STRUCTURAL AND ORGANIZATIONAL CHANGES OF THE HOUSEBUILDING INDUSTRY IN THE UNITED STATES AND JAPAN

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ABSTRACT

This study has three parts. The first chapter investigates the construction sectors in the United States and Japan using the analytical framework of interindustry analysis. Six U.S. and five Japanese input-output tables are analyzed. The second chapter presents the housebuilding policy of Japan. Postwar industrialization of housing production and the recent efforts of the private sector to develop new markets are described. The third chapter explores housing production in the United States. Finally, the relationships between market characteristics and organizational structure of the housebuilding industry in both countries are considered.

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PREFACE

The aim of this study is to investigate the principal mechanisms which constitute the structure and organization of the conventional housebuilding industry. To this end, this study analyzes postwar developments in the housebuilding industry in the U.S. and Japan.

The housebuilding industries in the U.S. and Japan have some similar features: a high level of homeownership, a market shifiting toward remodeling construction, and an increasing public demand for a certification system to ensure construction quality. However, the housebuilding industries in the U.S. and Japan also differ in important ways. In Japan, the relatively strong public sector is deeply involved in research and development to promote greater popularity for manufactured housing. In the U.S. the housing market is more regionally concentrated and less active per capita than it is in Japan. Interestingly, these dissimilarities help point up important common principles of housebuilding as an industry.

This study has three parts. The first chapter analyzes the characteristics of the construction sectors in the U.S. and Japan. The analytical framework is an input-output analysis introduced by Leontief in 1936. The chapter first introduces the construction sector's role in each national economy and demonstrates its linkages with other sectors. The input structure of the construction sector is studied in detail. The market for the construction sector is also analyzed. The purpose of this chapter is not only to elucidate the postwar development of the construction sector in economic terms but also to lay groundwork for further investigation of proper distribution systems for the construction and housebuilding industries.

The first chapter reveals that the construction sectors in the U.S. and Japan have been increasing input from service-related sectors. This indicates that the construction sector is becoming more service oriented. The first chapter also demonstrates that the construction sectors in the U.S. and Japan have quite similar input structures compared to other sectors in both countries. Despite these similarities, this chapter indicates that the construction sector in Japan still has a stronger need to utilize factory-made components than its U.S. counterpart, because in Japan the construction sector requires larger primary input than does the manufacturing sector.

The second chapter describes the postwar development of the housebuilding industry in Japan. It introduces the housebuilding policy implemented by the Japanese Ministry of Construction (MOC) and describes the MOC's involvement in encouraging an open system of housing supply in Japan. The major developments of manufactured housing are also studied. Finally, this chapter analyzes the recent shift of the housing market from new construction to remodeling construction. The second chapter concludes that the housebuilding industry in Japan will strengthen its marketing ability and become more service oriented in the near future.

The third chapter starts by comparing housebuilding activities in the U.S. and Japan, goes on to introduce the characteristics of the U.S. housing market, and analyzes the organization of the U.S. housebuilding industry, with special attention to the different levels of production efficiency achieved by building firms of small, medium, and large sizes. This chapter emphasizes the regionally disaggregated features of the U.S. housing market. Each local housing market is much smaller than that of Japan, because of less new construction per capita and a less concentrated population. This analysis indicates that the optimum size of housebuilding firms in the U.S. is smaller than that in Japan.

This study concludes that the housebuilding industries in the U.S. and Japan have to expand their operations by vertical and horizontal integration. Vertical integration means the expansion of business to enabling sectors and horizontal integration implies the expansion of markets. The largest construction firms in the U.S. and Japan already have started the expansion of their fields in these ways. The declining demand for non-residential construction is encouraging these large contractors to enter residential construction. In addition, non-construction sectors are trying to become involved in the housebuilding industry in several ways. Building material suppliers and the real estate industry will become competitors for existing housebuilding opportunities. Expected future changes in the housing supply systems require the housebuilding industry to implement its own independent and consistent research and development.

CHAPTER 1

COMPARATIVE INPUT-OUTPUT ANALYSIS OF THE UNITED STATES AND JAPANESE CONSTRUCTION SECTORS

1. INTRODUCTION

1.1. Analytical Framework

This study discusses the input-output structure of the economies of the U.S. and Japan since World War II, and pays the most attention to their construction sectors. The analytical framework is that of input-output analysis, introduced by Leontief [1936]. This chapter is based on Prof. Ranko Bon's studies of the construction sector in the United States [Bon, 1986]. The producer's price input-output (I-O) tables of the U.S. and Japan are used for this purpose.

An input-output table is a square table the cells of which contain the monetary transactions from the sector of the row to the sector of the column for a particular year. Each sector's column sum and row sum are the same because purchases must be equal to sales. Such a table contains the intermediate goods and services, the value added, and the final demand of production. The construction sector has one column and one row. The column vector shows how much the construction sector purchases from other sectors for its production. The row vector shows how much the construction sector sells to other sectors. The column vector of the construction sector consists of the intermediate input, which mainly consists of material costs, transportation costs, and the cost of services, including engineering and

architectural services, as well as the value added which includes wages and salaries, profits, net investment payments, depreciation allowances, and indirect taxes. The intermediate transactions of the construction sector's row vector show maintenance and repair construction. The final demand of construction represents new construction.

When each flow shown in the input-output table is divided by the column sum of each column, a direct-input coefficient matrix is obtained (demand side). A direct-output coefficient matrix results when each flow is divided by the row sum of each row (supply side). The column vector of the coefficient matrix represents the input structure of each sector and is transformed according to the technological changes of production. Therefore, the coefficients are called "technical" coefficients. The chronological analysis of the technical coefficients of the U.S. and Japanese construction sectors characterizes the difference of the production structure in the two countries and reveals their structural changes since World War II.

If future demand or value added are decided exogenously, input-output analysis can forecast total output or input accordingly. Econometrics analysis can predict future final demand and value added. I-O analysis is also useful to examine how production technology changes will affect sectoral transactions.

The I-O tables are particularly useful for enabling industries involved in the construction sector to forecast how their direct and total requirements will be altered by overall change in construction activities. These industries can make long-term investment plans based on that forecast. Government agencies also may use I-O tables to estimate the economic effects of their construction expenditures on the national economy.

An input-output table is usually divided into four parts; Quadrants I, II, III, and IV. Quadrant I (upper left section) indicates the intersectoral transaction of goods and services. Quadrant II (upper right section) indicates final demand. Quadrant III (lower left section) indicates value added. Usually Quadrant IV (lower right section) contains very few components or none at all. The sum of Quadrant II represents Gross National Product and that of Quadrant III represents Gross National Input (Appendix A).

An I-O analysis can examine both a demand-side and a supply-side model by column or row normalizing the original tables respectively. Direct-Input Coefficients (A), which is the column normalized coefficients of I-O tables, stands for the cost distribution of each sector. Intermediary input and value added are its basic two components. Direct-Output Coefficient (B), which is the row-normalized coefficient of an I-O table, represents how much each sector distributes

goods and services to other sectors, including itself. Intermediary output and final demand constitute total output of each sector.

The direct-input coefficients (requirements) deal only with the direct transaction of two sectors. In fact, every change in transactions will cause rippling changes in the supplying sector's production, which ultimately spread to other sectors. This repercussion effect is called total requirements. Mathematically, it is obtained by inverting the (I-A) matrix in which I is the identity matrix and A is the technical coefficient matrix. The resulting inverse matrix (I-A) explains how much each sector will increase the total output of all sectors by the unit increase of that sector's final output.

The column sum of the total requirements matrix is called the Output Multiplier; it indicates the total impact of the production change of each sector on the whole national economy. The Output Multiplier is always larger than 1.0, because it shows how much the output of the national economy will increase or decrease as each sector's output increases or decreases by one monetary unit, including that sector's own change of output. The larger the Output Multiplier is, the more strongly that sector can generate output from other sectors. The row sum of the (I-A) inverse matrix tells how much each sector will increase its

total output by the marginal increase of all sectors' final output.

The Input Multiplier is the row sum of the (I-B) inverse matrix, which shows the effect of marginal increase of some sector's primary input (value added) on total input of all sectors. Input Multiplier represents how much the sector's resources are constrained for the development of the national economy. The column sum of (I-A) inverse and the row sum of (I-B) inverse are mirror images, because input and output must be equal for each sector. The base year's projections of total output and input, using the (I-A) inverse and (I-B) inverse, must be same. The difference between projected total output and input becomes larger as the projected year deviates more from the base year. The column sum of the (I-B) inverse explains how much the marginal increase of the national economy will require the increase of the relevant sector's primary input.

This study uses a static model for the chronological analyses of the economies of the U.S. and Japan, i.e. it compares I-O tables, which show only the current sectoral transaction, over a stretch of time. However, this analytical framework does not consider the effect of the following items [Construction Review, 1965]:

1. A change in the relative importance of the various types of new construction.

2. Differential price changes among the various inputs of construction including construction labor costs.

3. Changes in the regional composition of construction activity, due to substantial regional variation in the material and labor inputs, especially for housing construction.

4. Technological developments making certain types of structures less expensive and more widely used, as they require different materials and types and quantities of labor.

5. Change in public taste and new designs by architects and engineers requiring different materials and techniques.

These are the basic problems of the chronological analysis of the I-O tables. Moreover, the U.S. and Japanese I-O tables are not fully compatible in terms of their levels of aggregation and accounting conventions. Nevertheless, this analytical framework can be used to meaningfully compare many characteristics of the U.S. and Japanese construction sectors by probing their relative differences from other sectors in each country and the transformation of these differences. This analysis will provide many subsequent research topics which should be scrutinized by this and other methods.

1.2. The U.S. and Japanese Input-Output Tables

This study uses the six U.S. I-O tables which were compiled by the Bureau of Economic Analysis of the United States Department of Commerce in 1947, 1958, 1963, 1967, 1972, and 1977. The seven sector-aggregation version of those tables from Miller and Blair [1985, pp 420-425] are analyzed. The seven sectors are: 1. agriculture, 2. mining, 3. construction, 4. manufacturing, 5. trade and transportation, 6. service (includes real estate industry as well as engineering and architectural services), 7. other (includes government enterprises, and scrap and secondhand goods).

The Japanese I-O tables analyzed in this study were compiled in 1960, 1965, 1970, 1975, and 1980 by the Economic Planning Agency and published by the Statistics Department of the Bank of Japan. The number of the production sectors of these tables are 10, 10, 13, 13, and 14 for 1960, 1965, 1970, 1975, and 1980, respectively. The original ten sectors are: 1. agriculture, 2. mining, 3. construction, 4. manufacturing, 5. utility, 6. trade and finance, 7. transportation, 8. service, 9. government service, and 10. other (undistributed). After 1970, the tables were restructured; real estate rents, office supplies, and packing materials were separated into independent sectors. In the 1980 table, construction repairs were extracted from

the construction sector. Therefore, it was necessary to reduce the size of the Japanese tables to that of the smallest tables. The real estate and construction repairs sectors were re-aggregated with their original sectors. The office supplies and packing materials sectors were included in the manufacturing sector.

2. SECTORAL ANALYSIS OF THE UNITED STATES AND JAPANESE ECONOMIES

2.1. Sectoral Share of National Product and Income

Figures 1.1 and 1.3 and Figures 1.2 and 1.4 show the sectoral share of final demand of total final demand (G.N.P.) in the U.S. and Japan. The U.S. service sector has increased its share, while the shares of all U.S. sectors have declined. The distribution of the U.S.'s final demand has shifted from clear dominance by the manufacturing sector to near equality between the manufacturing sector and the service sector. Most of the Japanese sectors, except the manufacturing sector, have been increasing their shares.

The shares of the manufacturing sectors in the U.S. and Japan have been declining, even though each remains relatively large. Meanwhile, the service sectors in both the U.S. and Japan have been increasing their shares. The U.S. service sector currently produces the largest final demand among all sectors. The U.S. and Japanese agriculture sectors have contributed very little to the formation of final demand.

The final demands of the Japanese construction sector, service sector, and trade and finance sector seem to be converging with that of the manufacturing sector. The share of the Japanese construction sector's final demand has

increased from 17.6 percent in 1960 to 20.4 percent in 1980. That of the U.S. construction sector has been decreasing, from 13.6 percent in 1958 to 10.4 percent in 1977.

Table 1.1. Construction Sector's Final Demand/Gross National Product (in percent)

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	9.9	13.6		12.9		11.7		11.7		10.4	
Japan			17.6		17.9		19.6		20.3		20.4

Figures 1.5 and 1.7 and Figures 1.6 and 1.8 show the sectoral shares of value added to total value added (G.N.I.) in the U.S. and Japan. As seen in comparing sectoral shares of demand to final demand, value added by the U.S. service sector has increased its share of total value added, while the shares of all other sectors have declined. The Japanese manufacturing sector has deceased its value added share, while most of the shares of the other sectors have increased. Both U.S. and Japanese construction sectors have had little impact on the formation of value added in the national economy: in Japan the share of this sector has increased from six percent in 1960 to nine percent in 1980, while in the U.S. it has remained little more than five percent since 1947.

Table 1.2. Construction Sector's Value Added/Gross National Income (in percent)

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	5.4	6.9		6.7		6.2		6.4		5.6	
Japan			6.1		7.3		8.0		9.5		9.3

Table 1.3. Employment Share of the Construction Sector in All Sectors except the Agriculture Sector (in percent)

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	4.5	5.4	5.3	5.3	5.3	4.9	5.1	5.3	4.5	4.7	4.8
Japan					6.9		7.7	8.4	9.2	9.3	9.9

(The numbers of Tables 1.2 and 1.3 are not compatible, because Table 1.3 does not include the agriculture sector.)

The Japanese trade and finance sector has increased its share significantly and has become as large as that of its manufacturing sector. In contrast, the U.S. trade sector, which is aggregated with the transportation sector, has decreased its share of value added. In 1970, the increase in the value added share of the Japanese service sector stopped as did final demand. The shares of both the U.S. and Japanese agriculture sectors have shown a sharp decrease; each currently has the smallest share among all sectors.

Table 1.2 and Table 1.3 show that in 1980 the Japanese construction sector reduced its share of value added, while its employment share has increased. This is the only year in which there is a countertrend between these two shares in the U.S. and Japanese construction sectors. The Japanese construction sector may have reduced its productivity significantly after the second energy crisis.

Fig. 1.9 and Fig. 1.10 show the sectoral shares of input into the total national inputs for the U.S. and Japan. Total input is the sum of intermediate input and value added. Because the Japanese manufacturing sector has kept the largest intermediate input and the largest value added, Fig. 1.10 emphasizes the dominance of this sector more than do Figures 1.2 and 1.4 and Figures 1.6 and 1.8.

2.2. Sectoral Backward and Forward Linkages

Fig. 1.11 and Fig. 1.12 show the sectoral backward linkage indicators in the U.S. and Japan. Backward linkages stand for the proportion of intermediary input in direct-input requirements. The rest of the direct-input requirements is value added, including land, labor, and capital cost. Backward linkages tell how much each sector depends for its direct-input on other sectors' output.

The range of the U.S.'s backward linkage indicators has been narrower than that of the Japanese ones; roughly speaking the former has been between 0.3 and 0.6 and the latter has been between 0.2 and 0.7. The U.S. and Japanese economies have two separate groups of backward linkage indicators: one group is high around 60 percent and the other is low around 30 percent. In both the U.S. and Japan, the manufacturing sector and the construction sector are included in the former group. It is noticeable that the U.S. and Japanese construction sectors reduced their backward linkage indicators before the energy crises. This may indicate that the U.S. and the Japanese construction sectors have common difficulties transforming their production technology from a labor intensive one to a capital intensive one. The U.S. agriculture sector also has been in the former group with high backward linkages, whereas that of Japan has been in the latter group with low backward linkages. The

U.S. and Japanese service sectors, the Japanese trade and finance sector, and the U.S. trade and transportation sector have shown low backward linkage indicators. The Japanese transportation sector has increased its backward linkages significantly since the first energy crisis, probably because a sudden increase of energy costs changed the structure of the transportation systems.

Table 1.4. Construction Sector's Backward Linkage Indicators

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	0.58	0.58		0.56		0.55		0.54		0.57	
Japan			0.68		0.62		0.62		0.56		0.57

Fig. 1.13 and Fig. 1.14 show forward linkage indicators in the U.S. and Japan. These figures indicate the proportion of intermediate output to direct-output requirements. The rest of the direct-output requirements is final demand, which includes private, business, and government consumption; capital formation; inventory accumulation; and net export.

Both the U.S. and Japanese construction sectors have kept the lowest forward linkage indicators and their agriculture sectors have kept the largest. Forward linkages of the Japanese mining sector were over 1.0, because that sector had a large net import.

Forward linkage indicators of a construction sector mean the proportion of maintenance and repair (M&R) construction to total construction. The forward linkages of the U.S. construction sector have been twice as large as that of the Japanese counterpart, because the U.S. already has large established building and infrastructure stocks to be kept up. It may be predicted that the Japanese construction sector will increase its forward linkages as it accumulates comparable stocks. This will be discussed in detail in the following 3.2 Direct-Output Requirements.

Table 1.5. Construction Sector's Forward Indicators

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	0.24	0.17		0.17		0.17		0.16		0.21	
Japan			0.09		0.08		0.08		0.07		0.07

2.3. Sectoral Multiplier Analyses

Fig. 1.15 and Fig. 1.16 show sectoral Output Multipliers in the U.S. and Japan. Basically, the U.S. and Japanese Output Multipliers and backward linkage indicators show similar features. Output Multipliers of the Japanese manufacturing sector have been significantly larger than those of the U.S. counterpart. This is because the backward linkages of the Japanese manufacturing sector have been higher than in the U.S.: those of Japan and the U.S. are 0.7 and 0.6 respectively. The larger Output Multipliers of the Japanese manufacturing sector increase the value of the Output Multipliers of its construction sector, because the Japanese construction sector has a large intermediate input from the manufacturing sector. Therefore, the difference between the Output Multipliers of the U.S. and the Japanese construction sectors may reflect mostly the structural differences between the U.S. and Japanese manufacturing sectors, rather than the structural differences between the construction sectors per se.

The decreasing trend of the Japanese construction sector's Output Multipliers means that the linkage between the construction sector and other sectors has been weakened in Japan. We may be able to say that the Japanese construction sector has been concentrating its transactions on fewer sectors since World War II. [Ranko with Minami,

1986] The decreasing trend of the Japanese construction sector's Output Multipliers is related to the decreasing input from the manufacturing sector to the construction sector. The trade sectors in the U.S. and Japan had the lowest Output Multipliers; around 1.5. The service sector of the U.S. has had a decreasing trend, while that of Japan jumped in 1970.

Table 1.6. Construction Sector's Output Multipliers

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	2.22	2.20		2.16		2.13		2.08		2.22	
Japan			2.70		2.35		2.42		2.36		2.42

Fig. 1.17 and Fig. 1.18 show row sum of (I-A) inverse of the U.S. and Japanese I-O tables. (Note: The scales of Fig. 17 and Fig. 18 are different.) These figures indicate that the Japanese manufacturing sector has produced significantly large total-output by the marginal increase of all other sectors' final demand. Figure 1.18 shows that if all sectors increased their final demand 1.0, the Japanese manufacturing sector increased its total-output more than 5.0. In contrast, both U.S. and Japanese construction sectors have kept the smallest numbers for this indicator. Marginal increase of final demand in a national economy does not usually require large total output from the construction sector, because it has very little intermediate output.

Fig. 1.19 and Fig. 1.20 show the U.S. and Japanese Input Multipliers. An Input Multiplier represents how a marginal increase in a given sector's primary input will increase total input of all sectors. These figures indicate that both the U.S. and Japanese mining sectors have constrained growth in each national economy. The large Input Multipliers of the Japanese mining sector reflect the increasing dominance of imports in the mining sector. For the U.S. economy, the agriculture sector has been another constraint. The construction sectors in the U.S. and Japan have always indicated the lowest Input Multipliers.

Table 1.7. Construction Sector's Input Multipliers

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	1.50	1.36		1.35		1.34		1.29		1.41	
Japan			1.19		1.17		1.16		1.15		1.16

Table 1.8. Manufacturing Sector's Input Multipliers

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	2.02	2.14		2.11		2.08		2.08		2.17	
Japan			2.44		2.31		2.42		2.51		2.64

Table 1.9. Mining Sector's Input Multipliers

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	2.78	3.03		3.00		2.94		3.16		3.97	
Japan			5.74		6.27		8.58		17.56		19.16

Fig. 1.21 and Fig. 1.22 show the column sum of (I-B) inverse of the U.S. and Japanese I-O tables. These figures indicate that the marginal increase of all sectors' primary input (value added) will require significantly large primary input of the manufacturing sectors in the U.S. and Japan. This is because the output of the manufacturing sector is the dominant portion of the input of all sectors. The kink in the Japanese manufacturing sector's trend around 1970 indicates that this sector changed its supply structure around that time. The Japanese construction sector has shown the second highest number for this indicator, following the manufacturing sector. This relationship reflects the relatively large dependence of the Japanese construction sector's input on the manufacturing sector's output.

3. INPUT AND OUTPUT PROFILES OF THE CONSTRUCTION SECTOR IN THE UNITED STATES AND JAPAN

3.1. Direct-Input Requirements

The direct requirements of the U.S. construction sector from 1947 to 1977 are presented in Figures 1.23 and 1.25. Those of the Japanese construction sector are shown in Figures 1.24 and 1.26. These figures represent the proportion of the intermediate input from supplying industries to the construction sector and the value added components.

The U.S. construction sector has maintained a relatively stable input structure since World War II. The manufacturing sector always supplied a large portion of the intermediate input of the construction sector, while the trade and transportation and service sectors followed it. A secular increasing trend of the ratio of the value added components is observed, although there is a kink between 1972 and 1977 because of the first energy crisis. Alternately, the ratio of intermediate to total input of the U.S. construction sector showed a decreasing trend.

The input from the trade subsector to the construction sector represents the trading margin of the distributing industries. The transportation costs paid by the construction sector are included in the transportation subsector. All six U.S. and five Japanese I-O tables show

that the sectors which include wholesale and retail trade and transportation were more important in the input structure of the construction sectors than they were in the manufacturing sectors. Because the construction sector is constituted of a large number of scattered small enterprises which purchase various kinds of construction materials in small quantities, the distribution costs of the construction sector are inevitably higher than they are in the manufacturing sector. The bulk and weight of construction materials also increase the sector's transportation and warehousing costs.

The major supplying sectors of the U.S. construction sector have been periodically introduced by the Construction Review [Construction Review, 1965 pp.4-10, Kinzie, 1970 pp.4-8, Williams, 1981 pp.4-20 and 1985 pp.2-19] According to these papers, the dominant supplying industries have been the wholesale and retail industries and the business and professional services industries. They have been increasing their importance in the construction sector's input structure, and also in the subsectors of the manufacturing sector which produce lumber and wood products, heating, plumbing and fabricated structural metal products, and cement and concrete products. Industries supplying paints and allied products as well as petroleum and related products (principally road and roofing materials) have

contributed more to maintenance and repair construction than to new construction. [Kinzie, 1970, p.4] Nevertheless, most of the supplying industries sell more to new construction than to maintenance and repair construction, even if the share of those industries seems smaller in the input structure of new construction subsector. This is because the output of new construction has been four to five times larger than that of maintenance and repair construction. However, the output of some of the supplying industries depends heavily on the construction sector's purchases. These industries are greatly affected by fluctuation in construction activity.

The Japanese construction sector has experienced a significant structural change since World War II. A sharp decrease in the input from the manufacturing sector and an increase in value-added components are evident. Since 1975, the value-added components have been larger than the input from the manufacturing sector. Two kinks may be observed in this general trend: one between 1960 and 1965, and the other between 1970 and 1975. Conversely, the input structures of 1965 and 1970, and of 1975 and 1980 were relatively similar. The impact of the second energy crisis probably explains the slight countertrend between 1975 and 1980. Compared with the U.S. input structure, the Japanese construction sector has required less input from the trade

and finance and the transportation sectors, which indicates differences between the distribution systems in the two counties as well as differences in accounting systems. The service sector, which includes engineering and architectural services, has supplied very little input to the construction sector in Japan, although it has been increasing in importance. The lumber and milling industry in Japan has decreased its importance in the construction sector's input structure. The direct requirement of this industry from the building construction subsector (excluding the civil construction subsector from the construction sector) was 16.6 percent, 12.4 percent, 11.2 percent, 8.2 percent, and 7.8 percent in 1960, 1965, 1970, 1975, and 1980, respectively [Japanese I-O tables, 60 to 72 disaggregation]. Table 1.10 and table 1.11 show that the Japanese construction sector is increasing its input from the service related sectors, decreasing its input from the manufacturing sector. In contrast, the U.S. construction sector has shown a stable input structure.

Table 1.10. Construction Sector's Direct-Input Requirements from Manufacturing Sector

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	0.37	0.38		0.37		0.36		0.35		0.37	
Japan			0.52		0.42		0.44		0.36		0.37

Table 1.11. Construction Sector's Direct-Input Requirements from Trade & Transportation and Service Sectors (the U.S), and Utility, Finance, Transportation, and Service Sectors (Japan)

Year	1947	1958	1960	1963	1965	1967	1970	1972	1975	1977	1980
U.S.	0.19	0.18		0.18		0.18		0.17		0.18	
Japan			0.10		0.13		0.13		0.15		0.16

The stability of the input structure of the U.S. construction sector and the changes in the structure of the Japanese construction sector can be explained by the changing rate of the unit construction labor cost during the period under consideration. The average wage of the U.S. construction worker has been consistently higher than the wages of workers in the manufacturing sector or in the wholesale and retail trade sector. [Economic Report of The President, 1985, p.265]. The average wage of the Japanese construction worker had been lower than the wages of workers in manufacturing sector until 1978 [Nakamura, 1985, p.27]. However, the Japanese construction worker's wage has increased significantly, especially in 1970's. In 1955, the average monthly wage of the Japanese construction worker was

12.6 percent less than that of a worker in the manufacturing sector. In 1984, a construction worker's wages exceeded that of a manufacturing worker by 3.7 percent. According to Howenstine [1980, pp.4-11], the rate of increase in U.S. construction labor costs was 2.5 percent lower than the rate of increase of the total cost of new housing from 1970 to 1977. Conversely, the rate of increase of material cost was 0.5 percent higher than that of the total cost of new housing during the same period. In Japan, the rate of increase of material cost was 2.0 percent lower than that of the total cost of new housing from 1970 to 1977.

These facts suggest that the U.S. construction sector has had less incentive to reduce labor cost than has its Japanese counterpart. The significant increase in the value-added components of the Japanese construction sector can be explained by the sharp increase of its unit labor cost, although the amount of the required labor also must be considered. The sudden increase in the cost of materials which was not promptly followed by the increase of labor cost after the second energy crisis, explains the countertrend of the Japanese construction sector's increasing input from the manufacturing sector in 1980.

The industrialization of construction leads to more input from the manufacturing sector and fewer value-added components to the construction sector, because it uses more

value-added materials and reduces the on-site labor. Regardless of efforts to industrialize the U.S. and Japanese construction sectors, the expected reduction trend of the value added cannot be observed in either case. The increasing trend of the U.S. construction sector's value added components, regardless of the relatively decreasing trend of the U.S. unit construction labor cost, can be explained by its decreasing productivity, defined as output per hour, since 1960. [Cremeans, 1981, pp. 4-6]

The ratio of the value added in the input structure of the U.S. and Japanese construction, manufacturing, and agriculture sectors is presented in Fig. 1.27. Three sectors in the U.S. have experienced stable and similar ratios of the value added in their input structure since World War II. In Japan, only the manufacturing sector has experienced a stable share of value added, probably because a mature production process already had been established before 1960. The Japanese agricultural sector has reduced the portion of value-added components within its output, mostly because of its post-war industrialization. Therefore, the increasing trend of the value added components of the Japanese construction sector can be understood as a peculiar structural change among the six U.S. and Japanese sectors.

The increase in the Japanese construction sector's value-added components depends mainly on the increase in the

unit construction labor cost. No significant structural change which might hace caused such a trend in the construction sector, (for example, a the shift from residential building construction to nonresidential and nonbuilding constructions or a shift from new construction to maintenance and repair construction) has been observed. The Japanese construction has responded to the increasing in construction unit labor cost by industrialization. At the same time, the Japanese construction sector may have increased its labor cost in its input structure excessively without effectively adjusting its production technology.

The proper proportion of the value added for the Japanese construction sector may be as large as for the Japanese manufacturing sector -- 30 percent. If so, the Japanese construction sector will continue to have even greater incentives to change its production technology, to use more factory-made materials and to reduce costly on-site labor, than has its U.S. counterpart. It is significant that the input structure of the U.S. and Japanese construction sectors have become very similar in recent years. However, in terms of value added in the direct requirements, the U.S. and Japanese manufacturing and agriculture sectors still indicate quite different input structures.

To render the previous discussion more precise, we may distinguish the construction sector into non-residential construction, residential construction, and nonbuilding construction subsectors, because each has a different input structure. Williams [1985,pp.2-19] writes:

> The largest concentration of this increase [in the proportion of goods and services purchased from all other industries] appears to be in the residential buildings sector. For example, the new residential builders' percentage of purchases of goods and services from all other industries jumped from 57.5 percent in 1972 to 64.8 percent in 1977. This suggests that the emphasis on prefabrication, begun in the late 1960's, is continuing as home builders increase their purchases of factory-made building components (such as prefabricated roof trusses and bath modules), thereby shifting more of their production process from the construction site to the factory.
>
> No such trend in the proportion of goods and services purchased from other industries can be detected in the nonresidential buildings and nonbuilding sectors. There was almost no change at all in the nonresidential building sector: 59.7 percent in 1972, 59.5 percent in 1977. However, there was almost 3 percent increase in the nonbuilding facilities category.

This trend cannot always be observed. Table 1.12 shows that for builders of new wooden residences in Japan the percentage of purchases of goods and services from all other industries dropped from 71.2 percent in 1955 to 67.4 percent in 1965. [Miura, 1977, p.79] In contrast, for builders of new reinforced concrete residences the percentage of purchases of goods and services from all other industries

decreased from 74.3 percent in 1955 to 68.7 percent in 1965, and the percentage for builders of new steel reinforced concrete office buildings declined from 76.7 percent in 1955 to 72.6 percent in 1965. This trend probably reflected the labor intensive construction of the wooden Japanese houses and also the increasing construction unit labor cost. It should be noticed that wood residential construction decreased the input of wood products and increased that of trading margin from 1955 to 1960. The shift of reinforced concrete residential construction's input from cement to cement products indicates industrialization of construction materials.

Table 1.13 represents the projected direct-input requirements of the U.S. residential construction in 1985. It demonstrates that lumber, stone and clay products, metal products, and trading margin share a large portion of the construction sector's input requirements. Table 1.12 and Table 1.13 show the similar input structure of the residential construction in the U.S. and Japan, although these tables are not compatible.

Table 1.12. Direct-Input Requirements of the Housebuilding Subsector in Japan

	House					Office	
	Total	Wood		R.C.		S.R.C.	
	1980	1965	1955	1965	1955	1965	1955
Basic Material	2	5	49	14	19	13	93
Gravel,Stone	63	194	126	181	233	106	178
Wood, Plywood	1052	2137	2943	841	1039	354	411
Furniture, etc.	-	611	688	199	325	41	109
Oil Products	20	40	6	66	29	78	24
Cement	43	101	167	165	869	80	482
Cement Products	85	157	165	894	63	619	91
Ceramics, Tiles	81	312	446	275	380	340	305
Fresh Concrete	148	-	-	-	-	-	-
Steel Pipe	29	83	84	133	210	133	138
Steel (Hot Roll)	141	10	1	405	889	453	730
Steel (Cold Roll)	12	143	258	79	69	108	103
Fabricated Metal	151	12	0	121	0	577	800
Metal Products	384	376	198	721	609	647	726
Cable (Elect.)	29	75	29	66	24	69	48
Machinery	-	5	30	163	206	966	1328
Machinery (Elect.)	118	73	42	166	79	410	235
Trade	726	787	446	687	525	592	388
Transportation	148	335	321	373	358	350	270
Others							
Value Added	4137	3258	2881	3130	2570	2742	2335
Total	10000	10000	10000	10000	10000	10000	10000

Source: Miura, T, Japanese Construction Industry, 1977, MOC, Construction White Paper, 1984

Table 1.13. Direct-Input Requirements (Projection) of Single-family Residential Units Construction in the United States

Industry	$ (in billions)
Agriculture & Mining	3924
Construction	964
Food & Tabacco	607
Fabrics	558
Floor Coverings & Textile Products	1233
Lumber	16795
Furniture	265
Paper, Printing & Publishing	2158
Chemicals & Plastics	1813
Paints	432
Petroleum & Related Products	1534
Rubber & Plastic Products	1447
Glass & Glass Products	298
Stone & Clay Products	>505
Metal Manufacturing	4959
Heating, Plumbing & Fabricated Metal Products	4951
Engines, Construction & Industrial Equipment	1787
Office, Service & Electrical Equip.	1603
Household Appliances	253
Electric Lighting & Wiring Equip.	519
Construction & Electrical Equip.	303
Miscellaneous Manufacturing	285
Transportation, Communication & Utilities	7666
Wholesale & Retail Trade	10071
Finance, Insurance & Real Estate	4642
Services & Government	8717

Source: Professional Builder, October 1985

A change in the proportion of new construction to maintenance and repair construction will also affect the demand structure of the construction sector. Maintenance and repair construction usually has a larger value added than new construction. Williams also explains [ibid.]:

> New construction consumed a much larger share of other industries' goods and services than did maintenance and repair construction; the proportions in 1977 were 61.3 and 48.7 percent, respectively, compared to 57.6 and 42.0 percent in 1972 [in the U.S.].

Table 1.14. The U.S. Construction Sector's Value Added Ratio to Direct-Input Requirements (in percent)

Year	1958	1963	1967	1972	1977
New Construction	35.4	39.5	39.8	42.4	38.7
Maintenance & Repair Const.	61.2	56.2	58.6	58.0	51.2

Source: Construction Review

The shift from new construction to maintenance and repair construction in the U.S. after the first energy crisis should have influenced the increasing ratio of the intermediate input of the construction sector as a whole, as shown in Figures 1.23 and 1.25.

3.2. Total-Input Requirements

Fig. 1.28 and Fig. 1.29 show the construction sector's total-input coefficients. These figures show configurations similar to those of the direct-input requirements. In the past the direct-input to the U.S. construction sector from the service sector has been smaller than that from the trade and transportation sector, though the total-input from the service sector has been larger than that from the trade and transportation sector since 1963. The Japanese construction sector has required significantly larger total-input from its manufacturing sector than has the U.S. construction sector. The increase of the Japanese construction sector's final demand will require total-input almost as large as in its manufacturing sector. The decrease in the Japanese construction sector's total-input from the manufacturing sector reflects the decrease of its direct-input from the manufacturing sector. The Japanese construction sector has increased the total-input from the service sector and the trade and finance sector. Total input from the agriculture sectors in the U.S. and Japan have shown decreased.

3.3. Direct-Output Requirements

Figures 1.30 and 1.32 and Figures 1.31 and 1.33 show the construction sector's direct-output coefficients in the U.S. and Japan. They show the distribution of the construction sector's intermediate output, i.e. maintenance and repair construction. As we have already observed in Fig. 1.9 and Fig. 1.10, the proportion of the U.S. maintenance and repair construction to its total construction is twice as large as that of its Japanese counterpart, around 20 percent in the U.S. and less than 10 percent in Japan.

Both countries have changed their decrease in maintenance and repair construction into an increase in recent years. The higher percentage ratio of the U.S. maintenance and repair work derives mostly from a larger housing and civil engineering stocks already in place. The trend in the Japanese trade and finance sector ran counter to those in most other sectors.

According to the 1958 U.S. I-O table, the real estate industry purchased more than one-third of the gross output of maintenance and repair construction. [Construction Review, 1965] The state and local government's purchases accounted for 20 percent, transportation and warehousing for 7.4 percent, state and local government enterprises for 7.1 percent, and the federal government for 6.3 percent. It

should be remembered that household expenditures for maintenance and repair works are relegated to the real estate industry, simply because they cannot be distinguished as final demand. This accounting procedure inflates the service sector's input of maintenance and repair construction.

In the U.S., the real estate industry is classified in the service sector which purchased almost 55 to 65 percent of maintenance construction between 1947 and 1977. This proportion was almost 10 to 15 percent of the total construction output. In Japan, the real estate industry is classified in the trade and finance sector which purchased 40 to 75 percent of maintenance and repair construction between 1960 and 1980. Manufacturing and utility sectors were respectively the second and third largest purchasers of maintenance and repair construction in Japan. In 1975, the share of the finance sector's input of maintenance and repair was almost three-fourths of the total output of maintenance repair construction. This may reflect the sharp shift of construction activity from new construction to maintenance and repair just after the first energy crisis in Japan. Because of the dominant share of new construction, maintenance and repair construction in the demand structure of the other Japanese sectors has been rather small.

3.4. Total-Output Requirements

Fig. 1.34 and Fig. 1.35 represent the construction sectors' total-output requirements in the U.S. and Japan. Both the U.S. and Japanese manufacturing sectors have indicated shares in total-output requirements larger than their shares in direct-output requirements. This means that manufacturing sectors in the U.S. and Japan have large indirect input of maintenance and repair construction.

4. CONCLUSIONS

This study suggests five major conclusions. First, since World War II the Japanese construction sector has experienced rapid structural changes, characterized by increasing value added and decreasing intermediate input from other sectors. Second, the reason for these changes is most likely the increase in the construction unit labor cost. Third, in recent years the input structures of the U.S. and Japanese construction sectors have become quite similar compared to the divergent input structures of the manufacturing and agriculture sectors in the two countries. Fourth, maintenance and repair construction in Japan has been insignificant, but may be expected to increase in importance as the building stock becomes more comparable to that in the U.S. Fifth, the linkage of the construction sector to other sectors in the national economy has been stronger in Japan than in the U.S., though this relationship is now weakening.

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Fig. 1.1. The U.S. Sectoral Final Demand to Total Final Demand Ratio -- Sectoral Shares in Gross National Product

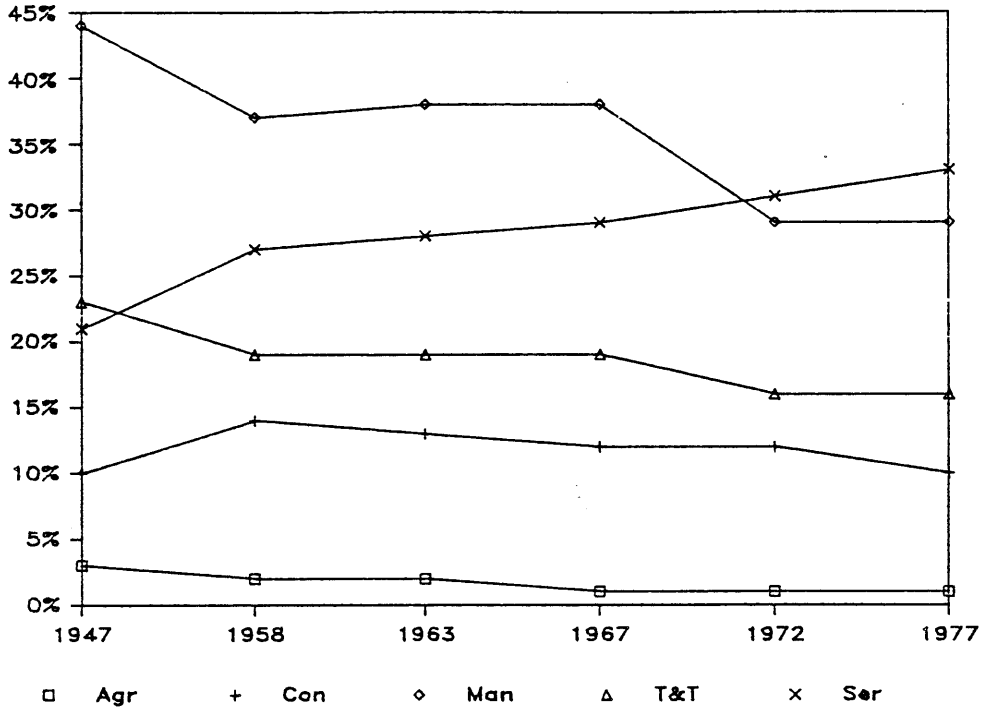


Fig. 1.2. The Japanese Sectoral Final Demand to Total Final Demand Ratio

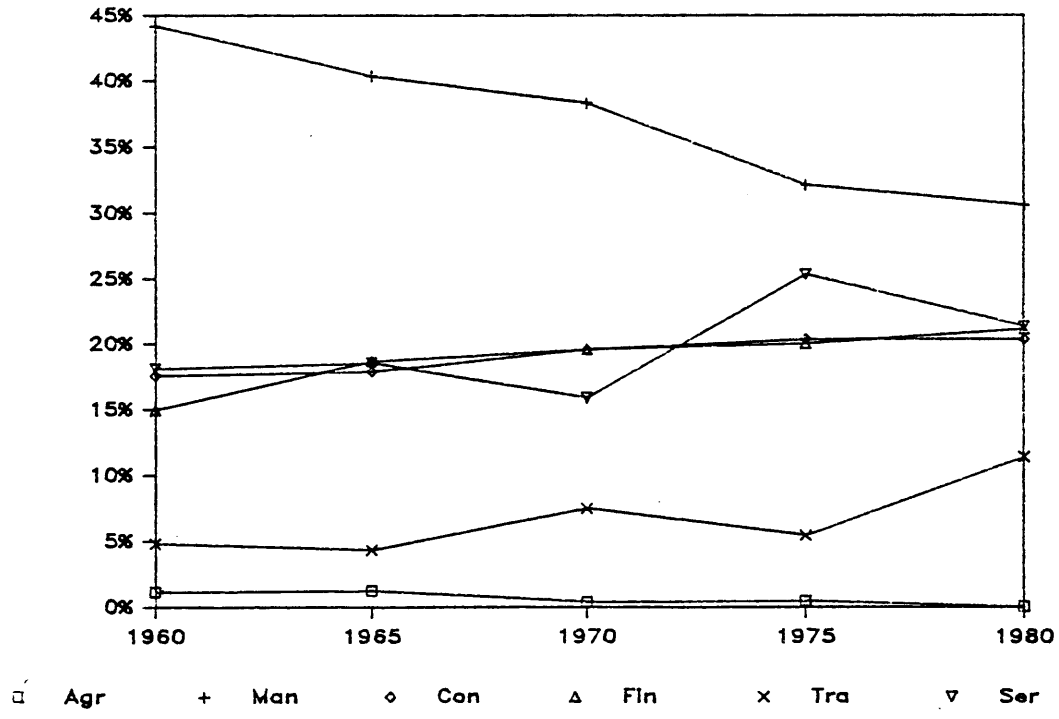


Fig. 1.3. The U.S. Sectoral Final Demand to Total Final Demand Ratio -- Sectoral Shares in Gross National Product

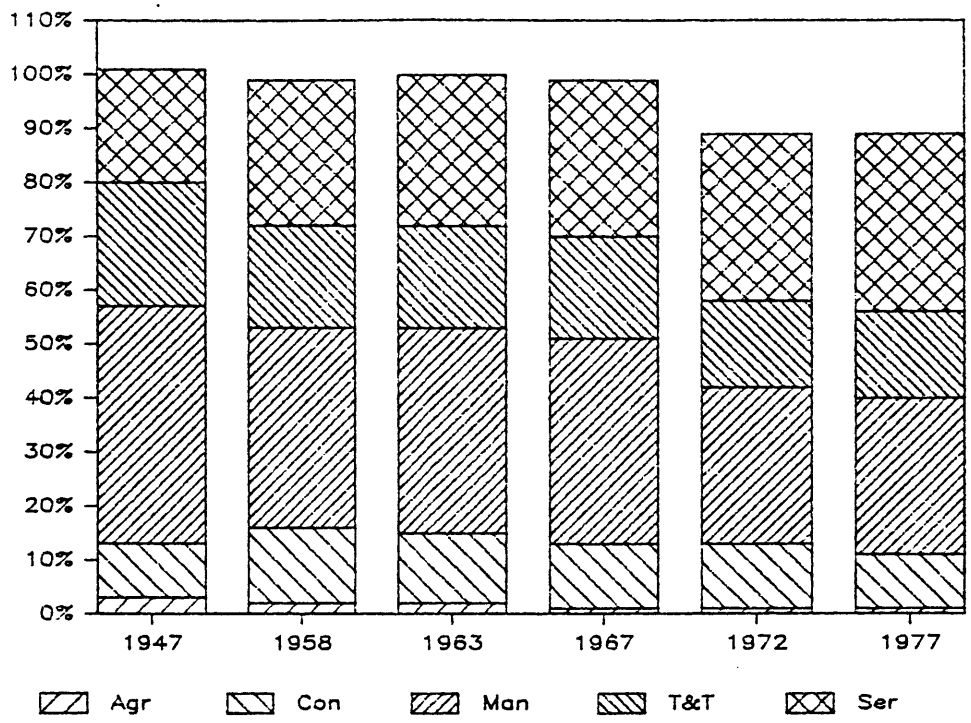


Fig. 1.4. The Japanese Sectoral Final Demand to Total Final Demand Ratio

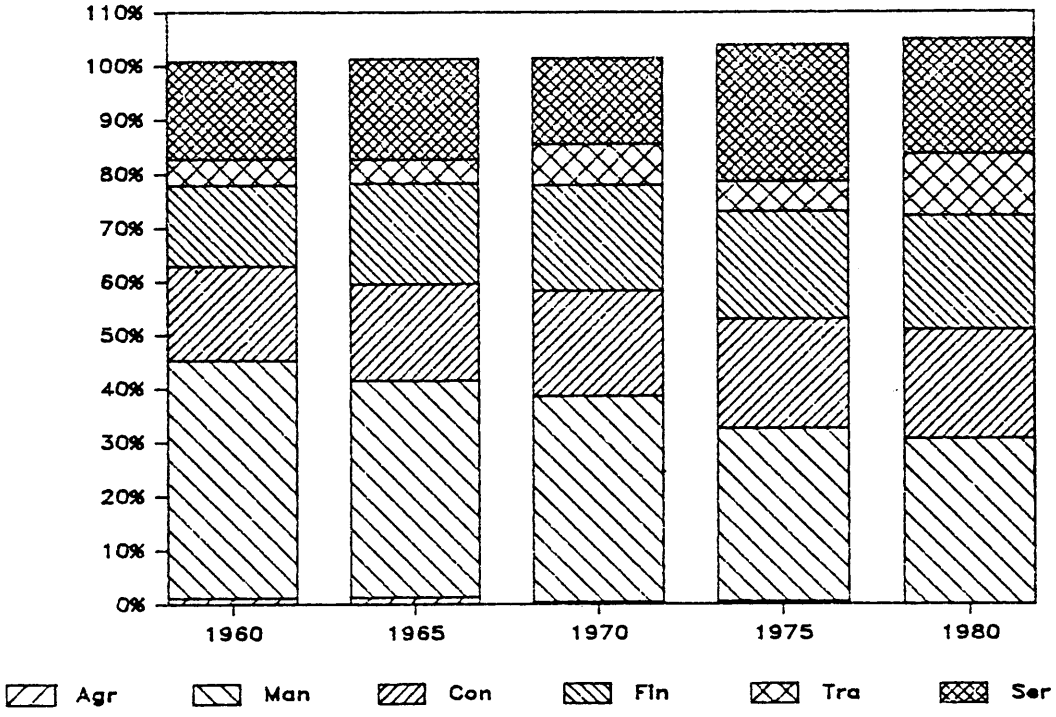


Fig. 1.5. The U.S. Sectoral Value Added to Total Value Added Ratio -- Sectoral Shares in Gross National Income

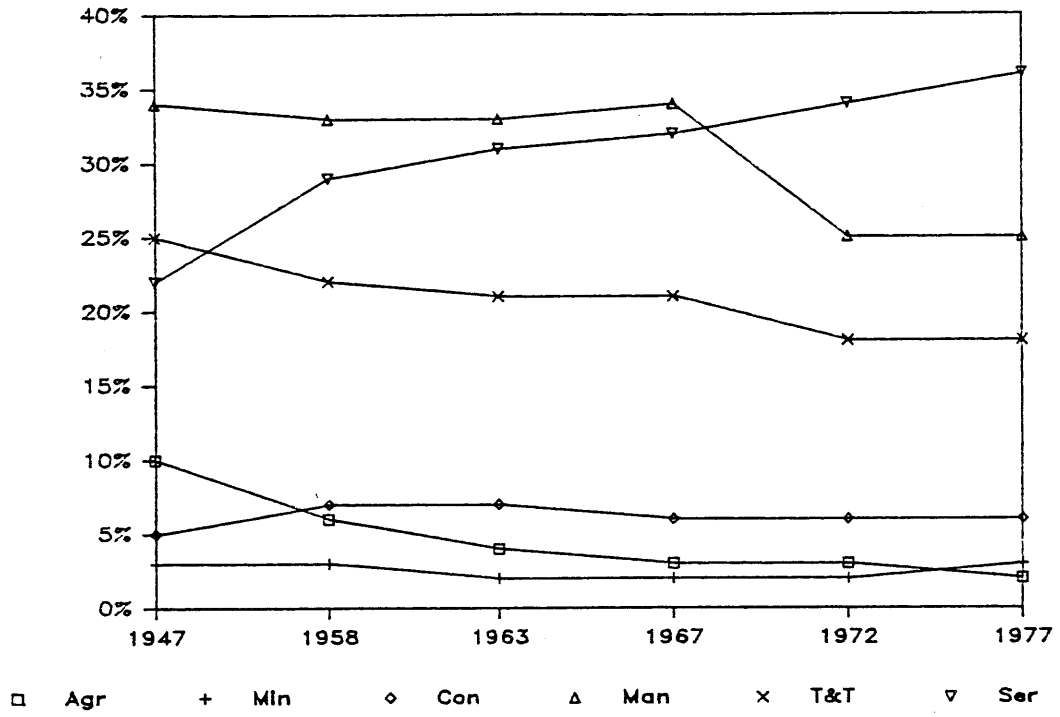


Fig. 1.6. The Japanese Sectoral Value Added to Total Value Added Ratio

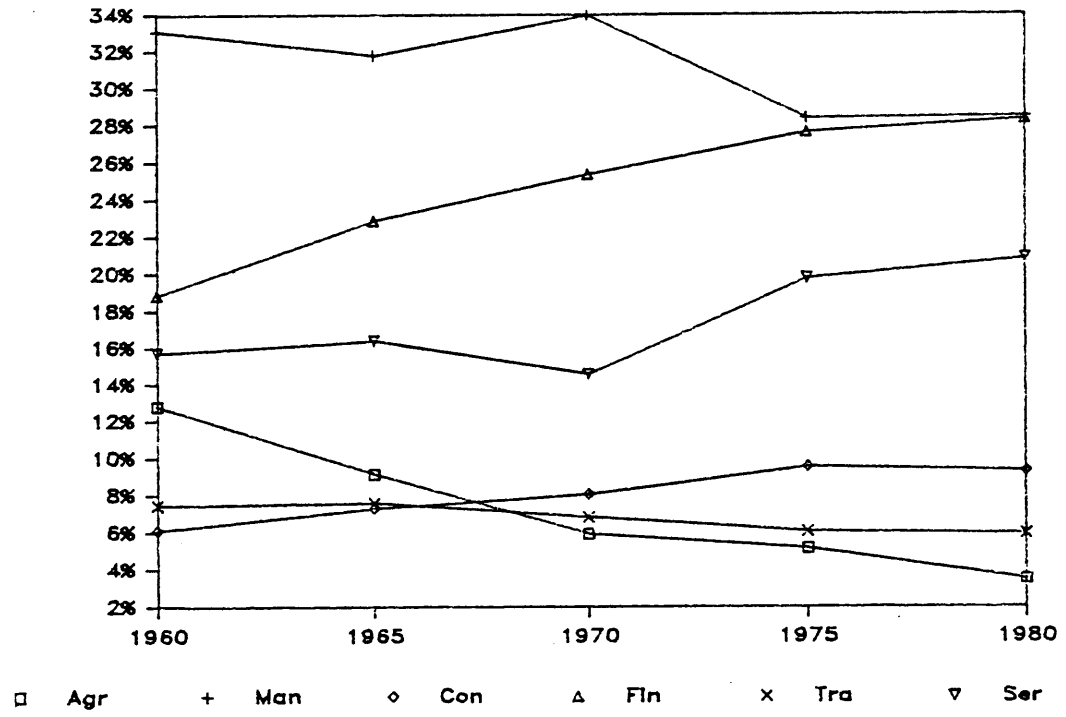


Fig. 1.7. The U.S. Sectoral Value Added to Total Value Added Ratio -- Sectoral Shares in Gross National Income

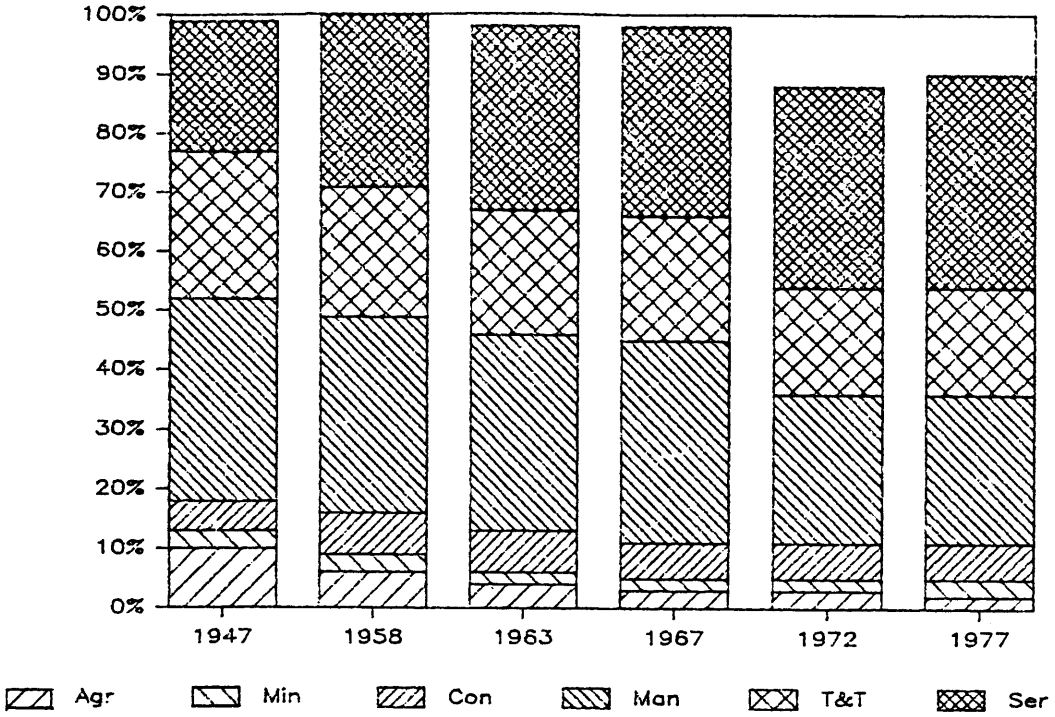


Fig. 1.8. The Japanese Sectoral Value Added to Total Value Added Ratio

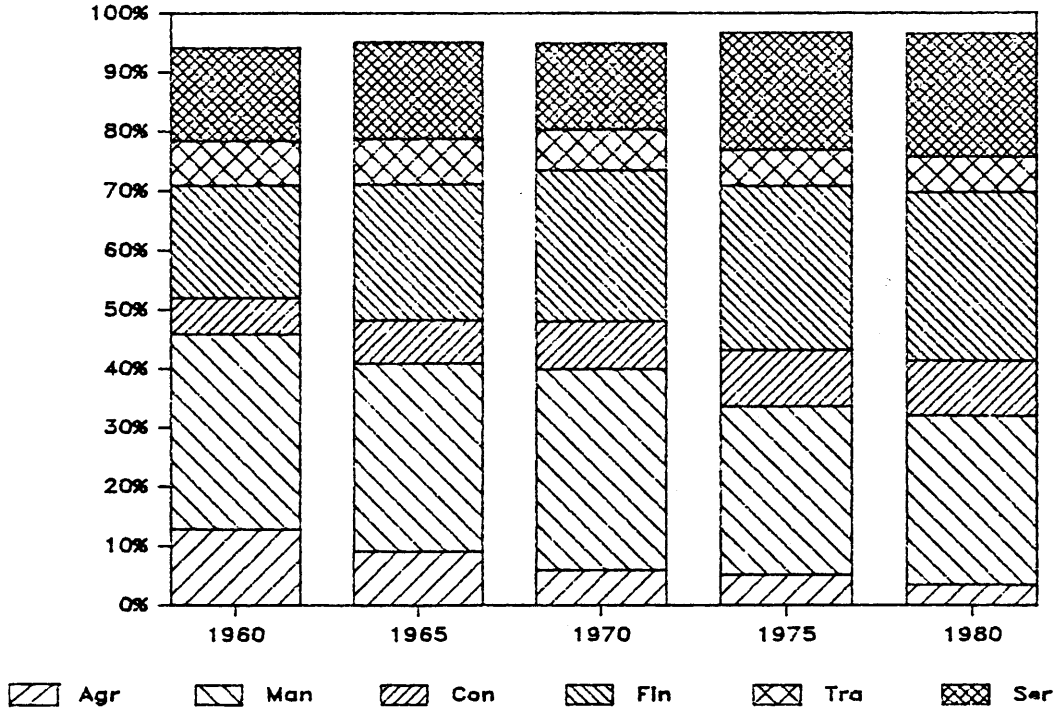


Fig. 1.9. The U.S. Sectoral Total Input to Total Input Ratio

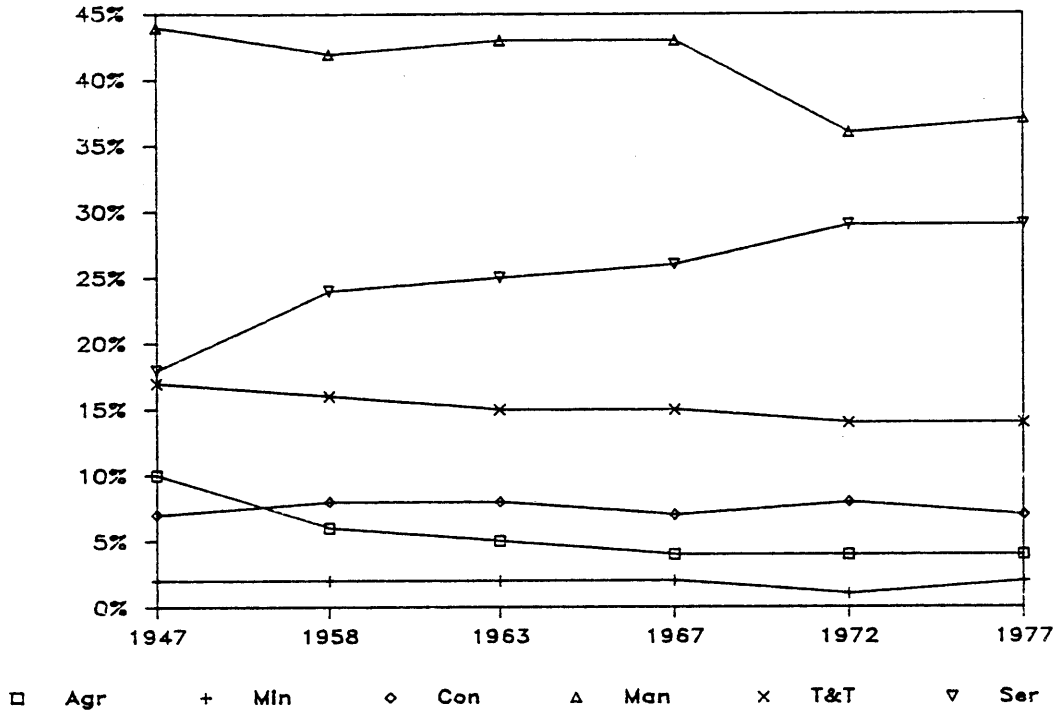


Fig. 1.10. The Japanese Sectoral Total Input to Total Input Ratio

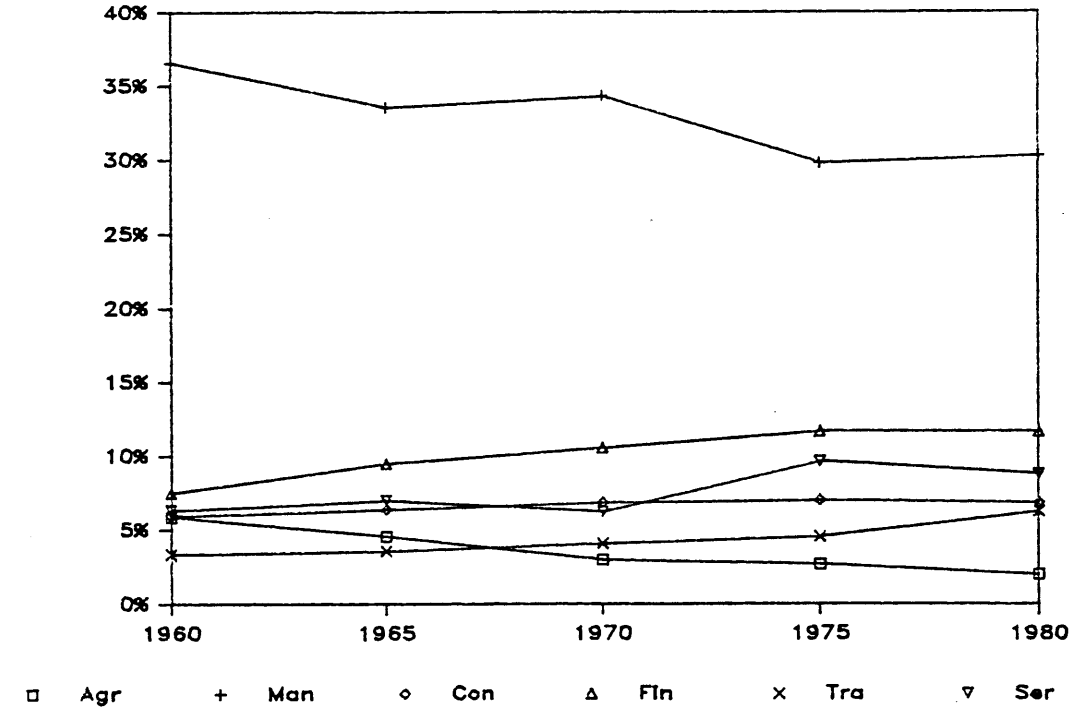


Fig. 1.11. The U.S. Sectoral Direct-Backward Linkage Indicators

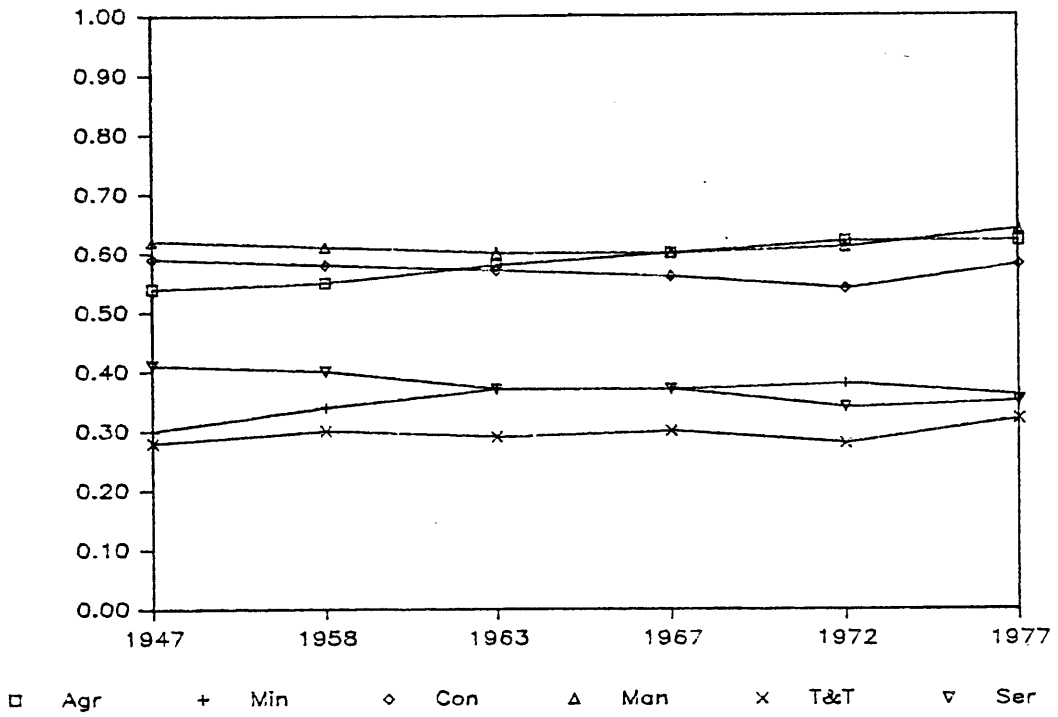


Fig. 1.12. The Japanese Sectoral Direct-Backward Linkage Indicators

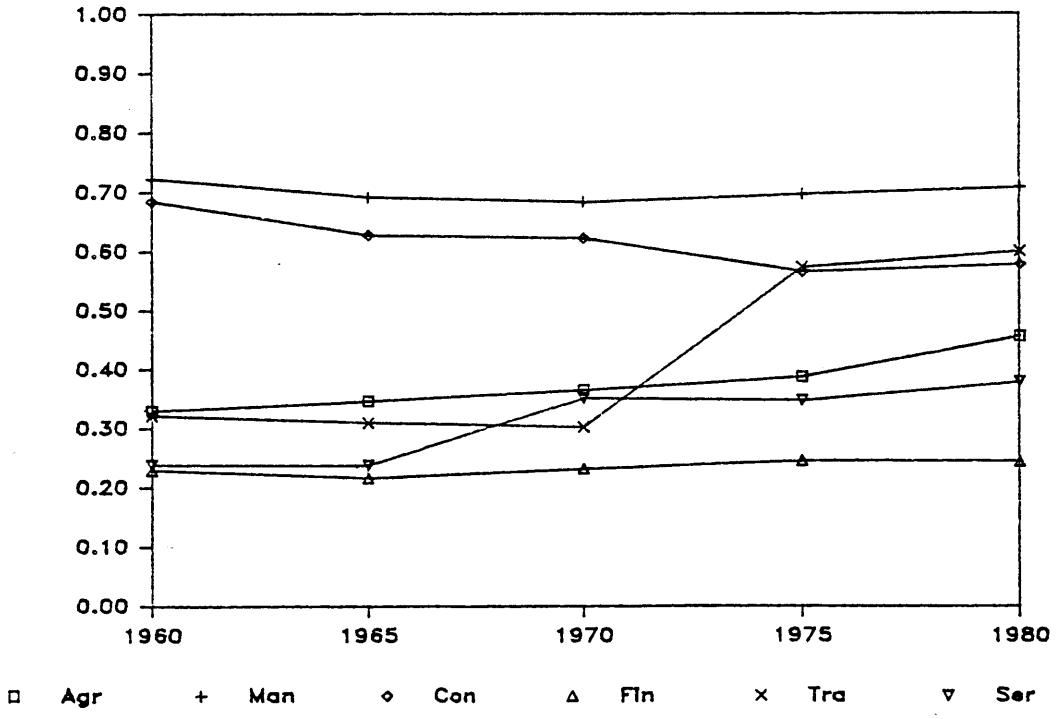


Fig. 1.13. The U.S. Sectoral Direct-Forward Linkage Indicators

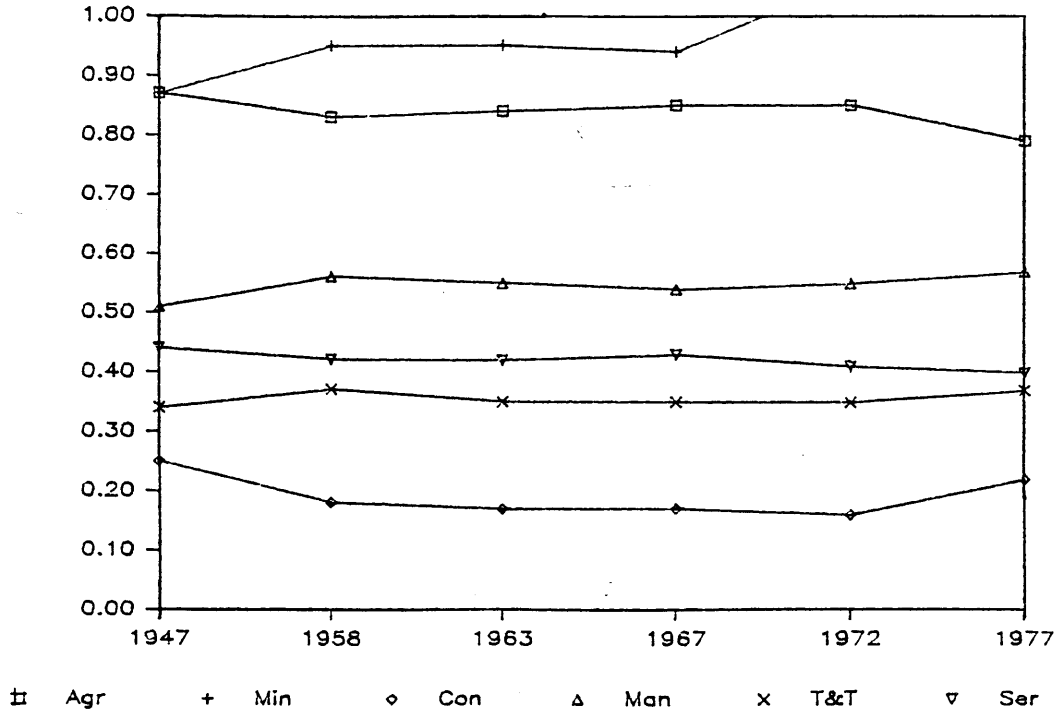


Fig. 1.14. The Japanese Sectoral Direct-Forward Linkage Indicators

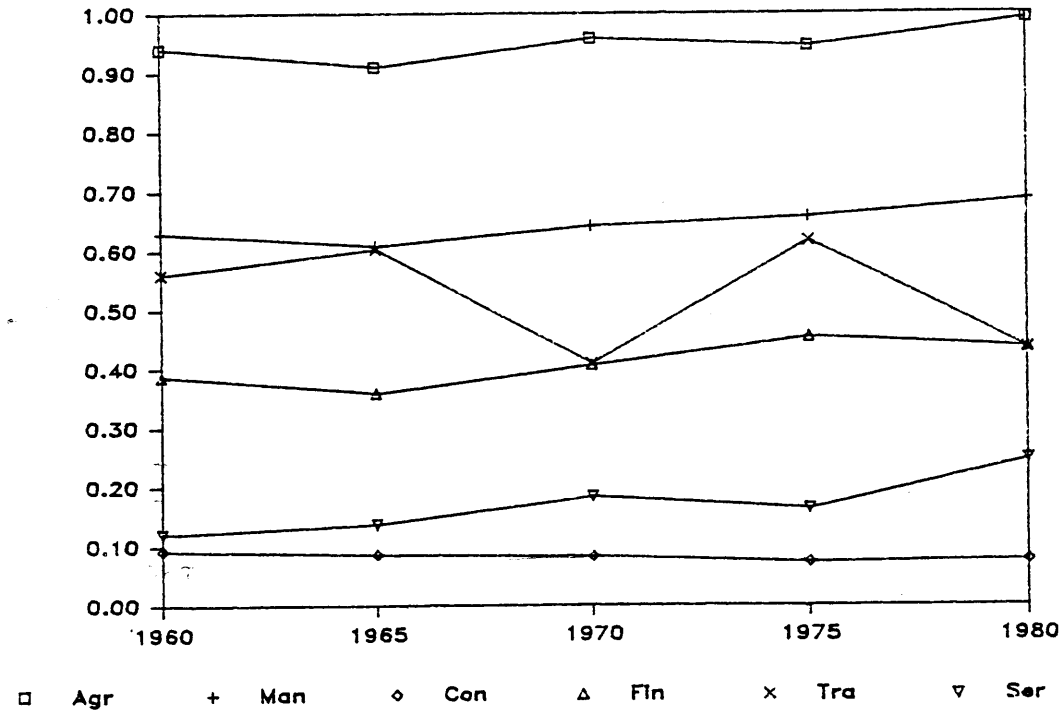


Fig. 1.15. The U.S. Sectoral Total-Backward Linkage Indicators -- Sectoral Output Multipliers

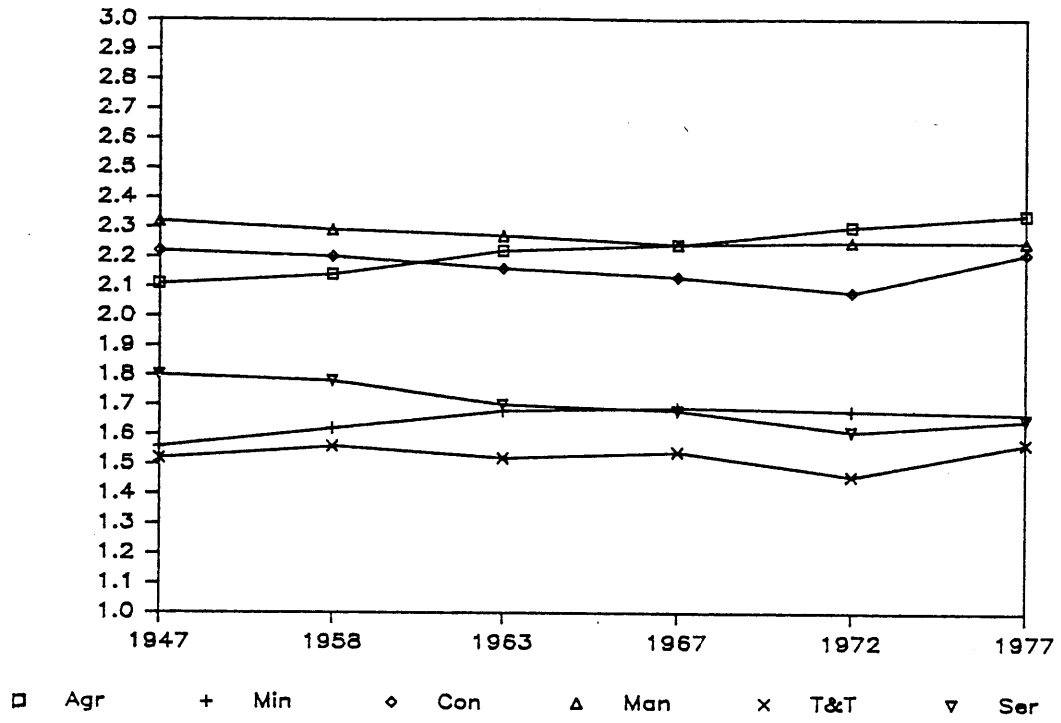


Fig. 1.16. The Japanese Sectoral Total-Backward Linkage Indicators -- Sectoral Output Multipliers

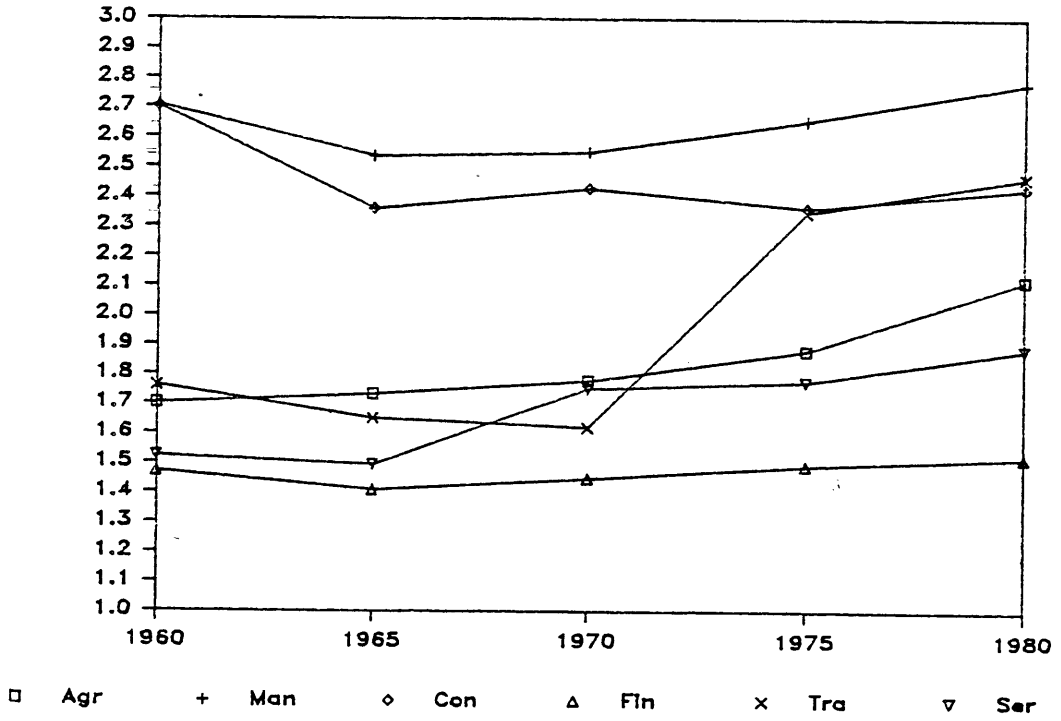


Fig. 1.17. Row Sum of the U.S. (I-A) Inverse Matrix

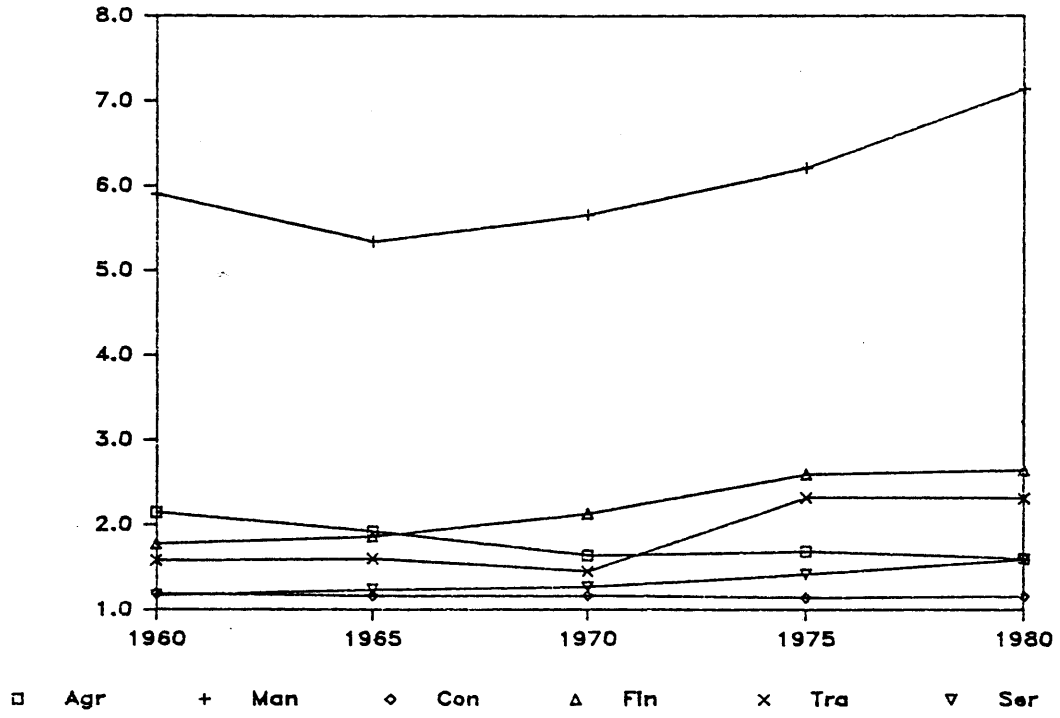


Fig. 1.18. Row Sum of the Japanese (I-A) Inverse Matrix

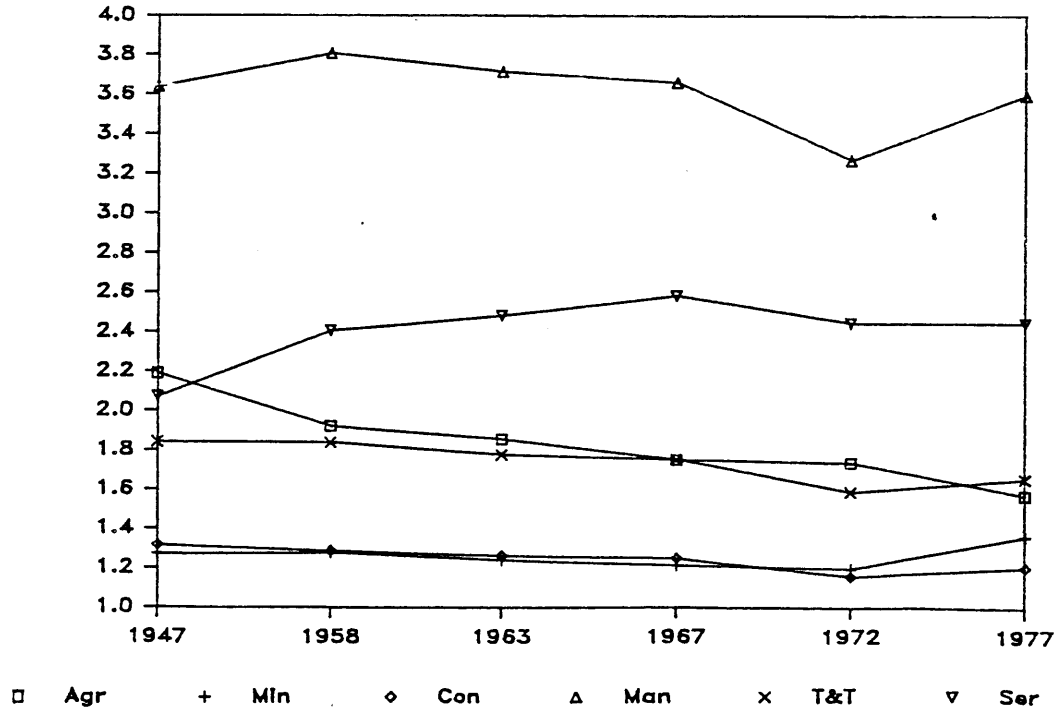


Fig. 1.19. The U.S. Sectoral Total-Forward Linkage Indicators -- Sectoral Input Multipliers

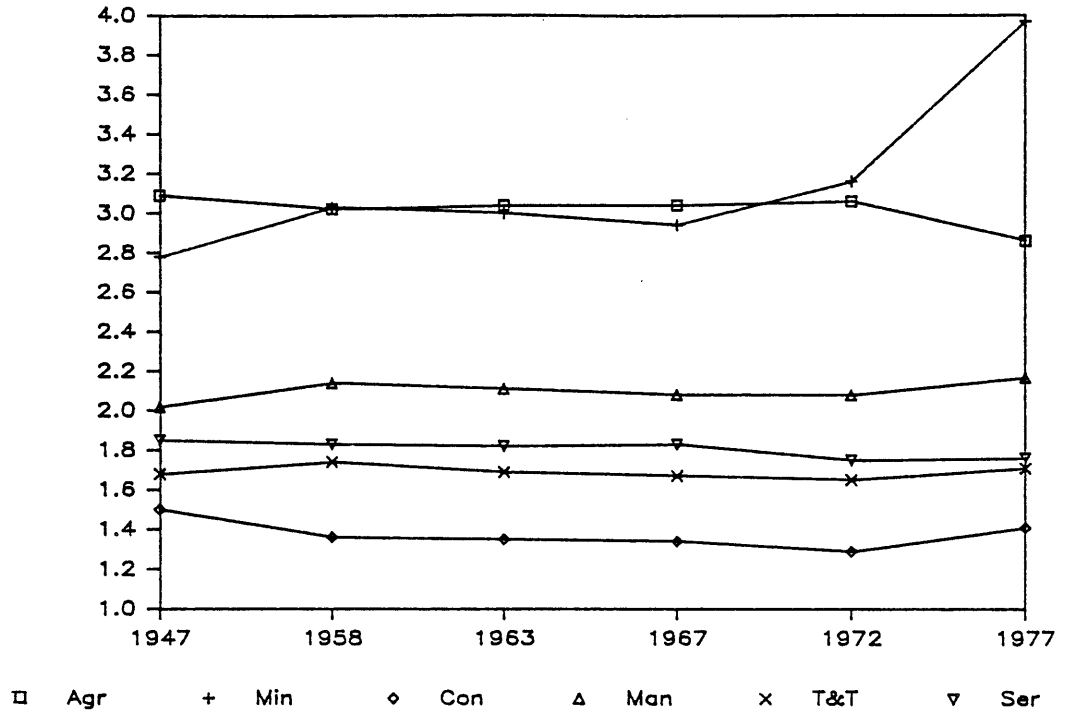


Fig. 1.20. The Japanese Sectoral Total-Forward Linkage Indicators -- Sectoral Input Multipliers

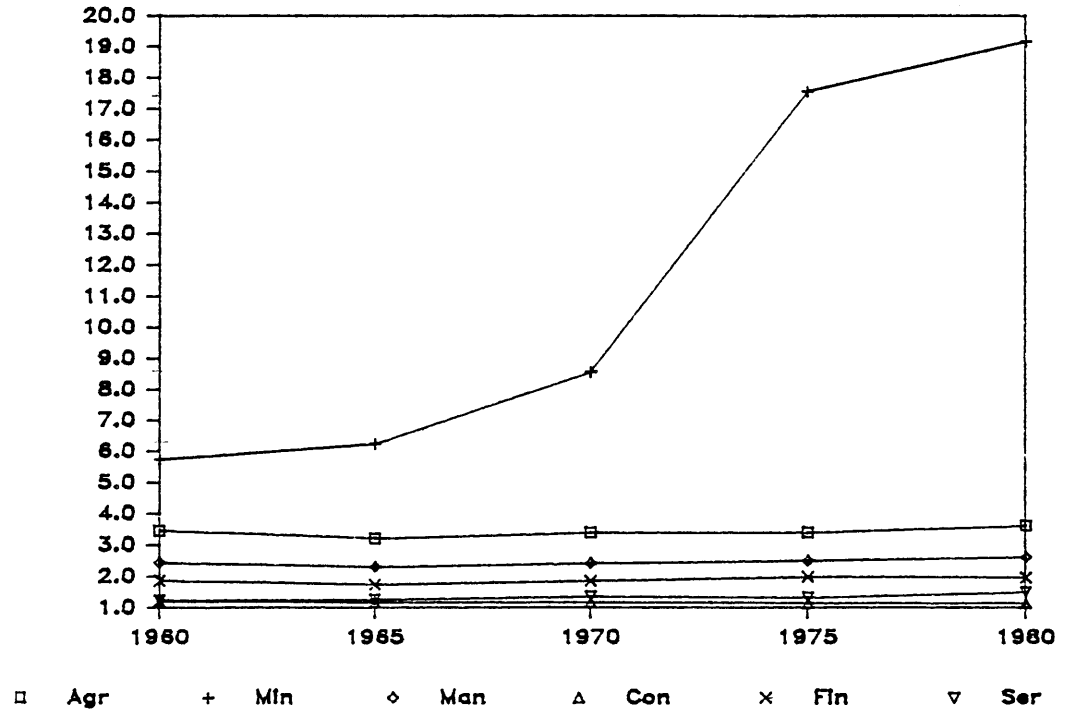


Fig. 1.21. Column Sum of the U.S. (I-B) Inverse Matrix

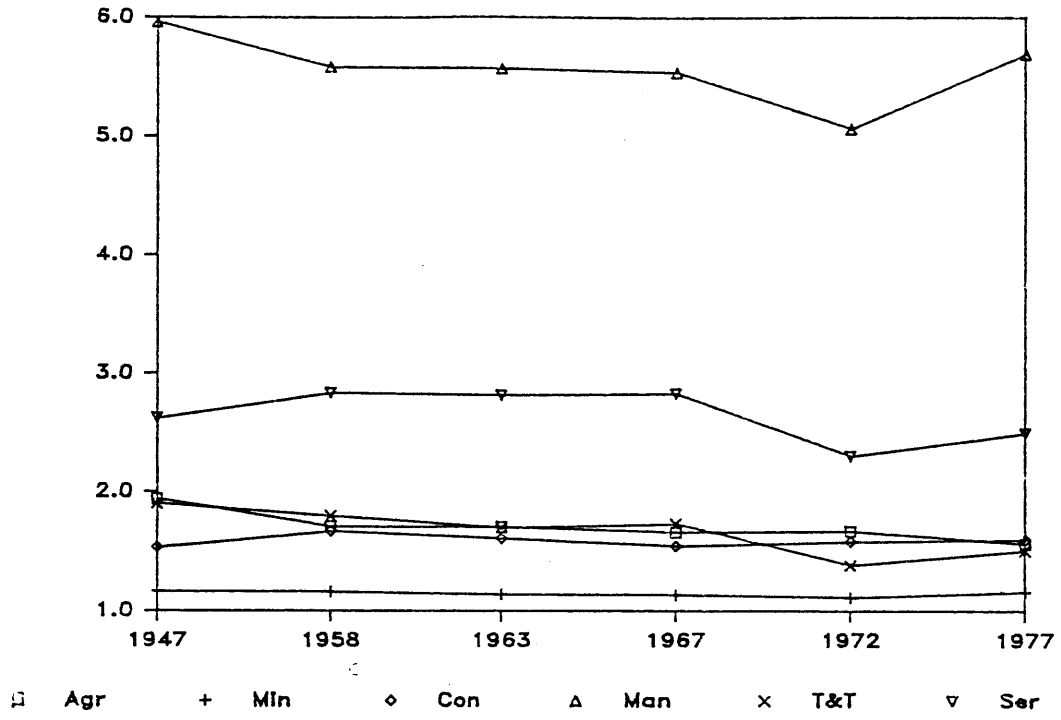


Fig. 1.22. Column Sum of the Japanese (I-B) Inverse Matrix

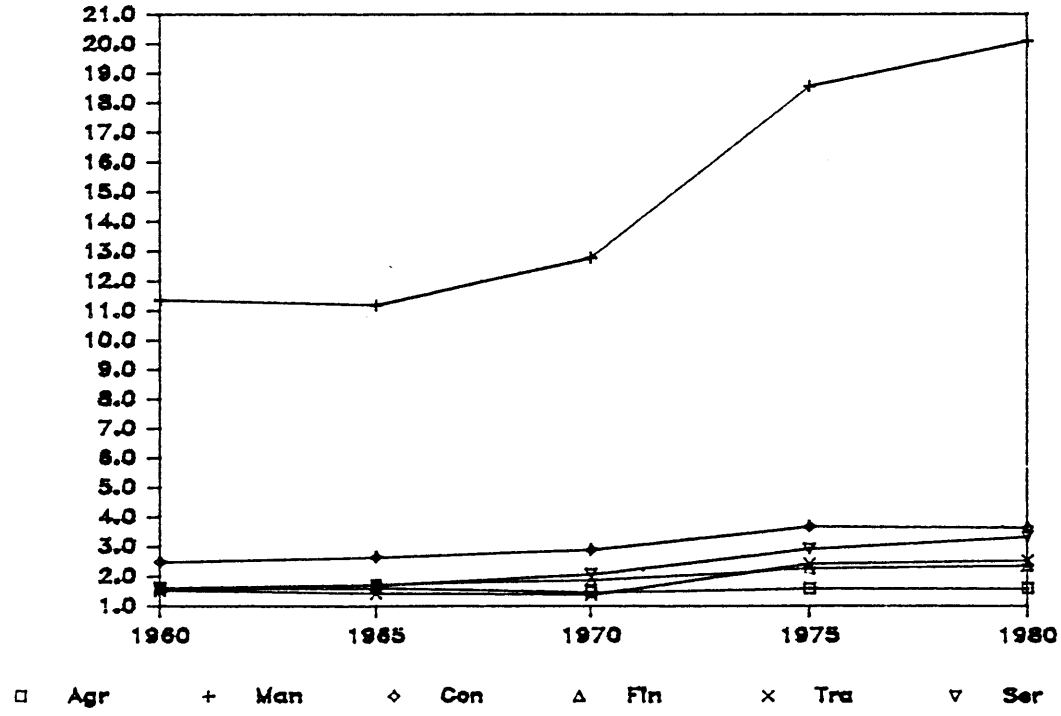


Fig. 1.23. The U.S. Construction Sector's Columns of Direct-Input Coefficients

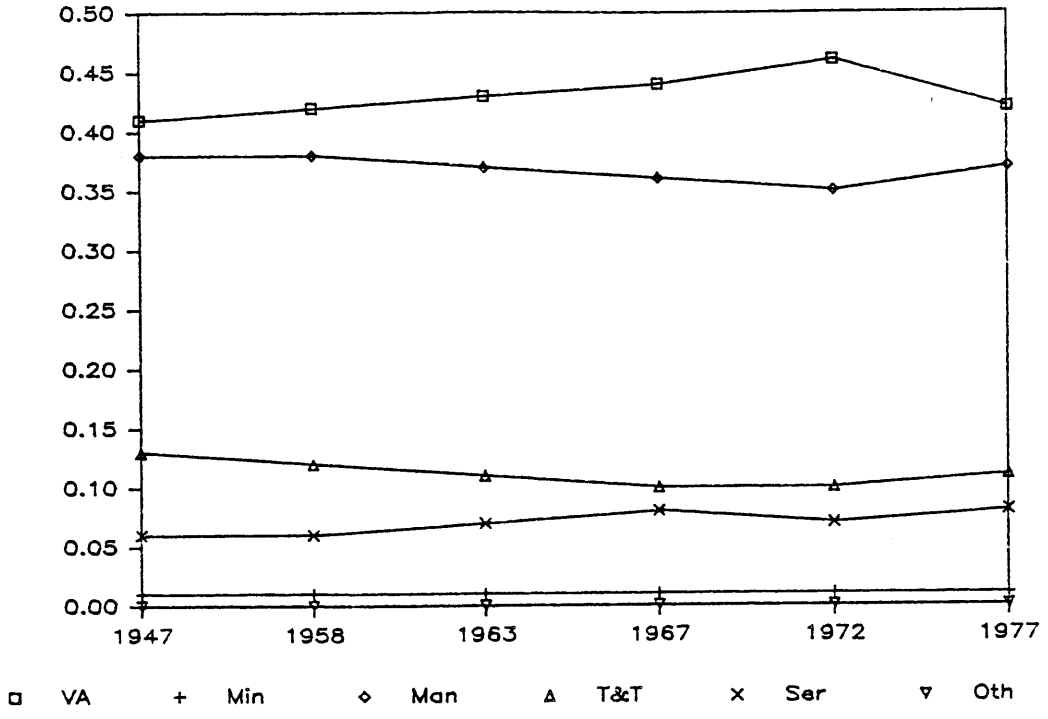


Fig. 1.24. The Japanese Construction Sector's Columns of Direct-Input Coefficients

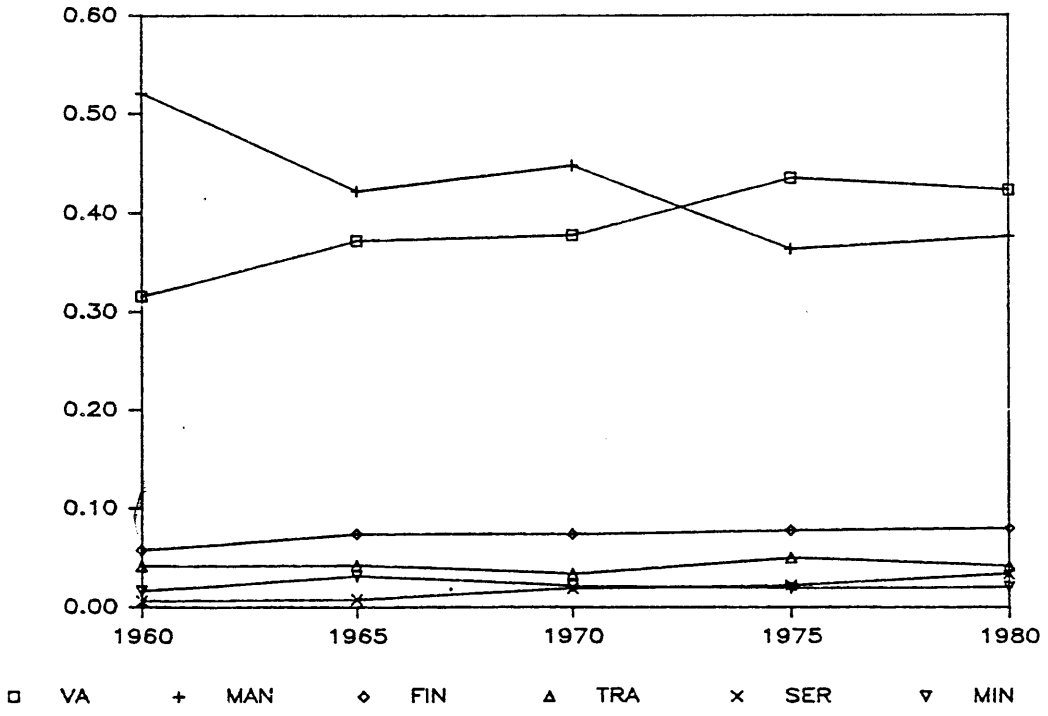


Fig. 1.25. The U.S. Construction Sector's Columns of Direct-Input Coefficients

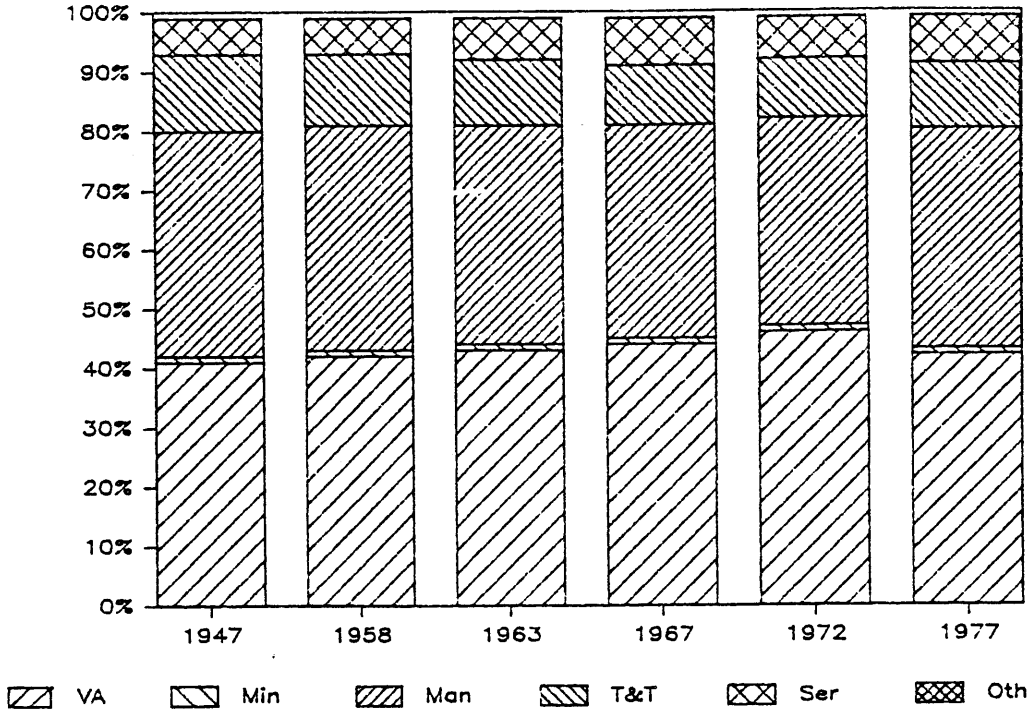


Fig. 1.26. The Japanese Construction Sector's Columns of Direct-Input Coefficients

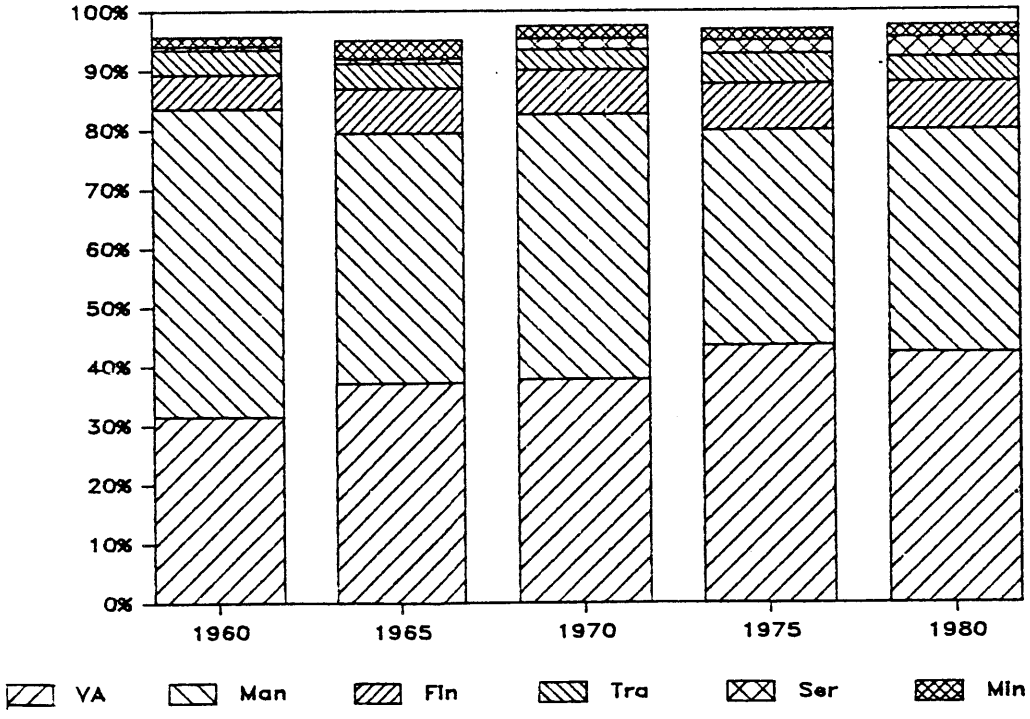


Fig. 1.27. The Ratio of the Value Added in Direct-Input Requirements

Legend:
- U.S. Construction Sector
- U.S. Manufacturing Sector
- U.S. Agriculture Sector
- Japanese Construction Sector
- Japanese Manufacturing Sector
- Japanese Agriculture Sector

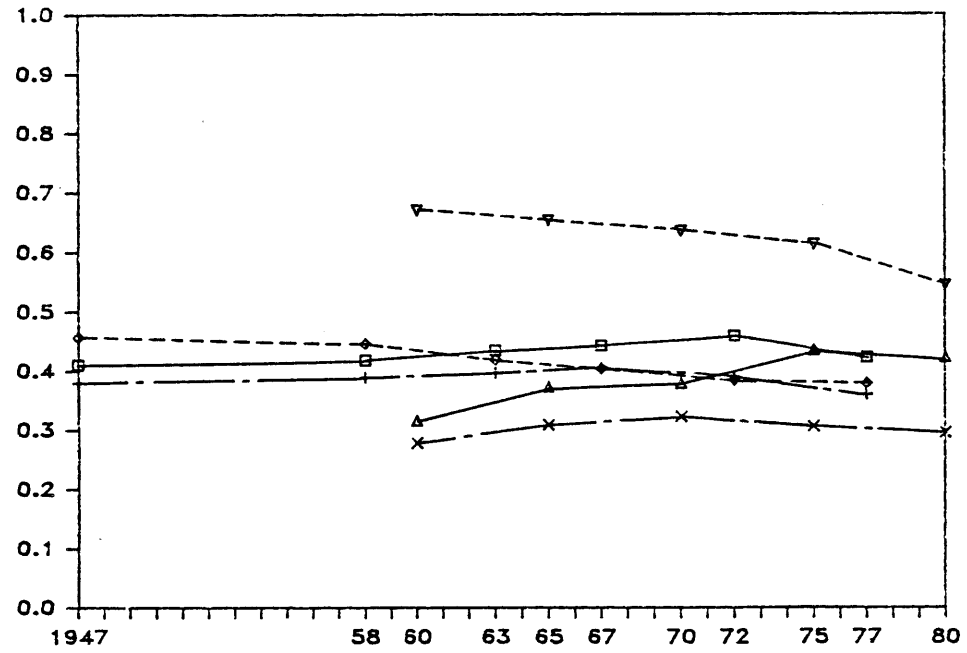


Fig. 1.28. The U.S. Construction Sector's Columns of Total-Input Coefficients

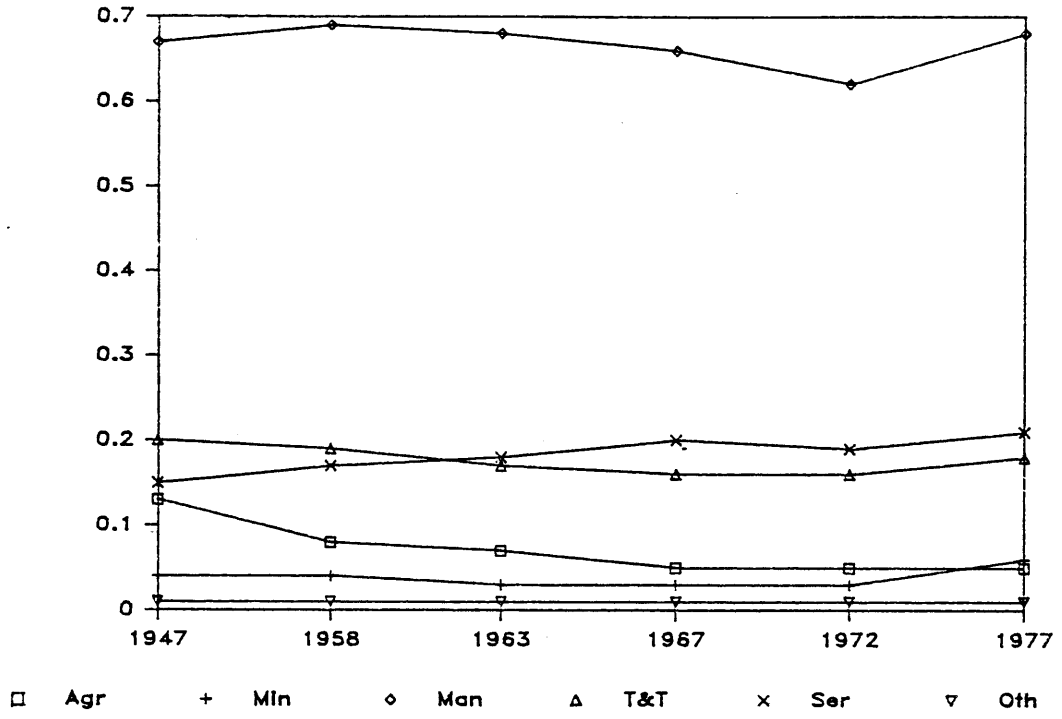


Fig. 1.29. The Japanese Construction Sector's Columns of Total-Input Coefficients

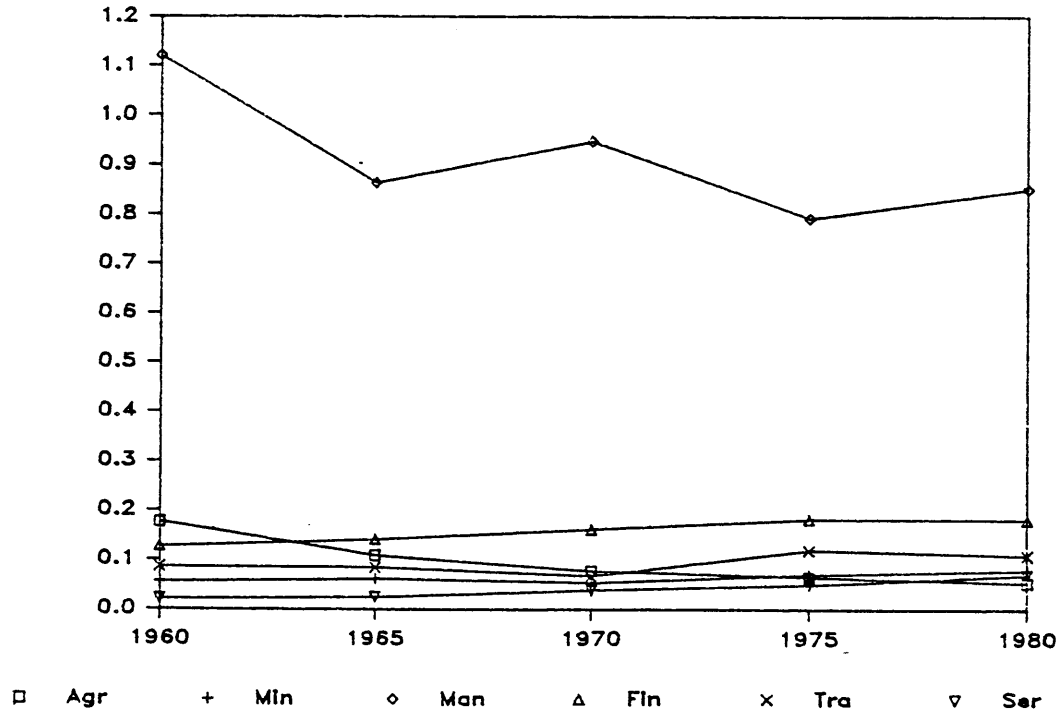


Fig. 1.30. The U.S. Construction Sector's Rows of Direct-Output Coefficients

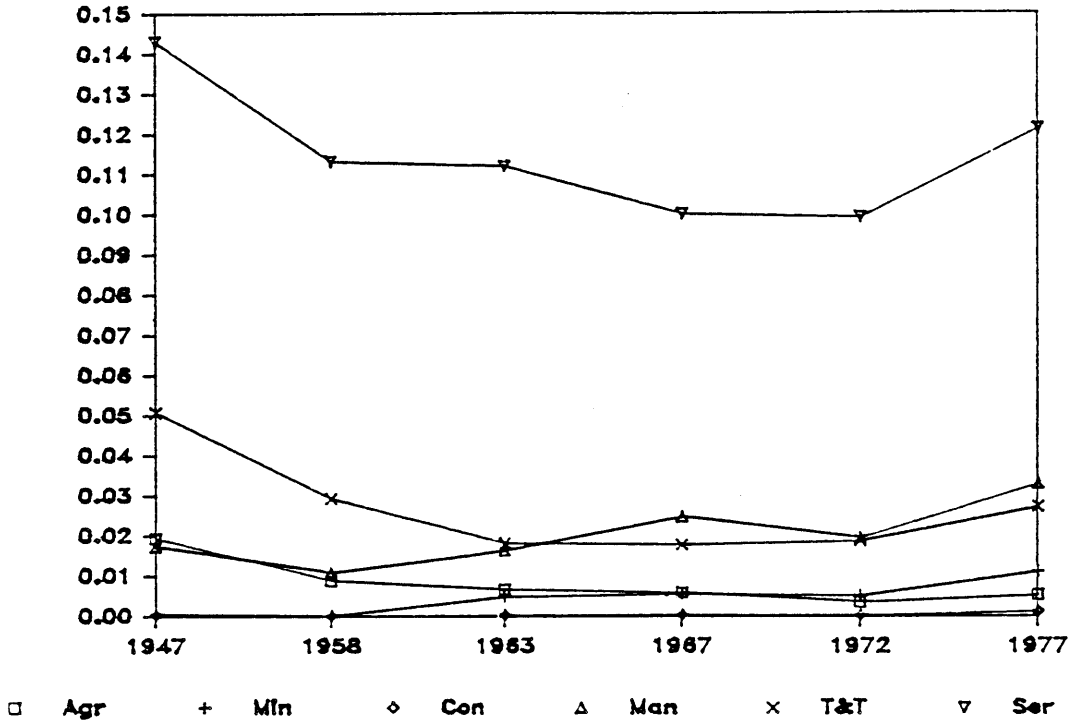


Fig. 1.31. The Japanese Construction Sector's Rows of Direct-Output Coefficients

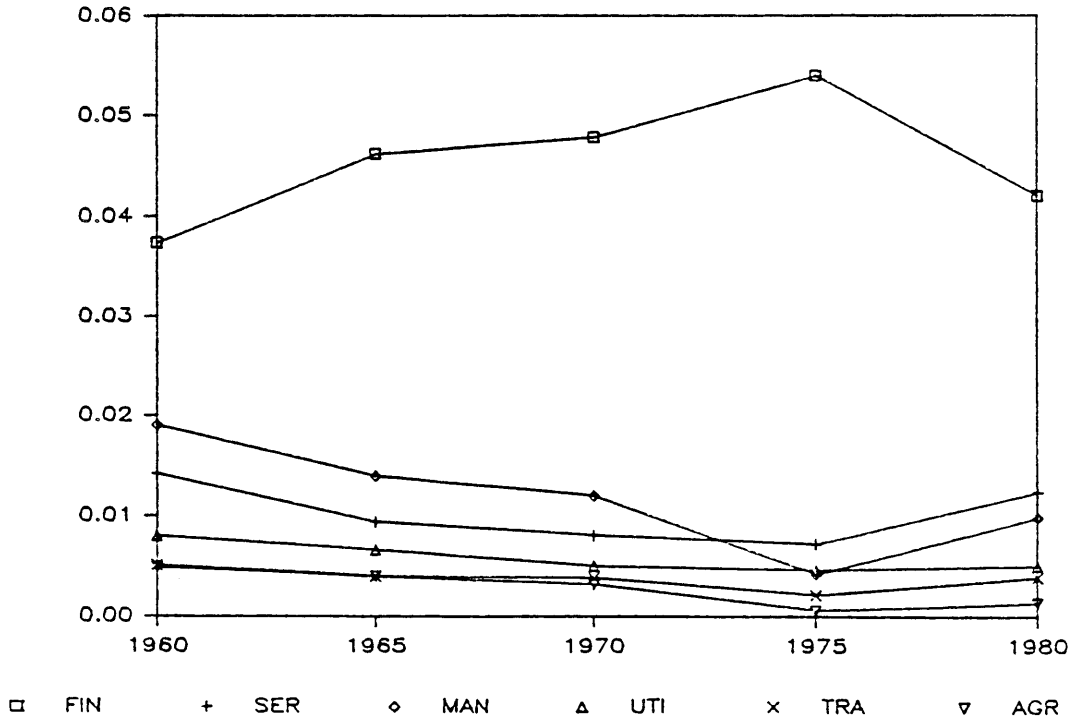


Fig. 1.32. The U.S. Construction Sector's Rows of Direct-Output Coefficients

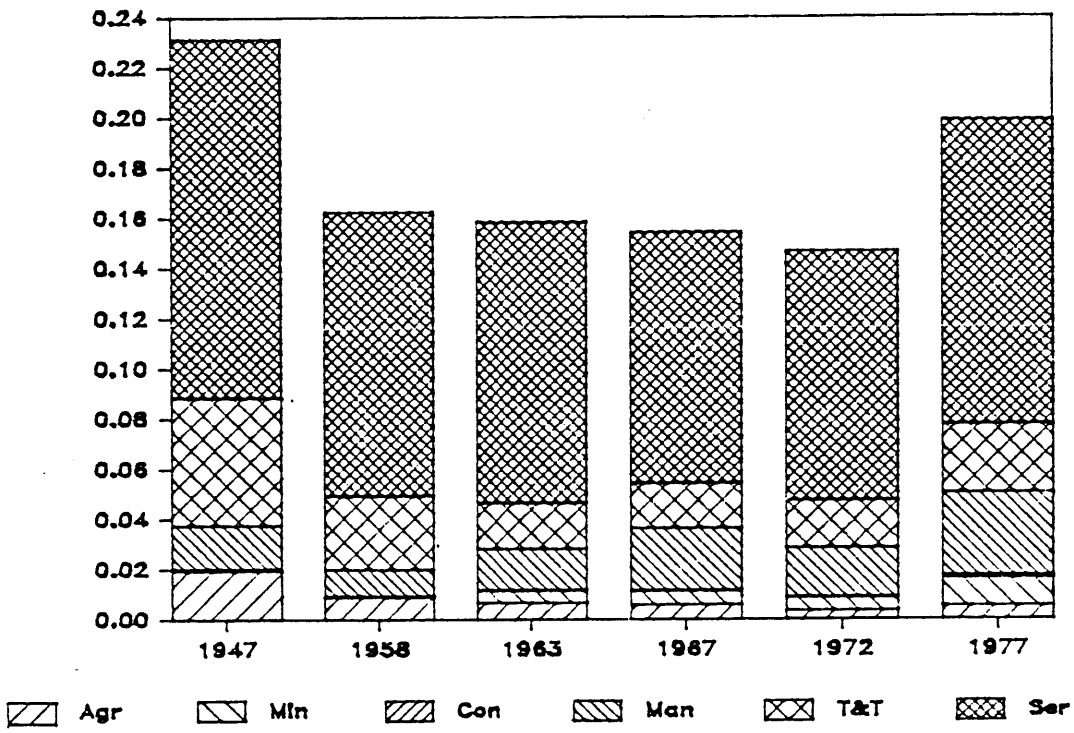


Fig. 1.33. The Japanese Construction Sector's Rows of Direct-Output Coefficients

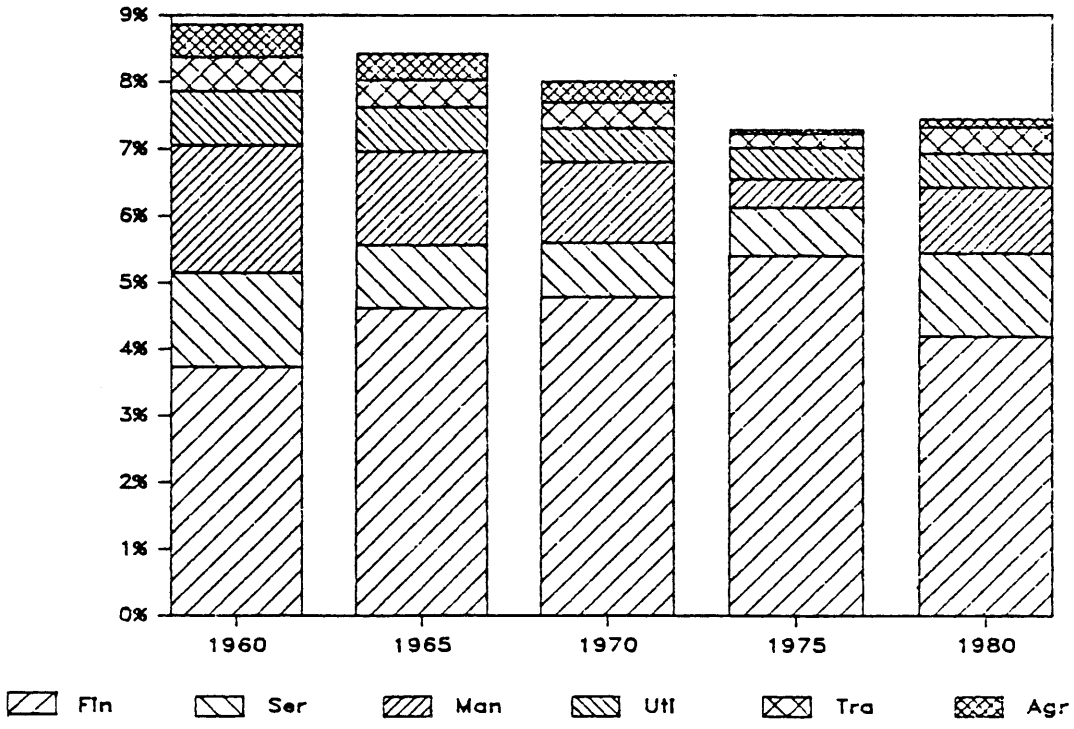


Fig. 1.34. The U.S. Construction Sector's Rows of Total-Output Coefficients

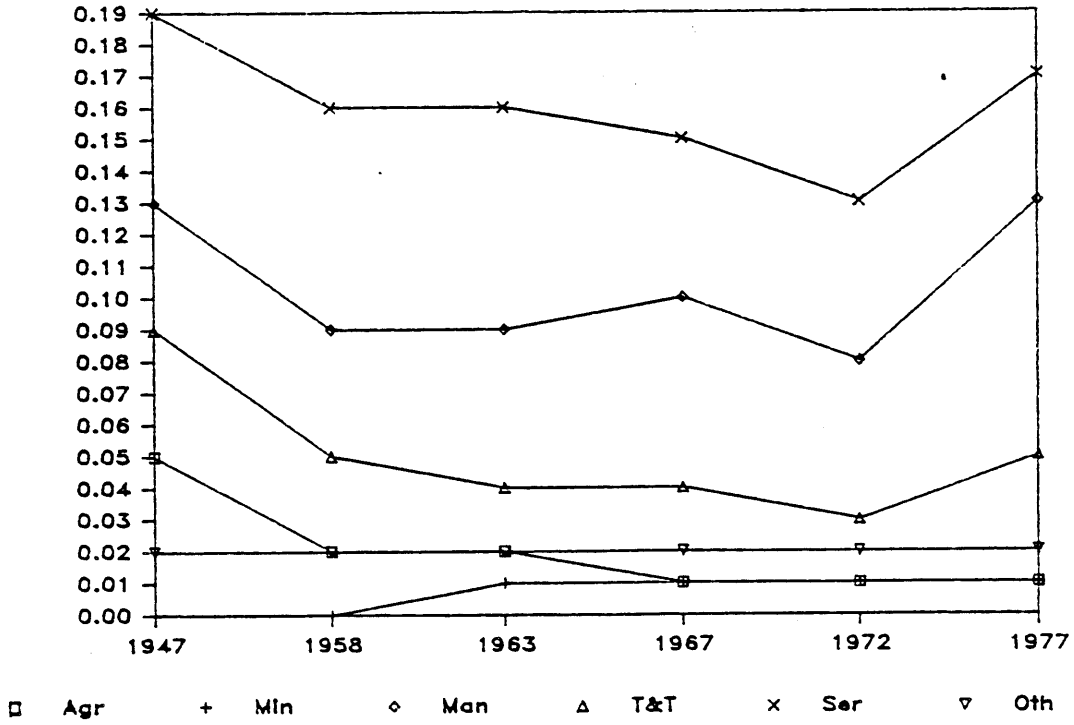
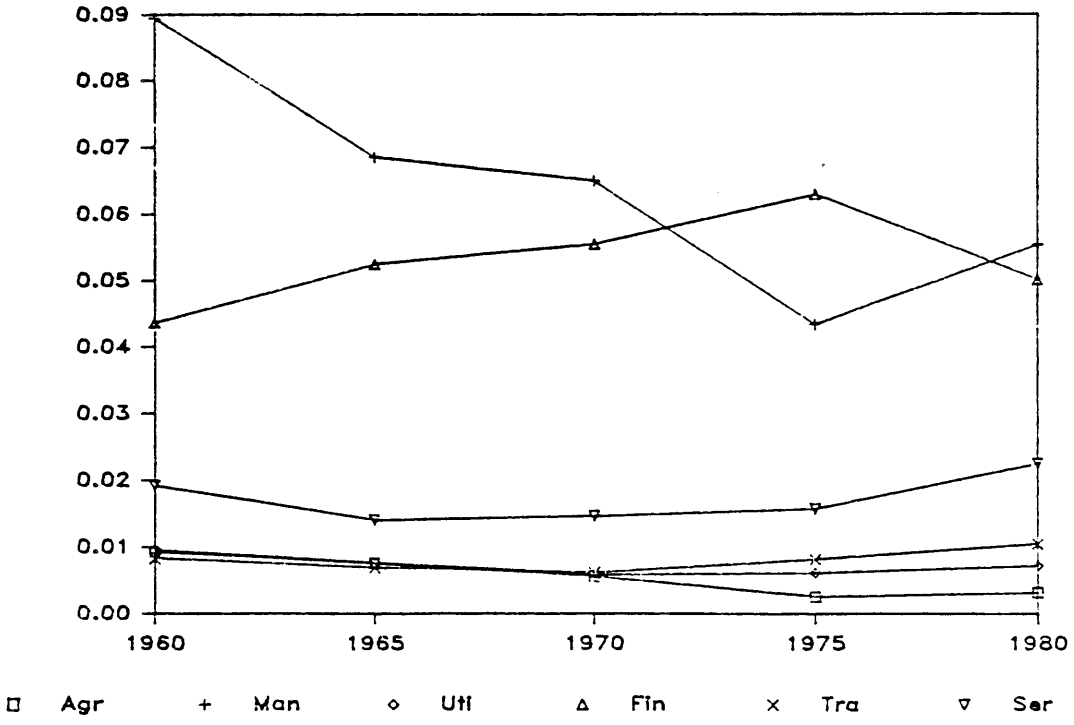


Fig. 1.35. The Japanese Construction Sector's Rows of Total-Output Coefficients



CHAPTER 2

JAPANESE HOUSEBUILDING POLICY AND R & D

1. INTRODUCTION

This chapter presents in three parts housing policy in Japan, based on government documents and available statistical data. The first part is a chronological analysis of post-war Japanese housing policy. A grasp of government policy is important to understand the development of industry, since the Japanese government usually takes the role of organizer in the collaboration of academia and industry. This section begins with an account of the establishment of public institutions related to the housebuilding industry. Next, government reports concerning the modernization of the housebuilding industry, and the relevant economic situation are analyzed. Finally, some important Research & Development projects organized by the government, are introduced.

The second part is a summary of the development of the manufactured housebuilding industry. Its increasing importance in the housing supply is mentioned, and the technical and organizational development of major manufactured house producers is analyzed.

In the third part of this chapter present housing policy provides a basis for understanding the present and future problems of the housebuilding industry. First, the shift in housing policy from an effort to increase the housing stock to an attempt to encourage the use of existing housing stock is studied. Second, the Century Housing

System, which is the current R & D project investigating the durable and adaptable housing, is introduced.

One of the aims of this chapter is to investigate the transition of the Japanese housing policy within the past ten years from the development of the manufactured housing to the promotion of conventional wood housing. Based on these analyses, the author suggests a suitable structure for the Japanese housebuilding industry, in the future.

In order to understand the Japanese housing problem properly, one must comparare the basic housing and demographic condition of the U.S. and Japan.

	Japan	United States
--Population	118.6m (1982)	226.5m (1980)
--Rate of Natural Population Increase	6.9% (1981)	7.2% (1981)
--Housing Stock	38653k (1983)	88207k (1980)
--Housing Starts	1135k (1983)	1670k (1980)
--Dwelling Investment as % of GDP	5.5% (1983)	3.9% (1983)
--Dwelling Investment as % of Gross Fixed Capital Formation	19.2% (1983)	23.4% (1983)
--Per Capita Income ($ = 220.54 Yen)	$8,379 (1981)	$11,347 (1981)

N.B.: m = million, k = thousand units

Fig. 2.1 shows the share of the housing investment in the Gross National Product in the U.S. and Japan. The share of the Japanese housing investment in Gross National Product is almost twice as large as that of the U.S.. It is notable that this share fluctuates more in the U.S. than in Japan. The decreasing importance of the Japanese housing investment since 1974 is associated with the sharp decrease of the Japanese housing construction after the first energy crisis.

Fig. 2.2 shows the share of the housing investment in the Gross Fixed Capital Formation in the U.S. and Japan. This figure shows that the Japanese housing investment has been reduced in importance to the Gross Fixed Capital Formation since 1976. According to Miura [1977], the Domestic Fixed Capital Formation of Japan has been almost 90 percent of the Capital Formation. Most of the investment in Japan has been used for construction and one-third of the construction has been housing. The Japanese construction investment stock as a proportion of Gross Capital Stock decreased from 66.8 percent in 1953 to 47.7 percent in 1964. [Miura, ibid.] Conversely, the investment in machinery, ships and vehicles has been increasing.

Fig. 2.1. Housing Investment in the U.S. and Japan
(in percent of gross national product)
Legend: 1 = U.S., 2 = Japan

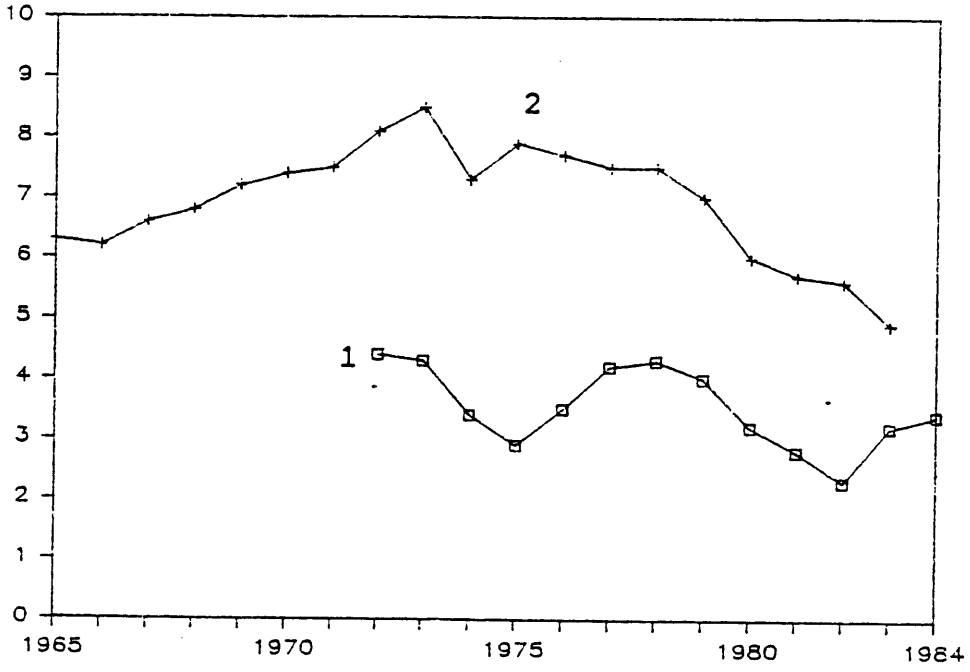


Fig. 2.2. Housing Investment in the U.S. and Japan
(in percent of gross fixed capital formation)
Legend: 1 = U.S., 2 = Japan

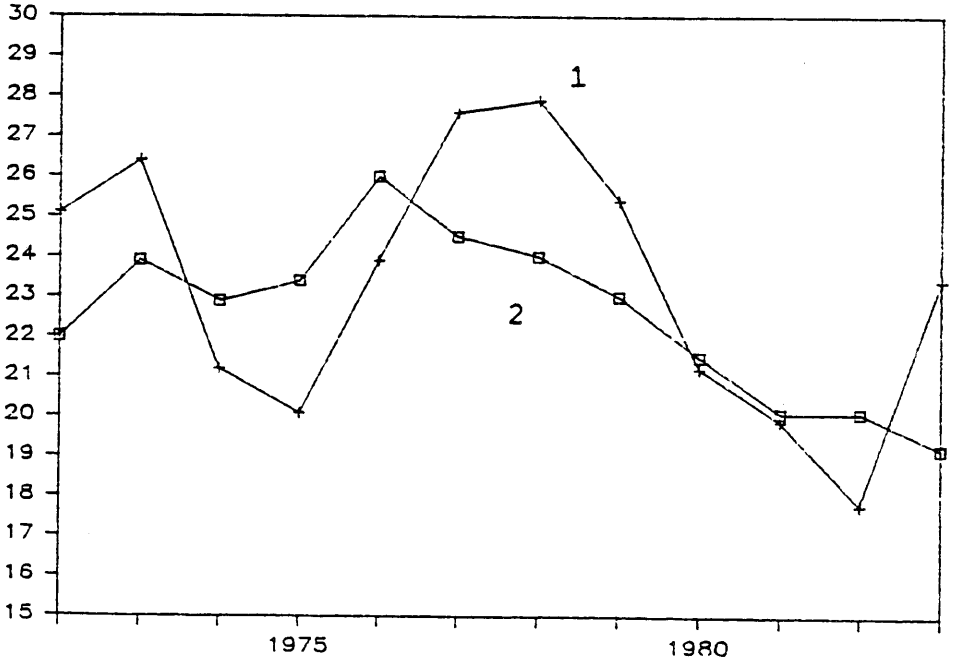


Table 2.1. Breakdown of the U.S. and Japanese Construction

(in percent)	U.S. 1977 Public	Private	Total	JAPAN 1973 Public	Private	Total
Residential	0.5	47.5	48.0	8.1	29.9	38.0
Nonresidential building	6.8	18.2	25.0	5.5	26.1	31.6
Public works, & utilities	14.6	12.1	26.7	15.4	15.0	30.4
Other	-	0.7	0.7	-	-	-
Total	21.9	78.1	100.0	29.0	71.0	100.0

(Source; U.S.,Department of Commerce, Bureau of Census, 1978 [Lange,J.E., 1979, p.3], Miura [1977, p.84])

Table 2.1 shows the structure of the annual construction investment in the U.S. and Japan. Residential construction is almost half of the total construction investment in the U.S. Public housing investment is substantially larger in Japan. Private nonresidential construction investment in Japan is larger than it is in the U.S..

2. HISTORY OF JAPANESE HOUSING POLICY

In 1945, the Reconstruction Agency was established and the government declared a five-year plan of housing production to build three million houses. This figure included a backlog of housing construction and the replacement of houses lost during World War II and the demand for houses by the people returing from abroad after the war. In 1948, the Reconstruction Agency and the Land Agency were combined into the Ministry of Construction (MOC). In 1949, MOC opened its Housing Bureau. In 1955, the Public Housing Agency was established. This agency came to have the central role of building public housing.

In order to produce a large number of housing units in a short time, the Public Housing Agency adopted a pre-cast concrete panel construction method. Government stimulated the development of pre-cast concrete panel construction by guaranteeing its demand from public housing projects. To this end, MOC also established a system for qualifying pre-cast concrete panel producers and contractors. A typical design for those public housing projects was a walk-up apartment; each unit had two bedrooms and approximately 500 square feet. At that time, architects like Kunio Maekawa were also developing single-unit low cost houses. These designs, influenced by the ideas of Walter Gropius became the origins of the Japanese manufactured house. The post-war need to build a large number of houses in a short time with

a limited budget was the strongest incentive to rationalize the housing construction technology in Japan.

The typical Japanese life style changed greatly following World War II. The post-war economic recovery and the development of industries created a large demand for housing in metropolitan areas. People working in the cities and living in public housing tended to form nuclear family groups instead of traditional extended families. The Public Housing Agency and professionals, such as professor Sigefumi Suzuki of the University of Tokyo, made efforts to coordinate the new Japanese life style with appropriate configurations of living space. Two major results of their efforts were the creation of the eat-in kitchen and the clear separation of private space from family common space. In contrast to traditional wooden Japanese housing, post-war housing units were divided into separate, individual rooms. The change of Japanese life-style and the improvement of housing design influenced the development of housing construction technology.

In 1950, the Housing Financing Agency was established to provide low cost mortgages. This was another way to stimulate new housing construction, utilizing private resources. The policy of encouraging the construction of owner-occupied houses reflects traditional Japanese preference to own one's house instead of renting it. The

upsurge of housing construction in the late 1950's accelerated the need to modernize housing construction. The scarcity of natural resources, like lumber, and the shortage of skilled labor (Table 2.2) made it difficult to meet the growing demand for new housing construction. In fact, the import of foreign lumber and wood products began to grow in the mid 1960's and provided more than half of wood consumption after 1969. (Fig. 2.3) Relatively inexpensive plywood from Korea and structural lumber from North America and U.S.S.R. bacame increasingly important in the Japanese market. The construction industry was less attractive to young labor than were the manufacturing industries. These factors were pivotal to the upsurge in the production of detached manufactured house in late 1950's.

Fig. 2.3. Increase in the Import of Foreign Lumber
(In thousand cubic meters)
Black: Foreign Lumber, White: Domestic Lumber
Source: Kentiku Bunka, December 1985

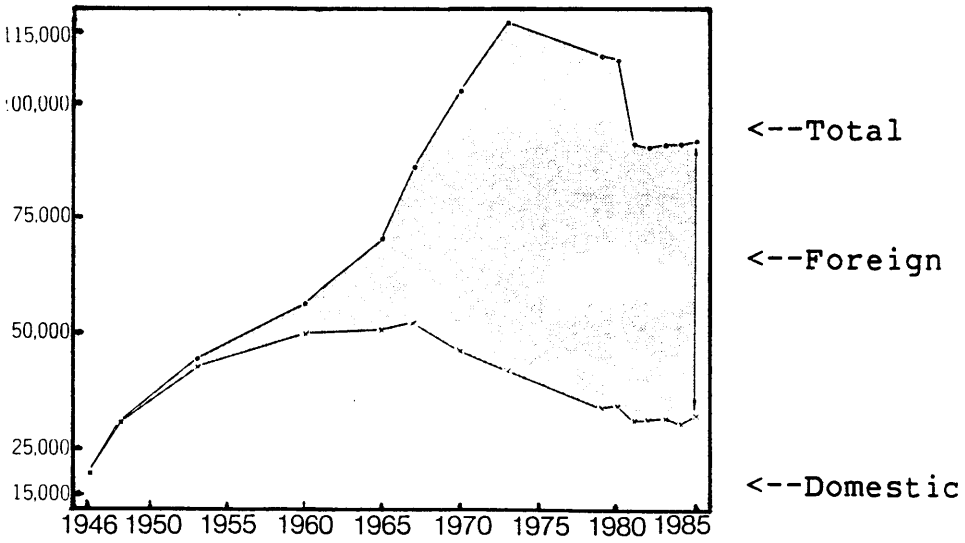


Table 2.2. Shortage of Construction Workers

	1955	1960	1960/1955[%]
Number of Carpenters	523,967	542,600	104
Plasterers	118,783	155,200	131
Plumbers	52,782	75,900	141
Construction Starts [in thousand square meter]	33,920	61,461	181

Source: AIJ, 1983 "Prefabricated House in Japan"

In 1968, a professional advisory committee presented the first report concerning the modernization of building construction to the Minister of Construction. [MOC, 1977]. This report recognized the increasing price of building materials and the labor shortage caused by the sharp increase in construction demand. The committee pointed out the necessity of a long-term analysis of construction demand. The report suggested nine ways to promote the modernization of the construction industry. The government was advised to:

(1) promote the industrialization of building production,

(2) promote R & D in building production,

(3) establish an evaluation system for building performance,

(4) standardize building materials and components, construction techniques and construction machinery and use industrialized [open] building components in public building for their promotion,

(5) promote job coordination and re-education of construction trades,

(6) improve the labor conditions of construction workers,

(7) modernize the management of construction firm and the organization of the construction industry,

(8) improve the distribution system of construction materials, especially that of industrialized building components, and

(9) improve procurement procedures, especially those for public construction.

In 1969, the Housing Bureau of MOC published a long-term policy for the industrialization of housing construction based on this report. [MOC, 1977] The 1960 input-output table indicated that each $ 100 housing investment induced $ 278 repercussive output of other industries and that this effect increased as more conventional wooden housing was replaced by manufactured housing. (For example, the material cost of public housing shares 60 percent of total cost.)

However, MOC had already begun to change its emphasis from the quantitative problem of housing to the issue of quality one when this policy was published. In fact, in 1974, the number of housing units exceeded the number of

households. Experts predicted that since people would have more freedom to chose their own houses in the future, diversity in housing supply was essential. Furthermore, they observed that each house should be designed to adapt to the changing demands of growing families. This policy was based on the expectation of a decline of new housing construction and a shift to the rebuilding of the housing stock. The premises of industrialization of housing production were examined under the following considerations.

(a) Production systems should be able to respond to diversified individual housing demand. Aesthetic value ought to be pursued. The regional characteristics of housing design should be respected.

(b) An industrialized production system for housing should be understood as a subsystem of the urban development system. It should be able to remodel and rebuild existing urban housing.

(c) The total process of construction, especially transportation and erection systems for bulky construction elements, should be improved.

(d) A proper land policy should control increases in land cost. The land cost was almost 50 percent of the total housing development cost in metropolitan areas. The total cost of purchasing a house in large cities, which includes the land cost, was five times the average annual income of Japanese. This proportion is twice that in the U.S. [Fig. 2.4 and Fig. 2.5]

(e) The distribution system for housing should be improved. Sufficient information about available real estate should be provided to turn over the existing stock effectively. Also an evaluation system for housing market price should be established.

Fig. 2.4. The Proportion of Unit Housing Price to the Average (Working) Japanese Household Annual Income. Source: Kentiku Bunka, Dec. 1985

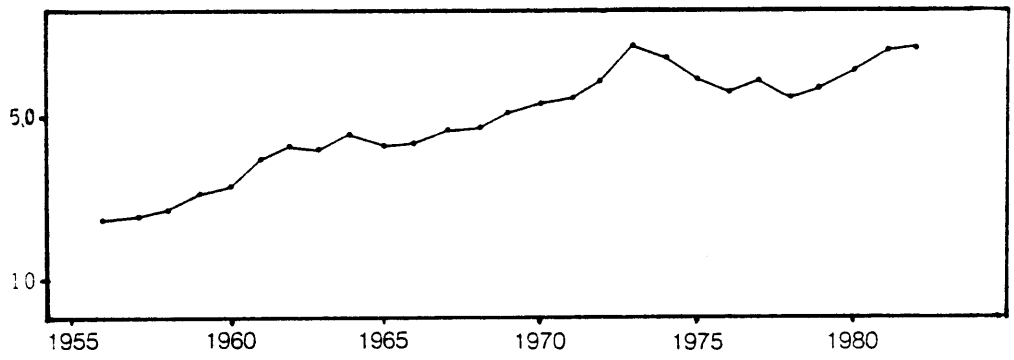
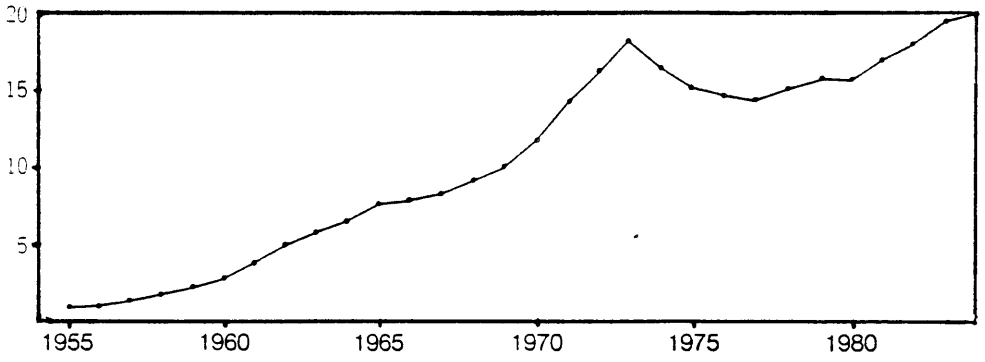


Fig. 2.5. The Proportion of The Increasing Rate of Land Price to That of Wholesale Price since 1955.
Y Axis is Land Price Index (1955=100) divided by Wholesale Price Index (1955=100).
Source: Kentiku Bunka, Dec. 1985



This long-term policy described the need to promote the open system of building components, which would help the development of both large-scale public housing in the suburbs and small-scale scattered housing units in the cities. Private developers were expected to play an important role in the incremental remodeling and rebuilding of existing urban housing for diverse user requirements. Manufactured house producers were supposed to develop mass production systems of diversified components and were required to have marketing techniques to aggregate scattered demand. Private financing organizations were expected to provide more mortgage money with fewer qualification requirements. The policy provided that development bank financing and tax benefits for investment in the housebuilding industry. A warranty system was also established to protect consumers from defects in newly developed products.

The 1970 report presented to the Minister of Construction from a professional advisory committee, reemphasized the need to industrialize and systematize the construction industry [MOC, 1977]. This report said that improvement of living environments as a whole, in addition to the improvement of housing units, was essential to upgrading the living standard. To this end, housebuilding firms were expected to collaborate to organize the whole

process of housing production, from land development, production of building materials and components, site assembly, distribution, management, and administration to financing of producers and consumers. The report suggested that long-term low-cost financing and tax benefits be given to private developers who were eligible to organize the whole housing production process in the future.

Some of the major research and development projects implemented by the initiative of the Ministry of Construction during that time are listed below.

1962: ESTABLISHMENT OF CERTIFYING SYSTEM OF BUILDING COMPONENTS (FOR PUBLIC HOUSING)

The aim of the certification systems first put in place in 1962 and revised in 1974 was to promote the open system of industrialized building components by coordinating and warranting performance and price, for the benefit of both producers and purchasers. Just as MOC helped the development of pre-cast concrete panel technology by guaranteeing its demand in public housing projects, MOC promoted an open system of building components by using them for public housing projects at the beginning.

1970: COMPETITION OF INDUSTRIALIZED HOUSING PRODUCTION TECHNOLOGY ---------- "Pilot House Project"

The Pilot House project was influenced by the Operation Breakthrough in the U.S.

1972: COMPETITION OF INDUSTRIALIZED PRODUCTION TECHNOLOGY FOR HIGH RISE LARGE SCALE HOUSING --"Ashiyahama High-Rise Project"

The Ashiyahama High-Rise Project was implemented by a group of the largest Japanese corporations: New Nippon Steel (super structure system), Matushita Electric (mechanical and electrical system), Takasago-netugau (district heating), Takenaka-komuten (general contractor), and Matushita-kousan (developer). The aim of the competition was to develop a whole technology to produce 3000 highly industrialized housing units. The Ashiyahama Project systematically arranged the ownership and price of housing to increase the heterogeneity of the community.

1974: QUALITY HOUSING COMPONENTS CERTIFICATION SYSTEM (Revision of 1962 system) -- "BL (Better Living) System"

The 1962 system was revised in 1974 to further stimulate the use of open components in private sector construction. As of June 1, 1985, 541 companies provide 1417 types of 31 items of open components to the market (Table 2.3).

Table 2.3. List of Certified BL (Better Living) Components (as of June 1, 1985)

Name of Component	(Certified Year,	# of Certified Producers,	# of Available Types)
1. Outdoor Storage Unit	(1975,	17,	37)
2. Mailbox Unit	(1977,	9,	26)
3. Door Closer	(1977,	4,	16)
4. Door Lock	(1984,	4,	12)
5. Front Door	(1977,	7,	26)
6. Pipe Shaft Door	(1977,	3,	6)
7. Stainless Steel Sash	(1977,	2,	4)
8. A-Class Aluminum Sash	(1977,	11,	22)
9. B-Class Aluminum Sash	(1984,	14,	27)
C-Class Aluminum Sash	(1974,	13,	16)
Heat Insulating Sash for R.C. Bldg.	(1981,	11,	31)
10. Heat Insulating Sash for Wooden House	(1981,	16,	62)
11. Handrail Unit	(1974,	30,	139)
12. Interior System	(1984,	20,	47)
13. Room Door	(1977,	47,	82)
14. Storage Unit	(1976,	10,	10)
15. Kitchen Unit	(1974,	6,	7)
16. Kitchen System (Kitchen Cabinet)	(1979,	26,	68)
Kitchen System (with Cooking Gas Heater)	(1979,	16,	27)
17. Gas Leakage Alarm System	(1980,	10,	64)
18. Hot Water Supply Unit	(1974,	23,	64)
19. Closed-Type Gas Boiler	(1981,	5,	12)
20. Heating System	(1977,	25,	38)
21. Solar Energy Heating System	(1980,	36,	73)
22. Ventilation Unit	(1976,	31,	101)
23. Wash Stand Unit	(1976,	21,	49)
24. Sanitation System	(1976,	14,	42)
25. Bathtub	(1976,	27,	37)
26. Bathroom Unit	(1975,	16,	38)
27. Water Supply System	(1980,	9,	30)
28. Water Tank	(1980,	12,	27)
29. Housing Information System	(1984,	25,	72)
30. Master Antenna TV System	(1977,	13,	87)
31. Elevator	(1977,	8,	18)

Source: MOC, 1985

1974: REGISTRATION TO OFFER PLATFORM SYSTEM (2 x 4 system) THE SAME LEGAL CONSTRUCTION PROCEDURE AS THE JAPANESE CONVENTIONAL SYSTEM

The 2 x 4 system was given legal code standing to be an open system like the Japanese traditional wooden system, following the research to adapt its structural system to seismic conditions. As a result, the approval procedures for the 2 x 4 system were made as simple as the Japanese conventional system. It is interesting that most of the manufactured house producers are making 2 x 4 houses currently. (Table 2.4)

Table 2.4. The Largest 2 x 4 Builders in Japan

Name of Company	Number of Houses Built in FY 1983
Mitsui Homes	4763
Taisei Const. Co. Ltd.	1060
Shekisui House	962
Iwatani Sangyou	793
Eidai Sangyou	688
Sum of the largest 40 companies	16067
Total	18109

Table 2.5. 2 x 4 Houses Built in Japan (in units)

Year	Starts	Accumulated Total
1979	11,720	-
1980	13,192	24,912
1981	14,148	39,060
1982	16,459	55,519
1983	18,109	73,628
1984	20,240	93,868

Source of Tables 2.4 and 2.5: Hajime Suzuki, Japanese Housebuilding Industry, 1985

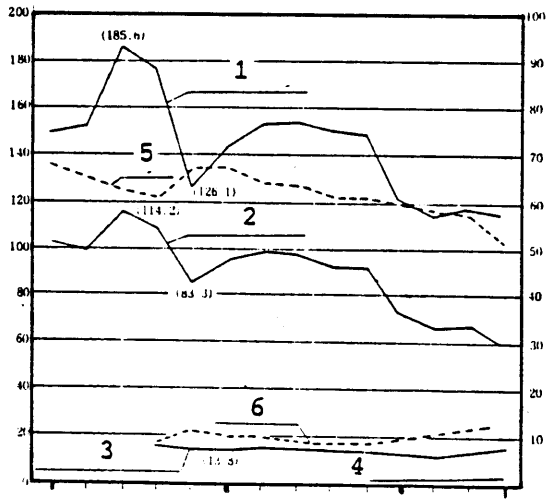
1976: COMPETITION OF NEW HOUSING PRODUCTION SYSTEM -- "House 55 Project" (Joint project of Ministry of International Trade and Industry and Ministry of Construction)

The House 55 Project Competition asked each entrant to develop an order entry system (flexible manufacturing system) to provide variation in the design of housing units within the limitations of factory production. Also this competition required each winner to produce 10,000 units of houses at a price as low as twice the average Japanese household's annual income. Currently, three winning projects are available in the market.

3. THE MANUFACTURED HOUSEBUILDING INDUSTRY IN JAPAN

In 1959, the first mass-produced Japanese factory-made house, Mizet House, came on to the market. It was developed by a steel fabricator, Daiwa House, for the purpose of the extension of a house. Basically, there are three structure types for Japanese detached manufactured houses; (1) light gauge steel frame, (2) pre-cast reinforced concrete panel and (3) stressed skin wood panel. The output of manufactured houses increased from 36,000 units in 1966 to 151,000 units in 1983. In 1972 and 1973, when the housing starts experienced record highs, the manufactured houses were also built at a record high, 200,000 units and 219,000 units respectively. The share of manufactured housing has been increasing because of the decline of other types of housing construction after the second energy crisis.

Fig. 2.6. Japanese Housing Starts



Source: MOC, 1985
(Statistics
on Housing Starts)

Legend:
Starts
(Left Y Axis:
in 10 thousand units)
1: Total Housing
2: Wooden Housing
3: Manufactured Hsng.
4: 2 x 4
Share
(Right Y Axis:
in percent)
5: Wooden / Total
6: Manufactured /
Total

Manufactured housing became eligible for low-cost public financing from the Housing Financing Agency in 1962, and increased its sales after that. During the 1950's, manufactured houses were regarded as substandard temporary houses. In the 1960's, in order to increase sales, manufactured housing companies tried to improve the image of their low-cost standardized houses. However, the more the manufactured house producers pursued design variety and finishing grade, the less they could enjoy the scale merit of mass production. In fact, those manufactured houses were constructed more than 50 percent on-site. In 1970, Sekisui-heim began the production of steel frame cubic unit houses, for which only 10 percent of assembly is required on the site. Sekisui-heim also has been producing 2 x 4 system wood cubic unit houses since 1982.

The economic stagnation caused by the energy crises oligopolized the manufactured house building industry. In recent years, the five largest corporations has produced more than 80 percent of manufactured houses. (Table 2.6). At the same time, the marketing strategy for manufacturing houses changed in the late 1970's, as sales increased and consumer demands rose. Manufacturers began to differentiate their products by developing unique housing types and installing highly value-added components, like systematized kitchen units or home automation systems. Because the largest companies produce nearly 30,000 units of houses per

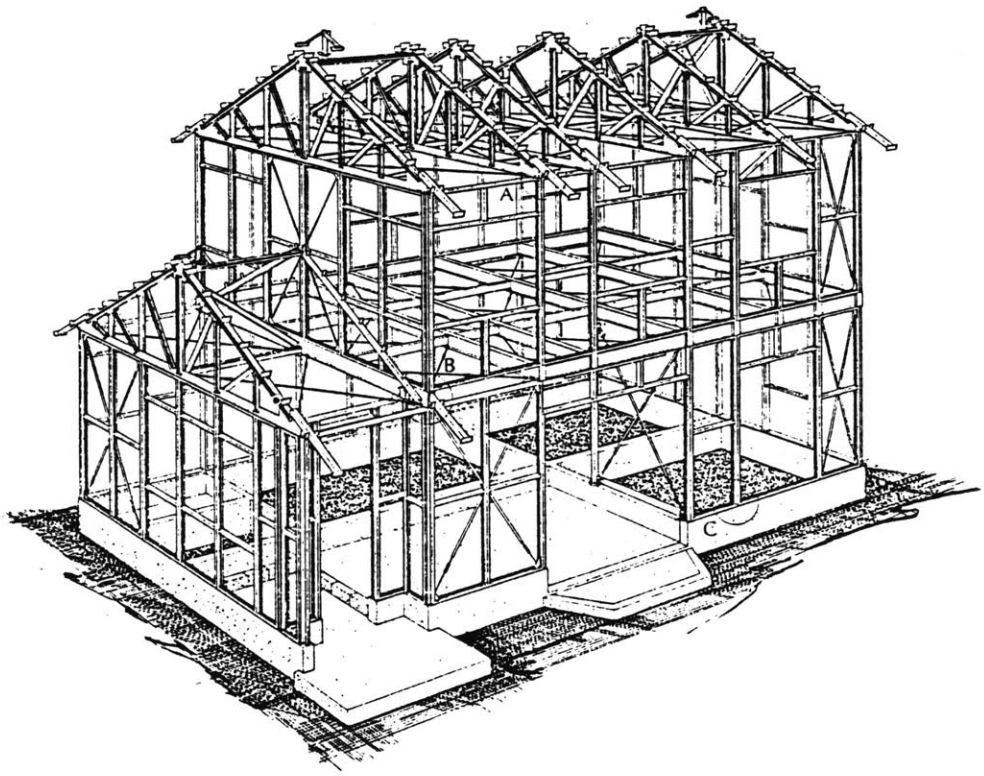
year, they can develop components specifically for their own systems. Moreover, some companies are trying to sell these components to the rebuilding market or even for the international market.

Table 2.6. Shares of Largest Five Manufactured House Producers, Source: Hajime Suzuki, "Japanese Housebuilding Industry", 1985

DETACHED (1983)	
Misawa-Homes	28.8 percent
Sekisui-House	19.9 percent
Daiwa-House	11.1 percent
National-Jyutaku Sangyo	10.7 percent
Sekisui-Kagaku (Heim)	10.0 percent
Total	80.5 percent
ATTACHED (1983)	
Sekisui-House	40.0 percent
Daiwa-House	19.2 percent
National-Jyutaku Sangyo	19.2 percent
Misawa-Homes	7.8 percent
Sekisui-Kagaku (Heim)	5.5 percent
Total	91.7 percent

Sekisui House is the largest manufactured house producer in Japan. It built about 23,000 units of detached houses in 1983. Nearly 400,000 units have been built since 1960. Providing mass-produced kits of parts, the company tries to offer a wide variety of design. The schematic designs are rendered by in-house designers, who also function as salesmen. In order to feed back market needs and technical problems in construction, Sekisui House centrally manages the whole production system, from R & D, to construction and maintenance.

Fig. 2.7. Structure of Sekisui House



Misawa Homes came into the housebuilding industry in 1962, from the lumber milling industry. Their system uses a stressed skin wood panel, whose basic module is 910 mm. Misawa Homes has changed its building system from a smaller panel (length = 910 mm) system to room size panel (length = 3,640 mm, height = 2,700 mm) system in 1976. Based on the classification of market demand, Misawa Homes developed several common types of house to fit several life styles.

It is significant that the marketing target of Misawa Home, like those of the other companies, has been shifting to the upper middle class recently. Clients can design their own houses by assembling nonstructural building components within the limitation of chosen type. Misawa Homes, unlike Sekisui House, has independent but affiliated R & D, sales, and construction organizations. Usually, the on-site construction takes 28 days including 9 days foundation work.

Fig. 2.8. Recent Product of Misawa Homes

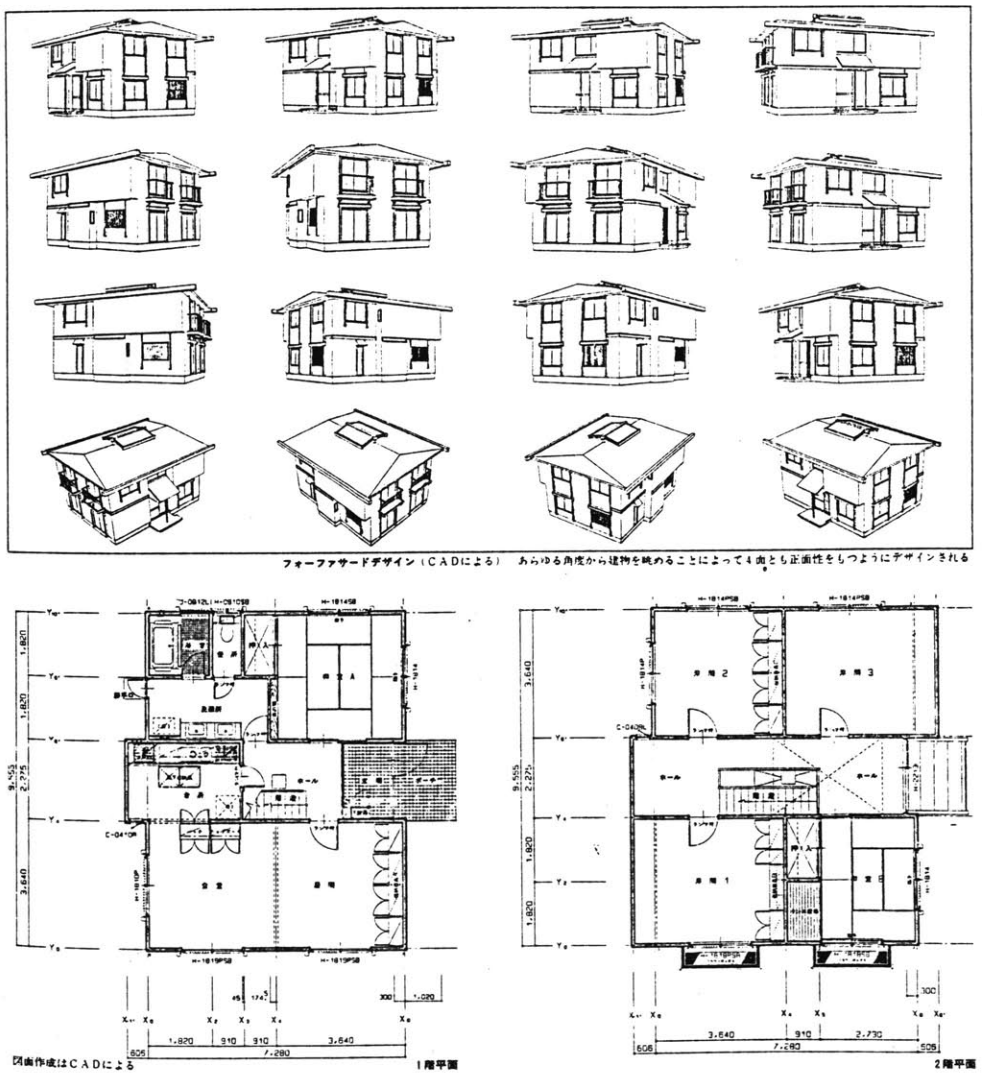
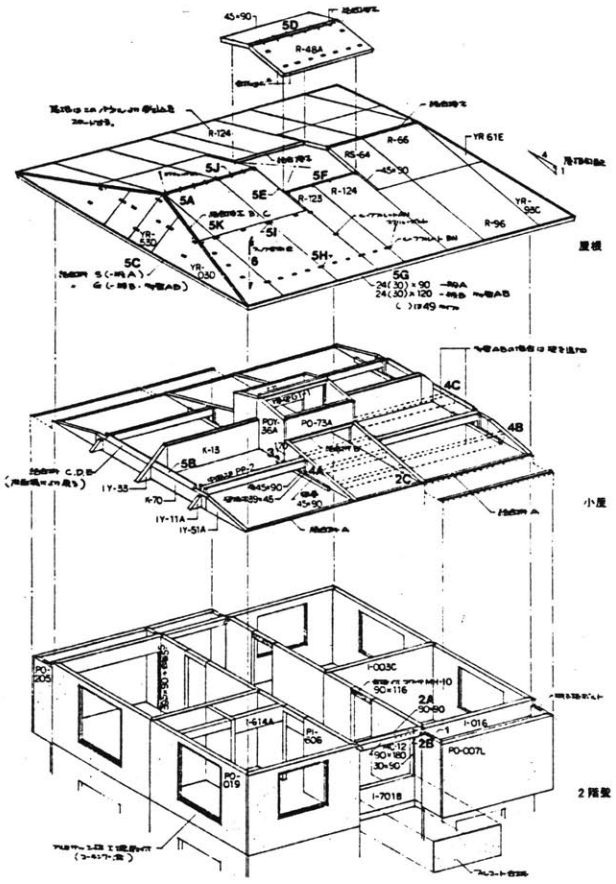


Fig. 2.9. Room Size Panel System of Misawa Homes



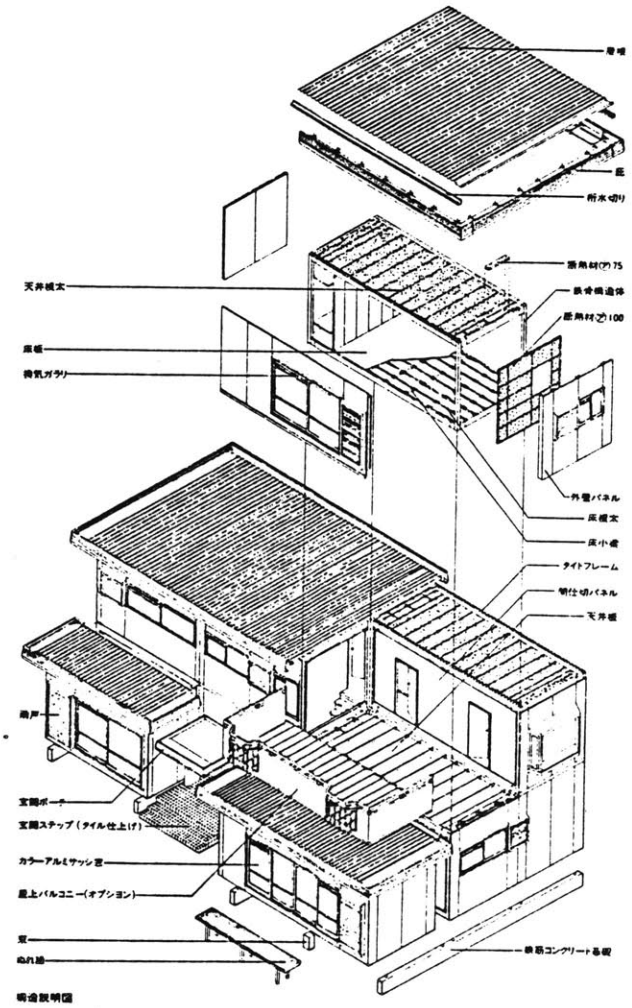
Sekisui Heim has produced more than 80,000 houses, using steel frame volumetric unit system since 1971. The maximum size of the unit is 2,464 mm (width) x 5,640 mm (length) x 2,830 mm (height), because of the traffic regulation. Six different size units and 18 different functional units are available. It is possible to stack the units to make two stories. Structural frames are fabricated by welding robots. The finishing work starts only after the

design decision has been made. A network of computer aided design and a sophisticated inventory control system makes this flexible manufacturing system possible. In fact, only five days' inventory of 27,000 kinds of components is reserved in the factory. Usually, 30 days is necessary to produce and assemble the required building components before the on-site construction starts. Sekisui Heim takes 131.5 worker-days to build a two-stories 90 square meters house, whereas the conventional wood construction system requires 272 worker-days. Actually, the on-site work for a Sekisui Heim structure is almost 80 percent less than that for a conventionally built wood house. The cost distribution of Sekisui Heim is shown in Table 2.7.

Table 2.7. Cost Distribution of Sekisui Heim
Source: Sinkentiku, April 1984

Factory Production	65.9 percent
Steel Frame	16.7 percent
Exterior Wall	15.5 percent
Other Building Materials	16.2 percent
Equipment	9.5 percent
Overhead	3.3 percent
Transportation	3.0 percent
On-Site Assembly Cost	17.4 percent
Overhead	13.7 percent
Total	100.0 percent

Fig. 2.10. Recent Product of Sekisui Heim



Two other major manufactured-house producers, National Jyutaku and Daiwa House, utilize a light-gauge steel frame structure system. We should notice that these five largest producers do not use basic modules of the same size. Their components cannot be shared as an open system. The module which each company takes is as follows:

Table 2.8. Module Used for Manufactured House

Sekisui House	:	1,000 mm, (910 mm)
Misawa Homes	:	910 mm
Sekisui Heim	:	900 mm
National Jyutaku Sangyo	:	900 mm
Daiwa House	:	910 mm, (940 mm)

The manufactured house building industry has a warranty system to increase its product liability. They repair the structural elements for 10 years and the nonstructural elements for two to five years for free, if repairs are required because of the design, production, or construction default. To this end, large manufactured house producers have established their own subsidiary maintenance companies. These companies are helpful to feed customers' needs back into the development of new products and also to accept remodeling and rebuilding orders from the initial clients.

We can say that these five companies concentrate business in housebuilding only. Usually, the land development is implemented by an affiliated subsidiary or another company. The sales structure of the four largest manufactured house producers is as follows (Table 2.9);

Table 2.9. Sales' Structure of Manufactured House Producers (As of FY 1984)
Source: Hajime Suzuki, "Housebuilding Industry", 1985, Tokyo

Sekisui House	(Total Sales: 443,743	Million Yen)
Housing Construction		78.7 percent
Real Estate		21.3 percent
Daiwa House	(Total Sales: 285,689	Million Yen)
Housing Construction		87.3 percent
Urban Development		12.7 percent
Misawa Homes	(Total Sales: 126,216	Million Yen)
Product Sales		69.0 percent
Sales of Houses with Land		13.0 percent
Construction		18.0 percent
National Jyutaku Sangyo	(Total Sales: 97,924	Million Yen)
Building Components		63.1 percent
Housing		27.0 percent
Developed Land		9.9 percent

4. PRESENT SITUATION

In 1976, a professional advisory committee of the Minister of Construction presented the first report to indicate changes in postwar housing policy. This report was based on the sharp decrease of housing starts after the second energy crisis. (Fig. 2.6) This report recommended that future housing policy should recognize that small-scale regional builders could meet scattered and diversified small-scale construction demand. The smaller builders still produced most of the new housing construction. On the other hand, the traditional management and organization system of these firms caused some inefficiency of production and some confusion with consumers. This report made five recommendations for encouraging traditional builders to resume their central role of housing production.

(1) The traditional builders should enhance their management ability to make contracts, schedule construction, and control costs. This will diminish problems in establishing price, meeting completion date, ensuring product quality and fixing warranties. Also, builders should cooperate to increase their financial ability and corporate credibility, to make bulk purchases, to retain professional services, and to subcontract at lower prices. Cooperative groupings of small contractors will help dampen the effects of fluctuations in housing demand.

(2) Technological development for traditional and new wooden construction method is necessary to reduce the housing price.

(3) Consumer education about the housebuilding industry will help reduce friction with contractors. Government should protect the consumers by publishing a standard contract form for housing construction and by establishing product warranty registration.

(4) Education of skilled construction laborers is necessary. They ought to be guaranteed a stable labor situation. Also, construction workers should receive adequate vacation and social security. This may help solve the anticipated labor shortage.

(5) The distribution system of building materials should be rationalized. Large margin and high distribution and transportation costs aggravated by the complicated distribution system, should be reduced, retaining the value of small-lot transactions in building materials. A public or private should be established in each region to provide timely information about the availablity of building materials.

The Housing Bureau of MOC surveyed 2,386 households planning to improve their living environments and asked them about their needs (Table 2.10). Investigators found that more than one third of households preferred to remodel or rebuild their own properties, including maintenance and repair.

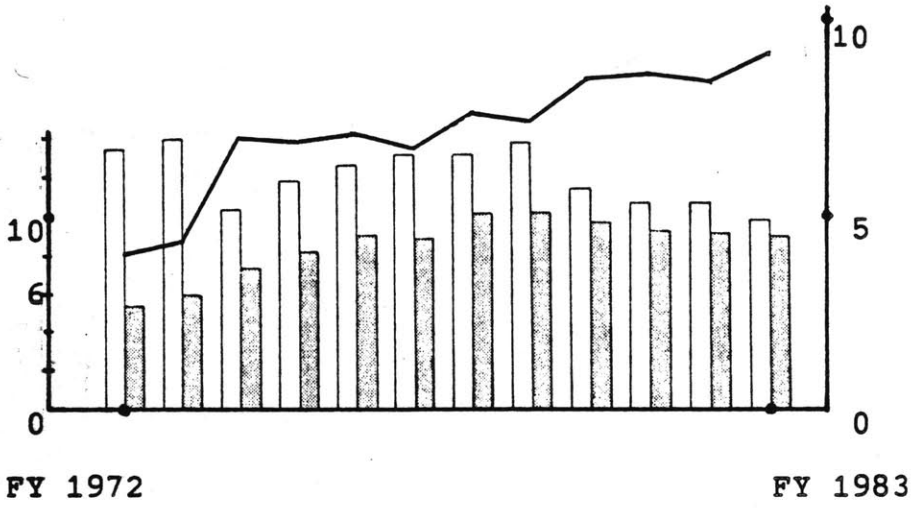
Table 2.10. Intentions for Improving Living Environment

Build a new house (on a new site)	22.3 percent
Buy a house	24.8 percent
Rebuild (demolish and build a new) house	14.6 percent
Buy land only	8.3 percent
Remodel (repair and/or expand) a house	22.6 percent
Rent a house	7.4 percent
Total	100.0 percent

Source: "Housing Production Indispensable Handbook," MOC, 1985

In fact, the proportion of total floor area of remodeling construction to total floor area of new housing construction has increased from four percent in 1972 to nine percent in 1983. (Fig. 2.11)

Fig. 2.11. Remodeling Housing Construction vs. New Housing Construction, Source: MOC, 1985
White Bar: (1) Total Floor Area of New Housing Construction Put in Place (in 10,000 square meters)
Black Bar: (2) Total Floor Area of Remodeling Housing Construction Put in Place (in 1000 square meters)
Line: Percent of (2)/(1)



Housing policy as of 1985 emphasizes the importance of the effective use of the existing housing stock. The Ministry of Construction is currently pursuing the following five targets:

(1) public assistance to housing construction, including
    (a) Public aids to secure the minimum living standard, and
    (b) public assistance to establish better housing stock;

(2) encouragement of private sector to establish better housing stock;

(3) effective use of existing housing stock, including
    (a) promotion of rebuilding,
    (b) promotion of remodeling, and
    (c) promotion of trading up housing;

(4) rationalization of housing production and supply, including
    (a) development of housebuilding technology and promotion of the relating industries, and
    (b) potection of consumers; and

(5) improvement of living environments.

MOC is still encouraging the construction of owner-occupied houses by supplying low cost financing through the Housing Financing Agency. The mortgage rate is a viable one. As of June 1st, 1985, it is between 5.5 percent and 7.2 percent, according to the size of the house and the income of the owner. One third of the housing mortgage is provided by the Public Financing Agency and two thirds come from the private financial organizations.

There are three of reasons for the decline of the housing starts since 1974. One of them is the decline of the residential land development (Fig. 2.12). Another reason is the small increase of the number of households, due to a recent decline in the marriage rate (Fig. 2.13). The most important reason is that, as mentioned above, the housing price in relation to annual personal income has skyrocketed (Fig. 2.4). It is clear that the difficulty of building a new house is stimulating remodeling construction.

Fig. 2.12. Supply of the Residential Land
Source: White Paper on Construction, 1986, MOC

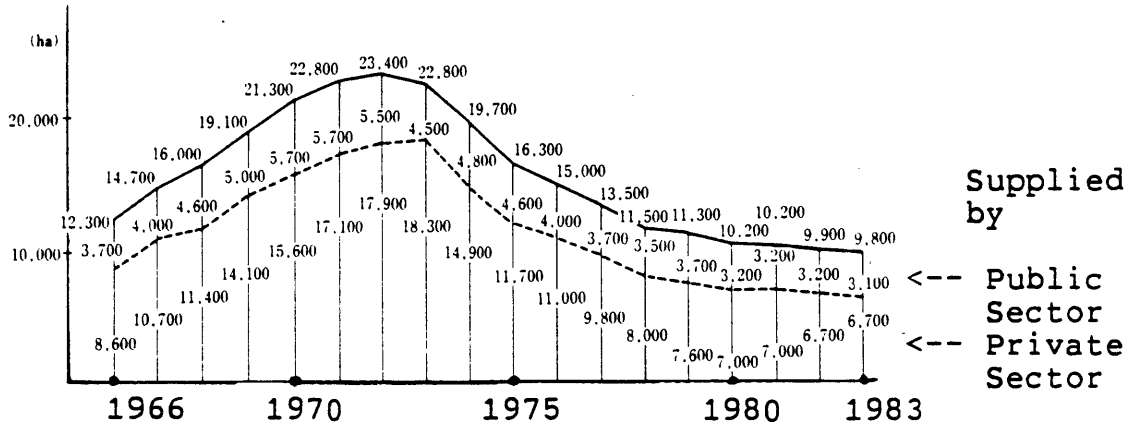


Fig. 2.13. Number of Marriage and the Housing Starts
Source: Statistics on Demography, Prime Minister Office, Statistics on Housing Starts, MOC
Left Y Axis: Housing Starts (in 10,000 units)
Right Y Axis: # of Marriage (in 10,000 couples)

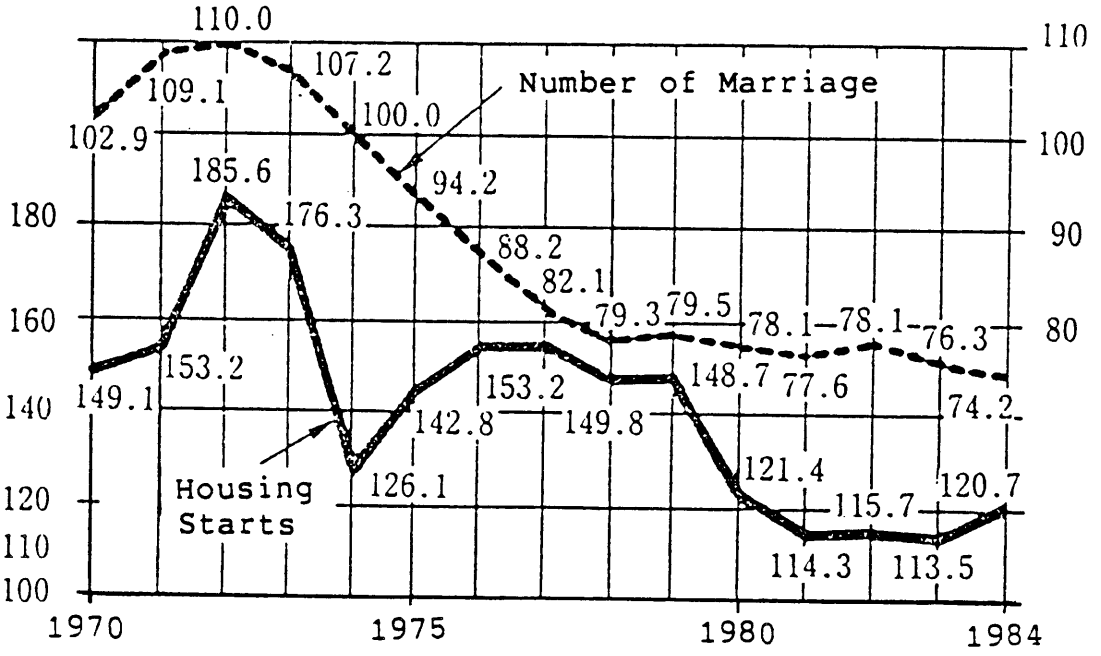


Fig. 2.14 shows the increasing trend of rebuilding housing in Japan. The number of new house construction, not utilizing existing stock, has been decreasing since the first energy crisis. Clearly, housing construction in Japan is shifting from increasing stock to replacing it.

Fig. 2.15 and Table 2.11 show that the decline in housing starts was also due to a sharp decline in the construction of rental housing after 1973. (Recently rental housing resumed its importance.)

Fig. 2.14. Increasing Rebuilding Housing Construction (Estimation)
Bold line : number of rebuilding construction projects
Dotted line: number of new house construction starts other than rebuilding construction
Source : Kentiku Bunka (Hiroshi Ito), 1985 Dec.

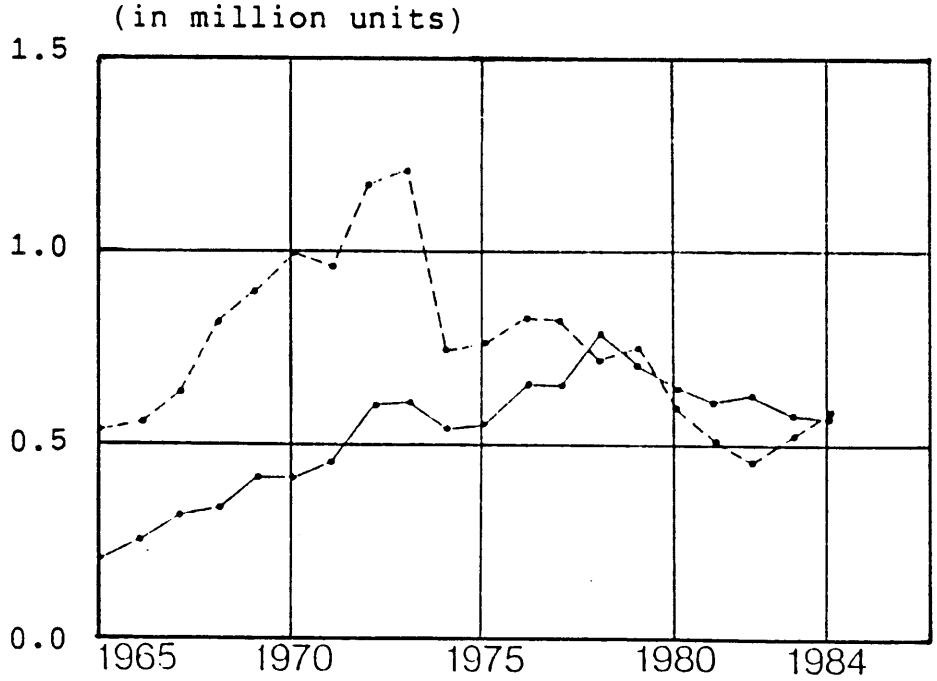


Fig. 2.15. Housing Starts by Tenure (in Million Units)
1: Owner Occupied Housing
2: Housing for Sale
3: Housing Issued by Employer
4: Rental Housing
Source: MOC, 1984 (Statistics on Housing Starts)

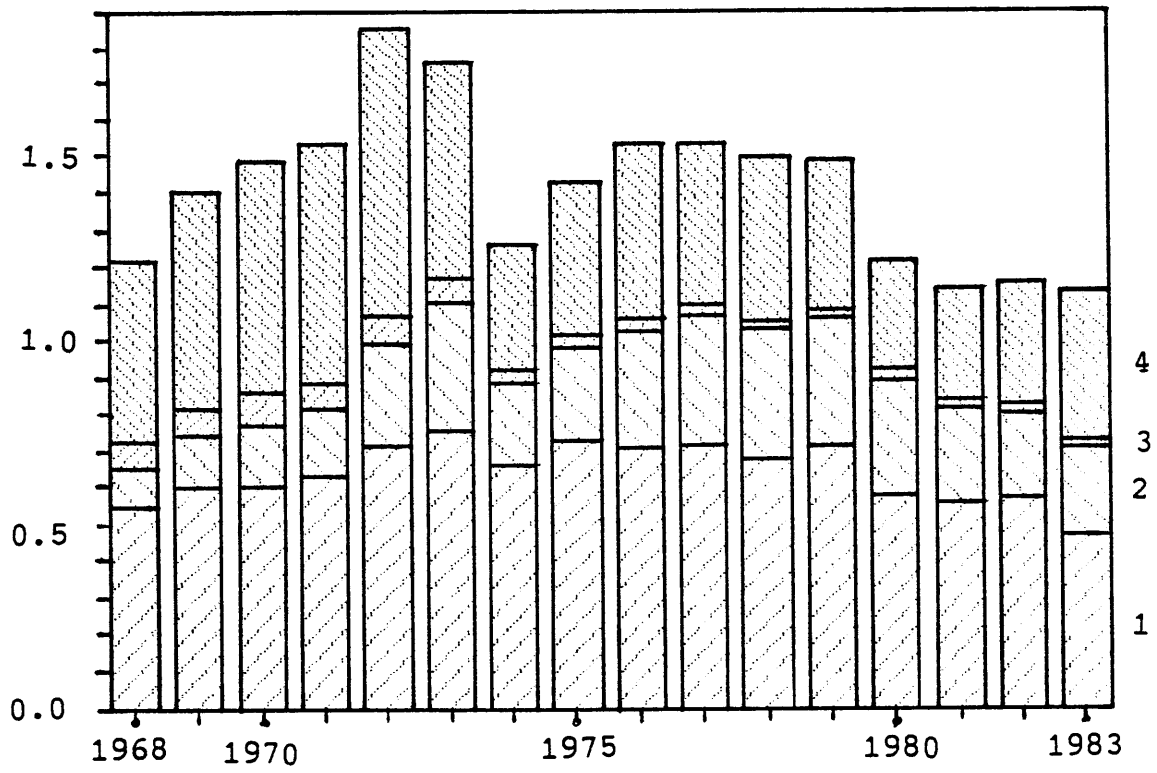


Table 2.11. Percent Share of Housing Starts by Tenure
1: Owner Occupied Housing, 2: Housing for Sale
3: Housing Issued by Employer, 4: Rental Housing

Fiscal Year (Starts, in 1000 Units)	1.Owner	2.Sale	3.Issued	4.Rental
1968 (1214)	45.5[%]	8.4[%]	6.0[%]	40.1[%]
1969 (1408)	42.7	9.9	5.3	42.1
1970 (1491)	40.4	11.4	5.9	42.3
1971 (1532)	41.3	11.9	4.3	42.5
1972 (1858)	38.6	15.1	3.7	42.6
1973 (1763)	42.9	19.8	3.6	33.7
1974 (1261)	52.7	17.2	3.2	26.9
1975 (1428)	51.1	17.6	2.6	28.7
1976 (1530)	45.9	20.8	2.3	31.0
1977 (1532)	46.7	23.1	1.9	28.3
1978 (1498)	45.2	23.5	1.9	29.4
1979 (1487)	48.1	23.3	1.8	26.8
1980 (1214)	48.0	25.6	2.0	24.4
1981 (1143)	48.7	22.5	1.9	26.9
1982 (1157)	49.6	19.6	1.9	28.8
1983 (1135)	41.5	21.0	1.5	35.7

Source: MOC, 1984 (Statistics on Housing Starts)

According to the Japanese Ministry of Construction [MOC, 1985], 60 percent of the total housing was built by homebuilding companies, 30 percent by general contractors, and 10 percent by manufactured housing firms in 1981. The homebuilding companies are small in size. There were 170,891 of them in Japan in 1981, of which 72,666 were subcontracting homebuilders (carpenters). The average homebuilder builds 3.4 wooden houses a year and has 4.4 employees. The number of wood housing contractors has been decreasing, in contrast to the number of subcontracting homebuilders. This shift has been observed both in the urban and local areas.

Another important project, which MOC is currently implementing, is the revitalization of conventional homebuilders in each region. Based on the understanding that local and traditional housebuilding organizations have produced regionally characteristic houses in the most efficient way, MOC is trying to reorganize the housebuilding industry in many localities. More attention is being paid to local differences in housing design.

Ando [1981, pp.889-890] analyzed the cost estimation of the larger conventional Japanese builders and found that they tend to claim more gross profit and overhead than do smaller builders. Profit and overhead are the major portion of the value added in addition to salary and wages. Ando writes that about 19 percent of the price of a house is the gross profit and overhead of the large builders who build more than twenty houses a year. The builders who build less than twenty houses a year receive about 13 percent of the price of the house as their profit and overhead. Naturally as the firm's size grows, the overhead tends to increase. Usually the smallest homebuilders are family operated. The company owners of those firms often began as subcontracting carpenters. They are skilled enough to manage the whole business by themselves. However, this type of homebuilder will soon decline in numbers because few among the younger generation are interested in this industry. Only the roofing

trade has attracted young workers recently due to a resurgence of consumer preference for traditional Japanese ceramic tile roofing [MOC, 1985].

Pre-cutting technology has been increasingly accepted by homebuilders and significantly altered that industry's organization. Some of the advanced pre-cutting firms have affiliated with developers to obtain a large and steady demand. They need to process lumber for at least 600 houses a year to pay off their expensive investments in equipment [Oono et.al., 1983, pp.183-189]. Most of the subcontracting carpenters have already agreed to use pre-cut lumber and have also recognized the value of the production precision found in pre-cut lumber. Some factories have a CAD/CAM system for their continuous production process from design, cost estimation, and inventory control to the Numerical Control production. Pre-cut lumber usually is shipped to the construction site by a crane equipped truck. Pre-cutting technology has enabled developers to expect a shorter and more accurate construction period, and higher quality lumber because they supervise purchasing themselves. Structural design also has become more reliable because the CAM of the pre-cutting industry can coordinate housing design and production.

Dr. Utida, a professor of the University of Tokyo, recently summarized the situation of the Japanese housebuilding industry in the mid 1980's [Utida, 1985]. He pointed out the following elements:

(1) A decrease in new housing construction has been clearly observed. It has become hard to sell new houses. Production of rental housing is increasing. More new housing construction is now in demand.

(2) Increased longevity in Japan has begun to change the traditional notion of housing as property purchased once in a life-time. The durability of houses in relation to the life of one generation has begun to be significant. Houses in which three generations live are increasing in number. Demand for houses has diversified (e.g. the adaptability of a house according to the life-cycle of a family).

(3) The development of building components through the application of so-called hightechnology has become more active. Building components requiring sophisticated manufacturing technology, have begun to be produced in large numbers. Foreign building technology has been well assimilated and applied to the Japanese situation. The skill of carpenters has declined significantly. However, durable hand-made furniture has become popular.

(4) The share of conventional wooden houses among housing starts fell below 50 percent for the first time in 1983. The average price of manufactured houses has become higher than that of conventional wooden houses. The share of manufactured houses among housing starts has begun to increase steadily.

(5) High quality domestic lumber is going to be available in the near future.

Dr. Utida has worried about the short life of postwar Japanese housing, because he thinks that it is an economic and social problem for an individual to purchase a house several times in one life time. Therefore, he has been one of the most active promoters of the Century Housing System (C.H.S.) to prolong the life of housing. The important characteristic of C.H.S. is the coordination of building elements according to their life span. Modular and positioning coordination rules were developed in order to replace shorter-lived building elements without causing any change to the more durable building elements. Several C.H.S. projects are currently under construction. C.H.S. classifies the life of each building element into five categories as follows;

(1) 3 to 6 years.
(2) 6 to 12 years.
(3) 12 to 25 years.
(4) 25 to 50 years.
(5) 50 to 100 years.

5. CONCLUSIONS

The number of housing units surpased the number of households in 1974, when housing starts dropped sharply because of the energy crisis. At that time, the Japanese housing problem shifted naturally from quantitative to qualitative issues. Japanese government and industry understand that annual housing starts will remain at the present level of a little more than one million units, nearly half of its peak level in 1973.

The average size of the Japanese house currently being built is about 90 square meters, slightly over half the size of the average U.S. house. It is predicted that Japanese housing starts will keep the rebuilding demand stable, upgrade the quality of the housing stock, and increase the size of houses to the that found in the U.S.

The largest manufactured house building companies have been steadily increasing their share in the market because of their marketing and R & D ability. As the market has shifted from new construction to remodeling and rebuilding, the largest housebuilding corporations have begun to see their services in terms of total living environments. They sell the image of a better life not just a new house, and offer to remake a family's life-style through remodeling an existing house. The Japanese housebuilding industry is

currently adding this new approach to services.

The number of skilled construction workers is declining along with the decrease in construction work. Some traditional carpenters, who used to work for conventional housebuilding firms, are seeking employment in manufactured housing companies offering better job security. Some have started their own companies, because the largest profits are to be made through the procurement of materials rather than through on-site construction work. However, these smallest builders will not be affector much long, because few of the younger generation are interested in becoming skilled carpenters, a profession which requires 15 years apprenticeship.

The MOC introduced the 2 x 4 system to Japan with they expectation that this construction technology might help simplify and systematize conventional Japanese wooden housebuilding technology, which required much skilled labor (MOC, 1977). Each of the largest housebuilding companies will have to educate their own on-site workers to manage its factory-built components, because skilled labor will be even less available in the future. It is almost certain that the largest housebuilding companies, whether they produce manufactured houses or use the 2 x 4 system, will influence and initiate the development and reorganization of this industry.

Large manufactured housing companies are now capable of producing housing units of various designs using the same production lines, without increasing either cost or time. These companies can integrate customers' needs into the design and production process through computer communication and data processing. The extreme competitiveness of this market encourages each company to differentiate its products from those of other firms.

The Japanese housing industry has several issues of immediate importance. All of these companies are faced with the problem of land cost, still the major cost of development. Some have reacted by developing a new type of high density, low-rise urban housing. Another imminent problem is anticipating what new services will be needed in a changing housing market. Because the population of Japanese society will include a greaterpropotion of elderly in the future, new kinds of housing provided complete home maintenance or even nursing care, could be viable. As they have since the postwar period, producers of housing will need to respond to the evolution of daily life in Japan to ensure the ongoing development of their industry.

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CHAPTER 3

HOUSING PRODUCTION IN THE UNITED STATES

1. INTRODUCTION

This chapter has three parts. The first section introduces the housing stock and flow in the U.S. and Japan. It demonstrates that the amount of new construction is determined by the quality and quantity of existing stock, the purchasing power of consumers, and other factors. The second section analyzes the characteristics of U.S. housing production, with special attention to its market changes. The third section investigates the organization of the housebuilding industry and analyzes the production efficiencies of housebuilding firms according to their annual construction scales. The last section is based on the study by Sherman Maisel in 1953. This chapter concludes with suggestions for future development of the housebuilding industry.

2. HOUSING STOCK AND FLOW IN THE U.S. AND JAPAN

In the first chapter, we found that maintenance and repair construction is substantially larger in the U.S. than in Japan, though this sector has become increasingly important recently in both countries. Remodeling of existing buildings into residential units provides a large portion of new house supply in the U.S. This is mainly due to the high price of new house construction, but also because the existing housing in the U.S. is of comparatively high quality and is worth preserving. Sixty percent of existing housing in the U.S. has been built after 1950 and remains adequate, even in terms of present standards. [National Association of Home Builders, pp.16-19, 1985] Utilizing older building stock to meet current housing needs is an efficient way to supply housing.

Table 3.1 shows the structural types of U.S. housing stock. Two-thirds of the annual housing starts in the U.S. has consisted of single-family housing. The remaining third has been multi-family housing. Demographic change in U.S. society, geographical movements of the population, and changes in the household size may alter preferences for housing types in the future. Nevertheless, the U.S. Bureau of the Census predicts that the single-family houses will be the dominant type of housing construction for the rest of this century, and will continue to provide two-thirds of the

annual housing starts. During the 1950's, single-family houses comprised 88 percent of the total housing starts. This strong preference for the detached single-family houses differentiates the housing supply in the U.S. and Japan from that in European countries.

Table 3.1. Structural Types of U.S. Housing Stock

types of house	percent
one-unit structure detached houses	63
2/4 units in structure	12
5/more units in structure	16
one-unit structure attached to another structure	4
mobile homes and trailers	4

Source: Annual Housing Survey, Bureau of Census, 1981 as quoted by NAHB,:Housing America-Challenges Ahead," 1985
(Total may not become 100 percent because of rounding.)

Private housing construction is strongly influenced by changes in mortgage interest rates; the average American usually delays building his or her house until it becomes affordable. The recently decreased mortgage rate in the U.S. has reduced housing prices by almost 50 percent. This large fluctuation in the financing cost for U.S. housing, coupled with the present high quality of available housing, may destabilize the housing production in the U.S.

Fig. 3.1 shows an international comparison of the number of houses annually built [Building Economics Bureau, 1985, pp.376-377]. Fig. 3.2 presents an international comparison of the number of houses per capita annually built. The U.S. has increased housing construction continuously. Japan has had higher per capita rate, which is increasing. The relatively great amount of housing construction in Japan is related to its large investment ratio to the GNP, which has caused rapid economic growth in the postwar period. Fig. 3.1 and Fig. 3.2 show that the fluctuation of U.S. housing starts is wider than that in Japan. Given that the housebuilding industry purchases large amounts of materials and services from the other economic sectors, we may conclude that the influence of this large fluctuation on the national economies must be significant.

Fig. 3.1. International Comparison of Annual Housing Starts
(in million units per year)
Legend: 1 = U.S., 2 = Japan, 3 = Great Britain
4 = West Germany, 5 = France, 6 = U.S.S.R.

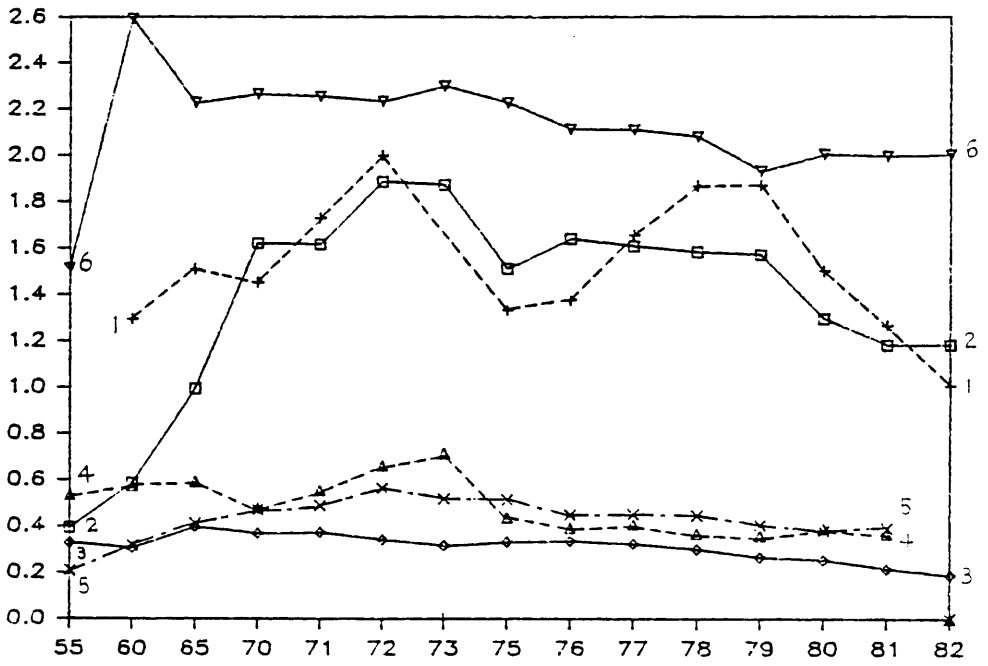
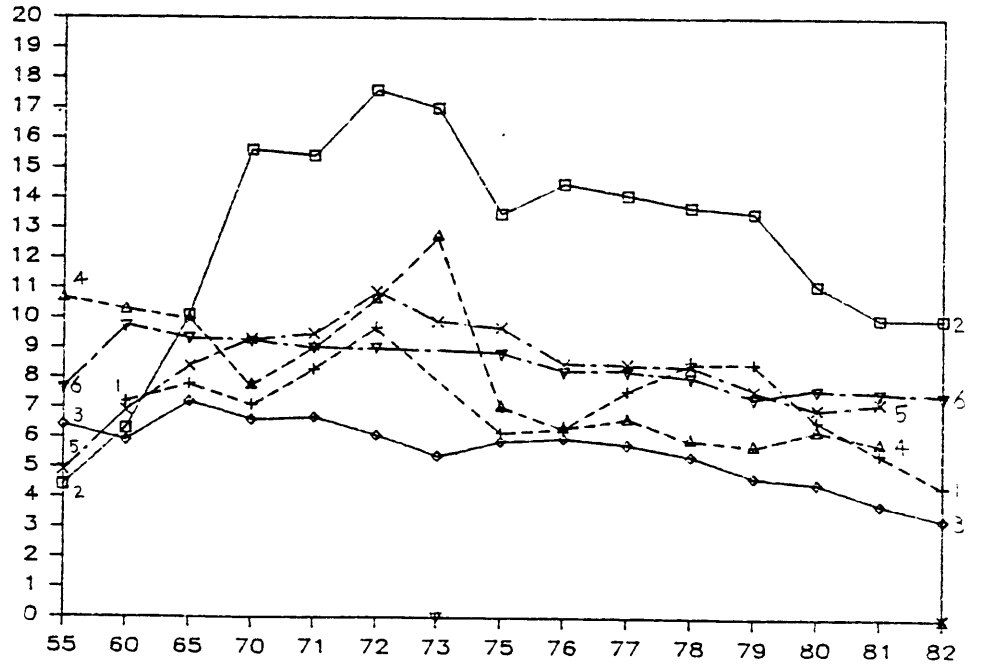


Fig. 3.2. Annual Housing Starts Per Capita
(in units per thousand habitat a year)
Legend: 1 = U.S., 2 = Japan, 3 = Great Britain
4 = West Germany, 5 = France, 6 = U.S.S.R.



The large number of housing starts in Japan did not begin immediately after World War II when housing was seriously in short. The major increase in Japanese housing starts per capita in the 1970's can be explained by;

(1) economic shift from industrial investment to private consumption,
(2) increase of the disposable income of the average Japanese household,
(3) movement of the population into the cities,
(4) nuclearization of the Japanese households,
(5) lack of custom to trade up housing, and
(6) existence of the substandard housing stock which was hard to remodel to meet new housing requirements.

Currently, the short life of Japanese housing is the basic problem being addressed by current housing policy makers. It is necessary to investigate just how short the life of Japanese housing is, compared to that of other countries. Table 3.2 shows the stock and flow of Japanese housing. Table 3.3, Table 3.4, and Table 3.5 show those in the U.S., Great Britain, and the Netherlands respectively. If we knew the rate of demolition of housing according to its age, we could calculate its expected average life. Because we lack this information, we sometimes measure the average life of housing by dividing the quantity of housing stock by the number of replaced houses or by

dividing the quantity of housing stock by the number of housing starts. Table 3.2 shows that the proportion of new housing construction to housing stock has been relatively large in Japan. Table 3.4 indicates the proportion of housing construction to stock in each country. The ratio of housing production to stock in Japan is outstandingly large. In contrast, Great Britain has had a very small increase in its housing inventory, not only because of its stagnated economy but also because of its strong emphasis on maintenance and repair construction. Of total British construction, 28.9, 34.3, and 45.0 percent was maintenance and repair construction in 1973, 1978, and 1983 respectively [British Government, 1984].

The ratio of new construction to housing stock in Japan will decline as the quality of the housing stock is upgraded. If this ratio becomes as large as that of the U.S., housing starts in Japan will drop more than 20 percent, from 1,100,000 units per year to 850,000 units per year. The government and all industries related to housebuilding have to recognize this serious implication of prolonging housing life through improved quality.

Table 3.2. Stock and Flow of Japanese Housing Production
(B-D: in thousand units)

A FISCAL YEAR	B STOCK	C NEW CONSTRUCTION	D LOSS	E B/C	F B/D
1958	17934	345		52.0	
1963	21097	720		29.3	
1968	25591	1214		21.1	
1973	31059	1763		17.6	
1978	35451	1498	276	23.7	128.4
1983	38653	1135		34.1	

Source: "Housing Production Indispensable Handbook," MOC, 1985

Table 3.3. Stock and Flow of the U.S. Housing Production
(B-F: in thousand units)

A YEAR	B STOCK	C GAIN (D+E)	D NEW CONST.	E OTHER GAIN	F LOSS	G B/C	H B/D	I B/F	J B/(C-F)
1973	75969								
1974	77601	2843	2094	749	1211	27.3	37.1	1211	47.5
1975	79087	2440	1594	846	954	32.4	49.6	954	53.2
1976	80881	2306	1549	757	512	35.1	52.2	512	45.1
1977	82420	2124	1795	329	585	38.8	45.9	585	53.6
1978	84618	2717	2059	658	519	31.1	41.1	519	38.5
1979	86374	2303	2114	189	547	37.5	40.9	547	49.2
1980	88207	2277	1670	607	444	38.7	52.8	444	48.1

Source: 1982 National Housing Production Report, HUD, 1983

Table 3.4. Stock and Flow of Housing Production in Great Britain (B-D: in thousand units)

A YEAR	B STOCK	C GAIN	D LOSS	E B/C	F B/D	G B/(C-D)
1971	18999	358.2	122.4	53.0	155.2	80.6
1972	19213	329.6	115.8	58.3	165.9	89.9
1973	19415	306.3	103.7	63.4	187.2	95.8
1974	19627	281.3	69.1	69.8	284.0	92.5
1975	19870	323.2	79.8	61.5	249.0	81.6
1976	20124	324.6	70.8	62.0	284.2	79.3
1977	20374	312.1	61.4	65.3	331.8	81.3
1978	20615	291.5	50.1	70.7	411.5	85.4
1979	20822	254.5	47.3	81.8	440.2	100.5
1980	21025	244.5	40.6	86.0	517.9	103.1
1981	21178	206.1	48.8	102.8	434.0	134.6
1982	21317	180.3	41.7	118.2	511.2	153.8
1983	21494	204.6	29.3	105.1	733.6	122.6

Source: Annual Abstract of Statistics 1985 Edition, London, 1985

Table 3.5. Stock and Flow of the Housing Production in Netherlands (B,C: in thousand units)

A YEAR	B STOCK	C NEW CONSTRUCTION	D B/C
1979	4748	87.5	54.3
1980	4849	113.8	42.6
1981	4957	117.8	42.1
1982	5072	123.3	41.1
1983	5178	111.1	46.6
1984	5289	112.2	47.1

Source: Prominent Facts on Housing and the Building Industry in the Netherlands 1979-1984, Ministry of Housing, Physical Planning and Environment, Department of Information and International Relations, 1985

Table 3.5. Summary of Table 3.2 to Table 3.4

YEAR	STOCK/NEW CONSTRUCTION			STOCK/GAIN	
	JAPAN	U.S	NETHERLANDS	U.S.	GREAT BRITAIN
1958	52.0				
1963	29.3				
1968	21.1				
1971					53.0
1972					58.3
1973	17.6				63.4
1974		37.1			69.8
1975		49.6			61.5
1976		52.2		35.1	62.0
1977		45.9		38.8	65.3
1978	23.7	41.1		31.1	70.7
1979		40.9	54.3	37.5	81.8
1980		52.8	42.6	38.7	86.0
1981			42.1		102.8
1982			41.1		118.2
1983	34.1		46.6		105.1
1984			47.1		
AVERAGE	29.6	44.9	45.6	33.0	79.8

3. CHARACTERISTICS OF U.S. HOUSING PRODUCTION

The U.S. government has a housing policy that encourages homeownership. The rate of homeownership has been increasing; 43.6, 55.0, 61.9, 62.9, 64.4 percent in 1940, 1950, 1960, 1970, and 1980 respectively. The economic benefits of owning a house encouraged the growth of homeownership in the U.S. in recent decades. The expected capital gain on a house was larger than the price increase in the average new house because of inflation. In fact, the proportion of the total cost of owning a house to medium family income decreased during the construction boom between 1965 and 1979. During that time, housing prices rose at a rate of 12.3 percent annually while consumer prices increased only 7.5 percent [Apgar,1985]. Inflation caused the value of a house to appreciate and devalued its outstanding mortgage. Homeownership also provides a tax shield, another incentive for making such an investment. Homeowners can take some advantage of inflation despite its deleterious effects on the national economy.

Established homeowners are more sensitive to changes in mortgage rates than are first-time home buyers, especially in the market for single-family detached houses. The have-nots, especially newly formed young households, have fewer alternatives. They shift to less expensive housing, such as smaller houses or mobile homes, when real housing cost

increases. The increase in mortgage rates may inhibit the constructionof single-family detached houses for the affluent more significantly than it will the construction of multi-family houses.

General economic policies have indirect but strong impacts on house building activities. The Report of the President's Commission on Housing [1982] claimed that " ... to bring down the rate of inflation through long-term and consistent monetary and fiscal restraint...is the most effective contribution the Government can make to housing stability and economy as a whole" [Temby, 1982]. The Reagan administration's policy of less borrowing by government will reduce interest rates by loosening competition in capital markets. Also, the U.S. government expected the strong linkage of the housing sector to provide counter-cyclical stimulus to the national economy as a whole.

Taxation policies affect the housing sector at federal, state, and local levels. Direct effects arise from policies such as (1) tax concession on mortgage interest for homeowners, (2) depreciation allowances for investors in housing, (3) capital gains tax deferrals, and (4) concessions for local property taxes. Indirect effects may come from (1) taxation advantages for the saving and loan industry and other providers of housing finance, and (2) general taxation policy, especially personal taxation, which

affects the ability of households to afford housing.

The MIT and Harvard Joint Center for Housing Studies pointed out that regional shifts in demography have an important influence on housing demand. Dr. Apger explains that during the 1970's, the center of U.S. economic activity moved from Northeast and North Central to South and West, where less expensive labor was available. [Apgar, 1985] Because new industrial technologies require neither skilled labor nor convenient downtown office locations, developing industries based on these technologies attracted a younger population into the nonmetropolitan areas and suburban part of the small metropolitan areas in these regions. This population movement generated large demand for less expensive houses. The construction cost for housing becomes more significant to the total development cost when the land cost is inexpensive. Lower land cost in the South and West had the effect of encouraging the construction of less expensive multi-family houses and installation of mobile homes. The construction of larger housing units and housing-related facilities, such as educational facilities, are expected to follow as these communities grow in the future.

The nonmetropolitan South gained population not only from the frostbelt but also from its own metropolitan areas. While married couples moved into the suburban areas, single-person households and households containing no

related individuals were likely to stay in metropolitan innercity areas. In fact, single-family units dominate housing production activities in the growing regions. In the period 1975-1980, 85 percent of the conventional houses built in nonmetropolitan areas were single-family houses. Of the houses built in suburban portions of metropolitan areas during the same period, 78 percent were single-family dwellings. In contrast, 49 percent of the conventionally built houses in central cities were for single-families.

The housing markets in the northeast and north central regions have been less active because of the out-migration of younger households. Conversion of existing housing stock (for example, conversion of a single-family house into multi-family houses) and adaptations of existing structures (for example, the transformation of a warehouse into condominiums) are common ways of augmenting housing supply in these areas. Demographic movements driven by economic change have had significant impacts on regional housebuilding activities and the types of houses during the last four decades.

4. ORGANIZATION OF THE U.S. HOUSEBUILDING INDUSTRY

The production performance of housebuilding firms differ according to the scale of production. This study classifies builders of conventional housing in the U.S. into three subsectors on the basis of the number of units produced annually; small firms (less than 25 units a year), medium firms (between 25 and 99 units a year), and large firms (more than 100 units a year). This classification will maximize the differences among the subsectors [Maisel, 1953]. Manufactured-house producers, building thousands of units a year, represent another type of builder. The small firms can be further divided into four groups by the annual number of units completed; 1, 2-4, 5-9, and 10-24 units. Within each group of builders, merchant (operative) builders and contract builders are also differenciated. We will argue that there are several optimum sizes for conventional housebuilders in the U.S. The similar organizational structure of the housebuilding industry in Japan suggests the existence of some principles inherent in this industry. In this chapter we characterize building firms at each of the three levels of production in order to determine what improvements are necessary for their future growth.

Table 3.6 and 3.7 show that smaller builders constituted 90 percent of builders in the U.S. but produced only 40 percent of houses in 1949. In contrast, large scale builders represented only one percent of all firms but built 24 percent of houses. Though there were many of them, small building firms in metropolitan areas built a much smaller portion of total units. Kaiser [1968, p.151] reported the shares of the U.S. annual housing starts by types of producers in the middle 1960's (Table 3.8). A relatively large number of houses were built by speculative builders and manufactured-house builders.

Table 3.6. Profile of Housebuilders by Number of Houses Built in 1949, (in percent)

# of houses built in 1949:	1-9	10-24	25-99	100-
United States	91	6	3	1
Metropolitan areas	87	7	4	1

Source: Maisel, 1953

Table 3.7. Shares of Housing Production by Number of Houses Built in 1949, (in percent)

# of houses built in 1949:	1-9	10-24	25-99	100-
United States	40	14	21	24
Metropolitan areas	28	15	25	31

Source: Maisel, 1953

Table 3.8. Producers of U.S. Housing

Type of Producer/Product, Percent of Total Annual Production	
Merchant builders:	
One-family unit (not including factory-built)	26
Multi-family building	15
General contractors:	
One-family units for private owners (not including factory-built)	10
Multi-family construction for private owners	15
For public agencies	2
Factory built:	
Home manufacturers	11
Mobile homes	12
Owner-built one-family homes intended for ultimate occupancy by the owner and built with the owner acting as general contractor and often doing some or all of the work	9
Total	100

Source: National Association of Home Builders, "Housing America-Challenges Ahead," 1985.
Note: The multi-family starts were split evenly between merchant builders and general contractors, because of the lack of data.

The large number of small-scale builders in the housing industry exists because of the competitive, varied, local, and fragmented nature of the market. Also the business is easy to enter. Fluctuation in demand keeps the average size of small building firms at an efficient minimum. The number of small builders is very sensitive to the state of their locally defined markets. Psychological factors may be involved in keeping these building firms small. Most of the owners began their professional lives as subcontracting carpenters. They are satisfied with the scope of their businesses, because they have acheived the goal of

self-employment. many wish to have their families retain control of their operation. Also their limited management and financial expertise reduces the oppotunities to expand their businesses.

The effective profit making for these small builders differs from that of the other two groups. Small-scale builders generate profit by minimizing overhead. In fact, profits often are hard to define because in a family-style operation. The smaller builder uses his house as an office and works even on weekends. His wife may take care of bookkeeping. He cannot afford to retain professional services.

The market for small-scale builders is more expensive houses in areas of higher land cost. Profit made by developing land is often large enough for a small builder to accept an unprofitable house construction. These builders can perform scattered small maintenance and repair construction more efficiently than larger firms. The smallest builders, who finish one unit a year, depend on maintenance projects for most of their income. Some small-scale builders have tried to collaborate to reduce procurement costs but in this effort they have not been as successful as large building firms. The lack of drive to expand differentiates the housebuilding industry from most of manufacturing industries.

Medium-size operative builders tend to choose the most common design of house to avoid marketing risks. The market for medium-size building firms is also locally defined, usually within one-day travel distance for crews. Some of them have established high credibility among local customers and financial institutions. However, medium-size builders are less flexible in reacting to market changes than are small-scale builders, who can move easily to another type of construction or non-construction business when the housing market declines. At present, U.S. housing construction activities are regionally concentrated; Texas constitutes 16 percent of housing starts, both Florida and California constitute 10 percent [NAHB, 1985]. Changes in regional economic activities can seriousely affect medium size builders providing housing in these areas.

The origins of medium size builders vary. Some began as small-scale builders; some were involved in other types of business. According to their origins, medium size builders differ in their emphasis on business. Those whose businesses grew from small-scale firms may concentrate in construction management. Those having strong backgrounds in financing or management may generate profit by more efficient procurement procedures. Medium-size builders have more diverse business opportunities than do smaller builders who spend most of their time on supervising their own construction projects.

Even the largest housebuilders are relatively small compared to manufacturing companies in terms of their market shares. This is because the market of large building firms is also locally constrained. Even if they build nationally, their market is still composed of many regional markets, each having different characteristics. Large-scale builders often obtain better financing. Small builders may have higher financial costs because they posses less credibility. Some builders are subsidiaries of large corporations in other industries. These builders can obtain better financing because of the credibility of their parent companies. According to the National Association of Home Builders [NAHB, 1985];

> With the advent of the new home financing system of the early 1980's ..., the big builders' greatest advantage has been their access to the credit markets. Several large building firms, such as U.S. Homes, Ryan Homes and Plute Homes, have their [own] mortgage companies and enjoy direct access to the secondary mortgage market. They are thus able to issue builder bonds and raise capital through public offerings.
>
> ...Although obtaining financing is still a top priority among small builders, buyers of custom-built homes often obtain their own financing.

Large-scale builders can spread the costs of marketing and designing fees over their many housing units. Their greater marketing and designing capacities may differentiate their products in the market. They compete in the less expensive standardized housing market. Only large builders

can meet the demand of a mass market. Large tract developments can internalize the profits created by the economic upgrading of regional areas, and capitalize on the population movements. Because the market price of houses is currently determined by less efficient small- and medium-size builders, more economically efficient largee building firms may generate a larger profit per house. others.

Large-scale builders can generate profit through bulk purchasing of construction materials. The cost saving by carload procurement is significant for some elements. (e.g. roofing materials, plumbing, heating equipment, doors and windows.) If the amount of materials purchased in bulk surpasses a certain quantity, builders can eliminate some distribution channels and save more costs. However, they may incur increased management and warehousing costs. Some large builders and manufactured-house firms even produce construction materials and value-added components themselves in order to internalize profit inherent in materials production and distribution. Builders in both the U.S. and Japan who build more than 5,000 units a year develop and produce their own value-added building components in order to differentiate their products in the market. Because of the locally limited size of housing market, expanding business to materials production may be one of few ways for large firms to increase profits. However, the vertical

expansion of business does decrease the efficiency of a company operation. Also, builders have to hire less skilled laborers at a higher cost when sales expand in labor-scarce market. These factors anf the uncertainty and high cost involved in cultivating new markets tend to encourage even the largest builders to remain in the same familiar markets.

Table 3.9 and Fig. 3.3 show the synthetic cost distribution of a composite house which a small, medium or large builder might have built. Because the U.S. construction sector has kept a stable input structure since World War II (chapter I), the cost distribution in 1949 is largely indicative of the present situation. Because lands developed by larger-scale builders are usually less expensive than those utilized by smaller building firms, the actual total development cost per house may be less for a large builders.

Increasing the size of a housebuilding firm significantly reduces the cost of subcontracting. With many units under construction, it is possible eliminate idle time and increase individual skills through repetitive work within a larger project. Costs also decline as project size increases because of more efficient use of materials (e.g. concrete, paint). However, overhead and profit increase as firms grow, which offset savings in direct costs. As a result, the consumer receives only a small benefit from the

increased production efficiency of larger builders. The price of a house built by a large firm is only 3.0 percent less than price of a comparable house produced by a small builder and 9.1 percent less than that by a medium-size firm. However, the reduction of overhead by large-scale builders may not be necessary, because larger builders often offer better services, like better design, than do smaller size builders. Better design not only reduce costs but also increase the market value of a house.

Table 3.9. Cost Distribution in a Composite House by the Size of Builders in 1949, Total Cost of Small Builders = 100

	Small	Medium	Large
Labor			
Builder	18.0	15.8	13.3
Trade Contractors	14.1	12.2	11.4
Subtotal	32.1	28.0	24.8
Materials			
Builder	27.1	23.3	22.1
Trade Contractors	18.5	17.3	15.3
Subtotal	45.6	40.6	37.5
Overhead and Profit			
Builder	9.0	16.2	19.5
Trade Contractors	8.4	7.2	5.4
Subtotal	17.4	23.4	24.9
Financing and Incidentals	5.0	5.0	3.8
Total	100.0	97.0	90.9

Source: Maisel,"Housebuilding in Transition", 1953

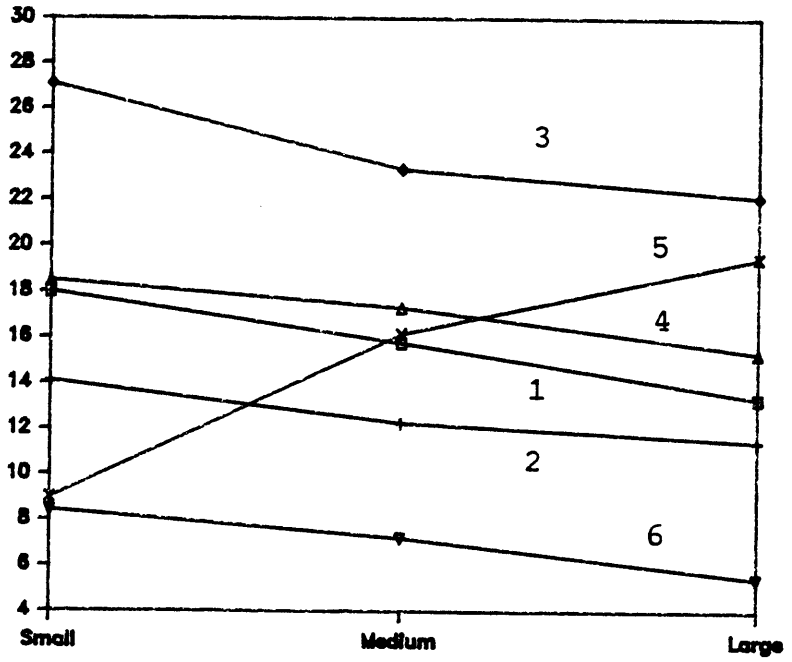
Table 3.10. Percentage Ratio of Inhouse Work and Subcontracting.
(compiled from Table 3.9.)

Builder	59.0	62.1	64.5
Subcontractors	41.0	37.8	35.4
Total	100.0	100.0	100.0

Fig.3.3. Cost Distribution of a Composite House by the Size of Builders in 1949, Total Cost of Small Builders = 100

Legend:
1 = Labor (direct)
2 = Labor (subcontract)
3 = Material (direct)
4 = Material (subcontract)
5 = Overhead & Profit (direct)
6 = Overhead & Profit (subcontract)

Source: Maisel, "Housebuilding in Transition," 1953



Construction technology does not change significantly once a project size surpasses 500 units. Even the largest development simply applies and repeats the same construction technology used in small projects. Time to install and adjust machinery will cause inefficiency unless several operations are steadily repeated. Therefore, only tract builders have a strongest incentive to mechanize on-site operations.

The production of a house can be divided into fabrication of building components and on-site assembly. The industrialization of construction materials shifts a builder's on-site role from fabrication to assembly. This trend devalues the higher on-site efficiency of larger builders and reduces the optimum scale of housebuilding firms.

The production efficiency of a housebuilder is more affected by the size of a project than by the number of houses each company builds in a year. The maximum size of a residential development is usually determined by external restrictions, such as the availablity of land or merchandising risks involved. If housing demand shifts from large-scale development to scattered remodeling construction, the housebuilding technology has to change accordingly. Therefore, the appropriate level of industrialization of housebuilding technology should differ

according to the each market characteristics.

In 1983, three U.S. housebuilders completed more than 10,000 houses and fourteen builders completed more than 5,000 houses in the U.S. [NAHB, 1985]. The number of companies that each build more than 5,000 units a year is larger in the U.S. than in Japan, although the largest Japanese manufactured-house producers build twice the number houses built by their U.S. counterparts. Large U.S. builders use a 2x4 system exclusively, while most Japanese manufactured-house producers use steel frame or wooden panel systems. To develop a 2x4 system for the mass production of housing in japan, it will be necessary to introduce the U.S. experience with the system.

Maisel has suggested four ways to improve the performance of housebuilding industry [1953]. Most of them apply to comtemporary housebuilders in each of the three groups. The improvements includes;

(1) at project or plant level;

a. cut waste of materials,
b. lower supervision and overhead cost,
c. reduce costs of land and incidentals,
d. improve use of labor
(e.g. reduce movement of men and equipment, reduce idle time, diminish reading of blueprints, increase skill by repetition, increase tooling, improve supervision, set work standards and improve controls, cut handling time for materials and equipment, and reduce turnover)

(2) at firm level;

a. better choice of technology
b. more accurate choice of inputs
c. research for improved technology
d. design
(e.g. better site planning, reduce size of structure, reduce variety of plans, substitute more efficient materials, rational arrangements of elements, simplify construction, and increase livability)
e. lower cost of materials
(e.g. cut out distribution channels, increase bargaining power, save on freight and handling, and reduce waste)
f. lower overhead and profit
(e.g. spread overhead over more units, reduce selling costs, obtain cheaper financing abd reduce profit margin)

(3) in scale and depth;

a. obtain optimum scale
(e.g. production or technical cost, selling or purchasing cost, financing, management, and risk)
b. integrate or disintegrate
(e.g. material suppliers, trade contractors, and other inputs)

(4) organization of industry;

a. change type of market in responce to
(e.g. amount of competition and fluctuation in demand)
b. create cooperative organizations for
(e.g. research, marketing and purchasing)
c. alter governmental policy
(e.g. credit, codes and guaranteed markets)
d. change relationships to suppliers
(e.g. improved bargaining and technology)

Government agency must take an initiative to improve the efficiency of housebuilding industry. Because the future housing market is expected to shift from new construction to remodeling construction, government may want to foster small size builders, which are suitable for small-scale scattered maintenance and repair construction. Government agency has to substitute the research and development of small size builders who can not afford to implement independently. In order to improve the distribution system of construction materials, government agency may have to negotiate with supplying industries on behalf of small-scale housebuilding firms.

5. CONCLUSIONS

Most people in the industry believe that present housebuilding technology has matured already and cannot be improved substantially. This belief limits the level of research and development in the housebuilding industry compared to higher levels in the supplying industries. Nevertheless, innovation in the supply systems may reduce the cost of housing significantly and even trigger drastic changes in this industry. Enterprises with sufficient ambition and capital to capture large share of the market through vertical and horizontal integration may come to dominate this field. As an industry, housebuilders should support research and development to protect present markets from outside competition and to secure their positions by expanding into other fields themselves.

Large housebuilders have already expanded vertically in many ways, including real estate development, architectural design, and financing. Entering the manufacturing sector by internalizing building material production may cause some conflict with existing supplying industries. Such expansion also require a company to carefully select the components it can merchandise successfully. Housebuilders are creating business by increasing their activities in maintenance and repair construction.

To implement horizontal integration, i.e. to develop new markets, housebuilders must emphasize the service phases of their business, which are design and maintenance. Competitive marketing of houses requires builders to differentiate their services. Large-scale builders do not always have the advantage in developing new markets, because the present housing market is shifting toward geographically scattered building reconstruction. Entering such an unfamiliar business involves a proportionally greater danger of inefficiency and operational risk for larger builders.

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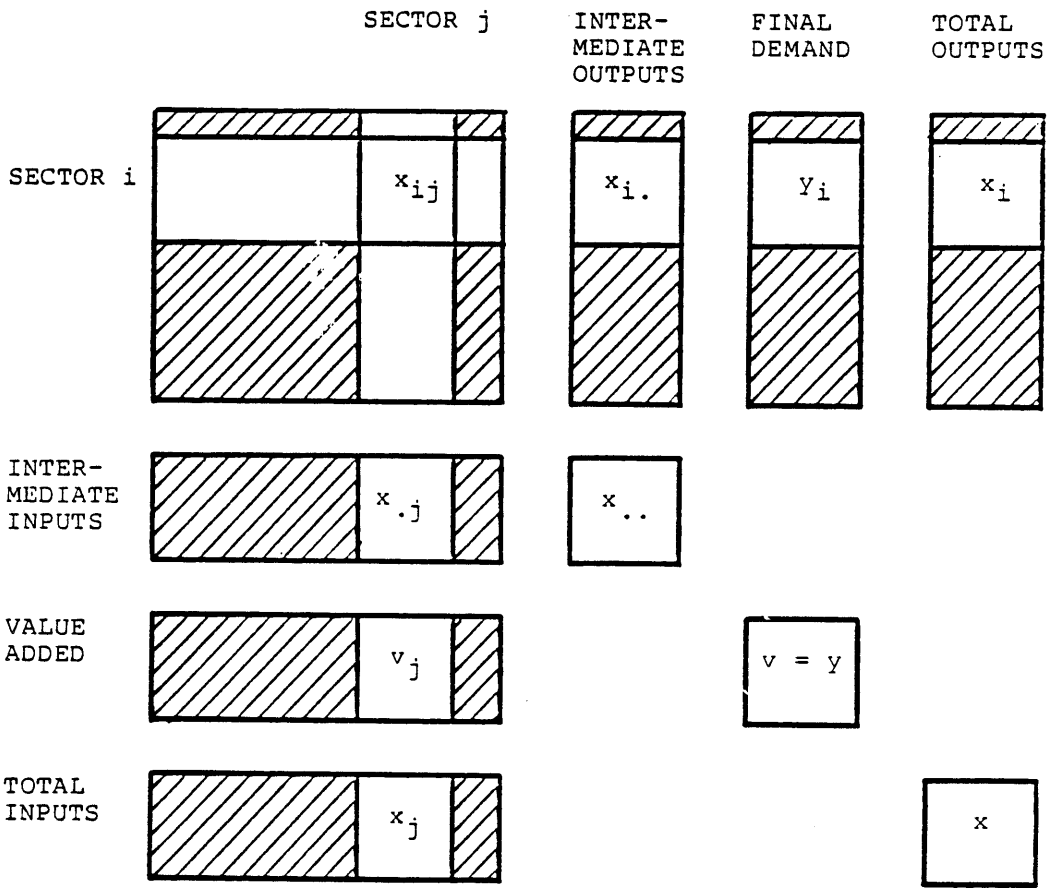
APPENDIX A

Definitions of Indicators of Chapter 1

Source: Direct and Indirect Resource Utilization by the Construction Sectors: the case of the U.S. since World war II

Ranko Bon, March 1986

Fig.1 Fundamantal Input-Output Relationships



where

x_{ij} = intermediate flow from sector i to sector j

$x_{..}$ = total intermediate flows

v = gross national income

y = gross national product

$x_j = x_{.j} + v_j$

$x_i = x_{i.} + y_i$

$x = x_{..} + v = x_{..} + y$

(1) x(i,j) = flow from sector i to sector j
(2) x(i) = total output of sector i
(3) x(j) = total input of sector j
(4) x(i,.) = total intermediate output of sector i
(5) x(.,j) = total intermediate input of sector j
(6) x(.,.) = total intermediate input (or output) in the national economy
(7) y(i) = final demand for the goooods and services of sector i
(8) y = total final demand (gross national product)
(9) v(j) = value added by sector j
(10) v = total value added (gross national income)
(11) x = total output (or input) in the national economy
(12) a(i,j) = dirct-input coefficient [x(i,j)/x(j)], representing the purchases of the sector j from sector i per $1.00 of the total input of sector j
(13) l(i,j) = tottal-input coefficient, representing the effect of a $1.00 change in final demand for the goods and services of sector j on the total output of sector i
(14) l(.,j) = column sum of total-input coefficients for sector j, representing theeffect of a $1.00 change in final demand of sector j on total output of all other sectors (output or demand multiplier, or total-backward linkage indicator);
(15) b(i,j) = direct-output coefficient [x(i,j)/x(i)], representing the sales of sector i to sector j per $1.00 of total output of sector i;
(16) g(i,j) = total-output coefficient, representing the effect of a $1.00 change in value added by sector i on total input of sector j;
(17) g(i,.) = row sum of total-output coefficients for sector i, representing the effect of a $1.00 change in value added by sector i on total input of all other sectors (input or supply multiplier, or total-forward linkage indicator).

(18) x(i)/x	=	total output (or input) of sector i to total output (or input) of the national economy ratio;
(19) x(.,j)/x(j)	=	intermediate to total input ratio for sector j (direct-backward linkage indicator);
(20) x(i,.)/x(i)	=	intermediate to total output ratio for sector i (direct-forward linkage indicator);
(21) y/x	=	gross national product to total output ratio;
(22) y(i)/y	=	final demand of sector i to total final demand ratio (the share of sector i in gross national product);
(23) v(j)/x(j)	=	value added to total input ratio for sector j;
(24) v/x	=	gross national income to total input ratio;
(25) v(j)/v	=	value added by sector j to total value added ratio (the share of sector j in gross national income);

APPENDIX B

The Role of Construction in the National Economy: A Comparison of the Fundamantal Structure of the U.S. and Japanese Input-Output Tables since World War II (part)

by

Ranko Bon with Kazunobu Minami

This paper will appear in
Habitat International vol. 10, NO.4, 1986

The demand and supply patterns in the U.S. from 1947 to 1977 are presented in Fig. 1. The demand and supply patterns in Japan from 1960 to 1980 are presented in Fig. 2. In both figures the blank circle denotes a coefficient larger than 5 percent of either total input or output while the black circle denotes a coefficient which is larger than 10 percent of either total input or output. The figures to the right of each table show the respective number of black and blank circles in the table. Although some information is lost in this form of presentation, it is valuable for two reasons: first, it eliminates inaccuracies created by the scheme used in deriving the nine-sector aggregation of the Japanese tables; and second it reconciles the incompatibilities associated with the differences in relative prices.

Fig. 1 shows that in the U.S. demand patterns are less stable over time than are the supply patterns. Two observations may be made. First, demand patterns exhibit a major shift from the upper right corner to the lower left corner of the tables. This is true especially for the flows larger than 10 percent of the total input. The main reason for this shift is in the increasing importance of services, as well as trade and transportation, concomitantly decreasing importance of manufacturing and government enterprises in the U.S. economy. Second, the supply

patterns in 1947, 1958, 1963, and 1967 tables exhibit a very large proportion of flows larger than 10 percent of total output in relation to the flows larger than 5 percent of total output. Two sectors, manufacturing and services, remained the main destinations of goods supplied by other sectors throughout this period, despite the shift in demand patterns.

In terms of both demand and supply patterns, the construction sector in the U.S. has exhibited considerable stability. On the demand side, a large proportion of its inputs comes from manufacturing, trade and transportation, and services. On the supply side, a large proportion of output of manufacturing, and trade and transportation goes to the construction sector. Also, a large proportion of the construction sector's output goes to services, that is, to its real estate component. The intersectoral supply of the construction sector is comprised of maintenance and repair construction. Therefore, the output of new construction (total construction less maintenance and repair construction) goes to final demand in its entirety by national income accounting convention.

The construction sector's demand and supply patterns are stable because the U.S. economy is mature; a large portion of its building stock is already in place. It might be interesting to compare the interdependence between new

construction and maintenance and repair construction subsectors, because the latter probably will increase in importance in a mature economy. MacAuley [1981, p. 7] supports these conjecture:

> Following a long period of rapid growth, the inflation-adjusted value of new construction put-in-place has apparently been on a downward trend since the early 1970's. (The all-time peak year was 1973.) When new construction is measured against population growth or GNP growth, the downward trend is more severe.
>
> Maintenance and repair (M&R) construction has been growing much faster than new construction since 1967. Largely for this reason, receipts of the construction industry have grown faster than the value of new construction.

Fig. 2 demonstrates that both demand and supply patterns have exhibit considerable change, with exception of the manufacturing sector. Not surprisingly, the Japanese economy has reflected the increasing importance of three sectors: trade and finance, transportation, and services.

However, despite dramatic changes in the Japanese economy during this period, the construction sector has exhibited surprising stability in both demand and supply patterns. On the demand side, a large proportion of its inputs comes from manufacturing, and trade and finance. On the supply side, a large proportion of output of mining, manufacturing, and transportation goes to the construction sector. This may suggest that the construction sector in

Japan can be considered a sector that has already reached maturity. An alternative suggestion is that the Japanese construction sector needs to expand into new areas. The White Paper on Construction 1983 [1983, p. 89], underscores this interpretation.

> Lately, the [construction] industry has attempted to develop the market for the extension, remodeling and repairing of houses which is jointly advanced by the public and private sectors to secure stable demand for the industry. Participation in overseas construction work is also increasing.

Despite the differences between the aggregation levels of the U.S. and Japanese input-output tables, it is quite clear that there is a significant similarity between the U.S. and Japanese patterns of demand and supply. This is especially evident if one compares the U.S. economy in 1963 and 1967, to the Japanese economy in 1975 and 1980. However, there are some significant differences. First, in Japan there is a marked predominance of the manufacturing sector over the emerging service-related sectors. And second, the number of coefficients included in the analysis has decreased in the case of the U.S. in 1972 and 1977, while it has increased in Japan in 1975 and 1980. It is possible that the U.S. economy, being more mature, has become more evenly interdependent in the recent period.

More important for our present purposes, the comparison of the construction sectors in the two countries shows some obvious differences, despite the similarity from the point of view of the overall stability of demand and supply patterns. First, in contradiction to the U.S., the Japanese construction industry relies heavily on supplies from the mining [gravel and stone] sector. This is because concrete is more widely used as basic construction material. Second, the Japanese construction sector is not a significant supplier of the real estate component of the trade and finance sector. This suggests that the maintenance and repair construction subsector is still in its infancy in Japan (as of 1980).

Fig. 1. Demand and Supply Patterns in the U.S. 1947 -1977

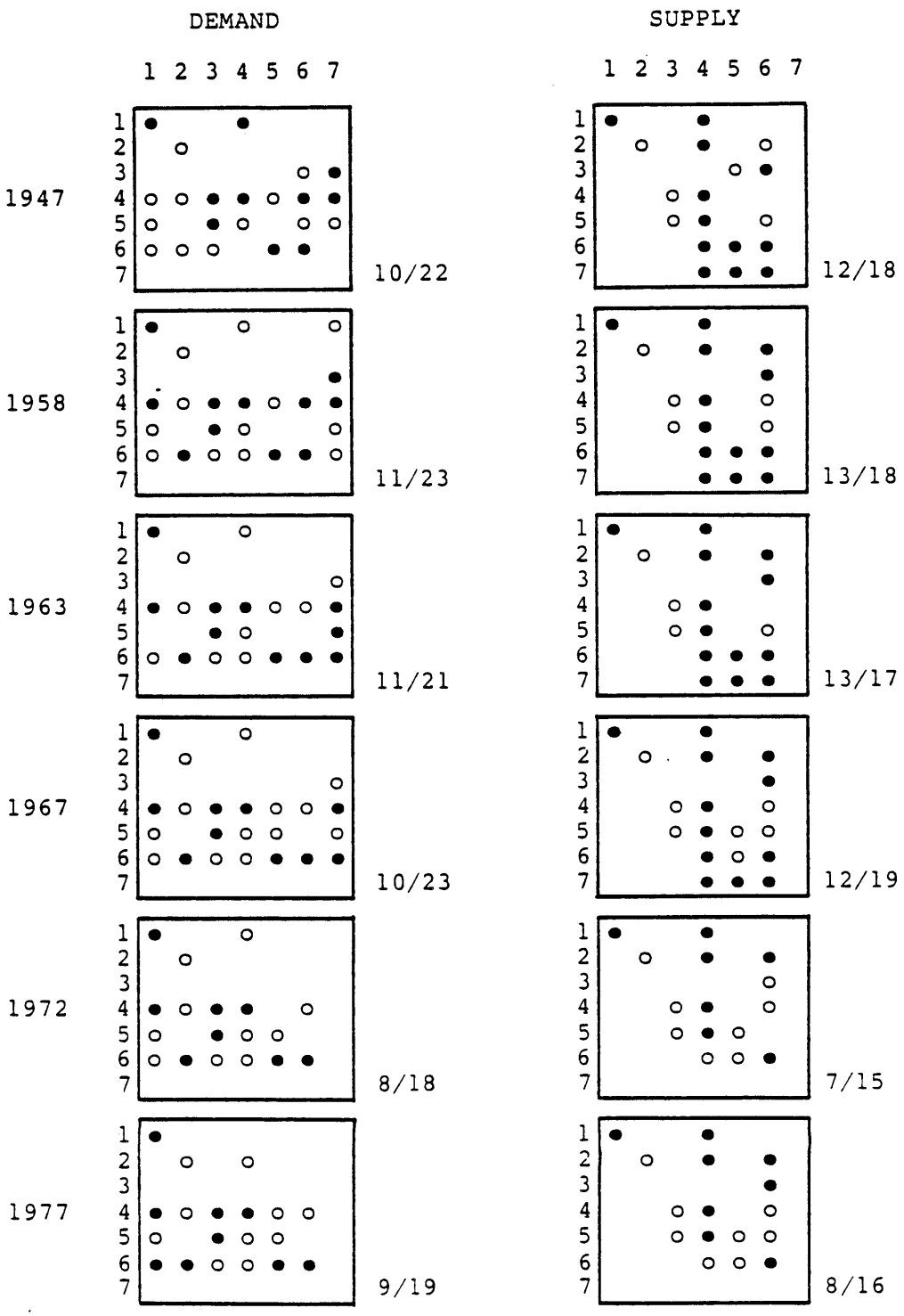
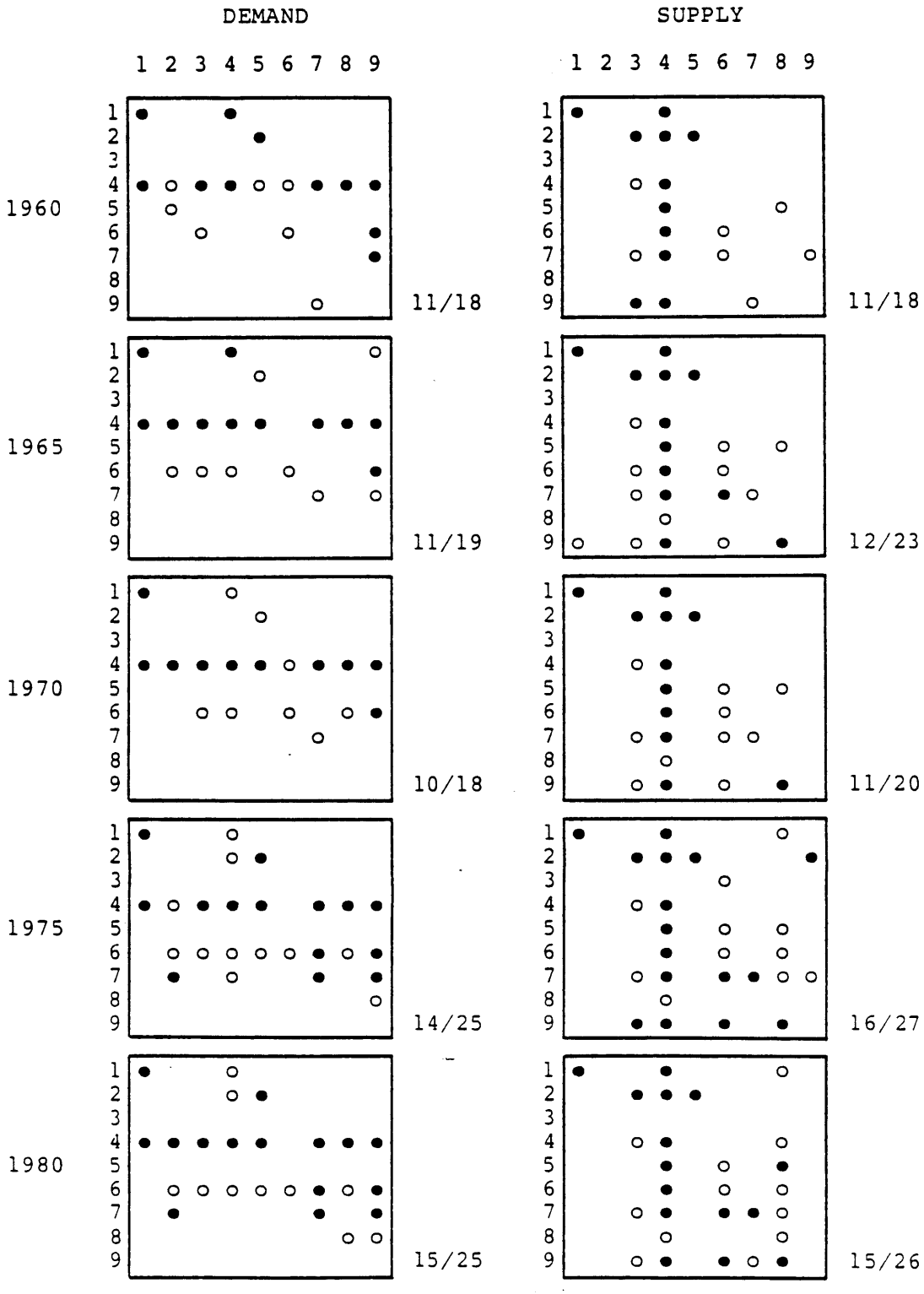


Fig. 2. Demand and Supply Patterns in Japan 1960 -1980



APPENDIX C

Japanese Natioanl Input-Output Tables
1960 - 1980
(in million yens)

Legend

AGRC.	:Agriculture
MINING	:Mining
MANUF.	:Manufacturing
CONST.	:Construction
UTILITY	:Utility
FINANCE	:Trade and Finance
TRANSP.	:Transportation
SERVICE	:Service (includes Government Service)
N.A.B.	:Not Adequately Described (undistributed)
SUB TOTA	:Sub Total
V.A.	:Value Added
F.DEMAND	:Final Demand

I-O Table, 1960

1960	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	4897	120	23917	258	0	-11	0	69	239	29490	1892	31382
MINING	11	63	6002	510	878	4	150	66	52	7737	-3806	3931
MANUF.	4148	383	88556	16553	604	2384	2860	3452	3937	122878	72485	195363
CONST.	156	72	607	31	255	1189	162	451	4	2927	28888	31815
UTILITY	62	228	2859	72	99	306	259	568	145	4599	1933	6532
FINANCE	568	123	7409	1831	118	2810	424	1031	1220	15534	24612	40146
TRANSP.	259	101	4253	1319	238	1362	764	813	991	10100	7937	18037
SERVICE	51	48	1661	195	30	755	183	1166	2	4092	29752	33844
N.A.D.	205	184	5814	989	146	397	998	448	0	9182	410	9592
SUB TOTA	10357	1321	141077	21766	2369	9197	5801	8063	6589	206540	164101	370641
V.A.	21026	2609	54285	10048	4163	30949	12236	25781	3004	164101	0	164101
TOTAL	31383	3930	195362	31814	6532	40147	18037	33844	9593	370641	164101	534742

A Matrix

1960	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1560	0.0305	0.1224	0.0081	0.0000	-0.0003	0.0000	0.0020	0.0249	0.0796	0.0115	0.0587
MINING	0.0004	0.0160	0.0307	0.0160	0.1344	0.0001	0.0083	0.0020	0.0054	0.0209	-0.0232	0.0074
MANUF.	0.1322	0.0975	0.4533	0.5203	0.0925	0.0594	0.1586	0.1020	0.4104	0.3315	0.4417	0.3653
CONST.	0.0050	0.0183	0.0031	0.0010	0.0390	0.0296	0.0090	0.0133	0.0004	0.0079	0.1760	0.0595
UTILITY	0.0020	0.0580	0.0146	0.0023	0.0152	0.0076	0.0144	0.0168	0.0151	0.0124	0.0118	0.0122
FINANCE	0.0181	0.0313	0.0379	0.0576	0.0181	0.0700	0.0235	0.0305	0.1272	0.0419	0.1500	0.0751
TRANSP.	0.0083	0.0257	0.0218	0.0415	0.0364	0.0339	0.0424	0.0240	0.1033	0.0273	0.0484	0.0337
SERVICE	0.0016	0.0122	0.0085	0.0061	0.0046	0.0188	0.0101	0.0345	0.0002	0.0110	0.1813	0.0633
N.A.D.	0.0065	0.0468	0.0298	0.0311	0.0224	0.0099	0.0553	0.0132	0.0000	0.0248	0.0025	0.0179
SUB TOTA	0.3300	0.3361	0.7221	0.6842	0.3627	0.2291	0.3216	0.2382	0.6869	0.5573	1.0000	0.6931
V.A.	0.6700	0.6639	0.2779	0.3158	0.6373	0.7709	0.6784	0.7618	0.3131	0.4427	0.0000	0.3069

B Matrix

1960	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1560	0.0038	0.7621	0.0082	0.0000	-0.0004	0.0000	0.0022	0.0076	0.9397	0.0603	1.0000
MINING	0.0028	0.0160	1.5268	0.1297	0.2234	0.0010	0.0382	0.0168	0.0132	1.9682	-0.9682	1.0000
MANUF.	0.0212	0.0020	0.4533	0.0847	0.0031	0.0122	0.0146	0.0177	0.0202	0.6290	0.3710	1.0000
CONST.	0.0049	0.0023	0.0191	0.0010	0.0080	0.0374	0.0051	0.0142	0.0001	0.0920	0.9080	1.0000
UTILITY	0.0095	0.0349	0.4377	0.0110	0.0152	0.0468	0.0397	0.0870	0.0222	0.7041	0.2959	1.0000
FINANCE	0.0141	0.0031	0.1846	0.0456	0.0029	0.0700	0.0106	0.0257	0.0304	0.3869	0.6131	1.0000
TRANSP.	0.0144	0.0056	0.2358	0.0731	0.0132	0.0755	0.0424	0.0451	0.0549	0.5600	0.4400	1.0000
SERVICE	0.0015	0.0014	0.0491	0.0058	0.0009	0.0223	0.0054	0.0345	0.0001	0.1209	0.8791	1.0000
N.A.D.	0.0214	0.0192	0.6061	0.1031	0.0152	0.0414	0.1040	0.0467	0.0000	0.9573	0.0427	1.0000
SUB TOTA	0.0279	0.0036	0.3806	0.0587	0.0064	0.0248	0.0157	0.0218	0.0178	0.5573	0.4427	1.0000
V.A.	0.1281	0.0159	0.3308	0.0612	0.0254	0.1886	0.0746	0.1571	0.0183	1.0000	0.0000	1.0000

I-O Table, 1965

1965	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	5482	75	36420	160	0	0	0	60	967	43166	4299	47465
MINING	9	57	11051	2101	971	1	80	38	24	14331	-8423	5908
MANUF.	7524	902	150106	28023	1358	4803	5924	7797	3548	211784	136349	348133
CONST.	264	64	930	60	440	3069	266	627	5	5725	60675	66400
UTILITY	90	239	5396	374	204	811	487	1158	271	9029	4078	13107
FINANCE	1466	339	17585	4947	223	5879	1346	2584	1109	35478	63281	98759
TRANSP.	666	147	9050	2831	334	3893	3050	1811	689	22472	14766	37238
SERVICE	69	48	4161	508	206	2392	248	2091	316	10038	62826	72864
N.A.D.	920	220	6065	879	434	594	143	1223	-1	10477	-36	10441
SUB TOTA	16489	2091	240764	41684	4169	21442	11544	17388	6928	362499	337816	700315
V.A.	30975	3815	107370	24717	8938	77315	25695	55477	3514	337816	0	337816
TOTAL	47464	5906	348134	66400	13107	98758	37239	72865	10441	700315	337816	1038131

A Matrix

1965	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1155	0.0127	0.1046	0.0024	0.0000	0.0000	0.0000	0.0008	0.0926	0.0616	0.0127	0.0457
MINING	0.0002	0.0097	0.0317	0.0316	0.0741	0.0000	0.0021	0.0005	0.0023	0.0205	-0.0249	0.0057
MANUF.	0.1585	0.1527	0.4312	0.4220	0.1036	0.0486	0.1591	0.1070	0.3398	0.3024	0.4036	0.3353
CONST.	0.0056	0.0108	0.0027	0.0009	0.0336	0.0311	0.0071	0.0086	0.0005	0.0082	0.1796	0.0640
UTILITY	0.0019	0.0405	0.0155	0.0056	0.0156	0.0082	0.0131	0.0159	0.0260	0.0129	0.0121	0.0126
FINANCE	0.0309	0.0574	0.0505	0.0745	0.0170	0.0595	0.0361	0.0355	0.1062	0.0507	0.1873	0.0951
TRANSP.	0.0140	0.0249	0.0260	0.0426	0.0255	0.0394	0.0819	0.0249	0.0660	0.0321	0.0437	0.0359
SERVICE	0.0015	0.0081	0.0120	0.0077	0.0157	0.0242	0.0067	0.0287	0.0303	0.0143	0.1860	0.0702
N.A.D.	0.0194	0.0373	0.0174	0.0132	0.0331	0.0060	0.0038	0.0168	-0.0001	0.0150	-0.0001	0.0101
SUB TOTA	0.3474	0.3540	0.6916	0.6278	0.3181	0.2171	0.3100	0.2386	0.6635	0.5176	1.0000	0.6746
V.A.	0.6526	0.6460	0.3084	0.3722	0.6819	0.7829	0.6900	0.7614	0.3366	0.4824	0.0000	0.3254

B Matrix

1965	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1155	0.0016	0.7673	0.0034	0.0000	0.0000	0.0000	0.0013	0.0204	0.9094	0.0906	1.0000
MINING	0.0015	0.0096	1.8705	0.3556	0.1644	0.0002	0.0135	0.0064	0.0041	2.4257	-1.4257	1.0000
MANUF.	0.0216	0.0026	0.4312	0.0805	0.0039	0.0138	0.0170	0.0224	0.0102	0.6083	0.3917	1.0000
CONST.	0.0040	0.0010	0.0140	0.0009	0.0066	0.0462	0.0040	0.0094	0.0001	0.0862	0.9138	1.0000
UTILITY	0.0069	0.0182	0.4117	0.0285	0.0156	0.0619	0.0372	0.0883	0.0207	0.6889	0.3111	1.0000
FINANCE	0.0148	0.0034	0.1781	0.0501	0.0023	0.0595	0.0136	0.0262	0.0112	0.3592	0.6408	1.0000
TRANSP.	0.0179	0.0039	0.2430	0.0760	0.0090	0.1045	0.0819	0.0486	0.0185	0.6035	0.3965	1.0000
SERVICE	0.0009	0.0007	0.0571	0.0070	0.0028	0.0328	0.0034	0.0287	0.0043	0.1378	0.8622	1.0000
N.A.D.	0.0881	0.0211	0.5809	0.0842	0.0416	0.0569	0.0137	0.1171	-0.0001	1.0034	-0.0034	1.0000
SUB TOTA	0.0235	0.0030	0.3438	0.0595	0.0060	0.0306	0.0165	0.0248	0.0099	0.5176	0.4824	1.0000
V.A.	0.0917	0.0113	0.3178	0.0732	0.0265	0.2289	0.0761	0.1642	0.0104	1.0000	0.0000	1.0000

I-O Table, 1970

1970	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	9109	38	55848	237	0	0	0	2395	461	68088	3047	71135
MINING	3	39	25922	3505	1607	1	28	17	443	31565	-21973	9592
MANUF.	12255	1960	370930	72820	3715	13866	9637	29545	8234	522960	291330	814290
CONST.	522	80	1964	225	817	7785	626	1321	99	13439	149149	162588
UTILITY	128	233	10674	773	384	2048	968	2227	312	17748	8530	26278
FINANCE	2181	391	47089	12103	741	19020	3144	9655	7589	101914	149127	251041
TRANSP.	852	224	16325	5500	468	6772	5969	2580	978	39669	57280	96949
SERVICE	12	48	9783	3085	377	6351	941	5607	1065	27269	121033	148302
N.A.D.	911	262	17582	2894	697	2370	1165	6668	0	32549	2450	34999
SUB TOTA	25973	3275	556117	101145	8806	58212	22479	60012	19183	855201	759976	1615177
V.A.	45163	6317	258172	61444	17473	192831	51960	110800	15816	759976	0	759976
TOTAL	71136	9592	814289	162587	26279	251042	74439	170812	34999	1615177	759976	2375153

A Matrix

1970	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1281	0.0040	0.0686	0.0015	0.0000	0.0000	0.0000	0.0140	0.0132	0.0422	0.0040	0.0299
MINING	0.0000	0.0041	0.0318	0.0216	0.0612	0.0000	0.0004	0.0001	0.0127	0.0195	-0.0289	0.0040
MANUF.	0.1723	0.2043	0.4555	0.4479	0.1414	0.0552	0.1295	0.1730	0.2353	0.3238	0.3833	0.3428
CONST.	0.0073	0.0083	0.0024	0.0014	0.0311	0.0310	0.0084	0.0077	0.0028	0.0083	0.1963	0.0685
UTILITY	0.0018	0.0243	0.0131	0.0048	0.0146	0.0082	0.0130	0.0130	0.0089	0.0110	0.0112	0.0111
FINANCE	0.0307	0.0408	0.0578	0.0744	0.0282	0.0758	0.0422	0.0565	0.2168	0.0631	0.1962	0.1057
TRANSP.	0.0120	0.0234	0.0200	0.0338	0.0178	0.0270	0.0802	0.0151	0.0279	0.0246	0.0754	0.0408
SERVICE	0.0002	0.0050	0.0120	0.0190	0.0143	0.0253	0.0126	0.0328	0.0304	0.0169	0.1593	0.0624
N.A.D.	0.0128	0.0273	0.0216	0.0178	0.0265	0.0094	0.0157	0.0390	0.0000	0.0202	0.0032	0.0147
SUB TOTA	0.3651	0.3414	0.6829	0.6221	0.3351	0.2319	0.3020	0.3513	0.5481	0.5295	1.0000	0.6800
V.A.	0.6349	0.6586	0.3171	0.3779	0.6649	0.7681	0.6980	0.6487	0.4519	0.4705	0.0000	0.3200

B Matrix

1970	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1281	0.0005	0.7851	0.0033	0.0000	0.0000	0.0000	0.0337	0.0065	0.9572	0.0428	1.0000
MINING	0.0003	0.0041	2.7025	0.3654	0.1675	0.0001	0.0029	0.0018	0.0462	3.2908	-2.2908	1.0000
MANUF.	0.0150	0.0024	0.4555	0.0894	0.0046	0.0170	0.0118	0.0363	0.0101	0.6422	0.3578	1.0000
CONST.	0.0032	0.0005	0.0121	0.0014	0.0050	0.0479	0.0039	0.0081	0.0006	0.0827	0.9173	1.0000
UTILITY	0.0049	0.0089	0.4062	0.0294	0.0146	0.0779	0.0368	0.0847	0.0119	0.6754	0.3246	1.0000
FINANCE	0.0087	0.0016	0.1876	0.0482	0.0030	0.0758	0.0125	0.0385	0.0302	0.4060	0.5940	1.0000
TRANSP.	0.0088	0.0023	0.1684	0.0567	0.0048	0.0699	0.0616	0.0266	0.0101	0.4092	0.5908	1.0000
SERVICE	0.0001	0.0003	0.0660	0.0208	0.0025	0.0428	0.0063	0.0378	0.0072	0.1839	0.8161	1.0000
N.A.D.	0.0260	0.0075	0.5024	0.0827	0.0199	0.0677	0.0333	0.1905	0.0000	0.9300	0.0700	1.0000
SUB TOTA	0.0161	0.0020	0.3443	0.0626	0.0055	0.0360	0.0139	0.0372	0.0119	0.5295	0.4705	1.0000
V.A.	0.0594	0.0083	0.3397	0.0808	0.0230	0.2537	0.0684	0.1458	0.0208	1.0000	0.0000	1.0000

I-O Table, 1975

1975	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	SUB TOTAL	TOTAL
AGRC.	13936	41	99590	372	0	0	3	6603	2549	123094	7287	130381
MINING	1	43	85442	6591	8275	0	2	49	1860	102262	-87148	15114
MANUF.	25486	1312	617015	123821	13009	15143	69738	66994	19888	952225	498018	1450243
CONST.	211	26	1452	85	1589	18397	732	2484	6	24980	315759	340739
UTILITY	333	361	24022	2325	1309	3422	2967	9039	1763	45541	20881	66422
FINANCE	6285	1038	96464	26668	3984	53738	23322	34953	10693	257002	310731	567733
TRANSP.	3493	3626	36075	17153	2259	23488	23355	15556	11067	136072	84765	220837
SERVICE	56	101	25949	7588	1018	18046	3531	16773	3806	76869	392835	469704
N.A.D.	713	437	24205	7908	1389	7115	2953	10556	0	55598	5533	61131
SUB TOTA	50514	6985	1010213	192511	32833	139348	126605	163004	51632	1773645	4548663	3322308
V.A.	79868	8129	440031	148227	33590	428385	94233	306699	9500	1548664	0	1548664
TOTAL	130382	15114	1450243	340739	66423	567733	220837	469704	61132	3322308	1548663	4870971

A Matrix

1975	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1069	0.0027	0.0687	0.0011	0.0000	0.0000	0.0000	0.0141	0.0417	0.0371	0.0047	0.0268
MINING	0.0000	0.0028	0.0589	0.0193	0.1246	0.0000	0.0000	0.0001	0.0304	0.0308	-0.0563	0.0031
MANUF.	0.1955	0.0868	0.4255	0.3634	0.1959	0.0267	0.3158	0.1426	0.3253	0.2866	0.3216	0.2977
CONST.	0.0016	0.0017	0.0010	0.0002	0.0239	0.0324	0.0033	0.0053	0.0001	0.0075	0.2039	0.0700
UTILITY	0.0026	0.0239	0.0166	0.0068	0.0197	0.0060	0.0134	0.0192	0.0288	0.0137	0.0135	0.0136
FINANCE	0.0482	0.0687	0.0665	0.0783	0.0600	0.0947	0.1056	0.0744	0.1749	0.0774	0.2006	0.1166
TRANSP.	0.0268	0.2399	0.0249	0.0503	0.0340	0.0414	0.1058	0.0331	0.1810	0.0410	0.0547	0.0453
SERVICE	0.0004	0.0067	0.0179	0.0223	0.0153	0.0318	0.0160	0.0357	0.0623	0.0231	0.2537	0.0964
N.A.D.	0.0055	0.0289	0.0167	0.0232	0.0209	0.0125	0.0134	0.0225	0.0000	0.0167	0.0036	0.0126
SUB TOTA	0.3874	0.4622	0.6966	0.5650	0.4943	0.2454	0.5733	0.3470	0.8446	0.5339	1.0000	0.6821
V.A.	0.6126	0.5378	0.3034	0.4350	0.5057	0.7546	0.4267	0.6530	0.1554	0.4661	0.0000	0.3179

B Matrix

1975	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1069	0.0003	0.7638	0.0029	0.0000	0.0000	.0000	0.0506	0.0196	0.9441	0.0559	1.0000
MINING	0.0001	0.0028	5.6532	0.4361	0.5475	0.0000	0.0001	0.0032	0.1231	6.7660	-5.7660	1.0000
MANUF.	0.0176	0.0009	0.4255	0.0854	0.0090	0.0104	0.0481	0.0462	0.0137	0.6566	0.3434	1.0000
CONST.	0.0006	0.0001	0.0043	0.0002	0.0047	0.0540	0.0021	0.0073	0.0000	0.0733	0.9267	1.0000
UTILITY	0.0050	0.0054	0.3617	0.0350	0.0197	0.0515	0.0447	0.1361	0.0265	0.6856	0.3144	1.0000
FINANCE	0.0111	0.0018	0.1699	0.0470	0.0070	0.0947	0.0411	0.0616	0.0188	0.4527	0.5473	1.0000
TRANSP.	0.0158	0.0164	0.1634	0.0777	0.0102	0.1064	0.1058	0.0704	0.0501	0.6162	0.3838	1.0000
SERVICE	0.0001	0.0002	0.0552	0.0162	0.0022	0.0384	0.0075	0.0357	0.0081	0.1637	0.8363	1.0000
N.A.D.	0.0117	0.0071	0.3960	0.1294	0.0227	0.1164	0.0483	0.1727	0.0000	0.9095	0.0905	1.0000
SUB TOTA	0.0152	0.0021	0.3041	0.0579	0.0099	0.0419	0.0381	0.0491	0.0155	0.5339	0.4661	1.0000
V.A.	0.0516	0.0052	0.2841	0.0957	0.0381	0.2766	0.0608	0.1980	0.0061	1.0000	0.0000	1.0000

I-O Table, 1980

1980	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	20119	54	126431	855	0	0	10	11951	125	159545	1569	161114
MINING	1	46	155558	11126	20238	0	1	87	704	187762	-161250	26512
MANUF.	37151	2731	1081373	207789	31368	25153	117862	129979	36875	1670284	765630	2435914
CONST.	739	84	5461	598	2789	23197	2162	6881	442	42352	510222	552574
UTILITY	776	649	53022	5030	4029	7788	6899	24566	2979	105739	41766	147505
FINANCE	7358	1750	152395	44249	11121	79123	41810	58230	12828	409701	529788	939489
TRANSP.	5334	6088	54486	23117	4160	44193	40015	31133	10653	219403	285895	505298
SEVICE	164	222	54450	18759	3558	36050	9982	45564	5553	174301	534024	708325
N.A.D.	1904	534	39443	4100	1459	14570	4888	10751	0	80048	-5870	74178
SUB TOTA	73547	12158	1722618	319086	78723	230073	223629	319142	70158	3049133	2501274	5550407
V.A.	87567	13854	713296	233488	68783	709415	148916	521936	4020	2501275		2501275
TOTAL	161114	26012	2435914	552574	147505	939489	372545	841078	74178	5550408	2501274	8051682

A Matrix

1980	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1249	0.0021	0.0519	0.0015	0.0000	0.0000	0.0000	0.0142	0.0017	0.0287	0.0006	0.0200
MINING	0.0000	0.0018	0.0639	0.0201	0.1372	0.0000	0.0000	0.0001	0.0095	0.0338	-0.0645	0.0033
MANUF.	0.2306	0.1050	0.4439	0.3760	0.2127	0.0268	0.3164	0.1545	0.4971	0.3009	0.3061	0.3025
CONST.	0.0046	0.0032	0.0022	0.0011	0.0189	0.0247	0.0058	0.0082	0.0060	0.0076	0.2040	0.0686
UTILITY	0.0048	0.0250	0.0218	0.0091	0.0273	0.0083	0.0185	0.0292	0.0402	0.0191	0.0167	0.0183
FINANCE	0.0457	0.0673	0.0626	0.0801	0.0754	0.0842	0.1122	0.0692	0.1729	0.0738	0.2118	0.1167
TRANSP.	0.0331	0.2340	0.0224	0.0418	0.0282	0.0470	0.1074	0.0370	0.1436	0.0395	0.1143	0.0628
SEVICE	0.0010	0.0085	0.0224	0.0339	0.0241	0.0384	0.0268	0.0542	0.0749	0.0314	0.2135	0.0880
N.A.D.	0.0118	0.0205	0.0162	0.0074	0.0099	0.0155	0.0131	0.0128	0.0000	0.0144	-0.0023	0.0092
SUB TOTA	0.4565	0.4674	0.7072	0.5775	0.5337	0.2449	0.6003	0.3794	0.9458	0.5494	1.0000	0.6893
V.A.	0.5435	0.5326	0.2928	0.4225	0.4663	0.7551	0.3997	0.6206	0.0542	0.4506	0.0000	0.3107

B Matrix

1980	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	SUB TOTAL	F.DEMAND	TOTAL
AGRC.	0.1249	0.0003	0.7847	0.0053	0.0000	0.0000	0.0001	0.0742	0.0008	0.9903	0.0097	1.0000
MINING	0.0000	0.0017	5.8675	0.4197	0.7634	0.0000	0.0000	0.0033	0.0266	7.0822	-6.0822	1.0000
MANUF.	0.0153	0.0011	0.4439	0.0853	0.0129	0.0103	0.0484	0.0534	0.0151	0.6857	0.3143	1.0000
CONST.	0.0013	0.0002	0.0099	0.0011	0.0050	0.0420	0.0039	0.0125	0.0008	0.0766	0.9234	1.0000
UTILITY	0.0053	0.0044	0.3595	0.0341	0.0273	0.0528	0.0468	0.1665	0.0202	0.7169	0.2831	1.0000
FINANCE	0.0078	0.0019	0.1622	0.0471	0.0118	0.0842	0.0445	0.0620	0.0137	0.4361	0.5639	1.0000
TRANSP.	0.0106	0.0120	0.1078	0.0457	0.0082	0.0875	0.0792	0.0616	0.0211	0.4342	0.5658	1.0000
SEVICE	0.0002	0.0003	0.0769	0.0265	0.0050	0.0509	0.0141	0.0643	0.0078	0.2461	0.7539	1.0000
N.A.D.	0.0257	0.0072	0.5317	0.0553	0.0197	0.1964	0.0659	0.1449	0.0000	1.0791	-0.0791	1.0000
SUB TOTA	0.0133	0.0022	0.3104	0.0575	0.0142	0.0415	0.0403	0.0575	0.0126	0.5494	0.4506	1.0000
V.A.	0.0350	0.0055	0.2852	0.0933	0.0275	0.2836	0.0595	0.2087	0.0016	1.0000	0.0000	1.0000

(I-A) Inverse

1960	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.2353	0.0852	0.2980	0.1764	0.0534	0.0296	0.0632	0.0423	0.1647	2.1483
MINING	0.0129	1.0367	0.0696	0.0563	0.1524	0.0093	0.0261	0.0145	0.0407	1.4183
MANUF.	0.3401	0.3142	2.0218	1.1201	0.3181	0.1975	0.4133	0.2649	0.9130	5.9030
CONST.	0.0094	0.0256	0.0145	1.0123	0.0465	0.0346	0.0146	0.0180	0.0134	1.1889
UTILITY	0.0094	0.0684	0.0379	0.0264	1.0315	0.0135	0.0253	0.0240	0.0361	1.2727
FINANCE	0.0428	0.0629	0.1043	0.1274	0.0502	1.0916	0.0581	0.0524	0.1899	1.7796
TRANSP.	0.0235	0.0491	0.0645	0.0866	0.0600	0.0486	1.0671	0.0392	0.1447	1.5833
SERVICE	0.0064	0.0182	0.0222	0.0208	0.0116	0.0240	0.0166	1.0400	0.0145	1.1743
N.A.D.	0.0211	0.0643	0.0716	0.0756	0.0455	0.0217	0.0748	0.0264	1.0415	1.4424
TOTAL	1.7009	1.7248	2.7046	2.7019	1.7692	1.4702	1.7590	1.5217	2.5584	17.9107

(I-B) Inverse

1960	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1805	0.0055	1.8102	0.1773	0.0115	0.0532	0.0265	0.1208	0.0292	3.4148
MINING	0.1084	1.0216	5.6417	0.9158	0.2088	0.1976	0.0947	0.2783	0.1168	8.5837
MANUF.	0.0365	0.0054	1.9891	0.1885	0.0122	0.0553	0.0284	0.0866	0.0234	2.4254
CONST.	0.0056	0.0009	0.0650	1.0113	0.0059	0.0555	0.0062	0.0147	0.0033	1.1683
UTILITY	0.0256	0.0121	0.9669	0.1357	1.0237	0.1239	0.0565	0.1407	0.0281	2.5132
FINANCE	0.0213	0.0035	0.4896	0.1049	0.0079	1.1052	0.0235	0.0735	0.0395	1.8689
TRANSP.	0.0206	0.0040	0.4509	0.1108	0.0094	0.1002	1.0746	0.0570	0.0193	1.8470
SERVICE	0.0043	0.0010	0.1760	0.0424	0.0043	0.0561	0.0108	1.0516	0.0113	1.3579
N.A.D.	0.0538	0.0114	1.1950	0.2114	0.0305	0.1265	0.0568	0.2600	1.0197	2.9650
TOTAL	1.4566	1.0654	12.7844	2.8982	1.3141	1.8735	1.3780	2.0833	1.2907	26.1441

(I-A) Inverse

1965	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1788	0.0637	0.2324	0.1094	0.0416	0.0199	0.0437	0.0335	0.1954	1.9185
MINING	0.0136	1.0263	0.0649	0.0621	0.0879	0.0073	0.0158	0.0109	0.0301	1.3190
MANUF.	0.3778	0.3705	1.9187	0.8633	0.3002	0.1564	0.3554	0.2521	0.7437	5.3382
CONST.	0.0105	0.0177	0.0131	1.0107	0.0387	0.0354	0.0122	0.0129	0.0119	1.1631
UTILITY	0.0108	0.0513	0.0370	0.0258	1.0271	0.0135	0.0223	0.0230	0.0440	1.2549
FINANCE	0.0661	0.0951	0.1251	0.1424	0.0523	1.0804	0.0674	0.0602	0.1713	1.8601
TRANSP.	0.0352	0.0496	0.0706	0.0847	0.0480	0.0550	1.1058	0.0416	0.1087	1.5992
SERVICE	0.0097	0.0184	0.0303	0.0250	0.0244	0.0302	0.0148	1.0358	0.0474	1.2361
N.A.D.	0.0311	0.0490	0.0432	0.0352	0.0447	0.0115	0.0134	0.0243	1.0216	1.2741
TOTAL	1.7338	1.7416	2.5353	2.3587	1.6650	1.4095	1.6507	1.4942	2.3742	16.9631

(I-B) Inverse

1965	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1787	0.0080	1.7052	0.1532	0.0115	0.0415	0.0343	0.0515	0.0430	3.2270
MINING	0.1095	1.0263	3.8302	0.6990	0.1951	0.1226	0.1001	0.1345	0.0534	6.2707
MANUF.	0.0515	0.0063	1.9188	0.1647	0.0113	0.0444	0.0380	0.0528	0.0223	2.3100
CONST.	0.0075	0.0016	0.0686	1.0107	0.0076	0.0525	0.0069	0.0141	0.0019	1.1713
UTILITY	0.0393	0.0231	0.9831	0.1306	1.0271	0.1020	0.0632	0.1277	0.0351	2.5313
FINANCE	0.0317	0.0057	0.4408	0.0958	0.0070	1.0804	0.0254	0.0444	0.0181	1.7492
TRANSP.	0.0449	0.0078	0.6596	0.1511	0.0169	0.1458	1.1058	0.0813	0.0305	2.2436
SERVICE	0.0062	0.0015	0.1441	0.0227	0.0044	0.0409	0.0075	1.0358	0.0067	1.2699
N.A.D.	0.1415	0.0277	1.4432	0.2246	0.0562	0.1090	0.0479	0.1694	1.0216	3.2411
TOTAL	1.6108	1.1080	11.1935	2.6526	1.3371	1.7391	1.4290	1.7114	1.2327	24.0140

(I-A) Inverse

1970	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1807	0.0417	0.1583	0.0778	0.0310	0.0151	0.0258	0.0501	0.0594	1.6399
MINING	0.0147	1.0217	0.0665	0.0542	0.0762	0.0076	0.0125	0.0156	0.0321	1.3010
MANUF.	0.4210	0.4591	1.9912	0.9472	0.3757	0.1802	0.3177	0.4124	0.5464	5.6509
CONST.	0.0128	0.0143	0.0130	1.0114	0.0366	0.0360	0.0137	0.0140	0.0152	1.1670
UTILITY	0.0095	0.0333	0.0313	0.0222	1.0237	0.0131	0.0204	0.0216	0.0212	1.1963
FINANCE	0.0756	0.0900	0.1513	0.1625	0.0747	1.1054	0.0809	0.1077	0.2840	2.1321
TRANSP.	0.0288	0.0419	0.0547	0.0674	0.0355	0.0394	1.0992	0.0329	0.0545	1.4541
SERVICE	0.0091	0.0160	0.0321	0.0388	0.0246	0.0332	0.0219	1.0446	0.0478	1.2680
N.A.D.	0.0266	0.0416	0.0514	0.0456	0.0406	0.0176	0.0272	0.0531	1.0197	1.3234
TOTAL	1.7788	1.7596	2.5497	2.4271	1.7186	1.4474	1.6193	1.7520	2.0801	17.1327

(I-B) Inverse

1970	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1805	0.0055	1.8102	0.1773	0.0115	0.0532	0.0265	0.1208	0.0292	3.4148
MINING	0.1084	1.0216	5.6417	0.9158	0.2088	0.1976	0.0947	0.2783	0.1168	8.5837
MANUF.	0.0365	0.0054	1.9891	0.1885	0.0122	0.0553	0.0284	0.0866	0.0234	2.4254
CONST.	0.0056	0.0009	0.0650	1.0113	0.0059	0.0555	0.0062	0.0147	0.0033	1.1683
UTILITY	0.0256	0.0121	0.9669	0.1357	1.0237	0.1239	0.0565	0.1407	0.0281	2.5132
FINANCE	0.0213	0.0035	0.4896	0.1049	0.0079	1.1052	0.0235	0.0735	0.0395	1.8689
TRANSP.	0.0206	0.0040	0.4509	0.1108	0.0094	0.1002	1.0746	0.0570	0.0193	1.8470
SERVICE	0.0043	0.0010	0.1760	0.0424	0.0043	0.0561	0.0108	1.0516	0.0113	1.3579
N.A.D.	0.0538	0.0114	1.1950	0.2114	0.0305	0.1265	0.0568	0.2600	1.0197	2.9650
TOTAL	1.4566	1.0654	12.7844	2.8982	1.3141	1.8735	1.3780	2.0833	1.2907	26.1441

(I-A) Inverse

1975	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1565	0.0362	0.1522	0.0653	0.0426	0.0130	0.0587	0.0464	0.1159	1.6868
MINING	0.0298	1.0327	0.1211	0.0711	0.1619	0.0116	0.0486	0.0267	0.0892	1.5927
MANUF.	0.4625	0.3971	1.9380	0.7924	0.5154	0.1470	0.7318	0.3645	0.8576	6.2063
CONST.	0.0066	0.0095	0.0101	1.0085	0.0311	0.0378	0.0126	0.0114	0.0145	1.1421
UTILITY	0.0141	0.0391	0.0411	0.0274	1.0375	0.0124	0.0330	0.0305	0.0551	1.2902
FINANCE	0.1118	0.1598	0.1886	0.1829	0.1483	1.1365	0.2110	0.1359	0.3206	2.5954
TRANSP.	0.0658	0.3087	0.1123	0.1202	0.1166	0.0685	1.1738	0.0727	0.2810	2.3197
SERVICE	0.0156	0.0287	0.0486	0.0499	0.0373	0.0438	0.0434	1.0526	0.0995	1.4195
N.A.D.	0.0180	0.0445	0.0428	0.0446	0.0402	0.0201	0.0343	0.0344	1.0290	1.3079
TOTAL	1.8806	2.0564	2.6549	2.3623	2.1310	1.4908	2.3473	1.7751	2.8624	19.5606

(I-B) Inverse

1975	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1565	0.0042	1.6920	0.1706	0.0218	0.0566	0.0994	0.1667	0.0543	3.4221
MINING	0.2570	1.0326	11.6223	1.6047	0.7118	0.4349	0.7111	0.8307	0.3608	17.5659
MANUF.	0.0416	0.0041	1.9378	0.1862	0.0237	0.0575	0.1114	0.1181	0.0361	2.5165
CONST.	0.0025	0.0004	0.0434	1.0085	0.0061	0.0630	0.0082	0.0158	0.0026	1.1505
UTILITY	0.0275	0.0089	0.8962	0.1404	1.0375	0.1063	0.1098	0.2158	0.0506	2.5930
FINANCE	0.0257	0.0042	0.4814	0.1097	0.0173	1.1365	0.0821	0.1125	0.0345	2.0039
TRANSP.	0.0388	0.0211	0.7370	0.1856	0.0351	0.1760	1.1737	0.1546	0.0777	2.5996
SERVICE	0.0043	0.0009	0.1497	0.0362	0.0053	0.0529	0.0204	1.0526	0.0129	1.3352
N.A.D.	0.0384	0.0109	1.0131	0.2488	0.0436	0.1870	0.1237	0.2639	1.0290	2.9584
TOTAL	1.5924	1.0873	18.5729	3.6906	1.9022	2.2706	2.4398	2.9306	1.6586	36.1450

(I-A) Inverse

1980	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1789	0.0304	0.1223	0.0537	0.0362	0.0109	0.0482	0.0430	0.0769	1.6005
MINING	0.0424	1.0382	0.1390	0.0804	0.1830	0.0140	0.0578	0.0344	0.1002	1.6893
MANUF.	0.6000	0.4584	2.0367	0.8521	0.5855	0.1671	0.7913	0.4269	1.2210	7.1389
CONST.	0.0113	0.0117	0.0127	1.0101	0.0274	0.0297	0.0161	0.0150	0.0222	1.1561
UTILITY	0.0251	0.0471	0.0575	0.0379	1.0528	0.0181	0.0474	0.0469	0.0851	1.4177
FINANCE	0.1235	0.1611	0.1885	0.1827	0.1681	1.1267	0.2222	0.1352	0.3401	2.6480
TRANSP.	0.0833	0.3029	0.1141	0.1102	0.1144	0.0755	1.1794	0.0795	0.2534	2.3127
SEVICE	0.0265	0.0399	0.0658	0.0710	0.0557	0.0553	0.0663	1.0793	0.1357	1.5955
N.A.D.	0.0282	0.0366	0.0432	0.0291	0.0291	0.0227	0.0349	0.0257	1.0341	1.2835
TOTAL	2.1191	2.1261	2.7797	2.4271	2.2522	1.5200	2.4638	1.8858	3.2686	20.8424

(I-B) Inverse

1980	AGRC.	MINING	MANUF.	CONST.	UTILITY	FINANCE	TRANSP.	SERVICE	N.A.D.	TOTAL
AGRC.	1.1782	0.0043	1.8339	0.1814	0.0321	0.0608	0.1077	0.2227	0.0344	3.6554
MINING	0.2513	1.0330	12.6321	1.6498	1.0100	0.4683	0.7808	1.0707	0.2714	19.1673
MANUF.	0.0388	0.0042	2.0175	0.1894	0.0342	0.0602	0.1163	0.1440	0.0359	2.6404
CONST.	0.0032	0.0005	0.0555	1.0099	0.0072	0.0502	0.0105	0.0227	0.0029	1.1628
UTILITY	0.0266	0.0077	0.9327	0.1389	1.0517	0.1123	0.1156	0.2659	0.0417	2.6930
FINANCE	0.0205	0.0040	0.4754	0.1047	0.0255	1.1238	0.0847	0.1188	0.0260	1.9835
TRANSP.	0.0255	0.0148	0.5249	0.1156	0.0317	0.1355	1.1268	0.1279	0.0357	2.1384
SERVICE	0.0057	0.0013	0.2222	0.0547	0.0113	0.0727	0.0337	1.0938	0.0139	1.5093
N.A.D.	0.0599	0.0119	1.3924	0.2119	0.0562	0.2821	0.1689	0.2868	1.0324	3.5024
TOTAL	1.6096	1.0819	20.0865	3.6563	2.2600	2.3658	2.5450	3.3532	1.4942	38.4525