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GROWTH ACCOUNTING OF THE PHILIPPINES: A COMPARATIVE STUDY OF THE 1965 AND 1969 INPUT-OUTPUT TABLES

by

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1. Introduction

National income statistics (NIS) and input-output table (IO table) constitute a basic part of the system of national accounts in the broad sense (SNA). They are closely related with each other in that net outputs or values added in NIS must be equal to primary inputs in IO table, while expenditures in NIS must be equal to outputs delivered to final demands in IO table. As a result, they must be mutually dependent also in terms of growth rates, on which the growth accounting is based.[1/] The purpose of this paper is to provide a growth accounting of the Philippine national economy using the two input-output tables of 1965 and 1969 and to show the linkage of this measurement based on IO tables to the corresponding measurement based on NIS.[2/]

The growth accounting is a method of analysis to account for growth of output(s) in terms of growth of various inputs, so that it is often called the analysis of sources of growth. In almost all cases, the output growth cannot be explained completely by the growth of inputs and the so-called "residuals" appear which mean the unexplained portion of output growth. The "residuals" can be identified with the rate of productivity increase or the estimated rate of disembodied technical progress. The measurement of productivity change, therefore, may be used synonymously with the growth accounting or the analysis of sources of growth. In this paper, the methodology of growth accounting under the input-output framework will be discussed from the point of view of measuring productivity change or technical progress. It will be shown that the productivity index which introduces intermediate inputs explicitly (i.e., growth accounting based on IO table) is theoretically better than the conventional one which uses value added as output neglecting in a sense intermediate goods as production factors (i.e., growth accounting based on NIS).[3/] This seems obvious in the industry level but it is still true even in the aggregate national level. The relationship or linkage between IO and NIS measures will be derived as a by-product.

Section 2 deals with methodology. Section 3 provides measurement on the Philippine economy.

2. Growth Accounting Based on the IO Framework -- Methodology

In this section, we will discuss the methodology of growth accounting from the point of view of productivity measurement. First, we will derive the productivity index of the i-th industry (T^i). Then we will derive the aggregate productivity index for the whole economy (T) and compare it with the conventional measure (P). Next, we will provide some mathematics of aggregation to justify T rather than P as an appropriate measure for aggregate productivity change. Finally, we will summarize the computational formulas from the point of view of growth accounting.

2.1. Industry Productivity Change

Under the framework of input-output table, the following accounting identity must hold for the i-th industry:[4/]

$$(1) \quad q_i y_i = \sum_{k=1}^{n} q_k y_{ki} + \sum_{j=1}^{m} p_j x_{ji} \qquad (i=1...n)$$

where y_i is quantity of total output, y_{ki}'s are quantities of intermediate inputs, x_{ji}'s are quantities of primary factor inputs, and q_k's and p_j's are corresponding prices. This accounting identity is the starting point of measuring productivity change in the sense that the Divisia productivity index for the i-th industry (T^i) can be derived from that identity,[5/] i.e.,

$$(2)\quad \frac{\dot{T}^i}{T^i} = \frac{\dot{y}_i}{y_i} - \sum_{k=1}^{n} \frac{q_k y_{ki}}{q_i y_i} \cdot \frac{\dot{y}_{ki}}{y_{ki}} - \sum_{j=1}^{m} \frac{p_j x_{ji}}{q_i y_i} \cdot \frac{\dot{x}_{ji}}{x_{ji}}$$

where $\dot{T}^i = dT^i/dt$ (t: time) and so on.

Now let us consider a theoretical justification for $\dot{T}^i/T^i$ as an appropriate measure of productivity change. For that purpose, let us write the production function of the i-th industry as

$$(3)\quad y_i = f^i\,(y_{1i} \cdots y_{ki} \cdots y_{ni},\, x_{1i} \cdots x_{ji} \cdots x_{mi};\, t)$$

and assume constant returns to scale. Then the time shifts of this function can be expressed as

$$(4)\quad \frac{\dot{f}^i}{f^i} = \frac{\dot{y}_i}{y_i} - \left(\sum_{k=1}^{n} \frac{f^i_k\, y_{ki}}{y_i} \cdot \frac{\dot{y}_{ki}}{y_{ki}} + \sum_{j=1}^{m} \frac{f^i_j\, x_{ji}}{y_i} \cdot \frac{\dot{x}_{ji}}{x_{ji}} \right)$$

where $\dot{f}^i = \partial f^i/\partial t$, $f^i_k = \partial f^i/\partial y_{ki}$ and $f^i_j = \partial f^i/\partial x_{ji}$.

Under the marginal conditions of producer equilibrium, the shifts in production function reduce to the Divisia index for productivity change defined above, i.e.,

$$(5)\quad \dot{T}^i/T^i = \dot{f}^i/f^i \quad \text{if } f^i_k = q_k/q_i \text{ and } f^i_j = p_j/q_i.$$ [6/]

There is another justification for $\dot{T}^i/T^i$. By using the input coefficients (i.e., $a_{ki} = y_{ki}/y_i$ and $b_{ji} = x_{ji}/y_i$) equation (2) can be rewritten as

(6) $$\frac{\dot{T}^i}{T^i} = -\left(\sum_{k=1}^{n} \frac{q_k y_{ki}}{q_i y_i} \cdot \frac{\dot{a}_{ki}}{a_{ki}} + \sum_{j=1}^{m} \frac{p_j x_{ji}}{q_i y_i} \cdot \frac{\dot{b}_{ji}}{b_{ji}} \right)$$

which means the weighted average of the rates of <u>decrease</u> in input coefficients. This is the continuous version of Leontief's definition on the rate of technical progress in the i-th industry.[7/]

It should be noted here that the above measure of industry productivity change allows explicitly for intermediate inputs as production factors. In many cases, however, the industry productivity change or industry technical progress is measured by using real value added and primary factor inputs only. It is obvious that this conventional measure is not an appropriate one, since real value added does not represent quantity of output correctly and the role of intermediate goods is not clear in this measure.

2.2. Aggregate Productivity Change

Let us now consider the aggregate productivity change for the national economy as a whole. For the purpose of aggregation, let us bear in mind the following accounting definitions:

(7) $U_k = \sum_{i=1}^{n} y_{ki}$ (total intermediate input of the k-th good)

(8) $X_j = \sum_{i=1}^{n} x_{ji}$ (total primary input of the j-th factor)

(9) $Y_i = y_i - U_i$ (output of the i-th industry delivered to final demands)

Then, using equation (1), we get

(10) $\sum_{i=1}^{n} q_i y_i = \sum_{j=1}^{m} p_j x_j$.

(11) $\sum_{i=1}^{n} q_i y_i = \sum_{i=1}^{n} q_i U_i + \sum_{j=1}^{m} p_j X_j$.

Judging from equation (6) and noting $\Sigma\Sigma q_k y_{ki} + \Sigma\Sigma p_j x_{ji} = \Sigma q_i y_i$, it is clear that the best way to define the aggregate productivity change $(\dot{T}/T)$ is

$$(12) \quad \frac{\dot{T}}{T} \equiv - \left(\sum_{ik}\sum \frac{q_k y_{ki}}{\Sigma q_i y_i} \cdot \frac{\dot{a}_{ki}}{a_{ki}} + \sum_{ij}\sum \frac{p_j x_{ji}}{\Sigma q_i y_i} \cdot \frac{\dot{b}_{ji}}{b_{ji}} \right)$$

which is equivalent with[8/]

$$(13) \quad \frac{\dot{T}}{T} \equiv \sum \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{T}^i}{T^i}$$

Then, using equations (2), (7) and (8), the above $\dot{T}/T$ can be transformed into[9/]

$$(14) \quad \frac{\dot{T}}{T} = \frac{\dot{y}}{y} - (1-\theta) \cdot \frac{\dot{U}}{U} - \theta \cdot \frac{\dot{X}}{X}$$

where

$$
(15)\begin{cases}
\theta \equiv \Sigma p_j X_j / \Sigma q_i y_i = \Sigma q_i Y_i / \Sigma q_i y_i & \text{(value added ratio)} \\
(1-\theta) = \Sigma q_i U_i / \Sigma q_i y_i & \text{(intermediate input ratio)} \\
\dot{y}/y \equiv \Sigma\, (q_i y_i / \Sigma q_i y_i) \cdot (\dot{y}_i / y_i) & \text{(Divisia quantity)} \\
\dot{U}/U \equiv \Sigma\, (q_i U_i / \Sigma q_i U_i) \cdot (\dot{U}_i / U_i) & \text{(Divisia quantity)} \\
\dot{X}/X \equiv \Sigma\, (p_j X_j / \Sigma p_j X_j) \cdot (\dot{X}_j / X_j) & \text{(Divisia quantity)}
\end{cases}
$$

In words, the aggregate productivity change $(\dot{T}/T)$ may best be defined as the weighted average of the rates of decrease in input coefficients all over the national economy [equation (12)]. Equivalently, it may also be defined as the weightd average of the industry productivity changes with value shares of industry outputs as weights [equation (13)]. Furthermore, it is identical with the Divisia index for productivity change derived from the identity (11) [equation (14)]. It should again be noted that, as in the case of industry productivity change, the above definition of the aggregate productivity change allows explicitly for intermediate inputs as production factors.

The conventional way of measuring the aggregate productivity change $(\dot{P}/P)$ is based on the Divisia index derived from the accounting identity (10):10/

$$(16)\quad \frac{\dot{P}}{P} \equiv \frac{\dot{Y}}{Y} - \frac{\dot{X}}{X} \equiv \Sigma \frac{q_i Y_i}{\Sigma q_i Y_i} \cdot \frac{\dot{Y}_i}{Y_i} - \Sigma \frac{p_j X_j}{\Sigma p_j X_j} \cdot \frac{\dot{X}_j}{X_j}$$

Using equations (9), (13) - (15), we can easily prove 11/

$$(17)\quad \frac{\dot{P}}{P} = \frac{1}{\theta} \cdot \frac{\dot{T}}{T} = \Sigma \frac{q_i Y_i}{\Sigma q_i Y_i} \cdot \frac{\dot{T}^i}{T^i}$$

This means that $\dot{P}/P$ is a weighted sum but not a weighted average of the industry productivity changes $(\dot{T}^i/T^i)$. Only when there exist no intermediate inputs in the economy, $\dot{P}/P$ is identical with $\dot{T}/T$ and can be regarded as an appropriate measure.

2.3. Some Mathematics of Aggregation

Jorgenson and Griliches [1967] provides a justification for $\dot{P}/P$ as an appropriate measure of aggregate productivity change. Using the aggregate production function

$$(18)\quad F\,(Y_1 \ldots Y_n\,,\, X_1 \ldots X_m\,;\, t) = 0$$

which is assumed to be homogeneous of degree zero, they define shifts of this function in terms of the weighted averages of output growth and input growth:

$$(19)\quad \dot{GF} = \Sigma\left(\frac{F_i Y_i}{\Sigma F_i Y_j} \cdot \frac{\dot{Y}_i}{Y_i}\right) - \Sigma\left(\frac{F_j X_j}{\Sigma F_j X_j} \cdot \frac{\dot{X}_j}{X_j}\right)$$

where $\dot{F} = \partial F/\partial t$, $F_i = \partial F/\partial Y_i$, $F_j = \partial F/\partial X_j$ and $1/G = \Sigma F_i Y_i = \Sigma F_j X_j$. Then, under the marginal conditions of producer equilibrium, the shifts in production function can be shown identical with the growth rate of P, i.e.,

(20) $G\dot{F} = \dot{P}/P$.

Their justification above, however, is not sufficient, because they do not provide a justification for using $G\dot{F}$ as an appropriate measure of shifts in production function. Furthermore, we can say that $G\dot{F}$ is not an appropriate measure as far as the aggregate production function (18) means the transformation locus or production possibility frontier which is derived from the components industry production functions (3). This fact can be understood by considering the following aggregation procedure:

Maximize Y_1

with respect to Y_1, y_{ki}, x_{ji}, y_i and U_k

subject to the constraints

$y_i = f^i(y_{1i} \ldots y_{ki} \ldots y_{ni}, x_{1i} \ldots x_{ji} \ldots x_{mi}, t)$ $(i=1\ldots n)$

$U_k = \Sigma y_{ki}$ $(k=1\ldots n)$

$Y_i = y_i - U_i$ $(i=1\ldots n)$ and

$X_j = \Sigma x_{ji}$ $(j=1\ldots m)$

under the given parameters $Y_2 \ldots Y_n$, $X_1 \ldots X_m$ and t.

In this problem of constrained maximization, the Lagrangean function becomes

$$(21)\quad L = Y_1 + \sum_{i=1}^{n} \xi_i \Big(y_i - f^i\,(y_{1i}\ldots y_{ki}\ldots y_{ni}\quad x_{1i}\ldots x_{ji} \ldots x_{mi},\ t)\Big) + \sum_{k=1}^{n} \eta_k (U_k - \sum_{i=1}^{n} y_{ki}) + \sum_{i=1}^{n} \lambda_i\ (y_i - U_i - Y_i) + \sum_{j=1}^{m} \mu_j\ (X_j - \sum_{i=1}^{n} x_{ji})$$

and the first order conditions for maximization become

$$(22)\quad \begin{cases} 1 - \lambda_1 = 0 & \\ - \xi_i \partial f^i / \partial y_{ki} - \eta_k = 0 & (i = 1 \ldots n,\ k = 1 \ldots n) \\ - \xi_i \partial f^i / \partial x_{ji} - \mu_j = 0 & (i = 1 \ldots,\ j = 1 \ldots) \\ \xi_i + \lambda_i = 0 & (i = 1 \ldots n) \\ \eta_k - \lambda_k = 0 & (k = 1 \ldots n) \end{cases}$$

These first order conditions, together with the constraints of the present maximization problem, determine the maximized value of Y_1 in terms of the given parameters:

$$(23)\quad Y_1 = f(Y_2 \ldots Y_n,\ X_1 \ldots X_m,\ t)$$

which, when written in the form of implicit function, gives the transformation locus or production possibility frontier

(18). Furthermore, from the properties of Lagrangean multipliers,[12/] we get

$$(24)\quad \begin{cases} \partial Y_1/\partial Y_i = -\lambda_i & (i = 2..,n) \\ \partial Y_1/\partial t = -\sum_{i=1}^{n} \xi_i \dot{f}_i & \end{cases}$$

so that, using the first order conditions, we can derive

$$(25)\quad \dot{F} = -F_1 \cdot (\partial Y_1/\partial t) = +F_1 \sum_{i=1}^{n} \xi_i \dot{f}^i = -F_1 \sum_{i=1}^{n} \lambda_i \dot{f}_i$$

$$= -F_1\lambda_1\dot{f}^1 + \sum_{i=2}^{n} F_1 \cdot (\partial Y_1/\partial Y_i)\dot{f}^i = -F_1\dot{f}^1 + \sum_{i=2}^{n} (-F_i\dot{f}^i)$$

$$= -\sum_{i=1}^{n} F_i y_i \cdot (\dot{f}^i/f^i) \quad \text{where } F_i = \partial F/\partial Y_i \quad (i = 1 \ldots n).$$

This last relation suggests that the best way to define the shifts in production function (18) is

$$(26)\quad H\dot{F} = \sum \frac{F_i y_i}{\Sigma F_i y_i} \cdot \frac{\dot{f}^i}{f^i}$$

$$= \sum \frac{F_i y_i}{\Sigma F_i y_i} \cdot \frac{\dot{y}_i}{y_i} - \frac{\Sigma F_i U_i}{\Sigma F_i y_i} \cdot \sum \frac{F_i U_i}{\Sigma F_i U_i} \cdot \frac{\dot{U}_i}{U_i} + \frac{\Sigma F_j X_j}{\Sigma F_i y_i} \sum \frac{F_j X_j}{\Sigma F_j X_j} \cdot \frac{\dot{X}_j}{X_j}$$

where $1/H = -\Sigma F_i y_i = -\Sigma F_i U_i + \Sigma F_j X_j$

which means that $\dot{HF}$ is a weighted average of the shifts in industry production functions. The $\dot{HF}$ reduces to $\dot{T}/T$ when all of the marginal rates of substitution and marginal rates of transformation become equal to the corresponding relative prices. In other words,

$$(27) \quad \dot{HF} = \dot{T}/T$$

is guaranteed in the case where the marginal conditions hold. On the other hand, from equation (25), we get

$$(28) \quad \dot{GF} = \sum \frac{F_i y_i}{\Sigma F_i Y_i} \cdot \frac{\dot{f}^i}{f^i} \quad \left(= \frac{\Sigma F_i y_i}{\Sigma F_i Y_i} \cdot \dot{HF} \right)$$

so that we can understand $\dot{GF}$ is a weighted sum but not a weighted average as in the case of $\dot{P}/P$. Again, only when these exists no intermediate goods in the economy, $\dot{GF}$ can be regarded as a proper measure of shifts in the production function.

2.4. Growth Accounting Formulas

It is now clear that the productivity measurement based on the IO framework is theoretically better than that of the NIS basis not only in the industry level but also in the aggregate national level. That is to say, the growth accounting based on IO table is theoretically better than the growth accounting based on NIS at any level of aggregation.

In the next section, we will provide a growth accounting for the Philippine economy mainly by using the two input-output tables, so that it seems useful to summarize here the related computational formulas from the point of view of the growth accounting.

First, from equation (2), we get the relationship between output growth, input growth and residual growth for each inudstry:

$$\text{(29)} \quad \frac{\dot{y}_i}{y_i} = \sum_{i=1}^{n} \frac{q_k y_{ki}}{q_i y_i} \cdot \frac{\dot{y}_{ki}}{y_{ki}} + \sum_{j=1}^{m} \frac{p_j x_{ji}}{q_i y_i} \cdot \frac{\dot{x}_{ji}}{x_{ji}} + \frac{\dot{T}^i}{T^i} \qquad (i=1 \ldots n)$$

$$= (1-\theta_i) \cdot \left(\sum_k \frac{q_k y_{ki}}{\Sigma q_k y_{ki}} \cdot \frac{\dot{y}_{ki}}{y_{ki}} \right) + \theta_i \left(\sum_j \frac{p_j x_{ji}}{\Sigma p_j x_{ji}} \cdot \frac{\dot{x}_{ji}}{x_{ji}} \right) + \frac{\dot{T}^i}{T^i}$$

where $\theta_i = \Sigma p_j x_{ji} / q_i y_i$ = value added ratio in the i-th industry. Note that, in the latter expression above, the two bracketted terms represent Divisia aggregation for the quantities of intermediate inputs and primary factor inputs respectively in the i-th industry. Second, for the aggregate national economy, we get the following growth rlationship from equations (13) and (29):

$$\text{(30)} \quad \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{y}_i}{y_i} = \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \left(\sum_k \frac{q_k y_{ki}}{q_i y_i} \cdot \frac{\dot{y}_{ki}}{y_{ki}} \right)$$

$$+ \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \left(\sum_j \frac{p_j x_{ji}}{q_i y_i} \cdot \frac{\dot{x}_{ji}}{x_{ji}} \right) + \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{T}^i}{T^i}$$

which is equivalent with

$$(31)\quad \frac{\dot{Y}}{Y} = (1-\theta)\cdot\frac{\dot{U}}{U} + \theta\cdot\frac{\dot{X}}{X} + \frac{\dot{T}}{T}$$ [See equations (14) and (15)]

Third, the similar relationships for the aggregate economy on the NIS basis can be expressed from equation (16) as

$$(32)\quad \sum \frac{q_i Y_i}{\Sigma q_i Y_i}\cdot\frac{\dot{Y}_i}{Y_i} = \sum \frac{p_j X_j}{\Sigma p_j X_j}\cdot\frac{\dot{X}_j}{X_j} + \frac{\dot{P}}{P} \quad \text{or} \quad \frac{\dot{Y}}{Y} = \frac{\dot{X}}{X} + \frac{\dot{P}}{P}\,.$$

Finally, from equation (31), we get

$$(33)\quad \frac{1}{\theta}\left(\frac{\dot{Y}}{Y} - (1-\theta)\frac{\dot{U}}{U}\right) = \frac{\dot{X}}{X} + \frac{1}{\theta}\cdot\frac{\dot{T}}{T}$$

which is equivalent with equation (32) since $\dot{P}/P = (1/\theta).(\dot{T}/T)$ from equation (17). This is the formula which transforms the growth accounting of the IO basis into that of the NIS basis.

It must be noted that, in the above formulas, any aggregate variable is expressed in terms of Divisia index. The Divisia quantity in particular is useful since it automatically incorporates quality changes in components variables, provided that their quality elements can be reflected by their relative prices.[13/] For example, if the classified data on employment and wage rate are available, we can construct the Divisia quantity for labor input (say, L). Of course, we know total employment (say, L´). Then, we can compute the ratio L/L´ and regard it as the quality index of labor, provided that the relative wage rate is a good measure of relative efficiency or relative quality. The same is true for capital and output under the same premise. Crucial problems here are, of course, the availability of classified data on price and quantity and the plausibility of the premise.

3. Growth Accounting of the Philippines -- Measurement

In this section, we will provide a growth accounting of the Philippine national economy comparing two input-output tables, the 1965 table of National Economic Council (NEC) and the 1969 table of National Economic and Development Authority (NEDA), and link the results to the corresponding measurement based on the national income series of NEDA. For expository purposes, we will present, first, simple computations concerning the latter (i.e., growth accounting based on NIS) only for the aggregate economy and, then, we will discuss the data and the results of comparison concerning the two input-output tables (i.e., growth accounting based on the IO framework) for each industry as well as for the aggregate economy.

3.1. Growth Accounting of the NIS Basis for the Aggregate Economy

Only the work of Lampman [1967] is enough to be mentioned here as the reference. Since he provides two-point comparisons only (for 1955-65 and 1947-65), it seems worthwhile to construct annual estimates for each year in the postwar period. The results for 1957-74 are shown in Table 1.

Computations of the table are based on formula (32), where the aggregate output Y is simply replaced by real GNP while the primary factor inputs X_j's are simply represented by homogeneous labor L and homogeneous capital K (i.e., $X_1 = L$ and $X_2 = K$). Real GNP is, of course, from the NEDA National Income Series of latest version. It is the GNP at constant 1967 prices. It is an approximation to Y in the sense that it is not a Divisia quantity aggregated in terms of real expenditures on industry outputs. The data for L is total employment in October or in November which is based on the nationwide sample surveys of households. Since no surveys were conducted in 1964, 1969 and 1970, the annual compound growth rates for 1963-65 and 1968-71 are used to fill up the missing part. The data for K is from Canlas, Encarnación and Ho [1975]. They estimate a series of

Table 1. Growth Accounting of the NIS Basis, 1957-1974

(%)

	$\dot{Y}/Y$ 1)	=	w_L 2)	x	$\dot{L}/L$ 3)		+	w_K 4)	x	$\dot{K}/K$ 5)		+	$\dot{P}/P$
1957	5.1	=	.44	x	6.5	(2.9)	+	.56	x	5.7	(3.2)	+	(-1.0)
1958	3.9		.44	x	1.6	(0.7)		.56	x	6.4	(3.6)		(-0.4)
1959	6.6		.44	x	3.0	(1.3)		.56	x	5.9	(3.3)		(2.0)
1960	2.0		.44	x	(-0.4)	(-0.2)		.56	x	6.3	(3.5)		(-1.3)
1961	6.4		.44	x	6.5	(2.9)		.56	x	5.2	(2.9)		(0.6)
1962	5.6		.44	x	5.6	(2.5)		.56	x	5.7	(3.2)		(-0.1)
1963	7.0		.44	x	1.7*	(0.7)		.56	x	5.2	(2.9)		(3.4)
1964	2.5		.44	x	1.7*	(0.7)		.56	x	5.9	(3.3)		(-1.5)
1965	5.2		.44	x	1.7*	(0.7)		.56	x	6.4	(3.6)		(0.9)
1966	4.8		.44	x	8.3	(3.7)		.56	x	6.3	(3.5)		(-2.4)
1967	5.8		.44	x	(-0.9)	(-0.4)		.56	x	6.0	(3.4)		(2.8)
1968	5.2		.44	x	(-3.6)	(-1.6)		.56	x	6.7	(3.8)		(3.0)
1969	5.9		.44	x	6.2*	(2.7)		.56	x	6.5	(3.6)		(-0.4)
1970	5.7		.44	x	6.2*	(2.7)		.56	x	6.1	(3.4)		(-0.4)
1971	6.2		.44	x	6.2*	(2.7)		.56	x	5.7	(3.2)		(0.3)
1972	4.2		.44	x	0.3	(0.1)		.56	x	5.6	(3.1)		(1.0)
1973	9.8		.44	x	10.2	(4.5)		.56	x	5.4	(3.0)		(2.3)
1974	5.8		.44	x	(-0.3)	(-0.1)		.56	x	5.6	(3.1)		(2.8)

1) Real GNP = NEDA Statistical Yearbook 1975 (pp. 106-107), NEDA National Income Series (Number 3) [1975, p. 29], Canlas, Encarnación and Ho (1975, p. 29). 2) Labor share = NEC input-output table of 1965. 3) Total employment = NEDA Statistical Yearbook 1975 (pp. 52-53). 4) Capital share = $1 - w_L$. 5) Real capital stocks = Canlas, Encarnación and Ho [1975 , p. 29] .
*Intrapolations.

real capital stocks for the aggregate economy using average incremental capital-output ratio, real GNP at the starting year (1955) and the series of real capital formation. Their series is useful not only because there exists no nationwide survey of capital stocks or national wealth, but also because it is consistent with the national income statistics.

As can be seen from formula (32), the data for value shares of labor and capital (i.e., $p_j X_j / \Sigma p_j X_j$) are also needed in computations. However, the national income series does not provide separate estimates for "compensation of employees" and "entrepreneurial and property income of persons," so that the ratio of "wages and salaries" to total value added (GNP) in IO table is used for the labor share.[14/] This means that the compensation of capital (or capital service price) includes indirect taxes as well as depreciations and "other value added". Indirect taxes may be interpreted as the inputs of government services and the use of the above ratio assumes that the quantity of such government services is proportional to the quantity of capital inputs. There are three input-output tables available now. Correspondingly, the wages-GNP ratio in IO table takes three different values, i.e.,

.426 for 1961, .444 for 1965 and .410 for 1969. The ratio in the middle year 1965 is adopted here and the labor share is set equal to a constant .44 throughout the sample period.

The growth accounting of Table 1 shows considerable year-to-year fluctuations especially in productivity change and labor contribution.15/ However, if we demarcate the sample period into several appropriate subperiods, we can find some systematic changes in the average growth rates. Table 2 shows this demarcation and the corresponding average growth rates. In the demarcation, 1960-62 and 1970 are selected as the critical years, because the former is the period of decontrol and devaluation and the latter is the year of foreign exhcange crisis and the floating of pesos.16/ In the table, we can observe a slight trend accelaration in output growth and productivity growth. Especially, it seems remarkable that the productivity change jumps from zero to about 1% between pre-decontrol and post-decontrol periods. This fact may be relevant to the conclusion of Williamson and Sicat [1968] that decontrol and devaluation contributed to the improvement of resource allocation. Their analysis is concerned about the technical progress in the manufacturing industry. We will

Table 2.

Average Annual Growth Rates.*

(%)

	$\dot{Y}/Y$	$\dot{L}/L$	$\dot{K}/K$	$\dot{P}/P$
1957-60	4.4	2.7	6.1	-0.2
1957-61	4.8	3.4	5.9	-0.0
1957-62	4.9	3.8	5.9	-0.0
1961-69	5.4	3.0	6.0	0.7
1962-69	5.3	2.6	6.1	0.7
1963-69	5.2	2.7	6.1	0.8
1970-74	6.3	4.5	5.7	1.2
1963-74	5.7	3.1	6.0	1.0
1957-74	5.4	3.4	5.9	0.6

*Computed from Table 1.

refer to their paper later again in discussing the <u>intra</u>- and <u>inter</u>-industry technical progress.

3.2. Growth Accounting of the IO Basis (Data)

The 1965 and 1969 input-output tables (at producers' prices) have dimensions 51 x 51 and 60 x 60, respectively.[17/] However, to simplify the analysis and to get stable estimates, we aggregate the two transactions tables into smaller 7 x 7 tables in accordance with the NEC and the NEDA-NCSO classification codes almost in the same way as Jurado and Encarnacion [1974],[18/] who analyze structural change in the Philippine economy using the 1961 and 1965 tables. The resulting seven sectors are:

(1) Agriculture, Fisheries and Forestry	[Agriculture]
(2) Mining and Quarrying	[Mining]
(3) Manufacturing	[Manufacturing]
(4) Construction	[Construction]
(5) Transportation, Communication, Warehousing and Storage, and Utilities	[Transportation,etc.]
(6) Trade, Banking, Insurance and Real Estate	[Commerce]
(7) Private and Government Services	[Serives]

For the resulting 7 x 7 tables, see the Appendix tables (where the transactions for final demands are omitted, since they are unnecessary in the present analysis).

For the aggregated seven-industry level, let us check up the data consistency between national income statistics and input-output tables. Table 3 shows this comparison between the NIS and the IO data in terms of net output or value added. It can be seen in the table that the two data indicate considerably big discrepancies in many sectors. Especially in commerce and services sectors, big discrepancies are observed in both years of 1965 and 1969. This is due to the gaps in Real Estate and Trade for the commerce sector and the treatment of imputed rent (ownership of dwellings) for the services sector (as is indicated in the lower half of Table 3). It seems interesting to observe that underestimation (or overestimation) of net domestic product at factor cost is cancelled by overestimation (or underestimation) of depreciations and indirect taxes almost completely, resulting in very small discrepancies in the GNP estimates.

In spite of those big discrepancies in sectoral net output, we will employ the deflators implicit in the national income statistics (NIS deflators for sectoral outputs) to get the input-output structures expressed at constant 1967 prices. This is because it is attempted

(million pesos)

	1965			1969		
	NIS	IO	(NIS/IO)	NIS	IO	(NIS/IO)
1. Agriculture	6201	5607	(+10.6%)	10605	9012	(+17.7%)
2. Mining	232	245	(- 5.3%)	530	588	(- 9.9%)
3. Manufacturing	3400	3184	(+ 6.8%)	5073	5440	(- 6.7%)
4. Construction	758	835	(- 9.2%)	979	1278	(-23.4%)
5. Transportation, etc.	786	829	(- 5.2%)	1078	1562	(-31.0%)
6. Commerce	2914	5392	(-46.0%)	4075	7299	(-44.2%)
7. Services	4571	3833	(+19.2%)	6645	5165	(+28.7%)
NDP at factor cost	18862	19927	(- 5.3%)	28985	30344	(- 4.5%)
8. Net factor income from abroad	-123	-123		-285	-285	
NNP or NI	18739	19804	(- 5.3%)	28700	30059	(- 4.5%)
9. Indirect taxes less Subsidies	1491	928	(+60.7%)	2297	1884	(+21.9%)
10. Depreciations	1799	1185	(+51.8%)	3093	2135	(+44.9%)
GNP	22029	22227*	(- 0.9%)	34090	34077	(+ 0.0%)

	1969 NIS	1969 IO
6. Commerce	4075	7299
Wholesale and Retail Trade	2761	4199
Insurance, Banking and Nonbanking Inst.	1010	1020
Real Estate	304	2079
7. Services	6679	5165
Government Services	2212	2213
Educational Services	198	389
Recreational Services	118	219**
Personal Services	1291	289**
Professional Services	1040	762
Ownership of Dwellings	1411	
All Other Industries	409	1743**

* This figure includes statistical discrepancy (=310).

** These figures may not correspond exactly to the NIS classification.

Sources: NEDA Statistical Yearbook 1975 (p. 101), NEDA National Income Series (Number 1) [1973, p. 61] and the two input-output tables.

in the present paper to provide a growth accounting of the IO basis as consistently as possible with that of the NIS basis. The aggregation into seven industries above is also due to that reason. Table 4 shows the NIS deflators for sectoral outputs which are derived by the ratio of net domestic product by industrial origin to its real counterpart. Table 4 includes also the Mangahas-Encarnacion deflators, which are used in Jurado and Encarnacion [1974] for the same purposes. We will provide the results based on the latter deflators later for the sake of comparison. Here we note only the fact that, in the case of NIS deflators, price increase is bigger so that output growth becomes smaller than in the case of Mangahas-Encarnacion deflators.

The results of deflation using the NIS deflators are presented in Tables 5 and 6. The tables contain also the data for the inputs of labor and capital in each industry (L_i and K_i , i=1 ... 7), so that all of the data necessary in growth accounting are provided in the tables except for the data of value shares which are derivable from the original (i.e., undeflated) input-output tables. Note that the labor inputs (sectoral employments) here are the ILO figures based on May series for which the 1969 data are available. No intrapolations are made for 1969 unlike the

Table 4.

Deflators for Sectoral Outputs

(1967=1.000)

	NIS Deflators[1]		Mangahas-Encarnación Deflators [2]	
	1965	1969	1965	1969
1. Agriculture	.857	1.202	.866	1.136
2. Mining	.826	1.132	.856	1.114
3. Manufacturing	.926	1.054	.947	1.110
4. Construction	.876	1.194	.971	1.038
5. Transportation, etc.	.923	1.079	.929	1.062
6. Commerce	.913	1.036	.915	1.019
7. Services	.886	1.116	.917	1.059

[1] NEDA Statistical Yearbook, 1975 (pp. 100-103).

[2] Mangahas and Encarnación [1972, p. 344].

Table 5. Input-Output Table, 1965 (at constant 1967 prices)

(millions of pesos)

	1	2	3	4	5	6	7	Subtotal 1)
1. Agriculture	276.4	6.9	3635.1	9.3	11.0	-	196.0	4134.7
2. Mining	1.2	2.5	354.0	32.2	.1	1.1	1.0	392.0
3. Manufacturing	505.6	94.4	2482.7	780.3	404.4	207.0	627.9	5102.5
4. Construction	-	.3	3.7	30.5	2.1	47.9	4.2	88.5
5. Transp. etc.	41.3	13.8	307.5	33.5	125.4	179.3	102.6	803.1
6. Commerce	215.2	26.1	1027.6	164.8	132.2	487.5	283.7	2337.2
7. Services	60.8	18.3	359.1	91.5	86.1	439.4	314.0	1369.4
Subtotal 2)	1100.5	162.3	8169.7	1142.1	761.3	1362.2	1529.4	14227.4
8. Labor 3)	6393	29	1191	315	410	1184	1506	11128
9., 10., 11. Capital 4)	19343	2149	14384	6365	9341	10416	20666	82664
Subtotal 5)	6872.2	312.6	4360.9	1027.1	1111.8	6525.6	4830.7	25040.9
Total 6)	8032.7	492.4	12190.5	2221.5	1868.6	7877.8	6394.8	39078.3

1) Row sums. 2) Column sums. 3) Employment (thousands of persons). Source: ILO [1974, p.394]. 8 = Wages and Salaries in the original input-output table. 4) Capital stocks at 1967 prices (millions of pesos). 9 = Depreciation, 10 = Other value added, and 11 = Indirect taxes less subsidies in the original input-output table. 5) Real value added deflated by the NIS deflators (Table 4) except for the last which is row sum. 6) Total output at 1967 prices deflated by the NIS deflators (Table 4) except for the last which is row sum.

Table 6. Input-Output Table, 1969 (at constant 1967 prices)

(millions of pesos)

	1	2	3	4	5	6	7	Subtotal 1)
1. Agriculture	588.4	6.9	4203.6	37.4	11.1	-	213.5	5061.0
2. Mining	3.6	4.0	535.4	34.5	.3	-	1.4	579.2
3. Manufacturing	567.9	174.0	4264.2	940.1	462.7	288.6	907.6	7605.3
4. Construction	-	.8	18.2	46.2	3.0	125.1	15.4	208.7
5. Transp. etc.	93.0	24.1	408.2	42.9	156.9	341.0	160.2	1226.2
6. Commerce	213.2	45.3	1324.8	192.1	146.1	879.5	297.5	3098.5
7. Services	159.8	22.9	308.8	134.8	108.2	527.6	439.7	1701.8
Subtotal 2)	1625.9	278.0	11063.2	1428.0	888.3	2161.8	2035.3	19480.7
8. Labor 3)	6633	54	1352	366	432	1162	1733	11732
9., 10., 11. Capital 4)	22655	4129	22020	7410	15244	12915	21490	105863
Subtotal 5)	7935.9	585.8	6602.0	1175.0	1799.9	8043.1	4950.5	31091.6
Total 6)	9440.6	846.9	18302.7	2452.9	2677.2	10283.9	6926.3	50930.5

1) 2) 3) 4) 5) and 6): the same as in Table 5.

case of growth accounting based on NIS which employs October-November series for total employment (L). The capital inputs (capital stocks at 1967 prices) for seven sectors here are the results of a crude guesswork. We have the data for total capital stocks (K) which is consistent with national income statistics (i.e., Canlas-Encarnacion-Ho series). We can compute the capital-output ratio for each of the seven industries (k_i, i=1 ... 7) from Maton, Paukert and Skolka [1975] which gives a detailed data on that ratio for 64 industries.[19/] We can also compute the real net output (V_i, i=1 ... 7) of the IO basis by deflation.[20/] The estimates of sectoral capital stocks in Tables 5 and 6 are the results of prorating total capital stocks to each industry by the following formula:

$$K_i = \frac{k_i V_i}{\Sigma k_i V_i} \cdot K \quad \text{or} \quad \frac{K_i}{K} = \frac{k_i V_i}{\Sigma k_i V_i} .$$

The discrepancy between $\Sigma k_i V_i$ and K is not negligible. The former is smaller than the latter by 38% in 1965 and by 40% in 1969. This is due to the relatively small values of k_i's, since the average capital-output ratios for the whole economy (i.e., $\Sigma k_i V_i / \Sigma V_i$) are only 2.39 in 1965 and 2.43 in 1969, while the ratios of K to real

GNP are 3.35 and 3.47 respectively.[21/] However, the estimated capital stocks in the manufacturing sector here are, at least, not contrary to the available census data for the establishments with five or more workers in that sector.[22/]

3.3. Growth Accounting of the IO Basis (Measurement)

Table 7 summarizes the final results both for industries and for aggregate nationaleconomy. It also indicates the linkage to the measurement of the NIS basis. Computations of the industry growth accounting are based on formula (29), where the primary factor inputs x_{ji}'s are represented by labor input L_i and capital input K_i (i.e., $x_{1i} = L_i$ and $x_{2i} = K_i$, i=1 ... 7).[23/] Note that labor and capital here are assumed to be homogeneous within each industry but not so between industries, because (average) wage rates and (average) rates of return to capital differ between industries. Growth rates are computed by using 1965 values as base, while value shares here are the arithmetic averages of those derived from 1965 and 1969 input-output tables. This is an approximation to formula (29) or other formulas expressed in terms of continuous variables, so that certain approximation errors are unavoidable in computations. Growth accounting of the total

Table 7. Growth Accounting of the IO Basis, 1965-1969

(%)

Industries:1/	$\frac{\dot{y}_i}{y_i}$ =	$(1-\theta_i) \sum \frac{q_k y_{ki}}{\Sigma q_k y_{ki}} \cdot \frac{\dot{y}_{ki}}{y_{ki}}$ +	$\theta_i w_{Li} \cdot \frac{\dot{L}_i}{L_i}$ +	$\theta_i w_{Ki} \cdot \frac{\dot{K}_i}{K_i}$ +	$\frac{\dot{T}^i}{T^i}$
1. Agriculture:	17.5 =	.152 x 59.9 + (9.1)	.390 x 3.8 + (1.5)	.458 x 17.1 + (7.8)	(- 0.9)
2. Mining:	72.0 =	.337 x 72.8 + (24.5)	.201 x 86.2 + (17.3)	.463 x 92.1 + (42.6)	(-12.4)
3. Manufacturing:	50.1 =	.641 x 38.1 + (24.4)	.106 x 13.5 + (1.4)	.254 x 53.1 + (13.5)	(10.8)
4. Construction:	10.4 =	.529 x 28.1 + (14.9)	.240 x 16.2 + (3.9)	.231 x 16.4 + (3.8)	(-12.2)
5. Transp. etc.:	43.3 =	.366 x 16.6 + (6.1)	.276 x 5.4 + (1.5)	.358 x 63.2 + (22.6)	(13.1)
6. Commerce:	30.5 =	.195 x 63.1 + (12.3)	.261 x(-1.9)+ (-0.5)	.545 x 24.0 + (13.1)	(5.6)
7. Services:	8.3 =	.265 x 35.1 + (9.3)	.487 x 15.1 + (7.3)	.249 x 4.0 + (1.0)	(-9.3)

Total economy2/: $\frac{\dot{Y}}{Y} = (1-\theta) \cdot \frac{\dot{U}}{U} + \theta w_L \cdot \frac{\dot{L}}{L} + \theta w_K \cdot \frac{\dot{K}}{K} + \frac{\dot{T}}{T}$

(Divisia aggregation): 31.3 = .374 x 40.7 + .268 x 8.6 + .359 x 29.8 + [3.0]
[15.2] [2.3] [10.8]

Total economy (NIS base):3/ $\frac{\dot{Y}}{Y} = w_L \cdot \frac{\dot{L}}{L} + w_K \cdot \frac{\dot{K}}{K} + \frac{\dot{P}}{P}$

From input-output tables:4/ (Divisia aggregation): 25.6 = .428 x 8.6 + .572 x 29.8 + [4.8]
[3.7] [17.0]

Fron national income Series:5/ (Simple aggregation): 23.6 = .428 x 5.4 + .572 x 28.1 + [5.2]
[2.3] [16.1]

1/ See formula (29) . (w_{Li} = labor share in the i-th industry and $w_{Ki}=1-w_{Li}$).

2/ See formula (31) . (w_L = labor share in the total economy and $w_K = 1-w_L$).

3/ See formula (32) . (w_L = labor share in the total economy and $w_K = 1-w_L$).

4/ See formula (33).

5/ Similar to Table 1.

economy is the weighted average of the components industry growth accountings with values of total industry outputs as weights (see formula (30) which is equivalent with formula (31)). It is the result of Divisia aggregation, so that not only output (y) and intermediate input (U) but also labor (L) and capital (K) are expressed in terms of Divisia quantities.

In Table 7, growth accounting of the NIS basis is shown in two ways for the total economy. One is derived from the input-output tables by using formula (33) and is expressed in terms of Divisia quantities. The other is based on the national income series and corresponds to the growth accounting of Subsection 3.1.[24/] The difference between the two depends on the method of aggregation in constructing the quantity data, i.e., the Divisia aggregation or the simple aggregation (which means the simple sum of components quantity variables). For example, in the case of labor inputs, the growth rate of Divisia quantity is 8.6% while that of total employment (sum of employment in each industry) is 5.4%. The gap between the two growth rates can be interpreted as the growth rate of labor quality, which is 3.2% in this case, provided that the relative (average) wage rates between industries are a good measure for the relative efficiencies or qualities of labor between industries.[25/] A similar interpretation may be made also for capital and output, noting, however, that capital stocks in each industry are the results of a guess work and real GNP is the sum of the real expenditures but not the sum of the real industrial outputs delivered to final demands.

In Table 7, a considerable growth in productivity is observed between 1965 and 1969 for the aggregate economy. It is 3% (or 0.7% at the annual compound rate) on the IO base, while it is about 5% (or 1.0% at the annual compound rate) on the NIS base. The manufacturing sector has the biggest positive contribution (3.6% = .3336 x 10.8%) to this increase in aggregate productivity, since its productivity growth (10.8%) is one of the biggest and its value share (i.e., the weight .3336 in aggregation) is dominant among others.[26/] In the manufacturing sector, gorwth of intermediate inputs (38.1% in Divisia quantity), growth of labor input (13.5%) and growth of capital input (53.1%) are considerably large but, still, a large producti-vity increase is observed due to a much larger growth in total output (50.1%). The services sector, on the other hand, has the biggest negative contribution (-1.4% = .1499 x (-9.3%)) to the increase in aggregate productivity by the similar reasons in the opposite direction. Note that, in each industry, input growth minus output growth means the growth in the corresponding input coefficient (See equation (6)). In the manufacturing sector, for example, the growth rates of input coefficients are -12.0% for intermediate goods (in the weighted average sense), -36.6% for labor and +2.0% for capital, so that the productivity increase in the manufacturing sector is heavily dependent on the intermediate-goods-saving and labor-saving technologies.[27/] The same is true for the sector of transportation, communication, storage and utilities, and the similar interpretations may be made for the other sectors.

In Table 7, productivity decrease or negative productivity change is observed for many industries. This is mainly due to the relatively slow growth of output in those industries. Our industrial outputs in real terms are obtained by deflation using the NIS deflators (Table 4). The NIS deflators indicate sharper price increases in almost all industries compared to the Mangahas-Encarnacion deflators (Table 4). Therefore, it seems worthwhile to provide the growth accounting based on the latter deflators for the sake of comparison. Table 8 shows the final results, which are obtained completely in the same way as the results of Table 7 except for the use of different

Table 8. Growth Accounting of the IO Basis, 1965-1969 (Using Mangahas-Encarnación Deflators)

Industries					
1. Agriculture:	25.7 =	.152 x 65.1	+ .390 x 3.8	+ .458 x 18.4	+ (5.
		(9.9)	(1.5)	(8.4)	
2. Mining:	81.1 =	.337 x 71.9	+ .201 x 86.2	+ .463 x 87.2	+ (-0.
		(24.2)	(17.3)	(40.4)	
3. Manufacturing	45.8 =	.641 x 40.9	+ .106 x 13.5	+ .254 x 41.3	+ (7.
		(26.2)	(1.4)	(10.5)	
4. Construction:	40.8 =	.529 x 29.5	+ .240 x 16.2	+ .231 x 40.7	+ (11.
		(15.6)	(3.9)	(9.4)	
5. Transp. etc.:	46.5 =	.366 x 17.5	+ .276 x 5.4	+ .358 x 59.2	+ (17.
		(6.4)	(1.5)	(21.2)	
6. Commerce:	33.0 =	.195 x 71.4	+ .261 x (-1.9)	+ .545 x 21.1	+ (8.
		(13.9)	(-0.5)	(11.5)	
7. Services:	18.1 =	.265 x 38.5	+ .487 x 15.1	+ .249 x 7.4	+ (-1.
		(10.2)	(7.3)	(1.8)	
Total economy (IO base)					
(Divisia aggregation):	35.4 =	.374 x 44.1	+ .268 x 8.6	+ .359 x 27.6	+ (6.
		(16.5)	(2.3)	(9.9)	
Total economy (NIS base)					
From input-output tables: (Divisia aggregation)	30.2 =		.428 x 8.6	+ .572 x 27.6	+ (10.
			(3.7)	(15.8)	
From national income series (Simple aggregation)	23.6 =		.428 x 5.4	+ .572 x 28.1	+ (5.
			(2.3)	(16.1)	

(See the footnotes to Table 7).

deflators.[28/] The new results show, of course, upward revisions in output growth resulting in the corresponding upward revisions in productivity growth with the exception of the manufacturing industry.[29/] The observed productivity increase is positive in many industries and, even if it is negative, it is very small in absolute value. In this sense, the results of Table 8 may be regarded as more plausible than those of Table 7. Taht means that the NIS deflators may not be so appropriate as the Mangahas-Encarnacion deflators. It seems to the author that the plausibility or reliability in the national income series of NEDA should be checked at least about the data on "net domestic product by industrial origin at 1967 prices," since the NIS deflators here are defined as the ratios of nominal values to real values in industrial net products.

According to Massel [1961], aggregate technical progress can be decomposed into two parts: intra-industry technical progress, which is a weighted average of the component industry technical progress, and inter-industry technical progress, which arises from an inter-industry shift in resources. Noting that his concept of output is net or value added and his concept of aggregate output is the simple sum of components net outputs (in real terms), we can apply his analysis to our case of input-output framework which allows explicitly for intermediate inputs. In other words, total (aggregate) technical progress can be computed by using the last columns (subtotal) of Tables 5 and 6, while intra-industry technical progess can be computed by taking a weighted average of the components industry productivity changes (Table 7) with the output (quantity) shares in 1965 as weights. Inter-industry technical progress is, then, the difference between the above two. The results are summarized in Table 9, which includes also the results based on the Mangahas-Encarnacion deflators for the sake of comparison. Though some approximation errors mentioned before are contained in the computations,[30/] it can be said that a positive inter-industry technical progress is observed between 1965 and 1969. This result on the aggregate economy is consistent with the comprehensive study of Williamson and Sicat [1968] who conclude, after careful observations on inter-industry technical progress in the manufacturing sector, that decontrol and devaluation had important positive effects on the better resource allocation in that sector. Their conclusion and our result, however, may have to be discounted to some extent in the sense that the inter-industry technical progress vanishes if the Divisia method is used in aggregation.

Table 9. Total Intra-industry and Inter-industry Technical Progress

(%)

	Technical progress	=	Output growth	-	Contributions of intermediate inputs		labor inputs		capital inputs	
Total	4.7	=	30.3	-	(14.1	+	1.4	+	10.1	)
(1) = Intra-industry	2.6	=	30.3	-	(14.9	+	2.4	+	10.5	)
+ Inter-industry	2.1	=			0.8	+	1.0	+	0.4	
Total	7.9	=	34.7	-	(15.3	+	1.4	+	10.1	)
(2) = Intra-industry	6.6	=	34.7	-	(16.2	+	2.3	+	9.7	)
+ Inter-industry	1.3	=			0.9	+	0.9	-	0.6	

(1) = based on the NIS deflators.

(2) = based on the Mangahas - Encarnación deflators.

4. Concluding Remarks

In this paper, we have presented a methodological framework for growth accounting on the basis of input-output (IO) tables and provided a corresponding measurement on the Philippine economy using the 1965 and 1969 input-output tables of NEC and NEDA. We have also attempted to show explicitly the linkage to the conventional measurement which is based on national income statistics (NIS). Growth accounting of the NIS basis may be operationally better than that of the IO basis in the light of data availability. However, as our methodological analysis has shown, the latter is theoretically better than the former in the light of the treatment of intermediate goods. In the growth accounting, therefore, measurement of the NIS basis must be checked and supplemented by the measurement of the IO basis as much as possible. This has been pursued in our empirical analysis of the Philippine economy. Our measurement, of course, cannot be said to be very reliable due to the insufficient availability of basic data. Especially, capital stocks by industry are the results of a guess work. Neither different types of labor (classified by age, sex, education etc.) nor different types of capital (structures, equipments, inventories, land etc.) are allowed for. Working hours and utilization rate of capital are not introduced, either.[31/] Our measurement, therefore, must be revised and improved in accordance with the improvement of the basic data both in quality and in availability.

Appendix. Proof of Equations (13), (14) and (17)

$$\frac{\dot{T}}{T} \equiv -\left(\sum_{i}\sum_{k} \frac{q_k y_{ki}}{\Sigma q_i y_i} \cdot \frac{\dot{a}_{ki}}{a_{ki}} + \sum_{i}\sum_{j} \frac{p_j x_{ji}}{\Sigma q_i y_i} \cdot \frac{\dot{b}_{ji}}{b_{ji}}\right) \qquad \text{(equation (12))}$$

$$= -\sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \left(\sum_k \frac{q_k y_{ki}}{q_i y_i} \cdot \frac{\dot{a}_{ki}}{a_{ki}} + \sum_j \frac{p_j x_{ji}}{q_i y_i} \cdot \frac{\dot{b}_{ji}}{b_{ji}}\right)$$

$$= \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{T}^i}{T^i} \qquad \text{(equation (13))}$$

$$= \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \left(\frac{\dot{y}_i}{y_i} - \sum_k \frac{q_k y_{ki}}{q_i y_i} \cdot \frac{\dot{y}_{ki}}{y_{ki}} - \sum_j \frac{p_j x_{ji}}{q_i j_i} \cdot \frac{\dot{x}_{ji}}{x_{ji}}\right)$$

$$= \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{y}_i}{y_i} - \sum_{i}\sum_{k} \frac{q_k y_{ki}}{\Sigma q_i y_i} \cdot \frac{\dot{y}_{ki}}{y_{ki}} - \sum_{i}\sum_{j} \frac{p_j x_{ji}}{\Sigma q_i y_i} \cdot \frac{\dot{x}_{ji}}{x_{ji}}$$

$$= \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{y}_i}{y_i} - \frac{\Sigma q_i U_i}{\Sigma q_i y_i} \cdot \sum_k \frac{q_k U_k}{\Sigma q_i U_i} \cdot \sum_i \frac{q_k y_{ki}}{q_k U_k} \cdot \frac{\dot{y}_{ki}}{y_{ki}}$$

$$- \frac{\Sigma p_j X_j}{\Sigma q_i y_i} \cdot \sum_j \frac{p_j X_j}{\Sigma p_j X_j} \cdot \sum_i \frac{p_j x_{ji}}{p_j X_j} \cdot \frac{\dot{x}_{ji}}{x_{ji}}$$

$$= \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{y}_i}{y_i} - \frac{\Sigma q_i U_i}{\Sigma q_i y_i} \sum_k \frac{q_k U_k}{\Sigma q_i U_i} \cdot \frac{\dot{U}_k}{U_k} - \frac{\Sigma p_j X_i}{\Sigma q_i y_i} \sum_j \frac{p_j X_j}{\Sigma p_j X_j} \cdot \frac{\dot{X}_j}{X_j}$$

(from (7) and (8))

$$= \sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{y}_i}{y_i} - (1-\theta) \cdot \sum_i \frac{q_i U_i}{\Sigma q_i U_i} \cdot \frac{\dot{U}_i}{U_i} - \theta \cdot \sum_j \frac{p_j X_j}{\Sigma p_j X_j} \cdot \frac{\dot{X}_j}{X_j}$$

$$= \frac{\dot{y}}{y} - (1-\theta) \cdot \frac{\dot{U}}{U} - \theta \cdot \frac{\dot{X}}{X} \qquad \text{(equation (14))}$$

$$\frac{\dot{P}}{P} \quad \sum \frac{q_i Y_i}{\Sigma q_i Y_i} \cdot \frac{\dot{Y}_i}{Y_i} - \sum \frac{p_j X_j}{\Sigma p_j X_j} \cdot \frac{\dot{X}_j}{X_j} \qquad \text{(equation (16))}$$

$$= \frac{\Sigma q_i y_i}{\Sigma q_i Y_i} \cdot \sum_i \frac{q_i(\dot{y}_i - \dot{U}_i)}{\Sigma q_i y_i} - \sum_j \frac{p_j X_j}{\Sigma p_j X_j} \cdot \frac{\dot{X}_j}{X_j}$$

$$= \frac{1}{\theta} \left(\sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{y}_i}{y_i} - \sum_i \frac{q_i U_i}{\Sigma q_i y_i} \cdot \frac{\dot{U}_i}{U_i} \right) - \sum_j \frac{p_j X_j}{\Sigma p_j X_i} \cdot \frac{\dot{X}_j}{X_j}$$

$$= \frac{1}{\theta} \left(\sum_i \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{y}_i}{y_i} - (1-\theta) \cdot \sum_i \frac{q_i U_i}{\Sigma q_i U_i} - \theta \cdot \sum_j \frac{p_j X_j}{\Sigma p_j X_j} \cdot \frac{\dot{X}_j}{X_j} \right)$$

$$= \frac{1}{\theta} \cdot \frac{\dot{T}}{T} = \frac{\Sigma q_i y_i}{\Sigma q_i Y_i} \cdot \sum \frac{q_i y_i}{\Sigma q_i y_i} \cdot \frac{\dot{T}^i}{T^i} = \sum \frac{q_i y_i}{\Sigma q_i Y_i} \cdot \frac{\dot{T}^i}{T^i} \qquad \text{(equation (17))}$$

Appendix Table 1, Input-Output Table, 1965 (producers' prices)

(millions of pesos)

	1	2	3	4	5	6	7	Subtotal
1. Agriculture	236.9	5.9	3115.3	8.0	9.4	-	168.0	3543.4
2. Mining	1.0	2.1	292.4	26.6	0.1	0.9	0.8	323.8
3. Manufacturing	468.2	87.4	2299.0	722.6	374.5	191.7	581.4	4724.9
4. Construction	-	0.3	3.2	26.7	1.8	42.0	3.7	77.5
5. Transp. etc.	38.1	12.7	283.8	30.9	115.7	165.5	94.7	741.3
6. Commerce	196.5	23.8	938.2	150.5	120.7	445.1	259.0	2133.9
7. Services	53.9	16.2	318.2	81.1	76.3	389.3	278.2	1213.3
Subtotal	994.5	148.5	7250.2	1046.3	698.5	1234.5	1385.8	12758.2
8. Wages and Salaries	2834.7	93.0	1189.0	470.6	479.6	2091.7	2765.1	9923.7
9. Depreciation	289.9	26.5	278.7	42.4	125,8	321.7	99.8	1184.9
10. Other value added	2772.5	152,1	1995.4	364.6	349.5	3300.5	1068.4	10003.0
11. Indirect taxes less Subsidies	- 7.6	-13.5	575.1	22.1	71.3	244.0	36.4	927.8
(Discripancy) Statistical	-	-	-	-	-	-	(310.3)	(310.3)
Subtotal	5889.5	258.2	4038.2	899.7	1026.2	5957.9	4280.0	22349.7
Total	6884.0	406,7	11288.4	1946.0	1724.7	7192.4	5665.8	35107.9

Source: NEDA, Statistical Yearbook of the Philippines 1975 (pp. 480-483).

Appendix Table 2. Input-Output Table, 1969 (producers' prices)

(millions of pesos)

	1	2	3	4	5	6	7	Subtotal
1. Agriculture	707.3	8.3	5052.7	44.9	13.4	-	256.6	6083.3
2. Mining	4.1	4.5	606.1	39.0	.3	-	1.6	655.6
3. Manufacturing	598.6	183.4	4494.5	990.9	487.7	304.2	956.6	8016.0
4. Construction	-	.9	21.7	55.2	3.6	149.4	18.4	249.2
5. Transp. etc.	100.3	26.0	440.4	46.3	169.3	367.9	172.9	1323.1
6. Commerce	220.9	46.9	1372.5	199.0	151.4	911.2	308.2	3210.0
7. Services	178.3	25.6	344.6	150.4	120.8	588.8	490.7	1899.2
Subtotal	1809.4	295.6	12332.5	1525.8	946.6	2321.5	2204.9	21436.3
8. Wages and Salaries	4171.9	188.9	2036.2	694.7	788.5	2452.7	3751.3	14084.1
9. Depreciation	467.5	86.7	509.1	79.7	271.3	513.3	207.2	2134.8
10. Other value added	4839.6	399.5	3403.6	583.6	773.6	4845.8	1413.7	16259.4
11. Indirect taxes less Subsidies	59.2	-11.9	1009.7	45.1	108.6	520.8	152.6	1884.1
Subtotal	9538.2	663.1	6958.5	1403.0	1942.1	8332.6	5524.8	34362.4
Total	11347.6	958.7	19291.0	2928.8	2888.7	10654.1	7729.8	55798.7

Source: NEDA, 1969 Input-Output Tables of the Philippines (1975, pp. 4-9).

FOOTNOTES

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1/ For the growth accounting in general, see the two comprehensive surveys on methodology and measurement made by Nadiri [1970, 1972].

2/ A similar analysis using the 1961 input-output table is left to be finished by those who know the table very well, since it is said that the 1961 table contains a misleading data compilation for capital formation. Palance [1974] attempts to analize the change in technical coefficients essentially in the same way as the present paper using the 1961 and 1965 tables. However, her analysis is incomplete to be called a growth accounting, since it deals with intermediate goods and imports only leaving primary factor inputs unexplained. The study of Lampman [1967] is the first attempt to provide a growth accounting for the Philippine (post-war) economy. See his paper for the Denison-type explanations.

3/ This view was expressed in the author's previous paper (Ezaki [1971]). It will be restated here compactly. The same view is proposed recently by Star [1974].

4/ Imports are assumed to be perfectly competitive so that they appear in the final demands side only. Indirect taxes can be regarded as the inputs of government services. They are treated as proportional to capital inputs in the actual measurement.

5/ For the Divisia index, see Jorgenson [1966], Jorgenson and Griliches [1967], Richter [1966], etc.

6/ Strictly speaking, these marginal conditions should be written as

$$q_i f_k^i \leq q_k \quad (k=1 \ldots n) \quad \text{and}$$

$$q_i f_j^i \leq p_j \quad (j=1 \ldots m)$$

By conventions (or as a result of profit maximization under non-negativity restrictions), the input quantities (y_{ki} or x_{ji}) are regarded as zero when the inequalities hold above, so that the identity (1) is always valid and consistent with the marginal conditions.

7/ Leontief et. al. [1953], pp. 31-35.

8/ See the appendix for the proof.

9/ See the appendix for the proof.

10/ Y in the equation (16), of course, means Divisia quantity for final demand so that Y must be measured in the expenditure side of NIS. Sometimes Y is measured in the factor input side by using real value added, but this is not precise even as the conventional measure. Note that equation (16) corresponds to the aggregate productivity change based on NIS.

11/ See the appendix for the proof.

12/ Let us consider a constrained maximization problem where the objective function

$$Z = f(x_1 \ldots x_n)$$

is maximized subject to the constraints

$$g^i (x_1 \ldots x_n, b_1 \ldots b_s) = 0 \qquad (j=1 \ldots m)$$

under the given parameters $b_1 \ldots b_s$. Then we can prove easily the following useful property:

$$\frac{\partial Z^*}{\partial b_k} = \sum_j \lambda_j \cdot \frac{\partial g^j (x_1^* \ldots x_n^*, b_1 \ldots b_s)}{b_k} \qquad (k=1 \ldots s)$$

where Z^* and x_i^*'s are the optimal solutions and the Lagrangean function is

$$L = Z + \sum_j \lambda_j \cdot g^j (x_1 \ldots x_n, b_1 \ldots b_s) \quad (\lambda_j = \text{Lagrange multiplier}).$$

This is a little extension of Hadley [1964, Ch. 3], for example.

13/ See Ezaki and Jorgenson [1973a, 1973b] for the reasoning.

14/ Note that this ratio allows exactly neither for the labor part of "entrepreneurial income of persons" nor for the labor income of unpaid family workers.

15/ We get a very similar result even when we use the ILO data for total employment and the wages - GNP ratio of Canlas, Encarnacion and Ho [1975, Table 1, R].

16/ See Power and Sicat [1971].

17/ The NEDA Statistical Yearbook 1975 provides a 12x12 transactions table for 1965, which is used here in computations. We employ the IO tables at producers' prices simply by reason of convenience.

18/ The treatment of "Unallocated Sector" in the 1965 table is different in that we include it in the "Services" sector without prorating it to all industries.

19/ The 64 k's are weighted averaged into the 7 k's using values added in 1965 IO table as weights.

The results are: $k_i = 2.04$, $k_2 = 5.00$, $k_3 = 2.39$, $k_4 = 4.50$, $k_5 = 6.07$, $k_6 = 1.15$, and $k_7 = 3.10$.

20/ The results are included in Tables 5 and 6, i.e., the row of subtotal corresponding to real value added.

21/ The average incremental capital-output ratio used in estimating K is 3.34 (Canlas, Encarnacion and Ho [1975, p. 22]). The average capital-output ratio in 1965 computed by Paukert, Skolka and Maton [1975, p. 222] is 2.376 which is (should be) almost identical with our result above.

22/ See "total book value of fixed assets" in Philippine Yearbook 1975 (Table XVI.2, p. 574) and compare it with "census value added" there.

23/ It is again assumed that inputs of government services such as "indirect taxes less subsidies" are proportional to capital inputs (See Tables 5 and 6).

24/ The correspondence is not precise due to the different data on labor share and labor input. The exact correspondence can be given by the following growth accounting (%):

$$\underset{}{23.6} = .44 \times \underset{[4.4]}{10.1} + .56 \times \underset{[15.7]}{28.1} + [3.5]$$

25/ The relative wage rates between industries (based on the average of the 1965 and 1969 average wage rates in each industry) are:

(1) 0.428, (2) 0.268, (3) 1.000, (4) 1.355, (5) 1.188, (6) 1.549, and (7) 1.598

where the average wage rate of manufacturing sector (3) is taken as base. Note that, in Table 7, the Divisia quantity for total labor inputs is give by the growth rate which is the weighted average of the components growth rates. When we construct the aggregate quantity in efficiency units by using the above relative wage rates, we get 9090 (thousand persons) for 1965 and 9783 (thousand persons) for 1969, so that its growth rate is 7.6% and the corresponding quality change becomes 2.2% which is 1% smaller than in the case of Table 7.

26/ Contributions to the aggregate productivity change by seven industries are as follows:

(1) -0.2% = .1998 x (-0.9%), (2) -0.2% = .0144 x (-12.4%),

(3) 3.6% = .3336 x 10.8%, (4) -0.7% = .0539 x (-12.2%),

(5) 0.7% = .0505 x 13.1%, (6) 1.1% = .1971 x 5.6%,

(7) -1.4% = .1499 x (-9.3%)

The sum of the above seven contribution is, of course, equal to the aggregate productivity charge 3.0%.

27/ Growth accounting of the manufacturing sector can be rewritten as follows based on equation (6):

10.8% = .641 x 12.0% + .106 x 36.6% + .254 x (-2.0%)
[7.7%] [3.9%] [-0.5%]

28/ Note that the stimates of industrial capital stocks are slightly different as a result of using different deflators. Note also that the difference in the growth rates of total capital stocks between Divisia quantity (27.6%) and simple sum (28.1%) is negligible in this case.

29/ Contributions to the aggregate productivity change (6.7%) by seven industries are:

(1) 1.2% = .1998 x 5.9%, (2) -0.0% = .0144 x (-0.8%),

(3) 2.6% = .3336 x 7.7%, (4) 0.6% = .0539 x 11.9%,

(5) 0.9% = .0505 x 17.4%, (6) 1.6% = .1979 x 8.1%,

(7) -0.2% = .1499 x (-1.2%).

Therefore, in the present measurement, the contribution of the manufacturing sector is not so dominant as in the previous measurement.

30/ This is true especially for the aggregation of intermediate inputs.

31/ See Bautista [1974] for capital utilization in the manufacturing sector.

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