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RESEARCH

The Linkage among Technology-Intensive Manufacture Industries in East Java by Input-Output Analysis Approach

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Abstract

The economic crisis in 1998 had caused the decrease in economic growth up to 13% and particularly for industrial sector 11.4%. This shock encouraged local governments, including East Java to actively promote industry by utilizing the available natural resources; processing them into products that have value added. The study intends to see the linkage among technology-intensive industrial sectors before the economic crisis (1994) and after the economic crisis (2006). The analysis method used in the study is input-output (I-0) analysis, using the dispersion power index and the degree of sensitivity index from the multiplier matrix. The classification of manufacturing industry is based on its technology intensity, i.e. high-tech, medium-high-tech, medium-low-tech, and low-tech. The result of the study shows that the seed industry sector in 1994 is the industries with high backward and forward linkages, i.e. the group of basic metal and metal goods industry, and non-pharmaceutical chemical industry. In 2006, however, both industries had only high backward linkage. Furthermore, the industrial group with no potential is the industry with low backward and forward linkages in 1994, i.e. food, beverages, and tobacco industry. Nevertheless in 2006 this low-tech intensity industry became a potential, together with timber and rattan industry, and pharmaceuticals and traditional medicine industry. In 2006, the group with less potentials was the low-tech industry like textile, textile product, leather and footwear industry; and the medium-low-tech industry like oil refining industry; as well as the high-tech industry like, railway, transportation tools and its restoration industry. The shift occurred due to the factors of raw material use (local/import) and capability to produce value added products.

Keywords: manufacturing industry, technology intensity, input-output analysis, East Java

I. Introduction

1998 is noted as the gloomiest period in the Indonesian economy when the economic growth drastically fell into -13%, negatively affected some economic sectors, among others manufacture industry. Many processing companies were out of business since they could no longer bear the cost of capital, on average based on imported raw materials. In 1996, there were 22,997 active processing companies. As a result of the crisis, the number decreased to 22,386 units in 1997 and gradually declined into 21,243 units in 1998. As the economy began to recover, gradually Indonesian manufacturing industry revived. The number of manufacturing companies in 1999 and 2000 rose to be 22,070 units and 22,174 units respectively (Central Bureau of Statistics/BPS, 2000). Recent statistics showed that the number of manufacturing enterprises had reached 23,370 units in 2011, meaning an increase of 5.4% in the last decade (BPS, 2013).

After the crisis, the government began to actively promote the industry to utilize the available natural resources to be processed into products that have value added, including East Java provincial government. East Java belongs to the provinces with the highest Gross Domestic Product (GDP). In 2010, East Java's GDP reached IDR 324,281 billion or 15.4% of total national GDP. The GDP growth of East Java during the last 3 years (2010-2012) has increased, from 6.68% (in 2010) to 7.27% (in 2012). As of the year 2011, East Java had a population of 37.68 million at a growth rate of 0.56 percent, living

Table 1. Distribution of Domestic Output and Gross Value Added in East Java by Sectors in 1994 and 2006

No	Sector	Domestic Output (%)		Gross value added (%)	
		1994	2006	1994	2006
1	Agriculture, livestock, forestry & fishery	13.39	12.87	18.26	17.39
2	Mining and quarrying	1.29	1.51	1.81	2.07
3	Processing industry	34.58	34.88	27.51	28.84
4	Electricity, gas and water supply	1.49	3.27	1.03	1.85
5	Construction	12.03	3.31	7.17	3.48
6	Trade, hotel and restaurant	18.35	23.73	21.46	28.05
7	Transportation and communication	5.44	6.31	5.92	5.59
8	Finance, real estate & business service	5.65	5.88	6.53	4.57
9	Services	7.77	8.23	10.31	8.16
	Total	100.00	100.00	100.00	100.00

Source: data processed from the tables of East Java Input-Output 1994 and 2006.

on a land area of 47,154.7 km^2. Industries in East Java are supported by 498,098 various industries, consisting of 4,825 large-and-medium-scale industries in 1997. This amount is then increased up to 6,288 large-and-medium-scale industries in 2011 (East Java Regional Statistics, 2013).

The picture of domestic output and gross value added in East Java can be seen in Table 1. In 1994, the total output produced by all sectors in East Java reached IDR 94.21 trillion; manufacturing industry, among others, contributed to IDR 32.57 trillion or 34, 58 percent of the total output in East Java. Furthermore, in 2006 the total output rose into IDR 794.6 trillion; processing industry, among others, was accounted for 34.88 percent.

In 1994, the gross value added in the manufacturing industry sector reached IDR 15.99 trillion or 27.51 percent of the total gross value added of all economic sectors in East Java (IDR 58.13 trillion). This means that the gross value added of industrial sector contributed the most, compared to other sectors. Compared with 2006, there are two sectors whose gross value added rose, i.e. the processing industry sector, rising from 27.51 percent into 28.84, and trade, hotel and restaurant sector, rising into 28.05 percent.

Processing industry has significantly contributed to the economy of East Java, both in output and gross value added. There are many industrial categories, one of which is based on the intensity of its technology. There are industries with low, low-medium, medium-high, and high-technology intensity (OECD, 2011). The performance of processing industry depends also on the performance of its upstream and downstream industries. Therefore, this study intends to see the linkage among industrial sectors by technological intensity before the economic crisis (1994) and after the economic crisis (2006). Both periods are due to the availability of Input-Output Table in East Java, that is only limited to the two periods, as discussed in the study by Rahayu, *et al.* (2013).

II. Literature Study

Input-output table can be used to analyze the sources of industry growth, and changes in production structure to assess the effectiveness of government policy in the economic restructuring of a country. In addition to seeing the direct impact of industry on the economy, input-output analysis is also often used to understand the indirect impact of industry output on the economy, through inter-sector linkages. Sandhu and Miller (1996) analyzed the forward and backward linkages of the high-tech industrial sector and their effects on GDP and employment in British Columbia, Canada. Cristobal and Biezma (2006) examined the inter-sectors linkage among mining industries in European Union countries to find the key sectors that drive regional economy.

Olteanu (2006) also studied the forward and backward linkage of manufacturing industries, categorized by their technology intensity in Romania and six other EU countries. The intermediate products, produced by the manufacturing industries, is a major mediator in diffusing knowledge from the high-tech intensity industry to others. With the input -output analysis, the impact of inter-industry linkages towards the economy can be seen.

In Indonesia the input-output analysis for the manufacturing industry is often done. Akita (1991) and Akita & Herman (2000) look at the structural changes and sources of Indonesian industry growth in the period 1971 to 1995. Irawan, Anggraeni, and Oktaviani (2010) analyze the role of manufacturing industry in the Indonesian economy. Nevertheless the input-output analysis of manufacturing industry and whose sector division is based on technology intensity (low, medium, high) has never been done.

Specifically for the manufacturing industry, Olteanu (2006) and Shandu & Miller (1996) introduced the input-output analysis by emphasizing the issue of technological developments in the industry. Both types of research broadly split the manufacturing industry sectors into sections according to the consensus agreed by the Organization for Economic Co-operation and

Table 2. Manufacturing Industry Classification Based on Technological Intensity (Content)

Hi-Tech (HT)	Medium-high-tech (MHT)	Medium-low Tech (MLT)	Low-Tech (LT)
Aircrafts and spacecrafts	Electrical machinery and its equipment	Ship and boat construction and repair	Recycling products
Pharmaceuticals	Motor-vehicles, trailer, and semi-trailer	Rubber and plastic products	Timber, pulp, paper, paper products, printing and publishing
Office, accounting and data processing machinery and equipment	Non-pharmaceutical chemicals	Coal, petroleum, natural gas and nuclear	Foods, beverages, and tobacco
Radio, television and communication equipment and its accessories	Railway equipment and other transport equipment	Other non-metal mineral products	Textile, textile products, leather and footwear
Medical equipment, measuring tools, navigation tools, optical equipment and clock	Machinery and its equipments	Basic metals and metal products	

Source: OECD Directorate for Science, Technology and Industry (2011)

Development (OECD). Here is the classification of manufacturing industry based on its technological intensity (content). The basis of this classification is the magnitude of research expenditures incurred to produce the goods/products. If expenditures for research or technological development of goods/ products is high, then the industries that produce the goods/products are classified as high-tech intensity industry, and vice versa. This classification assumes that the technology is attached to the goods/ products produced (OECD, 2011).

According to Shandu and Miller (1996), grouping these technologies requires us to see the direct impact caused by the initial change in the high-tech sector and its secondary impact on the economic sector. The secondary impact is due to the inter-industry linkages in the provincial economy. Secondary effects can occur through backward as well as forward linkages. Backward linkages occur when the high-tech sector industry demands more intermediate inputs produced by other industries in the provincial economy. The secondary impacts through forward linkages occur when an increase in the high-tech sector output becomes the intermediary input of others in the industry expansion in a province.

III. Analysis Method

Analysis method used in the study is input-output analysis (I-0 analysis). Different from shift-share analysis that only portrays the contribution of an economic sector to national economy, I-O analysis can see the forward and backward linkages among economic sectors, as well as see its impact on the entire economy. I-O analysis utilizes the index of dispersion power and degree of sensitivity from the multiplier matrix I-O. Multiplier matrix is an inverse matrix, basically used as a function that relate the final demand with the production level of output (Firmansyah, 2006). Multiplier matrix can be utilized to measure the effect of industrial sector on the economy as the impact of changes in final demand.

One of the known methods of sectoral linkage analysis is the calculation of the dispersion power and degree of sensitivity by using a multiplier matrix. Distributions capacity is also known as backward linkage or level of linking backward, and the degree of sensitivity known as forward linkage or level of linking forward. This analysis studies the connection between sectors, based on the impact of output. Basically industrial sectors influence one another in the economy; exogenous changes in a sector have an impact both directly and indirectly on sectoral output. A production activity of industrial sector with a high impact of forward linkages indicates that it has a quite strong capacity compared to other production activities. While those with a high impact of backward linkages indicate that they have a high dependence on other production activities.

The impact level of forward linkage indicates that the production activity with an index greater than one shows a linkage level above the average. The same notion applies to the impact level of backward linkage. A production activity that has an index greater than one means that it has a backward linkage above the overall average (BPS, 1999). The inter-sector linkage analysis can also be used to determine the seed sector, particularly technology-intensity-based industry. Industrial sector with a high linkage means it has the potential to produce similarly high production output.

This can be ascertained by determining the value of backward or α and forward linkage or β of each industrial sector activity. An industrial activity can be said to have a high backward linkage and forward

linkage when both values are greater than one (α and β> 1), and vice versa; it is said to be low if both values are less than one (α and β <1).

Through the I-O analysis on the type of industry based on technology intensity, it is expected that the resilience of the industry in influencing other sectors to actively participate in the Indonesian economy can be known. In addition to the direct contribution, industry sectors with four different technology intensity also give an indirect contribution in the form of a multiplier effect, i.e. the input-output linkages between industry, consumption and investment. The multiplier effect is significant in the national economy, so that the industry with good feasibility, both one of the high, medium, and low-tech intensity, can be treated as a mainstay industry for national economic development. The impact caused by the increase of 1 unit of final demand on the entire sector is called the degree of sensitivity or forward linkage, while the impact caused by 1 unit of each sector's demand on the output of the entire sector is called dispersion power or backward linkage (CBS, 1995). The multiplier effect is an effect that occurs either directly or indirectly on a variety of economic activities in the country as a result of changes in the exogenous variables of the national economy.

According to Olteanu (2006), if x_{ij} is the intermediary product value of an industry i consumed by industry j; and Xj is the total output value from industry j, then the technology coefficient from the matrix A consists of elements from:

$$a_{ij} = \frac{xij}{Xj}$$

Next is:

a. Counting (I-A)

   Subtracting an identity matrix (i.e. a matrix whose main diagonal is 1 and other elements is 0 towards the input coefficient matrix or also called the technology coefficient matrix) (Olteanu, 2006).

b. Counting the Multiplier Matrix (B)

   Multiplier matrix (B) is counted by inverting the (I-A) matrix or written as: $B=(I-A)^{-1}$

The linkage between output and final demand can be clarified as $X=(I-A)^{-1}F$, where X is the column vector of output, while F is the column vector of final demand. From the equation we can calculate forward linkage and backward linkage

Backward Linkage

Increasing output of the i-th sector will increase the input demand for the sector derived both from the sector itself and from other sectors. It also means there is an increase in the output of other sectors. The linkage between the industry sectors is called backward linkage, since its linkage comes from the mechanism of input use. In general, the total impact due to changes in final demand of a production activity on the output of the entire industrial sector is:

$$r_j = b_{1j} + b_{2j} + \ldots + b_{nj} = \sum_{i=1}^{n} b_{ij}$$

where

r_j = the total impact due to the changes in final demand of a production activity j on the output of the entire industrial sector

b_{ij} = the impact on the output of production activity i due to the changes in final demand of production activity j

The total impact is also called the total dispersion power; and this shows the impact of changes in final demand of a production activity on the output of the entire economic sectors in a region or country. Dispersion power is a measure for backward linkage of production activities from sectors of production in a region or country.

Next, the average impact on the output of each production activity due to changes in final demand of a production activity can be calculated:

$$Y_j = \left(\frac{r_j}{n}\right) = \left(\frac{1}{n}\right)\sum_{i=1}^{n} b_{ij}$$

where

Y_j = the average impact on the output of each production activity due to changes in final demand of production activity j.

However, since the nature of the final demand of each production activity differs from each other, then to compare the impact on each sector, it must be normalized, i.e. by dividing the average impact of a sector with the average impact of all production activities. The calculation resulting from this process is called the dispersion power index or backward linkage index, which is formulated as follows:

$$\alpha_j = \frac{\sum bij}{\frac{1}{n}\sum\sum bij}$$

where:

αj is the dispersion power index of production activity j and is also more known as dispersion power (BL) of production activity j, with the criteria:

αj =1 dispersion power of industry j is equal with the average of dispersion power of the entire economic sectors;

αj >1 dispersion power of industry j is above the average of dispersion power of the entire economic sectors;

αj <1 dispersion power of industry j is bellow the average of dispersion power of the entire economic sectors.

Forward Linkage

Increasing output of the i-th sector will increase the output distribution for the sector that makes the other sectors have more input that can improve their production process. Such linkage between industrial sectors is called forward linkage.

The impact on the output of production activity 1 (X_1) due to changes in the unit F_1 is b_{11}; further due to changes in the F_2 unit is b_{12}; and so on. The impact on the X_2 due to changes in the unit F_1 is B_{21}; due to changes in the unit F_2 is B_{22}, and so on. Thus, the total impact on the output of a production activity i, due to changes in final demand of the entire production activities can be written in the following form of equation:

$$b_{11} + b_{12} + \ldots + b_{1j} + \ldots + b_{1n} = \sum_{j=1}^{n} b_{1j}$$

$$b_{i1} + b_{i2} + \ldots + b_{ij} + \ldots + b_{in} = \sum_{j=1}^{n} b_{ij}$$

$$b_{n1} + b_{n2} + \ldots + b_{nj} + \ldots + b_{nn} = \sum_{j=1}^{n} b_{nj}$$

or in the general equation:

$$s_i = \sum_{j=1}^{n} b_{ij}$$

where

s_i = total impact on production activity i due to changes in the entire production activities

The value of S_i is called the total degree of sensitivity, i.e. a measure of forward linkage of economic sectors in a region. Next, the impact on each sector must be normalized, i.e. by dividing the average impact of a sector with the average impact of the entire production activities. The calculation resulting from this process is called the index of the degree of sensitivity or forward linkage index, which is formulated as follows:

$$\beta i = \frac{\sum bij}{\frac{1}{n}\sum\sum bij}$$

βi is the index of sensitivity degree in the industrial sector in the i-th column or commonly called the degree of sensitivity (FL).

$\beta i = 1$ the degree of sensitivity of industry j is equal with the average degree of sensitivity of the entire economic sectors;

$\beta i > 1$ the degree of sensitivity of industry j is above the average degree of sensitivity of the entire economic sectors;

$\beta i < 1$ the degree of sensitivity of industry j is below the average degree of sensitivity of the entire economic sectors.

To measure the linkage level of an industry in the economy and to determine the key sectors, according to Rasmussen (1957) in Olteanu (2006), is by determining the linkage between the indexes of upstream and downstream linkages. In the IO analysis so far, upstream linkage index is also known as the level of backward linkages, while downstream linkage index is known as the level of forward linkages.

IV. Result and Discussions

The processing result of I-O table of East Java, whose manufacturing industries have been classified based on their technology intensity, is shown in Table 3. The output value of manufacturing industry in East Java in 1994 which is only IDR 32.57 trillion sharply increased in 2006 into IDR 277.19 trillion. This is not separated from the policy of East Java provincial government as stated in their vision of 20 year development, to be an agribusiness center by strengthening their industrial sectors for the welfare of their people. To encourage innovation and industrial progress, the Office of Industry and Trade of East Java also facilitates the industry to apply for a patent and a grant through SME banks in areas of industrial centers, as well as facilitates the promotion of industry. In promoting their industrial products, East Java Government opened representative offices in other provinces and in 2013 there have already been 24 representatives. The encouragement and facilities given by the East Java Government to the industry caused a significant increase in the industrial contribution to the gross value added. The improvement of social welfare is seen from GDP per capita of East Java where before the reform in 1997 was amounted to only IDR 2.67 million, it increased to IDR 26.32 million in 2012 (East Java Regional Statistics, 2013).

In 1994, food, beverage, and tobacco industries are classified as low-technology (LT), largely contributing to the industrial sector amounted to 46.65 percent. In the second rank is timber and rattan industry (15.85 percent), and the lowest rank is the oil refining industry (MLT). Oil refining industry in East Java gave a small contribution, because Java lacks the oil refining industry. In 2006 the contribution of the food, beverages and tobacco industry increased to 48.11 percent, while timber and rattan industry rose to 19.86 percent.

Table 3 shows that the total output produced by the manufacturing industry sector in 2006 reached IDR 277.19 trillion or 34.88 percent of the total output of East Java. When compared with 1994, although the real value of output has increased very significantly, the contribution to total output only increased by 0.3 percent.

From the processing of East Java I-O table, we gained the average primary input allocation in 2006

Table 3. Output Alocation of Industrial Sector Based on Technology Intensity in East Java in 1994 and 2006 (Billion Rupiahs)

Classification	Types of Industry	Year 1994	Percent	Year 2006	Percent
LT	Food, beverage, and tobacco	15,199.0	46.65	133,367.1	48.11
	Textile, textile product, leather, and footwear	3,713.1	11.40	8,551.1	3.08
	Timber and rattan	5,164.1	15.85	55,044.4	19.86
MLT	Oil Refinery	1.2	0.00	1,130.8	0.41
	Rubber and plastic product	152.8	0.47	7,119.3	2.57
	Other non-metal mineral products	60.1	0.18	15,100.6	5.45
	Basic metal and goods from metal	2,005.4	6,16	27,917.8	10.07
MHT	Non-pharmaceutical chemicals	3,415.8	10.49	881,9	0.32
	Machinery industry	671.8	2.06	12,961.6	4.68
	Transportation equipment and restoration	827.2	2.54	693.3	0.25
	Ship, railway industry and restoration	189.1	0.58	2,180.6	0.79
HT	Medicine and herbal medicine	28.4	0.09	832.8	0.30
	Radio, television, and communication tool and their equipments	868.3	2.67	1,182.9	0.43
Other	Other manufacturing industries	281.4	0.86	10,234.7	3.69
Total Industrial Sectors		32,577.7	100	277,199.0	100.00

Source: the data processed from I-O Table of East Java, 1994 and 2006

amounted to 66.31 percent, higher than that in 1994 (49 percent). This shows that the allocation of production factor use (including labor, land and capital in the form of salary-wage, business surplus, depreciation of capital goods, and net indirect taxes) is much larger than the intermediary input (33.69 percent). The highest use of primary inputs in 2006 for the classification of medium-low-tech industry (MLT) was oil refining industry (96.47 percent); and for the classification of medium-high-tech industry (MHT) was a railway industry and restoration (80.07 percent) as well as machinery industry (87.17 percent).

Backward Linkage and Forward Linkage of Technology-Intensity-Based Industries in 1994 and 2006 in East Java

Backward linkage, also called dispersion power index (BL) and forward linkage or the degree of sensitivity (FL) in manufacturing industry based on technology intensity in 1994 and 2006 in East Java can be viewed in Table 4 below.

In 1994, almost all sectors of manufacturing industry has $\alpha j > 1$ or dispersion power (BL) above the average dispersion power of the entire economic sectors, except: a) food, beverages and tobacco; b) oil refining industry; and c) other industrial goods. Whereas in 2006, the food, beverages and tobacco industry had a dispersion power > 1. For the degree of sensitivity (FL), in 1994 the industry which has $\beta j > 1$ was oil refining industry, basic metals and metal goods, and non-pharmaceutical chemicals. In 2006 the industry whose degree of sensitivity > 1 was the machinery industry and other industrial goods.

Figure 1 below maps the position of manufacturing industries in East Java in 1994 into four quadrants. Industrial activities that occupy quadrant III have a high value of backward linkage and forward linkage. In 1994, the industry included in this quadrant is the group of medium-low-tech intensity industry (MLT4), namely basic metal and metal goods industry; and the group of medium-high-tech intensity industry (MHT1), namely non-pharmaceutical chemicals industry. It means the output produced by both industries has a significant impact on their upstream and downstream industries. The upstream industry for basic metals and metal goods industry is mining industry, while the downstream industries are among others machinery industry, radio and television industry, transportation equipment industry, as well as ships industry and restoration. The upstream industry for the chemical industry is non-metallic mineral industry, while the downstream industry are among others the food, beverages, tobacco industry; textile industry, textile

Table 4. Backward and Forward Linkages of Technology-Intensity-Based Industries in East Java Province in 1994 and 2006

Classification	Industry	Year 1994		Year 2006	
		FL	BL	FL	BL
LT1	Food, beverage, and tobacco	0.73	0.87	0.86	1.03
LT2	Textile, textile product, leather, and footwear	0.69	1.08	0.76	0.92
LT3	Timber and rattan	0.92	1.11	0.91	1.10
MLT1	Oil refinery	1.34	0.99	0.73	0.75
MLT2	Rubber and plastic product	0.90	1.20	0.80	1.02
MLT3	Other non-metal mineral products	0.65	1.11	0.85	1.22
MLT4	Basic metal and goods from metal	1.46	1.01	0.99	1.15
MHT1	Non-pharmaceutical chemicals	1.35	1.06	0.73	1.05
MHT2	Machinery industry	0.94	1.19	1.00	0.84
MHT3	Transportation equipment and restoration	0.66	1.16	0.73	0.99
MHT4	Ship industry and restoration	0.57	1.15	0.75	1.00
MHT5	Railway industry and other transportations	-	-	0.74	0.84
HT1	Medicine and herbal medicine	0.74	1.22	0.73	1.01
HT2	Radio, television, and communication tool and their equipments	0.88	1.18	0.72	0.98
Other	Other manufacturing industries	0.65	0.93	1.06	0.96

Source: the data processed from I-O Table of East Java, 1994 and 2006

products, leather, and footwear industry; and rubber and plastic products industry.

The production activities that occupy quadrants II and IV are potential industrial activities. In this second quadrant, there is only one high sectoral linkage. In quadrant II there is only one industry with medium-low-tech intensity (MLT1) with high forward linkage but low backward linkage, i.e. oil refining industry. While in quadrant IV the industrial groups that have high backward linkages yet low forward linkages are LT2, LT3, MLT2, MLT3, MHT2, MHT3, MHT4, HT1, and HT2 (textile industry, textile products, leather, and footwear industry; timber industry; rubber and plastic products industry; non-metallic minerals industry; machinery industry; transport equipment industry; medicine and herbal industry, as well as radio and television industry).

Industrial activity located in quadrant I is LT1, i.e. a type of food, beverage, and tobacco industry and other industries. In the case of food, beverages and tobacco industry, although it gave the highest contribution to the total output value (48.11%), its dispersion power index and degree of sensitivity index on other industries is the lowest. This may occur because the products of food, beverages, and tobacco industry are end products that do not become an input for other economic sectors. In addition, the low dispersion power can be caused by the high use of imported inputs materials by this industry.

Figure 2 shows the distribution of manufacturing industry in East Java in 2006. In contrast to 1994, none of the manufacturing industry has a high linkage with its upstream and downstream industries at once. Basic metals and metal goods industry and machinery industry no longer have a high degree of sensitivity. This could be due to the low absorption of output by their downstream industries.

Quadrant II is an industrial group that has high forward linkage yet low backward linkage, i.e. MHT2 (machinery industry) and other industries. While quadrant IV is industry groups that have high backward linkage yet low forward linkage, i.e. LT1, LT3, MLT2, MLT3, MLT4, MHT1, and HT1 (food, beverage, and tobacco industry; timber industry; rubber and plastic products industry; non-metallic minerals industry; basic metal and metal goods industry; non-pharmaceutical chemicals industry; and medicine and herbal industry).

Quadrant I is an activity group that has a low value of both backward and forward linkages. This means that the output produced by this industry group gives less significant impact on its upstream and downstream industries. In 2006, the industries included under this category are the textile, textile products, leather, and footwear industry; oil refining industry; transport equipment industry; railway industry; and radio and television industry.

When examined, there was a shift in the degree of dispersion and degree of sensitivity of manufacturing industries in East Java in between 1994-2006, caused by innovations, both product and

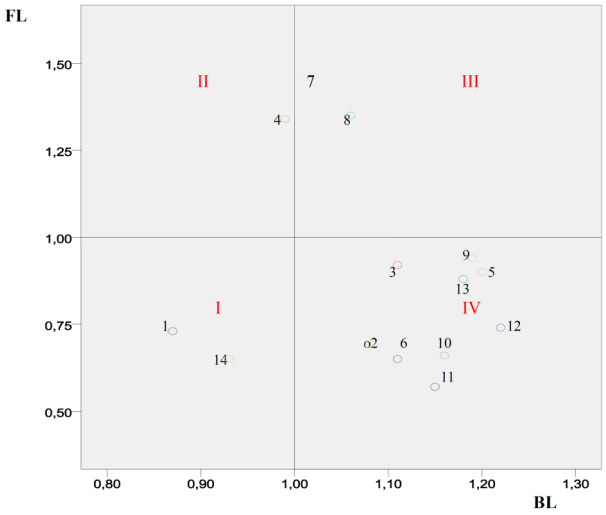

Figure 1. Diagram of Linkages of Technology-Intensity-Based Industry in East Java in 1994

Notes:
1=LT1; 2= LT2; 3=LT3; 4= MLT1; 5= MLT2; 6=MLT3; 7= MLT4; 8= MHT1; 9= MHT2; 10=MHT3; 11= MHT4; 12= HT1; 13= HT2; 14= others

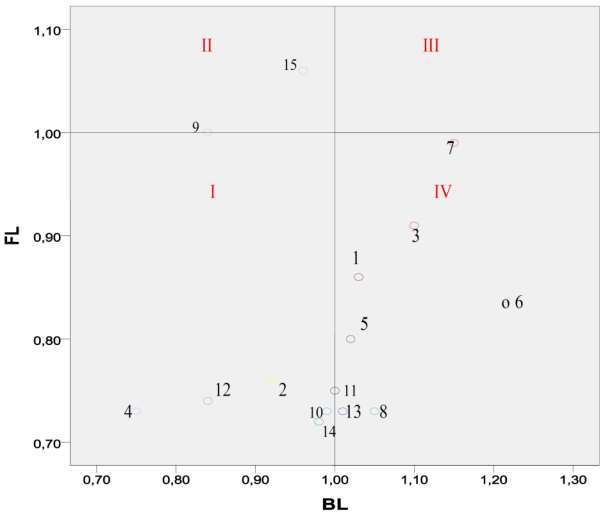

Figure 2. Diagram of Linkages of Technology-Intensity-Based Industry in East Java in 2006

Notes:
1= LT1; 2=LT2; 3=LT3; 4=MLT1; 5=MLT2; 6= MLT3; 7=MLT4; 8=MHT1; 9=MHT2;10=MHT3; 11=MHT4;12= MHT5; 13=HT1; 14=HT2; 15= others

process innovations in industry (Figure 3). For example, in 1994, the industrial activities occupying quadrant III and having a high value of both backward and forward linkages (MLT4) and (MHT1), in 2006 occupied the quadrant IV (potential industry group).

Furthermore, the industry group that in 1994 were included in the category of potential industry, in 2006 became a marginal industry groups residing in quadrant I (LT2, MLT1, MHT3, MHT5, and HT2). The shift occurs because each type of industry innovates to improve its competitiveness. It is seen from the increasing contribution of the industry types on gross value added.

Based on interviews with informants, the shift of manufacturing industry from potential industry in 1994 to a marginal industry in 2006—such as railway industry and restoration (MHT5)—is due to its production that is based on orders. Likewise, the shifting of textile, textile products, leather and footwear industry (LT2) to the marginal position is due to its lack of competitiveness with products from China, that are capable to innovate, so that they have products that are varied, with high quality and competitive prices

Industries with Low-Technology Intensity (LT)

In 1994, the food and beverages industry that previously lacked linkages with other industries turned to have high backward linkage in 2006. This shows that this industry tend to use local products as raw materials, generated among others by sectors of agriculture, livestock, and fisheries; chemical industry; as well as plastic products industry. On the contrary, the textile, textile products, leather and footwear industry that previously gave a significant effect on its upstream industry, turned to have less linkage with both its upstream and downstream industries. The cause of this shift is the increasing use of imported products as raw materials so that the activities of this industry no longer significantly impact the industrial supplier of textile, leather, and footwear raw materials. Timber and rattan industry in East Java during the two periods were not shifted, still a potential industry, growing its upstream industries.

In general, the manufacturing industry with low-tech intensity technology played the role in growing its upstream industry, nevertheless had not managed to grow its downstream industry. For food, beverages, and tobacco industry and textile, textile products, leather and footwear industry, it is reasonable if their degree of sensitivity is low because the products produced are a consumer product, not an intermediary product that becomes the input of other sectors. On the other hand, timber and rattan industry whose linkage with its downstream industry was low showed how low the value-added products made of timber and rattan were.

Industries with Medium-Low-Technology Intensity (MLT)

Basic metals and metal goods industry that in 1994 was a potential industry and enlivened its upstream and downstream industries, in 2006 had a declining

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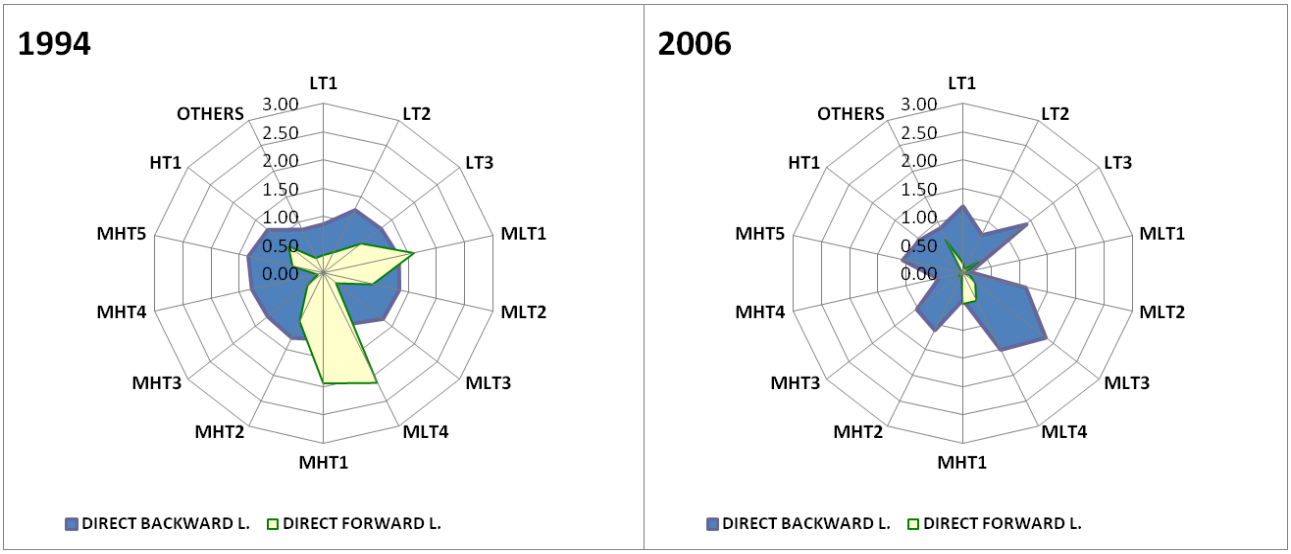

Source: the data processed by the writer

Figure 3. Inter-sectors Linkages Among Technology-Intensity-Based Manufacturing Industries in East Java Province in 1994 and 2006

impact on its downstream industry. In the meanwhile, rubber and plastic products industry, as well as non metallic mineral products, during the two periods were still in the group of potential industry, significantly developing their upstream industries. Oil refining industry that was previously included in the potential industry, in 2006 no longer had a significant impact on its upstream and downstream industries.

Industry with medium low-tech intensity previously became a driving engine for the growth of other industries, particularly basic metal and metal goods industry. Unfortunately, a decade later the role of this industry weakened, especially for its downstream industries. It can be due to the products which were exported in the form of intermediary products or semi-finished goods, whose value added is not as high as finished goods.

Industries with Medium-High-Technology Intensity (MHT)

Chemicals outside pharmacy industry that in 1994 had a high linkage with its upstream and downstream industries, in 2006 experienced a decrease in its degree of sensitivity, or less linked to its downstream industries. Transportation equipment and restoration industry, as well as the railway industry also experienced a decrease in the linkage with its upstream industries.

Similar with the medium-low-tech industries, the medium-high-tech industries, in their own term had been the driving source of their upstream and downstream industries, especially the chemical industry. There was a decline in linkage with the downstream industry (chemical industry) and the upstream industry (transportation equipment industry). This means that the products of chemical industry were not much developed into value added products; while transportation equipment industry used more imported raw materials.

Industries with High-Technology Intensity (HT)

Medicine and herbal industry for two periods, namely 1994 and 2006, still remained a potential industry, growing its upstream industries. This is supported by the herbal products that mainly use local traditional materials. While the radio, television, and communication equipment industry in East Java in 2006 experienced a decrease in the linkages with its upstream industry, due to imported raw material. This industry also has low linkage to its downstream industries because its products are consumer products.

V. Conclusion

The linkage among manufacturing industries based on technology intensity in East Java before the crisis (1994) and after the crisis (2006) shifted in several industrial sectors. In 1994 the seed industry sector was the industry with high backward and forward linkages, i.e. basic metal and metal goods industry and non-pharmaceutical chemical industries. However, in 2006 both industries became potential industries with only high backward linkage.

Furthermore, the less potential group was industries with low backward and forward linkages: in 1994 was the food, beverages and tobacco industry. Nevertheless in 2006, this low-tech industry has become potential industry. This is due to the facilities from the Provincial Government of East Java who facilitated their promotion, their patents arrangements, as well as established industrial office representative in several locations.

The less potential industry groups in 2006 were

the low-tech industry, i.e. textile, textile products, leather and footwear industry, and the medium-low-tech industry, i.e. oil refining industry, as well as the high-tech industry, i.e. railway industry, conveyance and restoration industry. The shifting of those industry groups is due to the onslaught of imported textile products, reduction of oil refinery numbers in East Java, as well as production system that depends on the orders such as the railway industry.

Based on the degree of linkage, no matter how high its technology intensity, the manufacturing industry in East Java showed a similar impact on the upstream and downstream industries. Therefore, the government of East Java needs to develop the low-tech manufacturing industry together with medium-low-tech, medium-high-tech, and high-tech manufacturing industries. The thing to improve is the ability of these industries in growing other related industries, especially their downstream industries. The policy that can improve the linkages among manufacturing industries is the policy of local raw materials use and value-added products development.

Study Limitations

This study has limitations, particularly in terms of data novelty. The problem with Input-Output Table is the difficulty in getting the latest data; it is not easy to collect the notably detailed data regarding inter-economic-sectors transactions. When the study was conducted, the latest East Java I-O table is the table compiled seven years earlier. In addition, the conformation of the classification of manufacturing industry sectors with the OECD Manual classification is itself a problem. There are several industry sectors that are separated in the OECD Manual classification, yet combined in East Java I-O table.

However, this analysis method can still be applied to other provinces, including for national I-O data, because there has already been a standard in the drafting system of I-O table for all countries and provinces. The thing that needs to be observed is the industry categorization according to its technology intensity. There are some provinces that combine the medium-high-tech with high-tech intensity industry sectors. Therefore, researchers must be careful when determining the category of an industry sector, whether it has suited the criteria of low-tech, medium-low-tech, medium-high-tech, or high-tech intensity industry.

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