THE INTEGRATION AND PRODUCTION INDUCEMENT MECHANISM IN THE PROCESS OF AGRICULTURAL TRANSFORMATION

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1 INTRODUCTION

Agricultural transformation is generally characterized by the decrease in the share of agriculture in the output and employment structures of an economy and by rapid agricultural growth which is concomitant with and essential to the achievement of general economic growth[1). Timmer (1988) suggested that the process of agricultural transformation is roughly definable into four phases based on resource flows from agriculture, namely, the Mosher, Johnston-Mellor, Schultz-Ruttan, and D. G. Johnson phases. Specific agricultural transformation features and policy settings distinguish these four phases, and thus their identification in a country's agricultural growth and development has important policy implications. Undoubtedly, the unfolding of these phases can be observed in changing agricultural production processes and relationships.

Agricultural production is conducted within an economic system sustained by interdependent production relationships. Changes in these interdependent production relationships have repercussions on the production process. The interdependent nature of agricultural production therefore calls for an examination of the changes in production interdependencies that occur with agricultural transformation.

Japan's agricultural transformation epitomizes the Asian agricultural growth and development experience. Output growth in Japanese agriculture has been ascribed to the increase and improvement of land and labor productivity. Growth in total output and output per worker in traditional small-sized family farms brought about by the application of biological and chemical technologies has been referred to as the Japanese model of agricultural development. The path leading to its attainment has been aptly called as the Asian path because of its relevance to agricultural development in Asian countries. The significance of the path to the monsoon economies of Taiwan, Korea, and the Philippines can not be undermined because Japan is also a monsoon economy[2)]. Indeed, studies have revealed that the newly industrializing economies of Taiwan and Korea have manifested some of the essential features of

1) This transformation also consists of social, economic, and political processes and involves institutions through which changes are achieved. These processes and institutions, however, are not dealt with in this paper because they are beyond the scope of the methodology adopted in this study.

2) Oshima (1989) refers to the economies of Japan, Taiwan, Korea, and the Philippines as monsoon economies. See Oshima (1989) for more about the features of monsoon economies. See Hayami and Ruttan (1985) for a discussion of the Asian path.

Japanese agricultural transformation[3]. For developing countries in monsoon Asia like the Philippines, the agricultural growth and development path taken by Japan, Taiwan , and Korea is therefore worth emulating.

The general purpose of this study is to identify the interindustry aspects of the process of agricultural transformation in Japan, Taiwan, Korea, and the Philippines. These countries were chosen because from an international aspect they exemplify the Asian path of agricultural development in the economic development stage. Moreover, the agro-industrial transition is best depicted by the experiences of Japan, Taiwan, and Korea. Since the primary objective of this study is to understand the changes in interdependent production relationships that help define the transformation process, the research reported in this paper specifically aims to elucidate in an input-output framework the patterns of change in the integration of agriculture into the productive system and the production inducement mechanism of agriculture. Changes in the integration of agriculture into the productive system can be investigated through the integration operator. The integration operator is ideal for this kind of analysis because it breaks down the total output of a sector into as many parts as there are final commodities. Thus the proportion of agricultural output which goes into the production of a particular final commodity can be studied. Changes in the production inducement mechanism of agriculture, on the other hand, can be analyzed through a sequential input-output model. Using the sequential input-output model, one can quantify the multiplier effects of an exogenous change in final demand on all sectors realized after a period of time.

The data used and sectors analyzed are presented in section 2. The rationale for the method of identifying the phases of agricultural transformation defined by Timmer is explained in section 3. The changes in the integration of agriculture into the productive systems of Japan, Taiwan, Korea, and the Philippines are analyzed in section 4 by using an integration operator. In sec-

3) See for example Myint (1975).

tion 5, a sequential input-output model is applied to trace the time framework of and patterns of change in the production inducement mechanism of agriculture. Some insights on the interdependent nature of the agricultural transformation process and its implications on the Asian path of agricultural development are elaborated in section 6.

2　SOME EXPLANATIONS ON THE DATA USED

2．1　Input-Output Tables

All the input-output tables used in this study are in competitive imports form and valued at current producers' prices[4]. The following are the input-output tables used in this study :

1．Japan	:	1960	56 and 163 sectors
		1965	56 and 163 sectors
		1970	28 and 71 sectors
		1975	28 and 71 sectors
		1980	28 and 71 sectors
		1985	28 and 84 sectors
Source	:	Management and Coordination Agency (Japan)	
2．Taiwan	:	1964	49 and 76 sectors
		1969	49 and 76 sectors
		1971	49 and 76 sectors
		1976	29 and 394 sectors
		1981	49 and 99 sectors
		1986	49 and 99 sectors
Source	:	Council for Economic Planning and Development (Executive Yuan)	

4)　The 1970 Korean input-output table is valued at purchasers' prices, but this was converted to producers' prices using the transportation and trade margin tables.

3. Korea	:	1963	43 and 109 sectors
		1963	43 and 109 sectors
		1968	43 and 109 sectors
		1970	56 and 153 sectors
		1975	60 and 164 sectors
		1980	65 and 161 sectors
		1985	65 and 161 sectors
Source	:	The Bank of Korea	
4. Philippines	:	1961	50 and 99 sectors
		1965	51 and 99 sectors
		1969	60 and 99 sectors
		1974	60 and 99 sectors
		1979	24 and 65 sectors
		1983	25 and 65 sectors
Source	:	National Economic Council (1961) Bureau of Census and Statistics (1965) National Economic and Development Authority/National Census and Statistics Office (1969, 1974, 1979,1983)	

These tables were aggregated into sixteen sectors[5]. Since the object of this study is the interindustry agricultural transformation process, agriculture was disaggregated into three sectors, namely, agricultural crops, livestock, and agricultural services. Food manufacturing, chemicals, and machinery were

5) Two input-output tables at different levels of aggregation for each year were used, but the table with the fewer number of sectors was used to facilitate aggregation. The table with the greater number of sectors was utilized as the basic reference when problems related to agricultural sector disaggregation and sectoral classification inconsistencies arose. Likewise, the input-output tables of Japan were considered as the standard to which other national tables were adjusted. The latest input-output table for each country was considered as the basis to insure consistency among the national tables.

likewise disaggregated from manufacturing in order to determine the changes in the interrelationships of agriculture with these sectors. Aside from the agricultural sectors, the analysis of the food manufacturing sector is also presented in detail because of its close relationship with agriculture.

The sixteen sectors used in this study and their corresponding symbols are as follows :

	SECTOR	SYMBOL
1.	Agricultural Crops	AGC
2.	Livestock	LS
3.	Agricultural Services	AGS
4.	Forestry	FOR
5.	Fishery	FISH
6.	Mining	MNG
7.	Food Manufacturing	FMFG
8.	Manufacturing	MFG
9.	Chemicals	CHEM
10.	Machinery	MACH
11.	Construction	CONST
12.	Electricity, Gas, Water/ Transportation and Communication	PUTC
13.	Wholesale and Retail Trade	COM
14.	Finance, Insurance, and Real Estate	FIRE
15.	Public Administration/Services	PWS
16.	Others	OTH

The general composition of the agricultural sectors is shown in table 2–1[6].

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6) The international comparison of input-output tables will always be suspect of inconsistencies mainly because of different national accounting procedures and practices, and sectoral classification methods. Like other studies of a similar orientation, attention was given more to sectoral classification consistency. It should be pointed out, however, that this research puts more emphasis on the changes in the nature of interdependence rather than on the mere comparison of interdependent production relationships.

Table 2-1. COMPOSITION OF AGRICULTURAL SECTORS

AGRICULTURAL SECTOR	COMPOSITION
AGRICULTURAL CROPS	Grains (rice, wheat, barley, cereals, corn)
	Fruits and vegetables (including potatoes, root crops, tubers, and pulses)
	Industrial crops (edible and inedible)
LIVESTOCK	Livestock (hogs, cattle, livestock products,etc.)
AGRICULTUAL SERVICES	Veterinary and other agricultural services

Sericulture, aggregated into livestock in Japan and Korea, was aggregated into the others sector because of the absence of a comparable sectoral classification in Taiwan and the Philippines. Likewise, agricultural services was disaggregated from agricultural crops in the case of the Philippines and from miscellaneous services in the case of Taiwan.

2. 2 Employment Data

The aforementioned sixteen sectors were further aggregated into nine sectors because of employment data limitations. The following are the nine sectors used in the analysis of inter-industry employment flows :

	SECTOR	SYMBOL
1.	Agriculture	AGRI
2.	Forestry/Fishery	FOR/FISH
3.	Mining	MNG
4.	Manufacturing	MFG
5.	Construction	CONST
6.	Electricity, Gas, Water/ Transportation and Communication	PUTC
7.	Wholesale and Retail Trade	COM
8.	Finance, Insurance, Real Estate/ Public Administration/Services	PWS
9.	Others	OTH

The analysis of interindustry employment integration is therefore focused solely on agriculture.

The sources of employment data are as follows :

1. Japan	Census of Population
2. Taiwan	Demographic Factbook, Republic of China, Department of Civil Affairs
	Statistical Abstract of the Republic of China, Directorate-General of Budgets, Accounts, and Statistics (Executive Yuan)
	Yearbook of Labor Statistics (International Labor Organization)
3. Korea	Population and Housing Census Report, National Bureau of Statistics, Economic Planning Board
	Korea Statistical Yearbook Economic Planning Board
	Yearbook of Labor Statistics (International Labor Organization)
4. Philippines	National Economic Development Authority Statistical Yearbook, National Statistical Coordination Board
	Census of Population and Housing, National Census and Statistics Office

3 THE PHASES OF AGRICULTURAL TRANSFORMATION IN JAPAN, TAIWAN, KOREA, AND THE PHILIPPINES

The phases of agricultural transformation was provisionally divided based on changes in the share of agriculture in the employment structure, one of the main features of the agricultural transformation process identified by Timmer (1988). The economic features and policy settings of these phases are shown in table 3–1. Timmer suggested that in the Mosher transformation phase much of a country's investable resources like labor are in agriculture. This was interpreted to mean that the share of agriculture in total employment is more than one-half of the total number of employed persons. Furthermore, Timmer elaborated that in the D. G. Johnson phase the share of agricultural labor falls below twenty percent.

One can definitely conclude from table 3–1 that certain features and policy settings of the Johnston-Mellor and Schultz-Ruttan phases overlap each other. Since the employment features of the Johnson-Mellor and Schultz-Ruttan environments were not defined by Timmer, an attempt was made to merge these two phases based on similarities in their policy concerns or orientation. Two of the major policy concerns in these two phases are increased market integration and efficiency, and the lessening of the income disparity between the rural and urban sectors. Therefore one can divide the phases of agricultural transformation in the following manner :

a) Phase 1 (developing agriculture phase), the major policy concerns are developing agriculture and increasing productivity ; the share of agricultural employment is more than fifty percent

b) Phase 2 (critical transformation phase), the major policy concerns are increased market integration and efficiency, and less income disparity between the rural and urban sectors ; the share of agricultural employment is between twenty to fifty percent[7)]

c) Phase 3 (agriculture in industrialized countries phase), the major policy concerns are less income disparity between rural and urban sectors, and im-

Table 3-1. FEATURES OF THE PHASES OF AGRICULTURAL TRANSFORMATION

	MOSHER ENVIRONMENT (1)	JOHNSON-MELLOR ENVIRONMENT (2)	SCHULTZ-RUTTAN ENVIRONMENT (3)	D. G. JOHNSON ENVIRONMENT (4)
KEY PHRASE	getting agriculture moving	agriculture as contributor to growth	integrating agriculture into the macro economy	agriculture in industrial economies
SHARE OF AGRICULTURAL OUTPUT AND EMPLOYMENT	significant share	decreasing	decreasing	decreasing; share of agricultural labor falls below twenty percent
DEGREE OF INTEGRATION INTO THE MACRO ECONOMY	less integrated	more integrated; establishment of market links	greater integration through more efficient market links	high degree of integration
RESOURCE FLOWS				
LABOR	increasing outflow with rise in productivity	outflow increases further	labor outflow peaks with the absolute decline in agricultural population	outflow decreases; share of agricultural labor force becomes fairly small
FINANCIAL	decreasing; trough point is reached	increasing with rise in agricultural productivity	increasing without high agriculturat protec protection; decreasing with high agricultural protection	increasing without high agricultural protection; decreasing with high agricultural protection
ECONOMIC ENVIRONMENT				
POLICY CONCERN	institutional changes; productivity increase; introduction of new techonoiogy	agriculture's contribution to growth; establishment of market links; improvement of factor markets; incentives to create a healthy agricultural sector	more efficient agriculture; more efficient labor, credit, and factor markets	dealing with agriculture in industrialized economies
INCOME DISTRIBUTION AND RELATED PROBLEMS	low productivity; low income	substantial disequilibrium between agriculture and industry due to difference in labor productivity and income	income distribution problems mount due to lagging rural productivity	income distribution becomes a political problem; effect of subsidies and supports on resource allocation

Note; Based on C. Peter Timmer, "The Agricultural Transformation," in HANDBOOK OF DEVELOPMENT ECONOMICS, vol. 1, ed. Hollis B. Chenery and T. N. Srinivasan, Amsterdam; North Holland Publishing Co., 1988; 279-83.

proved welfare and quality of life ; the share of agricultural employment falls below twenty percent.

In using the change in the share of agricultural employment as indicator of the phases of agricultural transformation, the authors explicitly adopt the transition concept favored by Oshima (1989) in his analysis of economic growth in monsoon Asia[8]. Therefore, the authors concur with Timmer (1988) in stating that the ultimate result of the process of agricultural transformation is an agriculture to industry structural transition that is characterized by social, political, and economic stresses caused by a declining role for agriculture. When the share of agricultural employment begins to fall and is eventually exceeded by non-agricultural employment, a new phase leading to the realization of the agro-industrial transition is reached. This point in time can be considered a critical phase in the structural transformation of an economy.

Based on the employment shares shown in table 3–2, which are the shares of the agricultural sector for the years in which input-output tables are available for Japan, Taiwan, Korea, and the Philippines, one can therefore hypothetically divide the phases of agricultural transformation in the following manner :

JAPAN	1960 – 1965	Phase 2 (critical transformation phase)
	1970 – 1985	Phase 3 (agriculture in industrialized countriesphase)
TAIWAN	1964 – 1976	Phase 2 (critical transformation phase)
	1981 – 1986	Phase 3 (agriculture in industrialized countries phase)

7) The identification of phases 1 and 2 basically follows that of Timmer (1988). Phase 2 is termed as the critical transformation phase because in this phase significant differences between the rural and urban sectors begin to emerge. This phase may be considered as the harbinger of a country's potential to successfully complete the agro-industrial transition.

8) Oshima (1989) contends that the study of the dynamics of rapid growth and structural change in monsoon Asia can be appropriately made within a framework based on the transition concept.

Table 3-2. SHARE OF AGRICULTURE IN THE INDUSTRIAL EMPLOYMENT STRUCTURE

		SHARE(%)
JAPAN		
	1960	30.3
	1965	22.79
	1970	17.91
	1975	12.64
	1980	9.86
	1985	8.31
TAIWAN		
	1964	40.46
	1969	34.74
	1971	31.52
	1976	24.81
	1981	16.61
	1986	15.02
KOREA		
	1963	56.16
	1968	52.6
	1970	47.88
	1975	46.17
	1980	35.11
	1985	23.2
PHILIPPINES		
	1961	55.78
	1965	52.14
	1969	52.73
	1974	44.17
	1979	38.84
	1983	39.01

Notes: Agriculture employment does not include persons employed in forestry and fishery. See text for data sources.

KOREA	1963 – 1968	Phase 1 (developing agriculture phase)
	1970 – 1985	Phase 2 (critical transformation phase)
PHILIPPINES	1961 – 1969	Phase 1 (developing agriculture phase)
	1971 – 1983	Phase 2 (critical transformation phase)

4 THE INTEGRATION OF AGRICULTURE INTO THE PRODUCTIVE SYSTEM

The productive system of an economy consists of interdependent sectors engaged in the production of output necessary to meet all final demand requirements. The fulfillment of the final demand for a given commodity is therefore the result of a productive process which directly or indirectly involves all the sectors in a productive system. The complex of all the activities necessary to meet the final demand for a given commodity can be called a subsystem or a vertically integrated sector. This implies that a subsystem is the result of breaking down a sector's output into as many parts as there are final commodities. A productive system's capacity to meet all final demand requirements therefore depends on the individual subsystems.

The variety of final demands in an economy presupposes different production processes. One can therefore think of a subsystem as a production process geared towards meeting final demand. The study of subsystems therefore enables us to analyze the structure of the productive system, its characteristics and variations over time, and the contribution of sectors to the productive process.

4.1 Methodology

The change in the integration of a sector into the productive system can be studied using the Momigliano-Siniscalco (1982) integration operator[9]. In the formulation of the operator, each sector is assumed capable of producing enough output to supply all final demand requirements. This can be express-

9) The matrix formulation of the Momigliano-Siniscalco integration operator is similar to that of Szabo (1976).

ed in matrix form as :

$$X = (I - A)^{-1} Y \qquad (4\text{–}1)$$

where X is the column vector of total output, I is the identity matrix, A is the square matrix of direct input coefficients, and Y is the column vector of final demand. Equation 4–1 can be expanded in the following way :

$$X_1 = r_{11} Y_1 + r_{12} Y_2 + \cdots\cdots + r_{1n} Y_n$$

$$X_2 = r_{22} Y_2 + r_{22} Y_2 + \cdots\cdots + r_{2n} Y_n$$

$$\vdots$$

$$X_n = r_{n1} Y_1 + r_{n2} Y_2 + \cdots\cdots + r_{nn} Y_n$$

where r_{ij} is the Leontief inverse matrix coefficient. The total output of each sector is therefore equal to the sum of the output induced in that sector by all final demands. Dividing all these component parts by the total sectoral output will necessarily yield that part of total sectoral output contributed to the production of each final commodity. This can be expressed as

$$1 = \frac{r_{11}y_1}{X_1} + \frac{r_{12}y_2}{X_1} + \cdots\cdots + \frac{r_{1n}y_n}{X_1}$$

$$1 = \frac{r_{21}y_1}{X_2} + \frac{r_{22}y_2}{X_2} + \cdots\cdots + \frac{r_{2n}y_n}{X_2}$$

$$\vdots$$

$$1 = \frac{r_{n1}y_1}{X_n} + \frac{r_{n2}y_2}{X_n} + \cdots\cdots + \frac{r_{nn}y_n}{X_n}$$

Based on these linear equations, one can obtain the Momigliano-Siniscalco integration operator in the following manner :

$$B = \langle X \rangle^{-1} (I - A)^{-1} \langle Y \rangle \qquad (4\text{–}2)$$

where B is the square matrix of integration operators or indices, $\langle X \rangle^{-1}$ is the inverse of the diagonalized total output matrix, and $\langle Y \rangle$ is the diagonalized final demand matrix. This integration operator yields an integration matrix whose row elements show the the proportion of a sector's output which comes under the various subsystems ; thus, it is a measure of the contribution of the sector to the productive process. The sum of these row elements is always equal to one. The column elements of this matrix show the proportion of the output of the various sectors which come under a particular subsystem. The column elements, however, can not be added up because they are proportions of different output values.

The formulation of the integration operator implies that the integration indices derived using the integration operator explicitly depends on the change in the total output of the sector, technological interdependencies, and final demand of the subsystem. Szabo (1976) stressed that the indices change proportionally with the final demand of the subsystem (sharing sector) and the change in the inverse coefficient used, but in inverse proportion to the total output of the sector (releasing sector). He pointed out that the ultimate effect is traced to the factor changing at a higher rate. Therefore, the integration of a sector into a subsystem decreases (increases) if the product of the rates of change in the final demand of the subsystem and the inverse coefficient used is less (more) than the rate of change in the total output of the sector itself.

The Momigliano-Siniscalco integration operator can be used to reclasify sectoral variables like exports, imports, employment, and capital into various subsystems. Therefore interindustry employment flows can be studied using the following expansion of equation 4–2 :

$$B^L = \langle L \rangle \langle X \rangle^{-1} (I - A)^{-1} \langle Y \rangle \qquad (4\text{–}3)$$

where B^L is the total employment matrix and $\langle L \rangle$ is the diagonalized sectoral employment matrix. Equation 4–3 can also be expressed as $\langle L \rangle$ B. Since the product of $\langle L \rangle \langle X \rangle^{-1}$ is equal to the diagonalized matrix of employment coefficients, equation 4–3 can also be expressed as

$$B^L = \langle \ell \rangle (I - A)^{-1} \langle Y \rangle \qquad (4\text{–}4)$$

where ℓ is the diagonalized employment coefficient matrix. Obviously, equations 4–3 and 4–4 both yield identical total employment matrixes.

Unlike the integration operator matrix, both the rows and columns of the total employment matrix can be added up. The row elements show the interindustry employment contribution of a sector to all subsystems, or the employment transferred from a sector to all subsystems to satisfy final demand requirements. The column elements of the total employment matrix indicate the employment contribution of all sectors to a subsystem, or the employment *required by a subsystem in order to produce its final demand requirements.* Furthermore, various interindustry employment flow ratios can be calculated from the total employment matrix[10].

Pasinetti (1981) emphasized that vertical integration analysis provides the analytical link essential to the comparison of input-output tables. The analysis of the patterns of change in the integration of agriculture and food manufacturing is possible through the use of the integration operator not only because it is one form of vertical integration analysis, but also because the integration operator is independent of prices[11].

4. 2　Results and Discussion

Equations 4–2 and 4–3 were used to analyze the integration of agriculture and food manufacturing into the productive system. The Leontief domestic inverse matrix, $(I - \langle U \rangle A)^{-1}$ was applied[12]. Final demand is therefore computed as $Y = \langle U \rangle D + E$, where $\langle U \rangle$ is the diagonalized matrix of the rates of self-sufficiency, D is the column vector of domestic final demand, and E is the column vector of exports. The hypothetical division of the phases of agricultural transformation explained in section 3 was used to facilitate the analysis of the patterns of change in the productive and employment integration of agriculture and food manufac turing. Figures presented in the succeeding analysis feature the general patterns of change in Japan and Korea on one hand, and Taiwan and the Philippines on the other. The patterns of change however, remain invariant even if the pairings are interchanged.

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10) See Marengo and Sterlacchini (1990) for examples of these interindustry flow ratios.

11) The proof of the independence of the integration index from prices can be found in Momigliano and Siniscalco (1982).

12) The use of the Leontief domestic inverse matrix $(I - \langle U \rangle A)^{-1}$ implies that the integration of agriculture and food manufacturing in the domestic component of output is the main focus of the analysis.

4.21 The Productive Integration of Agriculture and Food Manufacturing

A. Change in the Integration of Agricultural Crops

1. Integration into the Agricultural Crops Subsystem

Table 4-1. INTEGRATION OF AGRICULTURAL CROPS INTO SELECTED SUBSYSTEMS (%)

		AGC	LS	FMFG	MFG	PWS
JAPAN						
	1960	17.91	1.72	63.17	8.04	1.08
	1965	25.93	1.55	57.63	6.43	1.4
	1970	26.75	1.44	51.2	4.39	10.87
	1975	27.93	1.2	52.13	3.5	9.94
	1980	23.55	1.51	51.98	3.77	12.9
	1985	26.29	0.88	51.11	3.22	13
TAIWAN						
	1964	19.08	1.83	71.53	4.22	0.14
	1969	23.91	1.67	65.09	5.13	0.34
	1971	22.58	2.64	64.98	6.65	0.33
	1976	23.59	2.14	61.24	8.25	0.29
	1981	30.35	2.24	55.79	6.93	0.33
	1986	30.69	1.66	55.44	7.94	0.52
KOREA						
	1963	86.83	1.37	6.62	2.45	0.88
	1968	77.02	1.89	13.66	2.23	0.44
	1970	78.45	2.87	10.36	3.01	10.54
	1975	30.59	0.43	58.17	5.06	1.77
	1980	24.44	0.85	61.34	5.93	2.24
	1985	31.71	1.81	52.27	5.67	2.75
PHILIPPINES						
	1961	48.92	3.04	42.79	1.76	0.61
	1965	38.08	1.08	47.89	2.09	4.25
	1969	38	1.26	53.6	0.98	4.32
	1974	33.46	0.8	60.57	1.77	1.76
	1979	32.4	0.62	59.56	2.38	2.63
	1983	33.78	1.16	56.6	2.46	2.6

Notes: Columns represent subsystems. AGC (Agricultural Crops); LS (Livestock); FMFG (Food Manufacturing); MFG (Manufacturing); PWS (Public Administration/Services).

The integration of agricultural crop into the agricultural crops subsystem is generally higher in phase 1 than in phases 2 and 3. The integration, however, decreases over time as shown in figures 4–1 and 4–2. This implies that the integration of an agricultural sector into its own subsystem decreases with more advanced transformation. Of the factors affecting the change in the integration index pointed out in section 4–1, one can trace the decrease in the integration to the greater rate of change in the total output of agricultural crops sector compared to the rate of change in the final demand for agricultural crops[13]. This reflects increasing productivity and the Engel's Law. Integration also decreased because of weaker intraindustry technological interdependence.

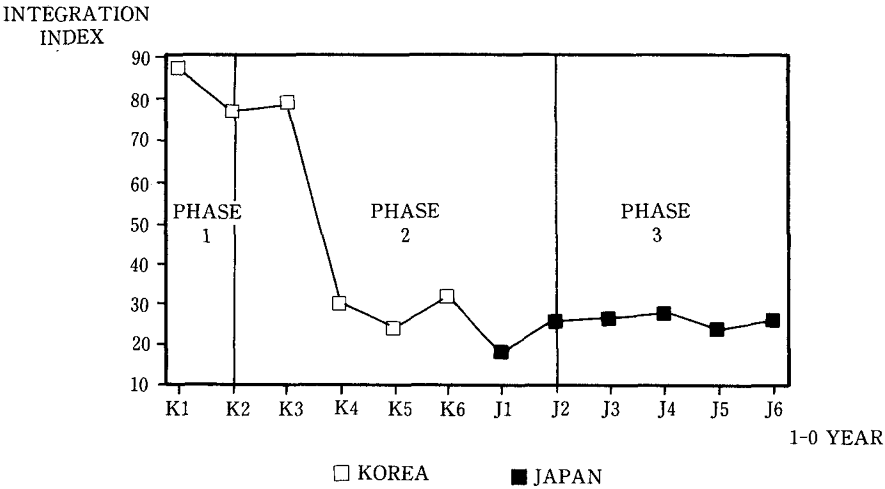

Fig. 4-1. PATTERN OF CHANGE IN THE INTEGRATION OF AGRICULTURAL CROPS INTO THE AGRICULTURAL CROPS SUBSYSTEM (JAPAN AND KOREA)

Notes: J stands for Japan and K for Korea. The numbers attached to J and K refer to the input-output table year arranged from the earliest to the latest. See table 4-4 for actual integration index values.

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13) The results of the analysis of the factors affecting integration that are not shown in this paper are available on request from the authors. Some of the results, however, are shown.

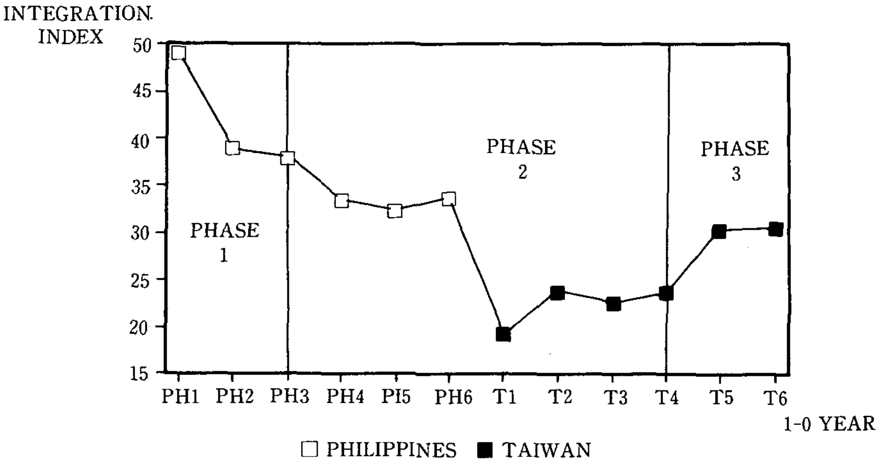

Fig. 4-2. PATTERN OF CHANGE IN THE INTEGRATION OF AGRICULTURAL CROPS INTO THE AGRICULTURAL CROPS SUBSYSTEM (TAIWAN AND THE PHILIPPINES)

Notes : T stands for Taiwan and P for the Philippines. The numbers attached to Tand P refer to the input-output table year arranged from the earliest to the latest. See table 4-4 for actual integration values.

Drastic integration changes are conspicuous in phase 2. Moreover, the integration tends to increase in phase 3. The tendency of the integration to increase in phase 3 can be traced to the slowdown in the rate of change in the total output of agricultural crops and the high rate of change in the final demand for agricultural crops.

2. Integration into the Livestock and Food Manufacturing Subsystems

As shown in figures 4–3 and 4–4, the integration of agricultural crops into the livestock subsystem remains low through time. The integration generally decreases with more advanced transformation. This suggests that the rate of change in agricultural crops output is greater than the rate of change in the final demand for livestock. Likewise, the weakening of the technological interdependence between agricultural crops and livestock, that is the decrease in the requirements of agricultural crops as input in livestock production, contri-

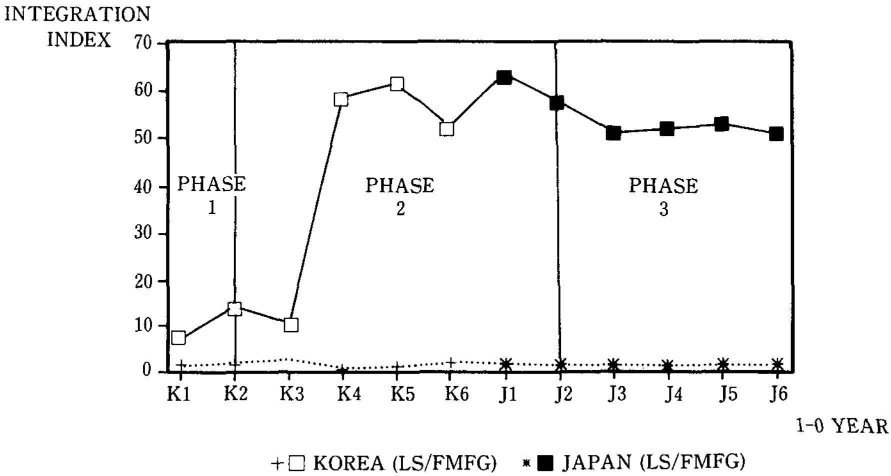

Fig. 4-3. PATTERN OF CHANGE IN THE INTEGRATION OF AGRICULTURAL CROPS INTO THE LIVESTOCK AND GOOD MANUFACTURING SUBSYSTEMS (JAPAN AND KOREA)

Notes: J stands for Japan and K for Korea. The numbers attached to J and K refer to the input-output table year arranged from the earliest to the latest. See table 4-4 for actual integration index values.

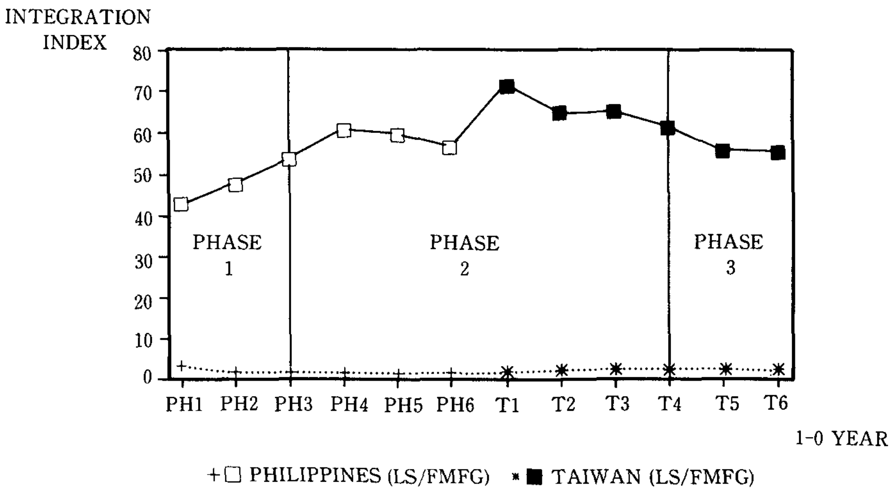

Fig. 4-4. PATTERN OF CHANGE IN THE INTEGRATION OF AGRICULTURAL CROPS INTO THE LIVESTOCK AND FOOD MANUFACTURING SUBSYSTEMS (TAIWAN AND THE PHILIPPINES)

Notes: T stands for Taiwan and P for the Philippines. The numbers attached to Tand P refer to the input-output table year arranged from the earliest to the latest. See table 4-4 for actual integration values.

buted further to the decrease in integration.

On the other hand, the integration of agricultural crops into the food manufacturing subsystem increases over time and is generally higher in phases 2 and 3 than in phase 1. The increase in integration can be attributed to the high rate of change in the final demand for food manufacturing as shown in table 4–2. In phase 1, the greater technological interdependence between agricultural crops and food manufacturing amplified the integration-increasing effect of the change in final demand for food manufacturing. In phases 2 and 3, however, the rate of change in the inverse coefficient reduced the integration increasing effect of the change in final demand.

Table 4-2. FACTORS AFFECTING THE CHANGE IN THE INTEGRATION OF AGRICULTURAL CROPS INTO THE FOOD MANUFACTURING SUBSYSTEM (PHASES 1 AND 2)

FACTOR	PHIL <1965-1969>	KOREA <1963-1971>	TAIWAN <1969-1971>	JAPAN <1975-1980>
	INDEX VALUE	INDEX VALUE	INDEX VALUE	INDEX VALUE
CHANGE IN FINAL DEMAND (FMFG)	1.6	4.38	1.23	1.42
CHANGE IN THE INVERSE COEFFICIENT	1.21	1.12	0.86	0.82
CHANGE IN TOTAL OUTPUT (AGC)	1.73	2.39	1.06	1.14

Notes: Index values are computed as the ratio of the terminal year value to the initial year value. Values are taken or derived from input-output tables. The relevant Leontief domestic inverse coefficient used was the coefficient between agricultural crops and food manufacturing.

The integration into the food manufacturing subsystem peaks in phase 2 and exhibits a downward trend in phase 3. The downward trend in phase 3 can be principally ascribed to the decline in the technological interdependence between agricultural crops and food manufacturing. The trend will most probably decline even more if food manufacturing production requires more livestock inputs than agricultural crops.

3. Integration into the Manufacturing and Public Administration Services Subsystems

The integration of agricultural crops into the manufacturing subsystem is

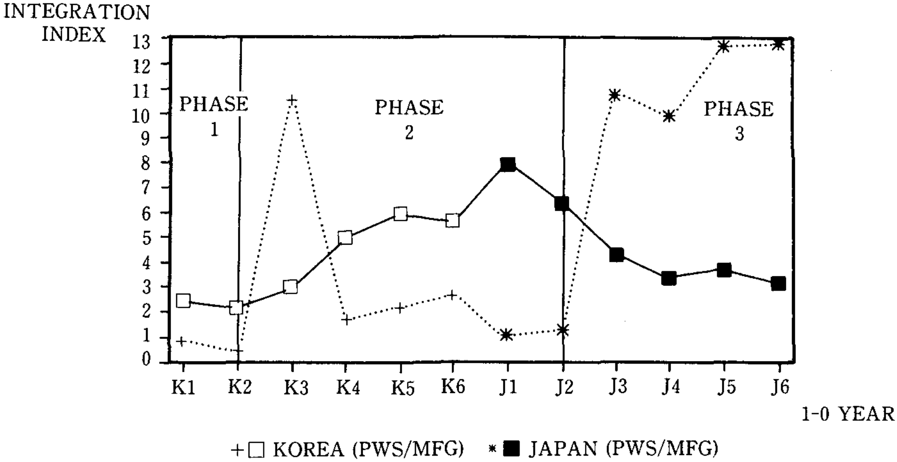

Fig. 4-5. PATTERN OF CHANGE IN THE INTEGRATION OF AGRICULTURAL CROPS INTO THE MANUFACTURING AND PUBLIC ADMINISTRATION/SERVICES SUBSYSTEM (JAPAN AND KOREA)

Notes: J stands for Japan and K for Korea. The numbers attached to J and K refer to the input-output table year arranged from the earliest to the latest. See table 4-1 for actual integration index values.

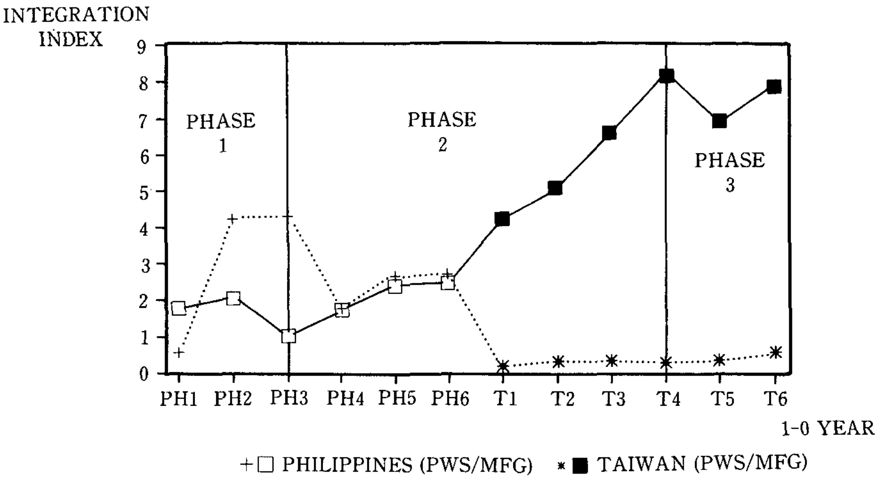

Fig. 4-6. PATTERN OF CHANGE IN THE INTEGRATION OF AGRICULTURAL CROPS INTO THE MANUFACTURING AND PUBLIC ADMINISTRATION/SERVICES SUBSYSTEMS (TAIWAN AND THE PHILIPPINES)

Notes: T stands for Taiwan and P for the Philippines. The numbers attached to Tand P refer to the input-output table year arranged from the earliest to the latest. See table 4-1 for actual integration values.

generally higher in the late phases of transformation as shown in figures 4–5 and 4–6. The integration peaks in phase 2. One can attribute the increase in integration to the spectacular increases in the rate of change in final demand for manufacturing, an essential feature of industrialization. The integration, however, tends to decrease in phase 3 primarily because of the decrease in the requirements for agricultural crops as input in manufacturing production. Thus the decrease in the inverse coefficient can dampen the integration-increasing effect of the change in final demand for manufacturing.

The integration of agricultural crops into the public administration/services subsystem generally increases with more advanced transformation. As shown in table 4–3, the rate of change in the final demand for public administration/services generally influenced the increase in integration. The index values for the Philippines, however, show that the rate of change in the inverse coefficient heightened the integration-increasing effect of the change in final demand. This means that the greater use of agricultural crops as input in public administration/services production brought about the increase in integration.

Table 4-3. FACTORS AFFECTING THE CHANGE IN THE INTEGRATION OF AGRICULTURAL CROPS INTO THE PUBLIC ADMINISTRATION/SERVICES SUBSYSTEM (PHASES 2 AND 3)

FACTOR	JAPAN <1975-1980>	PHIL <1974-1979>
	INDEX VALUE	INDEX VALUE
CHANGE IN FINAL DEMAND (PWS)	1.69	2.15
CHANGE IN INVERSE COEFFICIENT	0.87	1.54
CHANGE IN TOTAL OUTPUT (AGC)	1.14	2.19

Notes: Index values are computed as the ratio of the terminal year value to the initial year value. Values are taken or derived from input-output tables. The relevant Leontief domestic inverse cofficient used was the coefficient between agricultural crops and public administration/services.

B. Change in the Integration of Livestock

1. Integration into the Livestock Subsystem

The integration of the livestock sector into the livestock subsystem is generally higher in phase 1 than in phases 2 and 3. The integration eventually

Table 4-4. INTEGRATION OF LIVESTOCK INTO SELECTED SUBSYSTEMS

		AGC	LS	FMFG	MFG	PWS
JAPAN						
	1960	1.3	31.15	35.74	15.64	1.72
	1965	0.9	25.76	49.44	13.2	1.33
	1970	1.47	20.61	49.33	9.36	1.04
	1975	1.14	15.85	60.51	6.06	10.4
	1980	0.8	17.87	57.74	5.48	11.87
	1985	0.6	14.5	60.74	3.8	14.68
TAIWAN						
	1964	1.05	12.95	83.65	1.06	0.04
	1969	3.52	11.01	78.86	3.88	0.2
	1971	2.43	18.23	73.89	3.59	0.19
	1976	0.96	19.17	72.26	4.37	0.18
	1981	0.54	21.67	69.68	4.45	0.26
	1986	0.45	18.07	72.2	5.63	0.45
KOREA						
	1963	26.33	42.76	19.93	4.2	2.15
	1968	28.2	36.65	29.21	2.28	0.34
	1970	5.16	47.99	31.33	7.86	1.06
	1975	1.99	11.25	58.07	17.23	2.92
	1980	24.44	0.85	61.34	5.93	2.24
	1985	1.17	29.06	55.18	6.3	2.47
PHILIPPINES						
	1961	0.	83.43	15.93	0.03	0.39
	1965	0.01	49.51	43.65	0.2	5.33
	1969	0.07	42.21	48.89	0.36	6.62
	1974	0.04	45.54	50.13	0.3	2.74
	1979	0.08	21.97	70.44	0.46	5.11
	1983	0.08	31.05	60.12	0.46	5.37

Notes: Colums represent subsystems. AGC (Agricultural Crops); LS (Livestock); FMFG (Food Manufacturing); MFG (Manufacturing); PWS (Public Administration／Services)

decreases as shown in figures 4–7 and 4–8. The decrease in the integration can be traced to the greater rate of change in the total output of livestock compared to the rate of change in the final demand for livestock.

The results for agricultural crops and livestock show that the integration

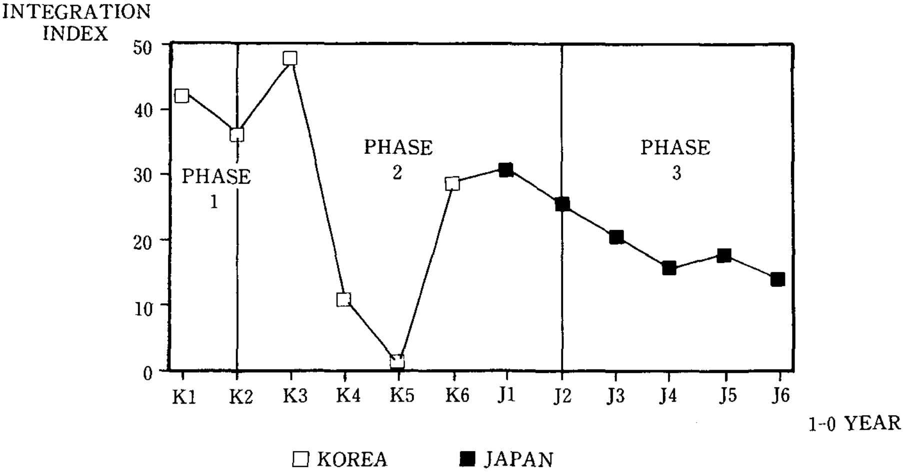

Fig. 4-7. PATTERN OF CHANGE IN THE INTEGRATION OF LIVESTOCK INTO THE LIVESTOCK SUBSYSTEM (JAPAN AND KOREA)

Notes: J stands for Japan and K for Korea. The numbers attached to J and K refer to the input-output table year arranged from the earliest to the latest. See table 4-1 for actual integration index values.

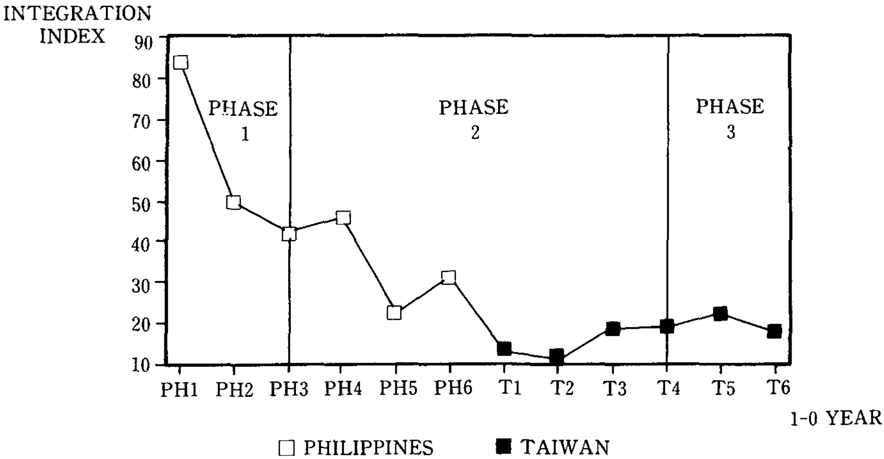

Fig. 4-8. PATTERN OF CHANGE IN THE INTEGRATION OF LIVESTOCK INTO THE LIVESTOCK SUBSYSTEM (TAIWAN AND THE PHILIPPINES)

Notes: T stands for Taiwan and P for the Philippines. The numbers attached to Tand P refer to the input-output table year arranged from the earliest to the latest. See table 4-1 for actual integration values.

of an agricultural sector into its own subsystem is highest in phase 1. Furthermore, the integration decreases over time because of lower rates of change in final demand.

2. Integration into the Agricultural Crops and Food Manufacturing Subsystems

As shown in figures 4–9 and 4–10, the integration of livestock into the agricultural crops subsystem generally decreases with more advanced transformation. This can be ascribed to the greater rate of change in the total output of livestock compared to the rate of change in the final demand for agricultural crops. Moreover, the technological interdependence between livestock and agricultural crops becomes weaker in the late transformation phases. Thus one can conclude that the integration of an agricultural sector with an agricultural subsystem generally decreases over time because of lower rates of change in final demand and weaker techonological interdependencies.

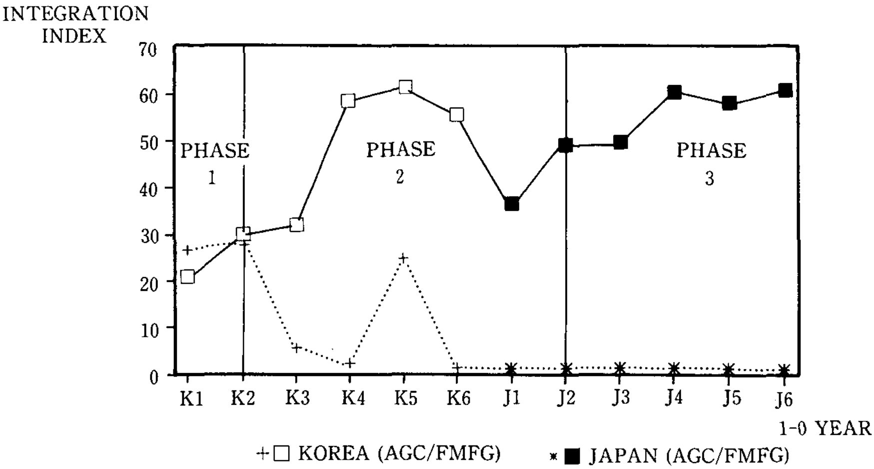

Fig. 4-9. PATTERN OF CHANGE IN THE INTEGRATION OF LIVESTOCK INTO THE AGRICULTUAL CROPS AND FOOD MANUFACTURING SUBSYSTEMS (JAPAN AND KOREA)

Notes: J stands for Japan and K for Korea. The numbers attached to J and K refer to the input-output table year arranged from the earliest to the latest. See table 4-1 for actual integration index values.

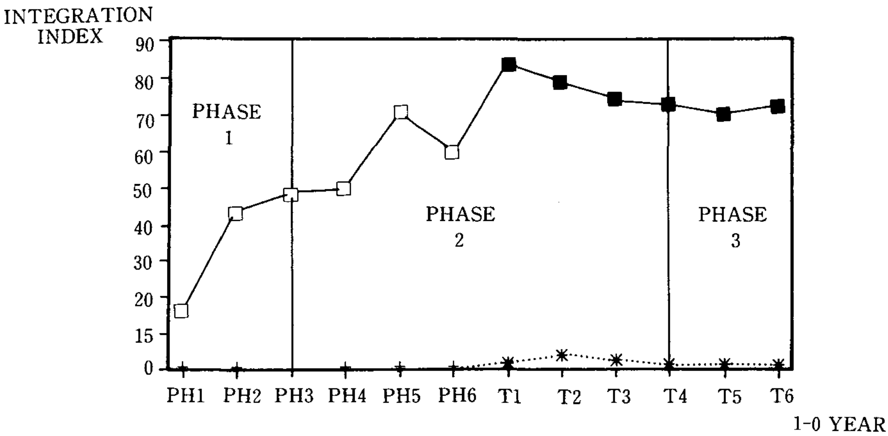

Fig. 4-10. PATTERN OF CHANGE IN THE INTEGRATION OF LIVESTOCK INTO THE AGRICULTURAL CROPS AND FOOD MANUFACTURING SUBSYSTEMS (TAIWAN AND THE PHILIPPINES)

Notes: T stands for Taiwan and P for the Philippines. The numbers attached to Tand P refer to the input-output table year arranged from the earliest to the latest. See table 4-1 for actual integration values.

The integration of livestock into the food manufacturing subsystem generally increases over time. One can observe from table 4–5 that the rate of change in the final demand for food manufacturing generally caused integration to increase. The high rate of change in the inverse coefficient, that is the greater use of livestock as input in food manufacturing production, magnified the integration-increasing effect of the change in final demand. Livestock may continue to be highly integrated into the food manufacturing system if technological interdependence remains at a high level.

3. Integration into the Manufacturing and Public Administration/Services Subsystems

The integration of livestock into the manufacturing subsystem is greater in phases 2 and 3 than in phase 1. As shown in table 4–6, dramatic increases in the rate of change in the final demand for manufacturing due to industrialization brought about the increase in integration. In the case of the Philippines, the change in the inverse coefficient augmented the integration-increasing

Table 4-5. FACTORS AFFECTING THE CHANGE IN THE INTEGRATION OF LIVESTOCK INTO THE FOOD MANUFACTURING SUBSYSTEM (ALL PHASES)

FACTOR	PHIL 〈1961-1965〉	KOREA 〈1963-1968〉	TAIWAN 〈1981-1986〉	JAPAN 〈1960-1965〉
	INDEX VALUE	INDEX VALUE	INDEX VALUE	INDEX VALUE
CHANGE IN FINAL DEMAND (FMFG)	1.59	4.38	1.27	1.6
CHANGE IN THE INVERSE COEFFICIENT	2.15	1.09	1	1.58
CHANGE IN TOTAL OUTPUT (LS)	1.24	3.26	1.23	1.84

Notes: Index values are computed as the ratio of the terminal year value to the initial year value. Values are taken or derived from input-output tables. The relevant Leontief domestic inverse coefficient used was the coefficient between livestock and food manufacturing.

Table 4-6. FACTORS AFFECTING THE CHANGE IN THE INTEGRATION OF LIVESTOCK INTO THE MANUFACTURING SUBSYSTEM (PHASES 2 AND 3)

FACTOR	PHIL 〈1974-1979〉	KOREA 〈1970-1975〉	TAIWAN 〈1971-1976〉	JAPAN 〈1980-1985〉
	INDEX VALUE	INDEX VALUE	INDEX VALUE	INDEX VALUE
CHANGE IN FINAL DEMAND (MFG)	2.13	5.79	3.45	1.19
CHANGE IN THE INVERSE COEFFICIENT	1.66	0.83	0.86	0.65
CHANGE IN TOTAL OUTPUT (LS)	2.35	2.19	2.46	1.09

Notes: Index values are computed as the ratio of the terminal year value to the initial year value. Values are taken or derived from input-output tables. The relevant Leontief domestic inverse coefficient used was the the coefficient between livestock and manufacturing.

effect of the change in final demand. The integration may eventually decrease in phase 3 as shown by Japan because of weaker technological interdependence between livestock and manufacturing.

Fluctuations and constrasting patterns characterize the integration of livestock into the public administration/services subsystem in the early phase of transformation. The integration of livestock, however, generally increases through time. From table 4–7, one can definitely conclude that the rate of change in the final demand for public administration/services greatly contributed to the increase in integration. This is in consonance with the emerging importance of the services sector as industrialization progresses.

Agricultural sectors like livestock and agricultural crops can also benefit from the de-industrialization of an economy, that is from the greater importance of the services sector in the economy, in terms of greater integration. This implies that agricultural production may eventually be oriented towards the services sector.

Table 4-7. FACTORS AFFECTING THE CHANGE IN THE INTEGRATION OF LIVESTOCK INTO THE PUBLIC ADMINISTRATION/SERVICES SUBSYSTEM (PHASES 2 AND 3)

FACTOR	JAPAN<1980-85>	TAIWAN<1981-1986>
	INDEX VALUE	INDEX VALUE
CHANGE IN FINAL DEMAND (PWS)	1.37	2.42
CHANGE IN INVERSE COEFFICIENT	0.99	0.87
CHANGE IN TOTAL OUTPUT (LS)	1.09	1.23

Notes: Index values are computed as the ratio of the terminal year value to the initial year value. Values are taken or derived from input-output tables. The relevant Leontief domestic inverse coefficient used was the coefficient between livestock and public administration/services.

C. Change in the Integration of Food Manufacturing

The integration of food manufacturing into the food manufacturing subsystem is generally greater in phases 2 and 3 than in phase 1. This is more conspicuous in phase 2 ; the integration tends to decrease in phase 3. Looking at table 4–9, one can note that the integration decreased because the rate of change in the total output of food manufacturing is greater than the combined effect of the rate of change in the final demand for food manufacturing and weaker technological interdependence.

The integration of food manufacturing into the public administration/services subsystem tends to increase with more advanced transformation. As shown in table 4–10, the rate of change in the final demand for public administration/services brought about the increase in integration inspite of the low technological interdependence between food manufacturing and public adminis-

Table 4-8. INTEGRATION OF FOOD MANUFACTURING INTO SELECTED SUBSYSTEM (%)

		FMFG	PWS
JAPAN			
	1960	95.72	0.22
	1965	95.57	0.24
	1970	83.	11.62
	1975	85.52	10.07
	1980	83.64	11.42
	1985	82.29	12.55
TAIWAN			
	1964	98.47	0.02
	1969	95.96	0.11
	1971	95.9	0.12
	1976	93.15	0.13
	1981	91.37	0.2
	1986	91.11	0.32
KOREA			
	1963	78.9	4.77
	1968	91.9	0.16
	1970	80.9	1.34
	1975	91.69	1.64
	1980	90.35	2.19
	1985	84.41	3.15
PHILIPPINES			
	1961	96.62	0.52
	1965	93.23	4.27
	1969	91.95	4.76
	1974	95.23	1.79
	1979	93.67	2.88
	1983	90.92	3.5

Notes: Colums represent subsystems. FMFG (Food Manufacturing); PWS (Public Administration/Services).

tration/services as in Taiwan and the Philippines. In Japan, however, the change in the inverse coefficient multiplied the integration-increasing effect of the change in final demand.

Table 4-9. FACTORS AFFECTING THE CHANGE IN THE INTEGRATION OF FOOD MANUFACTURING INTO THE FOOD MANUFACTURING SUBSYSTEM (PHASES 2 AND 3)

FACTOR	JAPAN<1975-1980>	TAIWAN<1971-1976>
	INDEX VALUE	INDEX VALUE
CHANGE IN FINAL DEMAND (FMFG)	1.42	2.5
CHANGE IN INVERSE COEFFICIENT	0.97	1.07
CHANGE IN TOTAL OUTPUT (FMFG)	1.42	2.76

Notes: Index values are computed as the ratio of the terminal year value to the initial year value. Values are taken or derived from input-output tables. The relevant Leontief domestic inverse coefficient used was the coefficient between food manufacturing and food manufacturing.

Table 4-10. FACTORS AFFECTING THE CHANGE IN THE INTEGRATION OF FOOD MANUFUCTURING INTO THE PUBLIC ADMINISTRATION/SERVICES SUBSYSTEM (PHASES 2 AND 3)

FACTOR	PHIL <1979-1983>	KOREA <1980-1985>	TAIWAN <1981-1986>	JAPAN <1980-1985>
	INDEX VALUE	INDEX VALUE	INDEX VALUE	INDEX VALUE
CHANGE IN FINAL DEMAND (PWS)	2.09	2.2	2.42	1.37
CHANGE IN THE INVERSE COEFFICIENT	0.96	1.16	0.85	1.11
CHANGE IN TOTAL OUTPUT (FMFG)	1.66	1.77	1.27	1.38

Notes: Index values are computed as the ratio of the terminal year value to the initial year value. Values are taken or derived from input-output tables. The relevant Leontief domestic inverse coefficient used was the coefficient between food manufacturing and public administration/services.

4. 22 The Integration of Agricultural Employment

Equation 4–3 was used to study the integration of agricultural employment in the productive systems of Japan, Taiwan, Korea, and the Philippines. Since the integration operator was pre-multiplied by the sectoral employment matrix L to get equation 4–3, the interpretation of the results in this section do not differ from section 4.21.

The employment integration implies that both direct and indirect employment are taken into account when a sector's integration into a subsystem is considered. Thus the use of agricultural inputs by a subsystem implies that the subsystem indirectly "employs" those engaged in the production of the particular agricultural input. This also signifies that agriculture indirectly transfers employment to the subsystems.

A. Integration into Selected Subsystems

Table 4-11. AGRICULTURAL EMPLOYMENT INTEGRATION INTO SELECTED SUBSYSTEMS (%)

		AGRI	MFG	PWS/FIRE
JAPAN				
	1960	21.63	59.95	3.38
	1965	26.97	55.31	3.81
	1970	26.47	50.6	8.34
	1975	26.33	49.01	9.09
	1980	23.34	49.24	11.55
	1985	24.42	50.78	11.74
TAIWAN				
	1964	20.27	70.34	0.79
	1969	22.82	67.69	1.4
	1971	23.3	67.9	1.3
	1976	23.08	67.81	1.06
	1981	27.76	62.77	1.52
	1986	26.25	65.76	2.12
KOREA				
	1963	86.23	9.89	1.27
	1968	76.72	15.79	1.08
	1970	78.06	14.9	1.49
	1975	29.63	57.66	3.7
	1980	24.17	58.88	4.85
	1985	32.07	53.16	4.53
PHILIPPINES				
	1961	58.26	34.87	1.32
	1965	41.73	47.31	4.68
	1969	39.91	49.65	4.7
	1974	36.71	56.00	2.03
	1979	30.86	57.2	2.78
	1983	33.61	53.29	3.32

Notes: Columns represent subsystems. AGRI (Agriculture; MFG (Manufacturing); PWS/FIRE (Public Administration/Services/Finance/Insurance/Real Estate)

1. Agriculture Subsystem

The integration of agricultural employment is greater in phase 1 than in phases 2 and 3. This integration tends to decrease over time. This implies that less agricultural employment is necessary in agricultural production in more advanced transformation phases.

2. Manufacturing and Public Administration/Services/Finance, Insurance, Real Estate (PWS/FIRE) Subsystems

Apparently, the integration of agricultural employment into the manufacturing and PWS/FIRE subsystems is higher in phases 2 and 3 because the productive integration of agriculture is greater in these phases than in phase 1 . Generally, the integration increases through time.

One can also observe that the employment integration of agriculture into the manufacturing subsystem is the highest among all subsystems regardless of the transformation phase. This denotes that manufacturing directly and indirectly acquires agricultural employment more than any other subsystem. The high integration of agricultural employment into the manufacturing subsystem may also mean that agriculture directly or indirectly transfers employment to manufacturing the most.

B. Share of Agricultural Employment in Selected Subsystems

1. Share in the Agricultural Subsystem

The share of agricultural employment in the agricultural subsystem is higher in phase 1 than in phases 2 and 3. This share decreases further over time. This connotes that the production of output to satisfy final demand for agricultural products require less agricultural employment.

2. Share in the Manufacturing and Public Administration/Services/Finance, Insurance, and Real Estate (PWS/FIRE) Subsystems

The share of agricultural employment in the manufacturing subsystem is higher than in any other subsystems. This share, however, decreases particularly in phase 3 . In phases 1 and 2, the share may increase and even peak because of greater industrial demand spawned by industrialization.

The share of agricultural employment in the PWS/FIRE subsystem ex-

Table 4-12. SHARE OF AGRICULTURAL EMPLOYMENT IN SELECTED SUBSYSTEMS (%)

		AGRI	MFG	PWS/FIRE
JAPAN				
	1960	95.48	41.71	5.7
	1965	93.41	31.95	4.46
	1970	93.68	25.23	6.54
	1975	90.27	19.71	4.49
	1980	89.58	16.72	4.04
	1985	89.07	14.00	3.37
TAIWAN				
	1964	94.28	55.02	2.71
	1969	92.04	47.5	3.04
	1971	92.9	42.89	28.01
	1976	90.65	32.59	7.22
	1981	76.26	12.98	1.53
	1986	90.25	19.67	1.86
KOREA				
	1963	94.19	27.86	6.11
	1968	97.11	35.8	4.39
	1970	95.51	31.38	5.29
	1975	97.46	55.76	12.15
	1980	96.12	45.62	11.04
	1985	92.28	30.82	5.74
PHILIPPINES				
	1961	98.	59.51	6.51
	1965	99.53	64.93	15.23
	1969	98.38	63.77	14.36
	1974	98.02	58.84	6.92
	1979	96.08	55.08	6.31
	1983	95.81	55.03	7.46

Notes:Columns represent subsystems. AGRI (Agriculture); MFG (Manufacturing); PWS/FIRE (Public Administration/Services)

hibits contrasting patterns of change, but when one compares the initial share with the terminal share, an upward trend can be observed. The share generally peaks in phase 2.

5 THE PRODUCTION INDUCEMENT MECHANISM OF AGRICULTURE

The complexity of the production relationships and transactions which characterize an interdependent productive system implies an adjustment process to change. The interdependent system in equilibrium is the result of this adjustment process. The process leading to equilibrium may differ depending on the degree of complexity of the interdependent production relationships and transactions. Countries with different degrees of complexity are therefore characterized by specific adjustment processes.

The production inducement mechanism, the result of an exogenous change in a particular sector, is one interindustry adjustment process. It embodies the impact inducement and response mechanism of interindustry production relationships. This aspect of interindustry production relationships is vital because of its implications on policy impact studies. Furthermore, the production inducement mechanism shows how the interdependent sectors of an economy react to exogenous changes and establish equilibrium. The analysis of the time framework of the multiplier effects of an exogenous change in agriculture and the changes in the production inducement mechanism of agriculture are therefore relevant to the understanding of the impact aspect of agricultural interindustry production relationships.

5.1 The Sequential Input-Output Model

The impact of an exogenous change in one particular sector on all the sectors of an economy is traditionally studied using the Leontief inverse matrix. Mules (1983) argued that the traditional input-output multiplier does not take into account the length of time taken to realize effects. He contended that the absence of a time framework seriously limits the usefulness of the input-output multiplier for impact analysis. In order to identify the delayed responses to an initial impact, he decomposed the usual input-output multiplier and presented a system of modelling input-output responses to an inital impact without recourse to the Leontief inverse. This system is called the sequential input-output model.

The sequential input-output model is essentially based on the power series expansion of the Leontief inverse. Therefore, it relies on the direct input coefficients to trace production responses. The power series $I + A + A^2 + A^3 + \cdots\cdots + A^n$ implies that the A, A^2, A^3, A^n are the first, second, third, and nth responses to the initial impact. Denoting the first response by R_1, one can derive the second response or second round effect by pre-multiplying A to R_1. This means that in order to produce the amounts required in the first round effect, sectors must purchase additional inputs. The second round effect AR_1 is thus the response to the first round effect, and the third round effect is the response to the second round effect and so on. Thus,

$$R_2 = AR_1 \qquad \text{(second round effect)}$$
$$R_3 = AR_2 = A\,(AR_1) = A^2R_1 \qquad \text{(third round effect)}$$
$$R_n = A^{n-1}R_1 \qquad (5\text{–}1)$$

where R_n is the nth round effect.

The sum of $R_1 + R_2 + \cdots\cdots + R_n$ is equal to the multiplier effect obtained using the Leontief inverse. In this formulation, it is assumed that each sector can respond immediately to the needs of the previous period without delay. This, however, is not the case in the real world : lag in production response is the normal state of things.

Assuming that lags in production response for each sector have been determined, the first round effect in a sequential input-output system is therefore equal to $R_1 = I_0AR_0$, where I_0 is the lag operator, A is the direct input coefficient matrix, and R_0 is the final demand vector representing the initial impact. The lag operator I_0 is a square matrix, the off-diagonal elements of which are all zeros. The on-diagonal elements can either be one or zero. If a sector can respond to the impact in the particular round in question, the corresponding diagonal element is given a value of one. Otherwise, the value remains zero. Thus I_0 identifies those sectors with no production lags, I_1 those sectors with a lag period of one, I_2 those sectors with a lag period of 2 and so on. On the other hand, R_0 is a column vector composed of zeros except for the sector or sectors in which a change in final demand has been induced.

The second round effect is therefore the sum of the responses of those sectors with a lag period of one to the initial impact and the responses of those sectors with no production lags to the first round effect. Thus $R_2 = I_0AR_1 + I_1 AR_0$. The effect for any round n can therefore be written as

$$R_n = \sum_{k=1}^{n} I_{k-1} AR_{n-k} \qquad (5\text{–}2)$$

where I_{k-1} is the lag operator for k–1 periods. Equation 5–2 is the matrix formulation of the sequential input-output model[14].

Model Measurement. An important procedure in the application of the sequential input-output model is the determination of the production lag. The determination of the lag within an interindustry framework is ideal because it is consistent with the interindustry formulation of the model.

The Robinson-Markandya quantity adjustment model offers one way of determining the "interindustry production lag". This model seeks to determine the period of time necessary for a significant portion of total output induced by final demand to be produced[15]. This period of time represents an interindustry production lag.

The model assumes that the economy produces output according to the power series expansion of the inverse. This means that the economy produces output in this manner :

$$\begin{aligned} X &= (I - \langle U \rangle A)^{-1} Y \\ &= (I + UA + (UA)^2 + \cdots\cdots + (UA)^n) Y \qquad (5\text{–}3) \end{aligned}$$

where U is the diagonalized rate of self-sufficiency matrix, A is the direct input coefficient matrix, and Y is final demand. Final demand is computed as ($\langle U \rangle$ D + E) where D is domestic final demand and E is exports. The power

14) See Mules (1983) for a discussion of the assumptions of the sequential input-output model and its extensions. See also Romanoff and Levine (1981) for a discussion of sequential interindustry models, the forerunner of the sequential I-O model.

15) See Robinson and Markandya (1973) for an exposition of the model. See Hewings (1982) for an interpretation of this model.

series is made to continue until a certain percentage of total output has been reached. In this study, the agricultural and food manufacturing sectors finish production after they have achieved ninety-eight percent of total output. All the other sectors finish production after they have achieved ninety-five percent of production.

The imposition of the cut-off point denotes that the power series can be written as :

$$X = (I + UA^{(1)} + UA^{(2)} + \cdots\cdots + UA^{(n)}\, UA^{(n-1)}\, UA^{(1)}\, Y) \qquad (5\text{–}4)$$

In this equation $UA^{(1)}$ is equal to UA. $UA^{(2)}$ is also equal to UA, but the elements in the columns of (UA) for those sectors which finished production in the previous round is set to zero. Equation 5–4 was used to determine the production lags for agriculture and food manufacturing shown in table 5–1.

The Leontief global inverse matrix, $(I\text{–}A)^{-1}$ was used in the analysis[16)]. The initial impact was a ten million change in final demand for agriculture and food manufacturing. Using equation 5–2, the output effect of the initial impact on all sectors was computed for six periods. The sum of the effects obtained after the sixth production lag was analyzed because this was the common maximum number of rounds observed for the agricultural sectors. The sum was compared with the total multiplier effect and the total sectoral multiplier effect. The sum of the column elements of the Leontief inverse matrix is referred to as the total multiplier effect and the individual column elements represent the total sectoral multiplier effect. Analysis was made for one and two impacted sectors. The analysis of the production mechanism for two impacted sectors was made to clarify its differences with the production inducement mechanism for one impacted sector.

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16) The use of the Leontief global inverse matrix $(I\text{–}A)^{-1}$ was deemed appropriate because the procedure used in determining the production lag used the Leontief domestic inverse matrix. Using the Leontief domestic inverse matrix in the sequential input-output model may lead to double accounting of the influence of the rate of self-sufficiency on transactions complexity and the realization of multiplier effects.

Table 5-1. INTERINDUSTRY PRODUCTION LAGS (AGRICULTURE AND FOOD MANUFACTURING) (NO. OF ROUNDS)

		AGC	LS	FMFG
JAPAN				
	1960	6	10	3
	1965	5	6	3
	1970	5	5	4
	1975	5	6	3
	1980	5	5	4
	1985	5	5	4
TAIWAN				
	1964	4	3	2
	1969	4	5	3
	1971	4	4	3
	1976	5	5	4
	1981	5	5	4
	1986	5	5	4
KOREA				
	1963	3	4	4
	1968	3	4	2
	1970	3	4	4
	1975	4	5	3
	1980	5	5	4
	1985	5	5	4
PHILIPPINES				
	1961	3	2	1
	1965	3	2	2
	1969	3	3	2
	1974	3	3	2
	1979	4	4	3
	1983	4	4	3

Notes: The number of rounds was determined by using the Robinson-Markandya quantity adjustment model. Results for the non-agricultural sectors are available on request.

5. 2 Results and Discussion

A. One Impacted Sector

1. Production Inducement by the Agricultural Crops Sector

On the average, the percentage of the multiplier effect of the change in final demand for agricultural crops realized after six rounds was greater in phase 1 than in phase 2 in Korea and the Philippines. The percentage was generally greater in phase 2 than in phase 3 in Japan and Taiwan. Therefore one can conclude that the portion of the total multiplier effect of the change in final demand for agricultural crops realized after a period of time tends to be higher in the early phases of agricultural transformation. As shown in table 5–1, the agricultural sector responds more quickly to changes in final demand in the early phases of the transformation because of less complex transactions. The faster the interindustry production response to changes in final demand, the faster and greater will be the transmission and realization of total multiplier effects.

The number of sectors in which sixty percent of the total sectoral multiplier effect had been realized after six rounds in Korea and the Philippines was greater in phase 1 than in phase 2. In Japan and Taiwan, the number was greater in phase 2 than in phase 3. One can therefore say that a significant portion of the sectoral mutiplier effects of a change in the final demand for agricultural crops are realized in more sectors in the early phases of agricultural transformation.

2. Production Inducement by the Livestock Sector

In Korea and the Philippines, the average portion of the total multiplier effects of the change in final demand for livestock realized after six rounds in phase 1 was greater than in phase 2. The percentage of realized multiplier effects in Japan and Taiwan was greater in phase 2 than in phase 3. Like the agricultural crops sector, the period of time for livestock to respond to changes in final demand was shorter in the early phases of the transformation process. The livestock sector acquires inputs from other sectors as it produces output. Therefore the more readily available are the inputs, the faster

Table 5-2. CUMULATIVE MULTIPLIER EFFECTS OF A CHANGE IN FINAL DEMAND FOR AGRICULTURE AND FOOD MANUFACTURING RING (AFTER SIX PRODUCTION LAG PERIODS, %)

		AGC	*	LS	**	FMFG	***
JAPAN							
	1960	81.51	4	77.61	5	75.56	5
	1965	85.19	7	76.4	6	77.45	5
	1970	94.8	6	73.4	3	76.5	5
	1975	83.98	6	75.48	6	75.3	6
	1980	78.89	4	70.15	4	72.62	4
	1985	82.85	7	71.14	3	74.66	5
TAIWAN							
	1964	92.28	10	87.45	5	85.95	8
	1969	87.13	10	75.71	5	78.15	6
	1971	88.2	9	76.84	6	79.61	5
	1976	88.47	4	69.21	4	76.01	5
	1981	87.06	4	66.94	3	74.26	5
	1986	88.85	5	68.47	2	73.69	3
KOREA							
	1963	94.17	12	87.77	10	86.15	12
	1968	91.79	9	89.12	8	81.6	14
	1970	93.35	10	87.09	9	84.6	11
	1975	91.74	6	81.97	9	84.63	5
	1980	88.79	6	75.91	8	80.11	4
	1985	89.99	6	72.61	7	78.5	4
PHILIPPINES							
	1961	98.98	13	98.03	13	97.46	15
	1965	99.36	12	98.12	15	97.44	16
	1969	99.03	13	97.49	13	96.73	14
	1974	98.96	10	97.25	12	96.98	13
	1979	97.13	11	84.3	8	86.52	10
	1983	95.58	8	82.87	6	84.67	7

Notes: Asterisk marks show the number of sectors in which sixty percent of the *sectoral multiplier effect had been realized after six production lag periods.*
* (AGC, Agricultural Crops); **(LS, Livestock); ***(FMFG, Food Manufacturing)

can livestock produce output. The faster it can produce output, the higher is the probability that a major portion of total multiplier effects will be realized. Moreover, livestock interindustry transactions are less complex in the earlier phases of transformation.

The average number of sectors in which sixty percent of the total sectoral multiplier effects had been realized after six production lag periods was also observed to be higher in the early phases of agricultural transformation.

3. Production Inducement by the Food Manufacturing Sector

The average realized multiplier effects of a change in final demand for food manufacturing after six rounds in Korea and the Philippines was greater in phase 1 than in phase 2. In Japan and Taiwan, the portion of the total multiplier effects realized after six rounds was higher in phase 2 than in phase 3. One can therefore say that the realization of the output multiplier effects of the change in final demand for food manufacturing is higher in the early phases of agricultural transformation. This can also be traced to the faster interindustry production response of food manufacturing to changes in final demand in the early phases of agricultural transformation, which is caused by less complex interindustry transactions.

The average number of sectors in which sixty percent of the sectoral multiplier effects had been realized was also higher in the early transformation phases.

B. Two Impacted Sectors

1. Production Inducement by Agricultural Crops and Livestock

The portion of the total output multiplier effects of a change in final demand for agricultural crops and livestock realized after six rounds in Korea and the Philippines was on the average higher in phase 1 than in phase 2. In Japan and Taiwan, the percentage of the realized effects was greater in phase 2 than in phase 3. Thus total multiplier effects are realized more in the early phases of the transformation process even in the case of two impacted sectors.

The average number of sectors in which sixty percent of the sectoral

Table 5-3. CUMULATIVE MULTIPLIER EFFECTS OF A CHANGE IN FINAL DEMAND FOR TWO SECTORS (AFTER SIX PRODUCTION LAG PERIODS, %)

		AGC/LS	*	AGC/FMFG	**	LS/FMFG	***
JAPAN							
	1960	79.26	6	77.94	4	76.54	5
	1965	79.81	7	80.52	8	76.91	7
	1970	77.93	5	79.85	7	74.93	5
	1975	78.81	7	78.75	7	75.39	6
	1980	73.71	5	75.33	5	71.34	5
	1985	75.71	4	78.06	6	72.81	4
TAIWAN							
	1964	89.42	7	88.45	9	86.68	6
	1969	80.07	8	81.78	9	76.87	7
	1971	81.15	8	83.1	9	78.14	7
	1976	76.04	6	80.99	6	72.29	4
	1981	74.07	5	79.42	5	70.22	3
	1986	75.71	5	79.71	5	70.85	2
KOREA							
	1963	90.48	10	89.29	14	86.86	13
	1968	90.35	9	85.74	15	84.96	15
	1970	89.64	9	88.07	11	85.82	10
	1975	85.76	9	87.35	6	83.32	6
	1980	80.9	8	83.47	6	78.01	6
	1985	78.73	8	82.82	6	75.41	6
PHILIPPINES							
	1961	98.47	14	98.08	14	97.71	13
	1965	98.68	15	98.17	16	97.73	16
	1969	98.19	13	97.6	14	97.05	14
	1974	98.02	12	97.75	13	97.1	12
	1979	89.49	11	90.52	12	85.47	10
	1983	87.78	10	88.66	10	83.81	6

NOtes: Columns show the combination of impacted sectors. Asterisk marks show the number of sectors in which sixty percent of the sectoral multiplier effect had been realized after six production lag periods. * (AGC, Agricultural Crops): **(LS, Livestock): *** (FMFG, Food Manufacturing) multiplier effects had been realized after six production lag periods was observed to be higher in the early phases of the transformation process.

2. Production Inducement by Agricultural Crops and Food Manufacturing

On the average, the portion of the total output multiplier effects realized after six rounds in Korea and the Philippines was higher in phase 1 than in phase 2. On the other hand, the percentage of realized multiplier effects after six rounds in Japan and Taiwan was higher in phase 2 than in phase 3. The realization of multiplier effects, therefore, is higher in the early phases of agricultural transformation.

The number of sectors in which sixty percent of the sectoral multiplier effects had been realized was also observed to be higher in the early phases of transformation.

3. Production Inducement by Livestock and Food Manufacturing

In Korea and the Philippines, a greater portion of the total output multiplier effects was realized in phase 1. The percentage of multiplier effects realized in phase 2 was also greater than in phase 3 in Japan and Taiwan. These observations imply that output multiplier effects are realized more in the early phases of agricultural transformation.

The average number of sectors in which sixty percent of sectoral multiplier effecs had been realized after six rounds was greater in the early phases of transformation.

Generally, differences between the one impacted sector case and the two impacted sector cases are inconspicuous. As far as the percentage of realized effects is concerned, both cases show that a major portion of total multiplier effects are realized more in the early transformation phase. Furthermore, the greater realization of multiplier effects is definitely influenced by the complexity of interindustry transactions. An inverse relationship exists between the percentage of realized multiplier effects and transactions complexity. The interindustry response to changes in final demand is more immediate in sectors with less complex interindustry transactions. In sectors with less complex transactions, production inducement spans a shorter period.

An agricultural transformation hierarchy can be made based on the average portion of agricultural and food manufacturing output multiplier effects realized after a period of time. A country with a more advanced agricultural transformation has, on the average, a smaller percentage of realized output multiplier effects because of more complex interindustry transactions. Therefore, Japan has the most advance form of agricultural transformation and the Philippines the least.

6 CONCLUSIONS

The nature of agricultural interindustry production relationships in the process of agricultural transformation in Japan, Taiwan, Korea and the Philippines was studied by examining its production inducement mechanism and the patterns of change in its productive and employment integration. The results of the analysis show that the ubiquitous reference to the decline in the role of agriculture in researches on structural change can be traced from an interindustry point of view to a declining productive integration and share in subsystem employment integration. Although agriculture's integration into the public administration/services subsystem was found to be increasing, the integration has remained small. In the four Asian countries studied, the integration of agriculture into subsystems like manufacturing, food manufacturing, and public administration/services generally peaks in phase 2, the critical transformation phase. Therefore agriculture is more linked and integrated into the economy in phase 2, a phase favorable to agricultural interindustry production and employment integration.

Greater productive agricultural and food manufacturing integration can be attained by strengthening existing linkage relationships between agriculture/food manufacturing and other sectors and stimulating final demand for the products of those sectors with strong backward linkage relationships with agriculture. Linkage relationship can be strengthened by finding ways of increasing the use of agriculture and food manufacturing as input in industrial production. Instead of just exporting sugar and coconut oil, commodities subject to the volatility of world prices, the Philippines should gear research and development towards developing sugarcane and coconuts as input in industrial production. The influence of interindustry linkage relationships is pivotal in the determination of the direction of change in integration ; it can intensify or weaken the integration-increasing effect of the change in final demand.

Similarities in the production inducement mechanism of agriculture and food manufacturing were observed in Japan, Taiwan, Korea, and the Philippines. Based on these features, an interindustry agricultural transformation hierarchy can be established. Japan's interindustry agricultural transformation is the most advanced, followed by Taiwan, Korea, and the Philippines.

In the early phases of economic development and agricultural transformation, the inducement of change in agriculture results in a greater percentage of realized multiplier effects and the realization of a significant portion of sectoral multiplier effects in more sectors. This lends further empirical support to Oshima's (1989) contention that in the monsoon economies of Japan, Taiwan, Korea, and the Philippines, agriculture should be sufficiently stimulated or developed in the early phases of development for it to play a significant role in the agro-industrial transition.

Similarities in the integration and production inducement mechanism of agriculture in Japan, Taiwan, Korea, and the Philippines imply that the Asian path of agricultural development has distinct interindustry aspects. This interindustry path of Asian agricultural transformation has to be studied and validated further by examining other interindustry structural production relationship indicators in order to understand better the nature of the interdependent Asian path identified in this study.

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