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# TECHNICAL PROGRESS AND LEVEL OF TECHNOLOGY IN ASIAN COUNTRIES, 1970–80: A TRANSLOG INDEX APPROACH

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## I. INTRODUCTION

THE purpose of this paper is to provide an international comparison of the sources of aggregate economic growth and difference of levels of aggregate output in order to identify the role of productivity growth in the course of economic growth. The countries included in this study are Japan, Singapore, Hong Kong, Taiwan, Malaysia, the Republic of Korea, the Philippines, Thailand, Indonesia, and India and the period covered is from 1970 to 1980.

Nadiri [17] points out that capital stock plays an important role in developing countries while its contribution to economic growth is relatively low in developed countries and, on the other hand, that the contribution of total factor productivity is small in developing economies as compared to its critical importance in industrialized countries. These findings can also be applied to Latin American countries. Elias [8] concludes that the contribution of total factor productivity accounts for no more than 20 per cent of growth in output for 1940–70 and that the contribution of capital accounts for more than 50 per cent of output growth.

Several earlier studies have examined the sources of economic growth of some of the countries included in this study. These results are presented in Table I. The table is only a brief summary which does not cover all the studies of this kind. These studies cover different periods and employ different methods so that we cannot easily compare the results. However, with some exceptions the studies demonstrate the high contribution of total factor productivity to output growth, which reaches nearly 50 per cent irrespective of the rate of economic growth and the level of economic development. Our purpose is to examine whether the role of productivity growth is uniformly important, or whether it differs according to the stage of development in Asian countries.

The hypotheses examined in this paper are "Verdoorn's law" and Gerschenkron's "borrowed technology." The former indicates a positive relationship between rate of economic growth and total factor productivity and the latter implies a higher contribution of technology to the economic growth of an economy at a relatively lower stage of economic development.

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TABLE I
SUMMARY OF OTHER STUDIES

(%)

| Country | Source | Period | Growth Rate | | Percentage of TFP |
|---|---|---|---|---|---|
| | | | Output | TFP | |
| Japan | Kanamori [14] | 1955–68 | 10.1 | 6.1 | 60.4 |
| | Ratcliffe-Yoshihara [21] | 1953–65 | 10.35 | 5.0 | 48.2 |
| | Jorgenson-Ezaki [11] | 1952–71 | 10.1 | 3.8 | 37.6 |
| | Nishimizu-Hulten [18] | 1955–71 | 11.5 | 2.9 | 25.2 |
| | Chen [2] | 1955–70 | 10.1 | 6.4 | 62.8 |
| | Kuroda-Yoshioka-Jorgenson [16] | 1960–79 | 8.5 | 2.2 | 25.8 |
| Singapore | Chen [2] | 1957–70 | 6.6 | 3.6 | 55.2 |
| | Tsao [22] | 1966–72 | 12.5 | 0.6 | 4.8 |
| | Tsao [22] | 1972–80 | 8.0 | −0.9 | −11.3 |
| Hong Kong | Chen [2] | 1955–70 | 9.3 | 4.3 | 46.5 |
| Taiwan | Chen [2] | 1955–70 | 8.0 | 4.3 | 53.6 |
| Korea | Chen [2] | 1955–70 | 8.8 | 5.0 | 56.4 |
| | Christensen-Cummings [5] | 1960–73 | 9.7 | 4.1 | 42.3 |
| Philippine | Ezaki [9] | 1957–62 | 4.9 | 0.0 | 0.0 |
| | Ezaki [9] | 1963–69 | 5.2 | 0.8 | 15.4 |
| | Ezaki [9] | 1970–74 | 6.3 | 1.2 | 19.0 |
| India | Birla Institute of Scientific Research [1] | 1950–80 | 3.5 | 1.3 | 39.1 |

Our results show that "Verdoorn's law" is established until the economy attains a high level of technology. That is, except for Japan, Singapore, Hong Kong, and Malaysia, which have relatively high levels of technology, there exists a positive relationship between output growth and productivity growth. One reason is suggested by utilizing Gerschenkron's "borrowed technology." Gerschenkron's pattern is found between level of technology and contribution of productivity growth. That is, the contribution of productivity growth is the highest for Taiwan and Korea where the levels of technology are not as high as in Japan, Singapore, and Hong Kong where the construction of productivity growth is not so high.

As Nadiri cautioned, we must be careful about the accuracy of data used in this study. As is often the case for developing countries, the data needed to measure total factor productivity are often subject to error, especially the data of capital stock and value shares of inputs. Thus our results are not sufficient to allow precise comparison between countries.

Section II presents our methodology briefly. The technical change in a country is measured by the translog index, and the difference in levels of technology between two countries at a given point of time is also measured by the translog index used cross-sectionally. Section III presents an international comparison of the sources of economic growth for all ten countries and Section IV analyzes differences in levels of technology between Japan and other countries. We choose Japan as the comparator of the level of technology because Japanese technology seems to be the most advanced among the countries studied. Section V is a summary and conclusion of this paper.

## II. METHODOLOGY

This section has two objectives. The first is to present the method of breaking down the rate of economic growth of a country into the contributions of factor inputs and total factor productivity by using the translog index [6]. The other is to present the method to breaking down the difference in levels of output for two countries into the contributions of each factor and level of technology [12].

### A. *Sources of Economic Growth*

Our methodology is based on the production function $F$ for a country:

$$Y = F(Kd, Km, L, T),$$

where $Y$ is output, $Kd$ is domestically-produced capital inputs (hereafter this is called domestic capital input), $Km$ is imported capital input, and $T$ is time.[1] We assume that the production function is characterized by constant returns to scale. The share of each input in the value of output is defined by

$$V_{Kd} = \frac{p_{Kd} \cdot Kd}{q_Y \cdot Y},$$

$$V_{Km} = \frac{p_{Km} \cdot Km}{q_Y \cdot Y},$$

$$V_L = \frac{p_L \cdot L}{q_Y \cdot Y},$$

where $V_{Kd}$, $V_{Km}$, $V_L$ are the value shares of domestic capital input, imported capital inputs, and labor input, respectively and $p_{Kd}$, $p_{Km}$, $p_L$ and $q_Y$ are the prices of domestic and imported capital input, labor input and output, respectively. Necessary condition for producer equilibrium is that the value share of input is equal to the elasticity of output with respect to the corresponding input:

$$V_{Kd} = \frac{\partial \ln Y}{\partial \ln Kd}(Kd, Km, L, T),$$

$$V_{Km} = \frac{\partial \ln Y}{\partial \ln Km}(Kd, Km, L, T),$$

$$V_L = \frac{\partial \ln Y}{\partial \ln L}(Kd, Km, L, T).$$

1 The definitions and methods of estimation and data for these concepts are given in Appendix A.

Since constant returns to scale is assumed, the sum of these value shares is equal to unity:

$$V_{Kd}+V_{Km}+V_L=1.$$

The rate of technical change, $V_T$, is defined as the growth of output with respect to time, holding factor inputs constant:

$$\begin{aligned}V_T&=\frac{\partial \ln Y}{\partial T}(Kd,\ Km,\ L,\ T)\\&=\frac{d\ln Y}{dT}-\frac{\partial \ln Y}{\partial \ln Kd}\frac{d\ln Kd}{dT}-\frac{\partial \ln Y}{\partial \ln Km}\frac{d\ln Km}{dT}-\frac{\partial \ln Y}{\partial \ln L}\frac{d\ln L}{dT}\\&=\frac{d\ln Y}{dT}-V_{Kd}\frac{d\ln Kd}{dT}-V_{Km}\frac{d\ln Km}{dT}-V_L\frac{d\ln L}{dT}.\end{aligned}$$

This equation shows that the rate of technical change is expressed as the rate of output growth minus a weighted average of the rates of input growth where the weights are the corresponding value shares. This expression for the rate of technical change $V_T$ is called the Divisia quantity index of technical change.

The Divisia quantity index of technical change is defined on continuum of time. But since our data are given at discrete points of time we have to extend the Divisia index so that it can be applied to data of discrete points of time. For this purpose we assume that the production function $F$ is the transcendental logarithmic production function or, more simply, the translog production function [3] [4]:

$$\begin{aligned}\ln Y=&\alpha_0+\alpha_{Kd}\ln Kd+\alpha_{Km}\ln Km+\alpha_L\ln L+\alpha_T T+\frac{1}{2}\beta_{KdKd}(\ln Kd)^2\\&+\beta_{KdKm}\ln Kd\ \ln Km+\beta_{KdL}\ln Kd\ \ln L+\beta_{KdT}T\ \ln Kd\\&+\frac{1}{2}\beta_{KmKm}(\ln Km)^2+\beta_{KmL}\ln Km\ \ln L+\beta_{KmT}T\ \ln Km\\&+\frac{1}{2}\beta_{LL}(\ln L)^2+\beta_{LT}T\ \ln L+\frac{1}{2}\beta_{TT}T^2.\end{aligned}$$

Then the average rate of technical change for a period ($T$-1, $T$) can be expressed as the difference between successive logarithms of output less a weighted average of the differences between successive logarithms of inputs where the weights are the corresponding average value shares [7]:

$$\begin{aligned}\overline{V}_T=&[\ln Y(T)-\ln Y(T\text{-}1)]-\overline{V}_{Kd}[\ln Kd(T)-\ln Kd(T\text{-}1)]\\&-\overline{V}_{Km}[\ln Km(T)-\ln Km(T\text{-}1)]-\overline{V}_L[\ln L(T)-\ln L(T\text{-}1)],\end{aligned}$$

where

$$\overline{V}_{Kd}=[V_{Kd}(T)+V_{Kd}(T\text{-}1)]/2,$$
$$\overline{V}_{Km}=[V_{Km}(T)+V_{Km}(T\text{-}1)]/2,$$

$$\bar{V}_L = [V_L(T) + V_L(T\text{-}1)]/2,$$
$$\bar{V}_T = [V_T(T) + V_T(T\text{-}1)]/2.$$

This expression for the average rate of technical change $\bar{V}_T$ is called the translog index of technical change. And in this paper we nominate $\bar{V}_{Kd}[\ln Kd(T) - \ln Kd(T\text{-}1)]$, $\bar{V}_{Km}[\ln Km(T) - \ln Km(T\text{-}1)]$, and $\bar{V}_L[\ln L(T) - \ln L(T\text{-}1)]$ as contributions of domestic capital input, imported capital input, and labor input, respectively. And further we term their share in $[\ln Y(T) - \ln Y(T\text{-}1)]$ as percentage contributions.

Because of lack of data for some countries, we did not aggregate components of each input and output by the translog index. So our index for inputs and output may not reflect changes in the compositions and quality except for the exceptional case in which all components may be growing at the same rate. Since our index of inputs and output do not reflect their quality changes, the effect of these changes is to raise the contribution of total factor productivity. An example is given by Kuroda, Yoshioka, and Jorgenson [16]. The percentage contribution of total factor productivity is 56.9 per cent by simple adding aggregation, as in our method, while it is 25.8 per cent by the translog index of inputs and output. Roughly speaking, our method and results are comparable with those in Table I which show high contributions of total factor productivity.

### B. *Sources of Difference in Levels of Output between Countries*

The sources of difference in levels of output between two countries at a given point of time can be measured by applying the translog index. In the source of economic growth model, it is time $T$ that connects two sets of data but in the source of difference in levels of output model, it is a dummy variable for country. The translog production function for this model is obtained by replacing time $T$ by a dummy variable $D$:

$$\begin{aligned}\ln Y = {} & \alpha_0 + \alpha_{Kd}\ln Kd + \alpha_{Km}\ln Km + \alpha_L \ln L + \alpha_D D + \frac{1}{2}\beta_{KdKd}(\ln Kd)^2 \\ & + \beta_{KdKm}\ln Kd \ \ln Km + \beta_{KdL}\ln Kd \ \ln L + \beta_{KdD} D \ \ln Kd \\ & + \frac{1}{2}\beta_{KmKm}(\ln Km)^2 + \beta_{KmL}\ln Km \ \ln L + \beta_{KmD} D \ \ln Km \\ & + \frac{1}{2}\beta_{LL}(\ln L)^2 + \beta_{LD} D \ \ln L + \frac{1}{2}\beta_{DD} D^2.\end{aligned}$$

In this case the average difference in levels of technology between two countries $A$ and $B$ is

$$\begin{aligned}\hat{V}_D = {} & [\ln Y(A) - \ln Y(B)] - \hat{V}_{Kd}[\ln Kd(A) - \ln Kd(B)] \\ & - \hat{V}_{Km}[\ln Km(A) - \ln Km(B)] - \hat{V}_L[\ln L(A) - \ln L(B)],\end{aligned}$$

where

TABLE II
GDP AND PER CAPITA GDP IN 1975

| Country | Per Capita GDP (U.S.$) | GDP | |
|---|---|---|---|
| | | U.S.$ million | Index (Japan=100) |
| Japan | 4,350 | 485,352 | 100.0 |
| Singapore | 2,376 | 5,371 | 1.1 |
| Hong Kong | 1,831 | 8,050 | 1.7 |
| Taiwan | 961 | 15,388 | 3.2 |
| Malaysia | 701 | 8,622 | 1.8 |
| Korea | 583 | 20,561 | 4.2 |
| Philippines | 362 | 15,282 | 3.1 |
| Thailand | 346 | 14,650 | 3.1 |
| Indonesia | 237 | 30,470 | 6.3 |
| India | 130 | 77,858 | 16.0 |

Sources: IMF, *International Financial Statistics, 1984* (Washington, D.C., 1984) and Asian Development Bank, *Key Indicators of Developing Member Countries of ADB*, Vol. 13, No. 1 (April 1982).

$$\hat{V}_{Kd}=[V_{Kd}(A)+V_{Kd}(B)]/2,$$
$$\hat{V}_{Km}=[V_{Km}(A)+V_{Km}(B)]/2,$$
$$\hat{V}_{L}=[V_{L}(A)+V_{L}(B)]/2,$$
$$\hat{V}_{T}=[V_{T}(A)+V_{T}(B)]/2.$$

This expression for the average difference in levels of technology $\hat{V}_D$ is called the translog index of difference in levels of technology. The percentage contribution is defined as those in the source of growth model.

## III. GROWTH ACCOUNTING

Our objective in this section is to compare the growth of output, inputs, and technical progress for the ten countries included in our study. Our analysis is based on data for three points of time, 1970, 1975, and 1980 whose sources as well as data are shown in Appendix A. The order of countries in the following tables is according to the per capita GDP in 1975 where the exchange rate from domestic currency to U.S. dollar is the official one though it does not usually reflect their purchasing power parity.[2] The per capita GDP in 1975 is shown in Table II.

[2] According to Kravis et al. [15], GDP in U.S. dollars converted at official exchange rate is U.S.$499,175, 9,299, 20,561, 15,820, 14,665, 87,974 millions for Japan, Malaysia, Korea, Philippines, Thailand, and India, respectively, while it is 547,421, 18,367, 52,360, 39,812, 39,194, 284, 129 millions international dollar which reflects purchasing power parity for these countries, respectively.

TABLE III
ANNUAL GROWTH RATE

| Country | Period | GDP | Labor | Capital Stock | | |
|---|---|---|---|---|---|---|
| | | | | Total | Domestic | Imported |
| Japan | 1970–80 | 4.9 | 0.8 | 9.3 | 9.5 | 5.8 |
| | 1970–75 | 4.6 | 0.5 | 12.0 | 12.2 | 5.5 |
| | 1975–80 | 5.1 | 1.2 | 6.7 | 6.7 | 6.0 |
| Singapore | 1970–80 | 9.1 | 4.9 | 9.6 | 8.8 | 14.4 |
| | 1970–75 | 9.5 | 4.5 | 10.5 | 9.0 | 19.1 |
| | 1975–80 | 8.7 | 5.3 | 8.8 | 8.5 | 9.9 |
| Hong Kong | 1970–80 | 9.6 | 3.7 | 14.0 | 14.8 | 11.0 |
| | 1970–75 | 6.9 | 2.8 | 12.8 | 13.3 | 11.3 |
| | 1975–80 | 12.3 | 4.5 | 15.2 | 16.3 | 10.7 |
| Taiwan | 1970–80 | 9.5 | 3.6 | 5.6 | 4.6 | 16.2 |
| | 1970–75 | 8.8 | 3.8 | 5.0 | 3.7 | 21.6 |
| | 1975–80 | 10.2 | 3.5 | 6.2 | 5.5 | 11.2 |
| Malaysia | 1970–80 | 7.8 | 4.3 | 8.6 | 8.5 | 11.8 |
| | 1970–75 | 7.1 | 3.9 | 8.5 | 8.3 | 13.8 |
| | 1975–80 | 8.6 | 4.9 | 8.7 | 8.7 | 9.9 |
| Korea | 1970–80 | 8.6 | 3.5 | 7.8 | 6.8 | 15.1 |
| | 1970–75 | 9.5 | 4.0 | 5.9 | 4.9 | 14.8 |
| | 1975–80 | 7.6 | 3.0 | 9.7 | 8.7 | 8.7 |
| Philippines | 1970–80 | 6.2 | 4.2 | 5.9 | 5.9 | 5.8 |
| | 1970–75 | 6.0 | 4.3 | 5.0 | 4.9 | 5.1 |
| | 1975–80 | 6.3 | 4.1 | 6.8 | 6.9 | 6.5 |
| Thailand | 1970–80 | 6.9 | 3.6 | 7.1 | 7.0 | 8.0 |
| | 1970–75 | 6.3 | 3.5 | 7.1 | 7.0 | 8.0 |
| | 1975–80 | 7.5 | 3.6 | 8.1 | 8.5 | 4.5 |
| Indonesia | 1970–80 | 7.7 | 3.6 | 7.4 | 6.6 | 25.2 |
| | 1970–75 | 7.8 | 3.5 | 6.5 | 5.2 | 38.6 |
| | 1975–80 | 7.5 | 3.8 | 8.4 | 7.9 | 13.0 |
| India | 1970–80 | 3.0 | 2.0 | 4.9 | 5.0 | 2.3 |
| | 1970–75 | 2.3 | 2.0 | 4.8 | 4.8 | 2.6 |
| | 1975–80 | 3.8 | 2.0 | 5.1 | 5.1 | 2.1 |

Source: Appendix Table I.

## A. *Output Growth*

Our concept of output is gross domestic product (GDP). The annual growth rates of GDP at constant prices for each country are presented in Table III. Table III shows that with the exceptions of Japan and India the growth rates of GDP at constant prices exceed 6 per cent which means a very high rate of growth by world standards in the 1970s. The growth rates of the Asian NICs are among the highest of the countries included in our study, that is, 9.6 per cent for Hong Kong, 9.5 per cent for Taiwan, 9.1 per cent for Singapore, and 8.6 per cent for

Korea. The lowest growth rate of GDP is the case of India whose rate is 3.0 per cent. The growth rate for Japan is relatively lower among these countries, at 4.9 per cent.

In the first half of the 1970s, Singapore and Korea attained the highest growth rate, 9.5 per cent, but in the second half of the 1970s their growth rates decreased to 8.7 and 7.6 per cent, respectively. On the other hand the highest growth rates in the second half of the 1970s were attained by Hong Kong and Taiwan whose rates are 12.3 and 10.2 per cent, respectively. In the case of Hong Kong the growth rate in the first half of the 1970s is so low, at 6.9 per cent, that it almost doubled between the first and the second half of the 1970s. These changes in quinquennial periods partly reflect the short-term fluctuations in economic conditions such as the two oil shocks.

B. *Labor Input*

Number of persons employed is used as our concept of labor input. The quality of labor such as age, sex, education, occupation, industry, etc. is not adjusted because of lack of data needed for such adjustment for some countries.

Growth rates of labor input for each country are presented in Table III. Except for Japan and India the growth rates of labor input in the period of 1970–80 range from Singapore's 4.9 per cent to Thailand's 3.6 per cent. The lowest rate is Japan's 0.8 per cent. In the case of India the growth rate is assumed to be constant through the 1970s.

Value shares of labor are presented in Appendix Table I. The value share of labor in this paper is estimated by imputing average wage rate to all persons employed, that is, not only to the employees but also other persons employed. This makes our estimation of labor share bigger than the share of employees' renumeration. In the case of Singapore, Philippines, Indonesia, and India where the wage data do not seem to be reliable or do not exist, we assume the labor share to be 50 per cent for Singapore, 60 per cent for the Philippines and Indonesia, and 70 per cent for India.[3] Labor shares range from 50 to 75 per cent. The highest is Japan's 75.4 per cent and the lowest is Singapore's assumed 50 per cent which would be as low as 35 per cent if we impute the average wage rate to all persons employed.

Contributions of labor input to output growth in the 1970s is presented in Table IV. Except for Japan, contributions of labor range from 1.4 to 2.6. The highest contribution is Malaysia's 2.6 per cent and then Singapore and Philippines' 2.5 per cent and Hong Kong's 2.4 per cent. Since contribution of labor is the product of growth rate of labor input and value share of labor, the high contributions of labor in these countries are due to high growth rate of labor input and large share of labor, except for Singapore. On the other hand, the low contributions of labor in Japan and India are solely due to low growth rate of labor input.

The highest percentage contribution of labor is found in the case of India and

[3] See the details in Appendix A and also the sensitivity analysis of value share of labor in Appendix B.

TABLE IV
SOURCES OF GROWTH

(%)

| Country | Period | GDP | Labor | Capital Stock | | | Productivity |
|---|---|---|---|---|---|---|---|
| | | | | Total | Domestic | Imported | |
| Japan | 1970–80 | 4.9(100.0) | 0.6(12.0) | 2.9(58.5) | 2.8(57.2) | 0.1(1.3) | 1.4(29.5) |
| | 1970–75 | 4.6(100.0) | 0.4( 7.8) | 3.6(77.0) | 3.5(75.7) | 0.1(1.3) | 0.7(15.2) |
| | 1975–80 | 5.1(100.0) | 0.9(17.3) | 1.7(32.7) | 1.6(31.8) | 0.1(0.8) | 2.6(50.1) |
| Singapore | 1970–80 | 9.1(100.0) | 2.5(27.7) | 4.8(52.7) | 3.7(40.7) | 1.1(11.9) | 1.8(19.7) |
| | 1970–75 | 9.5(100.0) | 2.3(24.4) | 5.2(54.9) | 3.9(40.5) | 1.4(14.4) | 2.0(20.7) |
| | 1975–80 | 8.7(100.0) | 2.7(31.1) | 4.4(50.2) | 3.5(39.9) | 0.9(10.3) | 1.6(18.6) |
| Hong Kong | 1970–80 | 9.6(100.0) | 2.4(24.6) | 5.2(54.1) | 4.3(45.4) | 0.8( 8.7) | 2.0(21.3) |
| | 1970–75 | 6.9(100.0) | 1.9(27.2) | 4.4(64.0) | 3.5(51.2) | 0.9(12.7) | 0.6( 8.8) |
| | 1975–80 | 12.3(100.0) | 2.8(23.1) | 5.9(48.0) | 5.1(41.2) | 0.8( 6.7) | 3.6(29.0) |
| Taiwan | 1970–80 | 9.5(100.0) | 1.9(19.7) | 2.9(30.3) | 2.1(22.2) | 0.8( 8.1) | 4.8(50.0) |
| | 1970–75 | 8.8(100.0) | 1.9(21.2) | 2.7(30.7) | 1.8(20.5) | 0.9(10.2) | 4.3(48.1) |
| | 1975–80 | 10.2(100.0) | 1.7(16.7) | 3.3(32.2) | 2.6(25.0) | 0.7( 7.2) | 5.2(51.1) |
| Malaysia | 1970–80 | 7.8(100.0) | 2.6(33.0) | 3.6(45.3) | 3.4(42.8) | 0.2(2.5) | 1.7(21.7) |
| | 1970–75 | 7.1(100.0) | 2.4(33.1) | 3.3(46.9) | 3.1(43.9) | 0.2(2.9) | 1.4(20.0) |
| | 1975–80 | 8.6(100.0) | 2.6(30.4) | 4.1(48.1) | 3.9(45.7) | 0.2(2.4) | 1.8(21.5) |
| Korea | 1970–80 | 8.5(100.0) | 2.3(27.3) | 2.7(31.5) | 2.0(23.9) | 0.7( 7.6) | 3.5(41.2) |
| | 1970–75 | 9.5(100.0) | 2.4(25.1) | 2.5(26.2) | 1.8(19.1) | 0.7( 7.2) | 4.6(48.7) |
| | 1975–80 | 7.6(100.0) | 1.9(24.7) | 3.7(48.6) | 2.8(37.2) | 0.9(11.4) | 2.0(26.6) |
| Philippines | 1970–80 | 6.2(100.0) | 2.5(41.2) | 2.4(38.2) | 2.2(34.9) | 0.2(3.3) | 1.3(20.6) |
| | 1970–75 | 6.0(100.0) | 2.6(43.0) | 2.0(33.0) | 1.8(30.0) | 0.2(3.0) | 1.4(24.0) |
| | 1975–80 | 6.3(100.0) | 2.5(39.4) | 2.7(43.2) | 2.5(39.6) | 0.2(3.6) | 1.1(17.4) |
| Thailand | 1970–80 | 6.9(100.0) | 1.9(27.1) | 3.7(53.2) | 3.4(49.0) | 0.3(4.3) | 1.4(19.7) |
| | 1970–75 | 6.3(100.0) | 2.1(32.5) | 3.0(47.6) | 2.7(42.0) | 0.4(5.7) | 1.3(19.8) |
| | 1975–80 | 7.5(100.0) | 1.9(25.8) | 3.8(51.2) | 3.6(48.4) | 0.2(2.9) | 1.7(23.0) |
| Indonesia | 1970–80 | 7.7(100.0) | 2.2(29.1) | 3.0(39.5) | 2.5(32.5) | 0.5(7.0) | 2.4(31.5) |
| | 1970–75 | 7.8(100.0) | 2.1(27.0) | 2.7(34.0) | 2.0(25.6) | 0.7(8.4) | 3.1(39.0) |
| | 1975–80 | 7.5(100.0) | 2.3(31.2) | 3.3(44.5) | 2.9(38.7) | 0.4(5.8) | 1.8(24.3) |
| India | 1970–80 | 3.0(100.0) | 1.4(46.4) | 1.5(48.4) | 1.5(48.3) | 0.002(0.1) | 0.2( 5.2) |
| | 1970–75 | 2.3(100.0) | 1.4(61.3) | 1.4(61.6) | 1.4(61.5) | 0.002(0.1) | −0.5(−22.9) |
| | 1975–80 | 3.8(100.0) | 1.4(37.3) | 1.5(40.4) | 1.5(40.3) | 0.001(0.04) | 0.8( 22.3) |

Note: Percentage contributions are in the parentheses.

the Philippines whose shares are 46.4 and 41.2 per cent, respectively. This is because of the low growth rate of output in these countries.

## C. *Capital Input*

Capital input takes the form of the services which the capital stock provides. In this paper we choose the unit of services of capital stock so that the quantity of the services is equal to the quantity of capital stock and we can thus use capital input and capital stock interchangeably.

Capital stock is divided into two categories; the one is domestically produced capital stock or, more simply, domestic capital stock and the other is imported capital stock.[4] In this study one of our interests is the importance of imported technology. Since there is no way to break down total factor productivity growth into the components attributable to foreign and domestic technology, we employed the concept of imported capital stock which may embody new technology developed in foreign countries. The ratio of imported capital stock to total capital stock is about 10 per cent; exceptionally low cases are India, Japan, and Malaysia whose ratios are less than 5 per cent and exceptionally high cases are Singapore and Hong Kong whose ratios are about 20 per cent.

Table III presents growth rates of total capital stock for each country. The highest growth rate in the 1970s is Hong Kong's 14.0 per cent while the lowest is India's 4.9 per cent. Relatively lower are Taiwan's 5.6 and Philippines' 5.9 per cent. Growth rates of the other countries range from 7.4 per cent to 9.6 per cent. Between the first half and the second the growth of capital stock decelerated in Japan and accelerated in Korea.

Growth rates of domestic capital stock show patterns similar to total capital stock since its share in total capital stock is very large.

As to growth rates of imported capital stock the highest rate in the 1970s is Indonesia's 25.2 per cent but this reflects the small amount of imported capital stock in 1970. Growth rates of Singapore, Taiwan, and Korea are about 15 per cent and those of Hong Kong and Malaysia about 11 per cent.

Contribution of capital input to GDP growth as presented in Table IV varies from 5.2 to 1.5 per cent for the period of 1970 to 1980. The highest contribution of capital input is Hong Kong's 5.2 and Singapore's 4.8 per cent. These countries are characterized by their high growth rate of capital stock and this is the reason for the high contribution. In these countries not only the contribution but also the percentage contribution is as high as 50 per cent. In other countries such as Japan, Malaysia, Thailand, and India, the percentage contributions of capital are about 50 per cent, as high as Hong Kong and Singapore, reflecting their relatively low growth rate of GDP. For Taiwan and Korea, percentage contributions as well as contributions of capital input are relatively low. Their contributions of capital are less than 3 per cent and their percentage contributions are only about 30 per cent.

Contributions of imported capital input are relatively large in the case of Singapore, Hong Kong, Taiwan, Korea, and Indonesia. Their contributions in

[4] For the methods of estimating the imported capital stock, see Appendix A.

the period of 1970–80 range from Singapore's 1.1 per cent to Indonesia's 0.5 per cent and their percentage contributions range from Singapore's 11.9 per cent to Indonesia's 7.0 per cent. These countries are characterized by the high growth rates and large shares of imported capital input and this is the reason for their high contributions. In the case of Malaysia, the contribution of imported capital input is not large though the growth rate of capital is high. This is because of the small share of the imported capital input.

D. *Total Factor Productivity*

Our concept of total factor productivity is defined broadly that it includes not only technical progress but also quality changes in capital and labor inputs, under-utilization of capital, economies of scale, such structural change as inter-sectoral shifts of resources, etc. So our estimates of total factor productivity may be affected by short-term fluctuations in economic conditions and long-term structural changes such as shifts from agriculture to nonagricultural sectors.

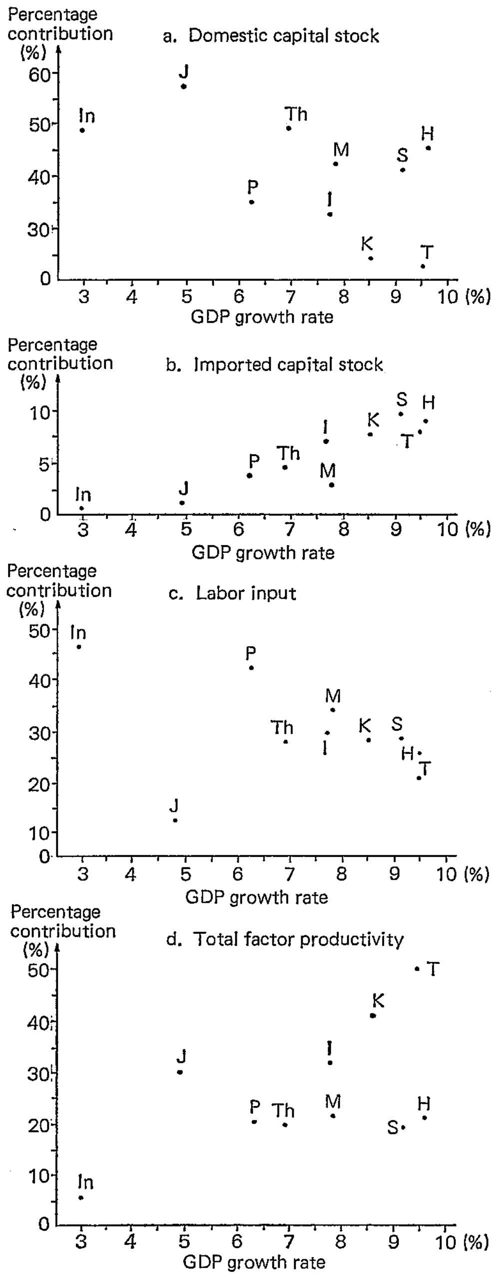
Contributions of total factor productivity for each country are presented in Table IV. Taiwan's 4.8 per cent and Korea's 3.5 per cent are the highest among the ten countries for the period of 1970–80. These two countries are characterized by the low contributions of capital input along with the high growth rates of GDP. Our results show that about half of their GDP growth rate is brought about by the total factor productivity growth. Next to Taiwan and Korea follows Indonesia where the contribution is 2.4 per cent and the percentage contribution is 31.5 per cent. When we explain this result we must take into consideration the fact that Indonesia is an oil-exporting country. This fact will make the total factor productivity growth rate higher.

The third group is Singapore, Hong Kong, and Malaysia whose contributions are 1.8, 2.0, and 1.7 per cent and percentage contributions are 19.7, 21.3, and 21.7 per cent, respectively. Though GDP growth rates of these countries are as high as those of Taiwan nad Korea, the contributions of productivity of this group heavily depend on growth of capital input in contrast to the case of Taiwan and Korea where GDP growth depends on productivity growth. These relatively low contributions of total factor productivity may be explained by the high level of technology of this group of countries which will be discussed in the following section. As Gerschenkron [10, p. 8] points out, "industrialization always seemed the more promising the greater the backlog of technological innovations which the backward country could take over from the more advanced country." The higher the level of technology, the smaller is the "backlog of technological innovations" and the smaller would be the contributions of total factor productivity. The opposite can be seen in the cases of Taiwan and Korea by the analysis of the difference in the level of technology.[5]

The fourth group is the Philippines and Thailand. For these countries contribution and percentage contribution are about 1.4 and 20 per cent. Differences between these countries are that contribution of capital is larger in Thailand and

[5] This topic is discussed in the next section again.

Fig. 1. Rate of Growth and Sources of Growth




Source: Tables III and IV.
Note: Abbreviations in the figures are: H=Hong Kong, I=Indonesia, In=India, J=Japan, K=Korea, M=Malaysia, P=Philippines, S=Singapore, T=Taiwan, Th=Thailand.

that contribution of labor is bigger in the Philippines. These two countries seem not to utilize enough the "backlog of technological innovations."

The extremely low contribution of technology occurs in the case of India, where the contribution and percentage contribution are 0.2 and 5.2 per cent, respectively. In the second half of the 1970s the percentage contribution of technology is about 20 per cent and as high as the fourth group but this is almost canceled by the negative contribution of productivity in the first half of the 1970s.

One of the hypotheses about productivity performance which has been discussed is the so-called Verdoorn's law.[6] Verdoorn [23] suggested in 1949 that there is a positive relationship between productivity growth and the growth rate of output. This positive relationship is called "Verdoorn's law." Many studies have been done to investigate this relationship. For example Kaldor [13] explained this law by economies of scale and Nishimizu and Robinson [19] showed a positive relationship between export expansion and productivity growth. In our study, instead of investigating the causes of "Verdoorn's law," we examine whether this law is established with our results. Figure 1 shows the relationship between GDP growth rates and percentage contributions of total factor productivity as well as factor inputs. Between GDP growth rates and percentage contributions of total factor productivity, there seems to be a positive relationship if we exclude the cases of Japan, Singapore, Hong Kong, and Malaysia where the level of technology is already high as shown in the next section. This means that to a certain level of technology "Verdoorn's law" exists but that as the "backlog of technological innovations" becomes exhausted the contribution of productivity becomes small, irrespective of output growth rate. The opposite pattern is seen between GDP growth rates and percentage contribution of domestic capital, that is, there seems to be a negative relationship between them (if we exclude Japan, Singapore, Hong Kong, and Malaysia). This could be called "inverted Verdoorn's law."

Between GDP growth rates and percentage contributions of imported capital stock we can see a positive relationship. Though the contribution of imported capital stock is relatively small—it increases output growth rate at most by only 1.1 per cent as seen in the case of Singapore—our results show that the higher the contribution of imported capital stock, the higher is the output growth rate.

In the analysis of the relationship between output growth and productivity, we found that the level of technology plays an important role in determining productivity performance. In the next section we shall discuss the level of technology.

## IV. SOURCES OF DIFFERENCE IN LEVELS OF OUTPUT BETWEEN COUNTRIES

Differences in levels of technology among countries can be measured with the translog index of productivity by using it in a cross sectional manner. Note that

[6] The following description is based on [19].

our measure of difference in levels of technology includes not only the difference in level of technology but also differences in quality of input as well as output, structure, etc. among countries.

We choose Japan as a comparator because it has (1) the biggest GDP and per capita GDP and (2) the highest level of technology among the ten countries. The first reason has an important meaning for our measure—percentage contributions of difference in levels of input and technology to the difference in levels of output. The percentage contribution depends not only on the differences in levels of inputs and technology but also the difference in levels of output. To compare the difference in levels of inputs and technology we had better exclude the effect of the difference in the level of output. Since Japan's GDP is overwhelmingly big among the ten countries as shown in Table II, we can neglect the effect of the difference in levels of output.[7] The results are presented in Table V where figures show indices of difference in levels of technology and percentage contributions of inputs and technology.

A. *Difference in Level of Technology*

Indices of difference in levels of technology in Table V refer to the difference of levels of technology between Japan and the corresponding country. Since Japan can be considered to have attained the highest level of technology among the ten countries, the smaller the index, the higher is the level of technology.

Table V, in which countries are listed according to the level of per capita GDP, shows that the order of the level of technology is almost the same as that of per capita GDP, that is, the larger the per capita GDP, the higher is the level of technology. The highest level of technology, except Japan, is attained by Hong Kong at every point of time studied. It is worth noting that even if the contribution of total factor productivity in the growth accounting is positive, our index of level of technology can increase, or decrease, as is the case of Hong Kong between 1970 and 1975. This is because our index shows the level of technology relative to Japan's level, not the absolute level of technology, at a given point of time. So we must be careful when we compare the indices between points of time. The highest level of technology next to Hong Kong is attained by Singapore. In 1975 Singapore's level of technology was as high as Hong Kong but in the latter half of the 1970s Singapore's productivity growth stagnated while Hong Kong accelerated productivity growth, which caused the level of technology of Singapore to lag behind that of Hong Kong.[8] Hong Kong and Singapore, however, can be grouped as having the highest level of technology. Malaysia in 1970 can be considered to belong to the same exceptional cases as Singapore and Hong Kong in the analysis of total factor productivity because its level of technology was the highest next to the first group. However, in fact Malaysia was overtaken by

[7] The figures in Table V are derived by converting into U.S. dollars with the official exchange rates. If we convert them by purchasing power parity, GDP is much bigger except Japan and then the ratio to Japan's GDP is becomes larger than the figures in Table V.

[8] See also Table IV.

TABLE V

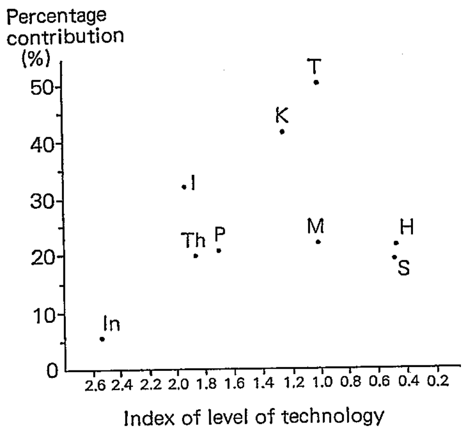
SOURCES OF DIFFERENCE IN LEVELS OF OUTPUT

| Country | Period | Index of Level of Technology | Percentage Contribution (%) | | | |
|---|---|---|---|---|---|---|
| | | | Technology | Labor | Capital Stock | |
| | | | | | Domestic | Imported |
| Singapore | 1970 | 0.63 | 13.3 | 52.2 | 32.4 | 2.1 |
| | 1975 | 0.49 | 10.8 | 58.0 | 29.0 | 2.2 |
| | 1980 | 0.49 | 11.2 | 56.9 | 29.8 | 2.1 |
| Hong Kong | 1970 | 0.44 | 10.5 | 54.0 | 32.8 | 2.7 |
| | 1975 | 0.48 | 11.6 | 57.2 | 28.8 | 2.4 |
| | 1980 | 0.35 | 9.3 | 56.8 | 31.7 | 2.2 |
| Taiwan | 1970 | 1.24 | 34.0 | 37.5 | 27.3 | 1.2 |
| | 1975 | 1.03 | 29.8 | 39.4 | 29.4 | 1.4 |
| | 1980 | 0.87 | 27.0 | 41.4 | 30.3 | 1.4 |
| Malaysia | 1970 | 1.08 | 25.9 | 42.6 | 30.3 | 1.2 |
| | 1975 | 1.01 | 25.1 | 41.4 | 32.4 | 1.2 |
| | 1980 | 0.97 | 25.0 | 38.7 | 35.1 | 1.3 |
| Korea | 1970 | 1.42 | 42.0 | 30.9 | 26.1 | 1.2 |
| | 1975 | 1.24 | 39.1 | 30.7 | 28.9 | 1.3 |
| | 1980 | 1.30 | 42.8 | 32.7 | 23.6 | 0.8 |
| Philippines | 1970 | 1.66 | 47.1 | 25.7 | 26.0 | 1.2 |
| | 1975 | 1.68 | 48.5 | 25.1 | 25.3 | 1.1 |
| | 1980 | 1.71 | 50.4 | 22.5 | 26.1 | 1.0 |
| Thailand | 1970 | 1.79 | 50.0 | 19.4 | 29.1 | 1.5 |
| | 1975 | 1.85 | 52.9 | 19.3 | 26.6 | 1.2 |
| | 1980 | 1.71 | 50.3 | 15.8 | 32.3 | 1.4 |
| Indonesia | 1970 | 1.96 | 67.2 | 5.7 | 26.1 | 1.0 |
| | 1975 | 1.94 | 70.0 | 3.0 | 26.0 | 0.9 |
| | 1980 | 1.93 | 72.7 | −0.2 | 26.7 | 0.9 |
| India | 1970 | 2.31 | 127.5 | −46.3 | 17.3 | 1.5 |
| | 1975 | 2.52 | 130.6 | −49.6 | 18.2 | 0.8 |
| | 1980 | 2.59 | 130.1 | −49.9 | 19.0 | 0.8 |

Taiwan in the latter half of 1970s. This is due to the higher growth rate of total factor productivity in Taiwan than in Malaysia. Taiwan and Korea are considered to have formed another group whose characteristics are high rates of output growth, high contribution of productivity, and low contribution of capital input. The levels of technology of these two countries were similar to each other at least in the first half of the 1970s. But in the latter half of the decade the gap in level of technology widened, that is, the index of level of technology in 1980 is 0.87 for Taiwan and 1.30 for Korea. This fact can be ascertained by the total factor productivity growth. In Korea the contribution of total factor productivity was halved between the first and the second half of the 1970s.

The Philippines, Thailand, and Indonesia can be considered as the third group

Fig. 2. Productivity Growth and Level of Technology




Sources: Tables IV and V.
Note: Abbreviations in the figure are the same as those in Figure 1.

where the levels of technology are relatively lower and stagnant, though the level of Indonesia's technology is somewhat lower among the three. For this group about 50 to 70 per cent of difference in levels of output is due to the difference in technology. Lastly, the level of technology in India is the lowest and the percentage contribution is more than 100 per cent.

Here we must once again consider "Verdoorn's law." As we pointed out in the previous section, "Verdoorn's law" asserts that there exists a positive relationship between growth rate of output and the contribution of productivity growth. There we suggested that there seems to exist such a relationship if we exclude the cases of Japan, Singapore, Hong Kong, and Malaysia where the levels of technology are high as discussed above, though a difficulty of this argument is that Malaysia and Taiwan are at the same level of technology. We also suggested an explanation of this phenomenon by citing Gerschenkron's "borrowed technology"; countries with a low level of technology can attain high GDP growth rate by achieving high productivity growth through importation of advanced technology from abroad. This implies that when the level of technology becomes higher and there remains only a small amount of technology to import, the contribution of productivity may become small. In this phase of technology level the relationship between level of technology and contribution of total factor productivity may be negative, while before this phase it may be positive. These two phases are expressed as an inverted-U-shape curve on a graph with level of technology as the vertical axis and productivity growth as the horizontal axis. This kind of graph is presented in Figure 2 though the positions of Taiwan and Malaysia appear to be deviating somewhat from this pattern.

### B. *Sources of Difference in Levels of Output*

Percentage contribution of differences in the level of labor input has a negative relationship with levels of technology. That is, the higher the level of technology, the larger is the contribution of labor input. For Singapore and Hong Kong the contribution of labor is more than 50 per cent while it is about 20 per cent for the Philippines and Thailand, nearly zero per cent for Indonesia, and −50 per cent for India. The minus value for India is due to the fact that labor input in India is bigger than in Japan.

For percentage contribution of domestic capital input there are relatively small differences among countries though there is a tendency for these to become bigger as the level of technology becomes higher. We can see the same tendency for imported capital input.

Our results show that as the level of technology becomes higher, the contributions of all three inputs (labor, domestic capital, imported capital) become bigger. Among these inputs the most important factor causing the difference in levels of output is labor input. Since the percentage contribution of capital, both domestic and imported, varies within a narrow range from 20 to 30 per cent, the percentage contribution of difference in the level of technology is almost determined by that of labor input.

## V. SUMMARY AND CONCLUSIONS

We have presented, though briefly, in Section II, our methodology for accounting for growth and difference in levels of output between countries, based on the translog index, and applied it, in Section III, to ten Asian countries for the three points of time, 1970, 1975, and 1980. For the period 1970–80 we find a positive relationship between growth rate of output and percentage contribution of total factor productivity except for Japan, Singapore, Hong Kong, and Malaysia. Singapore's low contribution of total factor productivity is the same result as Tsao [22]. This low contribution is due to low labor share which means high growth rate of total input. On the other hand in Hong Kong it is due to the extremely high rate of growth of capital input. According to Chen [2], all these countries revealed high contributions of total factor productivity until 1970. The decrease in this factor may be partly due to economic fluctuations in the 1970s caused by oil-shocks. But we also suggested another factor, that these countries already attained high levels of technology in the 1970s. Jorgenson and Nishimizu [12] shows that by 1973 the aggregate level of technology in Japan overtook and stood ahead of that in the United States. There is no reason to assume that high technology level means low technical progress. But one reason in favor of this assumption is that a relatively low level of technology may be sometimes advantageous in the sense of Gerschenkron's "borrowed technology."

In Section IV we have identified the translog index of level of technology and sources of difference in levels of output. The highest level of technology is that of Japan and next to Japan is Singapore and Hong Kong. Malaysia was next to them in 1970 but was overtaken by Taiwan by the end of 1970s. The difference in levels of technology between Taiwan and Korea was narrow in 1970 but it was widened in the 1970s, though these two countries showed similar performance of economic growth in the period. As for the source of difference in level of output, the smaller the contribution of level of technology, the bigger is the contribution of labor.

There are three points worth noting. The first is that both Singapore and Hong Kong have very small shares of agriculture in GDP. As we have mentioned before, our measure of total factor productivity includes the effect of structural change such as the shift from agriculture to nonagricultural sector. This may be one of the reasons for the low contributions of total factor productivity in these countries. The second point is the positive relationship between growth rate of output and contribution of imported capital input except Japan. This shows the important role of imported capital input irrespective of level of technology. The third point concerns the accuracy of data. The data used in this study are often limited and subject to error so that we could not adjust for the quality change. Thus our measurement is far from satisfactory and must be improved according to the improvement of data availability.

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## APPENDIX A

## DATA AND THEIR SOURCES

*GDP (Y).* Except for Japan, GDP data are taken from Asian Development Bank, *Key Indicators of Developing Member Countries of ADB,* various years. For Japan it is taken from Economic Planning Agency, *Annual Report on National Accounts,* various years.

*Number of persons employed (L).* With the exception of India, numbers of persons employed are taken from International Labour Office, *Year Book of Labour Statistics,* various years. In the case of India, the data for 1970, 1975, and 1980 are derived from *Census of India,* 1971 and 1981 editions by assuming the constancy of the annual growth rate.

*Capital stock (K).* In the case of Japan, capital stock data are taken from *Annual Report on National Accounts,* various years. The data for India are taken from [1]. For the other countries we use the estimates by Statistics Department of Institute of Developing Economies for Econometric Link System for Asian Countries (ELSA) project.

*Imported capital stock (Km).* This is made of machinery and transport equipment which are imported from abroad. (In the cases of Singapore and Hong Kong it is net import.) These capital goods belong to category 7 of the Standard

International Trade Classification (SITC). The values of import of these goods are deflated at the SITC four digit classification where the deflators are the unit values of the corresponding categories of their main partner country. Then these are aggregated to the investment of the imported capital goods at constant prices. The data are available since 1962. With these series of investment the imported capital stock is estimated by inventory method assuming that the depreciation rate is 0.1 and that the initial stock is zero. Though we ignored the existing capital stock in 1962, it would be of minor importance to our analysis because the larger share when we adjust the stock in 1962 would be partly canceled by the faster rate of growth.

*Domestically produced capital stock or domestic capital stock (Kd).* This category is defined as the capital stock $K$ minus imported capital stock $Km$.

*Value share of labor ($V_L$).* A problem in measuring labor share is how to divide the mixed income of the self-employed persons into compensation for labor and payment for the other factors of production. In this paper we impute the average wage rate to all persons employed. In the case of Japan, average wages in nonagricultural sector is used. For Singapore, average weekly earnings in 1975 and 1980 are extrapolated to 1970 by the hourly wage in the nonagricultural sector but these wage data caused very low labor shares such as Tsao's result of 35 per cent by *Labour Force Survey.* Tsao [22] shows that labor share increased from 35 to 44 per cent according to weekly earnings. In our study we chose the highest value and assumed it to be 50 per cent. In the case of Hong Kong, Taiwan, Malaysia, Korea, and Thailand, average wages in the manufacturing sector are used. All data are taken from *Year Book of Labour Statistics,* various years and industrial census of each country. In the case of the Philippines, the wage data of the Central Bank of the Philippines show a rapid decrease in real wages and do not seem to be reliable. So we assumed that the labor share is 0.6, that is, close to the value in 1970 when we apply the wage rate. (Ezaki [9] estimated value share of labor as the ratio of wages and salaries to total value added (GNP) in input-output table of 1965 and the result is 44 per cent which are used for all periods of time.) In Indonesia and India, there is no reliable wage data and so we assume the labor share is 0.6 for Indonesia and 0.7 for India. For India there are several estimates of the labor share. Rao [20] points out that the estimates of the United Nations' *Yearbook of National Accounts Statistics* are overestimated because it included the income of self-employed in the labor share. The UN estimate is 73 per cent in 1970 and we choose a lower value, 70 per cent. Sensitivity analysis of labor share is given in Appendix B.

*Value share of domestic and imported capital stock ($V_{Kd}$, $V_{Km}$).* Since there is no way to estimate the rental prices of domestic capital stock and imported capital stock separately, we assumed these rental prices to be equal to each other. This equal rental price means that their imputed cost of capital is derived by dividing GDP less labor share by total capital stock $K$, and that their shares are in proportion to the quantities of domestic and imported capital stock.

APPENDIX

DATA

| Country | Period | GDP | Labor (1,000) | Capital Stock | | |
|---|---|---|---|---|---|---|
| | | | | Total | Domestic | Imported |
| Japan | 1970 | 117,944 | 51,090 | 162,033 | 155,702 | 6,331 |
| | 1975 | 147,815 | 52,400 | 285,672 | 277,382 | 8,290 |
| | 1980 | 189,851 | 55,520 | 395,444 | 384,347 | 11,097 |
| Singapore | 1970 | 5,579 | 651 | 19,788 | 17,370 | 2,418 |
| | 1975 | 8,790 | 813 | 32,567 | 26,782 | 5,785 |
| | 1980 | 13,357 | 1,055 | 49,580 | 40,293 | 9,278 |
| Hong Kong | 1970 | 25,344 | 1,539 | 32,156 | 24,706 | 7,450 |
| | 1975 | 25,349 | 1,770 | 58,819 | 46,073 | 12,747 |
| | 1980 | 63,179 | 2,207 | 119,370 | 98,209 | 21,161 |
| Taiwan | 1970 | 403,821 | 4,576 | 1,932,746 | 1,828,488 | 104,258 |
| | 1975 | 616,869 | 5,521 | 2,471,361 | 2,193,700 | 277,661 |
| | 1980 | 1,004,613 | 6,547 | 3,337,506 | 2,866,287 | 471,219 |
| Malaysia | 1970 | 15,829 | 3,328 | 34,114 | 32,948 | 1,166 |
| | 1975 | 22,332 | 4,020 | 51,213 | 48,991 | 2,222 |
| | 1980 | 33,679 | 5,094 | 77,818 | 74,260 | 3,558 |
| Korea | 1970 | 6,315 | 9,745 | 21,033 | 19,136 | 1,897 |
| | 1975 | 9,952 | 11,830 | 28,069 | 24,288 | 3,781 |
| | 1980 | 14,342 | 13,706 | 44,526 | 36,777 | 7,749 |
| Philippines | 1970 | 51,014 | 11,772 | 193,945 | 177,029 | 16,916 |
| | 1975 | 68,361 | 14,517 | 246,970 | 225,229 | 21,742 |
| | 1980 | 92,792 | 17,746 | 343,434 | 313,697 | 29,737 |
| Thailand | 1970 | 150,092 | 16,022 | 479,180 | 429,404 | 49,777 |
| | 1975 | 204,056 | 19,068 | 675,580 | 602,323 | 73,257 |
| | 1980 | 292,852 | 22,787 | 995,370 | 904,268 | 91,102 |
| Indonesia | 1970 | 5,233 | 39,081 | 16,870 | 16,524 | 346 |
| | 1975 | 7,631 | 46,318 | 23,067 | 21,301 | 1,766 |
| | 1980 | 10,954 | 55,898 | 34,482 | 31,223 | 3,259 |
| India | 1970 | 348,020 | 176,940 | 1,080,990 | 1,078,084 | 2,906 |
| | 1975 | 389,790 | 195,388 | 1,364,270 | 1,360,966 | 3,304 |
| | 1980 | 469,480 | 215,760 | 1,752,070 | 1,748,407 | 3,663 |

TABLE I

| Value Share (%) | | | | Unit of GDP and Capital Stock |
|---|---|---|---|---|
| | Capital Stock | | | |
| Labor | Total | Domestic | Imported | |
| 63.2 | 36.8 | 35.3 | 1.4 | Billions of constant yen of 1975 |
| 75.4 | 24.6 | 23.9 | 0.7 | |
| 74.4 | 25.6 | 24.9 | 0.7 | |
| 50.0 | 50.0 | 43.9 | 6.1 | Millions of constant Singapore dollar of 1968 |
| 50.0 | 50.0 | 41.1 | 8.9 | |
| 50.0 | 50.0 | 40.6 | 9.4 | |
| 66.4 | 33.6 | 25.8 | 7.8 | Millions of constant Hong Kong dollar of 1973 |
| 63.1 | 36.9 | 28.9 | 8.0 | |
| 58.3 | 41.7 | 34.3 | 7.4 | |
| 50.1 | 49.9 | 47.2 | 2.7 | Millions of constant New Taiwan dollar of 1976 |
| 45.6 | 54.5 | 48.3 | 6.1 | |
| 50.0 | 50.1 | 43.0 | 7.1 | |
| 66.1 | 33.9 | 32.7 | 1.2 | Millions of constant ringgit of 1975 |
| 54.5 | 45.5 | 43.5 | 2.0 | |
| 50.9 | 49.1 | 46.8 | 2.2 | |
| 63.1 | 36.9 | 33.6 | 3.3 | Billions of constant won of 1975 |
| 54.8 | 45.3 | 39.2 | 6.1 | |
| 68.1 | 31.9 | 26.4 | 5.6 | |
| 60.0 | 40.0 | 36.5 | 3.5 | Millions of constant peso of 1972 |
| 60.0 | 40.0 | 36.5 | 3.5 | |
| 60.0 | 40.0 | 36.5 | 3.5 | |
| 56.5 | 43.6 | 39.0 | 4.5 | Millions of constant baht of 1972 |
| 58.4 | 41.6 | 37.1 | 4.5 | |
| 46.2 | 53.8 | 48.9 | 4.9 | |
| 60.0 | 40.0 | 39.2 | 0.8 | Billions of constant rupiah of 1973 |
| 60.0 | 40.0 | 36.9 | 3.1 | |
| 60.0 | 40.0 | 36.2 | 3.8 | |
| 70.0 | 30.0 | 29.9 | 0.1 | Millions of constant rupee of 1970–71 |
| 70.0 | 30.0 | 29.9 | 0.1 | |
| 70.0 | 30.0 | 29.9 | 0.1 | |

# APPENDIX B

## SENSITIVITY ANALYSIS

Since our estimations of value share of labor for Singapore, Philippine, Indonesia, and India are somewhat arbitrary, we tested the sensitivity of the sources of growth with respect to labor share. The results are shown in the table below. The alternative share of labor is presented in note 2 of the table.

APPENDIX TABLE II

SOURCES OF GROWTH

| Country | Period | GDP | Labor | Capital Stock | | | Productivity |
|---|---|---|---|---|---|---|---|
| | | | | Total | Domestic | Imported | |
| Singapore | 1970–80 | 9.1(100.0) | 1.8(19.3) | 6.3(68.6) | 4.8(53.1) | 1.4(15.6) | 1.1(12.1) |
| | 1970–75 | 9.5(100.0) | 1.6(16.5) | 6.9(72.8) | 5.1(53.7) | 1.8(19.2) | 1.0(10.7) |
| | 1975–80 | 8.7(100.0) | 1.8(20.9) | 5.8(66.7) | 4.6(53.0) | 1.2(13.7) | 1.1(12.4) |
| Philippines | 1970–80 | 6.2(100.0) | 1.9(30.2) | 3.3(53.5) | 3.0(48.9) | 0.3(4.6) | 1.0(16.3) |
| | 1970–75 | 6.0(100.0) | 2.1(35.3) | 2.5(41.9) | 2.3(38.1) | 0.2(3.8) | 1.4(22.8) |
| | 1975–80 | 6.3(100.0) | 1.4(22.3) | 4.5(71.4) | 4.1(65.5) | 0.4(5.9) | 0.4( 6.4) |
| Indonesia | 1970–80 | 7.7(100.0) | 1.9(24.2) | 3.8(49.3) | 3.1(40.6) | 0.7( 8.7) | 2.0(26.5) |
| | 1970–75 | 7.8(100.0) | 1.8(22.5) | 3.3(42.5) | 2.5(32.0) | 0.8(10.5) | 2.7(35.0) |
| | 1975–80 | 7.5(100.0) | 2.0(26.0) | 4.2(55.6) | 3.6(48.4) | 0.5( 7.3) | 1.4(18.4) |
| India | 1970–80 | 3.0(100.0) | 1.2(39.8) | 2.0(64.5) | 2.0(64.5) | 0.0(0.1) | −0.1( −4.3) |
| | 1970–75 | 2.3(100.0) | 1.2(52.5) | 1.9(82.1) | 1.9(82.0) | 0.0(0.1) | −0.8(−34.6) |
| | 1975–80 | 3.8(100.0) | 1.2(32.0) | 2.0(53.8) | 2.0(53.8) | 0.0(0.1) | 0.5( 14.2) |

Notes: 1. Percentage contributions are in the parentheses.
2. Value share of labor is as follows:

| | 1970 | 1975 | 1980 |
|---|---|---|---|
| Singapore | 34.9 | 32.4 | 34.8 |
| Philippine | 59.4 | 39.1 | 28.6 |
| Indonesia | 50.0 | 50.0 | 50.0 |
| India | 60.0 | 60.0 | 60.0 |