoclassical literature concentrates on the positive effects of free competition in financial markets and the negative effects of price control on markets. The World Bank (1993) breaks new ground in this respect, applying the concept of market-confirming intervention.

What follows looks into the "financial deepening" argument suggested by Shaw (1973), one of the most influential theorists of the finance-economic development nexus. Shaw's argument on financial deepening has influenced both practitioners and those in academia. Shaw's views on financial deepening, financial liberalization, and financial repression are examined in Section 2.3.1. A critique will be provided in Section 2.3.2.

2.3.1. Theory of Financial Deepening

Shaw recognized that markets in lagging economies are segmented, the capital market being the most fragmented of all. In fragmented markets, each segment reports different prices and monetization has not been exploited to the full. Thus, backwardness is an inefficient state. The inefficiency is caused partly by the tendency of a lagging economy to resolve transactions through barter and commodity money. But Shaw argues that inadvertent government intervention amplifies the tendency toward inefficiency.
In fragmented markets, there are as many opportunity costs of money as there are isolated markets for money. Here, money cannot be properly viewed as homogeneous wealth in the national balance sheet or analyzed as such. Shaw suggests instead that the services of monetary system be viewed as intermediate inputs for other industries. The monetary industry is one of the many industries that produce goods and services using intermediate inputs, capital, and labor services.

The introduction of monetary services as an intermediate input expands the production possibility frontier. Specifically, it releases resources from the inefficient search-and-bargain process. It also extends the boundaries of markets. The growth of the monetary system increases the "interconnectedness" (Townsend, 1983, 906) of the segmented capital markets. Eventually, it will consolidate them into one capital market. In doing so, it reduces interregional and interindustry differences in returns on investments, and the average yield on investment increases. It also increases the rate of return on physical capital that is not easily marketable by increasing its liquidity. This is a mechanism of financial deepening causing industrialization.

Financial deepening discloses the scarcity of savings and stimulates saving. It raises accessible rates of return on investment. It discriminates more effectively between
investments (Shaw, 1973, 77). It moderates investment dualism. In a dualistic market structure, firms favored by administered interest rates invest too much in capital-intensive projects, and firms that face free market interest rates invest too little. Financial deepening prevents these inefficiencies. It enables banks to accommodate larger lumps of investments; the banks can help firms exploit complementarities between investments. Once capital markets are integrated, the more effective utilization of resources and the realization of economies of scale and comparative advantage will result. There, financial institutions exercise selectivity in credit allocation among investment outlets on the basis of the information they collected about capital productivity.

This process of economic development accompanying financial deepening is stalled if government intervenes. The government intervention distorts the price mechanism through interest rate ceilings and by rationing funds according to its non-economic (usually, political) logic. It is a regime of "financial repression" causing economic stagnation. Financial repression is defined in terms of price control; that is, as "distortion of financial prices including interest rates and foreign-exchange rates" (Shaw, 1973, 3).²³

The use of the services of money for search and bargain is repressed because the real money balance is taxed by
inflation. Hence, the positive effect of monetization on income growth is being missed in a financially repressed economy. Repression of a feasible rate of return on institutional savings decreases savings; hence, the savings-income ratio decrease. It also decreases the allocative efficiency of investment. It decreases employment by allowing capital to be substituted for labor. It worsens income distribution. In short, the effects of financial repression are "[to twist] the path of development in lagging economies away from steady and optimal growth" (Shaw, 1973, 47). Shaw's prescription to heal these ailments is a liberal reform: remove the regulations that cause the financial repression by releasing real rate of interest.\textsuperscript{24} It is to let interest rate to discriminate ruthlessly among investment options. Then, he predicts, all the good things of financial deepening will take place; that is, more resources are pooled in the financial institutions and investment opportunities with higher rate of return are more efficiently exploited.

As shown in the previous section, the Korean financial system is characterized by interest rate ceilings and preferential pricing and allocation of loans. A direct application of Shaw's definition of financial repression to the Korean case leads to a proposition that the Korean financial system has been repressed. From this follows the prediction that the Korean economy should have stagnated.
To the contrary, the Korean industries have developed and the economy has recorded one of the highest growth rates in the world during the last three decades. This brings us to the question raised by C.H. Lee motivated this study, namely, "how has South Korea been able to develop so rapidly with a repressed financial system..." (Lee, 1992, 189). I want to distinguish between the genesis and the operation of the market mechanism. Shaw has explained the operation, but his argument lacks a genetic mechanism. It is based on the presumption that the market mechanism is innately perfect.

2.3.2. The Neo-structuralists' Critique of Financial Liberalization

Van Wijnbergen (1983; 1985) and Taylor (1983) are two of the critics of financial liberalization theory known as "neo-structuralists." Neo-structuralist macroeconomic models focus on the transmission mechanism of an increase in the interest rates. Assuming that in the absence of a security market, owners of firms in a lagging economy retain their earnings to lend them to their own firms at the curb market rate, van Wijnbergen (1983) has shown the theoretical possibility that a raise in the ceiling on domestic credit makes working capital more expensive to finance, increasing the marginal cost. The tighter credit will push up the interest rate and lead to lower investment and a lower demand for goods. Thus, the aggregate product will be reduced. The "direct transmission mechanism" between
domestic credit and production is based on the institutional fact in most lagging economies that "commercial bank credit is used almost exclusively for business loans to finance working capital requirements of firms" (van Wijnbergen, 1983, 63).

In an empirical work, van Wijnbergen (1985) has shown with a macroeconomic model of Korea that time deposits are closer substitutes to loans outstanding in the curb market than to cash. The model disproves the neoclassical assumption about the structure of the financial system that time deposits are closer substitutes to unproductive assets not providing any intermediation, such as gold or cash, than they are to assets providing more intermediation than the banking system such as loans in the curb market.

Taylor (1983) analyzed the effect of an increase in the time deposit rate when the time deposit is a close substitute to curb savings. He concludes that financial liberalization in the form of an increase in the deposit rate of interest decreases both investment and output. Even though questions are raised about superiority of curb market in intermediating savings and investments, Taylor has clearly shown that the substitution effects between liquid assets may lessen the positive effects of financial liberalization.

The condition that bank deposits should be closer substitutes to unproductive assets (cash, gold) and foreign
assets rather than to capital goods is also stressed by Morisset (1993) for effective financial liberalization. Using Argentine data during 1961-82, he has shown that the increase in real interest rates does not necessarily lead to an increase in private investment.

Daniel and Kim (1992), assuming a dualistic market structure, contend that interest rate ceilings on bank interest rates can stimulate total investments above the level that the free market would reach and that they need not sacrifice high productivity projects for low productivity ones. This argument presumes a marginal efficiency of investment schedule that depends only on the level of investment, two independent supply-of-funds schedules: the curb savings and bank savings. The presence of a dualistic market structure is due to the inability of banks to charge different rates to different customers for the same type of loans. Given that the curb market is independent of regulated markets, the free market leads to an excess of savings over investment because the savers who refrain from buying bank savings at a freely determined bank deposit rate (at which level investment is equal to bank savings) would save in the curb markets at higher rate of interest rate. In this case, the suppression of bank interest rates will increase investment and decrease savings, resuming an equilibrium at aggregate level. The baseline of the argument is that when the sources of funds
have distinct characteristics, a monopsonistic price
discrimination may help increase aggregate savings.

Even though Daniel and Kim's conclusion is telling,
their settings are unlikely to hold in a lagging economy
because there savings usually fall short of investment
demand even before repressive finance is introduced. A
possible counter-argument in line with Shaw is that the dual
market structure itself, the curb market being dependent on
the regulated markets, is the result of financial
repression; thus, financial liberalization would integrate
the two markets.

Money is substituted for unproductive assets such as
gold and commodity money during the early period of economic
development because industrial transactions increase, not
simply because the portfolio motive to maximize the rate of
return on wealth leads the households to select the most
productive investment opportunities. The studies by van
Wijnbergen, Taylor, and Morisset affirm this view. But,
they did not look into the details of the process in which
industrial trade increases. This relates to the structural
and technological difficulties that a lagging economy should
face to take advantage of being a latecomer.

As for Korea, the argument that financial
liberalization programs implemented during 1965-1972
improved savings is not convincing. A simple test for the
argument that a rise in interest rate would increase saving
is to take a look at the domestic savings rate during 1965-1972, a period of high-interest-rate policy, and that during 1972-1976, a period of low-interest-rate policy. Even in the latter period the domestic savings rate continued to increase. This reaffirms the World Bank's (1993) test of causality between savings and growth for Korea: Growth caused savings and savings did not cause growth in Korea.

Shaw's proposition that financial liberalization leads to economic growth may apply more readily to a developed economy in which growth is constrained by the technological capabilities for innovation. In a developed economy, Eurocurrency markets provide a natural open market. Any policy to obstruct its work would not be viable in the long run once control of foreign capital is loosened. But, even there, there are no guarantees that financial liberalization necessarily improves economic performance. The capital market may fail even in the most developed economy environment. Stiglitz (1989) argues that there may be credit rationing in the loan market (Stiglitz and Weiss, 1981) and equity-rationing in the capital market, because information can never be perfectly symmetrically held between fund users and fund providers; and financial liberalization may not necessarily lead to improvement in allocative efficiency.

Moreover, the economies of scale in financial service provision will allow a monopolistic power to come into
existence. The idea of a "self-disciplining market" is far from realistic for the financial market of developing economies.

Lane (1994, 61) provides four preconditions for financial markets to be able to discipline themselves. First, they must be free and open. Second, adequate information must be available about the borrower’s existing debts and the prospects of repayment. Third, there should be no possibility that lenders will be bailed out in the case of an impending default. Fourth, the borrower must respond to market signals before being excluded from the markets. All of these requirements seem too demanding for a lagging economy. Various problems would be expected to arise due to asymmetric information innate in intermediation and due to lumpiness of investment and interdependence of investments.

2.3.3. Critiques of Financial Deepening

While the neo-structuralists’ critiques focus on the relationships between financial prices and financial magnitudes such as savings, I will focus on financial deepening as a genetic mechanism of industrial development.

The shortcoming of the Shaw’s otherwise sound theory of financial deepening stems from his neglect of structural problems that lagging economies are sure to encounter in the course of industrial development. The critique below is in the same vein as the neo-structuralist argument in that
financial liberalization does not necessarily lead to economic growth (Van Wijnbergen, 1983). But the argument advanced here contends that the financial market develops as an effect of industrialization, especially in the case of latecomers.

Shaw divides industries into monetary and non-monetary industries. Non-monetary industries are treated either as if they are homogeneous or as if they are in an economy which is in steady state and where there are no structural problems. He has argued that financial deepening increases "the average and marginal products of factors" producing aggregate product; he calls this the allocative efficiency improvement effect of financial deepening. No further distinction of the industries with respect to their intensities of monetized transactions is explored.

But, as a matter of fact, even among the non-monetary sector, there are strong contrasts between industry and agriculture in their intensities of monetized transactions. Agriculture involves transactions that are not mediated with money. Peasant-owned agriculture uses little wage labor and retains a lot of output for their own consumption compared with the industrial sector that employs wage workers for market production. Thus, agriculture is much less intensive in monetization than industry. If there arises any gain from monetization in the economy, it occurs in close relation with industrialization. As the economic structure
changes toward industry, money grows faster than aggregate product. The trend toward urbanization will amplify the tendency. If monetization is not exploited to its full extent in a lagging economy, as Shaw has argued, it is because agriculture predominates over industrial activities.

Historically, the initial stage of economic development were characterized by increasing industrial activities and increasing monetization. Bordo and Jonung (1987) examined the behavior of income velocities of money, i.e., the ratio of income to M2, in thirteen advanced countries from the 1870s to the 1970s. They found a U-shaped pattern: a long-run fall and a subsequent secular rise. The initial decrease in the ratio is closely related to a industrialization. Korea seems to be still in the first stage. During 1960-1986, the share of labor employed in agriculture shrank from 76.5 percent to 23.6 percent. The income-money (M2) ratio decreased from 8.8 in 1960 to 2.98 in 1986.29

There are many theories about the behavior of income-money ratio. Most of them predict either an increasing trend (e.g., Friedman and Schwartz, 1963; Goldsmith, 1969) or a decreasing trend (I. Fisher, 1911; Baumol, 1952).30 According to Bordo-Jonung's explanation, the downward trend can be attributed to the process of monetization, and the upward trend to the dominant effects of increasing financial sophistication (that is, the appearance of money
substitutes) and improved economic stability causing precautionary demand for money to decrease. Monetization is the "growing use of money for transaction at the expense of a decline in barter and payments in kind, occurring simultaneously with an expansion of markets and decline of production for own consumption" (Bordo and Jonung, 1987, 22). Monetization requires expansion of a commercial banking system supplying the public with notes and deposit facilities. For that matter, supply-side initiation will help for new financial services to be provided. But, eventually, inter- and intra-industrial transactions should be increased. Industrialization process also shows an inverse U-shaped pattern as economies develop; that is, the shares of products and employment in industry first increase then decrease as services become more important activities. At this stage, the financial sector is highly sophisticated and money is economized on. Therefore, the dichotomy of an economy into a monetary sector and a non-monetary sector may be misleading as far as the monetization process is concerned. The in the early stage of economic development, it may be more relevant to discuss the effect of industrial development on financial growth than to discuss the effect of financial deepening on the non-monetary sector as a whole. To be meaningful, the discussion on the causes and consequences of underdeveloped monetization needs to include
discussions on the problems of industrial development such as technological capabilities.\textsuperscript{33}

In retrospect, it seems that Shaw was attacking a false version of structuralism that is based on the Phillips curve and its policy implication for suppressing the real interest rate through inflationary monetary expansion in order to reduce the unemployment rate.\textsuperscript{34} It is not the macroeconomic rigidity that concerns the selective credit allocation regime, but development of internationally competent domestic industries. Shaw never succeeded in refuting the alternative view that "subsidy at the expense of some savers appears necessary for desired investment" (Shaw 80)\textsuperscript{35} and the view that "direct controls can succeed in the savings-investment process" (Shaw 80). His arguments are based on the presumption that markets are innately perfect, which is being criticized on the basis of, among others, informational imperfections.

Shaw himself has recognized the possible obstacles to the effectiveness of financial liberalization. He has mentioned the zero elasticities of factor substitution, the zero elasticity of savings to the rate of interest, and high interest rate elasticity of investment (77-78). But, he predicts optimistically that "technologies and tastes are not the rigid constraints" (Shaw 78). In the same vein, we may understand Krugman's (1978) argument that, even when there coexist a traditional technology and a modern
technology which has increasing returns, a capital market could develop in the absence of interest rate restrictions.

Apart from informational imperfections, these views are criticized in the current literature. Contrary to their prediction, recent empirical studies about "indigenous technological capabilities" attest to the opposite. Pack and Westphal (1986), having surveyed empirical studies on the issue, contend that technology attainment is not a trivial problem. Furthermore, Bell, Ross-Larson, and Westphal (1984) find little support for the argument that firms entering a new industry benefit from free technology spillovers. Lall (1994) also finds that the technology market is imperfect. A firm incurs large costs to acquire a new technology to produce products new to the locals. Thus, technological constraint is indeed rigid and the whole argument of financial liberalization as a strategy for monetization-cum-industrialization is founded on a loose ground.

The task of overcoming technological and structural constraints may be addressed with efforts by the government through the technique of selective credit allocation (only if the country has the social capabilities to let the selective credit allocation be implemented effectively). That way, a lagging economy can exploit the gains from late industrialization, the rest of the tasks of shifting
resources from agriculture to industry being taken care of by the market mechanism.

The origin of fragmentation in the financial markets may be attributed to the extent of industrial backwardness (due, for example, to social incapacities) rather than to the presence of government intervention. Indeed, in the case of Korea, the presence of government intervention may evince the institutional efforts to overcome those obstacles to industrial development. Korea's success in industrial development enables us to posit that industrialization instrumented by selective intervention may have caused financial growth.36

2.3.4. Theory of Neutral Incentives

The theory of financial liberalization is closely related to that of "neutral incentives" suggested by Bhagwati (1978). Both are based on the idea of allocative efficiency resulting from free competition. But the latter recognizes the presence of government intervention.37 It argues that, if the effective exchange rate for export, after the differential effects of taxes and subsidies are taken into account, is equal to the effective exchange rate of import, then the incentives are defined to be neutral. Bhagwati calls it an "export promotion strategy."

By assuming that static allocative efficiency (especially of investment) is a necessary and sufficient condition for a maximum feasible growth rate, Bhagwati
attributes Korean economic growth to the achievement of allocative efficiency through neutral incentives. He contends that the neutral incentives policy has been the key to the Korean success, because the policy "brings incentives for domestic resource allocation closer to international opportunity costs and hence closer to what will generally produce efficient outcomes" (1988, 36).

This neutrality is an ex post version of the static efficiency condition in the presence of government intervention. The static efficiency conditions are stated in many different ways. The production-efficiency theorem (Peter A. Diamond and James Mirrlees, 1971) for an open-economy optimal tax problem is an example: in any case, the marginal rate of transformation should be the same as the foreign rate of transformation (Giovannini and De Melo 954). This first-order condition derives from a model that assumes the absence of externalities, especially, from learning by doing.

The absence of externalities accruing over time is a crucial condition for the validity of such rules. Thus, those who argue that Korean growth is due to neutral incentives should first show that external effects are non-extant or insignificant.

Apart from the issue of the existence of externalities, questions arise about whether the Korean incentives were neutral. The World Bank (1993) argues that the incentives
were neutral only on average. Pack and Westphal (1986) provide evidence that in Korea the incentives were biased in favor of some industries, the industries changing over time.\textsuperscript{38} This raises the essential question of whether their perception of Korean incentives as neutral ones is correct.\textsuperscript{39} The government’s commitment to exports may signify instead a bias in favor of export industries rather than a commitment to free-trade principles\textsuperscript{40}.

It seems that not only exports but also investments are governed by the systemic strategy. According to a Syrquin (1976)-type growth accounting\textsuperscript{41} for Korea during 1975-1980 and 1980-1985 periods performed by W. E. James, Hee-Sik Kim, and N. Fujita (1993), the export expansion (EE) effect dominated the import-substitution (IS) effects on output-expansion at a general level. But, at the disaggregate level, import-substitution was substantial in a number of export-led industries during the 1975-1980 period, including primary metal products, electrical and electronic products, and transportation equipment. IS effect was larger than EE effect in general machinery during the period. During the period 1980-1985, even though the IS effect became less significant across the board, its significance increased in general machinery, primary metal products, and transportation equipment. Thus, it can be said that Korea has used both strategies simultaneously.
A slightly different neoclassical argument for the source of Korean growth has been suggested by Krueger (1980; 1990). She asserts that neutral incentives solve all the problems of "minimum efficient size of plant, increasing returns, indivisibilities in the production process, and the necessity for competition" (Krueger, 1980, 289) through expansion of exports. But it is hard to believe that the mere restraint of the government from intervening except when necessary to make the incentives neutral has led to the rapid increase in exports in Korea. If the expansion of exports solved all the problems arising from the indivisibilities and so on, then the expansion of the heavy and chemical industries must also have been induced by the increase in export demand, since they are the industries for which the problems of scale and indivisibility are most severe. However, the theory does not explain the following fact: heavy and chemical products in Korea, which were initially imported, could be exported only after the deliberate efforts to produce them succeeded domestically. It is difficult to accept that the firms that grew out of exporting textile could undertake import-substitution projects without assistance from the government. Amsden (1989) observes a non-linear pattern in Korean industrial development; that is, it was not the existing textile-exporting firms but new entrants that were members of chaebols that could undertake a high-technology, capital-
intensive line of products such as synthetic fiber. While the non-durables were being exported, the import-substitution of the durables was undergone. This implies that Korea's rapid export-driven growth is not the result of neutral incentive policies, but rather the consequence of effective government intervention in "market entry and exit decisions, the allocation and price of funds, international trade and investment decisions, and labor market conditions." \(^{42}\)

One argument against the export-promotion strategy in a Bhagwatian sense, i.e., the neutral incentives strategy, is that the static efficiency gains may be dominated by dynamic efficiency gains. Notably, Ann E. Harrison (1994) finds a straightforward fault with the oft-cited paper by Krueger and Tuncer (1982). Although Krueger and Tuncer found no tendency for input per unit of output to fall more rapidly in more protected industries in Turkish manufacturing industries, Harrison has found "a statistically significant positive relationship between increased protection and higher productivity growth" (1994, 1090), using their result data. This leads to the opposite conclusion: the more protected an industry is, the faster its productivity grows. Another example is from Kwang-Suk Kim (1994) who argues that "there is no clear indication that import liberalization had any significant effect on industrial productivity." Thus, neutral incentives do not seem to be the cause of Korean
success. Moreover, it seems incentives were biased out of necessity.
NOTES

1. For more details, see Financial Systems in Korea, various years.

2. According to Hong and Park (1986 167), during 1962-66, the KDB alone provided more than one-third of total bank loans in the form of discretionary policy loans. During 1967-76, the KDB and the Korea Export-Import Bank provided only about 15 percent of total loans but their share in total bank loans expanded to about 18 percent during 1977-81.


4. The power of the Minister of Finance was strengthen and the function of formulating foreign exchange policy was transferred the BOK to MOF (Pyung Joo Kim, 1994, 279).


6. Oh, Pak, and Sin, July 1994, 16 n. 27.

7. Oh, Pak, and Sin, July 1994, 16 n. 27.


11. Song-Hun Lee, Si-Dong Kim, and Song-Ho Han, 1989, 85.

12. When the balance of payment turned into surplus during 1986-1989, the liquidity had to be controlled by the issuance of so-called Monetary Stabilization Bonds (MSB) by the BOK. Interest rates on the MSB were close to market interest rates. During the 1985-1990, the bonds rates were 12-16 percent per year while the rediscount rates were 3-7 percent annually. Thus, the difference may be considered as the costs of financing industrial policies through rediscounts from the viewpoint of the central bank.


16. The methods which Mayer (1988) used in calculating the numbers were also used for Korea. First, the current values with investment deflators are deflated. Second, the investment is depreciated on a straight line basis. Then the remaining values were summed up for each year.

17. The share of retention is greatest in U.K. and U.S.A., where the financial markets are most developed, and smallest in Korea and France, where the financial markets are least developed. Whether "development of capital markets does not necessarily lead to a larger role in financing industrial investment," as Mayer argued, or "the high shares of retention in U.K. and U.S.A. reflect low investment demand by corporates in those countries, rather than the deficiency of the capital market," as Mankiew (1988) argued, cannot be resolved with the data provided.


20. The World Bank (1993 226) also shares the view.


22. Sejiyama, 1988, 32-25, Table 4 and Table 5.

23. More specifically, Fry (1980) defines it as "the technique of holding institutional interest rates...below their market equilibrium levels." More generally, McKinnon (1991) defines it as a situation in which "governments tax or otherwise distort their domestic capital markets" (11). In the context of an open economy, Giovannini and De Melo (1993) defines it as "a combination of controls on international capital flows with restrictions on domestic interest rates" (953). They argue that it results in an artificially low cost of domestic funding to governments; and that the difference between the rate of interest that government pays for borrowing from world financial markets and the rate of interest that it pays for domestic debts represents the degree of financial repression. They measure the magnitude of government revenue from financial repression by multiplying the differential with the average annual stock of domestic debt. The financial repression is distinguished from inflation tax (or seigniorage) in that the base of inflation tax is the high-powered money, while financial repression affects the portfolio of real assets held by domestic residents.
24. Later discussions on financial liberalization emphasizes "prudential regulation and supervision" (Gelb and Honohan, 1991 77).

25. See for example Young (1994).

26. Refer to discussions in Park (1982).

27. Eurodollars dominate the Eurocurrency markets. Eurodollars are deposits of U.S. dollars in banks located outside the United States. Most Eurodollar deposits are short term.

28. Patrick's (1966) argument for opening a new capital market as a supply-leading finance may also fail due to asymmetric information. Imperfect information in the equity market may lead to equity-rationing or capital market failure. See Myers (1984).


30. For details, refer to Bordo-Jonung, Ch. 2.

31. In selective credit allocation regime, supply side initiation is taken by the government.

32. See, for example, Syrquin and Chenery (1989).


34. "The theory of structural inflation suggests as the guide to policy...that M [Money balance] should increase at the same rate as P\_e [expected price level] and, in order to reduce r[real interest rate], even higher" (Shaw 101).

35. Jappelli and Pagano (1994) argue that liquidity constraints on households contribute to economic growth by allowing savings and investment to increase.

36. Even though the M2-GDP ratio is exceptionally low in Korea compared with countries at similar level of development, the time series of Korea data suggest direction of causality running from industrialization to financial deepening (see Park and Patrick, 1994).


38. The presence of cross-industry biases in incentive systems can be observed even in Balassa, et. al. (1982).


41. It should be pointed out that the methodology has strong limitations in that it assumes an arbitrary causality with final demand creating supply.

42. See Hart-Landsberg, 39.
CHAPTER III
SYSTEMIC APPROACH

In search of the genetic mechanism of Korean industrial development, I have criticized both the arguments for financial deepening (actually, its prediction on the effect of financial repression) and neutral incentives in Chapter II. Strangely enough to the eyes of neoclassical observers, the repressive financial system relates to positive performance in the Korean industries. In fact, the Korean incentive schemes were strongly biased in favor of some manufacturing industries. Now, there remain two lines of search. The one is to test the hypothesis of the absence of external effects that underlies the neutral incentives theory (This will be done in Chapter IV). The other is to consider the theoretical possibility that the selective credit allocation is the center of the genetic process of Korean industrial development. This is the subject of this chapter.

My approach to making inference about the allocative efficiency of an economy differs from the neoclassical. The neoclassical approaches focus on the functioning of price mechanisms in the markets and then make inferences about the allocative efficiency of the economy. Instead, I include both the financial sector and the industrial sector into the scope and look into their interaction to make inference about dynamic efficiency. In an economy undergoing a rapid
structural change and subject to various obstacles to market functioning, finance matters for industry and vice versa. Thus, for analyzing such an economy, a holistic or systemic approach is inevitable.

3.1. Coordination Problem in Late Industrialization

In a market economy, "what, how, and for whom" to produce are coordinated by market prices. A lagging economy is characterized not only by the predominance of traditional agriculture but also by underdeveloped markets. In particular, capital markets are severely imperfect in the lagging economy simply because the dominant industry, agriculture, does not need a sophisticated capital market. In an underdeveloped market, prices fail to signal information. Thus, it is unlikely that anonymity of the market brings about best coordinations. This is particularly so because the investment opportunities will be highly indivisible and interdependent in a lagging economy. The indivisibility of investment is usually due to the fact that advanced technologies are available only in packages. Thus, the optimal size of investment is larger than the domestic market could support. In this case, interdependence of industrial investments is caused by (and causing) underdevelopment of domestic industries in general. At the same time, productivity of an investment by an
industry will depend greatly on what is going on in other industries.

### 3.1.1. Pecuniary External Effects and Big-push

Positive external effects in production are defined as "unpaid side-effects of one producer’s output or inputs on other producers" (Bohm, 1987, 261). Thus externalities are transmitted outside the markets. But pecuniary externalities are transacted inside the markets. For one example, suppose an economy in which most industries are underdeveloped such that they all have potentially increasing returns on technology but they are presently in operation with constant returns to scale. Even when they are independent from each other technologically, their productivity may be closely correlated through pecuniary external effects. Investment by one industry increases demand for another industry’s product, thus helping it to overcome difficulties coming from smallness of its market.

Pecuniary externalities are considered not to disturb efficiency conditions if information is perfect; it creates rents for one at the loss of another. But where information is not perfect, it may affect efficiency. For the sake of simplicity, let’s assume a closed economy. Investment in increasing returns will be profitable only when all the industries choose to invest at the same time. When only one industry invests in increasing returns on technology, domestic demand falls short of supply. But
simultaneous investment expands aggregate demand enough to accommodate the investments. Thus, two equilibria are possible: industrialization and non-industrialization. Current prices may fail to induce an industrialization equilibrium. In this case, the possibility of warranted government intervention arises in a symmetric environment where the paths of spillover are not specified and where problems due to asymmetric information are supposed to be absent. The government may just have to encourage simultaneous investments to shift the equilibrium toward the superior one. This is the big push theory developed by Rosenstein-Rodan (1944) and recently by Murphy, Schleifer, and Vishny (1989). It entails an extensive planning.

However, it is difficult to regard the policy suggestions based on the argument as relevant to a lagging economy. First, availability of goods from domestic industries in itself may not generate a beneficial effect on the activities of its customer industries because the same input materials will be available from abroad. Policies promoting import-substitution without expansion of exports may lead domestic production too costly to be internationally competitive. Second, increasing-returns technology will not be available just for the asking from the advanced economies. As Bell, Ross-Larson, and Westphal (1984) pointed out, firms entering a new industry may be paying high costs to obtain technologies. The big push
model neglects the details of obtaining technology, which include a lengthy process of increasing the capabilities to learn technology and to invest. Finally, it disregards the problems related to asymmetric information. The informational requirements for planning may be too large for the government in a lagging economy.

3.1.2. Learning-by-doing

Efficiency condition states that, in any case, the marginal rate of transformation should be the same as the foreign rate of transformation. In what follows, an exemplary model that shows this may not be the case for an environment closely resembling the reality in a lagging economy. It is Rauch's (1992) model of learning-by-doing effect which derives a rationale for subsidy to learning industry and a rule for optimum subsidy.³

Industry M has learning-by-doing effects external to its individual agents. Rauch defines a learning function as \( G_M(Q_M) \), where \( Q_M \) is the cumulative output of industry M. Assuming that \( K \) and \( L \) are sector-specific factors to M and A, respectively, the production functions for M and A are

\[
Y_M = G_M(Q_M) F_M(K, N_M)
\]

and

\[
Y_A = F_A(L, N-N_M),
\]

where \( F_i \) is a production function with constant returns to scale and diminishing marginal products of sector i; \( K \) and \( L \) represent capital and land, specific factors to the
production of $M$ and $A$, respectively. $N_i$ is the labor used in the production of $i$. Thus,

$$N_A + N_M = N.$$ 

The labor market is assumed to be perfect after government intervention. $G_M(Q_M)$, where

$$\frac{dQ_M}{dt} = \dot{Q}_M = Y_M,$$

denotes the effect of learning-by-doing on productivity. The learning-by-doing effect has a logistic curve: it is an increasing function of $Q_M$, the increasing rate diminishing for $Q_M$ less than a certain finite level, and being zero for $Q_M$ larger than the level.

The economy is assumed to be a small open economy such that

$$Y_A - C_A = p_M(C_M - Y_M),$$

where $C_i$ is consumption of $i$, and $p_M$ is the world relative price of $M$. The command economy will solve the problem of maximizing the discounted sum of utility

$$\int_0^{T} e^{-\rho t} U(C_A, C_M) \, dt,$$

where $\rho$ is rate of time preference,

subject to

$$Y_A - C_A = p_M(C_M - Y_M) \text{ and } \dot{Q}_M = Y_M.$$ 

A flow chart will help us understand the structure of the economy. It is drawn under the assumption that the
learning sector's products are exported and non-learning sector's products are imported.

The current-value Hamiltonian is

$$H = U[Y_A(L, N-N_H) - P_M[C_M - G_M(Q_M) F_M(K, N_M)], C_M] + \lambda G_M(Q_M) F_M(K, N_M),$$

where $\lambda$ is the costate variable of the state variable $Q_M$.

The first-order conditions for maximum are

$$C_M: - (\partial U/\partial C_A) P_M - \partial U/\partial C_M = 0$$

$$N_M: (\partial U/\partial C_A) [- (\partial F_A/\partial N_A)] + [(\partial U/\partial C_A) P_M + \lambda] G_M \partial F_M/\partial N_M = 0,$$

$$\lambda = \rho \lambda - [(\partial U/\partial C_A) P_M + \lambda] G_M^' F_M.$$
rate of transformation should be set equal to the world
price ratio plus $\lambda/(\partial U/\partial C_A)$. Under free trade, the
production of $M$ will be less than the socially optimal level
because it produces a learning-by-doing effect that is
external to the cost-incurring firms but internal to the
industry as a whole. The optimum subsidy rate is given by

$$P_M(1+S_M) = P_M + \lambda/(\partial U/\partial C_A)$$

or

$$S_M = \lambda/(\partial U/\partial C_A) P_M = \lambda/(\partial U/\partial C_M).$$

The subsidy increases the experience accumulation at the
cost of a decrease in the current consumption possibilities.

The expression for the optimal subsidy,

$$S_m = \lambda/(\partial U/\partial C_A) P_M = \lambda/(\partial U/\partial C_M),$$

suggests some criterion for the choice of policy instrument.
The numerator, $\lambda$, denotes the opportunity cost of
increments in cumulative output and hence the learning by
doing. In other words, it represents the marginal benefits
from experience accumulation. The denominator represents
the marginal social costs of the sacrifice of current
consumption for experience accumulation. The cost will
include the cost of public finance.

In a well-functioning market economy, arm's-length
control through a subsidy financed by lump-sum taxes may
suffice to fix the externality problem. But in the real-
world setting of a lagging economy, it is hard to believe
that such a control will work to encourage firms to invest in learning industries. The information for the selection of firms eligible for subsidy may not be sufficient. Thus, industrial policy to foster infant industries that are in the process of learning requires stronger involvement of the government.

With respect to the informational requirement, export performance may provide a "yardstick" for measuring the learning-by-doing effect. Subsidizing export activities through automatic provision of short-term loans will thus not be impeded by informational imperfections. But in helping potential export industries with protection of domestic markets before the exports are realized, the government should take risks. The infant may not grow up.

Investment in human capital by individuals may increase labor’s capability to learn by doing (which takes place mostly in the work place in modern industries). Thus, the government may subsidize education in the manner indicated by the above model.

With regard to the rapid accumulation of human capital in Korea, it should be pointed out that the land reform in 1949 and the 1950s, together with protection and subsidization of the agricultural sector since 1969 must have contributed to the rapid human capital accumulation. During this period, most young people were growing up in small farm households in rural areas. Land reform
transferred land from large landlords to multitudes of tenants. Even though the division of ownership into small sizes must have decreased agricultural productivity for a short period, it contributed to securing a stable source of income for those peasants. Facing a high rate of returns to education amidst rapid industrialization, they possessed the means to invest in the schooling of their children. Some were willing to sell their land to finance their son's college education--this was not considered unusual. With hindsight, those enthusiastic investments in human capital tended to pay off in the long run. During 1945-1960 period, the literacy rate more than tripled, and by 1960, more than 70 percent of the population were literate. In addition to land reform, subsidy and protection of agriculture must also have helped farmers to invest in their children's education out of a stable source of income.

Exporting activity opens opportunities for learning directly. Of course, the main contribution of export expansion to growth in the productivity of the manufacturing sector in a lagging economy is made through overcoming small domestic markets (relative to the production technology with economies of scale property). Export expansion also exposes domestic entrepreneurs and workers to the best practices in the world. In the absence of a perfect market for technology, contact with foreign buyers is an important source of learning technology. In order to improve the
quality of products that they are buying, the foreign buyers help domestic producers improve their technological capabilities. To the extent that exports are composed of manufactures, subsidizing manufactured exports will enlarge the benefit of the learning-by-doing effects accruing to exports.

3.1.3. Sectoral Difference in Productivity Growth

Subsidizing the learning-by-doing in the manufacturing sector (e.g., with credit; see Table 2.6) explains, at least partly, the differential rates of growth in real productivity between the manufacturing and agricultural sectors in Korea. During the 1970-1986 period, real product per worker in the manufacturing sector grew 6.4 percent annually, while that in agriculture grew at 4.4 percent per year. Meanwhile the share of labor employed in manufacturing increased rapidly and that in agriculture decreased.

With the assumptions that production depends only on the per worker productivity (or, average skill level) and that the per worker productivity growth depends only on the fraction of the work force devoted to producing each good, we can calculate the learning-by-doing coefficient of each sector. 7

<table>
<thead>
<tr>
<th></th>
<th>Agriculture</th>
<th>Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth rate of product per worker (annual rate)</td>
<td>0.044</td>
<td>0.064</td>
</tr>
<tr>
<td>Learning-by-doing coefficients (δ_1)^a</td>
<td>0.119</td>
<td>0.338</td>
</tr>
<tr>
<td>Growth rate of capital per worker^b</td>
<td>0.087</td>
<td>0.098</td>
</tr>
</tbody>
</table>

Sources: National Accounts, the Bank of Korea, 1987; Pyo, 1988.

Note: a. Learning-by-doing coefficient (δ_1) is the ratio of the annual growth rate of real product per worker to the average labor share of each sector.

b. The growth rates of capital per worker was calculated for 1973-1986 period.

According to Table 3.1, the manufacturing sector has almost three times as high learning-by-doing capacity as agriculture under the maintained assumptions. Assistance of exports may have induced the learning-by-doing effects to be realized in manufacturing sector. Indeed, the manufactured exports were composing most of the Korean exports.

But the assumption of a Ricardian production function in the above disregards the importance of capital as a productive input. Indeed, capital per worker increased faster in the manufacturing sector than in agriculture. Thus, the productivity differential may reflect the difference in capital intensities. If the differentials in capital intensities between manufacturing and agriculture...
explain all the differences in the growth rates of product per worker in each sector, then the law of diminishing returns together with the limit in the capability to increase capital intensity will predict that the rapid growth of labor productivity in manufacturing sector is not sustainable. Then the heavy control of capital allocation by the government, which is explained in chapter II, might not be internalizing learning-by-doing effects; and it could not be accredited with causing a sustained growth. Rather, it may have to be blamed for causing a medium-term growth at the cost of long-term growth.

But attributing the growth of manufacturing product per worker solely to capital accumulation raises questions. First, increasing capital intensities in the manufacturing sector is not simply a matter of choosing technology among those available; the capabilities to learn technology matters. Even for standard technologies (that declining firms in advanced economy are willing to provide to firms in a lagging economy), a firm must have the capabilities to adapt the technology to the local environment and incrementally improve the technology. The increased capital intensity in the manufacturing sector as a whole might not have been possible without such technological capabilities of indigenous firms. If those technological capabilities improve together with capital intensities and employment shift toward manufacturing sector, the total factor
productivity of the manufacturing sector as a whole must have increased.\textsuperscript{8}

Furthermore, the increase in capital intensity of the manufacturing sector concurred with the increase in the share of labor employed in the manufacturing sector. If a simultaneous increase of labor and capital inputs has the effect of increasing returns to scale, then the improvement in product per worker in the manufacturing sector will be partially explained by the improvement in efficiency brought about by economies of scale.

Second, if the manufacturing sector is inhabited by closely interdependent industries, an industry’s output may increase not only from increased inputs of its own but also from beneficial effects from the expansion of its customers or its domestic suppliers.\textsuperscript{9} In this case, even though the capital intensity of the manufacturing sector as a whole increases, more labor may be employed in the manufacturing sector. This explains the increase in the share of labor employed in manufacturing sector at the same time as the capital per worker grew faster in the manufacturing sector.

The economies-of-scale property and interdependence in the manufacturing sector may be tested. To test the existence of the economies of scale and externalities in the manufacturing sector of Korea is the subject of Chapter V.
3.2. Credit-Based Systemic Approach to Industrial Development

A failure in coordination is most likely to occur in the allocation of credits. First, many manufacturing industries are subject to the learning-by-doing effects, economies of scale, and unknown technology, whereas investments in other activities are subject to familiar technologies. Indigenous savers' ignorance of modern technology may mislead the allocation of capital in favor of well-known technologies. Learning while exporting may alleviate some technological problems. But the effects may not be sufficient to solve all the problems arising in the process of transition (from low-wage-earning, end-product technologies to high-wage-earning upstream technologies). Asymmetric information between borrowers and lenders intensifies the failure of market coordination. Second, external effects are more likely to be generated among manufacturing sectors. To the extent that they are, many socially profitable investment projects are unlikely to be picked up. Third, the economies of scale may entail large set-up costs exceeding the domestic capital market's capacity to finance them.

The market mechanism in a lagging economy is itself in an inchoate stage of development. That is, the markets are in construction as well as in operation. It is premature to perform the harsh task of handling the problems of scale and external effects. These problems were tackled instead by
setting up a systemic strategy, what the World Bank (1993) calls a "mechanism through which business and government could exchange information and coordinate investment decisions" (93). It is a corrective mechanism of market failures. Its rationale is the simultaneous imperfection of technology market and capital markets.

3.2.1. Government-Business Relationship

Two main factors that constitute the credit-based systemic approach are the government-business relationship and the selective credit allocation. The credit-based financial system of Korea may have been conducive to internalizing externalities both from export expansion and from investments in strategic sectors under a well-functioning government-business relationship.

In order to prevent collusion and rent-seeking behavior, it "combines cooperative behavior - including sharing of information among firms and between the private and public sectors, coordination of investment plans, and promotion of interdependent investments--with competition by firms to meet well-defined economic performance criteria."10 The competition differs from that of the market mechanism, in which firms compete with prices.

An alternative competitive principle to market-based competition is utilized in the systemic approach. It is what the World Bank (1993) named "contest-based competition" (93). Firms compete for access to credit by
meeting the criterion that the government uses for selection. For example, to those who get the export order, which is verified through a letter of credit, automatic access to pre-shipment and post-shipment credits are rewarded. In its implementation, the government proper does not get involved. It is administered by the commercial and other eligible banks and the Bank of Korea. Conglomerates which have performed well in exports are given licenses to enter new lines of business. Thus, those which exported lots of textiles could enter a machine industry without any past experience in the trade.\footnote{11}

The new industries that had been strongly supported by the government in credits usually belong to the heavy and chemical industries especially during the 1973-1979 period. Since such industries are subject to economies to scale, the government often set the minimum size of the plant for eligibility. For example, the iron and steel producing firms eligible for support based on the Steel Industry Fostering Act (1970) were to have capacity to produce one hundred thousand tons of iron per year, for which only one company was qualified. The trading companies that qualify government support also had to have a minimum size, which left only about ten firms as eligible.

Controlling eligibility with past performance and size reduces the institutional costs of coordinating industrial investments. The value added in the firms whose president
are eligible to attend the monthly export promotion meetings or deliberative councils cover a lion’s share of the total value added in the manufacturing sector. As Olson (1982) suggests, "if an organization represents, say, a third of the income-producing capacity of a country, its members will on average obtain about a third of the benefit from any effort to make the society more productive" (48). Such a coalition has "some incentive to make the society in which they operate more prosperous, and an incentive to redistribute income to their members with as little excess burden as possible, and to cease such redistribution unless the amount redistributed is substantial in relation to the social cost of the redistribution." Olson calls such an organization an "encompassing coalition."

3.2.2. Selective Credit Allocation

State direction of credit has been the most important single ingredient for the systemic approach. According to Jones (1994):

Discretionary credit allocation is the fulcrum upon which partial mutuality rests. The critical importance of credit to the enterprise, and its virtually complete control by the government, make this a powerful tool for ensuring private compliance with almost any command the government wishes to give. Government control of the banks is thus the single most important economic factor
explaining the distinctly subordinate position of the private sector (510).

The control of credit allocation is made possible by the control of interest rates on bank deposits and bank lending. As Zysman (1983) argues, compared to tax and subsidy technique, the selective credit allocation gives the government the ability to discriminate, to make decisions contingent on actions often unrelated to the particular choice at hand, and to coordinate policies. According to him:

Discretion in the provision of industrial finance—in the selective allocation of credit—is necessary for the state to enter continuously into the industrial life of private companies and to influence their strategies in the way that a rival or partner would. Selective credit allocation is the single discretion necessary to all state-led industrial strategies (76).

While the selective credit allocation affects corporate behavior by directly affecting their balance sheet, taxation affects the marginal returns; thus it has stronger effect on investment decision than subsidy through tax exemption or subsidies. Furthermore, tax and subsidy are not so flexible as credit allocation. Tax and subsidy are difficult to manipulate toward specific industrial ends. They tend to follow rather than to lead new activities.
Actually, selective credit allocation amounts to the definition of "financial repression" by Shaw (1973). Ironically, the repressive financial policies are the cornerstone for the systemic approach.

Historically, government intervene financial sector to extract easy public finance by printing money; the government monopolize the fiat money issues and restrict the supply of money substitutes.\textsuperscript{12} The fiscally motivated repression of financial sector may not be effective. Under fiscally motivated financial regulation, paradoxically, it is the ineffectiveness of the regulation (or, the efficient evasion by financial industries) that may allow an efficient allocation of financial resources.

To the extent that funds are fungible, the directed credits may be diverted to other uses that are not warranted by the mandate of the loans. The whole system of selective credit allocation may fall prey to rent-seeking activities which are not compatible with systemic efficiency. In that case, the selective credit allocation becomes "selective squander" (Hutchcroft); and the government-business relationship a "distributional coalition" (Olson, 1982).\textsuperscript{13}

Hutchcroft (1993) analyzed Philippines' preferential credit allocation.\textsuperscript{14} According to him(165-167), the Philippines' financial system has been troubled by both the "fragmentation" and the "inconsistency" of government credit programs. The selection of beneficiaries of preferential
loans were mainly related to favoritism rather than to a cohesive industrial policy; and the state apparatus is unable to enforce the goals of preferential loans.

The literature seems to distinguish the Korean and Philippine financial systems in terms of degree of financial repression. Roubini and Salai-i-Martin (1992) have found that while a moderate degree of financial repression may not affect excessively economic growth, a strong degree of financial repression is associated with significantly lower economic growth" (45). The World Bank (1993) study on Asian Miracles also uses such a distinction. It finds that "moderate financial repression has not necessarily hindered growth in Korea and Taiwan, China" (241). But in principle, the performance of the systemic approach depends not so much on degree of repression as on coherence of the mechanism to the objective of industrial development. In Korea, selective credit allocation is used to promote rapid economic growth and structural change toward industrial economy in a short period. In the words of Haggard and Lee (1993) it is "government-directed programs that provide lending to 'targeted' sectors, activities, classes of firms, or individual companies in quantities and at interest rates that would not be provided by existing financial institutions acting independently of government guidance" (6). The loans are allocated according to industrial plans and export pushing strategy.
Haggard and Lee (1993) argued that "what is commonly called financial "repression" is, in effect, a "hierarchical system of credit allocation" (12). In particular, it seems to be the case for Korea. The close relationship between government and business in Korea is viewed as something like an internal capital market, what Lee and Naya (1988) named a quasi-internal organization, in which the government plays the role of central unit of the internal capital market.15

While credit and capital markets are haunted by problems due to imperfect information, quasi-internal organization may efficiently allocate credits in a manner that a central unit in a multi-division firm may allocate funds efficiently among divisions. The basis for the efficiency is the government's capability to handle informational problems while solving the problems related to economies of scale and interdependent investment. That is, the coherence of the system as a whole can be achieved through government, rather than the market mechanism. The close communication with business is what enables the government to establish realistic industrial plans. The state control of credits is what enables it to effectively implement the industrial policy.

3.2.3. Consensus Formation

Selective intervention can be effectively implemented only upon explicit or implicit national consensus. Despite the discriminatory nature of the selective credit allocation
during the Park government (1963-1979), the government seemed to get acquiescence for the exercise of selectivity from the public.\textsuperscript{16} At least the agricultural sector, which represented the majority of the public, did not play the role of antagonist in the process of industrialization in Korea in spite of its being discriminated against in regards to credit allocation. For the formation of such an implicit national consensus, the land-to-tiller reform carried out by Rhee government (1948-60) from 1949 to the 1950s must have set the ground.\textsuperscript{17} It had divided farms into tiny sizes. Its effect on agricultural productivity in terms of per acre product seems to have been negative in the short run (Cole and Lyman, 1971). But it provided a backlog for the industrialization thereafter. It bestowed people with more equitable wealth distribution than ever before. Most former tenants became landowner, however small their land size may be. It ensured a potentially stable source of income from their own farm land given that the price of grains remained stable. But up to 1969 (when a two-tier grain price system in which the government purchased grains at higher than selling prices was introduced) farm income must have been suppressed due to the low price of farm products caused by food aid. During the 1970s, the agricultural sector was highly protected. Its effects on political economy was favorable to the government-led credit based systemic approach to
industrialization. The countryside, though still poor, remained calm. At least, people in the area did not turn out to be antagonists to industrialization policy. Large numbers of small firms were unable to form a strong distributional coalition. Partly due to the land reform since 1949, Korean rural areas were supporting the ruling party in elections throughout the rapid industrialization period.

3.2.4. Operation of the Systemic Approach

The incentive for the members to play by the "principle of shared growth" seems to have been strong in Korea. The Park government (1963-1979) was devoted to the objective of economic development because it hoped to gain legitimacy through sharing the fruits of economic growth. The government, staffed by relatively autonomous technocrats, interacted with the business through such channels as monthly export promotion meeting, quasi-state organizations (such as KOTRA), and producer associations. This enabled the government to interact flexibly and realistically with the business especially in making and implementing plans.

The government has leverage to control business mainly through control over credit. It also uses control of market entry, trade, and key industrial inputs like steel. The provision of access to credits is "carrot"; at the same time the removal of it could be a "stick." Any deviant
entrepreneur can be readily punished by tax examination or the suspension of new loans.

Even though the export-orientedness of Korean firms contributed to overcoming the smallness of domestic markets, the direct effects are limited to export industries. The market size limitation had been always extant for the heavy and chemical industries. Thus, the industries were designed to be export industries from the beginning. Survival of such industries in the world market meant survival of the industry itself. Thus, the government was eagerly promoting exports of the heavy and chemical industry products.

The government’s assistance included not only preferential treatment in loans but also setting product prices that benefitted exports. In the case of petrochemical industry, which provides raw materials to chemical fiber industries, the government reserved the right to determine the selling prices of the raw materials for chemical fibers such as acrylonitrile monomer and caprolactam since the beginning of their domestic production in 1972 and 1974, respectively. The prices of these products were set such that the export prices were lower than the average costs. The losses were redressed by the prices of domestic sales set at higher level than that for exports (see Table A3.1 in the appendix).

According to a study comparing Korean and Japanese capacities for producing synthetic fibers as of 1971, the
size of Korean plants for synthetic fiber did not reach an
efficient scale; the average Korean plant capacity, compared
to Japanese counterparts, was one sixty fourth for nylon
filament, one ninth for polyester filament and staple fiber,
and one fourth for acrylic fibers. Even though directly
comparable data for capacity comparison are not available,
there must have been improvement in the Korean side. The
synthetic fiber yarns appear in the specialty inputs of
textiles industry in Porter's (1990) clusters of
internationally competitive Korean industries in 1985(461). Behind this must be the role of petroleum industry's
expansion as well as expansion of the synthetic fiber
industry. Though the petrochemical industry itself could
hardly gain significant international competitiveness by
1985, it must have helped the international competitiveness
of textiles.

The above episode exemplifies the nature of
interdependencies of industrial activities in the course of
improving competitiveness under the systemic approach. Even
though there are ups and downs across the industries, the
petrochemical-textiles cluster seen as a whole may be
realizing learning-by-doing (as modeled in section 3.1.2).

3.2.5. Intra-group Spillovers

Firms learn production technology through engagement in
exports and licensing technology. In the process, local
skills for controlling production process increase and
accumulate. The accumulation of local know-how makes the labor more productive. The human capital thus formed has large external effects. Amsden (1989) shows how the human capital spills over across firms active in different trades within one ownership group. Some industries may have large externalities while others may not. For example, textiles do not require so much investments in "software" technologies (such as process control) as cement. The "software" can be incorporated in person and hence transferrable. It may become a source of external effects if another industry scouts the trained technicians. But the externalities may be internalized within the industrial organization of diversified business groups, chaebols, in Korean. For instance, as studied by Amsden (1989, 286-287), behind the event that the Hyundai Heavy Industry could jump-started to be a world-class ship-builder within 10 years is the fusion of human capitals gained in other trades within the same ownership group. Personnel were sent from other firms within the Hyundai group such as Hyundai Construction Company, Hyundai Motors, and Hyundai Cement. They played crucial roles in management, engineering supervision, and production control for the success of shipbuilding.

Insofar as a chaebol creatively utilizes its total capability to mobilize resources, the positive externalities can be exploited within the group. The governmental role in this case is similar to that of a client in a putting-out
system. It orders the chaebol to begin a line of production, which is totally new to local technicians. The government provides facilitation to the firm for cooperating with foreign sources of technology. It includes securing funds availability for investments and development of industrial sites, roads, harbors, and so on.

3.3. Theoretic Rationale for Selective Credit Allocation

When an agriculture-dominated nation is in the process of learning manufacturing skills, it is much more likely that the manufacturing sector as a whole will have a learning-by-doing property: accumulation of experience improves technical skills. Since the capital market is undeveloped, investments in productive factors may be socially suboptimal. Thus, government may have to intervene. The intervention cannot be implemented in a manner of an arm's length control because an arm's length control presumes an otherwise-perfect market economy.

The intervention by the government of a lagging economy can better be implemented in "a dynamic growth enterprise" (Bradford, 1992). The gains of growth accrues to different compartment of the economy over time. It is potentially collective in that each compartment has a chance to get exceptional benefits in turns. Thus individuals are willing to share the burden. Such an intervention changes the systemic nature of an economy. The channel through which
information are communicated changes. The conditions for achieving optimal performance change. A rule that is used to measure efficiency of a system before intervention may not be applied to that after intervention has changed the systemic structure. In order to analyze the effect of the systemic change, let's first assume a frictionless market economy.

In the economy, equilibrium prices of credits converge. A large price differentials on the same commodities, say, credits, across peoples or regions implies inefficiency in resource allocation. For example, the large interest rates spread between loan and deposit rates in Korea will be interpreted as implying the inefficiency of Korean financial intermediation.

Now, consider another economy in which market institutions are underdeveloped. Suppose also that economies of scale and externalities are characterizing industrial activities. When a new mechanism is introduced into this economy to replace the market in exchanging information and in coordinating investment decisions, the same rule may not be applied to determine the efficiency of the system. Instead, the large interest rates spread may be viewed as a systemic "cost" for a dynamic growth enterprise.

That is, the large spread of loan and deposit rates accompanying a rapid industrial development is not a prima facie evidence for a dead-weight loss. It may represents a
"cost" in the sense that it is inevitable to generate the benefits from dynamic growth enterprise. I refer this to a dynamic efficiency-based view of selective credit allocation. The dynamic efficiency becomes important when industrial investments are interdependent and subject to learning-by-doing. In this case, border price may not represent true opportunity cost (see section 3.1.2 for example).

3.3.1. Static Efficiency-Based View of Selective Credit Allocation

Shaw's theory of financial repression can be explained with a model described in Figure 3.2. It is a static efficiency model because it assumes no external effects due, for example, to learning by doing in an industry or to interdependent investments.

Assume that there are two identical firm sectors. Without interest ceilings and credit rationing, both sectors remain identical. The demand-for-funds schedule in the market is derived as a sum of the two sectors' demand schedules.
Figure 3.2 Static Efficiency-Based View of Selective Credit Allocation
(assuming that $I^*$ remains the same as before ceilings on interest rates are imposed)
Supply of funds is given by the schedule, \( S - S^2 \). When supply and demand in the market are equal at interest rate, \( r^* \), the market is in equilibrium. The amount of loanable funds is \( I^* \), where

\[
I^* = I_F^* + I_U^*.
\]

When an interest rate ceiling is imposed at \( r'_F \), the market is segmented into an organized financial market for favored firms and unorganized money market (or, curb market) for non-favored firms. In the organized market, interest rate on deposits is also set at low level. In the unorganized market, the contracts for loans are not protected and thus transactions are subject to high costs. Assuming that consumption and hence savings are insensitive to interest rate, it may be presumed that the aggregate amount of loanable funds remain the same as before the ceiling on interest rate is introduced; that is, it is assumed that savers change their portfolio, not aggregate amount of savings. In this case, funds are rationed to the favored sector by the amount of \( I_F' \); and the rest, \( I_U' \), to the unfavored sector through the curb market at the interest rate of \( r'_U \). Since \( r'_F < r'_U \), this is a financial repression in the sense defined by Shaw.

The favored sector gets rents by the amount equivalent to the area of \( \Delta abc \); the unfavored sector loses rents by
the amount equivalent to the area of $\Delta def$. The dead weight loss to the society is incurred because the favored sector, facing low cost of capital, invest too much and the unfavored sector is squeezed to reduce investments by high interest rates in the cash markets. The dead weight loss amounts to the area of $\Delta gch$. Thus, financial repression reduces allocative efficiency, and hence growth. McKinnon (1991) argues that the main transmission mechanism that financial repression reduces growth rates is through this decrease in allocative efficiency of capital rather than through reduced savings.

Shaw has been right in indicating that "while Korea has been active in interest-rate reform, its loan-rate structure is still a striking illustration of subsidy technique" (158). But his prediction that "bias in relative factor prices results in inferior factor allocation" (161) may not necessarily hold for the case of Korea. The industrial development in Korea (documented in section 2.2) supports this point.

3.3.2. Dynamic Efficiency-Based View of Selective Credit Allocation

The economy that is considered is a lagging economy which is predominated by traditional practice of agriculture. The process of industrial development in such an economy is one of learning modern ways of production and distribution. It is filled with various pecuniary and
technological external effects. In particular, most of the industries are in the process of learning-by-doing in the sense that their experience in adapting foreign technology to local environment accelerates adoption of higher technology to a larger extent. Such technological capabilities spillover to other industries. If the capital market is perfect, manipulation of marginal incentives for investment and production through tax and subsidies may suffice to internalize the externalities. In fact, the capital market is underdeveloped in the economy considered here because the predominant traditional agriculture does without a sophisticated capital market and various other factors (such as informational imperfection) deter spontaneous development of the capital market. Thus, the capital market in the economy is incapable of providing funding services for industrial investments. This is detrimental to industrial learning because it takes investments in new equipment and in new methods of production which entail a strong commitment in terms of investment.

In an economy with an underdeveloped capital market, availability of credit allocation is crucial to corporate investment decisions. Without deliberate efforts by the government, the market will fail to support profitable investment.
Figure 3.3. Effects of Selective Credit Allocation: Dynamic Efficiency-based View
The effect of selective credit allocation is analyzed in Figure 3.3. Suppose that there are two sectors: a learning sector which is given a preferential access to bank loans and a non-favored sector. Since the sector as a whole is in the process of learning, the choice of a specific firm within the sector is likely to be immaterial from the social point of view. The two demand-for-funds schedules describe divergent demands for investment by the society and the individual industries in the learning sector. The $DL-DL$ curve represents the marginal productivity of funds invested from the viewpoint of individual industries with no government assistance. The $DL'-DL'$ curve indicates the marginal productivity of funds inclusive of the learning effects that spill over to the other industry. It is the social marginal productivity of funds invested in the learning sector. The gap between the two curves also includes the agglomeration effects of the determination of industrial cites development. Labor migration from overpopulated rural areas to industrial urban area may lower wages in large cities. The entrepreneurial exploitation of abundant cheap labor by organizing it in a large organization underlies the background of the early stage of late-industrialization.

If the capital market is perfect, a subsidy on investment will suffice to internalize the externalities. But when the capital market is underdeveloped, changing
marginal incentives through subsidies is not sufficient to induce the large scale investment necessary for realizing learning-by-doing effects.

Under these circumstances, manipulation of balance sheet of firms through selective credit allocation may be more effective in influencing corporate investment behavior; and it may help the economy realize dynamic efficiency. For example, gains from preferential loans extended to an industry which invest in projects with economies of scale may be greater than social costs, when seen over time. To the extent that the benefits spill over to all of the society, the sector which bears the extra-burden may eventually be remunerated indirectly.

However, government intervention in credit allocation does not necessarily lead to a successful internalization of the external effects of investments. The selective credit allocation may effectively lead industries to commit themselves to achievement of dynamic efficiency only when the policy is implemented within an appropriate institutional framework.

Highly leveraged aggressive investments requires a "mechanism through which business and government could exchange information" (World Bank, 1993, 93). Within such an institutional framework, the selective credit allocation becomes a "hierarchical system of credit allocation" (Haggard and Lee, 1993, 12); and hence, it may achieve the
best possible allocation of credits in its own way, that is, through encouraging "contest-based competition" (World Bank, 1993, 93).

When the government successfully establishes such an institutional framework, selective credit allocation may be sufficient to bring about aggressive investment to realize gains from economies of scale. With under-priced loans, implicit subsidies are also provided to the extent that the interest rate differs from the market rate. Over time, the use of loans is monitored within the institutional framework.

The shift of the supply of funds schedule of SL-SL to SL'-SL' represents implementation of selective credit allocation. If it is effective, it will cause learning sector to face the marginal social productivity of funds, DL'-DL'. Provision of under-priced loans in a quantity to cover financing requirements will lead to increased investment. That is, the policy of shifting the supply of funds for the learning sector from SL-SL to SL'-SL' may cause the demand-for-funds schedule of the learning sector to shift from DL-DL to DL'-DL'. The investment will increase from IL to IL' as interest rate decreases from r0 to rL' for the learning sector.

Rationed firms will face a more stringent credit constraint than before, say, S'-S', as a result of the governments' selective credit allocation. Without access to
bank loans, the non-favored firms will be forced to reduce their investment along the $D-D$ curve.\textsuperscript{24}

But as the favored learning sector invests aggressively its learning-by-doing effects spillover to the rationed sector increasing their productivity; that is, the spillover effect shifts the $D-D$ curve to $D'-D'$. In this case, the extent of the movement will depends on the extent of the external effects. The non-favored sector will invest $I''$ facing interest rate $r''$.

Effective intervention through selective credit allocation may change the pattern of industrial investment. Before the intervention, the learning sector invests $IL$ and the other sector, $I$ at the same interest rate $r_0$. After the intervention, the learning sector's investment increases from $IL$ to $IL'$ and other sector's investment declines from $I$ to $I''$ (or increases to a lesser extent than the learning sectors investment, if the external effects more than offset the effects of the credit crunch).

At the interest rate $rL'$, there are excess demands for preferential loans. In this case, the presence of excess demand may not be considered as an evidence of inefficiency. If we see the presence of a sectoral productivity gap (secularly being narrowed down) as a token for disequilibrium, disequilibrium seems innate in being underdeveloped. The excess demand for bank loans may be viewed as a balancing-out of the labor surplus in
agricultural sector in the early period of economic development. Hence, it can be viewed as a necessary, if not sufficient, factor for achieving dynamic efficiency, or, rapid growth of product per worker.

Section 3.2 describes how the selective credit allocation in Korea could be made effective. The government used contests by exports performance and past experience (or simply by size) to select winners. It used subsidized loans and effective enforcement to get compliance from the firms.\(^25\)

The selective credit allocation is justified only when there are socially profitable opportunities that are not fully exploited by private firms and at the same time there are rigid economic structure that hinders private firms' adoption of new technologies.\(^26\) Relative inefficiency in financial intermediation may be considered to be the inevitable costs of getting the dynamic gains if the social opportunities are fully exploited.

However, the beneficiary industry may divert the funds to other uses which bear higher private rate of returns than the mandated use. Or, it may lend them to other firms at the market interest rates. The firm, getting rents, may not invest in projects that generates learning-by-doing effects. In this case the demand curve of the recipients stays at \(DL\). In other words, if the selective credit allocation is
implemented ineffectively, the actual investment opportunity envisioned by individual firms do not change.

3.3.3. Costs and Benefits of Selective Credit Allocation

Investments assisted by the government is risky. If the enterprise turns out to be successful, it is good for the society as a whole. If it turns out a failure, the entrepreneur will have to go bankrupt. But in Korea most of them were bailed out. The bail-out creates a severe problem of moral hazard. Businesses are willing to take excessively risky investments. The low interest rate on loans together with bailing-out practices socializes individual risks. That is, the burden of possible failures are shared by the society as a whole while the benefits of success are ascribed to the ownership. This is apparently an inequitable rule of game.

The costs should be weighed against the gains. The gains to the public from the "dynamic growth enterprise"\textsuperscript{27} are increased job opportunities and higher wages for workers and expanded markets for small businesses. Spillover of trained technicians may also be included to the benefit of small businesses. The costs are incurred to households due to the constrained liquidity for households and small businesses in the non-strategic sectors.

In fact, many of the government-supported investments were costly in terms of their own value added. According to Hong (1990), during 1966-1983 period:
The capital-intensive manufacturing sectors were provided with more than twice larger (domestic bank and foreign) loans per value added activity at more than three times cheaper (overall) financial costs (124-125).

But in a holistic point of view, the contribution of the government-supported investments to the industrial development may be greater than own value added. Their effects accrue over time across industries.

That the Korean economy, employing such a strategy, succeeded in industrial development and economic growth implies that the gains to the public from getting involved in the systemic approach must have been larger than the cost incidence on the public (so far). That is, the gains from realizing economies of scale and internalizing external economies might have exceeded the loss caused by relative shrink suffered by the non-preferred corporate sector.

3.3.4. Implication for Empirical Work

The test of externalities in Chapter V will determine which one is the appropriate framework to apply—static efficiency-based or dynamic efficiency-based view. If economies of scale and externalities accruing over time turn out to be significant, the dynamic efficiency-based view is the proper framework to apply to analyze the effect of selective credit allocation. Otherwise, the static efficiency-based model will apply.
In the dynamic efficiency-based model, the firms given access to preferential loans will invest more aggressively than non-favored firms. Thus, provision of bank loans at low interest rate influences interindustrial patterns of investment. That is, supply of funds to individual industries determines the kinds of investment that the individual industries undertake. Accordingly, the investment function will have changes in loans as a significant determinant. If current investment is explained by past values of determinant variables, a Granger-causality will obtain; that is, past values of interindustrial variations in incremental loans will help predict current values of the interindustrial variations of investment. The Granger-causality test is the theme of Chapter IV.

Before examining intertemporal interrelationship between selective credit allocation and investment patterns, looking into cross-sectional aspects of the finance-investment nexus will be of help to illuminate the difference between an economy with unified markets and one in which selective credit allocation is segregating the markets.

3.4. Economies With and Without Selective Credit Allocation: A Contrast

Does demand for investment determine the kinds of funds in terms of prices and quantities? Or, does the supply of
funds to individual industries determine the kinds of investment?

The answer to these questions will depend on the nature of financial system. In an economy in which the financial system is dominated by selective credit allocation, the latter pattern of investment-finance relationship--supply of funds influencing investment patterns--is predicted by the above discussions. On the other hand, in an economy which is advanced and driven by the market forces, the former question will be relevant.

3.4.1. The Case of Manufacturing Firms in the U.S.A.

For example, in U.S.A., the financial system is dominated by market forces. The financial markets are so closely interconnected that profitable opportunities can seldom go unexploited. In the U.S.A., the early literature even questions the relevance of finance to investment decision. Later literature revived the importance of finance. But it was revived in line with the former question; that is, "does demand for investment determine the kinds of funds supplied to the firm?" not with the latter question.

The mainstream literature has evolved in line with the former question. The theories start with Modigliani and Miller (1958; 1963). Their theory states that, in a complete capital market with two assets - bonds and equity - and without taxes, the weighted average cost of capital of a
firm is unaffected by its debt-equity ratio. If a firm borrows more on the judgement that the market interest rate on borrowing is less than the cost of equity issues, the cost of new equity issues increase because the probability of bankruptcy will rise; and the increased probability of bankruptcy is reflected in increased cost of new equity issues through the arbitrage operations in equity market. In equilibrium, the weighted average cost of capital remains unchanged. Thus, in the model of Modigliani and Miller, the way investment is financed is in itself inconsequential to its investment decisions.

The theory presumes a perfect capital market in which availability of funds is a non-issue. If the capital market is underdeveloped, availability of funds, if not the composition of the finance, will be of critical importance to firm investment decisions. Conventional wisdom on this is to open up new financial (capital) markets to allow a greater sharing of risks (e.g., Cho, 1986). But asymmetric information may fail the capital market too. "Equity rationing" is a possibility (Stiglitz 1989).

The Modigliani-Miller theorem also assumes no interest deductibility. The presence of tax on corporate income and interest deductibility of debts would lead a firm to totally rely on debt finance if it were not for the effects of borrowing on the firm’s cost of capital. Borrowing will increase marginal cost of new debt partly because the firm
may face distresses in meeting its principal and interest obligations; and partly because the limited liability of corporate firms for debts creates incentives for corporate managers to undertake risky investments.

New issues of share will be costly to the firm due to the "lemons" problem under asymmetric information: "new shareholders implicitly demand a premium to purchase the shares of relatively good firms to offset the losses that will arise from funding lemons" (Fazzari, et. al., 1988 150). The "pecking order" theory can be described by the Figure 3.4. It states that, "if firms face different costs of capital for different sources of funds, they will use the least expensive source first, using more expensive one if very profitable investments present themselves" (Auerbach, 1984 30). When this rule applied to a market-based financial system, it will generate a positively sloped supply-of-funds schedule. The position of the demand-for-funds schedule will determine the respective cost of capital and investment level. In such an economy, finance matters for investment along the supply-of-funds schedule.

The "pecking-order" theory seems to explain the data of the U.S. manufacturing firms. Fazzari, Hubbard, and Petersen (1988) have shown that liquidity has a greater effect on investment for young and low-dividend firms than for mature and high-dividend firms (183). It supports the
Figure 3.4. Pecking-Order Theory for Corporate Finance

*Source: Fazzari, Hubbard, Petersen, 1988, 156, Fig. 1.*
view that finance matters for investment at least for young and rapid growing firms.

In the U.S.A., large firms have low ratio of debt to capital stock; they have also a low investment-capital ratio. Fazzari, Hubbard, and Petersen (1988) provide characteristics of the manufacturing firms in the U.S. from 1970-1984. They classified firms into three groups. Class 1, class 2, and class 3 are in ascending order of the ratio of dividends to income. As shown in table 3.2, the class with low investment-capital ratio has low debt-capital ratio. Moreover, the larger-firm class has higher dividend-income ratios. Thus, in general firms with high investment demand use even expensive funds to finance their investments.

In the U.S., as Fazzari, et al. (1988) argue, the small firms' investment is more sensitive to cash flows than large firms. The class 1 firms face a high cost of external finance. In the supply side, external investors require a "lemons premium" because of asymmetric information - a situation in which the firm managers have more information about their own firms and investors cannot distinguish the quality of the firms. Since the young and small firms have rapid sales growth, they are willing to borrow or to issue new stocks to finance their investment. These firms, facing high cost of external finance, try to retain earnings as much as possible; and their investment decisions are very
Table 3.2. Investment and Finance Indicators for Manufacturing Firms in the U.S.A., 1970-1984

<table>
<thead>
<tr>
<th></th>
<th>Class 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Class 2&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Class 3&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average capital stock</td>
<td>100.6</td>
<td>289.7</td>
<td>1,270.0</td>
</tr>
<tr>
<td>(millions of 1982 dollars)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average ratio of debt to capital stock</td>
<td>0.57</td>
<td>0.52</td>
<td>0.33</td>
</tr>
<tr>
<td>Average investment-capital ratio</td>
<td>0.26</td>
<td>0.18</td>
<td>0.12</td>
</tr>
<tr>
<td>Average annual q-values</td>
<td>3.8</td>
<td>2.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Average retention ratio</td>
<td>0.94</td>
<td>0.83</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Notes: a. Firms with dividend-income ratios of less than 0.1 for at least 10 years.
   b. Firms with dividend-income ratios greater than 0.1 but less than 0.2 for at least 10 years.
   c. Firms with dividend-income ratios greater than 0.2.


sensitive to cash flows. On the other hand, the class 3 firms have plenty internal funds relative to investment demand. They face a low cost of external finance; the "lemons premium" is low for them. They do not have to resort to external finance because they have plenty cash flows. Thus, the firms that invest actively have high leverages and face high cost of capital.

The slope of the plot of observed cost of external funds and observed activity in investment is positive. It seems that the supply curve of funds that each firm faces is positively sloped and demand curves of firms are placed crossing the curve. The markets are unified in the sense
that the supply of funds schedules are the same for all firms. This is reflected in the positive correlation between the $q$-value and capital growth: the high $q$-value reflects high "lemons premium" for the class 1 firms.

3.4.2. The Peculiarity of Korean Corporate Financing

The peculiarity of Korean corporate financing is revealed by comparison with that of U.S.A. In Korea, finance matters for investment on different grounds. It seems that supply of subsidized loans influences the magnitude of investment effectively. In contrast to the U.S.A., large firms have high debt-asset ratios and high investment-capital ratios. The *Financial Statement Analysis* summarizes the balance sheets and income statements for large firms and medium firms.\(^{31}\) For 1974-1983 period, the mean values are as follows.

<table>
<thead>
<tr>
<th></th>
<th>Medium Firms</th>
<th>Large Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average investment-capital ratio</td>
<td>24.835</td>
<td>28.991</td>
</tr>
<tr>
<td>Debt-asset ratio</td>
<td>40.890</td>
<td>48.440</td>
</tr>
<tr>
<td>Average cost of borrowing (percent)</td>
<td>15.069</td>
<td>13.762</td>
</tr>
</tbody>
</table>

*Source: Financial Statement Analysis*, the Bank of Korea, various years.
The most distinct feature is that the investment-capital ratios are high overall, as well as the debt-asset ratios. Furthermore, the investment-capital ratio, as well as debt-asset ratio, of the large firms are higher than that of medium firms.\textsuperscript{32}

In contrast to the case of manufactures in the U.S.A., the implied slope from the data for Korean manufactures in Table 3.3 is apparently negative: the firms that invest and borrow more actively face lower cost of debt than those invest and borrow less actively. The negative relationship between observed costs of borrowing and investment-capital ratios cannot be explained in the way the American finance-investment nexus is explained. The model for selective credit allocation should be employed to analyze the phenomenon.

Even in Korea, the relevance of the "pecking order" theory of firm finance itself is hard to deny: any firm will use low cost funds first especially when the markets are fragmented. Even large firms are frequent customers to curb markets when they face as high an interest rate as small ones.\textsuperscript{33} Instead of negating the "pecking-order" theory, the negative relationship between observed cost of borrowing and investment in Korea leads to the model described in section 3.3.

It relates to fragmentation of the financial markets. If they were unified, the Auerbach's (1984) argument that, "when firms are observed to use more expensive forms of
finance, the projects they undertake have a higher marginal product" (39) might apply. In this case, frequent use of curb market by both small firms and large firms in Korea might signify that they were undertaking projects with high marginal product of capital. But as a matter of fact, the credit markets are segmented. Hence, such an inference is not warranted.

In the segmented market, there are two (or more) kinds of supply-of-funds schedules. Only qualified firms face the preferential schedule. Thus, the schedule for both the large firms and for the medium-sized ones are positively sloped. But the smaller ones are more frequent customers of the curb markets.\(^3\)\(^4\)

With different structure of the financial markets, the reason that finance matters for investment in Korea differs from that in the U.S.A. The supply of large amount of low-price loans has been the key to active investments by major Korean manufacturing firms. The negative slope of the cost of borrowing-investment plot may indicate that selective credit allocation policy may have been effective in inducing huge commitments from the large firms in compliance with industrial policy. This possibility is more rigorously tested in Chapter IV.
NOTES

1. Viner, 1931.


3. It assumes symmetric information.

4. The third equation is called a canonical equation for the costate variable. It is derived from the formula, \( \frac{\partial H}{\partial Q} = \rho \lambda - \lambda \).

5. Interior solution is assumed to exist.


8. "Most, though not all, technical innovations which are capable of raising the productivity of labor require the use of more capital per man" (Kaldor, 1957, 595).

9. It is the idea from Bartelsman, et. al., 1994.


11. Refer to Jones and SaKong (1980, 127-32). For example, Dae-Woo group began with textiles exporting and enter machine industry by purchasing Han'gi (Korea Machinery Manufacturing Corporation) in 1975.

12. For the financial development in the early industrialization period, see Cameron (1969).

13. "Distributional coalitions slow down a society's capacity to adopt new technologies and to reallocate resources in response to changing conditions, and thereby reduce the rate of economic growth" (Olson, 1982).

14. "The Philippines has long had an extensive system of preferential credit, but the allocation of this credit has done little to promote larger goals of economic development" (Hutchcroft, 1993 165).
15. Cho and Hellman (1993) also view government, finance, large industrial firms in Korea to have formed an internal capital allocation mechanism. They call it a "government-led internal organization."

16. There were political dissents throughout the Park regime. The close relationship between government and business was often defined by learned dissents as Chŏnggyŏngyuch’ak (politico-economic adhesion).


18. "The post-land-reform peasantry also continued to be a conservative force in South Korean politics and the main base of Park's electoral victories, despite the fact that his economic policies were clearly geared toward the export manufacturing industries rather than agriculture" (Eckert, et. al., 1990 367).

19. They call this phenomenon Yŏch’onyado.


21. Even if there were corruption, it did not hinder efficiency very much. This is because the decision making is centralized that the briber needs to give bribes just once. In other countries where bureaucratic decision making is highly decentralized, bribing one office is not sufficient to get the benefit. For theoretical discussions, refer to Schleifer and Vishny, 1993.


23. The S-S curve is drawn under the choice-theoretic presumption that savings are elastic and positively related to interest rates. For analysis of the effect of interest rate ceiling on allocative efficiency, the S-S curve is assumed to be vertical at $I^*$ in the discussions below.

24. Even the $D-D$ curve may shift down if the argument that liquidity constraints have a direct transmission effect on productivity of a learning industry in an imperfect capital market (Greenwald, Kohn, Stiglitz, 1990) is taken into account.

25. Schumpeter (1961) argued that "granting credit ... operates as an order on the economic system to accommodate itself to the purposes of the entrepreneur, as an order on the goods which he needs: it means entrusting him with productive forces." (107)
26. Leibenstein (1978) observes that "in developing countries there are innumerable instances in which innovations are not adopted when it pays to do so ...." (5).


28. Thus, Zysman calls the financial system of the U.S.A. "market-based" one.

29. Here, capital is defined as "a quantum of current funds available or intended for investment" (Hirschleifer, 1970 154). The cost of capital is thus the weighted average of the cost of debts and equity. The "user cost of capital" differs from the cost of capital in that it includes a component for asset depreciation (Auerbach, 1983 912).

30. "Which of the three segments of this schedule the firm will actually choose depends on its 'demand' for funds: its marginal product of new capital" (Auerbach, 1984 37).

31. Up to 1975, the firms with 200 employees or more were considered large. Since 1976, however, those with 300 workers were defined to be large firms.

32. The feature of high leverage of Korean firms are also shown in Table 2.4.

33. The curb funds are complementary to the bank loans (Cole and Park, 1983).

34. According to Young-Sik Kim (1988), "larger firms that have access to bank resources for financing fixed investment depend on the curb market for their short-term working capital needs. Smaller firms that have little access to the banks tend to rely on the unorganized money market for most of their working capital and some financing of fixed capital" (257).
CHAPTER IV

EFFECTIVENESS OF SELECTIVE CREDIT ALLOCATION:
CAUSALITY TESTS BETWEEN INCREMENTAL LOANS AND INVESTMENT

4.1. Empirical Question about Effectiveness of Selective Credit Allocation

Has the government-controlled bank credit allocation in South Korea been effective in stimulating industrial development? To make this question testable, the question is put in terms of causality: has the industrial policy Granger-caused investment of industries? Then, the task boils down to estimating a vector autoregressive model which includes both investment and a proxy variable for selective credit allocation as endogenous variables and then testing whether the interindustrial variations in the increments in loans has caused those of investments in Granger-sense.¹

In the context of selective credit allocation, the pattern of interindustrial variations of the ratios of the increment in loans to the capital stock reflects the intention of the government to support strategic industries. Since the economy-wide total amount of the loans are to be limited (so that the credit expansion does not invoke a hyperinflation), provision of loans to an industry by the amount exceeding the average leaves less-than-average amount available for other industries. Thus, the interindustrial pattern of the ratios of the increment in loans to the capital stock of individual industries comes to represent
principally the government's selective credit allocation policy in Korea.

Furthermore, the increase in loans implies provisions of implicit subsidies to the industry via interest rate differentials (between the policy-related loans and market interest rates). Thus, selective credit allocation will also bias the interindustrial variations in the cost of borrowing.

The effectiveness of the selective credit allocation can be detected in an investment equation of a vector autoregressive model through seeing if the past values of the variables representing government's policy intention significantly explains the variations in investments. Since the policy intention is inferred from the pattern of interindustrial variations of bank loans and the cost of borrowing, the predicted result of causality running from loans to investment may raise an interpretational difficulty. That is, is it not possible that the significance of past interindustrial variations of incremental loans as a determinant of those of investment could be attributed to some other sources than the selective credit allocation, for example, to the natural workings of the credit market? Generally speaking, it may be the case. But, in the context of Korean economic development, it is not.
In the Korean context, the access to bank loans (and government-administered foreign loans) to a firm most likely signifies that the firm is in long-run relationship with the government. Within the relationship, the firm is required to comply with government’s industrial plan. The investment activities are monitored by the government (including banks). The relationship is intended to overcome informational imperfection related to selection of projects which has economies of scale. The government acts as a central unit to coordinate closely interdependent investments.

If the uses of subsidized loans are enforced strictly, the loans may be used for the proposed uses by a socially optimal amount. If, however, the uses of subsidized loans are not enforced strictly, the funds will be used for privately optimal uses and by the amount that private rate of returns is equal to the cost of capital before the subsidies are taken into account. Or, the firm can cash in on the interest rate differential by lending the funds in the curb market. Thus, if the diversion of funds are perfect, the subsidized loans cannot achieve its goal of increasing investment in a specific activity or industry.

In terms of the figure 3.2, the subsidized loan does not change the cost of capital, or, the opportunity cost of funds in the investing firm. The schedule of marginal rate of returns of investment will also remain intact if the
production technology is not subject to internal or external economies. Thus, the firm's optimal amount of investment will also be unaffected by the subsidized loans. The opportunity cost of investing in one unit of productive asset will be dictated by the conditions in the capital markets.

If the government of a late industrializing economy designs a cohesive industrial policy which attempts to realize gains from late-industrialization, especially, the economies of scale and external economies, then it may be able to make a firm's optimal investment be compatible with the systemic optimum. For the firms, it means that the subsidized loans can shift the marginal rate of returns of firm investments outward (Figure 3.3); and as a consequence, the investment and employment of the economy increase. In this case, the generation of rents leads to achievement of systemic efficiency; rent-seeking behaviors are directed toward optimal resource allocation. In the case of Korea, this type of systemic cohesiveness may be observed. In terms of the causality tests, this amounts to the pattern in which the vector of the ratios of the incremental loans to the capital stocks causes the vector of the ratios of capital expenditures to capital stocks. Therefore, what is being implied by the causality running from incremental loans to investment is the effectiveness of the selective
credit allocation in the context of Korean economic development.

4.2. Previous Empirical Studies on the Issue

Do the industrial policies revealed in the inter-industrial distribution of loans have Granger-caused the inter-industrial distribution of investment? This is an important empirical issue though it has seldom been a subject of serious empirical studies. The study of directed credit programs in the Japanese machinery industry by Calomiris and Himmelberg (1993) is the first attempt of this sort. They applied the panel data VAR methods to show the intertemporal linkages between the inter-firm distribution of industrial policy-related loans and the inter-firm distribution of real investment.

Before the panel data VAR method is available, empirical studies of the intertemporal nexus between finance and economic development were generally limited to intertemporal relations among macroeconomic time-series variables. Focuses were either on determining the sign of contemporaneous association between aggregate proxy variables for financial deepening - such as real interest rates, currency ratio, and M2/GDP ratio - and real economic growth or on the causal relationship between them. For example, using pooled time series data for seven Asian countries and applying OLS to bivariate linear regression
model, Fry (1980; 1988) showed that real growth rate was positively related with real deposit rate of interest. The World Bank (1993) reexamined this positive association with pooled time series data for 20 countries. They have got a different result: when the effect of inflation on growth is controlled, the association between growth and real interest rate becomes negative (245-247). This result indicates that repression of real interest rate while keeping inflation rate at low level may be consistent with high growth rate. On the other hand, Jung (1986) tested the causal relationship between financial development and real economic growth in a bivariate vector autoregression model. For Korea, no causal relation between real economic growth and financial deepening measured either by currency ratio and real GDP growth or by M2/GDP ratio during 1953-80 period. Similarly, Darrat, LaBarge, and LaBarge (1989) also found no causality between real GDP growth and M2/GDP growth rate for Korea even when real export growth rate and inflation expectation effects are controlled in a multivariate vector autoregression model. Using quarterly data for the period from 1975-1992, Chang and Ham (1994) report a Granger causality test between corporate debt and investment; investment caused private corporate debt, while private corporate debt did not cause investment.

It will be of importance to check whether the conclusions from these macroeconomic data analyses are
sustained when the same idea is tested with industry level panel data. If the economy has been undergoing structural change toward another steady state, industry level panel data will have more information than the macroeconomic data.

4.3. Causality Test: Methodology

From the time series of investment and loans data for all industries, rich information can be extracted. The information content of the data is ampler than that of a time series of an aggregate variable. From the intertemporal relationship of the vector of loans and the vector of investment, a causality can be inferred in Granger (1969) sense.

A variable, say, x is said to Granger-cause a variable, say, y if the one step ahead predictor of y based on all past information has a smaller mean square error than the predictor of y, based on all past information excluding x (Harvey, 1991 304). In other words, if exclusion of a variable from right hand side of a VAR model reduces the fit of the model significantly, the variable may be said to Granger-cause the left-hand side variable of the VAR model.

The methodology adopted in this paper is developed by Holtz-Eakin, Newey, and Rosen (1988, HNR hereafter). It tests causality with panel-data vector autoregressive model (PVAR). A univariate autoregressive model tries to explain the behavior of a variable in terms of its own and other
variables' past. A vector, or multivariate, autoregressive model (VAR) attempts to explain the behavior of a vector of variables in terms of its own past. The merit of PVAR compared to time-series VAR is that it does not require the data generating process to be stationary, which is required in time-series VAR. Hence, it need not transform non-stationary data into stationary data employing arbitrary formulae.

The VAR technique is data-driven rather than theory-driven. It lets data "speak" without imposing too many theory-induced a priori restrictions. Since the focus is put on the estimation of investment equation, theory is involved in the choice of relevant variables. The minimal number of variables to include for the current purpose is two: interindustrial variations of investment and incremental loans.

However, a bivariate PVAR comprised of the industrial incremental loans and the industrial capital expenditures may be misleading because it may be that in fact the two variables are not correlated and both are caused by another variable. According to Lütkepohl (1988), a false inference of causality may result if an important variable is omitted. For example, suppose that the purpose of the estimation of investment equation is to see the effect of access to loanable funds on investments. If loans and investments are
indeed not correlated while expected sales causes both, then omission of sales may lead to a false inference.

In order to control the effect of sales on investment (via "flexible accelerator" model of investment), the variable of industrial sales are included in the model. Moreover, to reflect the argument that changes in profits convey some new information about future profitability of an industry, industrial profits are included in the model. Profits also carries information about cash flows within a firm.

Thus, I will first include four variables in the PVAR model, following suit Calomiris and Himmelberg (1993): interindustrial variations in the ratios of the incremental loans to the capital stocks by industry, the ratios of capital expenditures to capital stocks by industry, the ratios of sales to capital stocks by industry, and the ratios of profits to capital stocks by industry.\textsuperscript{5}

The variable of the cost of borrowing will be added to the model. The cost of borrowing is the interest paid plus discount expenses divided by the total borrowing by an industry. It is an average cost of external finance; it is different from the cost of capital, which is the weight-average cost of both external finance and internal finance. But, when the firms are highly leveraged, as in Korea, the cost of borrowing will be dominantly important in determining the cost of capital.
If the cost of borrowing of an industry and the amount of bank loans purveyed to the industry are closely correlated, test statistics for one of the two variables in estimation of investment equation will be reduced in significance substantially. In this case, the causality test will be implemented with one variable omitted.

Application of the methodology of testing causality with panel data to the test of effectiveness of selective credit allocation is highly appropriate. Most studies on the effect of financial development on economic growth use aggregate variables. The use of an aggregate variable presumes that the data generating process of the economy is stationary or even when it is non-stationary, it can be transformed into a stationary process through the application of difference operators to the variables. This condition is highly restrictive. Most non-stationary processes are not to be modeled yet. The PVAR method enables us to estimate the parameters of non-stationary processes. Since the economy of Korea underwent rapid structural change, the possibility of non-stationarity of the economic process cannot be excluded a priori. If the economic process is non-stationary, aggregation of industrial or sectoral data will distort the information in the disaggregate data. Hence, using aggregate data for testing non-stationarity of the economy is unwarranted.
A four-variable vector autoregressive model was set up with panel data composed of time-series from 65 individual industries. With 65 observation of cross sectional units and initial lags number four, the maximum feasible number of variables to be included is four and three years can be included in one model. With this limit, the strategy of empirical study is to fit two non-nested models for two time periods - one from 1977 to 1979, the other from 1981 to 1983. To be meaningful, it requires several assumptions. First, the government's influence on credit allocation by the banking sector must be so large that it can manipulate the credit allocation according to its industrial policy. Second, the government indeed does use the bank loans as the main instrument for industrial policy. Then, the pattern of inter-industrial loan allocation can be viewed as a policy variable. Third, the government selection of beneficiary is based on industry. If the government allocates credits on the basis of functional, instead of selective, criteria which are unrelated with industries, even when the credit policy is effective in firm level, the resulting pattern of industrial credit allocation may be unrelated with industrial investment pattern. Thus, the power of the inter-industrial credit allocation pattern as a proxy for industrial policy will be weakened. But, to the extent that the criteria of functional industrial policy favor specific
industries, such interpretation of credit allocation pattern is still valid.

As for econometrics, the methodology here was developed by Holtz-Eakin, Newey, and Rosen (1988) and Holtz-Eakin (1988). My contribution to the methodology part is limited to clarification of some details of testing stationarity of individual effects.

Let us denote the vector of the ratios of investment to capital stocks as \( I_t \), \( t = 1, \ldots, T \), the vector of the ratios of sales to capital stocks as \( S_t \), \( t = 1, \ldots, T \), the vector of the ratios of operating income to capital stocks as \( \Pi_t \), \( t = 1, \ldots, T \), and the vector of the ratios of the incremental loans to the capital stocks as \( dL_t \), \( t = 1, \ldots, T \). All variables are represented in 1985 prices. All variables for the \( j \)-th industry, \( i_{jt} \), \( s_{jt} \), \( \pi_{jt} \), and \( dl_{jt} \), for a given time period \( t \) are expressed as ratios relative to the beginning-of-period real capital stock of each industry. The inter-industrial patterns, \( I_t \), \( S_t \), \( \Pi_t \), and \( dL_t \) are distributions defined over the domain of industries for given time \( t \).

In the PVAR model, all the variables are treated as endogenously determined in the model. The first set of \( T \) equations (the equation 1) describes the determination of current pattern of inter-industrial distribution of
investment-capital ratios \( I_t, (t = 1, \ldots, T) \) in terms of the inter-industrial variations of the ratio of the increments in loans to the capital stock in the near past, \( dL_{t-1} (l = 1, \ldots, m) \), inter-industrial variations of the sales-capital ratio in the near past, \( S_{t-1} (l = 1, \ldots, m) \), and inter-industrial variations of the operating income-capital ratio in the past, \( \Pi_{t-1}, (l = 1, \ldots, m) \). The full set of equations would include the set of equations for \( S_t, \Pi_t, \) and \( dL_t \). Estimation of these set of equations will not be so meaningful unless all the important variables for the determination of them are included. In particular, the set of equations for \( dL_t \) will require further information about relative prices of the substitute financial and real assets such as stocks or real assets. Since the data are limited to the five variables, the estimation of the set of equations for investments will have the most appropriate interpretation. Thus, I will focus on the estimation of the set of equations for investment.

Let lower case characters denote scalars and upper case characters vectors or matrices. The set of equations for investment (marked by the superscript \( I \)) is

\[
i_{jt} = \alpha^I_t + \sum_{l=1}^m \beta^I_{lt} i_{jt-1} + \sum_{l=1}^m \gamma^I_{lt} S_{jt-1} + \sum_{l=1}^m \delta^I_{lt} \Pi_{jt-1} \\
+ \sum_{l=1}^m \zeta^I_{jt-1} dL_{jt-1} + \Psi^I_{jt} F_j + u^I_{jt} \quad (j = 1, \ldots, N; t = 1, \ldots, T) \quad (1)
\]
where subscript \( j \) denotes the \( j \)-th industry, subscript \( t \) denotes time period, and

\[
\alpha_t^I, \beta_t^I, \ldots, \beta_{mt}^I, \ldots, \delta_{mt}^I, \gamma_{mt}^I, \ldots, \gamma_{mt}^I, \zeta_{mt}^I, \ldots, \zeta_{mt}^I, \Psi_t^I
\]

are the coefficients of the linear regression of \( i \) on a constant, own past values, and past values of \( s_{jt}, \pi_{jt}, dl_{jt} \), and an individual effect \( f_j \) which is latent. Though the number of time periods, \( T \), is relatively small, the size of cross-section \( N \) is considered large. Notice that the coefficients are subscripted by \( l \) and \( t \). The former denotes the number of lags and the latter denotes an equation for the time period \( t \). The error term, \( u_{jt}^I \), is assumed to be orthogonal to all the regressors. That is,

\[
E[i_{js}u_{jt}^I] = E[s_{js}u_{jt}^I] = E[\pi_{js}u_{jt}^I] = E[dl_{js}u_{jt}^I] = 0, \quad (s < t). \tag{2}
\]

It is assumed that orthogonality holds true for the remaining sets of equations for \( S_t, \Pi_t, \) and \( dL_t \). The right hand side variables of each set of equations are same for all sets of equations.\(^9\) Thus, discussion of estimation will be confined to the equation (1); and the superscripts on the parameters will be suppressed.

Due to the presence of the latent variable \( f_j \), the equation (1) is not estimable in itself. In HNR, the latent variable \( f_j \) is eliminated by, so called, quasi-differencing. That is, the equation for \( t-1 \) is multiplied
by \( r_t = \frac{\psi_t}{\psi_{t-1}} \) and is subtracted from the equation for \( t \).

The transformed model is

\[
i_{j,t} = a_t + \sum_{l=1}^{m+1} b_{l,t} i_{j,t-1} + \sum_{l=1}^{m+1} c_{1,t} y_{l,j,t-1} + \sum_{l=1}^{m+1} d_{l,t} \xi_{j,t-1} + \sum_{l=1}^{m+1} e_{l,t} \delta_{l,j,t-1} + u_{j,t} - r_t u_{j,t-1} \quad (t = (m+2), \ldots, T) \tag{3.1}
\]

where

\[
\begin{align*}
a_t &= a_t - r_t a_{t-1}, \\
b_{l,t} &= r_t + \beta_{l,t}, \\
b_{l,t} &= \beta_{l,t} - r_t \beta_{l-1,t-1} \quad (l = 2, \ldots, m), \\
b_{m+1,t} &= -r_t a_{m,t-1}, \\
c_{1,t} &= \gamma_{1,t}, \\
c_{1,t} &= \gamma_{1,t} - r_t \gamma_{1-1,t-1} \quad (l = 2, \ldots, m), \\
c_{m+1,t} &= -r_t \gamma_{m,t-1}, \\
d_{1,t} &= \delta_{1,t}, \\
d_{1,t} &= \delta_{1,t} - r_t \delta_{1-1,t-1} \quad (l = 2, \ldots, m), \\
d_{m+1,t} &= -r_t \delta_{m,t-1}, \\
e_{1,t} &= \zeta_{1,t}, \\
e_{1,t} &= \zeta_{1,t} - r_t \zeta_{1-1,t-1} \quad (l = 2, \ldots, m), \\
e_{m+1,t} &= -r_t \zeta_{m,t-1}.
\end{align*}
\]
In equations (3.1)-(3.2), the error term shows an autocorrelation pattern. In the case of autocorrelated error, a consistent estimator of the parameters may be obtained if a proper set of instruments exists. In the case of the equation (3.1)-(3.2), the vectors with two-or-more periods lagged variables are suitable instrumental variables; those variables are orthogonal to the error terms while closely related to the regressors. Thus, the instrumental variables that qualify as instrumental variables to get consistent estimates of the equation $i_{jt}$ are, in a vector form,

$$Z_{jt} = [1, i_{jt-2}, \ldots, i_{jt}, s_{jt-2}, \ldots, s_{jt}, \pi_{jt-2}, \ldots, \pi_{jt}, d_{jt-2}, \ldots, d_{jt}].$$

Consistency of the estimates is secured by the magnitude of $N$.

Denoting the number of cross-sectional units as $N$, let

$$I_t = \begin{bmatrix} i_{1t} \\ \vdots \\ i_{Nt} \end{bmatrix}, \quad S_t = \begin{bmatrix} s_{1t} \\ \vdots \\ s_{Nt} \end{bmatrix}, \quad \Pi_t = \begin{bmatrix} \pi_{1t} \\ \vdots \\ \pi_{Nt} \end{bmatrix}, \quad dL_t = \begin{bmatrix} d_{1t} \\ \vdots \\ d_{Nt} \end{bmatrix}$$

be $N$-dimensional vectors of observations for a given time period $t$. Denoting the number of lags as $m$, let
\[ W_t = \{ e, I_{t-1}, \ldots, I_{t-m-1}, S_{t-1}, \ldots, S_{t-m-1}, \Pi_{t-1}, \ldots, \Pi_{t-m-1}, \\
\quad dL_{t-1}, \ldots, dL_{t-m-1} \} \]

be \( N \) by \((4m+5)\) matrix of right-hand side variables of the VAR model in which \( e \) is an \( N \)-dimensional vector of ones. Let the following be \((4m+5)\)-dimensional unrestricted coefficient vector, and \( N \)-dimensional error terms vector, respectively:

\[
B_t = \begin{bmatrix}
  a_{t,1} \\
  b_{1,t} \\
  \vdots \\
  b_{m+1,t} \\
  c_{1,t} \\
  \vdots \\
  c_{m+1,t} \\
  d_{1,t} \\
  \vdots \\
  d_{m+1,t} \\
  e_{1,t} \\
  \vdots \\
  e_{m+1,t}
\end{bmatrix}, \\
V_t = \begin{bmatrix}
  u_{1,t} - I_t u_{1,t-1} \\
  \vdots \\
  u_{N,t} - I_t u_{N,t-1}
\end{bmatrix}.
Then, the investment equation of the VAR model can be expressed as a system of equations:

\[ I_t = W_t B_t + V_t, \quad \text{where } t = (m+2), \ldots, T. \]  

(4)

This can be stacked as follows:

\[
\begin{bmatrix}
I_{m+2} \\
\vdots \\
I_T
\end{bmatrix} =
\begin{bmatrix}
W_{m+2} & \cdots & O \\
\vdots & \ddots & \vdots \\
O & \cdots & W_T
\end{bmatrix}
\begin{bmatrix}
B_{m+2} \\
\vdots \\
B_T
\end{bmatrix} +
\begin{bmatrix}
V_{m+2} \\
\vdots \\
V_T
\end{bmatrix},
\] (5)

or,

\[ I = W B + V, \] (5')

where the dimensions of \( I, B, V, \) and \( W \) are \((T-m-2)N \) by 1, \((T-m-2)(4m+5) \) by 1, \((T-m-2)N \) by 1, and \((T-m-2)(4m+5) \) by 1, respectively.

The matrix of legitimate instrumental variables for time period \( t \) is

\[ Z_t = [e, I_{t-2}, \ldots, I_1, S_{t-2}, \ldots, S_1, \Pi_{t-2}, \ldots, \Pi_1, dL_{t-2}, \ldots, dL_1] \] (6).

The number of instrumental variables is limited by the number of observations. The former cannot exceed the latter. Otherwise, matrix inversion fails due to non-positive definite-ness of the matrix to be inverted.
Let

\[
Z = \begin{bmatrix}
Z_{m+3} & O & \ldots & O \\
O & Z_{m+4} & \ldots & O \\
\vdots & \vdots & \ddots & \vdots \\
O & O & \ldots & Z_T
\end{bmatrix}
\]

be a \((T-m-2)N\) by \((T-m-2)(4m+5)\) matrix of instrumental variables for system of investment equations. Then, the stacked equation (5)' can be transformed into a form to which a generalized least squares (GLS) estimator is applicable.

\[
\frac{Z'\mathbf{I}}{\sqrt{N}} = \frac{Z'\mathbf{WB}}{\sqrt{N}} + \frac{Z'\mathbf{V}}{\sqrt{N}}
\]

(7).

The GLS estimation requires an estimate of the variance-covariance matrix of disturbances in model (7), \(\Omega\), at hand. The variance-covariance matrix of disturbances can be written as

\[
\Omega = \text{var}\left(\frac{Z'\mathbf{V}}{\sqrt{N}}\right) \\
= \mathbb{E}\left(\frac{Z'\mathbf{V}V'Z}{N}\right)
\]
under the orthogonality condition, \( E(Z'\nu) = 0 \). The submatrix of \( \Omega \) for time periods \( r \) and \( s \) \((r, s = (m+2), \ldots, T)\) can be expressed in terms of individual observations:

\[
\Omega_{r,s} = N^{-1} \sum_{j=1}^{N} E(Z_{j,r}^t, \nu_{j,r}, \nu_{j,s}^t, s Z_{j,s}) + N^{-1} \sum_{k=1}^{N-1} \sum_{j=k+1}^{N} E(Z_{j,r}^t, \nu_{j,r}, \nu_{j-k}^t, s Z_{j-k,s} + Z_{j-k,r}^t, \nu_{j-k,r}, \nu_{j,s}^t, s Z_{j,s})
\]

where \( j, k \in \{1, \ldots, N\} \). Under the assumption that disturbances for any individual industry is not correlated with those of other industries, a variance-covariance matrix is formed by:

\[
\Omega_{t,s} = N^{-1} \sum_{j=1}^{N} E(Z_{j,t}^t, \nu_{j,t}, \nu_{j,s}^t, s Z_{j,s})
\]

Under the above assumptions, an heteroskedasticity consistent covariance matrix estimator in line with and White (1984, 134) is obtained:

\[
\tilde{\Omega}_{t,s} = N^{-1} \sum_{j=1}^{N} Z_{j,t}^t, \tilde{\nu}_{j,t}, \nu_{j,s}^t, s Z_{j,s}
\]

where \( \tilde{\nu}_{j,t} \) is the \( j \)-th element of \( \tilde{\nu}_t \) which is a residual vector from a two-stage least squares (2SLS) estimation of an equation (4) for time period \( t \). That is,

\[
\tilde{\nu}_t = I_t - W_t \tilde{\beta}_t,
\]
where $\tilde{B}_t, \ (t=m+2, \ldots, T)$, is the two-stage least squares estimator (2SLS) estimator of $B_t$. In other words, a heteroscedasticity consistent covariance matrix for the system (7) can be obtained by the following:

$$(r, s) \text{ block of } \hat{\Omega} = \frac{Z_r'\hat{\Lambda}Z_s}{N},$$

where

\[
\hat{\Lambda} = \begin{bmatrix}
\bar{v}_{1r}\bar{v}_{1s} & 0 & \ldots & 0 \\
0 & \bar{v}_{2r}\bar{v}_{2s} & \ldots & 0 \\
\cdots & \cdots & \cdots & \cdots \\
0 & 0 & \ldots & \bar{v}_{Nr}\bar{v}_{Ns}
\end{bmatrix}.
\]

Now, with an estimator of $\Omega$, $\hat{\Omega}$, a GLS estimator can be applied to (7). For this, a matrix $P$ is required such that $P'P = \hat{\Omega}^{-1}$, where $\hat{\Omega}$ is the variance-covariance matrix. In practice, $P$ is derived from the property:

$\hat{\Omega}^{-1} = X\hat{\Lambda}X'$,

$= (X\hat{\Lambda}^{\frac{1}{2}})(X\hat{\Lambda}^{\frac{1}{2}})'$.

That is,

$P = (X\hat{\Lambda}^{\frac{1}{2}})'$. 
where $X$ is a matrix composed of eigen vectors and $\Lambda$ is a diagonal matrix of eigen values.

Premultiplying (7) with a matrix $P$ thus derived, then, applying OLS to

\[
\frac{PZ'I}{\sqrt{N}} = \frac{PZ'W}{\sqrt{N}}B + \frac{PZ'V}{\sqrt{N}} \tag{8}
\]

will lead to a consistent estimator, $\hat{B}$:

\[
\hat{B} = \left[ \frac{PZ'W}{\sqrt{N}} \right] \left[ \frac{PZ'W}{\sqrt{N}} \right]^{-1} \left[ \frac{PZ'W}{\sqrt{N}} \right] \left[ \frac{PZ'I}{\sqrt{N}} \right]
\]

\[
= [W'Z\hat{\Omega}^{-1}Z'W]^{-1}W'Z\hat{\Omega}^{-1}Z'I
\]

To show the consistency of $\hat{B}$, let the residual vector from the estimation of the system (5) be

\[
\hat{\nu} = I - \hat{W}\hat{B}
\]

and take the probability limit of $\hat{B}$ to obtain

\[
\text{plim} \hat{B} = B + \left[ \text{plim} N^{-1}W'Z \right] \left[ \text{plim} \hat{\Omega} \right] \left[ \text{plim} N^{-1}Z'W \right]^{-1}
\]

\[
\cdot \left[ \text{plim} N^{-1}W'Z \right] \left[ \text{plim} \hat{\Omega} \right] \left[ \text{plim} N^{-1}Z'\hat{\nu} \right]
\]

\[
= B.
\]

The second term in the right hand side is zero because of the assumptions of orthogonality and existence of second moments.
Asymptotically, \( \frac{PZ'V}{\sqrt{N}} \) is normally distributed with an identity covariance matrix. That is, 

\[
\frac{PZ'V}{\sqrt{N}} \overset{ASY}{\sim} N(0, I)
\]

since the variance-covariance matrix 

\[
E\left[ \frac{PZ'V}{\sqrt{N}} \right] = P E\left[ \frac{Z'VV'Z}{N} \right] P' = P\Omega P' = I.
\]

Therefore, the sum of squared residuals from GLS estimation of equation (7) (or, OLS estimation of equation (8)) has a \( \chi^2 \) distribution in a large sample.

4.4. Hypothesis Testing

The test of over-identifying restrictions and test of linear restrictions on parameters such as testing stationarity of individual effects and testing causality will be discussed in this section.

4.4.1. Test of Over-identifying Restrictions

The sum of squared residuals forms a test for over-identifying restrictions of the unrestricted model. The so-called \( Q \)-statistic is
\[
Q = \left[ \frac{PZ'\hat{V}}{\sqrt{N}} \right] \left[ \frac{PZ'\hat{V}}{\sqrt{N}} \right]^T
= \frac{\hat{V}'Z\Omega^{-1}Z'\hat{V}}{N},
\]

which has a \( \chi^2 \) distribution.\(^{10}\) The degree of freedom of \( Q \) statistics is equal to the number of instrumental variables minus the number of parameters.

4.4.2. Test of Linear Restrictions on Parameters

Hypotheses of linear restrictions on \( B \) can be formulated in either of the following two forms. The standard formulation is to restrict \( B \) by premultiplying it with a restriction matrix \( R \) whose number of rows equals to the number of restrictions; and then letting \( RB \) equal to a constant vector \( r \). An alternative formulation, being adopted here, is to express \( B \) as a linear function of a vector of parameters of the restricted model, \( \gamma \).

A convenient test statistic for testing hypotheses in the latter formulation is developed by Gallant and Jorgenson (1979) in an identical-and-independent distribution (i.i.d.) environment. They use the difference of the sum of squared residuals of restricted model and that of the unrestricted model, what they called \( T^0 \), as a test statistic. In the current context, HNR (1988) named the difference of sum of

4.4.2.1. Testing Stationarity of Individual Effect

The hypothesis testing with specific examples is discussed here. The first example is to test stationarity of the individual effect, $\Psi_t$. The hypothesis amounts to the restriction $r_e=1(t=(m+2),\ldots,T)$ in equation (3.2). In terms of the stacked model, the hypothesis is:

$$B = H\theta + G \quad (9),$$

where $B$ is a $(T-m-2)(4m+5)$ vector of unrestricted parameters, $H$ is a $(T-m-2)(4m+5)$ by $(T-m-2)(4m+1)$ matrix which maps the restricted parameter, $\theta$, to the unrestricted parameter $B$; and it is a block diagonal matrix which has $T-m-2 H_e$ matrices in its diagonal. The $\theta$ is a $(T-m-2)(4m+1)$ vector. The $G$ matrix is a $(T-m-2)(4m+5)$ vector of constants; and it is a stacked vector of $T-m-2 G_e$ vectors.

For the investment model, the $H$ matrix is a block diagonal matrix where $H_e$ repeats itself $T-m-2$ times along its diagonal. Thus,
$$H_t = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}$$; and $$G_t = \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$G_t$$ also repeats itself $T-m-2$ times in $G$. 
The specificity of the matrices $H$ and $G$ can be found by substitution of the restriction $r_t = 1(t = (m+2), \ldots, T)$ into the equation (3.2). Then, the equation (3.2) becomes

$$a_t = a_{t-1},$$
$$b_{1t} = 1 + \beta_{1t},$$
$$b_{lt} = \beta_{lt} - \beta_{l-1,t-1} \quad (l = 2, \ldots, m),$$
$$b_{m+1,t} = -a_{m+1,t-1},$$
$$c_{1t} = \gamma_{1t},$$
$$c_{lt} = \gamma_{lt} - \gamma_{l-1,t-1} \quad (l = 2, \ldots, m),$$
$$c_{m+1,t} = -\gamma_{m+1,t-1},$$
$$d_{1t} = \delta_{1t},$$
$$d_{lt} = \delta_{lt} - \delta_{l-1,t-1} \quad (l = 2, \ldots, m),$$
$$d_{m+1,t} = -\delta_{m+1,t-1},$$
$$e_{1t} = \zeta_{1t},$$
$$e_{lt} = \zeta_{lt} - \zeta_{l-1,t-1} \quad (l = 2, \ldots, m),$$
$$e_{m+1,t} = -\zeta_{m+1,t-1}.\]
In the case where \( m \) is three, the equation (3.3) can be expressed as

\[ B_c = H_c \theta_c + G_c, \]

where

\[
\theta_c = \begin{bmatrix}
\alpha_c - \alpha_{c-1} \\
\beta_{1,c} \\
\beta_{2,c} \\
\beta_{3,c} \\
\gamma_{1,c} \\
\gamma_{2,c} \\
\gamma_{3,c} \\
\delta_{1,c} \\
\delta_{2,c} \\
\delta_{3,c} \\
\zeta_{1,c} \\
\zeta_{2,c} \\
\zeta_{3,c}
\end{bmatrix}.
\]

The restricted parameter \( \theta \) is a stacked vector of \( \theta_c \) for \( t = (m+2), \ldots, T \).
Substituting $H\theta + G$ into $B$ in the model (5)', $I = WB + V$, imposes a linear restriction of stationary individual effects on a quasi-differences model (5); it is to transform the quasi-differences model into a differenced model. The hypothesis $B = H\theta + G$ (9) is tested by comparison of the sum of squared residuals, $Q_R$, of a differenced model with that of the unrestricted quasi-differences model (5), $Q$. If the null hypothesis is correct, the value of $Q$ and $Q_R$ will not differ very much. Thus, HNR's $L$ statistic is

$$L = \frac{\hat{Y}'Z\Omega^{-1}Z\hat{Y}}{N} - \frac{\hat{Y}'Z\Omega^{-1}Z\hat{V}}{N},$$

where

$$\hat{Y} = Y - W(H\theta + G)$$

and $\theta$ is estimated by applying the same methods that are used for getting $\hat{B}$ to the differenced model, $Y - WG = \hat{W}H\theta + V$.

The $L$ statistics has a $\chi^2$ distribution.

The degree of freedom of $L = Q^R - Q$ is equal to the degree of freedom of $Q_R$ minus the degree of freedom of $Q$. The degrees of freedom of $Q$ is the number of rows minus the number of columns of $PZ'W$. The number of rows equals to the number of instrumental variables and the number of columns equals to the number of parameters for the unrestricted
model. The same applies to the restricted model. Thus, in general, the degree of freedom of $L$ is equal to the difference in the number of parameters in restricted model and unrestricted model.\(^{11}\)

In the current example of testing the hypothesis of stationary individual effects, the number of parameters of unrestricted model is $(T-m-2)(4m+5)$ and the number of parameters of restricted model is $(T-m-2)(4m+1)$. Therefore, the degrees of freedom of the test statistic $L$ for testing the hypothesis that $r_t = 1$ for $t = m+2,\ldots,T$ is equal to $4(T-m-2)$.

The degrees of freedom of $L$ thus calculated is equal to the number of restrictions in the first formulation of the hypothesis, $RB = r$. This can be demonstrated by examining the cross equation restrictions in $B = H\Theta + G$. When $m = 3$, they are, for $t = m+2,\ldots,T$, 

\[ . \]
\[
\begin{bmatrix}
  a_t \\
  b_{1,t} \\
  b_{2,t} \\
  b_{3,t} \\
  b_{4,t} \\
  c_{1,t} \\
  c_{2,t} \\
  c_{3,t} \\
  c_{4,t} \\
  d_{1,t} \\
  d_{2,t} \\
  d_{3,t} \\
  d_{4,t} \\
  e_{1,t} \\
  e_{2,t} \\
  e_{3,t} \\
  e_{4,t}
\end{bmatrix} =
\begin{bmatrix}
  1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 \\
  0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 \\
\end{bmatrix}
\begin{bmatrix}
  \alpha_t - \alpha_{t-1} \\
  \beta_{1,t} \\
  \beta_{2,t} \\
  \beta_{3,t} \\
  \gamma_{1,t} \\
  \gamma_{2,t} \\
  \gamma_{3,t} \\
  \delta_{1,t} \\
  \delta_{2,t} \\
  \delta_{3,t} \\
  \zeta_{1,t} \\
  \zeta_{2,t} \\
  \zeta_{3,t} \\
\end{bmatrix} + \begin{bmatrix}
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
  0 \\
\end{bmatrix}
Summing the restrictions of the second to the fifth leads to the restriction of the form, \( b_{1,t} + b_{2,t} + b_{3,t} + b_{4,t} = 1 \).

Summing the next four restrictions leads to the restrictions of the form, \( c_{1,t} + c_{2,t} + c_{3,t} + c_{4,t} = 0 \). The restrictions \( d_{1,t} + d_{2,t} + d_{3,t} + d_{4,t} = 0 \) and \( e_{1,t} + e_{2,t} + e_{1,t} + e_{4,t} = 0 \) are obtained likewise. Thus,

\[
\begin{align*}
&b_{1,t} + \ldots + b_{m-1,t} = 1, \\
c_{1,t} + \ldots + c_{m-1,t} = 0, \\
d_{1,t} + \ldots + d_{m-1,t} = 0, \\
e_{1,t} + \ldots + e_{m-1,t} = 0
\end{align*}
\]

for \( t = (m+2), \ldots, T \). These can be written as

\[
R_t B_t = r_t \text{ for } t = m+2, \ldots, T, \text{ where}
\]

\[
R_t = \begin{bmatrix}
0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1
\end{bmatrix};
\]

\( B_t \) is same as before; and

\[
B_t = \begin{bmatrix}
1 \\
0 \\
0 \\
0
\end{bmatrix},
\]

\[
r_t = \begin{bmatrix}
1 \\
0 \\
0 \\
0
\end{bmatrix}.
\]
Thus, the degrees of freedom, \( 4(T-m-2) \), is equal to the number of restrictions for testing the stationarity of individual effects in the \( f \).

4.4.2.2. Testing Causality

Causality between, say, \( I_t \) and \( dL_t \) can be tested by omitting the lagged variables of one from the model for the other. That is, if \( Q \) from the system (7) and \( Q_R \) from the system (7) with all lagged variables of \( dL_t \) omitted are significantly different and, at the same time, \( Q \) from the system for \( dL_t \) and \( Q_R \) from that with all lagged variables of \( I_t \) omitted are close enough to make \( L \) significantly different from zero, then \( dL_t \) is said to cause \( I_t \). \( dL_t \) causes \( I_t \) in the sense that the past values of the former help predict the latter given the other variables in the system for the latter, while the past values of the latter fail to help predict the former given the other variables in the system for the former. This concept of causality is in the spirit of Granger (1969)-causality.

This methodology provides us with a powerful tool to attack the causality issue. Even for an economy of which the aggregate data reveal highly non-stationary pattern inference of causality such that the usual causality tests following Granger (1969) or Sims (1972) cannot be applied meaningfully, this methodology allows us to infer causality. In what follows, the data compilation is explained. Then,
the models and their estimation and test results are reported.

4.5. Data

The industrial data are taken from various issues of *Financial Statement Analysis* (FSA hereafter) compiled by the Bank of Korea each year. The sample consists of 4-digit basis 65 manufacturing industries in Korea from 1972 to 1983. Since the industry classification underwent a major change in the data for 1978, 11 industries before 1978 are merged leaving 65 industries. The industry classification used in this paper is listed in Table A4.1 in the appendix.

The values for sales and operating income are taken from the income statements and deflated with 3-digit industries’ WPI and valued in 1985 prices. The source of price indices is the *Price Statistics Summary* (the Bank of Korea, 1987).

The values for each item of capital stock net of depreciation is derived from the balance sheets of each industry in FSA and related tables and ratios. They are deflated with industrial capital stock price indices in *Estimates of Yearly Capital Stocks in Manufacturing Industries of the Republic of Korea* (in Korean, October 1990, Research Department, the Korea Development Bank).

While the balance sheets include the end-of-period book value of tangible fixed investments for nine items, i.e., land, buildings, structures, machines and equipments, ships,
trucks and delivery equipment, construction in process, tools, and others, the price indices are provided for three sub-categories of capital goods: (1) buildings and structures, (2) machines, tools, and equipments (3) transportation equipments. Thus, the balance sheet items were aggregated accordingly. This means that land, construction in process, and other fixed tangible assets are excluded from the capital stock. This improves the quality of the data because the book value for land is highly unreliable due to rapid changes in land prices.

Derivation of the values of each item of capital stock was needed because the published values of balance sheets are not directly comparable across years. Fortunately, consecutive balance sheets for the beginning and the end of each year could be recovered from the Funds Flow Statement in the FSA and the ratios related to the balance sheets.

The changes in loans include long-term and short-term borrowing from banks and foreign loans. Since the allocation of foreign loans as well as bank loans were tightly controlled by the government, it is safe to consider that the changes in loans in firm finance reflect the influence of the government policy on industrial investment decisions. A few caveats are in order in considering the loans data in FSA as a real amount of credits purveyed to industries by banking sector. First, many firms report "borrowing from the curb market" as "borrowing from banks"
since transaction in the curb market is illegal. To that extent, the loans reported in FSA may be overestimated (Dee, 1985). However, since what counts in this paper is the change in loans, this problem seems less serious. Second, the compensating balance held at the bank blurs the real amount of credit supply to industries. The balance is required informally by the lending banks in a way to increase effective rate of lending rate in a circumstance where the interest rate is regulated. However, if the degree of this problem is same across industries, it will not change the inter-industrial variations of the change in loans. Since it is unlikely that the banks discriminate against firms on the basis of industries in requiring compensating balance, this problem will not affect the conclusion of this study in an important way.

The Funds Flow Statement in the FSA reports the sources and uses of funds flow of each industry during a period. Until 1977, the Funds Flow Statement reported the rate of change in each item and the share of each item in the total sources or in total uses of funds. The inventory items in the balance sheet (raw materials, goods in process, finished or partly finished goods, and supplies), inventories turnover ratio, and the share of inventories in total uses of funds are combined to obtain the changes in bank and foreign loans as sources of funds. The nominal value of the changes in bank and foreign loans is deflated with a price
deflator. The average of the ratio of the nominal value of tangible fixed assets at the beginning of the period to the 1985 real value and the same ratio for the end of the period value of tangible fixed assets is used as a price deflator for the changes in loans. For 1977-1983, the FSA reports the value of the changes in the sources and uses of funds. The items for bank and foreign loans are read from the table and deflated with the same method as used for previous years.

The cost of borrowing is the interest paid plus discount expenses divided by the total borrowing. The total borrowing includes all sources of borrowing such as bank loans, loans from non-bank financial institutions, bonds, foreign loans, and so on. The real cost of borrowing was calculated by subtracting the rate of change in the price of industrial output from the cost of capital. Where data for industries should be merged for consistency in time series, the sales-weighted average cost of capital is used.

4.6. Estimation and Test Results

Calomiris and Himmelberg (1993) include lagged values of interindustrial variations of investment, sales, profits, and incremental loans in the PVAR model. With an additional variable--the cost of borrowing--which is highly relevant to the investment at hand, different specifications of the
investment model have to be considered. There are a multitude of plausible initial specifications.

This study proceeds with a strategy to resolve the problem of multiple feasible specifications. The selection of the number of variables to be included and the initial number of initial lags is constrained first of all by the paucity of the number of observations of industries. Inclusion of all five variables in the model is feasible only when the lag length is given at most $m = 2$. The number of industries in the data is 65 while that required for estimation of a four-variable model with lag length given by $m = 3$ for $t = m+2$, $m+3$, and $m+4$ is 63. The five-variable specification with $m = 3$ requires at least 78 observations of industries. Thus, the maximum number of lags is given by $m = 2$ with the five-variable model. If the lag length is given by $m = 3$, inferences will be made by looking into the results of all plausible four-variable specifications. If all the four-variables show a type of Granger-causality running from selective credit allocation to investment pattern, it may be concluded that the selective credit allocation may really have been effective in changing industrial investment patterns.

The data cover the period of 1972-1983. The whole period is split into two sub-periods: one for the period from 1977 to 1979 and another for the period from 1981 to 1983. This is mainly because the number of observations on
industries is insufficiently large. For example, to estimate parameters for the last seven years with one model, at least 203 industrial observations are required. Since the available number of industrial observations is 65, the period of the seven years is divided into two sub-periods; and the parameters for the 1977-79 period and for 1981-1983 periods are estimated under different estimators of the variance-covariance matrix. Thus, the parameter estimates for the two periods are not directly comparable.

The division of the sample period is not totally arbitrary. There is evidence that the Korean economy underwent a structural change around 1980. In that year, it recorded a negative aggregate growth rate for the first and only time in its history. Moreover, the backbone of economic policy changed from growth-first to stability-first. New economic technocrats promoted economic liberalization reforms: the policy tone toward heavy and chemical industry promotion was switched from an aggressive expansion to structural adjustment. State control of the financial sector was also lessened in several respects. Preferential interest rates were unified and nationwide commercial banks were privatized.

If the financial system was effectively controlling investment behaviors by industries, the pivotal change from growth-based to stability-based policy might have affected the manner in which investment patterns were related to
selective credit allocation. In terms of the investment model, the structural change may be reflected in lag length or patterns of Granger-causality. If structural change has happened, the explanatory variables in the far past will have ceased to be relevant due to the structural change and thus the lag length will tend to be shorter in the later periods than in the earlier periods.

However, it is not necessarily the case that shortened lag length reflects a structural change. This study does not make any rigorous effort to test the structural change around 1980 for Korean industrial activities. Empirical methodology for testing structural change in the context of the PVAR model is yet to be developed and is beyond the scope of this study.

The sequence of tests is structured in such a way that the hypothesis of non-causality is nested within the hypothesis about stationarity of parameters and that about lag length. Given the maximum possible length of lags, the hypothesis of stationary individual effects is tested. The hypothesis of stationarity of coefficients is nested within that of stationarity of individual effects. The test of lag length is carried out based on the result of the stationarity tests. When the optimal lag length is thus decided, causality tests are performed.
4.6.1. Determination of Investment Patterns During 1977-1979 Period

The test results for the four-variable specification of the investment model for the 1977-79 period which includes lagged variables of $I$, $S$, $H$, and $dL$ on the right hand side are summarized in Table 4.1. We start with a quasi-differenced model with $m=3$. The first line shows that the $Q$-statistic for the test of over-identifying restrictions is equal to 5.16 with 12 degrees of freedom; the $p$-value is 0.952. The second line shows that given $m = 3$, the hypothesis of stationary individual effects is rejected. The $Q$-statistic for testing over-identifying restrictions in the third line is equal to 26.756 with 24 degrees of freedom (see the third line); this implies a $p$-value of 0.316, which indicates that we got a good fit with $m=2$.

Unfortunately the $L$ statistics for testing the hypothesis of reducing the lag length from $m = 3$ to $m = 2$ in the third line is 0.042 and thus sensitive to the choice of significance level, as the $p$-value is thus lower than the usual significance level of 0.05. If the 5-percent significance level is chosen, the hypothesis of the reducing lag length from the starting model is rejected. This seems to conflict with the $Q$ statistics which shows a good fit with $m = 2$.

In general, fixing significance at a specific level is a moot question. Significance level is the probability of
Table 4.1. Test Results for Investment Equations
($I_t$, $t = 1977-79$) with 4 Variables: $I$, $S$, $II$ and $dL$

<table>
<thead>
<tr>
<th></th>
<th>$Q$</th>
<th>df</th>
<th>p-value</th>
<th>$L$</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>$m = 3$</td>
<td>5.162</td>
<td>12</td>
<td>0.952</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>station-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>arity of $f$</td>
<td>56.940</td>
<td>24</td>
<td>0.000</td>
<td>51.778</td>
<td>12</td>
</tr>
<tr>
<td>(iii)</td>
<td>$m = 2$</td>
<td>26.756</td>
<td>24</td>
<td>0.316</td>
<td>21.594</td>
<td>12</td>
</tr>
<tr>
<td>(vi)</td>
<td>$m = 1$</td>
<td>117.989</td>
<td>36</td>
<td>0.000</td>
<td>91.233</td>
<td>12</td>
</tr>
<tr>
<td>(v)</td>
<td>exclude $dL$</td>
<td>51.562</td>
<td>33</td>
<td>0.021</td>
<td>24.806</td>
<td>9</td>
</tr>
<tr>
<td>(vi)</td>
<td>exclude $S$</td>
<td>44.990</td>
<td>33</td>
<td>0.080</td>
<td>18.234</td>
<td>9</td>
</tr>
<tr>
<td>(vii)</td>
<td>exclude $II$</td>
<td>59.348</td>
<td>33</td>
<td>0.003</td>
<td>32.593</td>
<td>9</td>
</tr>
<tr>
<td>(viii)</td>
<td>exclude $I$</td>
<td>55.532</td>
<td>33</td>
<td>0.008</td>
<td>28.776</td>
<td>9</td>
</tr>
<tr>
<td>(ix)</td>
<td>exclude $dL$</td>
<td>17.169</td>
<td>24</td>
<td>0.841</td>
<td>12.007</td>
<td>12</td>
</tr>
<tr>
<td>(x)</td>
<td>exclude $S$</td>
<td>20.971</td>
<td>24</td>
<td>0.640</td>
<td>15.809</td>
<td>12</td>
</tr>
<tr>
<td>(xi)</td>
<td>exclude $II$</td>
<td>22.725</td>
<td>24</td>
<td>0.536</td>
<td>17.563</td>
<td>12</td>
</tr>
<tr>
<td>(xii)</td>
<td>exclude $I$</td>
<td>26.809</td>
<td>24</td>
<td>0.313</td>
<td>21.646</td>
<td>12</td>
</tr>
</tbody>
</table>

Note: The results of causality tests in lines (v)-(viii) are based on the model with $m = 2$. Those in lines (ix)-(xii) are based on the model with $m = 3$. 
type I error, i.e., the probability of rejecting a true hypothesis. If it is set at too low a level, the type II error, i.e., the probability of accepting a false hypothesis, increases. Thus, econometricians usually use a 5 percent significance level. Nevertheless, test statistics ranging from 0.01 to 0.10 raise questions about rejection or acceptance of a null hypothesis.

In the above case, the null hypothesis relates to the optimal lag length. To see the adequacy of the 5-percent significance level, I carry out causality tests under both null \( m = 2 \) and alternative \( m = 3 \) hypotheses. The results under the null hypothesis are reported in lines (v) - (viii) and those under the alternative hypothesis are reported in lines (ix) - (xii).

Now, if the usual significance level, 5 percent, is selected, the hypothesis of \( m = 2 \) is rejected. Then \( m = 3 \) becomes appropriate. But this leads to an unacceptable conclusion; that is, all the lagged variables (with the exception of investment)--sales, profits, and the increments in loans--are insignificant in explaining investment decisions of Korean industries during the period of 1977-1979. This is not admissible because the literature on investment predicts that either sales or profits affect investment.

At the significance level of 1 percent, the lagged variables of investment, profits, the changes in loans help
predict investment. This is consistent with the standard theory of investment. Thus it seems that, for the nature of the data at hand, anchoring the significance level at 1 percent leads to more probable statistical decision making.

With the significance level set at 1 percent, the proposition that selective credit allocation (represented by interindustrial variations of the ratios of incremental loans to capital stocks) Granger-causes investment may not be rejected.

To be sure about the causality between investment and selective credit allocation, different specifications of the investment equation are estimated. The first candidate for an alternative model is to omit the lagged variable of sales from the equation (3.1) while including the lagged variable of the cost of borrowing in the equation; thus, the model includes lagged values of investment, profits, the cost of borrowing, and the changes in loans in the right hand side of the equation.\(^\text{16}\) Denote the cost of borrowing by industry \(j\) with \(dc_{j,t}\). This model can be expressed as follows:

\[
i_{j,t} = a_t + \sum_{l=1}^{m+1} b_{l,t} i_{j,t-l} + \sum_{r=1}^{m-1} c_{r,t} \pi_{j,t-r} + \sum_{l=1}^{m+1} d_{l,t} dc_{j,t-l} \\
+ \sum_{l=1}^{m+1} e_{l,t} dl_{j,t-l} + u_{j,t} - \lambda_t u_{j,t-1} \quad (t=(m+2), \ldots, T) \tag{3.3}
\]
Table 4.2. Test Results for Investment Equations
($I_t$, $t = 1977-79$) with 4 Variables: $I$, $II$, $DC$ and $dL$

<table>
<thead>
<tr>
<th></th>
<th>$Q$</th>
<th>df</th>
<th>p-value</th>
<th>$L$</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) $m = 3$</td>
<td>11.339</td>
<td>12</td>
<td>0.500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) stationarity of $f$</td>
<td>62.052</td>
<td>24</td>
<td>0.000</td>
<td>51.713</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(iii) $m = 2$</td>
<td>59.184</td>
<td>24</td>
<td>0.000</td>
<td>47.845</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(iv) $m = 1$</td>
<td>105.602</td>
<td>36</td>
<td>0.000</td>
<td>46.418</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(v) exclude $dL$</td>
<td>54.466</td>
<td>24</td>
<td>0.000</td>
<td>43.126</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(vi) exclude $DC$</td>
<td>54.541</td>
<td>24</td>
<td>0.000</td>
<td>43.201</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(vii) exclude $II$</td>
<td>43.200</td>
<td>24</td>
<td>0.009</td>
<td>31.861</td>
<td>12</td>
<td>0.001</td>
</tr>
<tr>
<td>(viii) exclude $I$</td>
<td>50.061</td>
<td>24</td>
<td>0.001</td>
<td>38.722</td>
<td>12</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: The results of causality tests in lines (v)-(viii) are based on the model with $m = 3$. 
The results of tests with the model (3.3) are summarized in Table 4.2. The \( Q \) statistics in line (i) for the quasi-differenced model with \( m = 3 \) shows that it passes the test of over-identifying restrictions. Any further restriction of the model is rejected as shown in lines (ii)-(viii). Given the quasi-differenced model with \( m = 3 \), both the cost of borrowing and the changes in loans are shown to Granger-cause investment.

A third specification of the four-variable model is obtained by replacing \( \Pi \) with \( S \) in the equation (3.3). Thus:

\[
i_{j,t} = a_t + \sum_{j=1}^{m-1} b_{j,t} i_{j,t-1} + \sum_{j=1}^{m-1} c_{j,t} s_{j,t-1} + \sum_{j=1}^{m-1} d_{j,t} d_{c,j,t-1} \\
+ \sum_{j=1}^{m-1} e_{j,t} d_{l,j,t-1} + u_{j,t} - r_{t} u_{j,t-1} \quad (t = (m+2), \ldots, T) \quad (3.4)
\]

The test results are summarized in Table 4.3. The first line shows that the quasi-differenced model with \( m = 3 \) passes the test of over-identifying restrictions. The second line shows that, given the quasi-differenced model with \( m = 3 \), the hypothesis of stationary individual effects is rejected. The third line shows that, given the quasi-differenced model with \( m = 3 \), the hypothesis of reducing lag length to \( m = 2 \) can not be rejected. Since the fourth line indicates that further reduction of the lag length is not
Table 4.3. Test Results for Investment Equations
($I_t$, $t = 1977-79$) with 4 Variables: $I$, $S$, $DC$ and $dL$

<table>
<thead>
<tr>
<th></th>
<th>$Q$</th>
<th>df</th>
<th>p-value</th>
<th>$L$</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>9.134</td>
<td>12</td>
<td>0.691</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stationarity of $f$</td>
<td>56.716</td>
<td>24</td>
<td>0.000</td>
<td>47.582</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(iii)</td>
<td>15.661</td>
<td>24</td>
<td>0.900</td>
<td>6.522</td>
<td>12</td>
<td>0.888</td>
</tr>
<tr>
<td>(vi)</td>
<td>114.923</td>
<td>36</td>
<td>0.000</td>
<td>99.262</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(v)</td>
<td>51.225</td>
<td>33</td>
<td>0.022</td>
<td>35.564</td>
<td>9</td>
<td>0.000</td>
</tr>
<tr>
<td>(vi)</td>
<td>38.086</td>
<td>33</td>
<td>0.249</td>
<td>22.425</td>
<td>9</td>
<td>0.008</td>
</tr>
<tr>
<td>(vii)</td>
<td>66.141</td>
<td>33</td>
<td>0.001</td>
<td>50.480</td>
<td>9</td>
<td>0.000</td>
</tr>
<tr>
<td>(viii)</td>
<td>48.131</td>
<td>33</td>
<td>0.043</td>
<td>32.470</td>
<td>9</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: The results of causality tests in lines (v)-(viii) are based on the model with $m = 2$. 
accepted, causality tests are nested in the quasi-differenced model with $m = 2$. The fifth and the sixth lines show that changes in loans and the cost of borrowing Granger-cause investment. Therefore, the proposition that selective credit allocation has been effective in changing interindustrial investment patterns is confirmed with this specification as well.

The parameter estimates for this model are reported in Table A4.2 in the appendix, which is estimated from the quasi-differenced model with $m=2$.

A model including all five variables might be considered. But no attempt is made to estimate it here because the result from the second four-variable model shows a lag length with $m = 3$. With five variables, only a lag length with $m = 2$ is estimable.

All three four-variable models indicate that the variables that represent the selective credit allocation Granger-cause investment. Therefore, the proposition that the selective credit allocation implemented during 1974-78 effectively influenced the interindustrial variations of investment during 1977-79 is sustained.

4.6.2. Determination of Investment Patterns During 1981-1983 Period

Next, the study examines whether a change in causality patterns arises when the periods of dependent variable are shifted to the 1981-83 period. The dependent variables are now interindustrial variations of investment during 1981-
1983 instead of those during 1977-79. Estimation and tests procedures are basically the same as before.

The first four-variable model (equation 3.1) includes lagged variables of investment, sales, profits, and the changes in loans in the right hand side of the equation. Estimation results are summarized in Table 4.4. Given the quasi-differenced model with \( m = 3 \), the hypothesis of stationarity of individual effects is rejected; but, the hypothesis of reducing lag length from \( m = 3 \) to \( m = 2 \) is not rejected. Given the quasi-differenced model with \( m = 2 \), the hypothesis of reducing lag length from \( m = 2 \) to \( m = 1 \) is not rejected either. Since further reduction of lag length is rejected, causality tests are nested within the quasi-differenced model with \( m = 1 \). The hypothesis that changes in loans did not Granger-cause investment is rejected. Thus, when the initial specification is maintained, the proposition of effectiveness of selective credit allocation is also supported for the 1981-83 period.

Compared with the investment model for 1977-1979 (summarized in Table 4.2), two changes are notable. First, the lag length has been reduced from \( m = 2 \) (or, \( m = 3 \)) to \( m = 1 \). This is somewhat consistent with the argument that there has been a structural change occurred around 1980. Second, at the 1-percent significance level, profits do not
Table 4.4. Test Results for Investment Equations
($I_t$, $t = 1981-83$) with 4 Variables: $I$, $S$, $\Pi$ and $dL$

<table>
<thead>
<tr>
<th></th>
<th>$Q$</th>
<th>df</th>
<th>p-value</th>
<th>$L$</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>$m = 3$</td>
<td>11.292</td>
<td>12</td>
<td>0.504</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) stationarity of $f$</td>
<td>57.038</td>
<td>24</td>
<td>0.000</td>
<td>45.746</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(iii) $m = 2$</td>
<td>18.775</td>
<td>24</td>
<td>0.764</td>
<td>7.483</td>
<td>12</td>
<td>0.824</td>
</tr>
<tr>
<td>(iv) $m = 1$</td>
<td>32.418</td>
<td>36</td>
<td>0.640</td>
<td>13.643</td>
<td>12</td>
<td>0.324</td>
</tr>
<tr>
<td>(v) $m = 0$</td>
<td>77.652</td>
<td>48</td>
<td>0.004</td>
<td>45.234</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(vi) exclude $dL$</td>
<td>57.339</td>
<td>42</td>
<td>0.057</td>
<td>24.921</td>
<td>6</td>
<td>0.000</td>
</tr>
<tr>
<td>(vii) exclude $S$</td>
<td>67.815</td>
<td>42</td>
<td>0.007</td>
<td>35.397</td>
<td>6</td>
<td>0.000</td>
</tr>
<tr>
<td>(viii) exclude $\Pi$</td>
<td>48.276</td>
<td>42</td>
<td>0.234</td>
<td>15.858</td>
<td>6</td>
<td>0.014</td>
</tr>
<tr>
<td>(ix) exclude $I$</td>
<td>55.672</td>
<td>42</td>
<td>0.077</td>
<td>23.254</td>
<td>6</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Note: The results of causality tests in lines (vi)-(ix) are based on the model with $m = 1$. 
Granger-cause investment for the period 1981-83 while sales do not Granger-cause investment for the period 1977-1979, all other variables Granger-causing investment.

The second model with four variables (equation 3.3) includes the lagged variables of $I$, $S$, $DC$, and $dL$ on the right hand side of the equation. The results are summarized in Table 4.5. Given the quasi-differenced model with $m = 3$, stationarity of individual effects is rejected, but the hypothesis of reducing the lag length to $m = 2$ is not rejected. Given $m = 2$, the hypothesis of $m = 1$ is rejected. Thus, the causality tests are based on the model with $m = 2$. Under the usual 5 percent significance level, all variables fail to Granger-cause investment. At a significance level of 10 percent, the changes in loans and sales Granger-cause investment. This seems to result from misspecification of the model.

The third model with four variables (equation 3.4) includes lagged variables of $I$, $II$, $DC$, and $dL$ on the right hand side of the equation. The test results are summarized in Table 4.6. Given the quasi-differenced model with $m = 3$, stationarity of individual effects is rejected; but, the hypothesis of reducing lag length to $m = 2$ is not rejected. Since the hypothesis of reducing lag length to $m = 1$ is
Table 4.5. Test Results for Investment Equations
($I_t$, $t = 1981-83$) with 4 Variables: $I$, $S$, $DC$ and $dL$

<table>
<thead>
<tr>
<th></th>
<th>$Q$</th>
<th>df</th>
<th>p-value</th>
<th>$L$</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) $m = 3$</td>
<td>13.734</td>
<td>12</td>
<td>0.317</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) station-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>arity of $f$</td>
<td>85.382</td>
<td>24</td>
<td>0.000</td>
<td>71.648</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(iii) $m = 2$</td>
<td>26.665</td>
<td>24</td>
<td>0.320</td>
<td>12.931</td>
<td>12</td>
<td>0.374</td>
</tr>
<tr>
<td>(iv) $m = 1$</td>
<td>55.675</td>
<td>36</td>
<td>0.019</td>
<td>29.010</td>
<td>12</td>
<td>0.004</td>
</tr>
<tr>
<td>(v) exclude $dL$</td>
<td>43.066</td>
<td>33</td>
<td>0.113</td>
<td>16.401</td>
<td>9</td>
<td>0.059</td>
</tr>
<tr>
<td>(vi) exclude $DC$</td>
<td>43.526</td>
<td>33</td>
<td>0.104</td>
<td>16.860</td>
<td>9</td>
<td>0.051</td>
</tr>
<tr>
<td>(vii) exclude $S$</td>
<td>41.938</td>
<td>33</td>
<td>0.137</td>
<td>15.272</td>
<td>9</td>
<td>0.084</td>
</tr>
<tr>
<td>(viii) exclude $I$</td>
<td>30.003</td>
<td>33</td>
<td>0.617</td>
<td>3.337</td>
<td>9</td>
<td>0.949</td>
</tr>
</tbody>
</table>

Note: The results of causality tests in lines (v)-(viii) are based on the model with $m = 2$. 
rejected, causality tests are nested within the quasi-differenced model with \( m = 2 \).

Changes in loans fail to Granger-cause investment, but the cost of borrowing does Granger-cause investment. Interpretation of this is potentially ambiguous. If the cost of borrowing of an industry is completely determined by government policy, the result may be interpreted to imply that the government could effectively change the investment behavior of industries through influencing the cost of borrowing. But if the cost of borrowing is determined more by non-government factors, the result implies a government failure to influence private firms' investment decision.

In any case, this specification suggests a structural change in the interrelationship between government and industry through government financial control. In the model of investment for 1977-79 period, all explanatory variables Granger-cause investment. But, in the model for 1981-1983 period, only the cost of borrowing Granger-causes investment (at a significance level of 1 percent), the lag length being the same.

A five-variable model including \( I, S, \Pi, DC, \) and \( dL \) is now estimable since all the three four-variable models for the 1981-1983 period show that the length of lags is given at most by \( m = 2 \). Thus, the model to be estimated is:

\[
\begin{align*}
  \frac{dI_{j,t}}{dt} &= \alpha_t + \sum_{i=1}^{m+1} b_{1,i} I_{j,t-1} + \sum_{i=1}^{m+1} c_{1,i} S_{j,t-1} + \sum_{i=1}^{m+1} d_{1,i} \pi_{j,t-1} + \sum_{j=1}^{m+1} e_{1,e} dC_j, t-1 \nonumber \\
  &+ \sum_{j=1}^{m+1} g_{1,e} dL_j, t-1 + u_{j,t} - r_t u_{j,t-1} \quad (t = (m+2), \ldots, T) \quad (3.5) .
\end{align*}
\]
Table 4.6. Test Results for Investment Equations

\( (I_t, t = 1981-1983) \) with 4 Variables: \( I, II, DC \) and \( dL \)

<table>
<thead>
<tr>
<th></th>
<th>( Q )</th>
<th>( df )</th>
<th>( p-value )</th>
<th>( L )</th>
<th>( df )</th>
<th>( p-value )</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) ( m = 3 )</td>
<td>10.804</td>
<td>12</td>
<td>0.546</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) stationarity of ( f )</td>
<td>96.300</td>
<td>24</td>
<td>0.000</td>
<td>85.496</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(iii) ( m = 2 )</td>
<td>14.856</td>
<td>24</td>
<td>0.925</td>
<td>4.053</td>
<td>12</td>
<td>0.982</td>
</tr>
<tr>
<td>(iv) ( m = 1 )</td>
<td>52.284</td>
<td>36</td>
<td>0.039</td>
<td>37.427</td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>(v) exclude ( dL )</td>
<td>27.487</td>
<td>33</td>
<td>0.738</td>
<td>12.630</td>
<td>9</td>
<td>0.180</td>
</tr>
<tr>
<td>(vi) exclude ( DC )</td>
<td>40.352</td>
<td>33</td>
<td>0.177</td>
<td>25.495</td>
<td>9</td>
<td>0.002</td>
</tr>
<tr>
<td>(vii) exclude ( II )</td>
<td>34.593</td>
<td>33</td>
<td>0.392</td>
<td>19.736</td>
<td>9</td>
<td>0.020</td>
</tr>
<tr>
<td>(viii) exclude ( I )</td>
<td>21.336</td>
<td>33</td>
<td>0.941</td>
<td>6.479</td>
<td>9</td>
<td>0.691</td>
</tr>
</tbody>
</table>

Note: The results of causality tests in lines (v)-(viii) are based on the model with \( m = 2 \).
So long as $m = 2$ is maintained, the specification generates the most appropriate tests.

The test results with this model are reported in Table 4.7. The first line shows that the five-variable quasi-differenced model with $m = 2$ passes the test of over-identifying restrictions. The second line shows that given the quasi-differenced model with $m = 2$, the hypothesis of stationarity of individual effects is not rejected. Given the stationary individual effects with $m = 2$, the fourth line shows that the hypothesis that all coefficients remain the same over time is rejected. Further shortening of lag length is also rejected. Thus, the causality tests are implemented given the differenced model with $m = 2$.

The hypothesis that the changes in loans do not Granger-cause investment is not rejected at a significance level of 1 percent, but it is rejected at 5 percent (see the fifth line). The non-causality hypothesis is rejected with respect to the cost of borrowing (see the sixth line) and sales (see the seventh line). But profits turn out not to Granger-cause investment (see the eighth line).

The parameter estimates for this model are reported in Table A4.3 in the appendix. It is estimated from the five-variable model with $m=2$ and stationarity of individual effects given that profit variables are insignificant.
Table 4.7. Test Results for Investment Equations
($I_t$, $t = 1981-83$) with 5 Variables: $I$, $S$, $\Pi$, $DC$, and $dL$

<table>
<thead>
<tr>
<th></th>
<th>$Q$</th>
<th>df</th>
<th>p-value</th>
<th>$L$</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) $m = 2$</td>
<td>13.858</td>
<td>15</td>
<td>0.536</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) stationarity of $f$</td>
<td>23.318</td>
<td>30</td>
<td>0.554</td>
<td>14.460</td>
<td>15</td>
<td>0.491</td>
</tr>
<tr>
<td>(iii) $m = 1$</td>
<td>340.651</td>
<td>45</td>
<td>0.000</td>
<td>312.333</td>
<td>15</td>
<td>0.000</td>
</tr>
<tr>
<td>(iv) stationarity of coefficients</td>
<td>285.287</td>
<td>52</td>
<td>0.000</td>
<td>256.969</td>
<td>22</td>
<td>0.000</td>
</tr>
<tr>
<td>(v) exclude $dL$</td>
<td>44.748</td>
<td>36</td>
<td>0.150</td>
<td>16.430</td>
<td>6</td>
<td>0.012</td>
</tr>
<tr>
<td>(vi) exclude $DC$</td>
<td>137.649</td>
<td>36</td>
<td>0.000</td>
<td>109.331</td>
<td>6</td>
<td>0.000</td>
</tr>
<tr>
<td>(vii) exclude $S$</td>
<td>49.307</td>
<td>36</td>
<td>0.069</td>
<td>20.990</td>
<td>6</td>
<td>0.002</td>
</tr>
<tr>
<td>(viii) exclude $P$</td>
<td>36.813</td>
<td>36</td>
<td>0.431</td>
<td>8.496</td>
<td>6</td>
<td>0.203</td>
</tr>
<tr>
<td>(ix) exclude $I$</td>
<td>307.270</td>
<td>36</td>
<td>0.000</td>
<td>278.952</td>
<td>6</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: The results of causality tests in lines (v)-(ix) are based on the model with stationary individual effects and $m = 2$. 
At the usual 5-percent significance level, the proposition that selective credit allocation had effectively influenced investment patterns is supported, as it is by the first four-variable model (equation 3.1) including lagged variables of $I$, $S$, $II$, and $dL$. Compared with the test results for the previous period, the results for the 1981-83 period show a change in the length of lags in the case of the first four-variable model (equation 3.1) and one in the stationarity of individual effects for the five-variable model (equation 3.5). Both seem to suggest a structural change around the year 1980.

But at the 1-percent significance level, a drastic change is observed: changes in loans do not Granger-cause investment. This is in line with the test results from the third four-variable model including lagged variables of $I$, $II$, $DC$, and $dL$ (equation 3.4). Thus, for the 1981-1983 period, the incremental loans variable turns out not to Granger-cause investment when it is simultaneously included in the model together with that of the cost of borrowing. This implies a close correlation between the two variables.

Table 4.8 shows that there exist a significant contemporaneous correlation between changes in loans and cost of borrowing, particularly in the periods relevant for the estimation of the model for 1981-1983 period. These imply that the nature of selective credit allocation had changed in such a way that the availability of credits and
the cost of borrowing became closely related. The control of credit availability did not have independent explanatory power for the determination of investment patterns.

This does not lend itself to any obvious interpretation. Nevertheless, it may be conjectured that the manner in which industrial policy was implemented underwent a change. It changed in such a way that credits were allocated to accommodate the investment needs of industries. The government's selective industrial policy may have been exercised not through direct control of credit allocation in itself but more indirectly through influencing the interindustrial variations of the cost of borrowing.

The opposite interpretation is also possible; that is, the insignificance of the past values of investment in explaining investment patterns may indicate that selective credit allocation in the 1981-1983 period was ineffective. Even if this interpretation is chosen, it can not be denied that the government retained its influence over interindustrial variations in investment through control over interindustrial variations in the cost of borrowing.

4.6.3. Implications

Several implications may be drawn. First, as the period of the dependent variables is changed from 1977-79 to 1981-83, all the specifications of the model imply some
Table 4.8. Contemporaneous Correlations Between Interindustrial Variations in Incremental Loans and Costs of Borrowing

<table>
<thead>
<tr>
<th>Year</th>
<th>Pearson Correlation Coefficient</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>-.27</td>
<td>0.03</td>
</tr>
<tr>
<td>1977</td>
<td>-.28</td>
<td>0.02</td>
</tr>
<tr>
<td>1978</td>
<td>-.35</td>
<td>0.00</td>
</tr>
<tr>
<td>1981</td>
<td>-.43</td>
<td>0.00</td>
</tr>
<tr>
<td>1982</td>
<td>-.22</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Note: The p-values are for the hypothesis of zero correlation. Only the values that are significant at the 10 percent level are reported. The data are for 1972-1983.
structural change in different ways. On the one hand, the test results from the model including the lagged variables of $I$, $S$, $II$, and $dL$ (equation 3.1) show a shortened lag length. On the other hand, the test results from the model including lagged variables of $I$, $S$, DC, and $dL$ (equation 3.3), the model including past variables of $I$, $II$, DC, and $dL$ (equation 3.4) model, and the five-variable model including $I$, $S$, $II$, DC and $dL$ suggest that incremental loans do not Granger-cause investment at least at the 1-percent significance level.

Furthermore, the five-variable model shows stationarity of individual effects. This means that the features that characterized individual industries came to have their own unique characteristics unchanging over time. It may signify that industrial development resulted from aggressive investment in previous years and that industrial development allowed each industry to invest at its own pace, so that the manufacturing sector acquired its own momentum under the partial financial liberalization reforms.

Second, the fact that all models reveal non-stationarity of coefficients implies that the relevancy of the estimated parameters is limited to the sample periods. Non-stationarity of parameters is consistent with the idea that the process of late industrialization leads to rapid structural change. During such a period, the aggregate variables may behave as if the economy is in a
disequilibrium. Shocks have long-run effects in non-stationary states. Thus, no out-of-sample prediction is possible.

The estimation results enable us to perform no deductive reasoning on the parameters of the model for the periods beyond sample periods. Tests for causal relationships are valid only for the sample periods. Thus, the validity of the proposition that selective credit allocation can effectively change investment patterns does not extend to the future. Moreover, in the latter period, there is a slight indication that the intertemporal interrelationship between investment and selective credit allocation is undergoing a structural change.

Most importantly, there is no indication that continuation of the government's control over the central bank, the Bank of Korea, may be justified in the future as market forces continue to gain their own momentum. Instead, there is some indication that as market forces strengthen, governmental control may become ineffective. That is, changes in loans fail to cause investment patterns with the five-variable model for 1981-83, with the significance level at 1 percent. This implies that in the 1981-83 period, the contest-based competition principle may have been gradually replaced by the market-based competition.
1. Where confusion is unlikely, "interindustrial variation of investment" will be "investment." Similarly for interindustrial variations in sales, in profits, in the cost of borrowing, and in changes in loans.

2. In this sense, the bank loans may be considered as a form of "inside finance" (Calomiris and Himmelberg, 1993, 15).

3. See the analysis by E. Han Kim (1990 352-354).

4. This is reminiscent of the "monetary policy ineffectiveness proposition" in macroeconomics.

5. Division of variables with capital stocks is to adjust for residual heteroscedasticity.


7. HNR (1988) explains bi-variate panel data VAR estimation and tests, whereas the basic model is a four-variable model in this study. For exposition of my methodology, a substantial part of HNR (1988) is reproduced, the first model being used as an example.

8. See for similar examples Fazzari, et. al. (1988) and Calomiris and Himmelberg (1993).

9. The rest of the model is

\[
S_{jt} = \alpha^S_t + \sum_{i=1}^m \beta^S_{it} i_{jt-1} + \sum_{i=1}^m \gamma^S_{it} S_{jt-1} + \sum_{i=1}^m \delta^S_{it} \pi_{jt-1}
+ \sum_{i=1}^m \xi^S_{t-1} d_{jt-1} + \Psi^S_{it} \ell_j + u^S_{jt} \quad (j=1, \ldots, N; t=1, \ldots, T) \quad (1.2)
\]

\[
\pi_{jt} = \alpha^\Pi_t + \sum_{i=1}^m \beta^\Pi_{it} \pi_{jt-1} + \sum_{i=1}^m \gamma^\Pi_{it} S_{jt-1} + \sum_{i=1}^m \delta^\Pi_{it} \pi_{jt-1}
+ \sum_{i=1}^m \xi^\Pi_{t-1} d_{jt-1} + \Psi^\Pi_{it} \ell_j + u^\Pi_{jt} \quad (j=1, \ldots, N; t=1, \ldots, T) \quad (1.3)
\]

\[
dl_{jt} = \alpha^dL_t + \sum_{i=1}^m \beta^dL_{it} l_{jt-1} + \sum_{i=1}^m \gamma^dL_{it} S_{jt-1} + \sum_{i=1}^m \delta^dL_{it} \pi_{jt-1}
+ \sum_{i=1}^m \xi^dL_{t-1} d_{jt-1} + \Psi^dL_{it} \ell_j + u^{dL}_{jt} \quad (j=1, \ldots, N; t=1, \ldots, T) \quad (1.4).
\]
10. Q is also called "Hansen (1982)'s test of over-identifying restrictions" (Calomiris and Himmelberg, 1993, 28).

11. In Holtz-Eakin, Newey, and Rosen (1989), the number of parameters in the unrestricted model is 50 and that of the restricted model with the hypothesis of stationary individual effect, is 35. Thus there are 15 degrees of freedom. Their count is 9 for reasons that are not made clear in their paper (1989, 424, the second line). Fortunately, this does not affect their conclusion on the stationarity of individual effects.

12. The number is calculated as follows: For $t = m+2$, four lags of five variables plus the constant make 21 instrumental variables. For $t = m+3$, five lags of five variables plus one make 26 instrumental variables, and for $t = m+4$, six lags of five variables plus one makes 31 instrumental. The sum: $21 + 26 + 31 = 78$. The number of industries should be more than the total number of instrumental variables. Otherwise, the variance-covariance matrix cannot be obtained.

13. For changes in financial policies, see Choi (1987).

14. The degrees of freedom is the difference of the number of instrumental variables and the number of parameters to be estimated. Since the number of instrumental variables for each year varies, I count them for each year. For 1977, 4 years of data for each variable (1972-1975) are available. Adding a constant gives 17 instrumental variables. This number increases to 21 in 1978 and to 25 in 1979. Thus, the total number of instrumental variables is the sum of all these, that is, 63. The number of parameters is the same for each year, that is, 17. So, the total number of parameters are 51. The degrees of freedom is the difference: $63 - 51 = 12$.

15. The number of instruments is 63 as before. The number of parameters is 39. Thus there are 24 degrees of freedom.

16. The omission of the lagged variable of sales is suggested by line (vi) in table 4.2 when the significance level is chosen at 1 percent.

17. It should be pointed out that this model shows some symptoms of misspecification.
CHAPTER V

EMPirical TESTS OF EXTERNALITIES AND ECONOMIES OF SCALE IN KOREAN MANUFACTURING SECTOR

It is important to check the existence of economies of scale and externalities in manufactures because existence of those effects are a necessary, if not sufficient, condition for government intervention in private investments. Then the dynamic-efficiency based view and learning by doing in the manufacturing sector will be supported.

Improvement in productivity can be achieved not only through technological progress in the narrow sense, but also through economies of scale and externalities. It is important to check whether the Korean manufacturing sector has been subject to internal and external economies. If there are no such effects, the result of Young's (1994) growth accounting that Korea's total factor productivity has been negligible may be confirmed. As Krugman (1994) suggested, continuing capital accumulation in the absence of total factor productivity improvement will trigger the law of diminishing returns. In this case, the static-efficiency based view will hold. On the other hand, if there are such effects, the assumptions of the Young-type growth accounting - that all the nations have the same production technology and technological progress is independent of capital accumulation - should be brought into question. This point will be further discussed in section 5.5.4.
5.1. Methodology

A model developed by Bartelsman, Caballero, and Lyons (1994) is applied to Korean case, and their methodology was followed as closely as possible. In this way, comparison could be made with their results about the manufacturing sector of U.S.A.

The growth of output (or gross production) in a manufacturing industry $s$ $y_{st}$ can be expressed as follows:

$$y_{st} = \gamma x_{st} + \beta_1 x_{st}^{ow} + \beta_2 x_{st}^{iw} + v_{st},$$

where $x_{st}$ is the growth rate of input costs in industry $s$. It is defined as

$$x_{st} = \alpha_{lst} l_{st} + \alpha_{kst} k_{st} + (1 - \alpha_{lst} - \alpha_{kst}) m_{st},$$

where $\alpha_{lst}$ and $\alpha_{kst}$ are the shares of labor and capital in total costs, respectively, $l_{st}$ the growth rate of labor input (man-hours), $k_{st}$ the growth rate of capital input, and $m_{st}$ is the growth rate of materials input. The $x_{st}^{iw}$ is the weighted average of other industries' activity, the weights being inputs from other industries. The $x_{st}^{ow}$ is the output-weighted average of other industries' activity, the weights being outputs to other industries. Thus,

$$x_{st}^{ow} = \sum_{r \neq s} \frac{\alpha_{sr}}{\sum_{r \neq s} \alpha_{sr}} x_{rt}$$

and

$$x_{st}^{iw} = \sum_{r \neq s} \frac{\alpha_{rs}}{\sum_{r \neq s} \alpha_{rs}} x_{tt},$$
where \( \alpha_{st} \) is the \( sr \)-th element of the direct requirements matrix of an input-output matrix. The residual \( v_{st} \) represents the growth rates of industry \( s \)'s technology (total factor productivity). The coefficient \( \gamma \) measures returns to scale. The returns to scale are assumed to be the same for all the industries and thus the coefficient \( \gamma \) has no subscripts because of the constraint that returns to scale are the same for all industries. If it is larger (smaller) than one, there exist increasing (decreasing) returns to scale. The coefficient \( \beta^{IW} \) measures the effects that the growth of supplier industries have on the industry. The coefficient \( \beta^{OW} \) measures the effects from customer industries as a whole to the industry.

The "within" estimator and the "between" estimators are estimated according to the following methods. Denoting time average with a bar,

(1) Within:

\[
\gamma_{st} - \bar{\gamma} = \gamma (x_{st} - \bar{x}_s) + \beta^{OW} (x_{st} - \bar{x}_s^{OW}) + \beta^{IW} (x_{st}^{IW} - \bar{x}_s^{IW}) + \theta_{st}
\]

(2) Between:

\[
\bar{\gamma}_s = \theta_0 + \bar{\gamma} \bar{x}_s + \beta^{OW} \bar{x}_s^{OW} + \beta^{IW} \bar{x}_s^{IW} + \theta_s.
\]

In addition, the "mixed" estimators is also calculated as follows.
(3) Mixed:

\[ Y_{st} = \theta_o + \gamma X_{st} + \beta^{OW} (X^{OW}_{st} - \bar{X}^{OW}_s) + \beta^{IW} (X^{IW}_{st} - \bar{X}^{IW}_s) \]

\[ + \bar{\beta}^{OW}_s \bar{X}^{OW}_s + \bar{\beta}^{IW}_s \bar{X}^{IW}_s + \theta_{st}. \]

The estimates of parameters in the "within" equation are to grab short-run relations between the explanatory variables - input growth rate, influences from customers' activities, and influence from suppliers' activities - and the dependent variable - the growth rates of output in the sub-sectors of manufacturing sector. The "within" estimates are to grab the short-term relationship among variables. By running a regression with data generated by averaging over 17 years, the "between" estimator is hoped to catch long-run relations.

5.2. Data

The 1975 input-output tables of Korea at 1975 producer prices (The Bank of Korea, 1978) were used. The table was in the format of 118 sector by 118 sector matrix. The manufacturing sector was partitioned out and aggregated into 38 sectors. The same weights are used as weights in calculating \( x^{OW}_{st} \) and \( x^{IW}_{st} \) for \( t = 1, \ldots, 17 \). The data for growth rates of labor inputs, capital inputs, and material inputs and factor share during 1966-1983 are from K. S. Kim and S. N. Park (1988). The list of data from Kim and Park
are as follows:


6. Industrial ratios of labor income to gross output (1963-1983)

### Table 5.1. Estimation Results for the Manufacturing Sector of Korea

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Within</th>
<th>Between</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma$</td>
<td>0.89</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.02)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\gamma}$</td>
<td>1.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta^{ow}$</td>
<td>0.14</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
<td></td>
</tr>
<tr>
<td>$\beta^{in}$</td>
<td>0.02</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\beta}^{ow}$</td>
<td>0.05</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.08)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\beta}^{in}$</td>
<td>0.06</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.12)</td>
<td></td>
</tr>
<tr>
<td>$AR^2$</td>
<td>0.68</td>
<td>0.96</td>
<td>0.73</td>
</tr>
</tbody>
</table>

*Note: Standard errors are in parenthesis.

### Table 5.2. Estimation Results for the Manufacturing Sector of the U.S.A.

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Within</th>
<th>Between</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma$</td>
<td>1.094</td>
<td>1.094</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.014)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\gamma}$</td>
<td>1.090</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta^{ow}$</td>
<td>0.119</td>
<td>0.119</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.023)</td>
<td></td>
</tr>
<tr>
<td>$\beta^{in}$</td>
<td>0.020</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.029)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\beta}^{ow}$</td>
<td>0.066</td>
<td>0.063</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.071)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\beta}^{in}$</td>
<td>0.313</td>
<td>0.312</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
<td>(0.097)</td>
<td></td>
</tr>
<tr>
<td>$AR^2$</td>
<td>0.72</td>
<td>0.85</td>
<td>0.73</td>
</tr>
</tbody>
</table>


Note: Standard errors are in parenthesis.
5.3. Results

The first row in table 5.1 shows estimates of returns to scale obtained from variables in deviations of growth rates from means. Since the estimates are less than one, we may interpret it as showing a decreasing returns to scale in the Korean manufacturing sector in the short run. This does not mean that all manufacturing sectors are subject to decreasing returns to scale in the short run; it shows technology characteristics of a representative firm of the Korean manufacturing sector. In actuality, some industries may have increasing returns to scale in the short run.

By contrast, the second row shows estimates of returns to scale from variables of industrial time-averages. Since the estimates significantly exceeds one, we may interpret it as showing increasing returns to scale in the manufacturing sector in the long run, in which all adjustments have taken place in each industry. That is, it may be viewed as reflecting returns to scale estimated from industrial performance.

The estimates about the returns to scale in the Korean manufacturing sector shows an interesting feature because it strongly contrasts to the case of U.S.A. studied by Bartelsman et. al. In U.S.A., the manufacturing sector shows increasing returns to scale both in the short run and in the long run. This may reflect the tendency in Korea that investment in manufacturing sector incurs large initial
costs which would be recouped only with lag. This reflects that some adjustments in Korean manufacturing capacity takes a longer period than adjustments in American manufacturing capacity. If it is the case, the reason may be that while U.S.A. firms invest with their own technology, Korean firms have to buy technology. It may be that the imported technology incorporates increasing returns to scale and it takes time for Korean firms to adapt to the technology and to realize the increasing returns to scale. If it is the case, such a learning process must accompany a financing problem which is beyond each firm's capability.

The third row shows that over the short-run, the output-weighted externalities are positive and significant. The following three rows show the insignificance of the input-weighted externalities in the short run, the output-weighted externalities and the input-weighted externalities in the long run. These also contrast the case of U.S.A. where there is a dramatic switch from a pattern of positive output-weighted externalities and insignificant input-weighted externalities in the short-run to a pattern of insignificant output-weighted externalities and significant input-weighted externalities.

5.4. Profiles of Estimates

We have seen estimates resulting from year-to-year industrial variations and from data averaged over 17-year interval. Now, let's look into coefficients that would
result from data averaged over years ranging from one year to 17 years. This amounts to considering the dynamic profile of the internal and external economies. It can be done by estimating the following set of equations:

\[ y_{stt} = \theta_0 + \gamma x_{stt} + \beta_{IW} x_{stT}^{IW} + \beta_{OW} x_{stT}^{OW} + \theta_{stt} \]

for each \( t = \tau \) to \( t = T \) and each \( \tau = 1 \) to \( T-1 \), where \( y_{stt} \) is defined as \( \log Y_{st} - \log Y_{st-\tau} \) and \( Y_{st} \) is defined as the level of gross production in industry \( s \). The same applies to input measures. Thus, the number of periods over which the growth rates are calculated is increased from one year toward the full sample period of 17 years.

The resulting estimates for the parameters are displayed in figures 5.1 to 5.3. Figures 5.1 shows that the returns to scale is decreasing with the yearly data but increasing with the data averaged over two years and more. The dotted lines denote confidence intervals of \( \pm 1.96 \) times standard errors. Figure 5.2 shows that the output-weighted externalities are significantly positive with the data averaged over years ranging from one to fourteen. In the longer-period averaged data, the output-weighted externalities become insignificant.

Figure 5.3 shows that the input-weighted externalities are insignificant with data averaged over whatever duration of years. It means that domestic availability of intermediate inputs does not affect the growth rate of
Figure 5.1. Dynamic Profile of Returns to Scale

- BGX=Coefficients of the input growth rates;
- Dotted lines mark 5% confidence interval.
Figure 5.2. Dynamic Profile of External Effects
Externalities from Customer Industries

BXOW

Length of differencing:

*BXOW* = Coefficients of output-weighted externalities;
*Dotted lines mark 51 confidence interval.*
Figure 5.3. Dynamic Profile of External Effects

Externalities from Input Suppliers

- BXIW = Coefficients of input-weighted externalities,
- Dotted lines mark 5% confidence interval.
manufacturing industries. Thus, domestic availability of intermediate goods does not seem to give any additional advantage to the customer industries: to the customers, they are the same as imported intermediate goods.

5.5. Implications

The time profile of the economies of scale and externalities seem to reveal several important characteristics of Korean economic development. The implications are discussed below.

5.5.1. Innovation Capabilities of Korean Manufacturing Sector

From the economic viewpoint, the result of supplier externalities implies that increases in import-substitution, as a supply-side change, do no better than imports in that it does not have positive side effects on domestic customer industries. In other words, forward linkage effects are not pronounced among domestic productions. But, it does not mean that imports are equivalent to domestic provision. The import-substitution may be worth taking since, as figure 5.2 shows, the growth of domestic customers affect the growth of suppliers positively. That is, the backward linkage effect of import-substitution may be substantial even after the leakages due to imports are taken into account.

The contrast between U.S.A and Korea in supplier-originated externalities bears on the characterization of
the two economy's manufacturing technology. The Korean economy whose manufacturing sector is in the process of learning lacks innovating capabilities. The term, innovating capability, in this study refers to the firm's capability to introduce new goods and new production processes to the world. How could Korea succeed in gaining international competitiveness in a variety of manufactured goods without innovating capabilities? Let's look into exporting industry and import-substituting industry.

As for the exporting industry (e.g., the textile industry) much of the rapid growth was characterized by "processing trade" (Watanabe, 1992), in which imported materials and intermediate goods are fabricated and processed using imported machinery and equipment and then exported" (97). The technologies are originated in advanced countries. The original technology may be adapted to local conditions. But, the main competitive edge stems from cheap labor organized in large scale and managed efficiently.

As for the import-substituting industry (e.g., petrochemical industry), import of technology on turn-key basis was not unusual. The economies of scale was realized over time. But, only after the economies of scale and new vintage technology are realized, it's productivity could be comparable to competing firms in developed countries. No external effects accrued from the expansion of import-substitution industry to customer industries directly.
On the other hand, there were positive externalities from import-substitution industry to supplier industries. Supplier industries include small businesses which subcontracts with the large import-substituting industry. Most import-substituting industries originally targeted as export industry eventually became export industries. For example, shipbuilding industries and car industries switched from import-substituting to export industries.

External effects from domestic suppliers may occur only when the expansion of domestic supply results from technological competition - the situation in which firms compete with introduction of new technology and new products. Firms in late industrializing economies lack the capability to compete with technology. Introduction of new products and new technology which are developed in advanced economies may have economies of scale; but not distinct forward linkage effects.

By contrast, the manufacturers in the U.S. receive positive externalities due to the growth of supplier industries in the long run. In the U.S., the manufacturing sector’s growth is dependent on the customer industries’ growth in the short run; and on the supplier industries’ growth in the long run. In Korea, the manufacturing industries receive positive externalities from customer industries’ expansion as in the U.S. But, they do not receive positive externalities from supplier industries’ in
the long run. The dominant importance lies in the realization of economies of scale.

From this, we may conjecture that the Koreans have larger technological handicaps than American counterparts. There must be some difficulties in acquisition and adaption of technology. Together with underdeveloped capital markets, it implies that there are limits for firms to respond spontaneously to profitable opportunities.

In the short run, there are no returns to scale and no supplier-originated externalities. But, there are positive externalities from demand side in the short- and medium-run. This implies that demand spills over from domestic customer industries of its own to each industry. The expansion of domestic industries as customers to others in turn stem from export expansion. The export expansion may interact with agglomeration effects of urbanization to generate the external effects. It helps supplier industries to realize economies of scale, which entails selective credit allocation, later on. Thus, the combination of selective credit allocation to promote industries and outward-orientation seems to explain the Korean industrial development.

In other words, the export-expansion and selective credit allocation may have been necessary to realize the opportunities that entails economies-of-scale technology. A lagging economy, lacking innovating capabilities, encounters
such opportunities in the midst of capital market imperfection.

5.5.2. Half-fullness of Korean Industrial Development

Porter (1990) provides a qualitative picture of international competitiveness of, among others, Korean industries as of 1985 and the changes in competitive position between 1978 and 1985. His main source of data is the UN trade statistics for 10 countries. He compares the industrial export performance of selected countries in a unique framework, what he calls "cluster charts." He groups industries into clusters based on end-use application such as materials/metals, forest products, petroleum/chemicals, semiconductors/computers, transportation, food/beverage, and textiles/apparel, and so on. Each clusters are further divided by vertical stages: end products, machinery used to make the end products, specialty inputs that go into the end products, and any closely-related service industries.

He summarizes the patterns of Korean industrial competitiveness revealed by industrial export performances in 1985. First, by far the most important clusters are in textiles and apparel-related industries. There are some important clusters in transportation equipment, consumer electronics products, iron and steel, and other industries. Some of them evolved in link with others. For example, shipbuilding and automobiles have developed in parallel with steel; semiconductors have grown out of consumer
electronics; international construction in connected with cement and steel; apparel and textiles are interconnected. Second, successful Korean industries are those characterized by:

- [standardized], mass-produced products, relatively low requirements for customer contact or after-sale service, and the availability of product and process technology on international markets from independent machinery suppliers or faltering Western competitors willing to license their technology (477).

Finally, Korea lacks vertical depth in each cluster. "Success is almost exclusively in end products, with few specialty input industries and virtually no machinery industries or services" (464). Those components and machines are mostly imported. Thus Korean clusters are still shallow, showing vulnerability in national competitiveness.

He also summarizes the changes in competitiveness of Korean industries in terms of changes in the share of world exports between 1978 and 1985. Reading from his figure 8-11 (478), 108 industries (based on 5-digit SITC) among the ones producing primary-goods gained world export share by 15 percent or more; and 60 of them lost it by 15 percent or more. Among machinery industries, only one industry gained and one industry lost 15 percent or more of world export.
share. Among specialty-input industries, 13 industries gained and 12 industries lost 15 percent or more of world export share. The fact that a greater number of those industries gained export shares rather than lost shares represents Korea's rapid upgrading of industry. Similarly, a fact that Korea still holds relatively few competitive positions in machinery and in specialty inputs is "a clear indication that Korea is still not a full-fledged advanced nation" (477).

5.5.3. Intraindustry Differentials in Productivity Changes

The conventional practice in growth accounting seems not justifiable in the presence of the kind of externalities that may be present in a rapidly industrializing economy. Dollar and Sokoloff (1990) are an example of the standard practice. They calculate the rate of total factor productivity increase as the residual from the following identity.

\[
\left( \frac{\dot{Y}}{L} \right)_i = \alpha_i \left( \frac{\dot{K}}{L} \right)_i + TFP_i
\]

where \( Y_i \) is value added in sector \( i \) and \( \alpha \) is the capital share of income, \( (K/L)_i \) denotes the per-worker net capital of \( i \)-th industry, and \( TFP_i \) means the rate of total factor productivity increase in the \( i \)-th industry. From the results in Table A5.1 in the appendix, Dollar and Sokoloff (1990) draw a policy implication that "the government cannot simply choose to create comparative advantage" (140). They
point to the cases of the iron and steel industry and the chemical industry as evidence for this. There, the government direction of investments increased the capital intensities, but the increase in the average labor productivity was offset by the relatively poor \( TFP_i \) performance and the firms in those industries of the country could not emerge as successful exporters (140).

The criticism is first that the assumption of independence of technical progress and capital intensity increase within an industry is unrealistic especially when the manufacturing sector of a lagging economy is in a learning process. The choice of capital intensity may be closely related to efficiency improvements through economies of scale and to technical progress. In practice, the \( \alpha_i \)'s are measured by capital cost shares or by estimates of the production elasticity with respect to capital input. Any of them may not lead to a correct estimation of it if the technical progress and capital intensity growth are correlated; and the decomposition becomes arbitrary. This means that the representation of the first column in Table A5.1 as the sum of the second column multiplied by the \( \alpha_i \) estimate and the third column may not be justified as long as the estimate of \( \alpha_i \) is arbitrary. Another consideration is that when externalities are prevalent across industries, the decomposition formula itself will not be obtained. It
needs to incorporate the influence of other industries' activity on the activity of an industry (see Chapter IV).

If one accepts the externalities argument, one will focus on the high growth rate of per worker product in the manufacturing sector as a whole instead of examining the interindustrial variations in the growth rates of total factor productivity derived from a dubious methodology. The relatively high growth rates of capital intensity in the iron and steel and chemicals industries may be viewed as an achievement in scaling up the production capacities in the face of the difficulties in obtaining new technologies. The high costs of those industries in terms of high required capital intensities may be recouped by other industries through the linkage effects: the car and shipbuilding and other machinery industries for the case of iron and steel; and the textiles industries for the case of chemicals industry.

5.5.4. Sustainability of Korean Economic Growth

In the model discussed in Chapter III, sustainability of Korean economic growth is interpreted into the question: Will the shift of DL-DL to DL'DL' be a persistent movement? Young (1994) performed a growth accounting with data from the Penn World Table (Mark 5) compiled by Summers and Heston (1991) for 1960-1985. His model for decomposition of the growth rate of per worker product assumes a common production technology across countries and independence of
productivity growth rates from capital intensity growth rate. He found that the residual for Korea was low, absolutely as well as relatively.

Based on Young's results, Krugman (1994) predicts that the phenomenal economic growth of Korea is not sustainable. The underlying economic reason is that in the absence of technical progress, diminishing returns will come into effect eventually. That is, in order to keep growth rate of output per worker at high level, capital per worker should grow as fast. But, as capital per worker increases, marginal productivity of capital diminishes. As marginal productivity of capital diminishes, the growth rates of capital per worker and hence of output per worker will eventually diminish.

In the way of criticizing Krugman's prediction, La Croix and Lee (1995) found from Young's data that Gabon and Lesotho, two countries which did better than the Asian NIEs in terms of the annual growth of output per worker during 1960-1985, suffered an annual decrease in the percentage of the population employed, the rates of decrease being -0.024 and -0.006. In addition, in Botswana, of which the growth rates of output per capita and output per worker are on the very top and "total factor productivity" (1970-85) is third largest, the growth rate of population exceeded that of employment, the decreasing rate in the percentage of the population employed being -0.009 per annum between 1960-
1985. This is mainly the result of high population growth and no comparable expansion of manufactures. The population in Botswana grew 3.5 percent per year between 1965-80 and 3.4 percent per year during 1980-89, while the population growth rate for world average is 2.0 percent per year and 1.8 percent per year, for these respective periods. On the other hand, in Korea, whose growth rate of "total factor productivity" is the 18th largest among 29 countries (from my data), employment grew faster than population, the exceeding rate being 0.007 per annum during the same period (from Young's data). The population grew 2.0 percent per year between 1965-80 and 1.2 percent per year between 1980-1989.

The decreasing ratio of population employed in those super-performing economies is at odds with the economic development process. Economic development is supposed to increase division of labor. As economic specialization among agents goes on, the portion of goods and services transacted through market increases. At the same time, the portion of population employed will most likely increase. Actually, in almost all developed countries, this portion increased between 1960-1985. This suggests that the super-performance in growth rates of output per worker, capital per worker, and particularly "total factor productivity" alone may not fully reflect the degree of achievement in economic development. These can be considered as such only
when they are combined with increasing portion of population employed especially for economies lagging in economic development. Therefore, it can be argued that the growth accounting framework as described in the above cannot explain this essential incongruence of the technical progress indicator with the degree of division of labor.

According to the World Development Indicators in the *World Development Report 1991*, the portion of GDP produced in the industry of Botswana increased from .19 in 1965 to .57 in 1989. But, the portion of GDP produced in manufacturing sector decreased from .12 percent to .4. Since industry comprises mining, manufacturing, construction, electricity, gas, and water, the part of industry with high capital-labor ratio, such as electricity or the part of industry with high output-labor ratio such as mining, must have increased. In Korea, both industrial and manufacturing portions increased from .25 and .18 to .44 and .26, respectively.

Looking at annual growth rate of earnings per employee in manufacturing during 1970-1980 and 1980-1988, the growth rates are higher in Korea than in Botswana for both periods. Those for Korea are 10.0 and 5.9 in percentages. Those for Botswana are 2.6 and -5.7 in percentages. Laborers's earnings decreased in Botswana during the latter period. Division of labor seem to have decreased despite high numbers for the estimate of total factor productivity. Some
of the high growth rates of "total factor productivity" turns out to be associated with regressing, not progressing, division of labor.

How can we associate this with its third highest performance among 118 countries in terms of "total factor productivity" growth? It may be that the Young-type of growth accounting model is flawed. It may also be that application of OLS method to equation (2.2) is not justified when there is any kind of interaction between technical progress (or efficiency improvement) and increase in economy-wide capital per worker. If these are the case, the above growth accounting framework should be questioned.

The results from estimation of economies of scale and externalities based on the methodology of Bartelsman, et. al. (1994) show that Korea was actively realizing dynamic efficiencies through economies of scale and customer-originated externalities. This affirms the suspicion about the irrelevance of Young-type growth accounting. This is the assumption that leads to Korea's negligible growth in total factor productivity. The rapid growth of per worker product in Korea seems to have been backed by dynamic efficiency improvement as well as by factor accumulation.

The limitation of Korean growth strategy lies in its inability to upgrade innovating capabilities. The strategy so far does not seem to be conducive to that purpose.
NOTES

1. Hakkuk Joh (1990 100) finds that, in the case of Korea, city size has positive effect both on production and consumption. The firms in Korean large cities, enjoying high labor productivity, induce migration of people to large cities. The migrants in turn lower wage rates.
CHAPTER VI
CONCLUSION

This study has posited that government intervention in credit allocation in Korea reflects a hierarchical mechanism of investment coordination in operation, selective credit allocation being the main instrument for the government to induce the cooperation of the business sector. The remarkable growth of Korean industries may be attributed to the successful operation of such a mechanism. That is, it enabled the industries to exploit the interdependent investment opportunities which, having economies of scale, required large amounts of funds. This was possible because the government implemented its industrial policies through selective credit allocation, which was effective because it involved the firms in the decision-making process. Thus, the selective credit allocation might have changed industrial investment pattern.

The strategy undertaken in this paper to test the hypothesized explanation of Korean performance is to test two of its implications: (1) the effectiveness of selective credit allocation in changing industrial investment pattern and (2) the existence of economies of scale and externalities in the manufacturing sector.

The effectiveness of selective credit allocation has been tested with causality tests. The causality tests are carried out for two periods--from 1977 to 1979 and from 1981
to 1983—with the methods of estimating vector autoregression models with panel data. The results from the model for the 1977-79 period suggest that the past interindustrial variations in the incremental loans-capital ratio help predict interindustrial variations in the investment-capital ratio. This implies that the selective credit allocation was effective in changing industrial investment patterns.

However, the results for the 1981-83 period suggest that the intertemporal interrelationship between incremental loans and investment underwent a change. This seems to imply that the industries gained their own momentum in investment decisions in the latter period. This indicates that firms’ industrial success leads to their gaining influence in credit allocation.

The results from the application of the growth model of Bartelsman, et. al. (1994) to Korean manufacturing industries suggest that there are economies of scale being realized over time and externalities from customers (in the short and the medium run) in Korean manufacturing industries. These imply that positive learning-by-doing effects were in operation within the manufacturing sector as a whole.

These results from the two empirical tests combine to support the main hypothesis of this study (i.e., the dynamic efficiency-based view of the effect of selective credit
allocation). That is, the financially repressed Korean economy could develop its industries so rapidly not despite but because of selective credit allocation. In a transitional economy characterized by underdeveloped capital markets together with opportunities for development of economies-of-scale technologies and interdependent investments due to externalities, selective credit allocation played the instrumental role in transforming an agricultural economy into a industrial one.

However, several caveats are in order. First, the test results for the 1981-83 period do not show unambiguous evidence for the effectiveness of selective credit allocation in changing industrial investment pattern. For example, according to the test results from the five-variable PVAR model, incremental loans do not Granger-cause investment patterns at 1-percent significance level. If this is the case, it can be interpreted to signify that selective credit allocation could have affected investment patterns in the period only indirectly through affecting the interindustrial variations in the cost of borrowing.

Second, all of the conclusions about the effectiveness of selective credit allocation apply only to the within-sample periods. This judgement is based on the non-stationarity of parameters for the investment models detected by the tests. The non-stationarity implies that the data generating process itself was in genetic process.
The change in industrial effects from non-stationarity to stationarity may signify the relative rise of market forces. The very success of selective credit allocation seems in the end to diminish the effectiveness of such a policy. The policy that worked in previous periods may not work in later periods. After its success becomes an established fact, the market mechanism and the capital market will steadily replace the non-market mechanism for resource allocation. The change in the data generating process between the 1977-79 period and 1981-83 period seems to support this idea.

Third, the time profiles of the economies of scale and external effects suggest that the content of the Korean success story is confined to a narrow range of industrial products. According to Porter, the international competitiveness of the industries in Korea remained in end-products production up to as late as 1985. There is as yet no significant sign that Koreans have achieved a basic-innovation capability. The incomplete nature of Korean industrial development is also evinced by the lack of supplier-originated externalities.

It seems that realization of economies of scale has been essential for Korean industrial development. It was made possible by combining export promotion and aggressive investments that the government encouraged through selective credit allocation. But, to the extent that the expansion is not based on domestic technological capability for supplying
inputs and capital goods, the foundation for sustainable growth is weak. For now, that much might be the most that Koreans can hope for from the "dynamic growth enterprise."

One may conjecture, on the basis of the absence of supplier-originated externalities, that Korea can achieve a full-fledged industrial economy only when selective credit allocation fades away. The foundation for sustainable growth can become firm only when domestic suppliers of inputs and capital goods gain competitiveness. This can be achieved only through the growth of myriads of small firms competing in the markets, for which the selective credit allocation is inappropriate.

Since no out-of-sample prediction is possible from the estimation of the investment model, the conjecture remains as such. However, this much may be said, based on the results, that actual development of Korean industries will depend on the relative strength of (1) the industrial structure and institutions set up during the selective credit allocation period in obtaining advanced technologies and (2) market forces arising rapidly as a consequence of the success of selective credit allocation. Extension of the data to recent periods in which institutions change will shed light on the issue.
Table A3.1. Prices of Caprolactam and AN Monomer, dollars per ton

<table>
<thead>
<tr>
<th>Date</th>
<th>Caprolactam Domestic Sale</th>
<th>Caprolactam Export</th>
<th>Caprolactam Import</th>
<th>AN Monomer Domestic Sale</th>
<th>AN Monomer Export</th>
<th>AN Monomer Import</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/1973</td>
<td>-</td>
<td>-</td>
<td>700</td>
<td>757</td>
<td>222</td>
<td>230</td>
</tr>
<tr>
<td>7/1974</td>
<td>1,350</td>
<td>-</td>
<td>1,470</td>
<td>787</td>
<td>702</td>
<td>657</td>
</tr>
<tr>
<td>12/1975</td>
<td>1,299.9</td>
<td>1,281.3</td>
<td>850</td>
<td>782.3</td>
<td>782.4</td>
<td>520</td>
</tr>
<tr>
<td>12/1976</td>
<td>1,377.4</td>
<td>968.5</td>
<td>933</td>
<td>812.2</td>
<td>812.2</td>
<td>520</td>
</tr>
<tr>
<td>12/1977</td>
<td>1,377.4</td>
<td>969.5</td>
<td>915</td>
<td>855.3</td>
<td>777.6</td>
<td>370</td>
</tr>
<tr>
<td>12/1978</td>
<td>1,377.4</td>
<td>853</td>
<td>850</td>
<td>780.8</td>
<td>370</td>
<td>405</td>
</tr>
<tr>
<td>3/1977</td>
<td>1,377.4</td>
<td>1,000</td>
<td>1,300</td>
<td>780.8</td>
<td>450</td>
<td>520</td>
</tr>
</tbody>
</table>

Table A4.1 Industry Classification Used in this Study

<table>
<thead>
<tr>
<th>Code</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3111 Dairy products</td>
</tr>
<tr>
<td>2</td>
<td>3112 Canning and preserving</td>
</tr>
<tr>
<td>3</td>
<td>3113 Grain mill products</td>
</tr>
<tr>
<td>4</td>
<td>3114 Sugar refineries</td>
</tr>
<tr>
<td>5</td>
<td>3115 Bakery and confectionery</td>
</tr>
<tr>
<td>6</td>
<td>3118 Seasoning</td>
</tr>
<tr>
<td>7</td>
<td>3119 other food products</td>
</tr>
<tr>
<td>8</td>
<td>3121 Distilling, rectifying, and blending spirits</td>
</tr>
<tr>
<td>9</td>
<td>3122 Malt liquors and malt</td>
</tr>
<tr>
<td>10</td>
<td>3123, 3124 wine etc.</td>
</tr>
<tr>
<td>11</td>
<td>3125 Soft drinks and carbonated waters</td>
</tr>
<tr>
<td>12</td>
<td>3211 Knitting</td>
</tr>
<tr>
<td>13</td>
<td>3212 Cordage, rope, and twine</td>
</tr>
<tr>
<td>14</td>
<td>3213 Cotton yarn and fabrics</td>
</tr>
<tr>
<td>15</td>
<td>3214 Woolen yarn and fabrics</td>
</tr>
<tr>
<td>16</td>
<td>3215 Synthetic fibers</td>
</tr>
<tr>
<td>17</td>
<td>3216 Raw silk</td>
</tr>
<tr>
<td>18</td>
<td>3217 Weaving</td>
</tr>
<tr>
<td>19</td>
<td>3218 Bleaching and dying</td>
</tr>
<tr>
<td>20</td>
<td>3219 Other textiles</td>
</tr>
<tr>
<td>21</td>
<td>3221 Footwear</td>
</tr>
<tr>
<td>22</td>
<td>3222 Wearing apparel</td>
</tr>
<tr>
<td>23</td>
<td>3230 Leather</td>
</tr>
<tr>
<td>24</td>
<td>3310 Sawmills</td>
</tr>
<tr>
<td>25</td>
<td>3320 Furniture and fixture</td>
</tr>
<tr>
<td>26</td>
<td>3410 Paper and paper products</td>
</tr>
<tr>
<td>27</td>
<td>3420 Printing and publishing</td>
</tr>
<tr>
<td>28</td>
<td>3511 Basic industrial chemicals</td>
</tr>
<tr>
<td>29</td>
<td>3512 Fertilizers and pesticides</td>
</tr>
<tr>
<td>30</td>
<td>3513 Plastics</td>
</tr>
<tr>
<td>31</td>
<td>3521 Paints, varnishes, and lacquers</td>
</tr>
<tr>
<td>32</td>
<td>3522 Drug and medicines</td>
</tr>
<tr>
<td>33</td>
<td>3523 Soap, perfumes, and cosmetics</td>
</tr>
<tr>
<td>34</td>
<td>3529 Other chemicals</td>
</tr>
<tr>
<td>35</td>
<td>3530 Petroleum refineries</td>
</tr>
<tr>
<td>36</td>
<td>3540 Coal products</td>
</tr>
<tr>
<td>37</td>
<td>3551 Tires and tubes</td>
</tr>
<tr>
<td>38</td>
<td>3559 Other rubber products</td>
</tr>
<tr>
<td>39</td>
<td>3560 Plastic products</td>
</tr>
<tr>
<td>40</td>
<td>3610 Pottery, china, and earthenware</td>
</tr>
<tr>
<td>41</td>
<td>3620 Glass and glass products</td>
</tr>
<tr>
<td>42</td>
<td>3691 Structural clay products</td>
</tr>
<tr>
<td>43</td>
<td>3692 Cement, lime, and plaster</td>
</tr>
<tr>
<td>44</td>
<td>3699 Other non-metallic</td>
</tr>
<tr>
<td>45</td>
<td>3710 Iron and steel</td>
</tr>
<tr>
<td>46</td>
<td>3720 Non-ferrous metal</td>
</tr>
<tr>
<td>47</td>
<td>3811 Cutlery, hand-tools, and general hardware</td>
</tr>
<tr>
<td>48</td>
<td>3812 Furniture and fixtures of metal</td>
</tr>
</tbody>
</table>
49 3813 Structural metal products
50 3821 Engines and turbines
51 3823 Metal and wood working machine
52 3824 Special industrial machinery and equipment
53 3829 Other machinery
54 3831 Industrial electrical machinery and apparatus
55 3832 Ratio, TV, communication appliances; Electrical, electronic parts and components
56 3833 Electrical appliances and housewears
57 3839 Other electrical machinery and appliances
58 3841 Shipbuilding and repairing
59 3842 Motor vehicles
60 3843 Motor vehicle parts and accessories
61 3849 Other transport equipment
62 3851 Watches and clocks
63 3859 Other machinery and appliances
64 3910 Musical instruments
65 3990 Other manufacturing
Table A4.2. Parameter Estimates of the Four-Variable Investment Model Including I, S, DC, dL for the 1977-1979 period

<table>
<thead>
<tr>
<th></th>
<th>$I_{1977}$ estimates</th>
<th>$I_{1978}$ estimates</th>
<th>$I_{1979}$ estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>std</td>
<td>std</td>
<td>std</td>
</tr>
<tr>
<td>constant</td>
<td>0.108 0.141</td>
<td>-.560* 0.175</td>
<td>0.134 0.088</td>
</tr>
<tr>
<td>$I_{76}$</td>
<td>0.421 0.353</td>
<td>-.480 0.373</td>
<td>0.484* 0.139</td>
</tr>
<tr>
<td>$I_{75}$</td>
<td>-.014 0.249</td>
<td>-.191 0.318</td>
<td>-.175 0.141</td>
</tr>
<tr>
<td>$I_{74}$</td>
<td>0.163 0.121</td>
<td>0.858* 0.196</td>
<td>0.008 0.126</td>
</tr>
<tr>
<td>$S_{76}$</td>
<td>-.010 0.046</td>
<td>8.788* 4.055</td>
<td>0.021* 0.006</td>
</tr>
<tr>
<td>$S_{75}$</td>
<td>0.066* 0.035</td>
<td>-.083* 0.028</td>
<td>-2.194* 1.213</td>
</tr>
<tr>
<td>$S_{74}$</td>
<td>-.057* 0.021</td>
<td>-.094* 0.031</td>
<td>0.012 0.011</td>
</tr>
<tr>
<td>$DC_{76}$</td>
<td>0.439 0.521</td>
<td>4.374* 1.045</td>
<td>0.163 0.369</td>
</tr>
<tr>
<td>$DC_{75}$</td>
<td>-.198 0.125</td>
<td>-.959 0.688</td>
<td>-.406 0.301</td>
</tr>
<tr>
<td>$DC_{74}$</td>
<td>-.091 0.110</td>
<td>-.395 0.206</td>
<td>-.169 0.205</td>
</tr>
<tr>
<td>$dL_{76}$</td>
<td>-.178* 0.068</td>
<td>0.146 0.153</td>
<td>-.074 0.086</td>
</tr>
<tr>
<td>$dL_{75}$</td>
<td>0.155* 0.039</td>
<td>0.233* 0.068</td>
<td>0.115 0.067</td>
</tr>
<tr>
<td>$dL_{74}$</td>
<td>-.017 0.021</td>
<td>-.136 0.065</td>
<td>0.039 0.031</td>
</tr>
</tbody>
</table>

*Note:* * indicates significance at 10 percent level.
Table A4.3. Parameter Estimates of the Five-Variable Investment Model for the 1981-1983 period

<table>
<thead>
<tr>
<th></th>
<th>( I_{1981} ) estimates</th>
<th>( I_{1982} ) estimates</th>
<th>( I_{1983} ) estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>-0.095 0.065</td>
<td>0.384* 0.090</td>
<td>0.099 0.080</td>
</tr>
<tr>
<td>( I_{79} )</td>
<td>-1.142* 0.189</td>
<td>-1.486 0.136</td>
<td>-0.641* 0.108</td>
</tr>
<tr>
<td>( I_{77} )</td>
<td>-0.272* 0.093</td>
<td>-0.001 0.086</td>
<td>0.007 0.061</td>
</tr>
<tr>
<td>( S_{80} )</td>
<td>-0.011 0.008</td>
<td>0.005 0.008</td>
<td>2.246* 1.141</td>
</tr>
<tr>
<td>( S_{79} )</td>
<td>-0.000 0.006</td>
<td>0.007 0.005</td>
<td>-0.016* 0.009</td>
</tr>
<tr>
<td>( S_{77} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( DC_{80} )</td>
<td>-0.005 0.013</td>
<td>-0.859* 0.249</td>
<td>-0.138 0.378</td>
</tr>
<tr>
<td>( DC_{79} )</td>
<td>0.470* 0.146</td>
<td>-0.012* 0.002</td>
<td>-0.113 0.281</td>
</tr>
<tr>
<td>( DC_{77} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( dL_{80} )</td>
<td>-0.346* 0.114</td>
<td>0.049 0.054</td>
<td>-0.065 0.060</td>
</tr>
<tr>
<td>( dL_{79} )</td>
<td>0.036 0.046</td>
<td>-0.028 0.037</td>
<td>-0.001 0.039</td>
</tr>
<tr>
<td>( dL_{77} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( P_{80} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( P_{79} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( P_{77} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note:* * indicates significance at 10 percent level.
Table A5.1. Rates of Growth of Labor Productivity, Capital Intensity and TFP in Korean Manufacturing Industries, 1963-79 (annual rates of growth in percentages)

<table>
<thead>
<tr>
<th></th>
<th>$Y_i/L_i$</th>
<th>$K_i/L_i$</th>
<th>$TFP_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heavy industries</strong></td>
<td>12.4</td>
<td>10.9</td>
<td>4.4</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>14.1</td>
<td>15.4</td>
<td>2.5</td>
</tr>
<tr>
<td>Chemicals</td>
<td>12.3</td>
<td>7.4</td>
<td>6.9</td>
</tr>
<tr>
<td><strong>Medium industries</strong></td>
<td>14.5</td>
<td>8.3</td>
<td>8.5</td>
</tr>
<tr>
<td>Transport equipment</td>
<td>14.5</td>
<td>7.9</td>
<td>8.7</td>
</tr>
<tr>
<td>Machinery</td>
<td>13.6</td>
<td>10.2</td>
<td>6.2</td>
</tr>
<tr>
<td><strong>Light industries</strong></td>
<td>11.3</td>
<td>6.1</td>
<td>7.0</td>
</tr>
<tr>
<td>Textiles, clothing and footwear</td>
<td>10.3</td>
<td>6.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Electrical goods</td>
<td>14.7</td>
<td>6.1</td>
<td>10.4</td>
</tr>
<tr>
<td><strong>Natural-Resource Industries</strong></td>
<td>12.2</td>
<td>7.9</td>
<td>6.5</td>
</tr>
</tbody>
</table>

BIBLIOGRAPHY


---. *Financial Statement Analysis*. Seoul, Korea, various years.


Baumol, W. "The Transaction Demand for Cash: An Inventory


Economic Planning Board of Korea. *Korea Statistical Yearbook,* various years.

Fazzari, Steven M., R. Glenn Hubbard, and Bruce C. Peterson. "Financing Constraints and Corporate Investment."
Gelb, Alan H. and Honohan. "Financial Sector Reform."


Jappelli, Tullio and Marco Pagano. "Saving, Growth, and


---. "Trade Policy as an input to Development," *AEA Papers*


Syrquin, Moshe Sources of Industrial Growth and Change: An Alternative Measure, World Bank. (1976)


White, Halbert. Asymptotic Theory for Econometricians.


