Appendix

1. Framework of Input-output Tables

An input-output table is a "rough sketch" of an economy in which a flow of goods and services is compactly expressed by using the value of transactions between industries. The demand sectors for goods and services are listed along the columns, and supply sectors are listed along the rows. At each intersection point is listed the value of transactions between the two sectors.

Now, suppose that we are given the figures for gross outputs and a hypothetical input-output table for the economy with only three sectors; i.e. the machinery industry, steel industry, and transport industry, as shown in Figure 1. If we look at the intersection point between the machinery sector (column) and the steel sector (row), we see a figure of 1600 million yen. This indicates that the machinery sector purchased 1600 million yen worth of steel products from the steel sector. For example, the purchases by automobile manufacturers of steel for car chassis materials would be included in this figure.

Also, the intersection point just below indicates that the machinery sector paid the transport sector 400 million yen for its services. This shows the total value of transport used by the machinery sector to move production materials (in this case, machinery and steel) to the factories.

So, seen in a column-wise direction, the input-output table gives each industry's input value of goods and services as well as of the value added items (see the glossary), and, seen row-wise, it gives the distribution of goods and services to the intermediate demand sectors and final demand sectors (Also, see the glossary).

2. Mechanism of Production Spillover

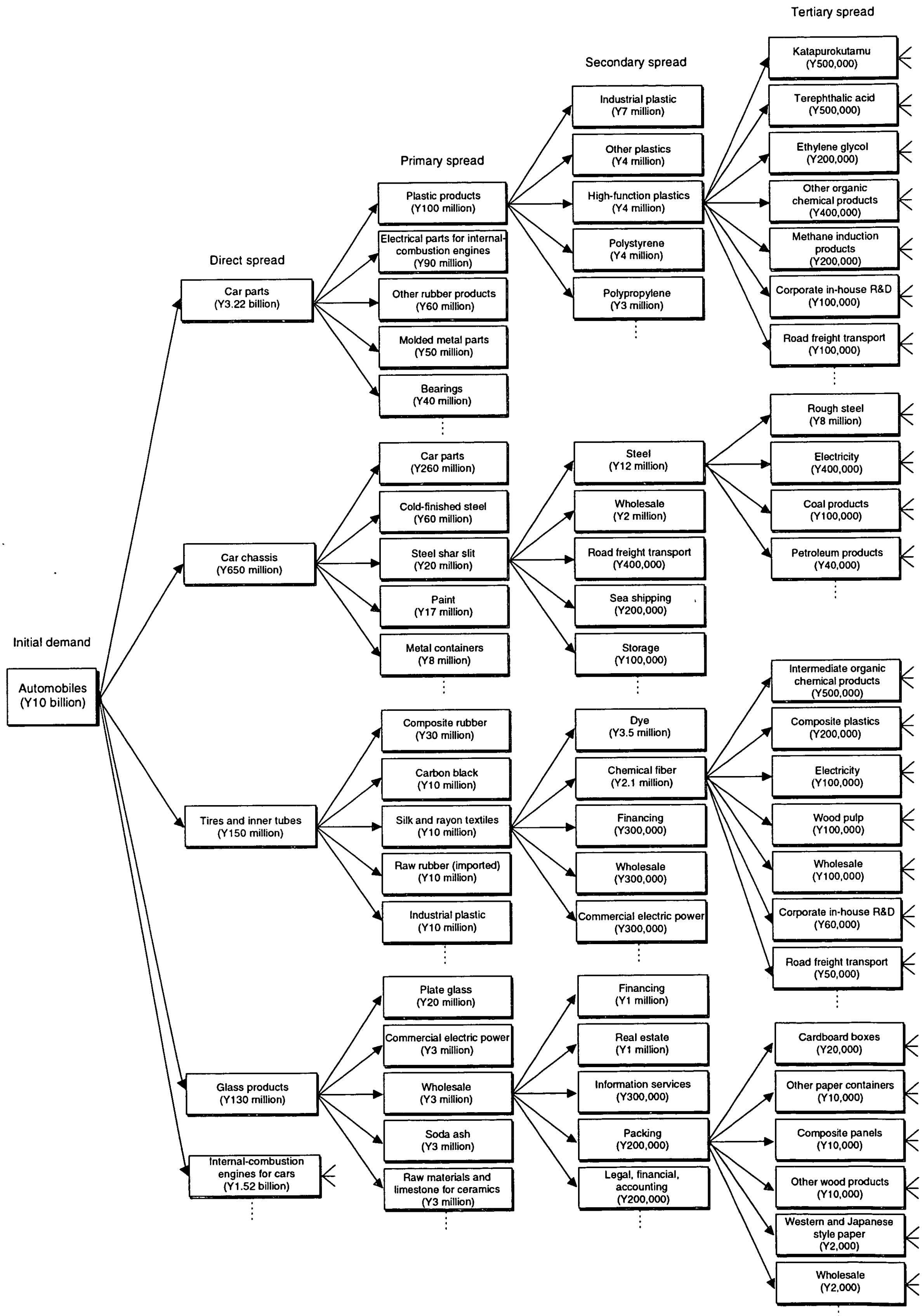
Generally speaking, when the amount of production changes, its effect spreads over to the related industries, through both direct and indirect channels. For example, if the automobile industry increases its production, the demands for component parts such as chassis and tires are bound to increase. Then, if the production of these products is increased in turn, the demands for steel and rubber and all other raw materials used for the production are to rise, too, etc. (Figure 2).

How is this mechanism of production spillover represented in the input-output table? Take a look at Figure 3. Now, let's suppose that production in the steel sector has increased by 10 billion yen.

Figure 1 Input-output Table (100 million yen)

		Intermediate transactions			Final demand			
		Machinery	Steel	Transportation	Consumption	Investment/inventory	Export	Gross output
Intermediate transactions	Machinery	800	1800	200	600	400	200	4000
	Steel	1600	600	500	0	50	250	3000
	Transportation	400	300	900	350	50	0	2000
Value added	Employee income	800	200	250				
	Operating surplus	250	50	100				
	Capital depreciation	100	30	40				
	Indirect taxes	50	20	10				
	Gross output	4000	3000	2000				

Figure 2 Overview of Backward Linkage Effects



Note: Some of the sector names and figures in the chart differ from those used in the original tables.

Source: Compiled from "1990 Input-output Table", Management and Coordination Agency

By looking at the figures column-wise, we first divide each industry's input values of goods and services by corresponding gross output of that industry. Since the columns are the listings of the goods and services purchased by each industry, the coefficients thus derived indicate how much input the industry in question must take from each type of goods and services in order to achieve one unit (= 1 billion yen) of production. The figure is called an input coefficient, and the right-hand table shown in Figure 3 is called an **input coefficient table**.

So, we can calculate from the table the demands for the goods and services generated by a 10 billion yen increase in steel production, by means of multiplying this value by each of the input coefficients listed for the steel sector (column). In this example, the calculation shows us that 6 billion yen worth of extra demand (derived demand) is generated for the machinery sector, 2 billion yen for the steel sector, and 1 billion yen for the transportation sector.

Of course, each industry needs to expand its production in order to meet these new demands, and the production thus increased will trigger further demands for the production materials.

So, let us simulate the mechanism. First, we multiply the value of 6 billion yen, which is an amount of production increase in the machinery sector, by its column coefficients to give the derived demand; i.e. 1.2 billion yen for the machinery sector itself, 2.4 billion yen for the steel sector, and 0.6 billion yen for the transportation sector. Likewise, the derived demand for the steel sector (2 billion yen) and for the transportation sector (1 billion yen) can be calculated by multiplying these values by the coefficients in the corresponding columns. The figures obtained can then be used to calculate the secondary spillover effect by summing them up in a row-wise direction for each industry (Figure 4).

The same procedure can be repeated recursively to obtain the tertiary and quaternary spillover effects. That is, the value of increased production in each industry is multiplied by the corresponding input coefficients in a column-wise direction, and then the derived figures are summed up in a row-wise direction. The resulting totals represent the value of demand increase in each industry. They can then be fed back into the system again to determine the next round of production spillover.

Note, however, that production spillover does not continue endlessly. As with the rings around a pebble dropped into a pool of water, the spillover effect grows weaker the further it travels into the more peripheral industries, and it eventually vanishes entirely (Figure 5).

Then, if we could anticipate a priori the entirety of the spillover up to the vanishing point, it would be possible to quantify beforehand the ultimate amount of demand that would arise for various goods and services via production linkages. For this purpose, a **Leontief inverse matrix** should be calculated from the input coefficients table (Figure 6). The matrix shows the result that could be alternatively obtained by performing the infinite feedback process illustrated in Figure 3. Each of the intersection points in this table shows the ultimate amount of the demand for each good and service of row-wise industries, induced by both direct and indirect channels of industrial linkages, for the production activity needed to satisfy a unit increase in demand in each column-wise industry. It gives us an important index of the degree of interdependency between different industries. For example, in the Leontief inverse matrix shown in Figure 6, the production spillover brought about in various industries by a 10 billion yen increase in demand in the steel industry can be determined simply by multiplying the coefficients for "steel" (column) by 10 billion yen; that is, the figures for induced production in each industry are; 1.97 × 10 billion yen = 19.7 billion yen for the machinery sector, 2.49 × 10 billion yen = 24.9 billion yen for the steel sector, and 0.81 × 10 billion yen = 8.1 billion yen for the transportation sector.

3. Extension to International Input-output Analyses

An international input-output table can be considered a patchwork of the input-output tables of several countries consolidated for analytical purposes. Refer to Figure 7. This is an image of international input-output table of Japan and Korea, in which the blue portions are constructed from the input-output table of Japan and the gray portions are taken from the input-output table of Korea.

In input-output analyses, an index called the backward linkage effect is used in order to measure the degree of interdependency between different industries. A similar index is used in international input-output tables for the analysis of industrial linkages, whether within one country or across national boarders. Let us now examine the four areas in the table surrounded by thick lines: A^{JJ}, A^{KJ}, A^{KK}, and A^{JK}. The transactional relations indicated by each are listed below.

A^{JJ}: Table of Japan-produced goods and services used by Japanese industries, i.e., the Japanese domestic transaction matrix.

A^{KJ}: Table of Korea-produced goods and services used by Japanese industries, i.e., the import matrix from Korea.

A^{KK}: Table of Korea-produced goods and services used by Korean industries, i.e., the Korean domestic transaction matrix.

A^{JK}: Table of Japan-produced goods and services used by Korean industries, i.e., the imports matrix from Japan.

We can convert the entire area consisting of these four matrices indicated above into a Leontief inverse matrix, with the portions corresponding to the above four matrices designated as B^{JJ}, B^{KJ}, B^{KK}, and B^{JK}. The matrices tell us which country's which industry would face an extra demand for its product by what amount, when there is a unit increase in demand for a certain country's certain industry. Generally speaking, the effect measured by the size of B^{JJ} or B^{KK} is called the domestic backward linkage, and that measured by B^{JK} or B^{KJ} is called the international backward linkage.

Figure 3 Conversion to Input Coefficient Table

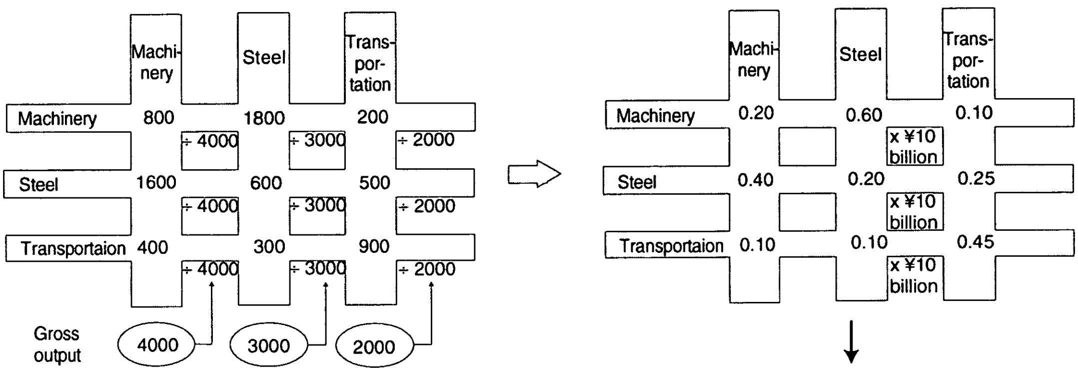


Figure 4 Mechanism of Production Spillover

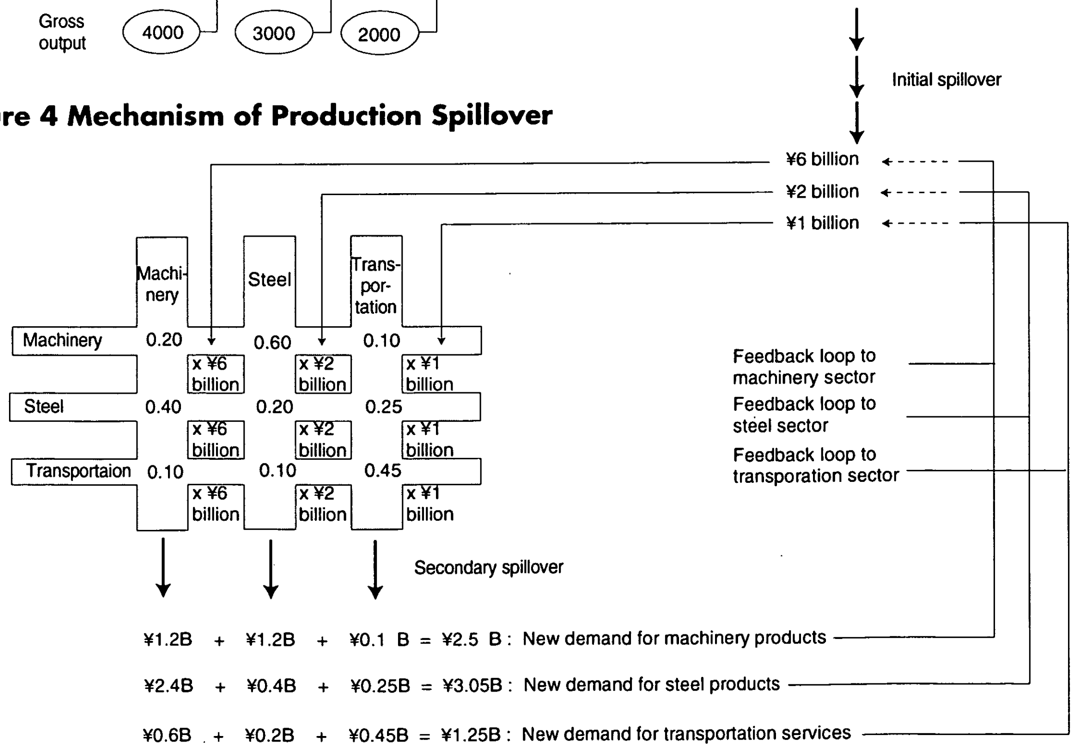


Figure 5 Production Spillover Decay

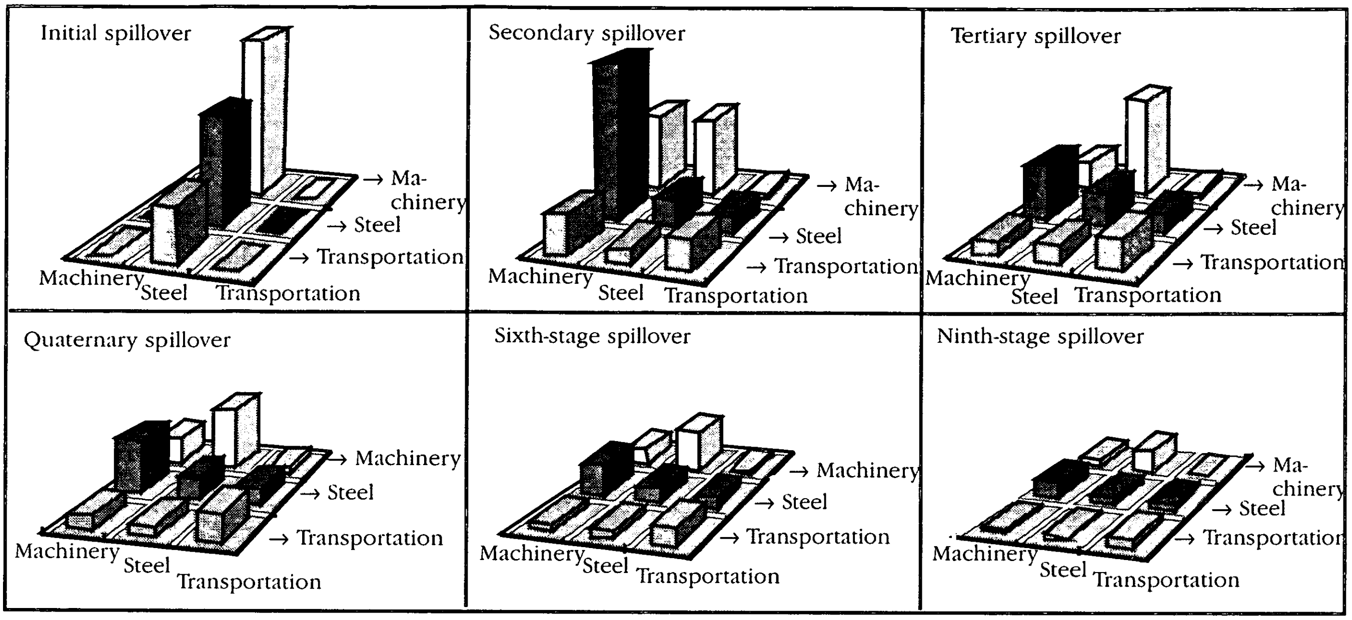


Figure 6 Conversion to Leontief Inverse Matrix

Input coefficient table

	Machinery	Steel	Transportation
Machinery	0.20	0.60	0.10
Steel	0.40	0.20	0.25
Transportaion	0.10	0.10	0.45

⇨ $B = (I - A)^{-1}$

Leontief inverse matrix

	Machinery	Steel	Transportation
Machinery	2.40	1.97	1.33
Steel	1.42	2.49	1.39
Transportaion	0.69	0.81	2.31

Figure 7 An image of Japan-Korea International Input-output Table

		Japan			Korea			Japan				Korea				
		Machinery sector	Steel sector	Transportation sector	Machinery sector	Steel sector	Transportation sector	Private consumption	Government consumption	Capital formation	Net increase in inventory	Private consumption	Government consumption	Capital formation	Net increase in inventory	Exports by country
Japan	Machinery sector	A^{JJ}			A^{JK}			F^{JJ}				F^{JK}				E^{J}
	Steel sector															
	Transportation															
Korea	Machinery sector	A^{KJ}			A^{KK}			F^{KJ}				F^{KK}				E^{K}
	Steel sector															
	Transportation sector															
Rest of the world	Machinery sector	A^{WJ}			A^{WK}			F^{WJ}				F^{WK}				
	Steel sector															
	Transportation sector															
	Employee income	V^{J}			V^{K}											
	Operating surplus															
	Capital depreciation															
	Indirect taxes															

Glossary

Final Demand Sectors

All manufactured goods are processed via input/output transactions between industries, and the final, finished product is bought by household consumers or the government, used for investment purposes, or exported to other countries. The sectors that purchase these final, finished products are called the final demand sectors. The final demand sectors comprise "private (household + non-profit organizations) consumption expenditure", "government consumption expenditure", "fixed capital formation", "net increase in inventory", and "exports".

Value Added Sectors

In addition to the payment to production materials, production activities involve various costs such as wages and taxes. The payment to the production factors that are not reproduced by industry go to the value added sectors, consisting of "employee income (wages)" paid for labor; "operating surplus (profit)" paid into capital; "capital depreciation", which is a yearly payment to machinery calculated by dividing the lump-sum cost by the machine's expected years of life; "indirect taxes" upon the production of goods and services; and "subsidies (deduction items)". The concepts of both the final demand sectors and the value added sectors are roughly adjusted to match national income statistics.

Value of Domestic Production (Gross Output)

At the column end of the input-output table is listed the value of total supply (= value of intermediate input + value added + value of imports) for the industry in question, and at the row end is listed the value of total demand (= value of intermediate demand + value of final demand) for the product in question. Since total supply equals total demand by definition, the column total and the row total for a given industry should match exactly (see Figure 1). This total value is called an industry's gross output. Since the figures are used as footholds for balancing rows and columns in the process of compiling the table, they are also dubbed as "control totals" (CT).