Japan-U.S. comparison of the domestic ripple effect of imported oil price#)

FUJIKAWA, Kiyoshi *)
SHIMOADA, Mitsuru †)
WATANABE, Takatoshi &)

Summary

Though price of oil soared by oil crisis in the 1970's, it has shifted stably low price from the latter half of the 1980's through the 90's except for the time of the first Gulf War. However, the oil price has changed to rise again after the year 2000, and it even marked the historical high price of 70 dollars a barrel in 2006. But there have not been occurred such panics in countries as those in the time of oil crises, which owes to the contribution of the efforts of each advanced country that tried to develop the saving technology of resources including oil since the oil crises. In this paper, we do the simulation how the change of the price of the imported oil influences the nation's economy by using two indices, the intensity of imported oil of domestic economy and the elasticity of the domestic price to the imported oil price, and compare the phases of the change in the technological structure in a long term as for Japan and the U.S..

The following was confirmed in this paper. Concerning the intensity of imported oil, it declined rapidly soon after the oil crisis in both the U.S. and Japan, however, it has showed almost no fluctuation in Japan though it even changed to rise a little in the U.S. in the late 1980's. It can be said that the sharp rise of the imported oil price has pushed the advance of the energy-saving technology, however, the stabilization of the oil price has stagnated the speed of the technological improvement in Japan and U.S., though the factors of change differ in the both countries. In Japan, the entire domestic input structure has shifted to the energy-conserving and resource-saving structure in addition to the decrease of the input rate of imported oil. However, it is not necessarily so in the U.S., and it seems that the efficiency improvement of domestic production system has not progressed much.

As for the influence that the price of imported oil gives to the domestic price, in Japan the % change of domestic price in accordance with the % change of the oil was extremely high, partly owing to the high price of oil immediately after the oil crisis. However, sensitivity of the domestic price to the imported oil price was drastically decreased, and had almost returned to the same level as that before the oil crises. The factors of the change were the decrease of the input rate of imported oil and the efficiency improvement of the entire domestic input structure as well as the change in the intensity of imported oil. On the other hand, it is found out that the U.S. has the structure where influence that the price of imported oil give to domestic price is quite small compared with Japan.

#)This paper is based on the papers presented in the Pacific Economic Outlook Forecasters Meeting (at Kansai Institute for Social and Economic Research) in March, 2006, International Input-Output Association (at Tohoku University) in July, 2006 and the Pan Pacific Association of Input-Output Studies (at Okinawa International University) in October, 2006. Valuable comments are given from a lot of researchers including Prof. Kuboniwa of Hitotsubashi University and Prof. Kagawa of Kyushu University. We would like to express deepest gratitude for the comments.

*) Graduate School of International Development, Nagoya University.
Furo, Chikusa, Nagoya 464-8601, JAPAN.
fujikawa@gsid.nagoya-u.ac.jp

†) Applied Research Institute, Inc.
Kanda-nishiki, Chiyoda, Tokyo 101-0054, JAPAN
shimoda@ari.co.jp

&) Aichi Gakuin University, Faculty of Business and Commerce
Araike, Iwasaki, Nisshin, Aichi, 470-0195, Japan.
twata@dpc.agu.ac.jp

1 Introduction: Background and focus of this study

1-1 Background and focus of this study

Figure 1 showed the transition of the imported oil price (CIF price) as for Japan and the United States. The imported oil price that was about two dollars a barrel in the beginning of the 70's rose up to 35 dollars a barrel in the first half of the 1980's. This steep rise of the oil price is the first oil crisis in 1973 and the second oil crisis in 1979. These were the times when the initiative of the oil pricing moved from the oil majors to oil-producing country (OPEC) due to the solidarity of oil-producing countries. As the sudden rise of the price of oil at the oil crisis brought big economical damage to the non-oil-producing countries, it was Japan that hardly produces domestic natural resources that was seriously affected in particular. This brought a strong deflationary pressure at the same time raising the prices in Japan since the rise of the energy price is a cost-pushing factor as well as the income transfer from Japan to foreign countries (This can be said taxation from foreign countries) [1].

Various energy-saving technologies are developed in advanced industrial countries including Japan afterwards, and the excessive demand over supply in the oil market becomes gradually weak. And, the decision making of the oil price had become independent of OPEC, and the price of oil came to be decided reflecting the supply-demand situation in the market. As a result, the oil price decreased to about 20 dollars a barrel after 1985, and it continued the time when the price was comparatively stable and low. Those bullish oil-producing countries that expected that the price of oil would remain high were disappointed. The sudden fall of the oil price at this time was called, "Reverse-oil crisis".

However, in the year 2000 the oil price came to make sudden rise again and updated the highest value of oil ever. Recently the price of oil is decided by the market; however, specialists view this phenomenon partly because of the suppliers side that the capital investment was insufficient in the oil-related sector after the mid 1980 and the oil manufacturers in the U.S. suffered damage by hurricane and of the demanding side that the geopolitical risk increased in the oil producing countries such as Middle East and South America so that speculative money flowed in the market expecting future rise of the price as well as the increase of demand of oil in the U.S. and other newly industrialized countries[2].

This rise of the price of oil this time is on par with the one in oil crises in the width of the price hike. It doesn't cause panic as it did in the oil crises though it certainly gives a constant influence on the entire world economy. It is considered that the efficiency improvement of the energy utilization at the manufacturing stage eased the size of the influence that the sudden rise of the price of oil gives to the importing country as well as the downsizing of the consumption structure (or, industrial structure). As for Japan-U.S. and Europe OECD nations, Figure 2 shows the consumption of the final energy for each real GDP in the purchasing power parity conversion. The line graph goes down lower right, and it is understood that the improvement of the energy efficiency on the macro base advanced. In U.S. the specific energy consumption that was 420(toe/1,000,000 dollar) in 1971 decreased to 245 (toe/1,000,000 dollar) which is about 60% in 2004. In Europe OECD nations it decreases from 237 of the 1971 to about 157 which is about 2/3, and also in Japan it has decreased from 205 of the 1971 to 154 and which makes about 3/4.

However, the fact is that the energy consumed for each GDP is increasing in newly industrializing countries such as China and India. Water power and the nuclear power energy are the energy sources with a long pregnancy period and new energy development (utilization) such as sunlight and terrestrial heats are still developing. Therefore, they have no choice but to rely on the fossil energy (especially, oil and natural-gas) that the energy demands of newly industrializing countries to be expanded. Steep rise of the oil price doesn't seem to be canceled soon, and the influence that the sudden rise of the price of the imported oil (It is an exogenous variable for the home economy) gives to the domestic price (consequently, domestic economy) is an important concern. Then, how the price change of imported oil and natural-gas gives influence on the domestic price will be examined in this paper.

This paper analyses the technological progress of the use of oil from the aspects of amount and price by applying the input-output analysis. First of all, “intensity of imported oil” is picked out for the aspect of amount. The intensity of imported oil means the amount of imported oil necessary to produce one unit of final goods. The intensity of imported oil is influenced by the change in the input rate of imported goods and the final demand structure as well as the improvement of energy-saving technology. In this paper, the factor that changes the intensity of imported oil is quantitatively evaluated. It might be an influence of the oil price on the price of domestic goods price that the people of the oil importing country feel it directly when there is a substantial change in the oil market. As for the aspect of price the sensitivity of domestic price to the imported oil price is picked out. Moreover, as for the change of the sensitivity of domestic price to imported oil it is possible to evaluate it by resolving the change in the price sensitivity to the change in the import input structure and the change in the efficiency of the domestic production structure as well as the analysis on the aspect of amount. In this paper, the factor that the sensitivity of the domestic price to the imported oil changes is quantitatively evaluated.

1-2 Previous studies concerning the influence of oil price on domestic price

In this section, some of the previous studies about the influence that the increase of the price of oil gives on the domestic price using input-output analysis are explained.

Harashima (1993) estimates to what extent the (Japan's) domestic wholesale price rises when the oil price rises 1% taking 1980s as the subject using the equilibrium price model of the input-output analysis. In 1980, 0.09% rise of the domestic wholesale prices goes down to about 0.03% in 1988, and then it rises gradually afterwards to about 0.04% in 1990. It is pointed out that the influence of the oil price gives on the domestic price tend to become larger in the latter half of 1980's, which is due to the decrease of oil price and the overall increase of demand brought by economic bubble. Moreover, Ono (2004, 2005a, 2005b) does the simulation analysis that uses the INFORUM model[3] that links input-output analysis with the macro model. In the simulation, it is assumed that Japan's price of imported oil will rise from 36.4 dollars per barrel in 2004 to 50.7 dollars (rise by 39.3%) in 2005. As a result, as for GDP deflator and consumption deflator, it is the rise of 0.32% and 0.87% respectively; as for real GDP and real consumption, it is decreases of 0.48 and 0.65 respectively. According to Ono, the elasticity of the oil price of consumption deflator reaches 0.022(=0.87/39.3), which is the value of quite small. In addition, a research group of Central Research Institute of Electric Power Industry (Hattori and Matsue (2006)) does factor analysis in the aspect how the change of the oil price was important in the change of actual domestic producer prices. In the first oil crisis period (1973 to 1976), the import price for coal and the natural-gas rose by 61.5%, and the producer prices rose by 37.3%. The pay factor is the largest with 25.5%, while the factor of the change of prices of oil, coal and natural-gas is 9.0%, which is far smaller than the pay factor. When the sensitive elasticity of domestic price to the imported oil price is calculated, it was considerably large figure of 0.146(=9.0/61.5). As for the recent sharp rise period of oil price (2002 to 2005), while the imported price of oil, coal and natural-gas rose by 14.0%, producer price rose by only 1.9%. Among them the pay is-0.2% which makes negative factor, while the factor of price change of oil, coal and natural-gas was 1.5%. In this period the sensitive elasticity of domestic price to the imported oil price decreases to 0.107(=1.5/14.0), which is about 2/3. In those 30 years, the influence of oil price change on domestic price decreased[4].

As for the studies of the influence of oil price on domestic price covering the U.S., there is Klein et al.(2005). This research simulates the influence on the domestic price when the oil price assumed to rise by 1% applying the equilibrium price model based on the input-output table of each bench mark year. Their estimate results (in a word, sensitive elasticity of the domestic price to imported oil) were 0.0700 in 1977, 0.1049 in 1982, 0.0380 in 1987, 0.0375 in 1992, 0.0334 in 1997. Though the influence of the oil price fluctuation on the domestic price was decreased during 1982 to 1987, it is pointed out that it was almost unchanged after that. Klein et al. questions the assertion that seen in the House report (2004) and other studies saying the change of the price of oil hardly influences (U.S.) domestic prices now. Certainly, in this estimates for the U.S. the width of a decrease of sensitiveness of domestic price to oil price is small, however, when it is compared with the research results of Hattori and Matsue (2005) of Japan the absolute value is also small.

As mentioned above, the sensitivity of domestic price to oil is considerably different depending on the researchers. Sometimes the model is not precisely comprehensible, and it is difficult to understand in what reason to cause such differences. Then, we decided we were going to compare the influences of the oil price on the domestic price using the same analysis model for Japan and the United States. The next section explains the analytic model that we based on.

2 Model

2-1 Intensity of imported oil

The following expression (1) is a basic equation of the equilibrium production model. When it is assumed that the row vector $\mathbf{f}$ stands for final demand, and $\mathbf{f_d}$ for domestic final demand and $\mathbf{B}$ for Leontief inverse matrix, gross domestic production $\mathbf{x}$(row vector) is shown by the product of the Leontief inverse matrix and the domestic final demand. This expression means that it is needed to produce necessary raw materials for the production in order to produce final products. Here, **M** stands for the import coefficient matrix, **e** for export row vector and **I** for the unit matrix.

$$\mathbf{x} = [\mathbf{I} - (\mathbf{I} - \mathbf{M})\mathbf{A}]^{-1}[\mathbf{e} + (\mathbf{I} - \mathbf{M})\mathbf{f}] = \mathbf{B}\mathbf{f_d} \tag{1}$$

Though a part of the raw material is covered by the import, vector **m** of imported raw material input is shown as the following expression (2). **MA** is an input

$$\mathbf{m} = \mathbf{MAx} = \mathbf{MABf_d} \tag{2}$$

Here we normalize the final demand f, and define one unit of final demand ($\bar{\mathbf{f}}_\mathbf{d}$) as follows:

$$(1,\cdots,1)\bar{\mathbf{f}}_\mathbf{d} = \boldsymbol{\iota}\bar{\mathbf{f}}_\mathbf{d} = 1 \tag{3}$$

The total production amount ($\bar{\mathbf{x}}$) and amount of input of import ($\bar{\mathbf{m}}$) of each sector that the production of one unit of final demand needs can be shown as the following expression:

$$\bar{\mathbf{x}} = \mathbf{B}\bar{\mathbf{f}}_\mathbf{d} \tag{4}$$

$$\bar{\mathbf{m}} = \mathbf{MA}\bar{\mathbf{x}} = \mathbf{MAB}\bar{\mathbf{f}}_\mathbf{d} \tag{5}$$

In this paper we call $\bar{\mathbf{m}}$ as "intensity of import" of the final demand. The subject matter of this paper is how much "imported oil" is ultimately included in the final demand. The factor of this vector corresponding to "oil" is the "intensity of imported oil " in final demand[5].

Well, what is also in our scope of subject matter is how and by what factor the intensity of imported oil change with the time change. From the 0th stage to the 1st stage, the change of $\bar{\mathbf{m}}$ can be expressed by the expression (6).

$$\begin{aligned} d\bar{\mathbf{m}} = \bar{\mathbf{m}}(1) - \bar{\mathbf{m}}(0) &= [\mathbf{M(1)A(1)} - \mathbf{M(0)A(0)}]\mathbf{B(1)}\bar{\mathbf{f}}\mathbf{(1)} \\ &+ \mathbf{M(0)A(0)}[\mathbf{B(1)} - \mathbf{B(0)}]\bar{\mathbf{f}}\mathbf{(1)} \\ &+ \mathbf{M(0)A(0)B(0)}[\bar{\mathbf{f}}\mathbf{(1)} - \bar{\mathbf{f}}\mathbf{(0)}] \end{aligned} \tag{6}$$

The first term in the right-hand side expresses the factor of technology of imported goods input; and the second term is the efficiency factor of the domestic production structure and the third term is the factor of structural change of the final demand[6]. Please note that the second term includes both the direct and indirect effect, and it is understood not only the productive structure of industry concerned but also the efficiency factor of the whole domestic production system.

Moreover, the element corresponding to "oil" of this vector is a factor of the change of "intensity of imported oil".

2-2 Sensitivity of domestic price to the imported oil price

First of all, $\mathbf{v_d}$ is assumed to be a domestic value added rate vector (value added per unit of the product). On the other hand, when $\mathbf{p_m}$ is assumed to be a row vector of the imported goods price, the rate of value added that flows to foreign countries as imported input goods is shown as follows.

$$\mathbf{v_m} = \mathbf{p_m MA} \tag{7}$$

Here, the following expression (8) is the basic expression of the equilibrium price model. Domestic price $\mathbf{p_d}$ is expressed as product of the value added rate and Leontief inverse matrix.

$$\mathbf{p_d} = [\mathbf{v_d} + \mathbf{p_m MA}][\mathbf{I} - (\mathbf{I} - \mathbf{M})\mathbf{A}]^{-1} = [\mathbf{v_d} + \mathbf{v_m}]\mathbf{B_d} \tag{8}$$

This means that domestic price $\mathbf{p_d}$ is expressed by product of value added rate and Leontief inverse matrix.

The subject matter of this paper is how much the domestic price changes when the price of the imported oil changes. Then, when the imported goods price changed by $\overline{\mathbf{p}}_\mathbf{m}$, the change of domestic equilibrium price can be expressed as $\overline{\mathbf{p}}_\mathbf{d}$ shown in the following expressions (9). This is called "import price sensitivity" of the domestic price in this paper.

$$\overline{\mathbf{p}}_\mathbf{d} = \overline{\mathbf{p}}_\mathbf{m}\mathbf{MAB_d} \tag{9}$$

What is calculated from this expression is "sensitivity to imported oil price" of the domestic price, when it is assumed that only the price of the imported oil changed among the imported goods prices.

Well, it is also our subject matter how and by what factor the sensitivity of the domestic price to import price changed with the time change. The change of $\overline{\mathbf{p}}_\mathbf{d}$ during the period 0 to 1 can be shown as follows.

$$\begin{aligned} \mathbf{d}\overline{\mathbf{p}}_\mathbf{d} = \overline{\mathbf{p}}_\mathbf{d}(\mathbf{1}) - \overline{\mathbf{p}}_\mathbf{d}(\mathbf{0}) &= [\overline{\mathbf{p}}_\mathbf{m}(\mathbf{1}) - \overline{\mathbf{p}}_\mathbf{m}(\mathbf{0})]\mathbf{M(0)A(0)B_d(0)} \\ &+ \overline{\mathbf{p}}_\mathbf{m}(\mathbf{1})[\mathbf{M(1)A_m(1)} - \mathbf{M(0)A(0)}]\mathbf{B_d(0)} \\ &+ \overline{\mathbf{p}}_\mathbf{m}(\mathbf{1})\mathbf{M(1)A(1)}[\mathbf{B_d(1)} - \mathbf{B_d(0)}] \end{aligned} \tag{10}$$

The first term in the right-hand side of the expression (10) stands for the factor of the initial price of imported goods[7], the second term is the factor of the change of technology of imported goods input, and the third term is the factor of efficiency change in the domestic production structure. As mentioned in the previous section, it is also understood that this term is not only about the production structure of industry concerned but also the efficiency factor of the entire domestic production system.

Moreover, it is assumed that domestic general price is defined by the weighted average of the domestic price for each sector. Then, the difference of the influence level to domestic general prices is defined by the next expression.

$$\begin{aligned} \mathbf{w(1)\overline{p}_d(1) - w(0)\overline{p}_d(0)} &= \mathbf{(w(1) - w(0))\overline{p}_d(0) + w(1)(\overline{p}_d(1) - \overline{p}_d(0))} \\ &= \mathbf{(w(1) - w(0))\overline{p}_d(0)} \\ &\quad \mathbf{+ w(1)[\overline{p}_m(1) - \overline{p}_m(0)]M(0)A(0)B_d(0)} \\ &\quad \mathbf{+ w(1)\overline{p}_m(1)[M(1)A(1) - M(0)A(0)]B_d(0)} \\ &\quad \mathbf{+ w(1)\overline{p}_m(1)M(1)A(1)[B_d(1) - B_d(0)]} \end{aligned} \tag{11}$$

The first term in the right-hand side is the factor of difference of influence to general prices by the difference of the weight of each sector.

3 Intensity of imported oil of Japan and the USA

3-1 Input-output tables of Japan and the USA

This chapter outlines the input-output table of Japan-U.S. used in this paper. Please refer to appendix 1”input-output table for The United States” and appendix 2” input-output table for Japan” for details.

Both U.S. and Japan are known as countries that has made the input-output table public for a long term. After the Second World War, Japan made public their bench mark table in the years whose unit digits are both 5 and 0 since 1995, and the U.S. made public their bench mark table basically in the years whose unit digits are both 2 and 7 since 1947.

Statistical authorities in Japan are working on the continuousness of the input-output table data in sincerity, and the Ministry of Economy, Trade and Industry (formerly the Ministry of International Trade and Industry) makes “Extension table” for every middle year when the bench mark tables are not published. Moreover, the Ministry of Internal Affairs and Communications also publishes “Connected input-output table” for three terms including the period concerned when the bench mark table is made public, and connects the industrial classification. However, it is undeniable that there is a problem in the continuousness of data as for a long-term time series of ten years or more. Therefore, in this paper we decided to use the long-term time series database of input-output table, which is compiled by former Professor of Keio University, Prof. Kiji. In Kiji’s database, though it has rather rough industrial classification of 45, we can utilize the connected input-output table through 1960-65-70 and the long term time series input-output table of 1973 through 1999 in the nominal and fixed price (price in 1990).

On the other hand, after 1972, U.S. Department of Commerce is making public the input-output table of the SNA (system of national account) type. In SNA, “One industry one commodity” that is the base in a usual input-output analysis is not assumed, and each industry supposed to produce a main product and some by-products. In a word, the sector is classified by two standards: “Industry” and “Commodity”. The input-output table in SNA format cannot apply conventional “Input-output analysis model” directly though it offers more information than the input-output table of traditional model. Then, since Japanese input-output table is compiled on the basis of commodity, we converted American table into “commodity × commodity” in this paper. There is another problem in an American table. That is, since there is no connected industrial input-output table of U.S. as the one prepared in Japan, we can not obtain price data matched to the classification of input-output table. Then, the price data by commodity issued by the U.S. Department of Labor and a part from the value added price data by industry were used; we made real input-output table in this paper.

3-2 Transition of intensity of imported oil in Japan and the USA

Figure 3 is the time series change of intensity of imported oil of Japan-U.S. The vertical axis in the figure 3 shows the amount (rate) of imported oil included directly and indirectly in one unit of final demand, i.e. the intensity of imported oil.

As for Japan (marked ◆), it was about 1% in 1965 and increased up to three times to 3% in 1973 immediately before oil crisis. It was the time of high growth and the industrial structure in Japan experienced “heavy chemistry industrialization” in this period. In the process of the heavy chemistry industrialization, “making energy into petroleum” that is called an energy revolution has progressed. Therefore, the intensity of imported oil has increased greatly. However, the intensity of imported oil began to decrease at the oil crisis and went down to about 2% in 1985. This almost corresponds to the fall of the price of imported oil shown in Figure 1 though it almost becomes a level-off by 1999 afterwards.

Next, as for the United States (marked ■), we should be careful to see this graph since it produces oil domestically. Among the total amount of supply of oil, the import is 44.6% in 1977, 24.2% in 1982, 29.9% in 1987, 31.1% in 1992 and 36.4% in 1997. In the most recent year, the ratio of domestic production to import is almost 2:1. Therefore, it becomes about three times the figures in Figure 3 as for the intensity of the imported oil as for the total of oil including domestic production and the import.

As for the intensity of imported oil of the U.S., it decreased greatly from 2.7% in 1977 to 0.9% in 1982, and then it rather turned to increasing trend and became1.2% in 1992. When the transition of the intensity of imported oil between the U.S. and Japan is compared, it can be said that they are similar in the point that they both fell greatly after the oil crisis, however, they are different since Japan remains almost at the same level after the late 80’s while the U.S. rather tends to rise after the late 80’s.

3-3 Factor of change in intensity of imported oil

Figure 4 shows factor resolution of the change in the intensity of imported oil of Japan. In this figure, the total of each factor shows the change in intensity of imported oil shown in Figure 3.

Japan’s intensity of imported oil increases at the time before oil crisis. The key factor to cause this was that the entire production structure of Japan had changed to be depending more on using oil[8]. Additionally, the increase of direct input rate of oil also gave boost to it. However, after the oil crisis the intensity of imported oil had decreased rapidly until the first half of the 80's. When it is totaled from 1973 to 1985, the change in the intensity of imported oil is -1.30%; two key factors to cause this decrease were the efficiency change in the domestic production structure (- 0.80%, screened part) and the technological change in imported goods input (- 0.52%, shaded part). On the other hand the change in the composition of final demand was not relatively a great factor (0.02%, white part) consequentially though there are some ups and downs. In the late 1980's when the oil price was steadily low, afterwards the intensity of imported oil has not changed much (slight increase of 0.18%). Among the factors the factor of technological change in imported goods input has turned to slightly positive (0.24%)[9] reflecting the low price of oil, while the factor of efficiency change of domestic production structure was still negative (-0.19%). The effect of the final demand was a slight rise (0.12%).

Figure 5 showed the factors of the change in the intensity of imported oil in the United States. In the period of 1977 to 1982 the intensity of the imported oil decreased greatly. Since the price of oil soared in this period, the decrease of the direct input rate of imported oil has become the key factor to cause decrease in the intensity of imported oil. However, when the factor of a domestic production system is seen, it was surprising that it become the factor to bring slight rise in the intensity of imported oil[10]. In a word, though an effort to reduce the import of oil was made against the sharp rise of the price of imported oil, domestic production structure was not necessarily made more efficient as in Japan. After 1980's the intensity of imported oil undergoes a transition in somewhat upward trend, and whose key factor was the rise of the import rate of oil, while the effect of efficiency of change in production structure was limited.

The following can be said by summarizing the results of Japan-U.S. as for the intensity of imported oil. As for Japan the intensity of imported oil was high and was 3% or less in the first half of the 1970's in both Japan and U.S. Though the intensity of imported oil decreases in the both countries afterwards, Japan undergoes a transition in somewhat higher level. When the key factor of the change in the intensity of imported oil is seen, the key factor to lead Japan to decrease the intensity of imported oil through whole period after the oil crises was the efficiency improvement of domestic production structure; on the other hand the key factor of decrease in the U.S. was the decrease of the import rate of oil and the efficiency improvement of domestic production structure itself was not seen.

4 Sensitivity of domestic price to the imported oil price for Japan and the USA

4-1 Transition of sensitivity of domestic price to the imported oil price for Japan and the USA

Figure 6 shows the transition of sensitivity of the domestic price to the imported oil for Japan and U.S. These figures in Figure 6 are estimates of the influence that the domestic price would be given (i.e. value of elasticity) when it is assumed that the price of imported oil rise by 100% (doubled).

As for Japan (marked ◆) the sensitivity of domestic price to the imported oil price was 1.4% in 1973 and then soared to 19.8% in 1974 of the first oil crisis. It changes by about 5% less (4.73%, 4.67%, 4.66%, 4.50%, 4.44%) through 1975 to 1979, however, it rises to 7.5% again in 1980 after the second oil crisis. However, Japan's sensitivity of domestic price to the imported oil price decreased rapidly afterwards, and went down to about 2% in 1986, and it changes almost in level-off after that.

The sensitivity of domestic price to the imported oil price of Japan of recent years that we estimated, which is 0.02, was almost the same as the estimate result by Ono (2005). This result suggests that even if the price of oil rises the impact to the domestic price would be not so big and that Japanese economy has grown to become stronger, secure economy to the external price shock.

Next, the sensitivity of domestic price to the imported oil price of the United

States (marked ■) is extremely small; 0.95%(0.0095) in 1977, 1.12%(0.0112) in 1982, 0.56%(0.0056) in 1987, 0.81%(0.0081) in 1992, and 0.98%(0.0098) in 1997[11]. Since this paper covers only the imported oil for the analysis, it would be several times larger if the domestic oil is included; this value is still considerably small though. Actually, Klein et al.(2005) reports the sensitivity of domestic price to the imported oil price of the United States as 0.070 in 1977, 0.1049 in 1982, 0.0380 in 1987, 0.0375 in 1992, 0.0334 in 1997, and it is about three times larger the estimate of us as for the most recent figure. The evaluation by Klein et al.(2005) was that it cannot be said that American economy become stronger for the change of the oil price. Certainly, it might be true in the meaning that there is little change in the sensitivity of domestic price to the imported oil price. However, when compared with Japan, the sensitivity of domestic price to the imported oil price is still smaller. It does not have to be viewed as too negative, we think.

4-2 Factor of change in the sensitivity of domestic price to the imported oil price

Figure 7 shows the factor of the change in the sensitivity of domestic price to the imported oil price of Japan after the first oil crisis. The factor total in this Figure shows the changed portion of the sensitivity of domestic price to the imported oil price shown in Figure 6. The equilibrium price model of the input-output analysis is a model that calculates the variation width of price in accordance with the variation width of the ratio of value added. Therefore, as in this paper, in the case when “change rate” of oil price is adjusted and the secular change of the influence is seen, there is no economic bearing in the effect itself though an initial price of oil becomes a big element for change of the equilibrium price. The sensitivity of domestic price to the imported oil price made a sharp rise from 1973 to 1974, which is supposed that the both positive effects of domestic input structure and input coefficient of imported oil have contributed. However, it is considered that there is somewhat statistical error is included because 1974 is a considerably confused year. The both minus effects of the domestic input structure and the input coefficient of the imported oil have influenced from 1974 to 75. In a word, it is shown that it has changed to resource-saving production structure. What should be paid attention is that the factor of the change in the domestic input structure contributes as a factor to suppress the sensitivity of domestic price to the imported oil price by mid-80's including the second oil crisis afterwards. Moreover, the efficiency improvement of the import input also contributes comparatively greatly as the factor to decrease the sensitivity of domestic price to the imported oil price in 1979-80 and 1981-82 and so on. It is considered that these reflect not only the progress of the direct energy saving technology but also the progress of the resource-saving technology of the whole economy. Oppositely, since the oil price was steadily low in the latter half of the 1980's an increase in the imported oil input become a factor to raise the sensitivity of domestic price to the imported oil price though it is a little.

Figure 8 shows the factor of the change in the sensitivity of domestic price to the imported oil price of the United States. The sensitivity of domestic price to the imported oil price of the United States has not changed greatly. However, the factors are different depending on the object period. Though the sensitivity of domestic price to the imported oil price of U.S. had hardly changed for the period of 1977-82, it is found out that the input coefficient of imported goods decreased considerably. However, the change in the input coefficient of imported goods is not seen and the domestic input structure has not become efficient afterwards.

In a word, Japan has advanced not only the immediate oil saving but also the efficiency improvement of entire domestic production structure for saving resources against the rise of imported oil price. On the other hand, the United States has reduced the influence of the rise of the imported oil price by reducing only the rate of intermediate input of oil against the change of the oil price. There is presence of domestic natural resources as background. Such country as the U.S. where not only oil but also other natural resources are produced can absorb external shock with domestic goods. However, it is considered that Japan can not substitute imported resources for domestic production, so there was no choice for Japan other than saving resources by improvement of efficiency of domestic production structure itself.

5 Conclusion

In this research, the comparison analysis of Japan and the United States as for the saving technology of imported natural resources in each country was done from two aspects, amount (intensity of imported oil) and price (the sensitivity of domestic price to the imported oil price) by using the input-output table data base of Japan and the United States.

We would like to point out the following two points from the analysis results of this paper. First, the United States is stronger to an external factor of price change of the imported oil. The intensity of imported oil of U.S. is smaller though both the U.S. and Japan have similar transition in the meaning that they fall down sharply after oil crises. As for the sensitivity of domestic prices to the imported oil price, the sensitivity of domestic price to the imported oil price of the United States is considerably low compared with that of Japan though the difference becomes smaller in recent years. Secondarily, the types of the technological progress are different in Japan and U.S. Japan has promoted the decrease in intensity of imported oil and the sensitivity of domestic price to the imported oil price from two sides, that is, the saving of imported oil input and the efficiency improvement of the domestic production structure. On the other hand, though the technology improvement to save imported oil was observed, it seems the efficiency improvement of the domestic production structure has not progressed in the U.S. as much as in Japan. It can be said that Japan where natural resources are scarce has promoted not only the saving of immediate input of oil but also the efficiency improvement of the domestic production technology structure.

Lastly tasks for the future are mentioned. It needs some reflections that the examinations of the model type are not sufficient since this is an experimental calculation. First of all, it is necessary to examine how to put weight in the factor resolution type. We would like to confirm how it would be different when it produces a different result if a different weight is put on each factor. Moreover, the analysis of domestic energy is insufficient by the model of this paper. It is because the effect of efficiency improvement of the domestic energy input is included in the Leontief inverse matrix in this paper. It is considered that it is significant for the countries with domestic natural resources such as U.S. to separate the change in the Leontief inverse matrix into the part that caused by the change in the input coefficient in domestic energy and the one caused by other input coefficient, and then analyze the efficiency of improvement of domestic energy input quantitatively. In addition, as for the factor analysis of the change in the sensitivity of domestic price to the imported oil price, the present model is influenced greatly by an initial price. We would like to try the development of the model type that would be unaffected.

References

Fujikawa, K.(1999) *Input-Output analysis: Foundations and applications*, Sobun-sha.

Fujikawa, K., Inada, Y., Shimoda, M. and Watanabe, T.(2006) “Comparative analysis on resource saving technology," *Innovation & I-O technique*, vol.14, No.2.

Hayashi, R. (2005) "Sudden rise of oil and energy security ", *Energy and resource* (Japan Society of Energy and Resources), Vol26, No.6 http://www.rieti.go.jp/jp/papers/contribution/hayashi/02.html

Harashima, T. (1993) "Influence of energy prices gives to prices", *Innovation & I-O technique*, vol.4, No.1.

Hattori, T. and Matsue,Y. (2006) "Influence of the soaring of the oil price given to prices by industry – Comparative analysis of the soaring period after 2002 and the oil crises period – " *Central Research Institute of Electric Power Industry Report (management) Research ReportY05013,* Central Research Institute of Electric Power Industry.

JETRO (2005) "Influence that the rise of the oil price gives to Japanese economy" *Investigation report*. September, 2005 Http://www.jetro.go.jp/jpn/reports/05001019

Klein, L. R., V. G. Duggal and C. Saltzman (2005) "The Sensitivity of the General Price Level to Change in the Price of Crude Oil", *Business Economics*, October 2005, pp.74-77.

Maeda, A. (2005) "the elasticity to international oil price of GDP and domestic price and its transition" *ESRI Discussion Paper Series* No.142, Economic and Social Research Institute, Cabinet Office.

Ministry of Economy, Trade and Industry (2005) Chap.1, Section 4 "Soaring of market condition of commodity with focus on the expansion of world market and oil" , *White Paper of Trade 2005*, Gyousei. http://www.meti.go.jp/report/tsuhaku2005/2005honbun_p/2005_0104.pdf

Ono, M. (2004) "Influence that the rise of oil price gives to Japanese economy", *Quarterly, International Trade and Investment*, No.58, Institute for International Trade and Investment. http://www.iti.or.jp/kikan58/58ono.pdf

Ono, M. (2005a) "Influence that the rise of oil price gives to Japanese economy (part 2) Estimate using dynamic measurement model" *Quarterly, International Trade and Investment* No.60, Institute for International Trade and Investment. http://www.iti.or.jp/kikan60/60ono.pdf

Ono, M. (2005b) "Influence that the rise of oil price gives to Japanese economy (part 3) Estimate using dynamic measurement model", *Quarterly, international trade and investment*, No.62, Institute for International Trade and Investment.

http://www.iti.or.jp/kikan62/62ono.pdf

Appendix 1 The Input-Output table for the U.S.

A-1-1 The assumption of technology

In Japan, Ministry of Internal Affairs and Communications, and the 10 center ministries and agencies cooperated in to make the “commodity-by-commodity” table. And, they make “Make Matrix (the make of commodities by industries)” as a supplementary table, after that, they make “Use Matrix (the use of commodities by industries) that based on them.

On the other hand, in the U.S. Input-Output tables which is published by U.S. Department of Commerce was changed to System of National Accounts (SNA) method. The Input-Output table in SNA has some advantages of merit for calculation; it is solving that the industry classification is whether industry or commodity, especially it makes the handling of a secondary produce clear. In this section, we show an outline transformation.

In the Input-Output table in SNA, there are two kinds of classification of “commodities” and “industries” about the produce. The appended table is a prototype. The U table part shows how much each industry inputted what commodity; the V table part shows how much each industry outputted what commodity.

Appended table Input-Output table in SNA

	commodit	industry	final demand	output
commodity		U	f	x
industry	V			q
value added		y		
output	x	q		

In Input-Output table in SNA, it uses two basic relations. First, A supply-demand balance for each commodity is shown as follows:

$$\mathbf{x} = \mathbf{U}\boldsymbol{\iota} + \mathbf{f} \qquad \text{(A-1)}$$

where, ι is the total vector that the total elements consist of one.

Next, we define an input coefficient matrix for each industry as $A_{ij} = Uij / q_j$,

where, Q is diagonal matrix that disposed the production for each industry qj on the diagonal line.

$$\mathbf{U} = \mathbf{AQ} \quad \text{(A-2)}$$

As the way of defining the inverse matrix of Leontief using these basic relational expressions, two ways are often used. It is “industry-based technology assumption” and “commodity-based technology assumption”. The former assumption is the composition for each industry which supplies each commodity is constant; the latter assumption makes the commodity composition which each industry produces constant.

(a) industry-based technology assumption

We define the supply industry composition matrix for each commodity as $D_{ij} = V_{ij} / x_j$,

where, X is diagonal matrix that disposed the production vectors on the diagonal line.

$$\mathbf{V} = \mathbf{DX} \quad \text{(A-3)}$$

And, we define the production for each industry as the column sum of V table.

$$\mathbf{Q} = \mathbf{V\iota} \quad \text{(A-4)}$$

If substituting these 2 equations for the equation (A-2), we can get the following equation.

$$\mathbf{x} = \mathbf{U\iota} + \mathbf{f} = \mathbf{AQ\iota} + \mathbf{f} = \mathbf{AV\iota} + \mathbf{f} = \mathbf{ADx} + \mathbf{f} \quad \text{(A-5)}$$

Therefore, we obtain the equilibrium output determination equation model which was defined the production for each commodity as follows:

$$\mathbf{x} = (\mathbf{I} - \mathbf{AD})^{-1}\mathbf{f} \,. \quad \text{(A-5')}$$

In the industry-based technology assumption, the equilibrium output determination equation model which was defined production for each industry is defined as follows:

$$\begin{aligned}\mathbf{q} &= \mathbf{DX} = \mathbf{D}(\mathbf{I} - \mathbf{AD})^{-1}\mathbf{f} = \mathbf{D}(\mathbf{I} - \mathbf{AD})^{-1}\mathbf{D}^{-1}\mathbf{Df} = \mathbf{D}[\mathbf{D}(\mathbf{I} - \mathbf{AD})]^{-1}\mathbf{Df} \\ &= \mathbf{D}(\mathbf{D} - \mathbf{DAD})^{-1}\mathbf{Df} = [(\mathbf{D} - \mathbf{DAD})\mathbf{D}^{-1}]^{-1}\mathbf{Df} = (\mathbf{I} - \mathbf{DA})^{-1}\mathbf{Df} \,, \end{aligned} \quad \text{(A-6)}$$

where, **Df** is a final demand of each industry.

(b) commodity-based technology assumption

We define the production commodity composition matrix for each industry as $C_{ij} = V_{ij} / Q_i$.

$$\mathbf{V'} = \mathbf{CQ} \tag{A-7}$$

And, the next equation means the sum of production for each commodity.

$$\mathbf{x} = \mathbf{V'\iota} \tag{A-8}$$

If substituting these 2 equations for the equation (A-1), we can get the following equation.

$$\mathbf{x} = \mathbf{U\iota} + \mathbf{f} = \mathbf{AQ\iota} + \mathbf{f} = \mathbf{AC^{-1}V'\iota} + \mathbf{f} = \mathbf{AC^{-1}x} + \mathbf{f} \tag{A-9}$$

Therefore, we can define final demand for each commodity and production for each commodity as follows:

$$\mathbf{x} = (\mathbf{I} - \mathbf{AC^{-1}})^{-1}\mathbf{f}\,. \tag{A-9'}$$

Moreover, we can get the model of production for each industry as follows:

$$\begin{aligned}\mathbf{q} &= \mathbf{C^{-1}x} = \mathbf{C^{-1}(I - AC^{-1})^{-1}f} = \{(\mathbf{I} - \mathbf{AC^{-1}})\mathbf{C}\}^{-1}\mathbf{f}\\ &= [\mathbf{CC^{-1}(I - AC^{-1})C}]^{-1}\mathbf{f} = [\mathbf{C(I - C^{-1}A)}]^{-1}\mathbf{f} = (\mathbf{I} - \mathbf{C^{-1}A})^{-1}\mathbf{C^{-1}f}\,.\end{aligned} \tag{A-10}$$

In this paper, we transform the U.S Input-Output table in SNA into “commodity-by-commodity” table using industry-based technology assumption, because Japanese I-O table is “commodity-by-commodity” table. As for the technology assumption, whether industry-based technology assumption or commodity-based technology assumption, they doesn’t always reflect a reality. It is the taste of the researcher that which is adoption.

However, thinking only from the aspect of technology of the computation, because of commodity-based technology assumption uses the inverse matrix of C matrix (the production commodity composition matrix), it has a condition that the C matrix must be regular matrix.

In this paper, we adopted industry-based technology assumption because of there are few condition.

A-1-2 How to make real tables and sector aggregation

The Department of Commerce of the United States has published US IO benchmark tables for the year of 1977, 1982, 1992 and an extended table for the year of 1997, on its website (https://www.bea.gov/Industry/Index.htm). Number of sectors is

79 for the years of 1977 and 1987, 90 for the year of 1987, and 91 for the year of 1997.

Because those tables are valued at current prices, we estimated tables valued at constant prices by means of deflating by row sector. We adopted the deflators for the gross output prices with the 2000 base year, published on the same web-site. However, those data were available only for the years of 1987 and later, then we estimated the prices for the year of 1977 and 1982, by taking advantage of change rate of value added prices which were published.

Next, we show that an outline aggregation of industry classification for Input-Output table. As stated above, we must aggregate a sector while we make the sector of price data and the sector of the I-O table correspond because of the I-O table must be to describe constant price. The gross output data was classified sector based on "North American Industry Classification System(NAICS)". On the other hand, the I-O table has industry classification related with "Standard Industrial Classification (SIC)". In the web site of U.S. Department of Commerce, it shows that the NAICS and SIC correspondence tables. Therefore, we aggregated a sector that considered the correspondence of price data and the I-O table through the SIC code.

Though both these tables were aggregated 38 sectors, at first, the following three sectors were prepared different two type tables, i.e. 38 sector tables in 1977 and 82 (the first half of the period) and 44 sector tables in 1987,92 and 97 (the second half of the period).

i) Transportation and warehousing

In the I-O table, there is only "Transportation and warehousing" sector in the first half of the period but in the second half of the period, it divides into 5 sectors in addition to "Air transportation".As for price data, these sectors can prepare them, so we define one sector ("Transportation and warehousing") in the first half of the period and 5 sectors in the second half of the period.

ii) Educational services, health care, and social assistance

Similarly, in the I-O table, there is only "Health, educational, and social services and nonprofit organization" sector in the first half of the period, but in the second half of the period, it divides into 2 sectors of "Educational and social services, and membership organizations" and "Health services".As for price data, these sectors can prepare them, so we define one sector (“Health, educational, and social services and nonprofit organization”) in the first half and 2 sectors in the second half.

iii) Wholesale and retail trade

In the second half of the period, these sectors define 2 sectors because of both the I-O table and price data were prepared “Wholesale trade” and “Retail trade”.On the other hand, in the first half of the period, the price data prepare both “Wholesale trade” and “Retail trade”. But, the I-O table has only “Wholesale and retail trade”, it doesn’t divide into “Wholesale trade” and “Retail trade”.In other words, because there is not “Wholesale and retail trade” in price data it can’t process as i) and ii). Therefore, through the whole period, this sector was calculated price data as follows, and we define one sector (“Wholesale and retail trade”).

In the second half of the period, we calculate weighted average price data for “Wholesale trade” and “Retail trade” using the weight of Gross Output by Industry which is published in the U.S. Department of Commerce Web site. Next, we aggregated into "Wholesale and Retail trade" using these data. In the first half of the period, it calculated in the rate of change based on the value-added price in 1987.

As we have seen, after preparing 38 sector tables and 44 sector tables, in the 44 sector table in 1987, 92 and 97,it makes the current table and constant table in 44 sectors. Finally, it aggregated a sector to become 38 sectors through whole period.

We show that the correspondence of industry classification for the original and aggregated tables as follows.

Industry classification of the U.S. I-O tables

	1977, 1982		1987		1992, 1997	
1 Farms	1	Livestock and livestock	1	Livestock and livestock	1	Livestock and livestock
	2	Other agricultural products	2	Other agricultural products	2	Other agricultural products
2 Forestry, fishing, and related activities	3	Forestry and fishery products	3	Forestry and fishery products	3	Forestry and fishery products
	4	Agricultural, forestry, and fishery services	4	Agricultural, forestry, and fishery services	4	Agricultural, forestry, and fishery services
3 Oil and gas extraction	8	Crude petroleum and natural gas	8	Crude petroleum and natural gas	8	Crude petroleum and natural gas
4 Mining, except oil and gas	5	Iron and ferroalloy ores mining	5+6	Metallic ores mining	05+06	Metallic ores mining
	6	Nonferrous metal ores mining	7	Coal mining	7	Coal mining
	7	Coal mining	9+10	Nonmetallic minerals mining	09+10	Nonmetallic minerals mining
	9	Stone and clay mining and quarrying				
	10	Chemical and fertilizer mineral mining				
5 Utilities	68	Private electric, gas, water, and sanitary services	68A	Electric services (utilities)	68A	Electric services (utilities)
			68B	Gas production and distribution (utilities)	68B	Gas production and distribution (utilities)
			68C	Water and sanitary services	68C	Water and sanitary services
6 Construction	11	New construction	11+12	Construction	11	New construction
	12	Repair and maintenance construction			12	Maintenance and repair construction
7 Wood products	20	Lumber and wood products, except containers	20+21	Lumber and wood products	20+21	Lumber and wood products
	21	Wood containers				
8 Nonmetallic mineral products	35	Glass and glass products	35	Glass and glass products	35	Glass and glass products
	36	Stone and clay products	36	Stone and clay products	36	Stone and clay products
9 Primary metals	37	Primary iron and steel manufacturing	37	Primary iron and steel manufacturing	37	Primary iron and steel manufacturing
	38	Primary nonferrous metals manufacturing	38	Primary nonferrous metals manufacturing	38	Primary nonferrous metals manufacturing
10 Fabricated metal products	13	Ordnance and accessories	13	Ordnance and accessories	13	Ordnance and accessories
	39	Metal containers	39	Metal containers	39	Metal containers
	40	Heating, plumbing, and fabricated structural metal	40	Heating, plumbing, and fabricated structural metal	40	Heating, plumbing, and fabricated structural metal
	41	Screw machine products and stampings	41	Screw machine products and stampings	41	Screw machine products and stampings
	42	Other fabricated metal products	42	Other fabricated metal products	42	Other fabricated metal products
11 Machinery	43	Engines and turbines	43	Engines and turbines	43	Engines and turbines
	44	Farm and garden machinery	44+45	Farm, construction, and mining machinery	44+45	Farm, construction, and mining machinery
	45	Construction and mining machinery	46	Materials handling machinery and equipment	46	Materials handling machinery and equipment
	46	Materials handling machinery and equipment	47	Metalworking machinery and equipment	47	Metalworking machinery and equipment
	47	Metalworking machinery and equipment	48	Special industry machinery and equipment	48	Special industry machinery and equipment
	48	Special industry machinery and equipment	49	General industrial machinery and equipment	49	General industrial machinery and equipment
	49	General industrial machinery equipment	50	Miscellaneous machinery, except electrical	50	Miscellaneous machinery, except electrical
	50	Miscellaneous machinery, except electrical	51	Service industry machinery	52	Service industry machinery
	52	Service industry machines				
12 Computer and electronic products	51	Office, computing, and accounting machines	52	Computer and office equipment	51	Computer and office equipment
	56	Radio, TV, and communication equipment	56	Audio, video, and communication equipment	56	Audio, video, and communication equipment
	57	Electronic components and accessories	57	Electronic components and accessories	57	Electronic components and accessories
13 Electrical equipment, appliances, and components	53	Electric industrial equipment and apparatus	53	Electrical industrial equipment and apparatus	53	Electrical industrial equipment and apparatus
	54	Household appliances	54	Household appliances	54	Household appliances
	55	Electric lighting and wiring equipment	55	Electric lighting and wiring equipment	55	Electric lighting and wiring equipment
	58	Miscellaneous electrical machinery and supplies	58	Miscellaneous electrical machinery and supplies	58	Miscellaneous electrical machinery and supplies
14 Motor vehicles, bodies and trailers, and parts	59	Motor vehicles and equipment	59A	Motor vehicles (passenger cars and trucks)	59A	Motor vehicles (passenger cars and trucks)
			59B	Truck and bus bodies, trailers, and motor vehicles parts	59B	Truck and bus bodies, trailers, and motor vehicles parts
15 Other transportation equipment	60	Aircraft and parts	60	Aircraft and parts	60	Aircraft and parts
	61	Other transportation equipment	61	Other transportation equipment	61	Other transportation equipment

	1977, 1982		1987		1992, 1997	
16 Furniture and related products	22	Household furniture	22+23	Furniture and fixtures	22+23	Furniture and fixtures
	23	Other furniture and fixtures				
17 Miscellaneous manufacturing	33	Leather tanning and finishing	33+34	Footwear, leather, and leather products	33+34	Footwear, leather, and leather products
	34	Footwear and other leather products	62	Scientific and controlling instruments	62	Scientific and controlling instruments
	62	Scientific and controlling instruments	63	Ophthalmic and photographic equipment	63	Ophthalmic and photographic equipment
	63	Optical, ophthalmic, and photographic equipment	64	Miscellaneous manufacturing	64	Miscellaneous manufacturing
	64	Miscellaneous manufacturing				
18 Food and beverage and tobacco products	14	Food and kindred products	14	Food and kindred products	14	Food and kindred products
	15	Tobacco manufactures	15	Tobacco products	15	Tobacco products
19 Textile mills and textile product mills	16	Broad and narrow fabrics, yarn and thread mills	16	Broad and narrow fabrics, yarn and thread mills	16	Broad and narrow fabrics, yarn and thread mills
	17	Miscellaneous textile goods and floor coverings	17	Miscellaneous textile goods and floor coverings	17	Miscellaneous textile goods and floor coverings
	18	Apparel	18	Apparel	18	Apparel
20 Apparel and leather and allied products	19	Miscellaneous fabricated textile products	19	Miscellaneous fabricated textile products	19	Miscellaneous fabricated textile products
21 Paper products	24	Paper and allied products, except containers	24	Paper and allied products, except containers	24	Paper and allied products, except containers
	25	Paperboard containers and	25	Paperboard containers and	25	Paperboard containers and
22 Petroleum and coal products	31	Petroleum refining and related industries	31	Petroleum refining and related products	31	Petroleum refining and related products
23 Chemical products	27	Chemicals and selected chemical products	27A	Industrial and other chemicals	27A	Industrial and other chemicals
	29	Drugs, cleaning and toilet preparations	27B	Agricultural fertilizers and chemicals	27B	Agricultural fertilizers and chemicals
	30	Paints and allied products	29A	Drugs	29A	Drugs
			29B	Cleaning and toilet preparations	29B	Cleaning and toilet preparations
			30	Paints and allied products	30	Paints and allied products
24 Plastics and rubber products	28	Plastics and synthetic materials	28	Plastics and synthetic materials	28	Plastics and synthetic materials
	32	Rubber and miscellaneous plastics products	32	Rubber and miscellaneous plastics products	32	Rubber and miscellaneous plastics products
25 Wholesale and retail trade	69	Wholesale and retail trade	69A	Wholesale trade	69A	Wholesale trade
			69B	Retail trade	69B	Retail trade
26 Transportation and warehousing	65	Transportation and warehousing	65D	Air transportation	65D	Air transportation
			65A	Railroads and related services; passenger ground transportation	65A	Railroads and related services; passenger ground transportation
			65C	Water transportation	65C	Water transportation
			65B	Motor freight transportation and warehousing	65B	Motor freight transportation and warehousing
			65E	Pipelines, freight forwarders, and related services	65E	Pipelines, freight forwarders, and related services
27 Publishing industries (includes software)	26	Printing and publishing	26A	Newspapers and periodicals	26A	Newspapers and periodicals
			26B	Other printing and publishing	26B	Other printing and publishing
28 Broadcasting and telecommunications	66	Communications, except radio and TV	66	Communications, except radio and TV	66	Communications, except radio and TV
	67	Radio and television	67	Radio and TV broadcasting	67	Radio and TV broadcasting
29 Finance and insurance	70	Finance and insurance	70A	Finance	70A	Finance
			70B	Insurance	70B	Insurance
30 Real estate and rental and leasing	71	Real estate and rental	71A	Owner-occupied dwellings	71A	Owner-occupied dwellings
			71B	Real estate and royalties	71B	Real estate and royalties
31 Professional and business services	73	Business services	73A	Computer and data processing services	73A	Computer and data processing services
			73B	Legal, engineering, accounting, and related services	73B	Legal, engineering, accounting, and related services
			73C	Other business and professional services, except medical	73C	Other business and professional services, except medical
			73D	Advertising	73D	Advertising
32 Educational services, health care, and social assistance	77	Health, educational, and social services and nonprofit	77A	Educational and social services, and membership organizations	77A	Educational and social services, and membership organizations
			77B	Health services	77B	Health services
33 Arts, entertainment, and	76	Amusements	76	Amusements	76	Amusements
34 Accommodation	72	Hotels; personal and repair services (except auto)	72A	Hotels and lodging places	72A	Hotels and lodging places
35 Food services and drinking	74	Eating and drinking places	74	Eating and drinking places	74	Eating and drinking places
36 Other services, except government	75	Automobile repair and services	72B	Personal and repair services (except auto)	72B	Personal and repair services (except auto)
			75	Automotive repair and services	75	Automotive repair and services
37 Federal	78	Federal Government enterprises	78	Federal Government enterprises	78	Federal Government enterprises
38 State and local	79	State and local government enterprises	79	State and local government enterprises	79	State and local government enterprises

Appendix 2　The Input-Output table for Japan

We used 45 sector linked IO table developed by professor Kiji.　The IO tables are disclosed on the professor Kiji's web site (http://www.sanken.keio.ac.jp/user/kiji/). Both nominal and real values (constant price at 1990) are available for the year of 1960, 1965, 1970 and all years from 1973 to 1999.

The sector classification is as follows. (1) agriculture, (2) forestry, (3) fishery (4) coal mining, crude petroleum and natural gas, (5) other mining, (6) foods, (7) beverage and tobacco, (8) textile products, (9) timber, wooden products , furniture and fixtures, (10) pulp, paper, paper products (11) newspapers and publishing, printing, (12) chemical fertilizer and agricultural chemicals, (13) intermediate chemical products, (14) final chemical products, (15) Petroleum and coal products, (16) rubber and plastic products, (17) leather and miscellaneous leather products, (18) ceramic, stone and clay products (19) iron and steel, (20) Non-ferrous metals, (21) metal products, (22) special industrial machinery, (23) other general machines, (24) household electronic and electric appliances, (25) other electrical equipment, (26) passenger motor cars, (27) other transportation equipment, (28) precision instruments, (29) miscellaneous manufacturing products, (30) construction, (31) civil engineering and construction, (32) electricity, (33) gas, heat supply and water supply, (34) sewage disposal and waste management, (35) commerce, (36) financial service, insurance, and real estate, (37) transport, (38) communication, (39) enterprise services, (40) public administration, (41) education and research, (42) medical service and health, (43) other services, (44) activities not elsewhere classified, (45) consumption expenditure outside households

---

1 Japan has recorded the first negative growth after the war in 1974.

2 For instance, refer to Ministry of Economy, Trade and Industry (2005), JETRO(2005), Hayashi(2005).

3 Japan's economic model is developed by Institute for International Trade and Investment and Chuo University. It is revised for Japanese economic model based on the dynamic input-output model of INFORUM institute of Maryland University, U.S.

4 Though it is not input-output analysis, Maeda(2005) estimates the sensitive elasticity of domestic price to imported oil by utilizing the elasticity of input goods price of supply price to be nominal share of the concerned input goods, when the cost function that is dual to linear homogeneous production function is considered. In the study, when the price of oil is assumed as 25 dollars per barrel, it is estimated that it needs the rise of oil price by about 100dollars to bring the domestic price change worth of that in the time of oil crises. In a word, it can be said the sensitive elasticity of domestic price to the imported oil price is extremely low at present.

5 The classification of the input-output table we used in this study is "oil and natural-gas". Precisely we have to call it "the intensiveness of imported oil and natural-gas", however it is a little too long so we decided to call it "the intensiveness of imported oil" instead. As for the sensitivity of domestic price to the price of imported oil and natural-gas, we also shortened and call it "sensitivity of domestic price to the imported oil price".

6 We understand that there are six resolving expressions in terms of form depending on how it is weighted. Though we use this expression, we would like to consider again for further research. The same can be said for the factor analysis of the change in the sensitivity of domestic price to crude oil.

7 The influence of the rise of the price of imported natural resources is calculated by 100% rise by the initial price of the import price of mining sector. Therefore the width of rise of the price of import resources differ among the standard of the initial price and the difference of the width of rise influences the difference of the change of domestic price.

8 One of the methods to capture in quantity the change in industrial structure is DPG (divergence from proportional growth) analysis. Fujikawa(1999) covers Japan during high growth period. When it is assumed that the size of the industrial change to 1960-70 to be ±100 (100 for the total of industries whose share expanded; -100 for that of industries whose share decreased), -47.4 for agriculture, forestry and fisheries, -1.0 for mining, 10.6 for light industry, 14.3 for chemical industry, 12.1 for heavy industry, 13.7 for construction and public services, and -2.3 for service industry. As the factor to pull, the effect of increase of the intermediate demand was big, and was 6.1in the chemical industry and 4.9 in heavy industry mining.

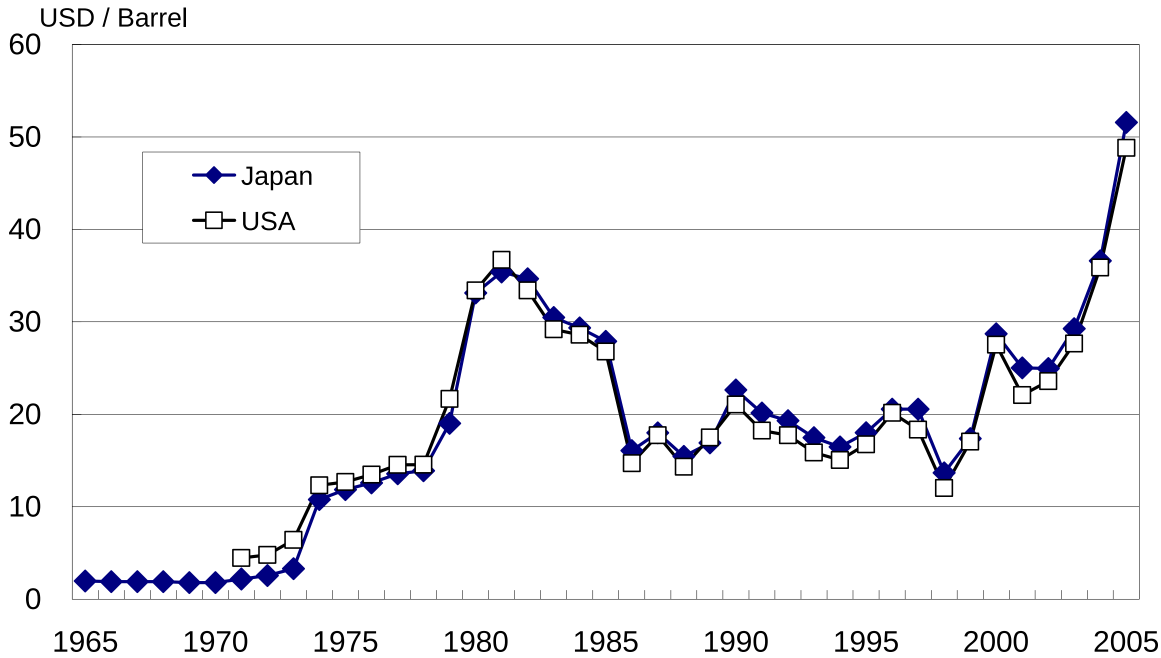
9 The White Paper on the Environment 2004 cited in its introduction as example of cars becoming larger in size. Travel distance per litter of gas of passenger car was 9.46 Km/l in

1989, and become worse to 8.38Km/l in 2002.

10 In GDP analysis it is possible to quantify the factor to bring change to industrial structure. According to Fujikawa(1999), as for Japan in 1970-80 when the total of change in the industrial structure is assumed as 100, the increase in total amount of intermediate input is 11.8 and the increase of the imported intermediate goods is -13.3(decrease), and the intermediate consumption of domestic goods is rather decreased compared with the comparative growth. On the other hand in the U.S. the increase of the total amount of intermediate input is 22.9 and the increase of imported intermediate goods is -20.5(decrease), the intermediate consumption of domestic goods is rather increased compared with the comparative growth.

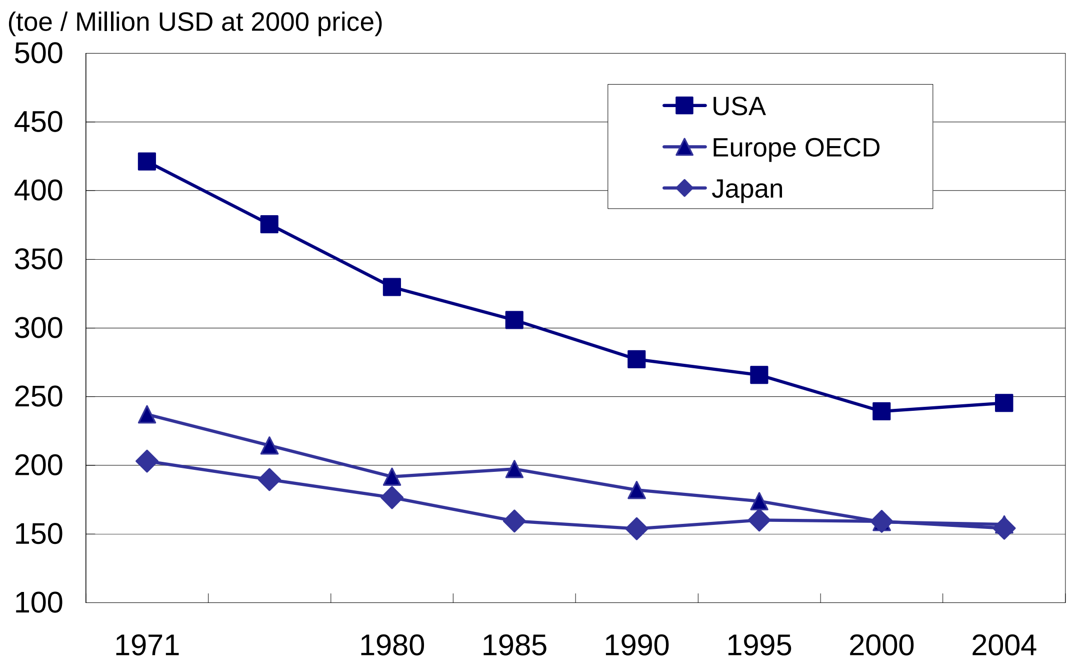
11The authors had done similar estimation using OECD input-output table (Fujikawa et al. (2006). However, in the OECD input-output table oil is not classified as independent industry but is included in mining. The sensitivity estimated using OECD table was 0.4% in 1972 and 1.9% in 1977.

Figure1 CIF Price of Crude Oil



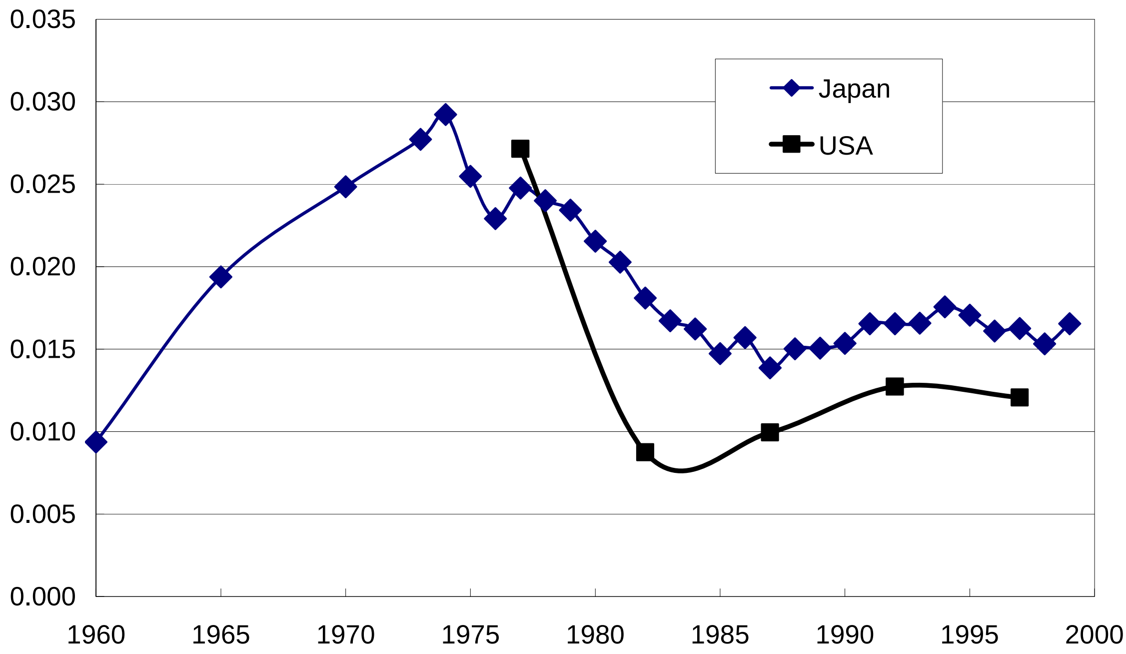
Source : The Institute of Energy Economics, Japan(2007) *2007 EDMC HANDBOOK of ENERGY & ECONOMIC STATISTICS in JAPAN*, The Energy Conservation Center, Japan.

Figure 2 Final Energy Consumption per PPP GDP



Source : The Institute of Energy Economics, Japan(2007) *2007 EDMC HANDBOOK of ENERGY & ECONOMIC STATISTICS in JAPAN*, The Energy Conservation Center, Japan.

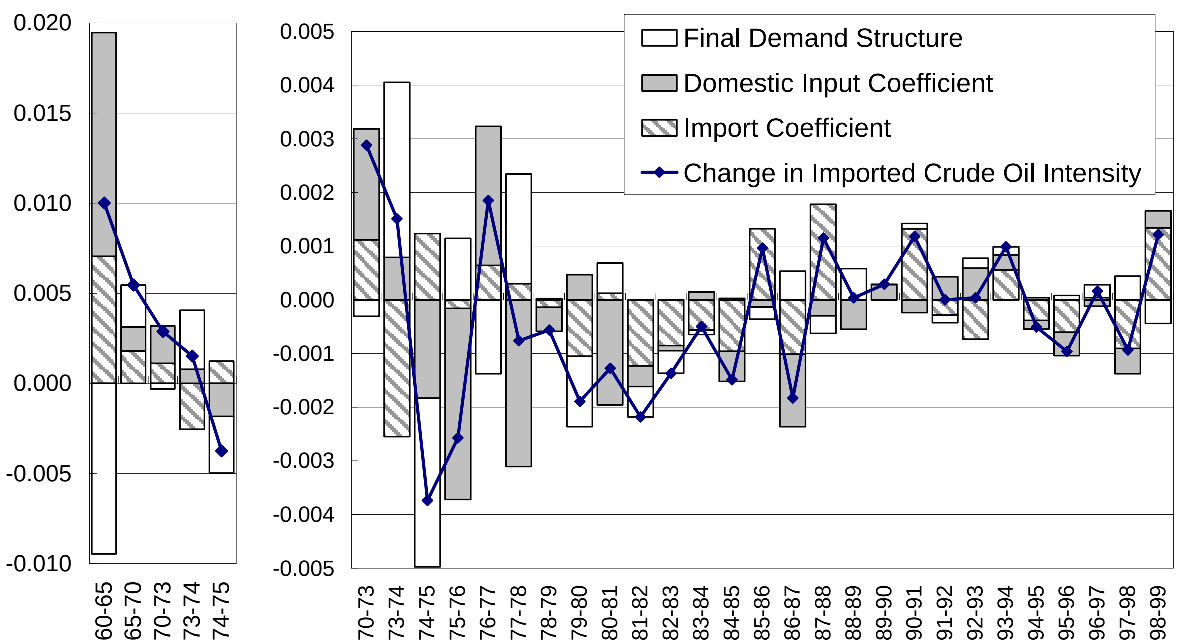
Figure 3 Imported Crude Oil Intensity for Japan and the USA



Source: Calculated form the Input-Output table of Japan and the U.S. et al.

Note: The imported oil included imported natural-gas.

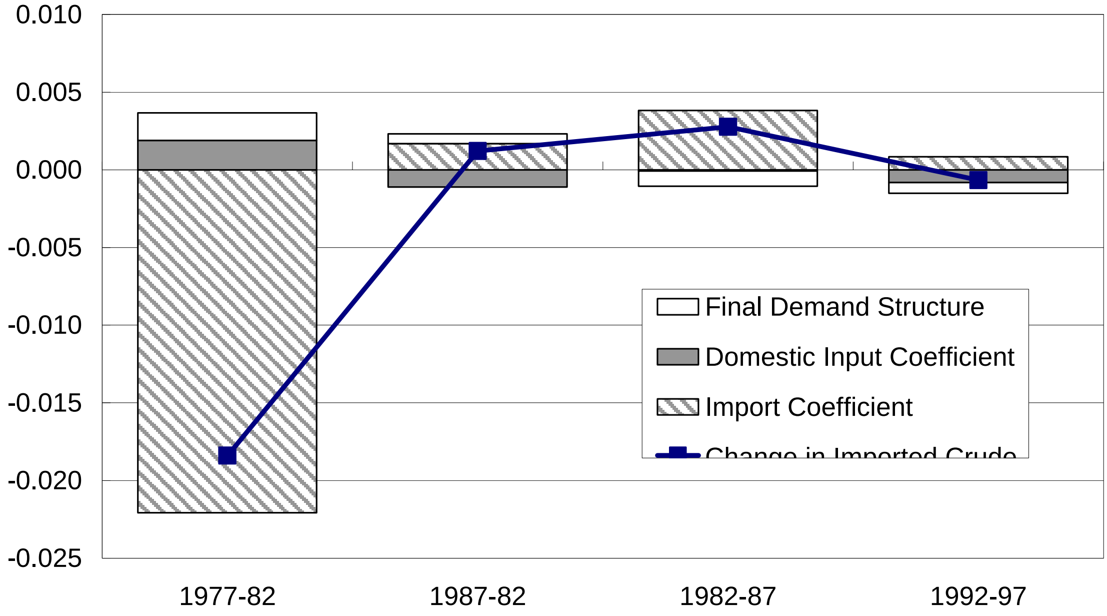
Figure 4 Decomposition of Change in Imported Crude Oil Intensity for Japan



Source: Calculated form the Input-Output table of Japan et al.

Note: The imported oil included imported natural-gas.

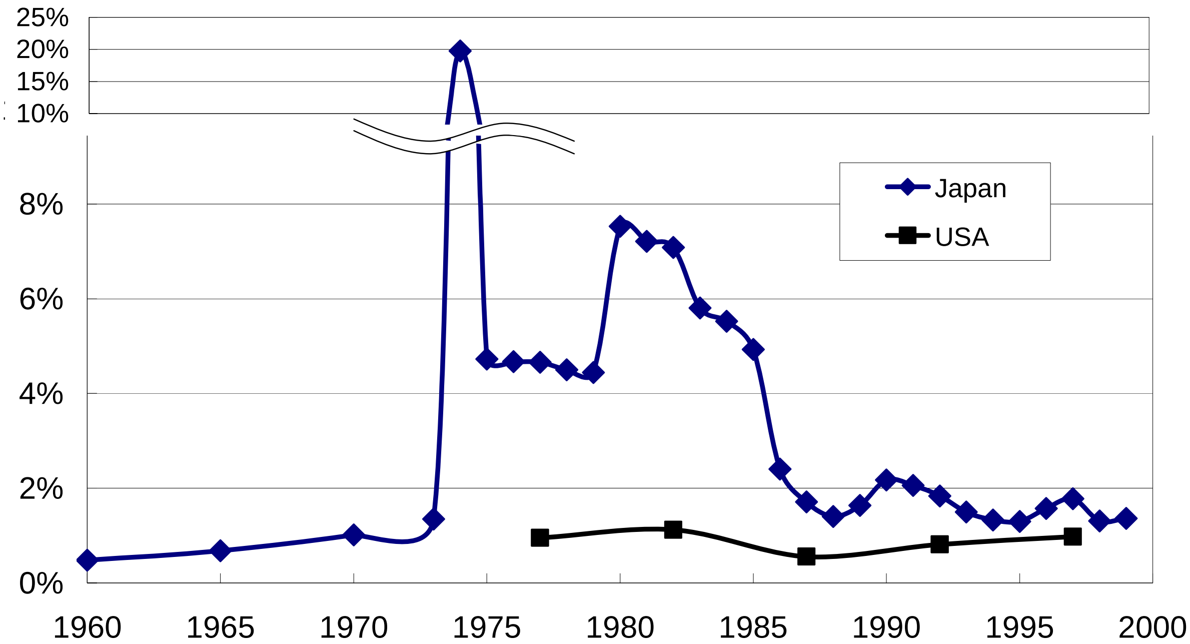
Figure 5 Decomposition of Change in Imported Crude Oil Intensity for the USA



Source: Calculated form the Input-Output table of U.S et al.

Note: The imported oil included imported natural-gas.

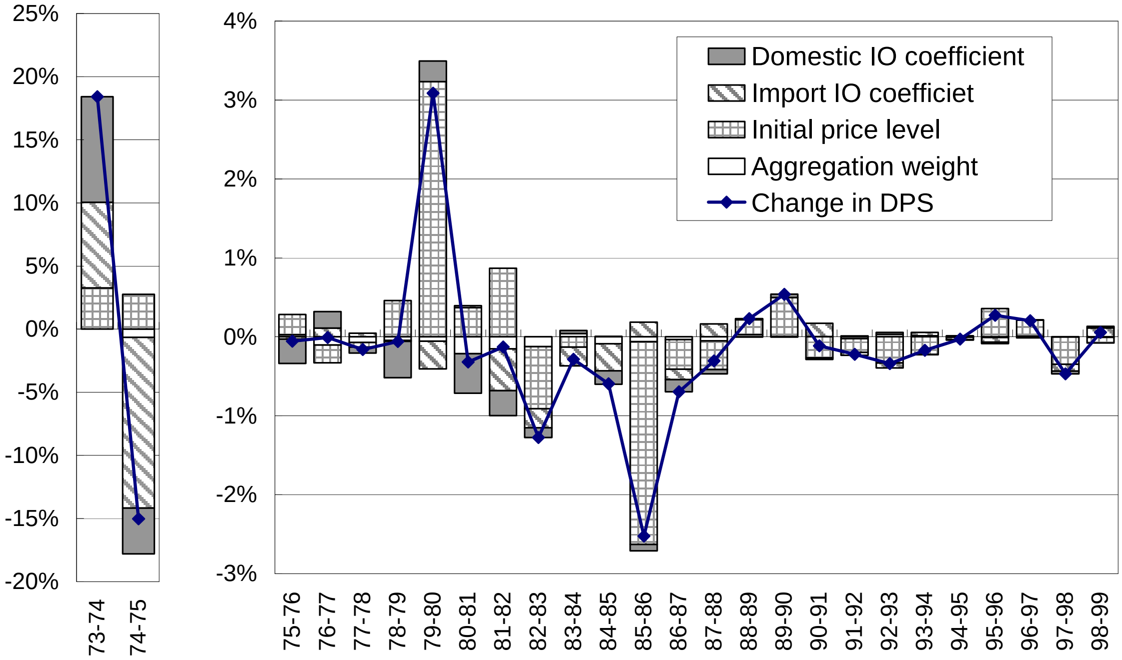
Figure 6 Domestic Price Sensitiviry against 100% Rise in Imported Crude Oil Price



Source: Calculated form the Input-Output table of Japan et al.

Note: The imported oil included imported natural-gas.

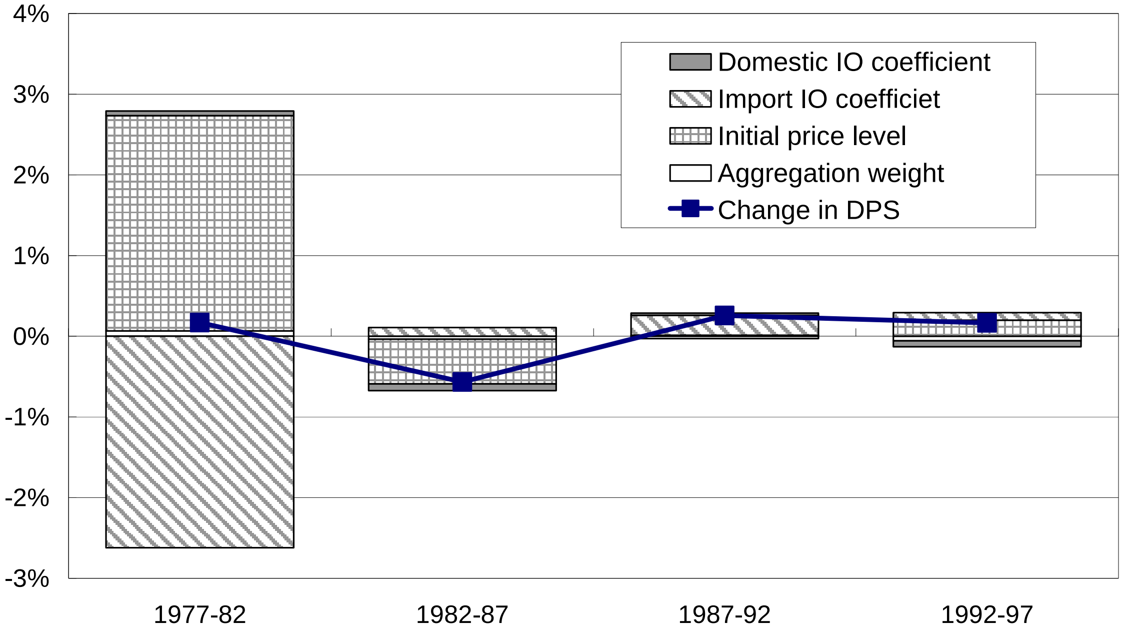
Figure 7 Decomposition of Change in DPS for Japan



Source: Calculated form the Input-Output table of Japan et al.

Note: The imported oil included imported natural-gas.

Figure 8 Decomposition of Change in DPS for USA



Source: Calculated form the Input-Output table of U.S et al.

Note: The imported oil included imported natural-gas.