Re-examination of the Effect of the Technological Change Induced by the Development Policy : An Application of the Input-Output Model*

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Introduction

We use the Input-Output table in various fields of development. However we can not be satisfied with the statistical problems in these fields. Considering this problem, we should widen and deepen the method of Input-Output analysis because these tables are given comparatively higher priority of completion due to policy decisions(1).

Next, we have to consider two effects of the development policy. One effect is that the policy has the income increasing effect through the increment of total output. Another one is the productivity growth effect, which has been paid less attention to. However, this effect must be greatly taken into account, because it helps make the economy more efficient. Thus, policy makers expect to increase the efficiency of the economy a great deal by using the development policy, like the construc-

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(1) For a number of the basic literatures on Input-Output analysis, see, Miller & Blair (1985), and Kaneko (1977, 1990). The application of the I-O methods to the development policy is shown in Bulmer-Thomas (1982).

tion of the infrastructures(2).

The method of estimation used on the income increasing effect is a well-known form of income multiplier analysis. Unfortunately, we don't have any analytical methods on the later one. This paper examines how to estimate the productivity effect using the Input-Output table.

Our idea is as follows. By decreasing intermediate input, the surplus will be increased while maintaining the same level of output. The reason for this is due to the improvement of productivity efficiency. Thus we'd like to confirm the estimation method of this effect.

In the next section, we will formulate the theoretical model of this problem. As a matter of fact, there is such a big gap between the theoretical model and the empirical one that we have to modify the theoretical one in order to apply it to the available date in section II. We can then formulate the empirical model in section III. By using the 1985 Input-Output table, we can actually estimate the economical impact of Taiwan's 6 year development plan now in progress.

I. Theoretical framework

① Model

We consider the change of the sectoral productivity as the change of physical input-output coefficients in the Input-Output table. In this section, we examine the impact of these changes on the relative prices and the rate of the profit(3). Our assumptions are as follows :

(2) The theoretical analysis is shown in Dietzenbacher (1988). Galatin (1988) studies the technological effect in the I-0 framework. However, this study is from the different point of our view.

(3) The analysis in this section is originally from Okishio (1977) Ch. 3. Here, we introduce the trade of his framework.

(1) After we input intermediate, labour consumption and export, our economy can enjoy a high productivity. In other words, there will be a surplus in the remainders of all sectors. This means our economy satisfies the surplus condition.

(2) The number of goods in total is S. Within S, the number of the domestic goods is N and of imported goods is (S-N).

(3) Each price is composed of intermediate input cost, a wage cost, and profit.

(4) The rate of the profit to the total cost is equalized among all sectors.

(5) The real wage rate is also equalized among all sectors. It doesn't change if technological change occurs.

(6) The terms of trade between the imported goods and the exported goods does not change as well.

We can build the theoretical models from these assumptions as follows(4) :

$$(1) \qquad P_j=(1+r)\{\sum_{i=1}^{n} a_{ij}P_i+\sum_{i=n+1}^{s} m_{ij}P_i^*+\tau_j w\} \quad (j=1, 2, \cdots, n)$$

$$(2) \qquad w=\sum_{i=1}^{n} b_iP_i+\sum_{i=n+1}^{s} \mu_iP_i^*$$

where P_j is the price of j-th commodity, r denotes the equalized rate of the profit, a_{ij} is the amount of i-th input used in producing one unit of output of j-th goods, P_i^* is the price of imported i-th goods in terms of domestic price, and m_{ij} denotes the amount of imported i-th input used in producing one unit of output of j-th goods. τ_j is the amount of labour force employed in j-th sector to produce one unit of j-th goods, w is the real wage rate, and μ_i denotes the amount of imported i-th goods consumed per unit labour. Parameters of b_i, μ_j $(i=1, 2, \cdots, n, j=n+1, \cdots,$

(4) This implicitly assumes the prepaid wage.

s) are constant from the assumption of the constant real wage.

Substituting equation (2) into equation (1) and dividing by P_1 regarding the commodity 1 as numeraire. Thus we can easily get the following equations.

$$1=(1+r)\{a_{11}+\sum_{i=2}^{n}a_{i1}q_i+\sum_{i=n+1}^{s}m_{i1}q_i^*+\tau_1(b_1+\sum_{i=2}^{n}b_iq_i+\sum_{i=n+1}^{s}\mu_iq_i^*)\}$$

$$\cdots\cdots\cdots$$

(3) $$q_j=(1+r)\{a_{1j}+\sum_{i=2}^{n}a_{ij}q_i+\sum_{i=n+1}^{s}m_{ij}q_i^*+\tau_j(b_1+\sum_{i=2}^{n}b_iq_i+\sum_{i=n+1}^{s}\mu_iq_i^*)\}$$

$$\cdots\cdots\cdots \qquad (j=2,\cdots,n-1)$$

$$q_n=(1+r)\{a_{1n}+\sum_{i=2}^{n}a_{in}q_i+\sum_{i=n+1}^{s}m_{in}q_i^*+\tau_n(b_1+\sum_{i=2}^{n}b_iq_i+\sum_{i=n+1}^{s}\mu_iq_i^*)\}$$

where $q_i\equiv P_i/P_1\ (i=2,\cdots,n)$, $q_j^*\equiv P_j^*/P_1\ (j=n+1,\cdots,s)$.

Here, we represent the change of Input-Output coefficients as the technological change introduced by the new infrastructure in this economy. That change makes the solutions of the equations (3) change from the antecendent vector $(q_2, q_3, \cdots, q_n, r)$ to the subsequent vector $(q_2', q_3', \cdots, q_n', r')$.

So our task is just concentrated to the qualitative analysis of the change of these vectors(5).

② The treatment of trade(6)

We have not yet mentioned how to decide the relative prices of the imported goods. This is a very important issue from the point of view in terms of trade in this economy. Suppose the terms of trade changes in favour of this economy, the rate of profit would rise even under the

(5) In our arrangement the increase of the income is only due to the increment of the profit. We would like to extend our analysis to changing the total income induced by the wage increment as well as the profit. When we take up this assumption, however, we need one more theoretical framework on how to determine the relative share to the factors.

(6) The formulation here follows Okishio (1977) p. 90–p. 96.

condition that the real wage and the technology was kept unchanged. So, we have to take care of the treatment of this problem.

We treat this problem as follows : First, we must choose a certain value of export, for example 1 million US dollars. Next, we divide this value of export by the actual export value to get a proportionate value. Then, we divide the actual exported vector by the proportionate value to determine the assumed physically exported goods vector. Consequently, this certain value of export is made up of the assumed physically exported goods vector $X^e\ (x_1^e, \cdots, x_n^e)$.

By doing this, we can calculate the assumed physically imported goods vector $X^m\ (x_{n+1}^m, \cdots, x_s^m)$ as well. We consider these unit exported goods from the 1st to the n-th in order to contribute exchanging imported goods from the $n+1$st to s-th in the world market equally. Assuming this physical exchange rate remains unchanged, we can definitely say that the assumption of the constant terms of trade is satisfied.

We define the domestic-produced goods vector to import one unit of the j commodity as follows :

(4) $$(e_{1j}, e_{2j}, \cdots, e_{nj}) \qquad (j=n+1,\cdots,s)$$

and these vectors are assumed to be constant. By using this definition, we can replace the relative prices of the imported goods $(q_{n+1}^*, \cdots, q_s^*)$ by the relative prices of domestic goods as follows :

(5) $$q_j^*=\{e_{1j}+\sum_{i=2}^{n}e_{ij}q_i\}$$

where e_{ij} denotes the amount of the goods being exported to import one unit of imported goods as the definition above. From equations (3) and (5), we can get the equilibrium vector of relative prices and equalized rate of profit as $(r, q_2, \cdots, q_n)$.

II. The productivity change and the rate of profit

We can group the equations together as shown below.

$$(6)\quad \begin{aligned} 1&=(1+r)(C_{11}+\sum_{i=2}^{n}C_{i1}q_i) \\ q_j&=(1+r)(C_{1j}+\sum_{i=2}^{n}C_{ij}q_i) \qquad (j=2,\cdots,n) \end{aligned}$$

where $C_{ij}\equiv a_{ij}+\sum_{k=n+1}^{s}m_{kj}e_{ik}+\tau_j(b_i+\sum_{t=n+1}^{s}\mu_t e_{it})$. The C_{ij} denotes the amount of i-th commodity used in producing the unit of j-th goods directly and indirectly as intermediate input, reproduction of the labour force, and international trade.

We can easily describe equation (6) as a form of matrix,

$$(7)\quad \beta\cdot\begin{bmatrix}1\\ q^2\\ \vdots\\ q_n\end{bmatrix}=\begin{bmatrix}C_{11} & \cdots & C_{n1}\\ C_{12} & \cdots & C_{n2}\\ \vdots & & \vdots\\ C_{1n} & \cdots & C_{nn}\end{bmatrix}\begin{bmatrix}1\\ q_2\\ \vdots\\ q_n\end{bmatrix}$$

where $\beta\equiv 1/(1+r)$.

Suppose the technological change occurs in the k-th sector, it would change the input coefficients of the domestic intermediate goods or the imported goods in that sector. In the case of technological progress, this movement deduces parameter C_{ij}.

As is well-known in the Frobenius theorem, we can easily prove that even if there are no technological changes in the other sectors and technologically improved changes occurs in the k-th sector, the rate of profit over all sectors will increase(7).

(7) β in the equation (7) is the Frobenius root of the matrix $[C_{ij}]$. Let the Frobenius root of $[C_{ij}]$ be $\beta\ (C_{ij})$. It is proved to be a simple increasing function of the elements. See, Takayama (1985) p. 372. From this theorem, $\beta(C^1_{ij})\geqq\beta(C^2_{ij})$ if $C^1_{ij}\geqq C^2_{ij}$. Therefore, the decrease of the coefficient C_{ij} makes the rate of profit rise.

Furthermore, we can extend this analysis to more general cases. We think of the technical change occurring in the k-th sector as follows :

$$(8)\quad \begin{aligned} &a_{1k}+\sum_{i=2}^{n}a_{ik}q_i+\sum_{i=n+1}^{s}m_{ik}q_i^*+\tau_k w/P_1 \\ &\quad > a'_{1k}+\sum_{i=2}^{n}a'_{ik}q_i+\sum_{i=n+1}^{s}m'_{ik}q_i^*+\tau'_k w/P_1 \end{aligned}$$

where the coefficient with a prime denotes the one embodied with new technology. This is the total cost reducing technical change that occurs in the k-th sector under the condition that relative prices are kept constant.

The new relative prices and the rate of profit are determined to satisfy the system as follows :

$$(9)\quad \begin{aligned} 1&=(1+r')(C_{11}+\sum_{i=2}C_{i1}q'_i) \\ q'_j&=(1+r')(C_{1j}+\sum_{i=2}^{n}C_{ij}q'_i) \qquad (j=2,3,\cdots,k-1,k+1,\cdots,n) \\ q'_k&=(1+r')(C'_{1k}+\sum_{i=2}C'_{ik}q'_i) \end{aligned}$$

where $C'_{ik}\equiv a'_{ik}+\sum_{t=n+1}^{s}m'_{tk}e_{it}+\tau'_k(b_i+\sum_{u=n+1}^{s}\mu_u e_{iu})$ and $(q'_2, q'_3, \cdots, q'_n, r')$ denotes the subsequent vector after the new technology introduced in the k-th sector.

Comparing equation (6) and (9), we can examine the change of the relative prices and the rate of profit from the antecendent vector $(q_2, q_3, \cdots, q_n, r)$ to the subsequent vector $(q'_2, q'_3, \cdots, q'_n, r')$.

Consequently, we can get the formulas from equation (6), (8) and (9) as follows :

$$(10)\quad \sum_{i=2}^{n}C_{i1}\Delta q_i=\Delta\beta \qquad \text{(1st sector)}$$

$$(11)\quad \sum_{i=2}^{n}C'_{ik}\Delta q_i-\beta\Delta q'_k-q'_k\Delta\beta>0 \qquad (k\text{-th sector})$$

$$
(12)\quad \begin{bmatrix} \beta'-C_{22} & -C_{32} & \cdots & -C_{n2} \\ -C_{23} & \beta'-C_{33} & \cdots & -C_{n3} \\ \vdots & \vdots & & \vdots \\ -C_{2n} & -C_{3n} & \cdots & \beta'-C_{nn} \end{bmatrix} \begin{bmatrix} \Delta q_2 \\ \Delta q_3 \\ \vdots \\ \Delta q_n \end{bmatrix} = -\Delta\beta \begin{bmatrix} q_2 \\ q_3 \\ \vdots \\ q_n \end{bmatrix}
$$

(except 1st and k-th)

where $\Delta\beta \equiv \beta' - \beta$, $\Delta q_j \equiv q_j' - q_j$.

When the k-th sector of innovation belongs to the fundamental sectors[8],
we can easily prove the solutions as $\Delta\beta<0$, $\Delta q_k<0$, $\Delta q_i>0\ (i \neq k)$. This means that the rate of profit must increase after the productivity is improved in order to satisfy all of formulas (10), (11) and (12)[9].

III. Some application problems of the actual Input-Output table

As we noted before, we can not directly apply the previous theoretical framework to the actual Input-Output table available. Before the empitical study, we must start by briefly mentioning these problems.

First of all, the physical input coefficients we used in previous sections are actually unavailable, except for some socialistic economies. The

(8) The basic sector is the one which produces the consumption goods for labour, or it is the sector which is directly or indirectly connected with that sector. In detail, see Okishio (1978) p. 52. The equalized rate of profit is independent of the non-basic sectors. See Okishio (1978) p. 88.

(9) Suppose the case of $\Delta\beta \geqq 0\ (\beta' \geqq \beta)$. The left side of the equation (17) is satisfied with the Howkins-Simon condition so that $\Delta q_i<0\ (i=2, 3, \cdots, k-1, k+1, \cdots, n)$, and $\Delta q_k<0$ in equation (11). However, these equations do not satisfy equation (10).
Next, we consider the case $\Delta\beta<0$. In this case, $\Delta q_i>0$. From equation (11), we can not fix the sing of Δq_k. Taking account of equation (10) as well, $\Delta q_k \geqq 0$ can not satisfy this. Therefore, we get $\Delta\beta<0$, $\Delta q_i>0$, $\Delta q_k<0$.

same goes for the physical terms of trade e_{ij} and the labour input coefficient τ_i. This is because the Input-Output table is made through the flow of money transactions instead of physical goods. We can only make use of the valued Input-Output table.

The physical Input-Output coefficient multiplied by the relative prices is the value-presented Input-Output coefficient that is available to us. So, we can not easily get the physical one by dividing the relative prices, because of date inconsistency. We have to treat this problem seriously.

Secondly, the treatment of trade can be also a problem in our theoretical framework. We adopted the assumption to keep the terms of trade constant. Yet, there is no date of physical exchange vectors as we define in equation (4).

Thirdly, the equalization of the real wage and the rate of profit is not achieved, because the real economy is not satisfied with the perfect competition condition. However, as we will examine later, this is not critical to develop our empirical analysis.

We must pay attention to these conflicts between our theoretical analysis and the real empirical analysis that we will develop later. We must find some useful devices to bridge these differences. We can find this in the next section.

IV. The application to the empirical analysis

In this section, we explain the process of how to modify the theoretical model for empirical analysis using the available dates.

Now suppose, in general, that the technological change happens in the j-th sector that makes the i-th input quantity reduced. This technological change can make the coefficient C_{ij} reduced in our model. We examine how this change affects the profit and the relative prices of the economy.

Here, we have to make another assumption that the gaps of the sectoral rate of profit will keep constant in all sectors even after the technological change occurs. Keeping in mind this assumption we can differentiate the equations (9) by the coefficiant C_{ij}, to get

$$(13)\quad \begin{aligned} 0 &= dr_1/(1+r_1)^2 + C_{21}dq_2 + \cdots\cdots + C_{n1}dq_n \\ dq_j/(1+r_j) &= q_j dr_j/(1+r_j)^2 + C_{2j}dq_2 + \cdots\cdots + C_{ij}dq_i + q_i dC_{ij} \\ &\quad + \cdots\cdots + C_{nj}dq_n \\ dq_n/(1+r_n) &= d_n dr_n/(1+r_n)^2 + C_{2n}dq_2 + \cdots\cdots + C_{nn}dq_n. \end{aligned}$$

Now the equations (13) can easily be rewritten as follows.

$$(14)\quad \begin{aligned} 0 &= dr_1/(1+r_1)^2 + C_{21}\frac{q_2}{q_2}dq_2 + \cdots\cdots + C_{n1}\frac{d_n}{q_n}dq_n \\ &\cdots\cdots\cdots \\ dq_j/q_j(1+r_j) &= q_j dr_j/(1+r_j)^2 q_j + C_{2j}\frac{q_2}{q_j q_2}dq_2 + \cdots\cdots + C_{nj}\frac{q_n}{q_j q_n}dq_n \\ &\cdots\cdots\cdots \\ dq_n/q_n(1+r_n) &= q_n dr_n/(1+r_n)^2 q_n + C_{2n}\frac{q_2}{q_n q_2}dq_2 \\ &\quad + \cdots\cdots + C_{nn}\frac{1}{q_n}dq_n \end{aligned}$$

We then pick up the coefficient of the i-th term in the j-th sector. This is presented as follows :

$$(15)\quad \begin{aligned} \frac{q_i}{q_j}C_{ij} &= \Big(a_{ij} + \tau_j b_i + \sum_{t=n+1}^{s} m_{ti}e_{it} + \tau_j \sum_{u=n+1}^{s} \mu_u e_{iu}\Big)\frac{p_i}{p_j} \\ &= x_{ij}P_i/x_jP_j + w\tau_j/P_j \cdot b_iP_i/w \\ &\quad + \sum_{t=n+1}^{s} P_t x_{tj}/P_j x_j \cdot P_i P_i/P_t x_t \\ &\quad + w\tau_j/P_j\Big\{\sum_{u=n+1}^{s} P_u x_u/w \cdot P_t x_i/P_u x_u\Big\} \\ &\equiv C^*_{ij} \end{aligned}$$

We easily find that the all terms of definition (15) can be expressed in

the value-presented terms. That is, $x_{ij}P_i/x_jP_j$ is the value-presented input-output coefficient of the i-th input used in the j-th sector, $w\tau_j/P_j$ is the labour relative share of the j-th goods, and b_iP_i/w is the relative consumption ratio of the j-th goods in the real wage. $P_t x_{tj}/P_j x_j$ is the input coefficient in the value-term of the t-th imported goods used in the j-th sector. $P_i x_i/P_t x_t$ is the value-presented exchange coefficient of the i-th exported goods to the j-th imported goods as we defined in the equation (4). Similarly $P_u x_u/w$ is the relative share of the u-th imported consumption goods in the unit real wage. Finally $P_t x_i/P_u x_u$ is the valued exchange coefficient of u-th imported goods instead of the i-th exported goods.

All of these terms can be expressed in the price-value form. Thus that we can easily calculate this with some available dates taken from the Input-Output tables and other complementary statistics. So, we define this calculable direct and indirect input-output coefficient as C^*_{ij}.

Then, using $\beta_j = 1/(1+r_j)$, we rewrite the equation (14) with the C^*_{ij}, we get the following matrix (16).

$$(16)\quad \begin{bmatrix} \beta_1^2 & C^*_{21} & \cdots\cdots & C^*_{n1} \\ & & \cdots\cdots\cdots & \\ \alpha_j\beta_j^2 & C^*_{2j} & \cdots C_{jj} - \beta_j \cdots & C^*_{nj} \\ & & \cdots\cdots\cdots & \\ \alpha_n\beta_n^2 & C^*_{2n} & \cdots\cdots & C^*_{nn} - \beta_n \end{bmatrix} \begin{bmatrix} dr_1 \\ \vdots \\ \hat{q}_j \\ \vdots \\ \hat{q}_n \end{bmatrix} = \begin{bmatrix} 0 \\ \vdots \\ -C^*_{ij}\hat{C}^*_{ij} \\ \vdots \\ 0 \end{bmatrix}$$

where $\alpha_j \equiv r_j/r_1$. This is the difference in the rate of profit between the 1st sector and the j-th sector. We assume that this rate gap is kept constant even after the technological change occurs. We denote $\hat{x}$ as the rate of time change of the variable x.

From equation (16), we can get the changes of the rate of profit and relative prices, when the first goods is numeraire.

$$(17)\quad \begin{bmatrix} dr_1 \\ \vdots \\ \bar{q}_j \\ \vdots \\ \bar{q}_n \end{bmatrix} = \begin{bmatrix} \beta_1^2 & C_{21}^* & \cdots\cdots\cdots & C_{n1}^* \\ & & \cdots\cdots & \\ \alpha_j\beta_j^2 & C_{2j}^* & \cdots C_{jj}^* - \beta_j \cdots & C_{nj}^* \\ & & \cdots\cdots & \\ \alpha_n\beta_n^2 & C_{2n}^* & \cdots\cdots C_{jn}^* \cdots\cdots & C_{nn}^* - \beta_n \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ \vdots \\ -C_{ij}^*\bar{C}_{ij}^* \\ \vdots \\ 0 \end{bmatrix}$$

V. The case study——An application of Taiwan's Input-Output table 1985——

In this section we apply this empirical study to the real world. It would be good to pick up Taiwan's case, not only because it has considerably well-arranged Input-Output tables, but also because they are having impregnable development plans that would overwhelmingly induce the technological change all over their economy.

This is a very interesting case in our Input-Output framework from our macro-economical point of view. In our analysis, we need an extensive technological change that will affect the great income impact of the economy.

In Taiwan the 6th economic plan from 1991 is now in procession. Compared to previous plans, Taiwan's 6th economic plan is the biggest thus far. This is partly because the Taiwanese government dares to construct the infrastructures in the economy. Transportation systems, the expressways, express railways and subway systems in Taipei city are some of the infrastructures that are focused upon. Such systems have been prolonged for a long timefor it's magnanimous cost. It will total about 71.6 billion U. S. dollars to complete this plan within six years(10).

(10) The actual data is from Taiwan Government Gazette. The budget of this plan is scaled back from 101.8 to 71.6 billion U. S. dollars.

We will estimate the effect of the plan here. We mainly focus on the income increment effect which the new-built transportation systems could induce. The procedure of the estimation is composed of two parts as follows :

(1) The total amount of the project budget reaches 71.6 billion U. S. dollars. The govermnment expenditure to the construction of new infrastructures must raise the total output of all sectors in the ecomony. We first estimate how much the additional increment of the final demand for the project will increase the income of the economy.

(2) The new-built transportation systems will improve the manufacturing technical efficiency. This means that the amount of the transporation cost in all sectors can be reduced. We assume here that the rate of reduction of the transporation expense in total production cost is 10 % equally in all sectors.

We use the 1985 Taiwan Input-Output table of 50 sectors to estimate these effects.

① The increment final demand effect

Here we calculate the income effect of (1). This is a well-known procedure to the development policy makers.

Let $\Delta v_i\,(i=1, \cdots, 50)$ be the increased value-added in the i-th sector due to the increasing final demand of the construction sector. The construction industry is the 43rd sector in the I-O table we are using here. Thus, we can calculate this effect as follows :

$$(18)\quad \begin{bmatrix} \Delta v_1 \\ \vdots \\ \Delta v_{50} \end{bmatrix} = \begin{bmatrix} v_1 & & 0 \\ & \cdots & \\ 0 & & v_{50} \end{bmatrix} \begin{bmatrix} \Delta x_1 \\ \vdots \\ \Delta x_{50} \end{bmatrix}$$

$$= \begin{bmatrix} v_1 & & 0 \\ & \cdots & \\ 0 & & v_{50} \end{bmatrix} \begin{bmatrix} I - A \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ \vdots \\ \Delta f_{43} \\ \vdots \\ 0 \end{bmatrix}$$

where v_i is the rate of the value-added to the output value in the i-th sector, Δx_i is the increased output of i-th sector, I is the unit matrix, A is the 50×50 input-output matrix of this economy, and Δf_{43} is the incresed final demand of the construction sector.

The total effect is calculated to 55.4 billion dollors by the sum of Δv_i.

② The efficiency-improved effect

Before we investigate this effect, we have to calculate the terms of trade as defined in equation (4). In the I-0 table we use here, there is only one import sector. Thus, we get the terms of trade vector as follows :

(4′) $(e^*_{1,51}, e^*_{2,51}, \cdots, e^*_{n,51})$

where * denotes that we calculate this exchange terms in the value form(11).

From our assumption, the new development policy decreases 10% of the transportation input cost. This deduces parameter $C^*_{43,i}$ $(i=1, 2, \cdots, 50)$. We can get $dr_1=0.010522$ from the equation (17). The increased amount of output value in all sectors is calculated to a sum of 0.38 billion U. S. dollars.

However, we must consider this efficiency effect to continue in the long run. This is one of the reasons why policy makers would not determine the policy priority. It is not only from the point of increased output maximum, but also from the point of productivity.

We can calculate the present value of this effect to 4.44 billion U. S. dollars(12).

③ The relative price effect(13)

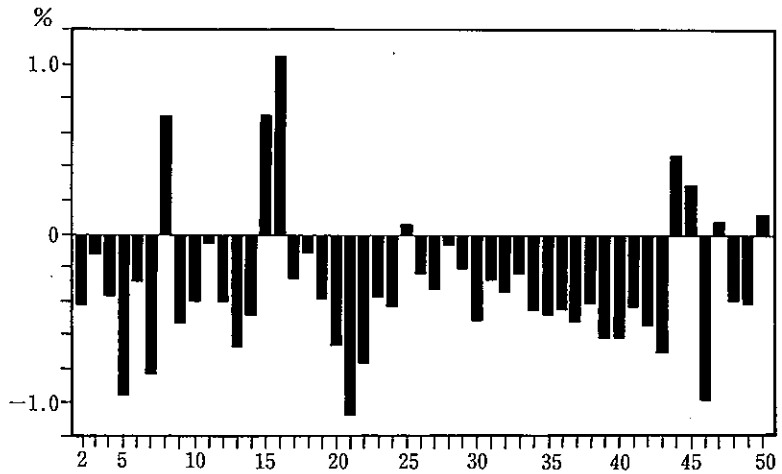
Equation (17) suggests that the efficiency-improved development

(11) We disregard the smaller part of the sectoral export in the total export. The 6th, 17th-20th, 22nd, 28th, 31st, 33rd-35th, 37th-42nd, 46th, 47th, and 49th are counted as the export sectors. Only these sectors are over 1 % of the sectional share to the total export value of this economy.

policy will affect the relative prices of this economy. When the price of paddy rice is taken as a numeraire, the change of relative prices will convert as shown in table No. 1 and figure No. 1.

It shows that there will be quite different effects on relative prices all over the economy. The change of prices implies that the effect of the efficiency-improved policy would have disproportionate influences on all sectors even if the inter-sectional gaps of the rate of profit were kept constant. If the price of goods A, for example, declined more than that

Figure 1 : The change of the relative prices.



Source : Table 1

(12) The increased total income due to the change of the rate of profit can be calculated as follows :

$$\begin{bmatrix} \Delta v_1 \\ \vdots \\ \Delta v_{50} \end{bmatrix} = \left[\begin{bmatrix} v'_1 \cdots 0 \\ \cdots \\ 0 \cdots v'_{50} \end{bmatrix} - \begin{bmatrix} v_1 \cdots 0 \\ \cdots \\ 0 \cdots v_{50} \end{bmatrix} \right] \begin{bmatrix} x_1 \\ \vdots \\ x_{50} \end{bmatrix}$$

where Δv_i is the changed total value-added in i-th sector, v_i is the rate of the value-added to the price, v'_i is the changed rate of the value-added induced by the technological change, and x_i is the total output of the i-th sector $(i=1, \cdots, 50)$.

(13) Nakatani (1993) shows this effects in the case of the Japanese economy.

Table 1 ; 50 sectors classifications and the simulated change of relative prices taking the 1st sector (paddy rice) as a numeraire*

No. 1	Paddy rice	0.0000 %	No. 26	Other chemical	-0.2323 %
No. 2	Sugarance	-0.4294	No. 27	Chmcl fertilizer	-0.3244
No. 3	Other crops	-0.1179	No. 28	Artificial fiber	-0.0594
No. 4	livestock	-0.3712	No. 29	Plastic products	-0.1997
No. 5	Forestry	-0.9535	No. 30	Misc. chemical	-0.5134
No. 6	Fishery	-0.2776	No. 31	Petro. refn. prdct	-0.2739
No. 7	Coal	-0.8271	No. 32	Cement products	-0.3419
No. 8	CrudeOil & gas	0.6940	No. 33	Misc. non-metl. prd	-0.2342
No. 9	Other minerals	-0.5261	No. 34	Steel & iron	-0.4500
No. 10	Slaughtering	-0.3920	No. 35	Iron & steel prds	-0.4734
No. 11	Rice products	-0.0497	No. 36	Non-iron prds	-0.4362
No. 12	Sugar	-0.4044	No. 37	Machinery	-0.5203
No. 13	Canned foods	-0.6701	No. 38	Household elec.	-0.4034
No. 14	Misc. food prdcts	-0.4807	No. 39	Electronic prds	-0.6122
No. 15	Bevarages	0.7035	No. 40	Elec. machinery	-0.6046
No. 16	Tobacco	1.0463	No. 41	Transport equip.	-0.4212
No. 17	Cotton fabrics	-0.2613	No. 42	Misc. manufactures	-0.5382
No. 18	Artificial fbrcs	-0.1136	No. 43	Construction	-0.6979
No. 19	Misc. fbr prdcts	-0.3889	No. 44	Electricity	0.4641
No. 20	Leather & prdcts	-0.6600	No. 45	Gas & city water	0.2961
No. 21	Lumber, plywood	-1.0687	No. 46	Transportation	-0.9673
No. 22	Wood products	-0.7572	No. 47	Communications	0.0758
No. 23	Paper, publishing	-0.3792	No. 48	Trade	-0.3889
No. 24	Rubber products	-0.4204	No. 49	Service	-0.4056
No. 25	Petro intm. mtrl.	0.0583	No. 50	Undistributed	0.1147

*** We simulated the change of the relative prices when the input cost for the transportation reduces to 10 % while the sectoral differences of the rate of profit are kept constant.**

Source : Computed from "International Input-Output table Taiwan-Japan 1985" Institute of Developing Economies, Tokyo 1992.

of goods B, the sector A would take some additional benefits through the price effect, while the gap of the rate of profit was kept constant. Goods A will be consumed more, while goods B has the opposite effect, ceteris paribus.

The favorable sectors have a larger input share of the transportation service as compared to the other sectors. The most favorable sector is

the 21-st, lumber and plywood, which is followed by transportation and warehousing, and forestry. The most distressful sector is the 16th, followed by beverage and crude oil & natural gas.

We can roughly suggest that, through relative prices change, this effect will influence international competitiveness, which is one of the main focuses when a certain project is planed. As the report of the 6 year plan assumes, this plan is contrived to encourage the international competitiveness of the strategic sectors.

Let us now turn to the exportable manufacturing sectors in this economy, such as electronic products, machinery, textile and so on. We can not assert that these industries are enhanced by this project just from the point of the price effect.

VI. Conclusion

Using the Input-Output table, we developed a new method to estimate the economic effect of economic development policy in this paper. Our main idea is that the policy must be a efficiency-improved one so that the policy could increase the social remainders of this economy. We formulate how to estimate this effect in the first half of this paper.

We investigate the development plan now in progress in Taiwan as the case study of this analysis. For convenience, we divided the policy impact into three effects. These are the final demand effect, the efficiency-improved effect and the relative prices effect.

The increase of the income can be evaluated by concluding 53.1 billion U. S. dollars as the extra final demand impact. Yet, in order to estimate the policy effect correctly, we have to attach the supplementary 4.44 billion U. S. dollars as the efficiency-improved effect.

Moreover, we can show the change of relative prices due to the technologically-improved development policy. We find out that the project will profit the sectors like wooden processing and transportation service sectors. Unfortunately, the electronic or machinery sectors, which are thought to enhance their international competitiveness, are less promoted in the consequence of this policy.

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