AN INPUT-OUTPUT ANALYSIS OF STRUCTURAL CHANGE IN HOKKAIDO AGRICULTURE, 1970-1985 *

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1. Introduction

Agriculture is one of Hokkaido's principal industries. Hokkaido agriculture is not only regionally but also nationally important. Hokkaido is blessed with rich natural resources, a vast land area, and cheaper land prices which

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enhance the attractiveness and potential of agricultural production Likewise, the share of Hokkaido's major agricultural products in national production has become more vital.

Hokkaido agriculture is confronted with challenges that are offshoots of national problems like the international clamor for the liberalization of trade and the rationalization of agricultural markets and the distribution system, higher domestic prices, and lesser government expenditures and subsidies. The extent to which agricultural policies can respond to these challenges and adapt to difficult conditions will most probably determine the fate of Hokkaido agriculture. The onerous task of responding and adapting to the changing economic environment requires an understanding of the ways growth and structural change in Hokkaido agriculture has evolved interdependently with other industries. Indeed, the increasing complexity of economic interrelationships among industries demands an interindustry perspective to agricultural policy.

The purpose of this paper is to determine in an input-output framework the basic sources of output and employment change in Hokkaido agriculture from 1970 to 1985.[1] What were the factors which caused agricultural output and employment change and to what extent did these factors cause change ? In which industrial sources did agricultural output change originate and to which industrial sectors and to what extent were these changes induced ? What relationships of change exist between agriculture and other industries ? The research reported in this paper seeks answers to these questions.

The period under consideration will be divided into two, namely, 1970–1980 and 1980–1985 (hereafter referred to as period 1 and period 2, respectively). A plausible explanation for this division is that period 1 ecompasses one of the most turbulent decades in Japanese agriculture as seen from policies like the rice production adjustment program and the planned production program for milk and period 2 represents the first five years after this decade. Likewise, period 1 embodies changes precipitated by the two oil crises and period 2 covers the first few years of what can be termed as the post-oil

crisis period. The decision to use only the most recent Hokkaido input-output tables also influenced the period division.

Section 2 briefly presents a discussion of relevant changes in the output and employment backward linkage indexes of Hokkaido agriculture. The decomposition analysis of output change using the Chenery (1980) model and the extension of this model by Fujita (1986) is presented in Section 3. Section 4 deals with the decomposition analysis of employment change in Hokkaido agriculture and presents the Pal (1986) model as a compromise decomposition method which bypasses the problem of index choice. Section 5 sums up the results of the decomposition analyses and propounds relevant policy insights.

2. Change in the Output and Employment Linkage Indexes of Hokkaido Agriculture

The production and employment inducement structures of an economy can be studied through linkage analysis. Linkage analysis has been used in regional industrial development planning as a way of identifying key sectors. Key sectors are, conventionally, those sectors with high linkages, that is those sectors with the most potential capacity to stimulate production.[2] Linkages exist because of interdependencies in production and thus, an input-output table is the ideal framework on which to base linkage measures.

Ever since Hirschman (1958) defined the concept of forward and backward linkages, various measures have been suggested.[3] Only backward linkages will be considered in this section because it is likely to be more predominant and more suggestive of interdependent production and employment conditions in a developing region like Hokkaido.[4] Likewise, Fujita (1986) has proposed the use of backward linkage measures to quantify the effects of agricultural expansion or contraction due to external economic pressures on other industries.

The 1970, 1980, and 1985 Hokkaido competitive imports input-output tables at current producer's prices were used to analyze changes in the output

and employment backward linkage indexes of the agricultural sectors of the Hokkaido economy. The sixty-one sector input-output tables were aggregated into fifteen sectors for the analysis of changes in output backward linkage indexes. These sectors are the following:

1. Edible Crops and Grains
2. Non-Edible Crops and Grains
3. Livestock
4. Agricultural Services
5. Forestry
6. Fishery
7. Mining
8. Construction
9. Manufacturing
10. Food Manufacturing
11. Commerce
12. Public Utilities, Transportation, and Communication
13. Finance, Insurance, and Real Estate
14. Public Works / Services
15. Others

Sectors 1 to 4 comprise what is referred to as the agricultural sectors of the Hokkaido economy. Food manufacturing was also separated from manufacturing.

Only eleven sectors were used in the analysis of changes in employment backward linkage indexes because employment data contained in the population census of Japan for 1970, 1980, and 1985 were not as detailed as the input-output tables. These sectors are the following:

1. Agriculture
2. Forestry
3. Fishery
4. Mining
5. Construction

6. Manufacturing
7. Commerce
8. Public Utilities, Transportation, and Communication
9. Finance, Insurance, and Real Estate
10. Public Works / Services
11. Others

2. 1 Output Backward Linkage Index

Ex-post linkage analysis will be carried out in this section. Bulmer-Thomas (1982) stated that this type of linkage analysis requires the use of domestic coefficients a_{ij}^{d} rather than technical coefficients a_{ij}. The Leontief domestic inverse matrix will, thus, be used. The power of dispersion index formulated by Rasmussen (1956) will be employed as a measure of backward linkage.[5] Hazari (1970) and Laumas (1976) consider the Rasmussen measure as reflective of Hirschman's backward linkage concept.

The output power of dispersion or backward linkage index is defined as follows :

$$BL_o = \varepsilon_j r_{ij} / 1/n \quad \varepsilon_i \ \varepsilon_j r_{ij}$$

where r_{ij} is the ith row and jth column element of the Leontief domestic inverse matrix $(I- \langle U \rangle A)^{-1}$ and n is the number of sectors. An increase in the output backward linkage index indicates that the power to induce production of intermediate inputs needed to satisfy production requirements due to greater demand has increased and vice versa.

As can be observed from table 2. 1, the backward linkage index of livestock is the highest among the agricultural sectors of the Hokkaido economy. This index decreased in period 1 but increased favorably in period 2 like the other agricultural sectors except for edible crops and grains. The backward linkage indexes of food manufacturing and livestock exceeded those of construction and manufacturing in 1985 and therefore became the two highest indexes in the Hokkaido economy. This implies the growing importance of these two closely related sectors in the production inducement structure.

Table 2.1 Change in the Output Backward Linkage Index of the Industrial Sectors of the Hokkaido Economy, 1970-1985

	1970	1980	1985	1	2
SECTOR 1	0.7526	0.8923	0.889	0.1397	-0.0033
SECTOR 2	1.1296	0.8502	0.9783	-0.2794	0.1291
SECTOR 3	1.1621	1.0473	1.1422	-0.1148	0.0949
SECTOR 4	0.7748	0.9369	0.9829	0.1621	0.046
SECTOR 5	0.8284	0.7455	1.0903	-0.0829	0.3448
SECTOR 6	0.8503	0.935	0.8548	0.0847	-0.0802
SECTOR 7	0.7725	0.8681	0.9692	0.0956	0.1011
SECTOR 8	1.5577	1.4351	0.9707	-0.1226	-0.4644
SECTOR 9	1.9124	1.7527	0.9978	-0.1597	-0.7549
SECTOR 10	1.1842	1.1483	1.221	-0.0359	0.0727
SECTOR 11	0.4143	0.5332	0.9355	0.1189	0.4023
SECTOR 12	0.4505	0.4482	0.8452	-0.0073	0.402
SECTOR 13	0.8424	0.9671	0.916	0.1247	-0.0511
SECTOR 14	0.6432	0.7527	0.9051	0.1095	0.1524
SECTOR 15	1.725	1.6924	1.3014	-0.0326	-0.3911

Notes: Column 1 is the difference between the 1980 and 1970 indexes. Column 2 is the difference between the 1985 and 1980 indexes. The agricultural sectors are edible crops and grains (sector 1), non-edible crops and grains (sector 2), livestock (sector 3), and agricultural services (sector 4). Food manufacturing is sector 10.

2. 2 Employment Backward Linkage Index

The employment power of influence or backward linkage index is derived from the employment generation matrix, a matrix obtained by premultiplying the Leontief inverse matrix by the diagonalized employment coefficient matrix. As in Section 2. 1, ex-post linkage analysis will be carried out in this section and the Rasmussen measure will also be used.

The employment backward linkage index is defined as follows :

$$BL_e = \varepsilon_j I_{ij} / 1/n \quad \varepsilon_i \ \varepsilon_j I_{ij}$$

where I_{ij} is the ith row and jth column element of the employment generation matrix and n is the number of sectors. An increase in the employment backward linkage index indicates that the power to generate employment needed to meet intermediate input requirements due to greater demand has increased and vice versa.

An inspection of table 2.2 reveals that the employment backward linkage index of agriculture is one of the highest in the Hokkaido economy.[6] Agricul-

Table 2.2 Change in the Employment Backward Linkage Index of the Industrial Sectors of the Hokkaido Economy, 1970-1985

	1970	1980	1985	1	2
SECTOR 1	1.7924	1.7578	1.541	-0.0346	-0.2168
SECTOR 2	0.9648	0.967	1.2325	0.0022	0.2655
SECTOR 3	1.2544	1.2	1.202	-0.0544	0.002
SECTOR 4	0.961	0.7896	0.7911	-0.1714	0.0015
SECTOR 5	0.8049	0.8906	0.9352	0.0857	0.0446
SECTOR 6	0.7134	0.691	0.7218	-0.0224	0.0308
SECTOR 7	1.3054	1.4647	1.5494	0.1593	0.0847
SECTOR 8	0.3436	0.4276	0.4601	0.084	0.0325
SECTOR 9	0.8961	0.9257	0.7936	0.0296	-0.1321
SECTOR 10	1.1248	1.0878	1.0452	-0.037	-0.0426
SECTOR 11	0.8387	0.7997	0.7281	-0.039	-0.0716

Notes: Column 1 is the difference between the 1980 and 1970 indexes. Column 2 is the difference between the 1985 and 1980 indexes. Agriculture is sector 1.

ture's high employment backward linkage index implies that a change in its final demand will relatively affect industrial employment more than other sectors. This index, however, decreased in both periods ; it decreased more in period 2 than in period 1. As a matter of fact, the employment backward linkage index of commerce exceeded that of agriculture in 1985. This suggests the in-

creasing direct labor input in commerce as opposed to the decreasing direct labor input in agriculture.

The emergence of livestock and food manufacturing as the sectors with the two highest output backward linkage indexes in 1985 and the high but decreasing employment backward linkage index of agriculture were the most prominent changes in the production and employment inducement structures of the Hokkaido economy from 1970 to 1985. These changes undeniably interplayed with the factors of agricultural output and employment change. The use of decomposition analysis in an input-output framework is therefore necessary in order to impute agricultural output and employment change to various factors, to quantitatively trace agricultural output change to its industrial origins, and to determine within the production inducement structure the induced effects of agricultural change on other sectors.

3. Decomposition Analysis of Output Change in Hokkaido Agriculture

3. 1 Decomposition Model

3. 1. 1 Survey of Related Literature

Chenery (1960) pioneered work on a direct type of decomposition analysis. The work of Chenery, Shishido, and Watanabe (1962) on the pattern of Japanese growth was the first application of the method in an input-output framework. Decomposition analysis in an input-output framework ascribes industrial growth and structural change to changes in demand, trade, and technology. The Chenery-Shishido-Watanabe model was then revised by Chenery (1969).

Syquin (1976) extended the revised Chenery model by using domestic demand ratios and defining import substitution as the change in the ratio of imports to total demand.[7] Chenery and Syrquin (1979) extended the Syrquin model by using import ratios and defining import substitution as the change in the proportion of imports in total supply. The Chenery-Syrquin model differs from the Syrquin model because it is a deviation formulation approach which only considers the domestic component of any deviation. The Leontief

domestic inverse matrix is therefore used in the decomposition analysis of changes in sector proportions. Chenery (1980) later presented the first difference formulation of the Chenery-Syrquin model.[8] Dervis, de Melo, and Robinson (1982) contends that the first difference formulation approach is most suitable for identifying the major "engines" of sectoral growth. Fujita (1985) used and extended the Chenery model in his research on the factors of output change in Japanese agriculture from 1965 to 1981.[9]

3. 1. 2 Output Decomposition Methodology

The Chenery (1980) model was used in the comparative static input-output decomposition analysis of output change in Hokkaido agriculture. The Chenery model was chosen because this first difference formulation approach enables the analysis of absolute regional output change in agriculture. Chenery expressed in matrix notation the equilibrium between total demand and total supply as follows:

$$X = \langle U \rangle (W + D) + E \tag{1}$$

where X is the column vector of total output, $\langle U \rangle$ is the diagonal matrix of self-sufficiency rates, W is the column vector of intermediate demand, D is the column vector of domestic final demand, and E is the column vector of exports. Since W = AX, equation 1 becomes

$$X = \langle U \rangle (AX + D) + E \tag{2}$$

where A is the matrix of input coeffifients. Intermediate and domestic final demands are premultiplied by the diagonal matrix of self-sufficiency rates because only the domestic component of output change is considered.

Comparative static analysis expresses total output change as follows:

$$\Delta X = X_1 - X_0 \tag{3}$$

where subscripts 1 and 0 refer to the terminal and initial years, respectively. Substituting (2) to (3) and deriving total output change yields the following first difference formulation of the decomposition equation:

$$\Delta X = R_0^d \langle U_0 \rangle \Delta D + R_0^d \Delta E + R_0^d \Delta \langle U \rangle (D_1 + W_1) + R_0 \langle U_0 \rangle \Delta AX_1 \tag{4}$$

where R_0^d is the Leontief domestic inverse matrix $(I - \langle U \rangle A)^{-1}$ [10] The

Chenery model therefore decomposes total output change as the sum of four structural changes : effect of the change in domestic final demand, effect of the change in exports, effect of the change in the rate of self-sufficiency, and the effect of the change in technology. The effect of the change in the rate of self-suficiency denotes the effect arising from changes in the proportion of supply produced domestically.[11] The effect of the change in technology refers to the change in total direct input coefficients, or in the total physical input requirements of all sectors.[12] Furthermore, the decomposition equation uses initial-year structural coefficients and terminal-year volume weights which is analogous to the Laspeyres price index.[13]

The change in domestic final demand was decomposed into its private consumption, government consumption, and investment components in order to determine the contributions of these components to total output change and their share in the effect of the change in domestic final demand. The Chenery model was therefore extended in the following manner :[14]

$$\Delta X = R_0^d \langle U_0 \rangle \Delta C + R_0^d \langle U_0 \rangle \Delta I + R_0^d \langle U_0 \rangle \Delta G + R_0^d \Delta E + R_0^d \Delta \langle U \rangle (D_1 + W_1) + R_0^d \langle U_0 \rangle \Delta AX_1 \quad (5)$$

where C is private consumption (business and household consumption), G is government consumption, and I is investment (gross domestic fixed capital formation and net increase in stocks).

Fujita (1985) pointed out that the results obtained from equation 4 are total changes which sum up the intersectoral effects of individual sectoral changes. He argued that there is a need to trace the sectoral origins of change ; he sought to separate and quantify the direct effect of change in the sector itself from its indirect effect on other sectors. This is implied in the decomposition equation by the premultiplication of each factor of change by the Leontief domestic inverse matrix which assures the accounting of the direct and indirect impact of each factor on sectoral output change. The Fujita model was therefore used to identify the sectors in which output changes originate and the sectors to which indirect effects are induced.

The Fujita extension of the Chenery model is expressed as follows :

$$\begin{aligned}\Delta X = {} & R_0^d U_0 [\Delta d_1] + R_0^d U_0 [\Delta d_2] + \cdots + R_0^d U_0 [\Delta d_n] \\ & + R_0^d [\Delta e_1] + R_0^d [\Delta e_2] + \cdots + R_0^d [e_n] \\ & + R_0^d [\Delta U_1] Z_1 + R_0^d [\Delta U_2] Z_2 + \cdots + R_0^d [\Delta U_n] Z_n \\ & + R_0^d U_0 [\Delta a_{n1}] X_1 + R_0^d U_0 [\Delta a_{n2}] X_2 + \cdots + R_0^d U_0 [\Delta a_{nn}] X_n \end{aligned} \quad (6)$$

where: $[\Delta d_1] = \begin{bmatrix} \Delta d_1 \\ 0 \\ \cdot \\ \cdot \\ 0 \end{bmatrix}$ $[\Delta d_2] = \begin{bmatrix} 0 \\ \Delta d_2 \\ 0 \\ \cdot \\ \cdot \\ 0 \end{bmatrix}$ $[\Delta a_{n1}] = \begin{bmatrix} a_{11} \\ a_{21} \\ \cdot \\ a_{n1} \end{bmatrix}$ $[\Delta a_{n2}] = \begin{bmatrix} a_{12} \\ a_{22} \\ \cdot \\ \cdot \\ a_{n2} \end{bmatrix}$

$[\Delta e_1] = \begin{bmatrix} \Delta e_1 \\ 0 \\ 0 \\ \cdot \\ \cdot \\ 0 \end{bmatrix}$ $[\Delta e_2] = \begin{bmatrix} 0 \\ \Delta e_2 \\ 0 \\ 0 \\ \cdot \\ \cdot \\ 0 \end{bmatrix}$ $D_1 + W_1 = \begin{bmatrix} Z_1 \\ Z_2 \\ \cdot \\ \cdot \\ Z_n \end{bmatrix}$

$[\Delta U_1] = \begin{bmatrix} \Delta U_1 \\ 0 \\ 0 \\ \cdot \\ \cdot \\ 0 \end{bmatrix}$ $[\Delta U_2] = \begin{bmatrix} 0 \\ \Delta U_2 \\ 0 \\ 0 \\ \cdot \\ \cdot \\ 0 \end{bmatrix}$

The Chenery model and its extensions are all expressed in national economic aggregates. These national economic aggregates were expressed in their regional economic aggregate equivalents. Domestic final demand therefore becomes regional final demand, exports and imports refer to interregional and foreign exports and imports, and investment denotes gross regional fixed capital formation and net increase in stocks.

The input-output tables and aggregation method used in Section 2 were used in the decomposition analysis of agricultural output change. Only the results obtained for the agricultural and food manufacturing sectors will be reported and discussed in the succeeding sections.

3. 2 Decomposition Analysis Results and Discussion

3. 2. 1 Factors of Agricultural and Food Manufacturing Output Change

The results of the decomposition analysis of agricultural output change

using the Chenery model (equation 4) is presented in table 3. 1. The effect of the change in regional final demand and exports in period 1 contributed the most to output change in edible crops and grains, livestock, agricultural services, and food manufacturing. The share of the change in exports in the agricultural and food manufacturing sectors was generally greater than the share of the change in regional final demand. Livestock is an exception because both the effect of the change in regional final demand and exports had an almost equal influence on output change in period 1. On the other hand, the effect of the change in the rate of self-sufficiency generally caused agricultural and food manufacturing production to decrease. The effect of the change in technology was negative except for agricultural services and food manufacturing. The effect of the change in the rate of self-sufficiency and technology signify that the proportion of agricultural and food manufactuing supply produced regionally and the requirements of edible crops and grains, livestock, and non-edible crops and grains as input in production decreased in period 1.

In period 2, the effect of the change in exports consistently figured as a major factor of output change. Except for edible crops and grains, the intensity of the effect of the change in exports was lesser in period 2 than in period 1. The effect of the change in regional final demand did not stand out as a major factor of output change except for edible crops and grains. Instead, the effect of the change in the rate of self-sufficiency, particularly in non-edible crops and grains and food manufacturing, and the change in technology, especially in livestock and agricultural services, figured as major contributors to output change.

The general positive contribution of the change in the rate of self-sufficiency in period 2 is noteworthy because it is a reversal of its general negative effect in period 1. This was primarily due to the positive effects of the change in the rate of self-sufficiency in the livestock and non-edible crops and grains sectors. The negative effect of the change in technology on edible crops and grains severely dampened the effects of the increase in the requirements for non-edible crops and grains, livestock, agricultural services, and

Table 3.1 Decomposition of Total Output Change in the Agricultural and Food Manufacturing Sectors, 1970-1985(one million yen, %)

	RFD		EX		RSS		TECH		TOTAL	
EDIBLE CROPS AND GRAINS										
〈1970-1980〉	120034	32.77%	299595	81.79%	-42841.3	-11.70%	-10493	-2.86%	366294	100.00%
〈1980-1985〉	47353.9	107.23%	143063	323.97%	-26923.4	-60.97%	-119334	-270.23%	44159.6	100.00%
NON-EDIBLE CROPS AND GRAINS										
〈1970-1980〉	25753.7	-197.32%	24634.6	-189.38%	-25484.1	195.75%	-37942.6	291.45%	-13018.5	100.00%
〈1980-1985〉	1326.39	1.27%	2806.12	2.68%	83630.3	79.84%	16978	16.21%	104741	100.00%
LIVESTOCK										
〈1970-1980〉	149560	55.46%	156477	58.02%	-30822.7	-11.43%	-5533.8	-2.05%	269680	100.00%
〈1980-1985〉	-8762.08	-9.37%	40243	43.02%	5853.32	6.36%	56116.3	59.99%	93551.1	100.00%
AGRICULTURAL SERVICES										
〈1970-1980〉	13600	42.66%	19734.4	61.91%	-4208.9	-13.20%	2753	8.64%	31878.5	100.00%
〈1980-1985〉	3044.46	12.14%	3349.25	33.28%	-279.8	-1.12%	13972.3	55.70%	25086.2	100.00%
FOOD MANUFACTURING										
〈1970-1980〉	552861	45.71%	774695	64.05%	-171338	-14.17%	53350	4.41%	1209569	100.00%
〈1980-1985〉	109973	18.20%	259526	42.95%	126458	20.93%	108306	17.92%	604263	100.00%

Notes: Figures enclosed in boxes indicate major contributions to output change. RFD denotes the effect of the change in regional final demand, EX denotes the effect of the change in interregional and foreign exports, RSS denotes the effect of the change in the rate of self-sufficiency, and TECH denotes the effect of the change in technology. Output changes are expressed in their nominal values. Totals may not add up due to rounding.

food manufacturing as inputs in production.

Since the Chenery model does not decompose the effect of the change in regional final demand, equation 5 was used to quantify the effects of private consumption, government consumption, and investment. The results of this extended Chenery decomposition analysis is shown in table 3. 2.

The effect of the change in private consumption was dominant among the agricultural and food manufacturing sectors in both periods. Interesting changes in the share of the change in investment, however, surfaced in period 2. The negative effect of the change in investment on edible crops and grains in period 1 became a major positive effect in period 2 ; the positive effect of the change in investment on livestock in period 1 became a major negative effect in period 2.

The results obtained by using the Chenery model are total effects which come from specific industrial sources. A quantitative description of the origins and direction of change is therefore necessary.

3．2．2　Sources of Agricultural and Food Manufacturing Output Change

The sources of agricultural and food manufacturing output change will be determined using the Fujita model (equation 6). In this section the effects of change will be termed either as direct or indirect. The direct effect of change refers to the effect on the sector itself ; the indirect effect of change refers to the effect induced on other sectors. Only the percentage distribution will be presented in tables 3. 3 to 3. 7 since absolute value changes were enumerated in tables 3. 1 and 3. 2. Numbering of sectors is the same as that in Section 2.

3．2．21　Change in Regional Final Demand

As presented in table 3. 3, the positive effect of the change in regional final demand was greatest on livestock in period 1. The major source of the positive output change due to the change in regional final demand was the livestock sector itself. The share of the direct effect of the change in regional final demand for livestock exceeded the sizeable share of the indirect effect of the change in regional final demand for food manufacturing. In period 2,

Table 3.2 Decomposition of Total Output Change in the Agricultural and Food Manufacturing Sectors due to the Change in Regional Final Demand, 1970-1985 (one million yen, %)

	PC		GC		INV		TOTAL	
EDIBLE CROPS AND GRAINS								
〈1970-1980〉	132665	110.52%	3984.7	3.32%	-16615.5	-13.84%	120034	100.00%
〈1980-1985〉	8855.33	18.70%	2471.42	5.22%	36027.1	76.08%	47353.9	100.00%
NON-EDIBLE CROPS AND GRAINS								
〈1970-1980〉	23716	92.09%	193.4	0.75%	1844.3	7.16%	25754	100.00%
〈1980-1985〉	1413.32	106.55%	23.02	1.74%	-109.94	-8.29%	1326.39	100.00%
LIVESTOCK								
〈1970-1980〉	74016.6	49.49%	803.1	0.54%	74740.3	49.97%	149550	100.00%
〈1980-1985〉	8576	-97.88%	1483.12	-16.93%	-18821.2	214.80%	-8762.08	100.00%
AGRICULTURAL SERVICES								
〈1970-1980〉	11574.6	85.11%	204	1.50%	1821.3	13.39%	13600	100.00%
〈1980-1985〉	2101.63	69.03%	189.45	6.22%	753.39	24.75%	3044.46	100.00%
FOOD MANUFACTURING								
〈1970-1980〉	529969	95.86%	2255.2	0.41%	20636.8	3.73%	552861	100.00%
〈1980-1985〉	102625	93.32%	7369.34	6.70%	-21.29	-0.02%	109973	100.00%

Notes: Figures enclosed in boxes indicate major contributions to output change. PC stands for private consumption (business and household consumption), GC stands for goverment consumption, and INV stands for investment (gross regional fixed capital formation and net increase in stocks). Output changes are expressed in their nominal values. Totals may not add up due to rounding.

however, the effect of the change in regional final demand on livestock output was negative. The direct effect of the change in regional final demand for livestock accounted for around 270 percent of the negative change in livestock output in period 2. This completely negated the positive indirect effect of the change in regional final demand for food manufacturing and public works / services. Livestock, thus, became the major source of negative change in livestock output in period 2. The emergence of public works / services as a major contributor to the change in livestock output is remarkable because in period 1 the indirect effect of the change in regional final demand for public works / services was almost negligible.

In period 2, the effect of the change in regional demand positively affected edible crops and grains output the most. Whereas in period 1 food manufacturing was the major source of output change in edible crops and grains due to the change in regional final demand, the edible crops and grains sector itself became the major source of output change in period 2. Food manufacturing still contributed positively to output change in edible crops and grains in period 2, but its share decreased considerably. Public works / services emerged as one of the major sources of output change in edible crops and grains due to the change in regional final demand. Livestock ceased to positively contribute to output change in edible crops and grains ; the change in regional final demand for livestock negatively affected the output of edible crops and grains.

Food manufacturing was the major source of output change in the non-edible crops and grains and agricultual services sectors due to the change in regional final demand in period 1. In period 2, however, the indirect effect of the change in regional final demand for food manufacturing on non-edible crops and grains and agricultural seuvices became less influential. The major source of output change in non-edible crops and grains in period 2 was the sector itself. The change in regional final demand for edible crops and grains was the major source of output change in agricultural services.

The major source of output change in food manufacturing was the sector

Table 3.3 Sources of the Change in Agricultural and Food Manufacturing Output due to the Change in Regional Final Demand, 1970-1985 (%)

	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 4	SECTOR 5	SECTOR 6	SECTOR 7	SECTOR 8	SECTOR 9	SECTOR 10	SECTOR 11	SECTOR 12	SECTOR 13	SECTOR 14	SECTOR 15	TOTAL
EDIBLE CROPS AND GRAINS																
(1970-1980)	-3.05%	-3.05%	11.38%	0.02%	0.03%	0.08%	-0.00%	12.02%	3.52%	59.37%	0.82%	1.62%	1.21%	8.48%	4.24%	100.00%
(1980-1985)	68.45%	68.45%	-9.41%	0.01%	0.01%	-0.08%	-0.01%	-0.27%	-0.02%	26.32%	1.43%	0.46%	0.32%	14.89%	-2.11%	100.00%
NON-EDIBLE CROPS AND GRAINS																
(1970-1980)	-0.01%	25.10%	2.21%	0.00%	0.01%	0.08%	-0.00%	5.10%	6.74%	57.22%	0.28%	0.31%	0.49%	2.03%	0.47%	100.00%
(1980-1985)	5.37%	85.19%	-0.93%	0.00%	0.00%	-0.04%	-0.00%	-2.40%	-0.05%	7.15%	0.73%	0.48%	0.21%	4.93%	-0.67%	100.00%
LIVESTOCK																
(1970-1980)	-0.05%	0.19%	51.24%	0.00%	0.01%	0.04%	-0.00%	1.92%	1.01%	42.97%	0.15%	0.26%	0.20%	1.38%	0.67%	100.00%
(1980-1985)	-9.02%	-0.04%	270.06%	-0.04%	-0.04%	0.36%	0.03%	1.08%	0.09%	-114.69%	-5.96%	-1.93%	-1.33%	-48.25%	9.70%	100.00%
AGRICULTURAL SERVICES																
(1970-1980)	-1.11%	2.00%	21.80%	14.20%	0.01%	3.25%	-0.00%	5.70%	2.49%	44.26%	0.39%	0.72%	0.57%	3.85%	1.85%	100.00%
(1980-1985)	49.56%	0.33%	-41.40%	41.17%	0.01%	-0.12%	-0.00%	-0.43%	-0.03%	33.50%	2.37%	0.78%	0.53%	17.73%	-3.99%	100.00%
FOOD MANUFACTURING																
(1970-1980)	-0.00%	0.02%	3.50%	0.00%	0.00%	0.07%	-0.00%	1.32%	0.57%	92.47%	0.14%	0.19%	0.15%	1.04%	0.51%	100.00%
(1980-1985)	0.13%	0.00%	-2.83%	0.01%	0.01%	-0.19%	-0.00%	-0.23%	-0.01%	83.46%	1.29%	0.38%	0.26%	19.14%	-1.43%	100.00%

Notes: Figures enclosed in boxes indicate major sources of output change. Columns indicate the sources of change. Numbering of sectors is the same as that in Section 2 (output sectors). Percentages were computed from nominal values. Total agricultural and food manufacturing output changes are shown in Table 3.1.

itself, but its share dropped by around 9 percentage points in period 2. The share of the indirect effect of the change in regional final demand for public works / services on output change in food manufacturing increased with the decrease in the share of the direct effect of the change in regional final demand for food manufacturing.

3. 2. 211 Change in Private Consumption and Investment

The effect of the change in private consumption was greatest on edible crops and grains among the agricultural sectors in both periods. As shown in table 3. 4, the change in private consumption of food manufacturing was the major source of output change in edible crops and grains due to the change in private consumption in both periods. Likewise, public works / services loomed as a major source of output change in edible crops and grains due to the change in private consumption in period 2. Livestock also showed the same pattern as edible crops and grains. Moreover, the direct effect of the change in private consumption of edible crops and grains and livestock sectors became negative in period 2.

The change in private consumption of the non-edible crops and grains and agricultural services sectors themselves became the major sources of output change in period 2. The change in private consumption of food manufacturing still contributed positively to output change in the non-edible crops and grains and agricultural services sectors but its share, particularly in non-edible crops and grains, decreased. Public works / services also became a major source of output change in agricultural services due to the change in private consumption.

As observed in table 3. 4, the major source of output change in food manufacturing due to the change in private consumption was the sector itself. The share of this direct effect, however, decreased in period 2. Public works / services emerged as a major source of output change in food manufacturing due to the change in private consumption.

The effect of the change in investment was greatest on livestock and was negative on edible crops and grains in period 1. In period 2, however, the re-

Table 3.4 Sources of the Change in Agricultural and Food Manufacturing Output due to the Change in Private Consumption, 1970-1985 (%)

	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 4	SECTOR 5	SECTOR 6	SECTOR 7	SECTOR 8	SECTOR 9	SECTOR 10	SECTOR 11	SECTOR 12	SECTOR 13	SECTOR 14	SECTOR 15	TOTAL
EDIBLE CROPS AND GRAINS																
(1970-1980)	34.10%	0.25%	0.56%	0.02%	0.01%	0.07%	-0.00%	0.00%	1.84%	54.61%	0.65%	1.47%	1.03%	4.50%	0.89%	100.00%
(1980-1985)	-89.19%	0.07%	-9.36%	0.05%	0.00%	-0.42%	-0.01%	0.00%	1.83%	134.11%	7.91%	2.45%	1.63%	51.82%	-0.89%	100.00%
NON-EDIBLE CROPS AND GRAINS																
(1970-1980)	0.07%	29.82%	0.13%	0.00%	0.00%	0.08%	-0.00%	0.00%	4.22%	63.17%	0.27%	0.33%	0.50%	1.29%	0.12%	100.00%
(1980-1985)	-1.23%	90.08%	-0.16%	0.00%	0.00%	-0.04%	-0.00%	0.00%	0.63%	6.39%	0.71%	0.45%	0.19%	3.01%	-0.05%	100.00%
LIVESTOCK																
(1970-1980)	1.28%	0.41%	5.63%	0.01%	0.01%	0.08%	-0.00%	0.00%	1.18%	88.26%	0.28%	0.53%	0.39%	1.64%	0.32%	100.00%
(1980-1985)	-2.24%	0.05%	-51.34%	0.04%	0.00%	-0.35%	-0.01%	0.00%	1.32%	111.67%	6.29%	1.98%	1.30%	32.08%	-0.79%	100.00%
AGRICULTURAL SERVICES																
(1970-1980)	16.09%	2.57%	1.39%	16.68%	0.01%	3.66%	-0.00%	0.00%	1.68%	52.87%	0.40%	0.85%	0.63%	2.65%	0.51%	100.00%
(1980-1985)	-17.49%	0.54%	-11.16%	59.65%	0.00%	-0.16%	-0.00%	0.00%	0.73%	46.24%	3.55%	1.13%	0.74%	16.71%	-0.46%	100.00%
FOOD MANUFACTURING																
(1970-1980)	0.06%	0.02%	0.20%	0.00%	0.00%	0.07%	-0.00%	0.00%	0.34%	98.06%	0.13%	0.20%	0.15%	0.64%	0.13%	100.00%
(1980-1985)	-0.03%	0.00%	-0.56%	0.01%	0.00%	-0.19%	-0.00%	0.00%	0.22%	85.23%	1.43%	0.40%	0.27%	13.35%	-0.12%	100.00%

Notes: Figures enclosed in boxes indicate major sources of output change. Columns indicate the sources of change. Numbering of sectors is the same as that in Section 2 (output sectors). Private consumption includes business and household consumption expenditures. Percentages were computed from nominal values. Total agricultural and food manufacturing output changes are shown in Table 3.2.

verse of this pattern happened. As seen from table 3. 5, the major source of positive output change in livestock due to the change in investment in period 1 was the sector itself. The positive effect of the change in investment in livestock explained for a major portion of positive output change in the agricultural and food manufacturing sectors due to the change in investment. The livestock sector itself, however, became the major source of negative output change in livestock due to the change in investment in period 2. The negative effect of the change in livestock on the agricutural sectors, especially agricultural services and food manufacturing was quite conspicuous in period 2.

The major source of output change in edible crops and grains due to the change in investment was the sector itself in both periods. The negative effect of the change in investment in edible crops and grains in period 1 contributed considerably to negative output change in the agricultural services sector. The positive effect of the change in investment in edible crops and grains in period 2 was greatest on the food manufacturing and the non-edible crops and grains sectors.

As observed in table 3. 5, food manufacturing singularly did not account for output change in the agricultural sectors due to the change in invesment in both periods. Instead, food manufacturing was affected more by the change in investment in the agricultural sectors, especially livestock, and sectors like construction and manufacturing. On the other hand, public works / services never figured as a source of output change in the agricultural sectors in both periods.

From the above observations two points have been clarified. A major portion of the change in livestock and edible crops and grains output in period 2 due to the change in regional final demand can be attributed to the change in investment. The indirect effect of the change in regional final demand for food manufacturing and public works / services on the agricultural sectors in period 2 was due more to private consumption than investment.

3．2．22　Change in Exports

The effect of the change in exports was greatest on edible crops and

Table 3.5 Sources of the Change in Agricultural and Food Manufacturing Output due to the Change in Investment, 1970-1985 (%)

	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 4	SECTOR 5	SECTOR 6	SECTOR 7	SECTOR 8	SECTOR 9	SECTOR 10	SECTOR 11	SECTOR 12	SECTOR 13	SECTOR 14	SECTOR 15	TOTAL
EDIBLE CROPS AND GRAINS																
(1970-1980)	294.28%	0.18%	-77.74%	0.00%	-0.13%	-0.03%	-0.02%	-86.94%	-11.05%	7.10%	-0.71%	0.00%	-0.31%	0.00%	-24.63%	100.00%
(1980-1985)	111.90%	0.00%	-10.06%	0.00%	0.01%	-0.01%	-0.01%	-0.36%	-0.48%	1.63%	-0.06%	0.00%	0.00%	0.00%	-2.55%	100.00%
NON-EDIBLE CROPS AND GRAINS																
(1970-1980)	-0.95%	-32.98%	28.91%	0.00%	0.06%	0.05%	0.02%	71.22%	40.91%	-13.24%	0.47%	0.00%	0.24%	0.00%	5.28%	100.00%
(1980-1985)	-80.60%	130.25%	9.09%	0.00%	-0.04%	0.04%	0.04%	28.90%	8.64%	-4.06%	0.29%	0.00%	0.02%	0.00%	7.44%	100.00%
LIVESTOCK																
(1970-1980)	-1.37%	-0.03%	96.96%	0.00%	0.01%	0.00%	0.00%	3.84%	0.88%	-1.42%	0.04%	0.00%	0.01%	0.00%	1.08%	100.00%
(1980-1985)	-5.22%	0.00%	102.33%	0.00%	-0.02%	0.01%	0.01%	0.50%	0.64%	-2.51%	0.09%	0.00%	0.00%	0.00%	4.16%	100.00%
AGRICULTURAL SERVICES																
(1970-1980)	-110.55%	-1.40%	153.96%	0.00%	0.07%	1.07%	0.01%	42.64%	8.07%	-5.47%	0.35%	0.00%	0.15%	0.00%	11.12%	100.00%
(1980-1985)	249.06%	-0.17%	-136.17%	0.00%	0.06%	-0.03%	-0.03%	-1.74%	-2.17%	6.37%	-0.31%	0.00%	-0.01%	0.00%	-14.84%	100.00%
FOOD MANUFACTURING																
(1970-1980)	-1.67%	-0.04%	88.78%	0.00%	0.08%	0.09%	0.01%	35.48%	6.63%	-41.03%	0.45%	0.00%	0.15%	0.00%	11.08%	100.00%
(1980-1985)	-859.14%	2.16%	-11879.99%	0.00%	-33.96%	65.95%	18.46%	1162.61%	1138.84%	-20277.60%	216.91%	0.00%	8.41%	0.00%	6777.41%	100.00%

Notes: Figures enclosed in boxes indicate major sources of output change. Columns indicate the sources of change. Numbering of sectors is the same as that in Section 2 (output sectors). Investment includes gross regional fixed capital formation and net increase in stocks. Percentages were computed from nominal values. Total agricultural and food manufacturing output changes are shown in Table 3.2.

grains among the agricultural sectors in both periods. As presented in table 3. 6, the major source of output change in edible crops and grains due to the change in exports was the sector itself in periods 1 and 2. Likewise, the change in exports of food manufacturing accounted for a substantial portion of output change in edible crops and grains due to the change in exports. The share of the effect of the change in exports on edible crops and grains increased in period 2 and thus, the share of the indirect effect of the change in exports of food manufacturing decreased. This was the same pattern exhibited by agricultural services in period 2.

Output change in livestock due to the change in exports was principally due to the change in exports of food manufacturing in both periods, although the direct effect of the change in exports of livestock itself also contributed a major portion of output change. Unlike edible crops and grains, however, the share of the indirect effect of the change in exports of food manufacturing on output change in livestock increased to around 69 percent in period 2. This automatically means that the share of the direct effect of the change in livestock exports decreased.

The major source of output change in food manufacturing due to the change in exports in both periods was the sector itself. The share of this direct effect was relatively stable. Food manufacturing ceased to be the singular source of output change in non-edible crops and grains due to the change in exports in period 2. The direct effect of the change in exports of non-edible crops and grains itself became the major source of output change in period 2.

3．2．23　Change in the Rate of Self-Sufficiency

The effect of the change in the rate of self-sufficiency implicitly shows the effect of the change in import coefficient. Since the rate of self-sufficiency is obtained after subtracting the import coefficient from one, the effect of the change in the rate of self-sufficiency will be positive only if the import coefficient will decrease and vice versa.

The negative effect of the change in the rate of self-sufficiency was

Table 3.6 Sources of the Change in Agricultural and Food Manufacturing Output due to the Change in Exports (Interregional and Foreign), 1970-1985 (%)

	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 4	SECTOR 5	SECTOR 6	SECTOR 7	SECTOR 8	SECTOR 9	SECTOR 10	SECTOR 11	SECTOR 12	SECTOR 13	SECTOR 14	SECTOR 15	TOTAL
EDIBLE CROPS AND GRAINS																
(1970-1980)	59.21%	0.00%	3.31%	0.00%	0.00%	0.07%	0.03%	0.00%	1.85%	35.07%	0.08%	0.00%	0.16%	0.24%	0.00%	100.00%
(1980-1985)	73.61%	-0.01%	1.17%	0.00%	0.01%	0.04%	-0.03%	0.00%	-0.13%	23.98%	-0.09%	0.01%	0.07%	1.11%	0.26%	100.00%
NON-EDIBLE CROPS AND GRAINS																
(1970-1980)	0.26%	0.16%	1.66%	0.00%	0.00%	0.16%	0.04%	0.00%	9.23%	88.10%	0.07%	0.00%	0.17%	0.15%	0.00%	100.00%
(1980-1985)	8.25%	82.01%	0.16%	0.00%	0.01%	0.03%	-0.03%	0.00%	-0.38%	9.30%	-0.07%	0.01%	0.06%	0.53%	0.12%	100.00%
LIVESTOCK																
(1970-1980)	2.38%	0.00%	35.53%	0.00%	0.00%	0.08%	0.01%	0.00%	1.27%	60.54%	0.03%	0.00%	0.06%	0.09%	0.00%	100.00%
(1980-1985)	6.38%	0.02%	22.04%	0.00%	0.03%	0.11%	-0.09%	0.00%	-0.34%	68.74%	-0.25%	0.02%	0.18%	2.38%	0.79%	100.00%
AGRICULTURAL SERVICES																
(1970-1980)	37.02%	0.01%	10.90%	0.00%	0.00%	4.47%	0.02%	0.00%	2.24%	44.96%	0.06%	0.00%	0.13%	0.18%	0.00%	100.00%
(1980-1985)	58.71%	0.24%	5.66%	0.00%	0.02%	0.06%	-0.06%	0.00%	-0.22%	33.62%	-0.17%	0.01%	0.12%	1.46%	0.54%	100.00%
FOOD MANUFACTURING																
(1970-1980)	0.16%	0.00%	1.81%	0.00%	0.00%	0.11%	0.01%	0.00%	0.53%	97.27%	0.02%	0.00%	0.04%	0.05%	0.00%	100.00%
(1980-1985)	0.18%	0.00%	0.45%	0.00%	0.01%	0.11%	-0.03%	0.00%	-0.10%	97.35%	-0.11%	0.01%	0.07%	1.83%	0.23%	100.00%

Notes: Figures enclosed in boxes indicate major sources of output change. Columns indicate the sources of change. Numbering of sectors is the same as that in Section 2 (output sectors). Percentages were computed from nominal values. Total agricultural and food manufacturing output changes are shown in Table 3.1.

greatest on edible crops and grains in both periods. As can be observed from table 3. 7, the change in the rate of self-sufficiency of food manufacturing accounted for around 54 percent of the total negative output change in edible crops and grains due to the change in the rate of self-sufficiency in period 1, but in period 2 the change in the rate of self-sufficiency of food manufacturing mainly contributed to positive output change in edible crops and grains. This positive contribution, however, was overshadowed by the share of the direct effect of the change in the rate of self-sufficiency of edible crops and grains in period 2. Edible crops and grains therefore became the major source of negative output change in the sector itself due to the change in the rate of self-sufficiency in period 2. The negative effect of the change in the rate of self-sufficiency of edible crops and grains also considerably affected output change in agricultural services in period 2.

The effect of the change in the rate of self-sufficiency of food manufacturing on output change in livestock due to the change in the rate of self-sufficiency in both periods was the same as that of edible crops and grains. Food manufacturing overwhelmingly contributed to total negative output change in period 1 and to total positive output change in livestock in period 2. The direct effect of the change in the rate of self-sufficiency of livestock in period 2 was also the most conspicuous negative contribution to output change in livestock.

The effect of the change in the rate of self-sufficiency of food manufacturing obviously accounted for a major portion of output change in the agricultural sectors due to the change in the rate of self-sufficiency. This effect, however, was not very influential on non-edible crops and grains. The change in the rate of self-sufficiency of food manufacturing in period 1 was the major source of negative change in the sector itself, but in period 2 it became the solitary source of positive change. The direct effect of the change in the rate of self-sufficiency of non-edible crops and grains also showed the same pattern as food manufacturing.

3．2．24　Change in Technology

Table 3.7 Sources of the Change in Agricultural and Food Manufacturing Output due to the Change in the Rate of Self-Sufficiency, 1970-1985 (%)

	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 4	SECTOR 5	SECTOR 6	SECTOR 7	SECTOR 8	SECTOR 9	SECTOR 10	SECTOR 11	SECTOR 12	SECTOR 13	SECTOR 14	SECTOR 15	TOTAL
EDIBLE CROPS AND GRAINS																
〈1970-1980〉	33.30%	2.20%	3.23%	0.00%	-0.04%	0.17%	0.54%	0.00%	4.73%	54.24%	0.00%	0.02%	0.47%	-0.58%	1.64%	100.00%
〈1980-1985〉	155.85%	-1.50%	-4.36%	0.00%	-0.07%	0.00%	-0.16%	0.00%	2.63%	-66.24%	0.01%	0.07%	0.23%	2.76%	2.07%	100.00%
NON-EDIBLE CROPS AND GRAINS																
〈1970-1980〉	0.02%	77.37%	0.22%	0.00%	0.00%	0.06%	0.12%	0.00%	3.27%	18.85%	0.00%	0.00%	0.07%	-0.05%	0.07%	100.00%
〈1980-1985〉	-0.11%	100.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.05%	0.16%	0.00%	0.00%	0.00%	-0.01%	-0.01%	100.00%
LIVESTOCK																
〈1970-1980〉	0.97%	2.74%	25.18%	0.00%	0.01%	0.14%	0.18%	0.00%	2.36%	67.98%	0.00%	0.01%	0.14%	-0.16%	0.45%	100.00%
〈1980-1985〉	-17.18%	4.50%	-104.87%	0.00%	0.24%	-0.01%	0.59%	0.00%	-8.32%	241.56%	-0.02%	-0.25%	-0.80%	-7.48%	-7.96%	100.00%
AGRICULTURAL SERVICES																
〈1970-1980〉	13.96%	19.67%	7.13%	0.00%	0.02%	7.62%	0.32%	0.00%	3.85%	46.63%	0.00%	0.01%	0.26%	-0.30%	0.82%	100.00%
〈1980-1985〉	697.97%	-264.48%	118.85%	0.00%	-0.68%	0.02%	-1.78%	0.00%	23.94%	-521.53%	0.06%	0.75%	2.36%	20.31%	24.20%	100.00%
FOOD MANUFACTURING																
〈1970-1980〉	0.06%	0.15%	1.15%	0.00%	0.01%	0.17%	0.08%	0.00%	0.88%	97.28%	0.00%	0.00%	0.07%	-0.08%	0.23%	100.00%
〈1980-1985〉	-0.15%	0.21%	-0.65%	0.00%	0.03%	0.00%	0.06%	0.00%	-0.79%	103.86%	0.00%	-0.03%	-0.09%	-1.75%	-0.69%	100.00%

Notes: Figures enclosed in boxes indicate major sources of output change. Columns indicate the sources of change. Numbering of sectors is the same as that in Section 2 (output sectors). Percentages were computed from nominal values. Total agricultural and food manufacturing changes are shown in Table 3.1.

As seen from table 3. 1, the effect of the change in technology on all agricultural sectors in period 1 was negative. The industrial sectors of the Hokkaido economy required less inputs from agriculture in period 1. The effect of the change in technology on non-edible crops and grains, livestock, and agricultural services in period 2, however, was positive. This signifies that in period 2 the industrial sectors required more inputs from these agricultural sectors. This change would have been favorable for over-all agricultural production if not for the sizeable decrease in output of edible crops and grains due to the change in technology.

To facilitate the discussion of the effect of the change in technology, simplified tables were made. These tables were derived from the decomposition table of the effect of the change in technology.[15] A plus sign indicates a positive contribution to output change by the row sector to output change in the column sector ; a minus sign indicates a negative contribution.

As presented in table 3. 8, the major source of negative output change in

Table 3.8 Sources of the Change in Agricultural and Food Manufacuturing Output due to the Change in Technology, 1970-1980

	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 4	SECTOR 10
SECTOR 1	−	+	+	+	+
SECTOR 2	−	+	−	−	−
SECTOR 3	+	−	+	+	−
SECTOR 4	+	+	+	+	+
SECTOR 8	−	+	−	−	−
SECTOR 9	−	−	−	−	−
SECTOR 10	+	−	−	−	−
SECTOR 11	+	+	+	+	+
SECTOR 14	+	+	+	+	+
TOTAL	−	−	−	−	+

Notes: Signs enclosed in boxes indicate major sources of output change. A plus sign indicates positive contribution to output change and vice versa. Columns indicate the agricultural and food manufacturing sectors: rows indicate the sources of change. Numbering of sectors is the same as that in Section 2 (output sectors). Derived from original decomposition tables.

the non-edible crops and grains and livestock sectors due to the change in technology in period 1 was food manufacturing. The direct effect of the change in technology of edible crops and grains was the major source of output change in the sector itself. Public works / services contributed the most to total positive output change in food manufacturing due to the change in technology.

The change in technology of the tertiary industries like commerce and public works / services generally contributed positively to agricultural and food manufacturing production in period 1. Secondary industries like construction and manufacturing contributed negatively to output change in the agricultural and food manufacturing sectors due to the change in technology. Livestock increased its edible crops and grains input requirements and edible crops and grains increased its livestock input requirements. Food manufacturing required less of all agricultural inputs except for edible crops and grains in period 1.

As seen from table 3. 9, the effect of the change in technology on the agricultural sectors except for edible crops and grains was positive in period 2. The change in technology of food manufacturing was the major source of positive output change in the sector itself and in livestock. The major source of the negative change in edible crops and grains output due to the change in technology, however, was food manufacturing. Food manufacturing required more livestock and less edible crops and grains inputs in period 2. This is clearly a reversal of the pattern in period 1. The major sources of positive output change in non-edible crops and grains and agricultural services were livestock and edible crops and grains, respectively.

Commerce required more agricultural and food manufacturing inputs except for edible crops and grains and livestock in period 2. Public works / services required less inputs from edible crops and grains and more from livestock and food manufacturing. The effect of the change in technology of manufacturing was negative on all the agricultural and food manufacturing sectors. The positive effect of the change in technology of food manufacturing on lives-

Table 3.9 Sources of the Change in Agricultural and Food Manufacuturing Output due to the Change in Technology, 1980-1985

	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 4	SECTOR 10
SECTOR 1	+	−	−	+	+
SECTOR 2	+	−	+	−	+
SECTOR 3	−	+	−	−	+
SECTOR 4	+	+	+	+	−
SECTOR 8	−	−	−	+	+
SECTOR 9	−	−	−	−	−
SECTOR 10	−	−	+	+	+
SECTOR 11	−	+	−	+	+
SECTOR 14	−	+	+	+	+
TOTAL	−	+	+	+	+

Notes: Signs enclosed in boxes indicate major sources of output change. A plus sign indicates positive contribution to output change and vice versa. Columns indicate the agricultural and food manufacturing sectors: rows indicate the sources of change. Numbering of sectors is the same as that in Section 2 (output sectors). Derived from original decomposition tables.

tock output and its negative effect on edible and non-edible crops and grains output in period 2 imply that the technological structure of food manufacturing production required more inputs from livestock and less inputs from edible and non-edible crops and grains.

3．2．3　Agricultural Change and Its Induced Effects on Other Sectors

The nominal values shown in table 3. 10 denote that the indirect effect of the change in regional fimand for the agricultural sectors except for livestock was induced the most in manufacturing. Positive changes in regional final demand for edible crops and grains seem to directly affect the sector less and indirectly affect manufacturing more and vice versa.

The indirect effects of the change in livestock were induced the most in food manufacturing and edible crops and grains. A positive change in regional final demand for livestock seem to indirectly affect food manufacturing more than edible crops and grains and vice versa.

The indirect effect of the change in regional final demand for food manu-

Table 3.10 Induced Effects of the Change in Regional Final Demand for the Agricultural and Food Manufacturing Sectors on Other Sectors, 1970-1985 (one million yen)

	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 4	SECTOR 5	SECTOR 6	SECTOR 7	SECTOR 8	SECTOR 9	SECTOR 10	SECTOR 11	SECTOR 12	SECTOR 13	SECTOR 14	SECTOR 15	TOTAL
EDIBLE CROPS AND GRAINS																
(1970-1980)	-3659.2	-1.3	-76.9	-150.7	-24.6	-5.2	-10.2	-31.8	-357.6	-25.7	-127.4	-58.2	-79.4	-28.4	-138.7	-4775.5
(1980-1985)	32414.3	71.25	790.14	1508.74	217.3	23.15	129.83	395.59	4095.71	147.07	2087.25	1017.33	1010.14	379.89	833.41	45121.1
NON-EDIBLE CROPS AND GRAINS																
(1970-1980)	308.9	6464.4	277.2	271.4	79.5	15.9	93.5	71.2	1169.2	35.4	344.4	124.4	234.6	77.4	331.1	9948.7
(1980-1985)	5.47	1129.97	.3.62	10	6.85	0.54	3.52	7.8	110.6	3.61	54.09	51.23	36.34	10.2	16.14	1449.98
LIVESTOCK																
(1970-1980)	13659.9	568.4	76641.1	2965.4	372.4	1962	201.5	776.6	5191.3	19375.2	4095.4	2107.4	3704	926.5	2092.7	134635.4
(1980-1985)	-4453.83	-12.27	-23662.5	-1260.36	-88.29	-357.3	-54.33	-276.82	-1401.7	-3107.44	-1487.06	-1123.3	-1171.25	-380.72	-1315.59	-40152.76
AGRICULTURAL SERVICES																
(1970-1980)	20.9	0.7	4.2	1931	17.6	4.1	7.9	117.5	181.6	11.7	88.1	83.9	174	96.4	242.9	2982.5
(1980-1985)	4.45	0.05	3.73	1253.53	10.39	2.05	6.3	12.62	165.87	7.11	95.78	60.58	134.91	40.66	173.97	1972
FOOD MANUFACTURING																
(1970-1980)	71269.7	14736.4	64265.7	6019.6	3664.6	51063.9	2282.4	4190.2	50921.7	511206	32117.9	14220.6	27875.7	11746.1	13932.9	879513.5
(1980-1985)	12462.5	94.8	10049.5	1019.78	464.77	10303.9	307.24	895.85	8082.76	91780.4	8812.67	3138.69	5297.27	2705.12	4498.07	159914.32

Notes: Figures enclosed in boxes indicate major induced effects. Columns indicate the destinations of induced effects. All effects are expressed in their nominal values. Numbering of sectors is the same as that in Section 2 (output sectors). Totals may not add up due to rounding.

facturing was more dispersed than the indirect effect of livestock and edible crops and grains. This indirect effect was greatest on the edible crops and grains and livestock sectors.

The analysis of the sources of output change reveals that food manufacturing accounted for a major portion of agricultural output change from 1970 to 1985. The share of the indirect effect of change in food manufacturing, however, decreased in period 2. The relationship of change between agriculture and other sectors from 1970 to 1985 can therefore be characterized not as the deepening of the dependency of output change in agriculture on food manufacturing alone but the widening of the dependency of output change in agriculture on other sectors aside from food manufacturing. The direct effect of the change in regional final demand, particularly investment, exports, and the rate of self-sufficiency of the agricultural sectors and the indirect effect of the change in regional demand, particularly private consumption of public works / services emerged as major sources of output change in agriculture. An increasing portion of output change in food manufacturing due to the change in private consumption and investment can in fact be imputed to public works / services and livestock, respectively. Food manufacturing, however, continued to intensely influence output change in the edible crops and grains and livestock sectors due to the change in private consumpion. Likewise, the effect of the change in exports of food manufacturing on the change in livestock output remained substantial.

The negative effect of the change in the rate of self-sufficiency of the edible crops and grains and livestock sectors affected these sectors more than the positive effect of the change in the rate of self-sufficiency of food manufacturing. The decrease in regional agricultural production due to a decrease in its rate of self-sufficiency will most probably undermine the benefits of an increase in regional food manufacturing production because food manufacturing would have to import some of its agricultural input requirements.

The technological structure of sectors like public works / services and food manufacturing required more inputs from livestock and less inputs from

edible crops and grains from 1970 to 1985. The lesser use of edible crops and grains as input in production negated the positive effects of the greater use of the products of the rest of the agricultural sectors as input in production.

Generally, the change in the regional final demand for the agricultural sectors except for livestock indirectly affected manufacturing the most. Livestock induced changes in the edible crops and grains and livestock sectors the most. A relationship of change exists therefore between livestock and edible crops and grains. This relationship to some extent can be characterized by the greater influence of changes in regional final demand for livestock on output change in edible crops and grains.

4. Factors of Employment Change in Hokkaido Agriculture

4. 1 Decomposition Model

4. 1. 1 Survey of Related Literature

Input-output decomposition analysis of the factors of employment change is usually an extension of the basic output decomposition model. Decomposition analysis of employment change in Japanese agriculture or agribusiness has not been done as often as output. Onodera (1982) incorporated in his book on Japanese agribusiness an input-output analysis of the causes of employment change from 1960 to 1970. Sasajima (1985) discussed the applications of input-output analysis to labor studies in Japan. He used a similar decomposition method as Onodera.

Researches done by Skolka (1981), Pal (1986), Forssell (1988), and Urata (1988) deserve attention because of their unique extensions of the basic output decomposition model to the study of the factors of employment change. Llkewise, the work done by Krishna (1975) on direct and indirect employment effects of agricultural growth and technical change merits special mention.

4. 1. 2 Employment Decomposition Methodology

The Pal model was used in the comparative static input-output decomposition analysis of employment change in Hokkaido agriculture. The virtue

of the Pal model lies in its use of the Marshall-Edgeworth weighted average index to bypass the index number problem common in decomposition equations.[16]

Pal defined in matrix notation the total number of persons employed in the following matter :

$$L = \langle 1 \rangle X \tag{1}$$

where L is the total number of persons employed, $\langle 1 \rangle$ is the diagonal matrix of employment coefficients and X is the column vector of total output. X is defined as follows :

$$\begin{aligned} X &= (I - \langle U \rangle A)^{-1}(\langle U \rangle D + E) \\ &= RY \end{aligned} \tag{2}$$

where R is the Leontief domestic inverse matrix $(I - \langle U \rangle A)^{-1}$ and Y is the final demand column vector $(\langle U \rangle D + E)$.

In comparative static analysis, total employment change is defined as follows :

$$\Delta L = L_1 - L_0 \tag{3}$$

where subscripts 1 and 0 denote the terminal and initial years, respectively. Substituting (1) to (3) and using the relationship given in (2) and the Marshall-Edgeworth index 1/2 will yield the following Pal employment decomposition equation :

$$\Delta L = 1/2\ \Delta \langle 1 \rangle (R_0Y_0 + R_1Y_1) + 1/2\ (\langle 1_1 \rangle + \langle 1_0 \rangle)\ [1/2\ (R_0 + R_1)\ \Delta Y + 1/2\ \Delta R\ (Y_1 + Y_0)] \tag{4}$$

The Pal model therefore identifies three factors of employment change, namely, the effect of the change in employment coefficient, the effect of the change in final demand, and the effect of the change in the Leontief inverse matrix. This model was extended by further decomposing the effect of the change in final demand and the change in the Leontief inverse matrix. The decomposition of the change in the Leontief inverse matrix is important because it contains the indirect effect of the change in the rate of self-sufficiency and the direct effect of the change in technology. The extended form of the Pal model used in the decomposition analysis of employment change in Hokkaido agri-

culture is as follows :

$$\begin{aligned}\Delta L = {} & 1/2\ \Delta\langle 1\rangle (R_0Y_0 + R_1Y_1) \\ & + 1/8\ (\langle 1_1\rangle + \langle 1_0\rangle)(R_0 + R_1)\ \Delta\langle U\rangle (D_0 + D_1) \\ & + 1/8\ (\langle 1_1\rangle + \langle 1_0\rangle)(R_0 + R_1)(\langle U_0\rangle + \langle U_1\rangle)\ \Delta D \\ & + 1/4\ (\langle 1_1\rangle + \langle 1_0\rangle)(R_0 + R_1)\ \Delta E \\ & + 1/8\ (\langle 1_1\rangle + \langle 1_0\rangle)\ \Delta b_1 (Y_1 + Y_0) \\ & + 1/8\ (\langle 1_1\rangle + \langle 1_0\rangle)\ \Delta b_2 (Y_1 + Y_0) \qquad (5)\end{aligned}$$

where $\langle 1 \rangle$ is the diagonal matrix of employment cofficients defined as the ratio of labor to output, R is the Leontief domestic inverse matrix, Y is the column vector of final demand, $\langle U \rangle$ is the diagonal matrix of the rates of self-sufficiency, D is the domestic final demand vector, E is exports, b_1 is the indirect effect of the change in the rate of self-sufficiency, and b_2 is the direct effect of the change in technology.

The extended Pal model therefore identifies five structural changes which contribute to employment change. These structural changes are the effect of the change in employment coefficient, the effect of the change in the rate of self-suffifiency which is a combination of the second and fifth terms of equation 5, the effect of the change in domestic final demand, the effect of the change in exports, and the effect of the change in technology.

Employment data used in Section 2 was also used in the decomposition analysis of employment change in Hokkaido agriculture. Only the results obtained for agriculture will be discussed in the next section.

4. 2 Decomposition Analysis Results and Discussion

Except for the effect of the change in employment coefficient, the interpretation of the other effects are definitionally similar to output decomposition. The elements of the employment coefficient diagonalized matrix 1 are the measures of labor intensity for each sector.[17] This measure is the inverse of the common labor productivity measure.

4. 2. 2 Factors of Employment Change

The results of the decomposition analysis using the Pal model (equation 5) is shown in table 4. 1. Total agricultural employment change was negative

in both periods. The major source of this change was the effect of the change in employment coefficient and the share of this effect increased in period 2. This implies that agricultural labor productivity improved further in period 2. The change in the rate of self-sufficiency contributed negatively to agricultural employment in both periods and its share also increased in period 2. The share of the negative effect of the change in the rate of self-sufficiency, however, was minified by the ascendancy of the negative effect of the change in employment coefficient on agricultural employment.

Table 4.1 Decomposition of Total Employment Change in Hokkaido Agriculture, 1970-1985 (million of persons employed)

AGRICULTURE	1		2	
CHANGE IN EMPLOYMENT COEFFICIENT	-538345	400.11%	-68809.3	584.85%
CHANGE IN REGIONAL FINAL DEMAND	187012	-138.99%	10507.6	-89.31%
CHANGE IN THE RATE OF SELF-SUFFICIENCY	-32651.8	24.27%	-6663.35	56.64%
CHANGE IN EXPORTS	269062	-199.97%	32173.7	-273.46%
CHANGE IN TECHNOLOGY	-19626.6	14.59%	21026.2	-178.72%
TOTAL	-134550	100.00%	-11765.2	100.00%

Notes: Figures enclosed in boxes indicate major contributions to total employment change. Colimn 1 refers to period 1 (1970-1980): column 2 refers to period 2 (1980-1985). Numbering of sectors is the same as that in Section 2 (employment sectors). Totals may not add up due to rounding.

The change in technology contributed to the decrease in agricultural employment in period 1, but in period 2 the effect of the change in technology on agricultural employment became positive. This suggests that the increased use of agriculture as an input in production stimulated agricultural employment.

The change in exports contributed more to agricultural employment in period 2 than in period 1. The share of the change in regional final demand decreased even more in period 2. Thus, the change in exports was the major

source of employment increase in agriculture. The positive contribution of exports to agricultural employment, however, was dwarfed by the negative contribution of the change in employment coefficient.

5. Summary and Conclusions

The effect of the change in exports accounted for approximately two-thirds of the total positive agricultural output change from 1970 to 1985. Food manufacturing unquestionably accounted for a major portion of agricultural output change due to the change in exports. The effect of the change in direct agricultural exports except for livestock, however, began to surpass the effects of the change in processed indirect agricultural or food manufacturing exports. This was particularly conspicuous in edible crops and grains.

Greater export dependency denotes lesser dependence on other final demand components. The share of the effect of the change in regional final demand, particularly private consumption, decreased further. Except for edible crops and grains and livestock, the effects of the change in private consumption of the agricultural sectors themselves and public works / services encroached upon the dominance of the effect of the change in private consumption of food manufacturing on agricultural output change. On the other hand, relationships of change among agricultural sectors, especially among edible crops and grains, livestock, and agricultural services were manifest in the effect of the change in investment.

A significant amount of agricultural output change due to the change in the rate of self-sufficiency can definitely be ascribed to food manufacturing. The negative effect of the decrease in the rate of self-sufficiency of the agricultural sectors, however, completely overshadowed the positive effects of an increase in the rate of self-sufficiency of food manufacturing. A decrease in the rate of self-sufficiency of the agricultural sectors due perhaps to decreased regional production or increased importation tends to severely undermine the positive effects of an increase in regional food manufacturing production due to an increase in self-sufficiency because food manufacturing would have to ac-

quire more agricultural inputs from outside the region.

Generally, tertiary industries like commerce and public works / services required more inputs from the agricultural sectors ; secondary industries, especially manufacturing, required less inputs from agriculture. Sectors like public work / services and food manufacturing began to require more inputs from livestock and less inputs from edible crops and grains.

Except for the livestock sector, the change in regional final demand for the agricultural sectors indirectly affected manufacturing more than any other sector. Livestock affected both food manufacturing and edible crops and grains the most. This gives credence to an earlier finding that a relationship of change exists between edible crops and grains and livestock. This relationship of change can be characterized by the greater indirect influence of livestock on output change in edible crops and grains.

The effect of the change in employment coefficient contributed the most to agricultural employment decrease from 1970 to 1985. This crudely indicates higher labor productivity in agriculture. The change in technology or the greater use of agriculture as input in production began to stimulate agricultural employment in the same way as the change in exports.

A dependent relationship of change exists between agriculture and food manufacturing. The relationship of change between agriculture and food manufacturing, however, did not deepen. Except for the deeper relationship of change due to exports between livestock and food manufacturing, the other agricultural sectors widened the scope of their dependent relationships to include public works / services and the agricultural sectors themselves. The widening of the relationship of change between agriculture and other sectors is most apparent in the effect of the change in regional final demand. To some extent, only livestock exhibited an interdependent relationship with food manufacturing.

5．1　Policy Insights

Within the limitations imposed by the method of analysis, the following policy guidelines can be made :

1. Agricultural policy should put more emphasis on agribusiness because of the manifest relationship of change between agriculture and food manufacturing. Agricultural policy should take into account the deepening of the relationship between livestock and food manufacturing and the widening of the scope of the relationships of change of agricultural sectors like edible crops and grains. Moreover, careful attention should be given to the relationship between livestock and food manufacturing because both sectors had the two highest backward linkage indexes in period 2.

2. A policy aimed at promoting agricultural exports should consider the fact that although food manufacturing accounted for a major portion of output change in agriculture due to the change in exports, the increase in exports of the agricultural sectors themselves have begun to influence output change. With changing consumer needs in mind, exports therefore should comprise not only processed agricultural and food manufacturing products but also direct agricultural exports of edible crops and grains and the like.

3. Policies should aim for stable production conditions and increased production of those agricultural products required by food manufacturing. The necessity of this policy guideline is alluded to by the increase in food manufacturing production and the effect of the change in the rate of self-sufficiency in agricultural products.

4. The direct and indirect employment effects of agriculture as expressed by its employment backward linkage index should also be taken into account in deliberating agricultural policies. Agricultural growth necessarily connotes a decrease in agricultural population. The depopulation of areas, however, is not desirable. The introduction of agribusiness-related activities and inputs such as machines and feedstuffs in rural areas will not only forestall depopulation but will also induce significant backward linkage employment effects.

5. 2 Limitations and Areas for Further Study

A detailed and perhaps a more revealing analysis of agricultural output change might be possible with a more detailed disaggregation of the agricultural sectors. Likewise, the results of the decomposition analysis reported

here were obtained using nominal values ; the discussion of the results focused on shares and not on actual values. Results may also differ depending on the level or degree of aggregation.[18]

The analysis of structual matrixes and linkage flows will probably bring out more concrete policy insights. Likewise, agricultural growth and structural change in a developing region like Hokkaido may have parallelisms with the experiences of developing countries like Korea, Taiwan, and the Philippines. The implications of the decomposition analysis of structural change in Hokkaido agriculture on the structural development of agriculture in these countries is another area for further study.

NOTES

1. Syrquin (1988) states that it has been a custom to call this type of analysis as a demand-side input-output decomposition analysis. He argues, however, that factors like trade and comparative advantage are more supply than demand-driven.
2. Panchamukhi (1975) questioned the prudence of this conventional key sector definition. He argued that linkage coefficients only consider intersectoral flows ; pressures of final demand and trade flows are neglected. The importance of a sector for income generation is not also considered.
3. See Chenery and Watanabe (1958), Augustinovics (1970), Yotopoulos and Nugent (1973), Schultz (1973), and Cella (1984) for examples of output linkage measures. For employment linkage measures see Hazari and Krishnamurthy (1970), Diamond (1974), Meller and Marfan (1981), and Groenewold, Hagger, and Madden (1987).
4. This, however, does not mean that forward linkages are dispensable. Cella (1984) and Lee (1986) have argued for consistent measures of total linkages based on both forward and backward linkages ; they have emphasized the inseparability of forward and backward linkage measurement.
5. Laumas (1976) preferred this measure over the Yotopoulos and Nugent measure because it considers the linkage index of a given industry with reference to the total degree of interdependence of all industries. Hazari (1970), however, argued that this measure is sensitive to extreme values and may give misleading results. Indeed, there is no perfect measure of backward linkages.
6. Diamond (1974) pointed out that the relatively heavy direct labor input as well as the technological linkages in the economy of primary industries like agriculture may explain for the high backward linkage index.
7. This method was used by Dervis, de Melo, and Robinson (1982) in their study of the international comparison of the structure of production.

8. Syrquin (1988) also used the first difference formulation in his study of the patterns of structural change.
9. Decomposition analysis of output change in Japanese agriculture do not abound in number. See Torii (1978), Hirose and Kuroyanagi (1981), and Onodera (1982).
10. The inverse matrix $(I-\langle U \rangle A)^{-1}$ is the simplified form of the Leontief domestic inverse matrix $[I-(I-\langle M \rangle) A]^{-1}$. Note that the expression $(I-\langle M \rangle)$ is equal to $\langle U \rangle$ or the rate of self-sufficiency.
11. Chenery (1980) and Syrquin (1988) calls this as the import substitution effect. Fujita (1985) termed the same effect as the change in the rate of self-sufficiency. The author thinks that the the concept of self-sufficiency is much easier to comprehend than import substitution.
12. Leontief (1953), Carter (1967), and Vaccara (1970) expound more on the various interpretations of the change in input coefficients.
13. Dervis, de Melo, and Robinson (1982), Urata (1988), and many others have recognized the index problem in decomposition equations. The index problem is discussed in Skolka (1981) and Forssell (1988). Pal (1986) suggested the Marshall-Edgeworth index to bypass the problem of choosing between the Laspeyres and Paasche indexes. For an evaluation of various indexes see Mudgett (1951).
14. Urata (1988) also saw the importance of decomposing final demand into its components. Kaneko (1980) presented a final demand decomposition method that is different from the straightforward decomposition method used in this paper.
15. Original decomposition tables are available on request.
16. Forssell (1988) discussed the index number problem in decomposition equations and concluded that it is unnecessary to use mixed index numbers like the Marshall-Edgeworth index because they give rise to interpretational difficulties. The author thinks, however, that the use of the Marshall-Edgeworth index is similar to the procedure of getting the average of the results obtained by using the Laspeyres and Paasche indexes favored by Dervis, de Melo, and Robinson (1982) and Urata (1988).
17. Meller and Marfan (1981) mentioned other labor intensity indicators in footnote 2 of their paper.
18. Jones (1976) advised the use of models with eighteen sectors or more in his study of Hirschmanian linkages and this may well apply to input-output decomposition analysis. Computational work, however, will become more tedious.

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