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Abstract

This paper provides a new methodology to measure the total factor productivity (TFP) of an economy. The major conclusions are as follows: (1) Ignoring the effect of industrial structural changes will underestimated the TFP growth of the whole economy of Taiwan by 23.23 percent during 1961-80, while it will overestimate the TFP growth by 23.94 percent during 1980-99; (2) the factors that explain the effect of industrial structural changes during 1970-99 include government industrial policies and liberalization policies; (3) the Krugman-Kim-Lau-Young ‘input-driven growth’ hypothesis for the NIEs is without basis, not only in this study and Liang (2002) but also in that of Young (1994b).

JEL classifications: D24; O00; O11; O14; O40; O47; O49

Keywords: Total factor productivity; Economic growth; Industrial Structure Changes; Industrial policy; Taiwan; NIEs

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The author would like to express his thanks to Professor Dale W. Jorgenson for his inspiring suggestion. He is also greatly indebted to his painstaking and very capable research assistants, Mr. Chih-Chun Liu, Ms. Ting Lie, Ms. Wan-Jou Liu, Ms. Jo-Chi Yu and Ms. Wen-Ting Chen.
1. Introduction

Basing his argument on the empirical results of Kim and Lau (1994), Lau (1994), Young (1994\textsuperscript{a}) and mainly Young (1994\textsuperscript{b}), Krugman (1994) maintained that the secret of the economic miracle in the four Newly Industrializing Economies (NIEs), i.e. Singapore, Hong Kong, Korea, and Taiwan, during the past three decades was the ‘input-driven growth’. In other words, it had little to do with TFP or technical change, and much to do with the rapid increase in factor inputs. Hence, the economic miracle could not be sustained owing to the law of diminishing returns. Hereafter, we refer to this as the Krugman-Kim-Lau-Young hypothesis.

Although they exhibit various similarities in terms of their results, the approaches employed by Kim and Lau (1994), Young (1994\textsuperscript{a}) and Young (1994\textsuperscript{b}) differ from each other. Kim and Lau (1994) use time-series and cross-sectional pooling data to establish an international production function. Young (1994\textsuperscript{a}) performs a cross-sectional regression based on the growth of output per worker on a constant plus the growth of capital per worker during 1970-85 in order to measure the residuals which he treats as TFP for a total of sixty-six countries. As Young (1994\textsuperscript{a}) points out, “This procedure is fraught with error. In particular, since technical change induces capital accumulation, the coefficient for capital per worker will tend to overstate the elasticity of output with respect to the capital input.” In addition, Young (1994\textsuperscript{b}) uses a ‘growth accounting’ approach, which is similar to that adopted by Gollop and Jorgenson (1980) and Jorgenson, Gollop and Fraumeni (1986).

The methods of data compilation also vary. Kim and Lau (1994) and Young (1994\textsuperscript{a}) do not take into consideration the heterogeneous characteristics of the factor inputs.
However, following Jorgenson and his associates (Christensen and Jorgenson (1970), Gollop and Jorgenson (1980) and Jorgenson, Gollop and Fraumeni (1986)), Young (1994b) takes into account the heterogeneous characteristics of the inputs, which might help avoid some of the measurement errors in relation to TFP changes. It is for this reason that we focus mainly on Young (1994b) in this study.

Liang (1995) points out that Young (1994b) discusses the past thirty years of economic growth without taking into account the different characteristics of the sub-periods. In order to forecast the TFP growth in the future, it is more relevant to determine the trend of TFP growth by comparing the growth rates of different sub-periods rather than by taking an average figure for the whole of the observation period. Using the dual approach, Hsieh (2002) argues that the TFP growth rates for Singapore, Korea, Hong Kong and Taiwan are greater than the corresponding rates that Young (1994b) obtained. Liang (2000) also found the similar result for Taiwan.

Moreover, Young (1994b), just as Gollop and Jorgenson (1980), Jorgenson, Gollop and Fraumeni (1986), ignores the heterogeneous characteristics of inputs by sector. The quality changes in inputs caused by the changes in industrial structure or the “input reallocation effect” should be taken into account in calculating the TFP for the economy as a whole. This paper therefore employs the approach adopted by Jorgenson and Liang (1995) and Liang (1995) and Liang and Jorgenson (1998) by incorporating the quality changes in inputs caused by changes in industrial structure, and treating them as a further heterogeneous characteristic of inputs in the TFP calculation.

In addition, as Jorgenson and Griliches (1967) correctly pointed out, to maintain theoretical consistency and avoid the aggregation error, the output should also be
decomposed before being summed up by using the translog index. If this output aggregation technique is to be applied to the whole economy, the quality changes in output with respect to changes in the industrial structure, or the “output reallocation effect,” should also be considered. However, few, if any, empirical studies, including Young (1994\textsuperscript{b}), have actually performed this exercise in measuring the TFP growth for the whole economy.\textsuperscript{1}

To sum up, both the “input reallocation effect” and “output reallocation effect” caused by changes in the industrial structure should be incorporated into the measurement of TFP growth for the whole economy.

Consequently, the objective of this paper is to incorporate the changes in industrial structure into the measurement of TFP growth for an economy. To reevaluate the Krugman-Kim-Lau-Young hypothesis, a comparison with Young (1994\textsuperscript{b}) is also conducted. For this comparison, and also as an example, we employ the data for Taiwan, one of the four NIEs, during the 1961-99 periods.

This paper has found that the TFP growth with industrial structure changes adjustment registered 2.03 percent per annum and 2.37 percent per annum during 1961-80 and 1980-99, respectively, in Taiwan. In contrast, the TFP growth without industrial structural changes adjustment was 1.55 percent and 2.94 percent per annum. In other words, ignoring the effect of industrial structural changes will underestimated the TFP growth of the whole economy of Taiwan by 23.23 percent during 1961-80, while it will

\textsuperscript{1}It is noted that Jorgenson and Griliches (1967) did decomposed the total output, i.e., GDP into investment goods and consumer's goods (not according to industrial sectors) to calculate TFP growth for the United States.
overestimate the TFP growth by 23.94 percent during 1980-99\(^2\). It is therefore important to consider the effect of industrial structural changes to measure the TFP growth correctly. The factors that explain the effect of industrial structural changes during 1970-99 include government industrial policies and liberalization policies. This conclusion differs with the argument of Krugman (1994) on the uselessness of industrial policies in the economic development of the NICs. Finally, this paper found that the Krugman-Kim-Lau-Young ‘input-driven growth’ hypothesis for the NIEs is without basis, not only in this study and Liang (2002) but also in that of Young (1994\(^b\)).

The remainder of this paper is organized as follows. Section 2 presents the methodology, Section 3 the compilation of the data, Section 4 the empirical results, and Section 5 the conclusions and suggestions for further research.

2. Methodology

First of all, following Gollop and Jorgenson (1980), Jorgenson-Gollop-Fraumeni (1986) and Young (1994\(^b\)), we measure sector-level productivity by using the translog production function:

\[
\ln Q = \ln \alpha_0 + \alpha_T T + \alpha_K \ln K + \alpha_L \ln L + \frac{1}{2} \beta_{KK} (\ln K)^2 + \beta_{KL} \ln K \ln L + \beta_{LT} \ln L \cdot T + \frac{1}{2} \beta_{TT} T^2
\]

Real value added (Q) is a function of the logarithms of capital (K), labor (L) and time (T) that indexes the level of technology. The production function is assumed to exhibit constant returns to scale, so that a proportional change in all inputs results in a proportional change in output.

Differentiating equation (1) with respect to T, the rate of technical change or TFP

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\(^2\) The percentages are calculated from the relevant TFP growth rates rounding up to six decimal places.
change \((R_T)\) can be expressed as:

\[
R_T = \alpha_T + \beta_{KT} \ln K + \beta_{LT} \ln L + \beta_{TT} T. \tag{2}
\]

For the data at any two discrete points in time, say \(T\) and \(T-1\), the average rate of TFP change can be derived from growth accounting, i.e. the difference between successive logarithms of real value added less a weighted average of the differences between successive logarithms of capital and labor inputs with weights given by average value shares:\(^3\)

\[
\overline{R}_T = \ln Q(T) - \ln Q(T-1) - \bar{s}_k [\ln K(T) - \ln K(T-1)] - \bar{s}_l [\ln L(T) - \ln L(T-1)], \tag{3}
\]

where

\[
\bar{s}_k = 1/2 [s_k(T) + s_k(T-1)], \tag{4}
\]

\[
\bar{s}_l = 1/2 [s_l(T) + s_l(T-1)], \tag{5}
\]

\[
s_k = \frac{P_k \cdot K}{P \cdot Q} = \text{Capital share in value added}
\]

\[
s_l = \frac{P_l \cdot L}{P \cdot Q} = \text{Labor share in value added}
\]

The index in (3) is referred to as the Tornqvist index of technical change or the translog index of technical change.

For considering the heterogeneous characteristics of factor inputs, the aggregate capital \((K)\) and labor \((L)\) have been decomposed to component capitals (e.g. buildings, machinery and so forth) and labors (by education, age and so on) before aggregating with translog index, such as:\(^4\):

\[
\ln K(T) - \ln K(T-1) = \sum_{i=1}^{m} \bar{s}_{ki} [\ln K_i(T) - \ln K_i(T-1)], \quad (i = 1 \cdots m) \tag{6}
\]

\(^3\) See Gollop and Jorgenson (1980); for the proof, see Diewert (1976).
and
\[
\ln L(T) - \ln L(T-1) = \sum_{j=1}^{n} \overline{s_{L_j}} \{\ln L_j(T) - \ln L_j(T-1)\}, \quad (j = 1 \cdots n) \quad (7)
\]

where \( \overline{s_{Ki}} = 1/2[s_{Ki}(T) + s_{Ki}(T-1)] \) \( (8) \)

\[
s_{ki} = \frac{P_{ki} \cdot K_i}{\sum_{i=1}^{m} P_{ki} \cdot K_i} = \text{The share of i capital compensation in the aggregate sector’s capital compensation}
\]

and \( \overline{s_{Lj}} = 1/2[s_{Lj}(T) + s_{Lj}(T-1)] \) \( (9) \)

\[
s_{Lj} = \frac{P_{Lj} \cdot L_j}{\sum_{i=1}^{n} P_{Lj} \cdot L_j} = \text{The share of i labor compensation in the aggregate sector’s labor compensation}
\]

However, to aggregate the sector-level inputs into the inputs of a larger sector or the whole economy, the following translog index is employed: \(5\)

\[
\ln K^x(T) - \ln K^x(T-1) = \sum_{x=1}^{P} \overline{s_{Kx}} \{\ln K_x(T) - \ln K_x(T-1)\} = \ln K(T) - \ln K(T-1) + KQR
\]

\[ x=1, \ldots, P \text{ sector} \quad (10) \]

where

\( KQR = \text{Capital quality changes due to capital reallocation among sectors} \)

\( \overline{s_{Kx}} = 1/2[s_{Kx}(T) + s_{Kx}(T-1)] \)

and \( s_{Kx} = \frac{P_{Kx} \cdot K_x}{\sum_{x=1}^{P} P_{Kx} \cdot K_x} = \text{The share of sector X’s capital compensation in the aggregate sector’s capital compensation} \)

Furthermore,

\[
\ln L^A(T) - \ln L^A(T - 1) = \sum_{x=1}^{P} s_{Lx} \left[ \ln L_x(T) - \ln L_x(T - 1) \right] \\
= \ln L(T) - \ln L(T - 1) + LQR
\]

where

\( LQR \) = Labor quality changes due to labor reallocation among sectors

\[
\overline{s_{Lx}} = \frac{1}{2} [s_{Lx}(T) + s_{Lx}(T - 1)] , \quad \text{and} \quad s_{Lx} = \frac{P_{Lx} \cdot L_x}{\sum_{x=1}^{P} P_{Lx} \cdot L_x}
\]

\[
= \text{the share of sector x’s labor compensation in the aggregate sector’s labor compensation}
\]

Since the output of the aggregate sector or the whole economy is an aggregate of individual sector-level output, we can also employ the translog function to aggregate its output. Similarly, for the data at discrete points in time, the difference between successive logarithms of aggregate output or the translog index of output change can be expressed as:

\[
\ln Q^A(T) - \ln Q^A(T - 1) = \sum_{x=1}^{P} s_{Qx} \left[ \ln Q_x(T) - \ln Q_x(T - 1) \right] \\
= \ln Q_x(T) - \ln Q_x(T - 1) + OQR
\]

where

\( OQR \) = Output quality changes due to output reallocation among sectors or output reallocation effect

\[
\overline{s_{Qx}} = \frac{1}{2} [s_{Qx}(T) + s_{Qx}(T - 1)]
\]
and \( s_{QN} \) = Moving average of the value share of sector x’ total output in the aggregate sector.

Finally, the rate of TFP change for this aggregate sector or the whole economy can be derived from:

\[
\bar{R}_T^A = \ln Q^A(T) - \ln Q^A(T - 1) - \bar{s}_K^A \left[ \ln K^A(T) - \ln K^A(T - 1) \right] - \bar{s}_L^A \left[ \ln L^A(T) - \ln L^A(T - 1) \right]
\]

(13)

where \( \bar{s}_K^A \) and \( \bar{s}_L^A \) are the moving averages of the value share of capital compensation in value added, and the share of labor compensation in value added, respectively, in the aggregated sector at any two discrete points in time.

The difference between equation (13) and equation (3) is:

\[
\bar{R}_T^A - \bar{R}_T = (\bar{S}_K^A \times KQR + \bar{S}_L^A \times LQR)
\]

\[
= Output reallocation effect – Input reallocation effect
\]

\[
= Effect of industrial structure changes
\]

(14)

It is also noted that, while Liang (1995), Liang and Jorgenson (1998) and Liang (2002) had considered the input reallocation effect in their TFP calculation, however, the output reallocation effect was still ignored.

For comparison purposes, in the next section, this study will calculate two kinds of TFP growth for the whole economy, based on equation (3) and equation (13), respectively.

3. Data Compilation Method and Sources

The observation period runs from 1961 to 1999. The economy is decomposed into the following thirty-one sectors: eight main sectors (agriculture, industry (including
mining, manufacturing, water, electricity & gas, and construction), transportation and services), seventeen manufacturing sectors (food processing, beverage & tobacco, textiles, clothes & wearing apparel, leather & leather products, wood & furniture products, paper & printing, chemicals & plastics, rubber products, non-metallic minerals, basic metals, metal products, machinery & equipment, electrical machinery & electronics, transportation equipment, and miscellaneous), three service sectors (commerce, finance & insurance, and personal services), and four energy sectors (coal, natural gas, oil refining, and electricity). It is noted that the government service sector is excluded from the whole economy, because the profit maximizing rule is not applicable to the government service sector. In addition, in the National Income Account, the output of the government service sector is identical with its labor compensation. This is unique.

3.1 Capital Input

The capital input is decomposed into six categories:

(1) Construction \((K_1)\), (2) other construction \((K_2)\), (3) transportation equipment \((K_3)\), (4) machineries \((K_4)\), (5) inventory \((K_5)\), and (6) land \((K_6)\).

The time series capital stacks data are complied by using the perpetual inventory approach. Except for land \((K_6)\), all types of capital are calculated by adding up corresponding net capital formation, which is the difference between the gross capital formation and the depreciation, starting from 1951. The gross capital formation during 1951-1989 comes from the DGBAS; the types of depreciation are compiled by employing the constant rate depreciation method and the years of depreciation listed in the National Wealth Census (1988). The time series capital stock during 1961-1989 is then calculated by adding up the net capital formation starting from 1951 – the beginning year of the National
Income Account in Taiwan. This method implicitly assumes that no net capital stock existed before 1951 that might lead to underestimate the capital stack 1951. However observation period starts from 1961 instead of 1951 that might help to lessen the estimated bias after 1961. The land data comes from the Industrial and Commercial Census for various years. For the same reason, we adjust the time series capital stock data by employing the National Wealth Census (1988) complied from perpetual inventory approach.

The types of capital service prices are compiled by using the following equation of Christensen-Jorgenson (1969, 1970):

\[
P_{ki} = \frac{1 - \mu(T) \cdot Z_i(T)}{1 - \mu(T)} \cdot \left[ P_{ni}(T - 1) \cdot (1 - \mu(T)) \cdot R_s(T) + \delta_i \cdot P_{ni}(T) - (P_{ni}(T) - P_{ni}(T - 1)) \right] + P_{ni}(T) \cdot \tau_i(T), \quad (i = 1, 2, 3, 4, 5, 6)
\]

where

\(\mu(T)\): The effective business income tax rate;

\(Z_i(T)\): The present value of depreciation deducted for tax purposes on a dollar’s investment in capital \(i\);

\(P_{ni}(T)\): The price index of gross investment in relation to capital \(i\);

\(\delta_i\): The depreciation rate in relation to capital \(i\);

\(\tau_i(T)\): The property tax rate for capital \(i\);

\(R_s(T)\): The rate of return for all types of capital.

The effective business income tax rate is the ratio of the business income tax divided by the total profit of all sectors. The data on business income tax comes from the Yearbook of the Ministry of Finance. The total profit of all sectors (excluding interest and rent) is
taken from the *National Income Account*.

By using the constant rate of depreciation method, the present value of deductions in relation to a dollar of investment good $i$ is calculated by means of the following equations:

\[
\delta_i = 1 - \left( \frac{s_i}{c_i} \right)^{\frac{1}{N_i}} \quad (\text{given } s_i = 0.1c_i)
\]

\[
Z_i(T) = \sum \left[ \frac{(1 - \delta_i)^{N_i - 1} \cdot \delta_i}{(1 + r)^{N_i}} \right]
\]

where $N$: The time span of investment good $i$,

$\delta_i$: The constant rate of depreciation of capital $i$,

$r$: The one-year prime rate

$c_i$: The cost of investment good $i$.

$S_i$: The remaining value of investment good $i$.

The data on $N_i$ and $r$ come from the *National Wealth Census (1988)* and *Financial Statistics Monthly*, respectively.

The deflator in relation to capital $i$ for each sector is the quotient of the gross capital formation at current prices and the gross capital formation at constant (1986) prices. Both of these are provided by the Statistics Bureau of the DGBAS.

One modification is made for questionable land prices that are obtained from the value of land assets divided by area. Due to the soaring prices of land in Taiwan during the late 1980s and early 1990s, many companies revalued their land assets, and these changes have never been adjusted in the records since their purchase. Such revaluation makes the data on land assets surveyed in 1996 somewhat unrealistic compared to those surveyed in 1991. We adopt data from the *City Land Price Index* to adjust land prices from 1992 to
Based on the corresponding tax code, tax rates for property \((Z_i(T))\) construction \((K_1)\) and misc. construction \((K_2)\) are assumed to be 3.0 percent. That for land \((K_6)\) is assumed to be 1.5 percent. No property tax is levied on machineries \((K_4)\) and inventory \((K_5)\).

The property tax rate with regard to the transportation equipment \((K_3)\) is calculated as:

\[
K_3 = \frac{\text{The license revenue for mobile cars}}{K_3 \text{ at current prices} - \text{the value of the transportation equipment of all residents}}
\]

The internal rate of return \((R_r(T))\) is calculated by:

\[
R_r(T) = \frac{PC \cdot \sum_{i=1}^{6} \left[ \frac{1 - \mu(T) \cdot Z_i(T)}{1 - \mu(T)} \cdot (\delta P_h(T) - P_h(T)) \right] \cdot K_i}{\sum_{i=1}^{6} (1 - \mu(T) \cdot Z_i(T)) \cdot P_h(T - l) \cdot K_i(T)}
\]

where PC denotes the property compensation, which is the sum of rent, interest and profit depreciation, and is equal to the summation of the products of \(K_i\) and \(P_k\):

\[
PC = \sum_{i=1}^{6} P_{ki} \cdot K_i(T - l)
\]

Since the production of unpaid workers especially in agriculture trade or in the quarrying industries and so on tends to be omitted from the National Income and Product Accounts, we adjust the value shares of capital and labor costs to output using the Input-Output Table for various years (i.e. 1976, 1978, 1986, 1991 and 1996). We interpolate and extrapolate the input-output tables to obtain the time-series \(S_K\) and \(S_L\) for adjusting the \(S_K\) and \(S_L\) series obtained from the National Income Account.

### 3.2 Labor Input
72 categories of labor for each industry are classified on the basis of:

a. sex  
   (a) male  (b) female  

b. employment status  
   (a) employed  
   (b) self-employed and/or unpaid family worker  

c. age  
   (a) 15-24  (b) 25-34  (c) 35-44  
   (d) 45-54  (e) 55-64  (f) over 65  

d. education  
   (a) junior high school graduate or less  
   (b) senior or vocational high school graduate  
   (c) college graduate and above  

Wages and labor inputs on the basis of 72 categories for each sector during 1978-99 are compiled from the magnetic tape of the *Survey of Family Income and Expenditure and Manpower Survey*, DGBAS. The data on working hours by sector during 1978-99 comes from *Monthly Bulletin of Earnings and Productivity Statistics*, DGBAS, various years.

For the data during 1961-78, basically we use the data compiled by Liang (1995). However in this study, we further incorporate the data of working hour by sector during 1961-78 into the labor input estimation. Working hour data comes form the *Monthly Bulletin of Labor Statistics*, DGBAS, various years. In Liang (1995), labor is classified into four groups: (1) managers and clerks; (2) engineers and technicians; (3) skilled labor; and (4) non-skilled labor. The data for the aggregate quantity of the labor input is provided by the DGBAS. The structure of the labor input, classified on the basis of the four types, is derived by interpolating the *Industrial and Commercial Census* data in 1961, 1966, 1971, 1976, 1981, 1986 and 1991.

The breakdown of labor compensation data after 1976 is in accordance with that
obtained from the DGBAS. The data for the breakdown of labor compensation before 1976 were compiled by: (1) interpolating the Census data for 1961, 1966, 1971, and 1976, and data from Labor Statistics Monthly for 1981 to obtain a preliminary estimate of four types of wages $P_{Li}$; (2) adjusting $P_{Li}$ with information from the Adjustment of the Manufacturing Wage Statistics in the Taiwan Area to obtain $P_{Li}'$; (3) multiplying $L_i$ by $PL_i$ to obtain the labor compensation $L_i P_{Li}$; (4) adjusting the labor compensation $L_i P_{Li}'$ with information from the National Income Account to obtain the adjusted labor compensation; and (5) using the adjusted labor compensation and $L_i$ to obtain the wage rate $P_{Li}$.

The value and the value share of labor compensation in total output is obtained from the National Income Account. Again, since the production of unpaid workers especially in agriculture or quarrying industries and so on tends to be omitted from the National Income and Product Accounts, we adjust the value shares of capital and labor costs to output using the Input-Output Table for various years (1976, 1978, 1986, 1991 and 1996). We interpolate and extrapolate the input-output tables to obtain the time-series $S_K$ and $S_L$ for adjusting the $S_K$ and $S_L$ series obtained from the National Income Account.

It is worth of noting that Young (1994b) multiplies the sectoral compensation based on employee data reported in the national accounts by one plus his sectoral estimates of the ratio of implicit to explicit labor income to estimate the share of labor in total factor payments. However, in the case of Taiwan, his estimate of the share of labor compensation in total factor payments is quite large. For instance, the share of labor for the economy as a whole is fairly stable, ranging between 0.72 and 0.70 during 1966-90, which is much larger than the labor share reported in the 1991 input-output table, i.e. 0.64. The Input-Output table of Taiwan has taken into account the implicit labor income such as that for unpaid
family workers and self-employed income.

### 3.3 Real Value Added

The time series for total output and value added at constant prices (1986 prices) during 1961-93 come from the DGBAS. However, the time series for two-digit sectors are available only after 1977. Therefore, we employ the output and value-added data of Liang (1995) for the two-digit sectors during 1961-1977. According to Liang (1995), the index of real total output comes from the *Statistics of Industrial Production*. The deflator of total output is derived from the *National Income Account* and the *Statistics of Industrial Production*. The capital input and the labor input. We then use the value-added data for one-digit sectors (at 1986 prices), such as manufacturing, published by the DGBAS, to control the sum of the corresponding value-added data (at 1986 prices) for two-digit sectors, such as food, textiles and so on.

It is also noted that Young (1994b) excludes the agricultural sector in its TFP estimation for the economy as a whole.

### 4. Empirical Results

The whole of the observation period extends from 1961 to 1999. In order to understand the trend of GDP and TFP growth, it is important to decompose the whole of the observation period into several sub-periods. The length of each sub-period should cover at least a whole economic cycle. Consequently, we decompose the whole observation period 1961-99 into six sub-periods: 1961-99, 1961-80, 1980-99, 1961-70, 1970-80, 1980-90, and 1990-99.

#### 4.1 The Growth of TFP
Table 1 gives the growth of TFP during 1961-99. (Please also refer to Diagram 1 and Diagram 2.) From Table 1, we conclude:

(1) For the economy as a whole, the growth rate of the TFP adjusted by structural changes averaged 1.77 percent per annum during 1961-70. It increased slightly to 2.26 percent per annum during 1970-80, and then surged to 3.17 percent per annum during 1980-90, before falling to 1.48 percent during 1990-99. However, compared with the periods before and after 1980, the TFP growth rate for the whole economy increased from 2.03 percent per annum during 1961-80 to 2.37 percent per annum.

(2) Among the seven main sectors, the transportation sector registered the greatest growth rate in terms of TFP, a 2.61 percent per annum growth during 1961-80. The manufacturing sector with a 2.51 percent annual growth rate ranked second. The services sector with 1.73 percent annual growth rate ranked fourth. The leading manufacturing sectors were miscellaneous manufacturing, 16.71 percent; transportation Equipment, 9.56 percent; electrical machinery & electronics, 9.53 percent; rubber products, 8.52 percent and textiles, 8.34 percent.

(3) During 1980-99, mining (6.01 percent) ranked first among the seven main sectors. Transportation & Communication ranked second, growing by 4.94 percent per annum. Those that followed were the water, Electricity and Gas sector, 4.78 percent; services, 3.06 percent; manufacturing, 1.85 percent; agriculture, 1.20 percent; and construction, -0.05 percent. The leading manufacturing sectors in terms of the TFP growth comprised furniture products, 8.24 percent; chemical products, 6.90 percent; oil refining, 4.32 percent; plastic products, 3.70 percent; electric machine and electronics, 3.44 percent; machinery & equipment, 3.43 percent; basic metals, 2.84 percent; and non-metallic
minerals, 2.76 percent.

(4) Compared with those for 1961-80, the growth rates of TFP for 1980-99 increased in the services, transportation & communications, mining, and water, elect. & gas sectors. Conversely, they decreased in the construction, manufacturing and agricultural sectors.

4.2 Sources of GDP Growth

The total output of the economy as a whole, that is, the gross domestic product (GDP) excluding government services and adjusted for output reallocation, registered a 10.29 percent per annum growth rate during 1961-70. It increased to 10.73 percent per annum during 1970-80, and then fell to 7.87 percent during 1980-90, and to 6.53 percent during 1990-99, respectively. Comparing the periods before and after 1980, the GDP growth rate decreased from 10.52 percent during 1961-80 to 7.23 percent during 1980-99. For the whole of the observation period (1961-99), GDP grew at an average rate of 8.88 percent per annum (see Table 2).

The relative contribution ratios of factor inputs and TFP to the growth in value added during 1961-99 are tabulated in Table 4 and Table 5. Based on these tables, the following important conclusions can be drawn:

(1) For the economy as a whole, the capital input accounted for 47.91 percent of GDP growth during the overall period 1961-99. Labor contributed 27.34 percent. TFP (with adjustments for structural change) was the smallest contributor, accounting for 24.76 percent of GDP growth during the whole of the observation period 1961-99.

(2) The rapid growth of capital accumulation played an important role in Taiwan's economic growth, due largely to the high saving ratio during 1961-99. The saving/GNP ratio averaged 28.4 percent during 1961-99. This can be attributed to: (i)
the influence of Confucian culture in which frugality is considered to be one of the
important virtues; (ii) the positive real interest rates that were generally maintained,
which encouraged saving, as emphasized by Mckinnon (1973), and the fact that the
consumer price index (CPI) growth rate averaged 4.71 percent, and the nominal interest
rate (on one-year deposits) fluctuated between 6.25 and 14.5 percent; (iii) incentives
provided by tax law, i.e. interest and dividend incomes up to NT$350,000 were tax
exempt before 1991, and N.T.$270,000 afterward; and (iv) high GNP growth rates
generated a rising saving ratio. However, the saving/GNP ratio has begun to fall since
1990 because of an increasing government budget deficit. It was 26.1 percent in 1999.

(3) It is worth noting that the contribution of TFP toward GDP growth surpassed that of the
capital input during 1980-90, becoming the most important source of GDP growth.
The contribution of TFP toward GDP growth surged from 19.25 percent during 1961-
80 to 40.33 percent during 1980-90. By contrast, that of capital and labor dropped
from 49.30 percent and 31.45 percent during 1961-80 to 37.91 percent and 21.75
percent during 1980-90, respectively.

(4) The contribution of TFP toward GDP growth dropped significantly during 1990-99.
Nevertheless, the contribution of TFP, which registered as 22.62%, still surpassed labor
(20.83%), as the second important source of GDP growth during the same period.

(5) During the last two decades (1980-99), the TFP was the second most important source
of GDP growth, with a contribution ratio of 32.76 percent. That is lower than the
contribution of capital (45.88percent), but higher than that of labor (21.35 percent).

From (3) to (5), we conclude that the Krugman-Kim-Lau-Young hypothesis, which
is that the fast growth of NIEs has little to do with the improvement in TFP, is unfounded
in Taiwan particularly during the past two decades.

4.3 The Explanation of TFP Growth

a. The Role of Industrial Structural Changes in the TFP Growth

As aforementioned, to consider the industrial structural changes makes the TFP for the whole economy adopted in this study (see equation 23) differ with that of Gollop and Jorgenson (1980), Jorgenson, Gollop and Fraumeni (1986) as well as Young (1994) (see equation 10).

From Table 4 and Table 5, we conclude that:

1. The upward and downward movements in both TFP growth, i.e., the growth of TFP with and without structural changes adjustment are basically identical during all sub-periods of 1961-99. Their average growth rates are also very close during 1961-99. The TFP growth with structural changes adjustment was 2.20 percent per annum, comparing with the TFP growth without structural changes adjustment, i.e., 2.25 percent per annum during 1961-99. However, the above two TFP growth rates varied widely with each other in all of the six sub-periods during 1961-99.

2. The TFP growth with industrial structure changes adjustment registered 2.03 percent per annum and 2.37 percent per annum during 1961-80 and 1980-99 respectively. In contrast, the TFP growth without industrial structural changes adjustment was 1.55 percent and 2.94 percent per annum.

3. The effect of industrial structure changes contributed 0.47 percentage point to TFP growth per annum during 1961-80. In other words, ignoring the effect of industrial structural changes will underestimated the TFP growth by 0.47
percentage point or 23.23 percent in terms of relative contribution during 1961-80. (see col. 2 in table 4 and 5)

4. Conversely, the effect of industrial structural changes contributed -0.57 percentage point during 1980-99. Consequently, regardless of the effect of industrial structural changes will overestimate the TFP growth by 0.57 percentage point or 23.94 percent in terms of relative contribution during 1980-99.

5. Input reallocation effect is positive in all of the sub-periods during 1961-99. It increased steadily from 0.0 percent per annum during 1961-70 to 0.46 percent per annum during 1970-80 and 0.94 percent per annum during 1980-90, before falling to 0.32 percent per annum during 1990-99. It is noted that although efficient input reallocation increase the contribution of capital and labor toward GDP growth, it lower the growth of TFP.

6. Output reallocation effect is positive in all of the sub-periods during 1961-99 except for the period during 1990-99. Positive output reallocation effect helps to push up the TFP growth. It is worth of noting that output reallocation effect decreased steadily from 0.71 percent and 0.70 percent per annum during 1961-70 and 1970-80 respectively, to 0.17 percent per annum during 1980-90 and –0.02 percent per annum during 1990-99.

b. The Driving Forces of TFP Growth in Taiwan

By comparing the growth rate of TFP and some key factors during 1961-1982 and 1982-1993, Liang (1995) singled out the following contributing factors to the increasing growth of TFP during 1982-93 in Taiwan. These factors include: (1) the industrial
structural changes; (2) educational improvements in employment; (3) the increase in R&D in GDP; (4) infrastructure investment; (5) foreign investment in total investment (FI/I) and (6) export surplus.6

In this section, we perform a regression analysis by employing the above factors to explain the TFP growth of the whole economy during 1978-1999.7

To avoid the multicollinearity problem, we separate the effect of industrial changes from our TFP growth estimate, i.e. $R_T^2$. Hence, the explained variable employed in our regression is TFP growth without the industrial structural change adjustment ($R_T$). We then conduct another regression analysis on the effect of industrial structural changes. It is noted that in this study the translog labor input index has taken into account the educational improvements in employment. Consequently, the variable of educational improvement in employment is excluded.

The regression result of TFP growth (without structural changes adjustment) in Taiwan during 1978-1999 is presented as:

$$\ln R_T = -3.359 \ln EXR(-1) + 2.507 \ln (FI/I) + 4.917 \ln INFRA(-1) + 6.425 \ln (R & D / GDP)(-1)$$

$$- 3.359$$  

$$2.507$$  

$$4.917$$  

$$6.425$$  

$$+ 4.776 \ln (E - I)(-1)$$

where $EXR(-1) =$ exchange rate (NT$/US$) of previous year

$FI/I =$ foreign investment in total investment

$INFRA(-1) =$ infrastructure investment of previous year

7 The regression analysis begins with the year 1978, because some variables, such as R&D/GDP are not available before 1978.
R&D/GDP(-1) = the value share of R&D in GDP of previous year

E-I(-1) = export minus import in GDP of previous year

\[ R^2 = 0.974 \quad DW = 1.25 \quad LM\ Test = 0.239 \]

The t values of all explanatory variables are significant at the 0.05 significance level (t>1.96). Goodness of fit measured using an adjusted \( R^2 \) is high (0.974). Durbin-Watson statistics (1.25) shows inconclusive at the 0.01 significance level (\( DW_L = 1.01 \), \( DW_U = 1.42 \)). However, the serial correlation LM test (0.239) accepts the null hypothesis of no serial correlation at the significance level of 0.05.

It implies that the factors that contributed to the TFP growth (without industrial structural change adjustment) during 1978-99 included the following: (1) exchange rate (i.e., changed of NTD toward U.S. dollar), (2) foreign investment in total investment, (3) infrastructure investment (4) R&D in GDP and (5) export surplus. All in a form of lag one year except foreign investment in total investment.

What are the causes of the industrial structural changes? According to Liang (1995), the driving forces behind the industrial structural changes are: (i) government liberalization policies such as the liberalization of the financial sector since 1988 and so on; (ii) government industrial policies to promote the high-tech industries through setting up science-based industrial parks, tax incentives, favorable loans and technology transfer from the ITRI, a government sponsored research institute; (iii) the New Taiwan dollar appreciation and (iv) wage increases.

Since the effects of the industrial structural changes, which are presented in row 4 of Table 2, result from industrial structural changes, we adopt the above four factors to
explain the effect of industrial structural changes on TFP growth. The effect of industrial structural changes consists of two effects, i.e., output reallocation effect and input reallocation effect. Positive output reallocation effect leads to higher GDP and TFP growth for the whole economy. Conversely, positive input reallocation effect increases GDP but lower TFP growth. Therefore, we make a separate regression analysis for input reallocation effect as well as output reallocation effect.

The regression results of the effect of input reallocation during 1970-1999 are presented as:

\[
\ln(I_{\text{IRE}}) = 0.005 \ln WAGE(-1) + 0.075 FINA + 0.025 TEL.OIL + 0.017 ELEC
\]

\[
(7.763) \quad (9.459) \quad (2.550) \quad (1.992)
\]

\[
\bar{R}^2 = 0.916 \quad DW = 1.13 \quad LM \text{ Test} = 0.042
\]

where \( I_{\text{IRE}} \) = the index of the effect of input reallocation effect

\( WAGE(-1) \) = wage in previous year

There are three dummy variables in the equation:

FINA : Liberalization of financial sector in 1988 (before 1988 = 0, after 1988 = 1)

OIL.TEL : Liberalization of the oil refining sector and telecommunications sector in 1996 (before 1996 = 0, after 1996 = 1)

ELEC : Hsinchu Science-Based Industrial Park set up in 1980 (before 1980 = 0, after 1980 = 1)

The t-values of all explanatory variables are significant at the 0.05 significance level except ELEC which is significant at the 0.1 significance level. The goodness of fit measure with an adjusted \( R^2 \) is high (0.916). Durbin-Watson statistics (1.13) shows inconclusive at
0.01 significance level \((DW_L = 0.94, DW_U = 1.51)\). However, the serial correlation LM test (0.04) accepts the null hypothesis of no serial correlation at the significance level of 0.01.

It implies that the factors that explain the effect of input reallocation effect during 1970-99 include the following: (1) the wage of previous year; (2) government liberalization policies on the financial sector since 1988, the oil sector since 1996 and the telecommunications sector starting from 1996; and (3) government industrial policies to promote the high-tech industries, such as the electronics and information industries, since 1980.

The regression results of the effect of output reallocation during 1970-1999 are presented as:

\[
\ln(I_{ORE}) = 0.014\ln WAGE(-1) + 0.021ELEC
\]

\[
(24.62) \quad (3.451)
\]

\[R^2 = 0.745 \quad DW = 0.99 \quad LM \quad Test = 0.208\]

The t values of all explanatory variables are significant at the 0.01 significance level. The goodness of fit measured with an adjusted \(R^2\) is 0.745. Durbin-Watson statistics (0.99) shows inconclusive at the 0.01 significance level \((DW_L = 0.94, DW_U = 1.51)\). However, the serial correlation LM test (0.208) accepts the null hypothesis of no serial correlation at the significance level of 0.05.

It is noted that the dummy variables of FINA and OILTEL are discarded owing to insignificant T-value. And hence, the factors that explain the effect of output reallocation during 1970-99 consists of wage changes and policies to promote the high tech industries, such as the electronics and information industries since 1980.

It is noted that the above conclusion differs with the argument of Krugman(1994) on
the uselessness of industrial policies in the economic development of the NICs. Krugman (1994) said, “If Asian success reflects the benefits of strategic trade and industrial polices, those benefits should surely be manifested in an unusual and impressive rate of growth in the efficiency of the economy. And there is no sign of such exceptional efficiency growth.”

The experience of Taiwan in promoting its TFP growth might be a useful point of reference for other developing countries.

4.4 Comparison with Young’s Findings

Comparing with Young (1994b) the following important conclusions emerge (see table 6):

Difference

(1) TFP estimation of this study deviated widely from those of Young, ranging from 0.55 percentage point during 1970-80 to -0.57 percentage points during 1966-70. This could be attributed to the difference in methodology and data.

(2) The TFP growth rate difference between this study and Young (1994b) due to methodology varied from 1.68 percentage point or 266.80 percent during 1966-70 to –0.77 percent point or –24.35 percent during 1980-90 (see table 6). Aforementioned, our methodology of TFP estimation considers the effect of industrial structural changes,

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8 Krugman (1994).
9 The TFP for the whole of the Taiwan economy estimated by this study considers not only the reallocation effect of the inputs but also the reallocation effect of output. Consequently, it is different from Liang’s (2002)
while Young (1994b) does not.

(3) The difference due to data difference ranges from 0.65 percentage point or 20.34 percent during 1980-90 to –2.25 percentage point or –357.60 percent during 1966-70 (see table 6). Our data are more accurate than Young’s in the following aspects: (1) the labor input takes into account the working hours with break-down of 72 categories; (2) the share of labor and the share of capital are adjusted by the Input-Output tables; (3) agriculture sector is included in the whole economy TFP estimation; and (4) sector-level data are incorporated into TFP estimation for the whole economy.

Similarity

(1) Although TFP estimation of this study differs from those of Young (1994) during the sub-periods, the average TFP growth rate during 1966-1990 was 2.37 percent for the whole economy in this study, comparing to the 2.30 percent growth rate in Young (1994b). That is a moderate 0.07 percent point or 2.8 percent difference (see table 6).

(2) According to this study, the average TFP rate (with structural changes adjustment) during 1966-70 was 0.63 percent per annum during 1966-70, then steadily increased to 2.25 percent during 1970-80 and 3.17 percent during 1980-90. In Young (1994b), the average TFP growth rate increased from 1.20 percent during 1966-70 to 1.70 percent during 1970-80, and to 3.30 percent during 1980-60 (see table 6). It can be seen that Young and this paper exhibit the same upward trend in TFP growth for the whole of the Taiwan economy during 1966-90. To forecast the TFP growth in the future, it is more relevant to determine the trend rather than find the average figure for the whole of the observation period.
(3) The relative contribution ratio of TFP to GDP growth was 40.33 percent during 1980-90 as estimated by this study, which was greater than that of capital (37.92 percent) and labor (21.75 percent) (see Table 3). By contrast, according to Young (1994b), the relative contribution ratio of TFP to GDP growth was 41.25 percent, which was also greater than that of capital (28.56 percent) and labor (29.49) during the same period.\footnote{Calculated from the figures of Young (1994b)} Hence, in the case of Taiwan during 1980-90, the Krugman-Kim-Lau-Young input-driven growth hypothesis cannot receive support from either this study or that of Young (1994b).

4.5 International Comparison

During the 1966-90 period, the aforementioned TFP growth (with structural changes adjustment) for the economy as a whole estimated by this paper, i.e. 2.37 percent, is greater than Young’s (1994b) 2.3 percent. TFP growth of this paper estimated by same methodology of Young (1994b) is same as Young. By making comparisons with the data for 14 other countries in the world provided by Young (1994b), we found that Taiwan was one of the economies with the highest TFP growth in both studies. We were also surprised to find that the same conclusion can apply to Hong Kong (2.30 percent) and Korea (1.70 percent) as well, with the exception of Singapore (0.2 percent). Consequently, the Krugman-Kim-Lau-Young ‘input-driven growth’ hypothesis for the NICs is unfounded, not only in this study but also in Young’s (1994b). This reinforced Liang (2002)’s findings.

From Young (1994b), we cannot find the following words such as ‘input-driven growth’ or ‘negligible growth’ in terms of TFP in relation to NICs. Young (1994b) only makes the following concluding remark: “With the exception of Singapore, productivity
growth in the NICs is not particularly low; it is also, by postwar standards, not extraordinarily high." Nevertheless, Young’s data do not support his concluding remarks very well.

5. Conclusions and Implications

This paper provides a new methodology to measure the TFP of an economy. Based on detailed sector-level data, this study measures the TFP of the whole economy of Taiwan during 1961-99 by considering the effect of industrial structure change. The major conclusions are the followings.

First, the TFP growth with industrial structure changes adjustment registered 2.03 percent per annum and 2.37 percent per annum during 1961-80 and 1980-99 respectively. In contrast, the TFP growth without industrial structural changes adjustment was 1.55 percent and 2.94 percent per annum. In other words, ignoring the effect of industrial structural changes will underestimated the TFP growth of the whole economy by 23.23 percent during 1961-80, while it will overestimate the TFP growth by 23.94 percent during 1980-99. It is therefore important to consider the effect of industrial structural changes to measure the TFP growth correctly. The factors that explain the effect of industrial structural changes during 1970-99 include government industrial and liberalization policies. This conclusion differs with the argument of Krugman (1994) on the uselessness of industrial policies in the economic development of the NICs.

Second, during the last two decades (1980-99), the TFP was the second most important source of GDP growth, with a contribution ratio of 32.76 percent. That is lower
than the contribution of capital (45.88 percent), but higher than that of labor (21.35 percent). The relative contribution ratio of TFP to GDP growth was 46.87 percent during 1980-90 according to this study, which was greater than that of capital (38.45 percent) and labor (16.48 percent). By contrast, according to Young (1994b), the relative contribution ratio of TFP to GDP growth was 41.25 percent, which was also greater than that of capital (28.56 percent) and labor (29.49 percent) during the same period. The Krugman-Kim-Lau-Young hypothesis, which is that the fast growth of NIEs has little to do with the improvement in TFP, is unfounded in Taiwan particularly during the past two decades.

Third, to forecast the TFP growth in the future, it is more relevant to determine the trend rather than find the average figure for the whole of the observation period. If we compare the TFP growth rate among three sub-periods, i.e. 1966-70, 1970-80 and 1980-90, it can be seen that Young and this paper exhibit the same upward trend in TFP growth for the whole of the Taiwan economy during 1966-90.

Fourth, the TFP growth rate difference between this study and Young (1994b) due to methodology varied from 1.68 percentage points 1966-70 to –0.77 percent point during 1980-90. That due to data difference ranges from 0.65 percentage point during 1980-90 to –2.25 percentage point during 1966-70.

Fifth, by making a comparison with the data for 14 other countries in the world provided by Young (1994b), we found that Taiwan was one of the economies with the highest TFP growth. The same conclusion can apply to Hong Kong (2.30 percent) and Korea (1.70 percent) as well, with the exception of Singapore (0.2 percent). This finding reinforces the argument of Liang (2002). In sum, the Krugman-Kim-Lau-Young ‘input-

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11 Calculated from the figures of Young (1994b)
driven growth’ hypothesis for the NICs is without basis not only in this study and Liang (2002) but also in that of Young (1994b).
References


Table 1. The Growth of Total Factor Productivity by Sector during 1961-1999
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Note: The Precision Instrument sector is separated from Miscellaneous Sector after 1978.

* TFP with industry structural change adjustment
Table 2. The Growth of GDP, Inputs and TFP in Taiwan, 1961-1999

Unit: (%)

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<tbody>
<tr>
<td>Growth of Input (Input Reallocation Adj.)</td>
<td></td>
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<tr>
<td>Capital</td>
<td>8.88</td>
<td>10.52</td>
<td>7.23</td>
<td>10.29</td>
<td>10.73</td>
<td>7.87</td>
<td>6.53</td>
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<tr>
<td>Labor</td>
<td>9.65</td>
<td>11.44</td>
<td>7.86</td>
<td>11.42</td>
<td>11.45</td>
<td>7.02</td>
<td>8.79</td>
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<tr>
<td>Growth of TFP (Structural Change Adj.)</td>
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<tr>
<td></td>
<td>2.20</td>
<td>2.03</td>
<td>2.37</td>
<td>1.77</td>
<td>2.25</td>
<td>3.17</td>
<td>1.48</td>
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</table>

Note: The difference between the growth of value added (Output Reallocation adjustment) and the growth of value added released by the DGBAS is the output reallocation effect.

Table 3. The Causes of GDP Growth in Taiwan, 1961-1999

Unit: (%)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Input (Input Reallocation Adj.)</td>
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<tr>
<td>Capital</td>
<td>47.91</td>
<td>49.30</td>
<td>45.88</td>
<td>54.16</td>
<td>45.11</td>
<td>37.92</td>
<td>56.55</td>
</tr>
<tr>
<td>Labor</td>
<td>27.34</td>
<td>31.45</td>
<td>21.36</td>
<td>28.63</td>
<td>33.88</td>
<td>21.75</td>
<td>20.83</td>
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<tr>
<td>TFP (Structural Change Adj.)</td>
<td>24.75</td>
<td>19.25</td>
<td>32.76</td>
<td>17.21</td>
<td>21.01</td>
<td>40.33</td>
<td>22.62</td>
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</table>

Source: Refer to Table 2.
Table 4. The Growth of TFP, Output Reallocation and Input Reallocation Effect in Taiwan, 1961-1999

Unit: (%)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Growth of TFP</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Structural Change Adj.)</td>
<td>2.20</td>
<td>2.03</td>
<td>2.37</td>
<td>1.77</td>
<td>2.25</td>
<td>3.17</td>
<td>1.48</td>
</tr>
<tr>
<td>Growth of TFP</td>
<td>2.25</td>
<td>1.55</td>
<td>2.94</td>
<td>1.07</td>
<td>1.99</td>
<td>3.95</td>
<td>1.82</td>
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<tr>
<td>(Without Structural Change Adj.)</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>The Effect of Structural Changes</td>
<td>-0.05</td>
<td>0.47</td>
<td>-0.57</td>
<td>0.70</td>
<td>0.25</td>
<td>-0.77</td>
<td>-0.34</td>
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<tr>
<td>(+) Output Reallocation Effect</td>
<td>0.41</td>
<td>0.74</td>
<td>0.08</td>
<td>0.70</td>
<td>0.71</td>
<td>0.17</td>
<td>-0.02</td>
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<tr>
<td>(-) Input Reallocation Effect</td>
<td>0.46</td>
<td>0.27</td>
<td>0.65</td>
<td>0.00</td>
<td>0.46</td>
<td>0.94</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Note:
1. The growth of TFP (without structural change adj.) is calculated by means of the Jorgenson-Gollop-Fraumeni method or equation (3) of this paper.
   The growth of TFP (with structural change adj.) is calculated by equation (13) of this paper.

Table 5. The Causes of TFP Growth in Taiwan, 1961-1999

Unit: (%)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP (Structural Change Adj.)</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td>TFP (Without Structural Change Adj.)</td>
<td>102.21</td>
<td>76.77</td>
<td>123.94</td>
<td>60.59</td>
<td>88.20</td>
<td>124.35</td>
<td>122.98</td>
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<tr>
<td>The Effect of Structural Changes</td>
<td>-2.21</td>
<td>23.23</td>
<td>-23.94</td>
<td>39.41</td>
<td>11.10</td>
<td>-24.35</td>
<td>-22.98</td>
</tr>
<tr>
<td>(+) Output Reallocation Effect</td>
<td>18.63</td>
<td>36.35</td>
<td>3.49</td>
<td>39.36</td>
<td>31.65</td>
<td>5.40</td>
<td>-1.07</td>
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<tr>
<td>(-) Input Reallocation Effect</td>
<td>20.84</td>
<td>13.12</td>
<td>27.43</td>
<td>-0.05</td>
<td>20.55</td>
<td>29.75</td>
<td>21.91</td>
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</table>

Source: See Table 4.

Note: The percentages are calculated rounding up to six decimal places of Table 4.
### Table 6. TFP Comparison between This Study and Young

Unit: %

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) TFP (with Structural Changes Adj.)</td>
<td>0.63</td>
<td>2.25</td>
<td>3.17</td>
<td>2.37</td>
</tr>
<tr>
<td></td>
<td>(100.00)</td>
<td>(100.00)</td>
<td>(100.00)</td>
<td>(100.00)</td>
</tr>
<tr>
<td>(2) TFP (Young 1994)</td>
<td>1.20</td>
<td>1.70</td>
<td>3.30</td>
<td>2.30</td>
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<tr>
<td></td>
<td>(190.80)</td>
<td>(75.40)</td>
<td>(104.00)</td>
<td>(97.20)</td>
</tr>
<tr>
<td>(3) TFP (without Structural Changes Adj.)</td>
<td>-1.05</td>
<td>1.99</td>
<td>3.95</td>
<td>2.30</td>
</tr>
<tr>
<td></td>
<td>(-166.80)</td>
<td>(88.20)</td>
<td>(124.35)</td>
<td>(97.10)</td>
</tr>
<tr>
<td>Total Difference (with Young)</td>
<td>-0.57</td>
<td>0.55</td>
<td>-0.13</td>
<td>0.07</td>
</tr>
<tr>
<td>(1)-(2)</td>
<td>(-90.80)</td>
<td>(24.60)</td>
<td>(-4.00)</td>
<td>(2.80)</td>
</tr>
<tr>
<td>Difference due to Methodology (with Young)</td>
<td>1.68</td>
<td>0.27</td>
<td>-0.77</td>
<td>0.07</td>
</tr>
<tr>
<td>(1)-(3)</td>
<td>(266.80)</td>
<td>(11.80)</td>
<td>(-24.35)</td>
<td>(2.90)</td>
</tr>
<tr>
<td>Difference due to Data (with Young)</td>
<td>-2.25</td>
<td>0.29</td>
<td>0.65</td>
<td>0.00</td>
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<tr>
<td>(3)-(2)</td>
<td>(-357.60)</td>
<td>(12.80)</td>
<td>(20.34)</td>
<td>(-0.10)</td>
</tr>
</tbody>
</table>

* The figures in parentheses are relative contribution ratio toward TFP growth (with structural changes adjustment)