FACTOR INPUTS, TOTAL FACTOR PRODUCTIVITY, AND ECONOMIC GROWTH: THE ASIAN CASE

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I. ALTERNATIVE APPROACHES TO THE STUDY OF SOURCES OF GROWTH

IN THE LAST two decades or so, studies on the relative contributions of factor inputs and technical progress to economic growth have been very numerous in the empirical literature on economic growth. There are two distinct approaches to such studies. One is to estimate the rate of technical progress and the marginal contribution of the individual factors to output growth by using econometric methods. The second approach, the one adopted in this paper, is to use factor shares in national income as weights to combine the individual factor inputs and forming an index of total factor input. Then to denote that part of output growth which cannot be explained by increases in factor inputs as total factor productivity or technical progress. This approach, compared with those of econometrics, has the advantage that results are less sensitive to the type of data and methods used. This national income accounting approach is most often associated with the names Denison, Solow, and Kendrick,[1] and can be explained as follows. Assuming a neoclassical production function, the formula is

$$Y=F(K,\ L,\ t)\,, \tag{1}$$

where Y is output, K and L are capital and labor inputs respectively, and t is time. Taking the logarithm of the production function and differentiating with respect to time, gives

$$\frac{\partial Y/\partial t}{Y}=\frac{(\partial F/\partial K)(\partial K/\partial t)}{F}+\frac{(\partial F/\partial L)(\partial L/\partial t)}{F}+\frac{\partial F/\partial t}{F}\,.$$

Denoting the proportional growth rates of output, capital, and labor as $\dot{Y}$, $\dot{K}$, and $\dot{L}$ respectively, obtains

[1] E. F. Denison, *The Sources of Economic Growth in the U.S. and the Alternatives before Us* (New York: Committee for Economic Development, 1962); idem, *Accounting for the Economic Growth in the U.S., 1929–69* (New York: Brookings Institution, 1974); [3]; J. Kendrick, *Productivity Trends in the United States* (New York: Princeton University Press, 1961); [16]. Solow's later work is however more concerned with the estimation of production functions by econometric techniques.

$$\dot{Y}=\frac{(\partial F/\partial K)K}{F}\dot{K}+\frac{(\partial F/\partial L)L}{F}\dot{L}+\frac{\partial F/\partial t}{F},$$

where $(\partial F/\partial t)/F$ is the proportional rate of shift of the production function. It is taken to represent total factor productivity or technical progress. Denoting it by $\dot{A}$, gives

$$\dot{Y}=\frac{(\partial F/\partial K)K}{F}\dot{K}+\frac{(\partial F/\partial L)L}{F}\dot{L}+\dot{A},$$

or

$$\dot{A}=\dot{Y}-\frac{(\partial F/\partial K)K}{F}\dot{K}-\frac{(\partial F/\partial L)L}{F}\dot{L}, \tag{2}$$

where $[(\partial F/\partial K)K]/F$ and $[(\partial F/\partial L)L]/F$ are the share of capital in income and share of labor in income respectively. If it is assumed that income shares are constant overtime, equation (2) is reduced to

$$\dot{A}=\dot{Y}-\beta_K\cdot\dot{K}-\beta_L\cdot\dot{L}, \tag{3}$$

where β_K and β_L are capital and labor shares in income respectively. Equation (3) is the basic equation used by growth economists to calculate the sources of growth. It can be seen that equation (3) is the same as the Cobb-Douglas production function expressed by log-linear form. As far as the experience of the industrialized countries is concerned, the factor shares in income have been stable, and hence most studies employ equation (3) with β_K and β_L as constants. It is in this way that most source of growth studies imply a Cobb-Douglas production function, though any form of the neoclassical production function should be compatible with this approach. If other production functions, such as CES, are assumed, then the weights β_K and β_L will change overtime, i.e., different weights have to be used in calculating total factor productivity at different moments in time.

Total factor productivity or technical progress as represented by $\dot{A}$ in equation (3) is a catch-all phrase embodying all those changes in output that are not explained by the changes in factor inputs. Rather than calling this technical progress, many economists prefer to use the term the "residual." The residual thus defined should include quality changes in inputs such as changes in the education level and the age-sex composition of the labor force and the new techniques embodied in the new capital goods, economies of scale, reallocation of resources, and changes in organization, management, and working methods. Some economists, notably Denison,[2] try to disentangle the many-faceted residual. However, in doing so, one has to make bold assumption,[3] e.g., that 40 per cent of the

[2] Recently, Denison proposes a classification of the residual into eleven items. E. F. Denison, "The Classification of Sources of Growth," *Review of Income and Wealth*, March 1972.

[3] For a review of the assumptions made by Denison, see A. P. Thirlwall, "Denison on 'Why Growth Rates Differ,'" *Banca Nazionale del Lavoro*, July 1969.

differences in earnings between workers of the same age are due to factors other than differences in the stock of education. Nevertheless, the general approach of using equation (2) to study the sources of growth does help to throw some light on the relative importance of factor input contributions and non-factor-input contributions to growth. The relative importance of different sources of growth often offers an explanation to the rate of growth, and the different levels of income and productivity attained by different countries. The sources of growth in five Asian economies, viz., Hong Kong, Japan, Korea, Singapore, and Taiwan along the lines of equations (2) and (3) are examined here. These Asian economies are of particular interest to us as all of them have been growing at 10 per cent or more per annum in the postwar period. In the present study, I do not attempt to adjust the inputs for quality changes. This is partly due to the lack of suitable data for such purposes, and partly because even if data are available there still is a need for certain bold assumptions before an assessment can be made of the contribution of qualitative change. Moreover, the major objectives here are not to exhaust the various possible sources of growth, but to examine in broad terms the input and non-input sources of growth in the economies under study and to compare the results with existing evidence on the developed and developing economies. Also to be examined is the role of resource reallocation during the growth process of the five economies under study. Owing to measurement and data problems, the analysis of resources reallocation has to be confined to the reallocation of human resources from the agricultural to the nonagricultural sector.

II. CONTRIBUTIONS OF FACTOR INPUTS AND TOTAL FACTOR PRODUCTIVITY TO GROWTH

While most source-of-growth studies focus on the aggregate economy or only on the non-farm sector, the present study attempts to measure sources of growth in individual sectors, viz., agricultural, manufacturing, and services.[4] As different sectors of the economy are characterized by different economic and technical features, there should be considerable difference in the source of growth among them. It is therefore highly desirable to investigate such differences and see how they are related to the growth and structural changes of an economy. In addition, the period under consideration 1955–70 is divided into three subperiods, 1955–60, 1960–66, and 1966–70.[5] This will, on the one hand, enable observation of changes in the sources of growth overtime, and on the other, provide sufficient observations to examine the relationship between output growth and contributions of factor inputs and total factor productivity by pooling time-series and cross-country data.

In calculating the sources of growth in different sectors of the five economies

[4] Service sector as used here includes construction, public utilities, and transport and communication in addition to commercial, social, and personal services.

[5] Data for the period 1955–60 are however not available for the agricultural, manufacturing, and service sectors of Korea, and the manufacturing sector of Hong Kong and Singapore.

under study and over different subperiods, equation (3) shall be used in which factor shares in income are treated as constants. Furthermore, β_K is assumed to equal 0.4 and β_L 0.6. There are two justifications for this procedure. Firstly, from the available data, the factor shares of the economies under study remain reasonably constant over the period 1955–70 and they lie very close to the assumed values. Secondly, the resulting calculations are in general, insensitive to the values of β_K and β_L around 0.4 for the former and 0.6 for the latter. Values of 0.3–0.5 for β_K and 0.5–0.7 for β_L were tried. The results are in no case significantly altered.

The task of explaining sources of growth of output instead of output per worker has been set. Literature on sources-of-growth has been largely concerned with the latter. This is perhaps justified in part by the concern of development economists with level of per capita output. However, such a measurement of sources of growth is highly sensitive to the rate of labor force expansion. In a study of developed countries in which the rate of labor force growth is low, it makes relatively little difference whether one is calculating the sources of growth of output or the sources of growth of productivity. On the other hand, for developing nations where population growth is generally high, it is much more informative and serves the purpose better if attention is focused on the sources of output growth instead of productivity growth.

In the source-of-growth literature, there are two contrasting patterns of empirical evidence. First, for a considerable time after the pioneer work of Abramovitz [1] and Solow [16], the findings had almost invariably been that total factor productivity constitutes by far the most important source of growth. For example, Denison found that in all eight European countries he studied (Belgium, Germany, Netherlands, Norway, Denmark, France, Italy, and the United Kingdom) over 50 per cent of output growth cannot be explained by increases in inputs even after allowance for quality change in labor input. It must however be noted that all these findings pertain to the industrialized economies. A somewhat contrasting pattern of findings has emerged from the experience of the developing economies. The application of the source-of-growth methodology to developing countries is only a very recent matter. So far, some detailed studies have been made with reference to the Philippine economy and that of Latin American nations [17] [18] [13] [2]. In these studies, it is found that the contributions of factor inputs to growth has been much more important than those of total factor productivity. These findings are in line with an earlier and somewhat neglected study on the postwar Israel economy [6]. In fact, even before such empirical evidence was provided, some economists doubted the relevance of the source-of-growth experience of developed countries to the less developed economies. For instance, Sir John Hicks remarked that "it is very wrong to give the impression to a poor country, which is very far from equilibrium even on a past technology that capital accumulation...is a matter of minor importance" [8, p. 304]. Nonetheless, little attention has so far been devoted to explaining such contrasting patterns of sources of growth in the developed and developing countries. The purpose here is to add to the existing evidence

the experience of five fast-growing Asian economies,[6] and go a further step to explain the differences in source-of-growth patterns.

A. *Economy as a Whole*

The sources of growth of real output for the five aggregate economies under study are shown in Table I. Over the entire 1955–70 period, total factor productivity accounted for a considerable growth in output in the economy as a whole, and for slightly less than 50 per cent of the growth in Hong Kong and slightly over 50 per cent in the other four. When compared with other findings, the results of this study suggest that the importance of total factor productivity in explaining growth in the five economies lies between the two contrasting patterns in the developed and developing countries. Moreover, the five economies form a homogeneous group with regard to the role of total factor productivity in growth, ranging from only 46 per cent to 56 per cent. Japan, the only economy in the group which has been previously studied in a similar way, had considerable increase in the importance of total factor productivity when compared with findings for an earlier period.[7] There were no previous studies on Hong Kong, Singapore, Taiwan, and Korea. These findings indicate that the percentage growth of output explained by total factor productivity in these economies is much higher than other developing economies. For Correa's study of nine Latin American countries during the period 1950–62, an average of 34 per cent of output growth is explained by total factor productivity.[8] Bruton's study of five Latin American countries during 1940–64 shows an even lower percentage of 28.[9] For Asian economies, it is 39 per cent for the Philippines in 1955–70, 31 per cent for Israel 1950–65, and 24 per cent for India 1950–60 [13] [7] [15]. For our group of five fast-growing Asian economies, the average is 53 per cent. This average is however lower than that for the advanced Western countries. Using Denison's findings, the average for the nine Western countries during the period 1950–62 is 64 per cent.[10] Thus, our results for the five economies under study complicate the findings in the literature. When we include our results in the existing findings, the two contrasting patterns of sources of growth between developed and develop-

6 There already are a number of studies on the sources of growth in Japan. The findings of all are consistent with those of the Western developed countries, i.e., a large proportion of output growth (over 50 per cent) is explained by total factor productivity. See K. Ohkawa, "Nihon-keizai no seisan·bumpai, 1905–1963 nen" [Production and distribution of Japanese economy for 1905–63], *Keizai kenkyu,* April 1968; H. Kanamori, "What Accounts for Japan's High Rate of Growth," *Review of Income and Wealth,* June 1972.

7 For instance, Aukrust found that only 38 per cent of output growth was accounted for by the "residual" in Japan for the period 1950–58 (O. Aukrust, "Factors of Economic Development: A Review of Recent Research," *Productivity Measurement Review,* February 1965).

8 [2]. The nine Latin American countries are Argentina, Brazil, Chile, Colombia, Ecuador, Honduras, Mexico, Peru, and Venezuela.

9 H. J. Bruton, "Productivity Growth in Latin America," *American Economic Review,* December 1967; the five countries are Argentina, Brazil, Chile, Colombia, and Mexico.

10 [3]. The nine Western countries are Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, United Kingdom, and the United States.

TABLE I

SOURCES OF GROWTH IN REAL NATIONAL INCOME: ECONOMY AS A WHOLE

Country	Period	Explanation of Sources of Growth			Income Growth Rate
		Capital Input	Labor Input	Total Factor Productivity	
Hong Kong	1955–60	1.87 (22.7)	3.98 (48.2)	2.50 (29.1)	8.25
	1960–66	4.33 (41.0)	1.97 (18.6)	4.27 (40.4)	10.57
	1966–70	1.11 (16.1)	1.49 (21.6)	4.30 (62.3)	6.90
	1955–70	3.12 (33.5)	1.86 (20.0)	4.33 (46.5)	9.31
Singapore	1957–66	0.72 (13.4)	0.94 (17.5)	3.70 (69.0)	5.36
	1966–70	3.76 (32.3)	2.78 (23.9)	5.10 (43.8)	11.64
	1957–70	1.44 (22.0)	1.50 (22.9)	3.62 (55.2)	6.56
Korea	1955–60	0.87 (20.6)	1.35 (32.0)	2.00 (47.4)	4.22
	1960–66	0.67 (9.7)	2.14 (31.0)	4.10 (59.3)	6.91
	1966–70	3.67 (36.3)	1.38 (13.6)	5.06 (50.1)	10.11
	1955–70	2.12 (24.0)	1.73 (19.6)	4.99 (56.4)	8.84
Japan	1955–60	2.71 (29.6)	0.90 (9.9)	5.53 (60.5)	9.14
	1960–66	4.15 (46.4)	0.79 (8.8)	4.00 (44.7)	8.94
	1966–70	3.86 (32.1)	0.74 (6.2)	7.44 (61.8)	12.04
	1955–70	3.70 (36.6)	0.84 (8.3)	5.58 (55.1)	10.12
Taiwan	1955–60	1.07 (20.4)	1.05 (20.0)	3.12 (59.5)	5.24
	1960–66	1.79 (19.3)	1.45 (15.6)	6.04 (65.1)	9.28
	1966–70	3.07 (38.0)	3.18 (39.4)	1.82 (22.6)	8·07
	1955–70	2.00 (24.9)	1.72 (21.5)	4.30 (53.6)	8.02

Note: Percentage points with percentage distribution in brackets.

ing countries become much less clear-cut. Our group of economies (with the exception of Japan) is by no means more developed than the Latin American countries or Israel and yet they have shown a source-of-growth pattern more similar to the developed countries than other developing nations. It seems then that there is more than stage of economic development attained that determining the role of total factor productivity in explaining the growth of output.

The results of course suggest that about 50 per cent of output growth in the economies under study is accounted for by increases in factor inputs. For the period 1955–70 as a whole, the contribution of capital to growth is generally greater than that of labor. The only exception is Singapore where contributions of capital and labor are roughly equal. The greater importance of capital in explaining growth is most marked in Japan, and least apparent in Taiwan. For the earlier period 1955–66, the contribution of labor is greater than that of capital in Korea. Over the three successive periods, the contributions of capital and labor in Taiwan are more or less equal in each period. Over time, the percentage contribution of total factor productivity increases in the case of Hong

Kong (and that of factor inputs decreases accordingly), but decreases in the case of Singapore. In Japan and Korea, the percentage has been reasonably stable over successive periods. In Taiwan, the percentage contribution of total factor productivity declines noticeably in the most recent subperiod 1966–70.

Turning to the actual size of contribution to income growth rates, it is observed that total factor productivity ranges from almost 6 per cent per annum in Japan to 3.6 per cent in Singapore. These compare very favorably even with the top scoring countries in Denison's study, 3.97 for Germany and 4.16 for Italy; and all five countries under study have achieved higher percentage points in total factor productivity than all the Latin American and other Asian countries which have been studied by similar methods. Over the successive subperiods, there is a general tendency for total factor productivity to rise in the economies under study, except for a drop in Taiwan during the subperiod 1966–70. In general, the five economies also have very high percentage points of capital contribution to growth, especially Hong Kong and Japan. This experience is shared only by Israel with a 4.1 per cent contribution of capital to growth during 1950–65. The percentage point of labor's contribution to growth was high in Hong Kong in the earlier period and in Singapore and Taiwan in the more recent periods. Like other developed countries, Japan has a relatively low percentage of labor contribution. Over time, the contribution of labor declines in Hong Kong and Japan, and rises in Singapore and Taiwan, while in Korea it is reasonably stable. It is expected that in a mature economy like Japan, the contribution of labor slowly declines. In Hong Kong, it is due to the slowing down of the inflow of labor from the Chinese mainland and possibly the use of more capital-intensive methods of production. In Korea and Taiwan where urban-rural migration is still going on and rate of population growth is high, labor's contribution to growth has shown no sign of decline. In Singapore, the large-scale inflow of labor force from Malaysia in the sixties is largely responsible for a considerable increase in the contribution of labor to growth. Generally, capital contribution increases over time, except for the most recent subperiod 1966–70 in Hong Kong.

Turning now to the role of resource reallocation among sectors, long considered one of the most important factors in explaining the differences in growth rates among countries [3] [11] [12]; in the general disequilibrium nature of developing economies, it is expected that resource reallocation must play an even more important role than in developed countries. According to the method used here, gains from resource reallocation lump together with total factor productivity or "residual." Unfortunately there are numerous problems associated with the concept and measurement of resource reallocation. First, there is the problem of which kind of resources should be considered. Traditionally, land is treated as fixed and therefore plays little or no part in resource reallocation. However, the reallocation of agricultural land for industrial and commercial use might be of great importance to city economies like Hong Kong and Singapore. One way of looking at land is of course to treat it as a kind of capital. Many economists are interested in studying the flow of capital resources between agricultural and nonagricultural sectors in the process of development. Some hold the view that

the supply of agricultural surplus to the nonagricultural sector is a prerequisite for rapid economic development,[11] while others maintain that there is a tendency of inflow into the agricultural sector in the process of development, especially with the Asian countries [9]. There is however always the problem of how to measure the resource flow and the items to be included in the flow. On the other hand, some economists concentrate their attention on the outflow of rural workers to the nonagricultural sector in the process of economic development. Such discussions are found in the dualistic models of growth associated with the names of Lewis [14], Fei-Ranis [5], and Jorgenson [10]. In studying the postwar growth experience of nine Western countries, Denison attempts to measure gains from the reallocation of labor force from the agricultural sector to the nonagricultural sector, and concludes that such a reallocation of resources constitutes one of the major factors in differences of growth rates among Western countries. Inasmuch as rural-urban migration is a dominant phenomenon in the economies under study, the reallocation of labor from one sector to another should have been the most important form of resources reallocation in these economies. Accordingly, Denison's method is used here in isolating the gains of resource reallocation from the residual to find out how much of total factor productivity is due to the reallocation of labor from the agricultural to the nonagricultural sector.[12] The basic idea is to calculate the amount by which the initial year national income would have been higher if the final year employment pattern had prevailed. The period 1955–70 is divided into three subperiods, and the results were derived as shown in Table II.

Table II suggests that resource reallocation of labor in those countries with a relatively large agricultural sector (Japan, Korea, and Taiwan) plays an important part in explaining the growth of output. Understandably, the two city economies, Hong Kong and Singapore, gain little from such a reallocation since the agricultural sector was extremely small even before modern economic growth. However, reallocation of land use might have played an important part though we have no way of quantifying its contribution. Among the other three economies under study, Korea with relatively the most backward and largest agricultural sector has benefited most from reallocation of the labor force, especially during the early subperiod 1955–60. During this period, 86 per cent of the total factor productivity or 41 per cent of output growth in Korea is explained by reallocation of the labor force. Japan with the least backward and relatively smallest agricultural sector benefits only moderately from such reallocation. Taiwan also benefits only moderately. This is perhaps due to the fact that the most rapid reallocation of labor force in Taiwan took place before 1955. Nevertheless, it is in relative terms that Japan and Taiwan have moderate gains from the reallocation of labor. In absolute terms, both countries increased about a percentage point per annum which should be regarded as very high. Of course, the gain of about 1.5 percentage points by Korea is extremely high by any

[11] See, e.g., B. F. Johnston and J. W. Mellors, "Agriculture in Economic Development," *American Economic Review*, September 1961.

[12] [3]. For explanation, see Appendix B.

TABLE II

GAINS FROM RESOURCE REALLOCATION

	Hong Kong	Japan	Korea	Singapore	Taiwan
1955-60:					
Percentage points		1.00	1.71		0.86
As a % of $\dot{A}$		18.10	85.50		27.60
As a % of $\dot{Y}$		10.90	40.50		16.40
1960-66:					
Percentage points	0.24	0.90	1.28	0.17	1.38
As a % of $\dot{A}$	5.60	22.50	31.2	4.60	22.80
As a % of $\dot{Y}$	2.30	10.10	18.50	3.20	14.90
1966-70:					
Percentage points	0.16	1.03	1.43	0.27	1.02
As a % of $\dot{A}$	3.70	13.80	28.30	5.30	56.00
As a % of $\dot{Y}$	2.30	8.60	14.10	2.30	12.60

Note: $\dot{A}$ =percentage of total factor productivity growth; $\dot{Y}$=rate of income growth. For detailed procedures in deriving the percentage points of gains from resource reallocation see Appendix B.

standard. It is also of interest to note that among the five economies under study, Korea with the largest proportion of output explained by total factor productivity is also the economy that gains most from reallocation of labor resources. At the same time, Hong Kong with the smallest proportion of output growth explained by total factor productivity is the economy that gains least from resource reallocation. It then seems that the greater the extent of resource reallocation, the more important total factor productivity is as a source of growth.

In examining the relationships among various growth rates (the contributions of capital and labor to growth, total factor productivity, and growth in output) a comparison can be made of the results arrived at here with those of the other developed and developing countries, and some light may be shed on the different growth source patterns. First, in examining the relationship between growth of output and percentage points of factor inputs' contribution to growth, equation (3) shows that growth in output is explained by the growth and increase in productivity of inputs. If for a group of similar countries the simple regression is calculated of $\dot{Y}$ on $\hat{X}$ ($\hat{X}=\hat{K}+\hat{L}=\beta_K\dot{K}+\beta_L\dot{L}$), which is the percentage points of factor inputs' contribution to growth, the resulting coefficient of $\hat{X}$ should be approximately unity and the intercept gives an average value of $\dot{A}$. Pooling the cross-section and time-series data of the five economies,[13] the following regression equation is obtained:

[13] There are fourteen observations: three observations corresponding to the three subperiods, 1955–60, 1960–66, and 1966–70 in each of the cases of Hong Kong, Japan, Korea, and Taiwan, and two observations corresponding to 1957–66 and 1966–70 in the case of Singapore.

$$\dot{Y} = \underset{(0.264)}{4.036 + 1.041\hat{X}}. \qquad R^2 = 0.564. \tag{4}$$

The coefficient of $\hat{X}$ is statistically significant but insignificantly different from one. In fact, 56 per cent of the variations in the growth rate of output is explained by change in the rate of growth of inputs. Equation (4) therefore indicates that the rate of growth of output is moderately dependent on the rate of growth of inputs and the former is roughly equal to the latter. Equation (4) also shows that the average value of $\dot{A}$ for the economies under study is about 4 per cent which is exceedingly high when compared with other studies. For the purpose of comparison, a similar regression can be performed on Correa's group of Latin American countries together with Israel, India, and the Philippines, and this group labeled LAA. The following regression equation is obtained:

$$\dot{Y} = \underset{(0.205)}{1.444 + 1.124\hat{X}}. \qquad R^2 = 0.751. \tag{4a}$$

Equation (4a) shows that the coefficient of $\hat{X}$ is statistically significant and that 3/4 of the variations of the rate of growth of output can be explained by changes in the rate of growth of inputs. Thus in the LAA group of countries, the rate of growth of output is very much dependent on the rate of growth of inputs. The average value of $\dot{A}$ in these countries is only 1.4 per cent.

For the purpose of further comparison, a similar regression is performed for Denison's group of Western industrialized economies (the W group). The resulting regression equation is

$$\dot{Y} = \underset{(0.736)}{1.543 + 1.416\hat{X}}. \qquad R^2 = 0.346. \tag{4b}$$

In this case, the coefficient of $\hat{X}$ is not statistically significant, and the coefficient of determination is relatively low. Equation (4b) thus indicates that for the W group the rate of growth of output is largely independent of the rate of growth of input. Hence, as far as dependence of growth on inputs is concerned, the group of economies being studied here lies between the W group and the LAA group.

As a further step, the relationship is examined between the rate of growth of output and the rate of growth of the individual inputs. To this end, the rate of growth of output is regressed on the percentage point contributions of capital ($\hat{K} = \beta_K \dot{K}$) and labor ($\hat{L} = \beta_L \dot{L}$) to growth. For the selected group of Asian economies, the following equations are obtained:

$$\dot{Y} = \underset{(0.260)}{4.819 + 1.462\hat{K}}. \qquad R^2 = 0.725. \tag{5}$$

$$\dot{Y} = \underset{(0.698)}{7.863 + 0.273\hat{L}}. \qquad R^2 = 0.01. \tag{6}$$

The coefficient of K is statistically significant while that of L is not. Moreover, while almost 3/4 of the variations in the rate of output growth are explained by the variations in the rate of growth of capital, there is no relationship between the rate of growth of output and that of labor. Indeed, equation (6) has a large trend term indicating that, even if labor force does not grow, output will grow at the high rate of 7.9 per cent which is not far from the average growth rate of 8.6 per cent in the five economies under study. Equations (5) and (6) thus suggest that the rate of growth of capital determines to a large extent the rate of growth of output in the selected group of Asian economies.

For the LAA group, the corresponding regression equations are:

$$\dot{Y}=2.850+\underset{(0.355)}{1.708}\hat{K}\,. \qquad R^2=0.698\,. \tag{5a}$$

$$\dot{Y}=0.430+\underset{(0.583)}{2.480}\hat{L}\,. \qquad R^2=0.644\,. \tag{6a}$$

The LAA group thus has a quite different pattern of relationships between rate of growth of output and rate of growth of individual input. Growth rates of capital and labor can explain 2/3 of the growth rate of output, and coefficients $\hat{K}$ and $\hat{L}$ are both statistically significant. The results seem to imply that the rate of growth of capital and the rate of growth of labor are important determinants of the rate of growth of output. However, a closer look at the regression equations reveals that the growth rate of labor is a much more important determinant of the rate of growth of output. The coefficient of $\hat{L}$ is significantly different from 1 while that of $\hat{K}$ is not, implying that a 1 per cent increase in labor can give rise to more than a 1 per cent increase in output. In addition, the constant term of equation (6a) is much smaller than that of equation (5a). While output can still grow at a rate of 2.9 per cent when there is no change in capital input, output can only grow at a rate of 0.4 per cent when labor ceases to grow.

For the group of Western countries, the following regression equations are obtained:

$$\dot{Y}=1.270+\underset{(1.470)}{3.609}\hat{K}\,. \qquad R^2=0.463\,. \tag{5b}$$

$$\dot{Y}=2.501+\underset{(1.270)}{1.613}\hat{L}\,. \qquad R^2=0.187\,. \tag{6b}$$

The coefficient of $\hat{K}$ is marginally significant while that of $\hat{L}$ is insignificant. The results indicate that the rate of growth of inputs plays only a minor role in determining the rate of growth of output in the Western countries. So far this study has come up with a very interesting pattern of relationships between rate of growth of output and rate of growth of input. The relationships are rather weak in the W group, but strong in the LAA group and group of Asian economies. For the LAA group, it is the rate of growth of labor that is more im-

portant, while for the group being studied here it is the rate of capital growth which has played the dominant role in explaining the variations in the rate of output growth.

The results obtained above of course suggest that total factor productivity plays an important part in explaining the variations in the rate of output growth in the W group and that it is of moderate importance in the selected Asian group and of minor importance in the LAA group. To confirm this belief, regressions are made of the rate of growth of output on the percentage point contributions of total factor productivity to growth of output. For the five economies under study:

$$\dot{Y} = \underset{(0.315)}{3.920 + 1.049\dot{A}} . \qquad R^2 = 0.481 . \tag{7}$$

For the LAA group:

$$\dot{Y} = \underset{(0.478)}{3.130 + 1.289\dot{A}} \qquad R^2 = 0.421 . \tag{7a}$$

For the W group:

$$\dot{Y} = \underset{(0.190)}{1.370 + 1.193\dot{A}} . \qquad R^2 = 0.849 . \tag{7b}$$

Coefficients of $\dot{A}$ are statistically significant in all cases. The W group has the highest t-value for the coefficient of $\dot{A}$; and 85 per cent of the variations in the rate of growth of output can be explained by variations in total factor productivity. By comparing equations (7) and (7a), it can be inferred that total factor productivity explains somewhat less the variations in the rate of growth of output in the LAA group of countries than in the selected group of Asian economies. This is not only because equation (7) has a higher R^2, but also because it has a *relatively* smaller constant term than equation (7a), though its constant term is in fact larger in absolute quantity. The explanation is that when total factor productivity is zero, output in the select Asian group will grow at a rate of 3.9 per cent which is 46 per cent of the actual average growth rate of the group; on the other hand, output of the LAA group will grow at a rate of 3.1 per cent which is 56 per cent of the actual average. Thus, without any growth in total factor productivity, the LAA group can achieve a rate of growth much nearer to the actual growth rate than the select Asian group of economies.

Having examined this much on sources of growth in the economy as a whole, the sources of growth in the individual sectors can now be discussed. Although a lot has been done in analyzing sources of growth in the aggregate economy, little attention has been directed to possible differences in the pattern of sources of growth among the individual sectors.

B. *Agriculture*

Data for only three of the five economies, Japan, Korea, and Taiwan was

TABLE III

SOURCES OF GROWTH IN REAL INCOME: AGRICULTURAL SECTOR

Country	Period	Explanation of Sources of Growth			
		Capital Input	Labor Input	Total Factor Productivity	Income Growth Rate
Korea	1960–66	0.58 (8.4)	0.77 (11.1)	5.59 (80.5)	6.94
	1966–70	2.06 (41.0)	−0.59 (−11.7)	3.56 (70.8)	5.03
	1960–70	1.31 (27.6)	0.10 (2.1)	3.34 (70.3)	4.75
Japan	1955–60	1.48 (55.9)	−1.60 (−60.4)	2.77 (104)	2.65
	1960–66	2.17 (54.7)	−2.20 (−55.4)	4.00 (101)	3.97
	1966–70	2.63 (62.8)	−3.91 (−93.3)	5.47 (130)	4.19
	1955–70	2.06 (53.5)	−2.45 (−63.6)	4.24 (110)	3.85
Taiwan	1955–60	1.38 (44.0)	0.44 (14.0)	1.32 (42.0)	3.14
	1960–66	1.97 (32.0)	0.88 (14.3)	3.30 (53.7)	6.15
	1966–70	2.06 (242)	0.32 (37.6)	0.32 (−180)	0.85
	1955–70	1.84 (49.1)	0.71 (18.9)	1.20 (32.0)	3.75

Note: Percentage points with percentage distribution in brackets.

attainable for this area, but the agricultural sector of the city economies is of negligible importance. Calculations of sources of growth in the agricultural sector are presented in Table III. In Japan and Korea, a very high percentage of growth is explained by total factor productivity, with Japan, it in fact explains more than 100 per cent of growth of output because of the negative contribution of the rate of growth of labor to growth. In Taiwan, on the other hand, total factor productivity plays a much less important part in explaining the growth of output. This is largely explained by the fact that while the agricultural labor force has continued to decline in Japan and Korea, it has increased in Taiwan. In addition, during 1966–70 in Taiwan, agricultural output hardly increased and as a result total factor productivity became negative. Invariably, the contribution of capital is greater than that of labor in explaining output growth. Moreover, the contribution of capital to growth increases overtime in all three economies. In order to obtain a clearer picture of the relationship between the rate of growth of agricultural output and the various sources of growth, the following regression is performed:[14]

$$\dot{Y} = \underset{(0.566)}{3.998 + 0.111\hat{X}}, \qquad R^2 = 0.006, \tag{8}$$

$$\dot{Y} = \underset{(1.204)}{5.932 - 1.015\hat{K}}, \qquad R^2 = 0.106, \tag{9}$$

$$\dot{Y} = \underset{(0.460)}{4.271 + 0.212\hat{L}}, \qquad R^2 = 0.03, \tag{10}$$

[14] We have eight observations by pulling time-series and cross-section data together: two observations for Korea for the two subperiods, 1960–66 and 1966–70, and three observations each from Japan and Taiwan for the subperiods, 1955–60 and 1966–70.

$$\dot{Y} = \underset{(0.208)}{2.059 + 0.672\dot{A}}, \qquad R^2 = 0.634, \tag{11}$$

where $\dot{Y}$ = rate of income growth; $\hat{X}$ = percentage points of factor input contribution to growth; $\hat{K}$ = percentage points of capital contribution to growth; $\hat{L}$ = percentage points of labor's contribution to growth; and $\dot{A}$ = rate of total factor productivity growth.

The regression shows that there is no relationship between rate of growth of output and rate of growth of inputs in the agricultural sector. However, the relationship between the rate of growth of output and total factor productivity is quite strong; almost 2/3 of the variations in the rate of growth of output is explained by the variations in total factor productivity, and the coefficient of $\dot{A}$ is statistically significant. Thus, the pattern of sources of growth in the agricultural sector is quite different from that of the economy as a whole. It is however not possible to judge whether this is specific to the group of economies under study here or if it can also be found in other cases.

C. *Manufacturing*

The calculations of the sources of growth in the manufacturing sector are given in Table IV. As can be seen, total factor productivity explains a much lower percentage of output growth than in the case of the aggregate economy. In Hong Kong, Singapore, and Korea, only 1/5 of output growth in the manufacturing sector was accounted for by total factor productivity. This was just below 40 per cent for Japan and Taiwan. In Hong Kong, Japan, and Taiwan, the contribution of capital to growth is greater than that of labor. On the other hand, the contribution of labor is greater for Singapore and Korea. In Singapore, a high rate of growth in the manufacturing sector labor force was made possible by a rapid inflow of workers from Malaysia. In Korea, it is undoubtedly the result of rapid rural-urban migration which has been taking place since 1954, the end of the Korean War. Overtime, there is a tendency for the percentage point contribution of capital to rise. The only exception is Hong Kong in which capital accumulation has slowed down in recent years. In addition, the percentage point contribution of total factor productivity tends to rise during 1960–70 in all economies under study. To show the relationship between the rate of growth of output and the various sources of growth, sets of regressions are performed as with other sectors.[15]

$$\dot{Y} = \underset{(0.128)}{4.144 + 0.971\hat{X}}. \qquad R^2 = 0.852. \tag{12}$$

$$\dot{Y} = \underset{(0.836)}{7.886 + 1.164\hat{K}}. \qquad R^2 = 0.162. \tag{13}$$

[15] There are twelve observations: two observations each from Hong Kong, Korea, and Singapore for subperiods 1960–66 and 1966–70, and three observations each from Japan and Taiwan for the subperiods 1955–60, 1960–66, and 1966–70.

TABLE IV

SOURCES OF GROWTH IN REAL INCOME: MANUFACTURING SECTOR

Country	Period	Explanation of Sources of Growth			
		Capital Input	Labor Input	Total Factor Productivity	Income Growth Rate
Hong Kong	1960-66	6.64 (68.3)	1.47 (15.1)	1.61 (16.6)	9.72
	1966-70	2.70 (25.3)	4.67 (43.7)	3.32 (31.1)	10.69
	1960-70	5.20 (52.4)	2.70 (27.2)	2.03 (20.4)	9.93
Singapore	1960-66	5.20 (31.9)	7.51 (46.1)	3.58 (22.0)	16.29
	1966-70	6.68 (27.3)	13.76 (56.3)	4.01 (16.4)	24.45
	1960-70	5.58 (30.6)	9.34 (51.2)	3.34 (18.3)	18.26
Korea	1960-66	2.28 (18.3)	7.54 (60.6)	2.62 (21.1)	12.44
	1966-70	4.80 (32.7)	5.12 (34.8)	4.77 (32.5)	14.69
	1960-70	3.59 (26.0)	7.14 (51.7)	3.08 (22.3)	13.81
Japan	1955-60	4.60 (34.2)	3.09 (23.0)	5.75 (42.8)	13.44
	1960-66	5.14 (64.9)	1.39 (17.6)	1.39 (17.6)	7.92
	1966-70	5.06 (36.8)	1.72 (12.5)	6.97 (50.7)	13.75
	1955-70	5.03 (43.9)	2.03 (17.7)	4.40 (38.4)	11.46
Taiwan	1955-60	2.42 (21.0)	3.73 (32.3)	5.39 (46.7)	11.54
	1960-66	4.25 (43.0)	1.84 (18.6)	3.80 (38.4)	9.89
	1966-70	5.45 (38.7)	5.35 (38.0)	3.28 (23.3)	14.08
	1955-70	4.16 (36.1)	2.78 (24.1)	4.58 (39.8)	11.52

Note: Percentage points with percentage distribution in brackets.

$$\dot{Y} = \underset{(0.180)}{8.243 + 1.049\hat{L}}\,. \qquad R^2 = 0.773\,. \tag{14}$$

$$\dot{Y} = \underset{(0.776)}{10.04 + 0.826\dot{A}}\,. \qquad R^2 = 0.102\,. \tag{15}$$

Thus, in the manufacturing sector, variations in the rate of output growth are largely explained by variations in the rate of input growth. In this respect, the manufacturing sector is similar to the economy as a whole. However, looking at the relationship between rate of growth of output and rate of growth of individual input, it can be observed that in the manufacturing sector it is the rate of growth of labor that largely determines the rate of growth of output. As shown above, for the aggregate economy the rate of growth of capital is important. Results therefore support to some extent the surplus-labor growth models. In particular, these results concur with Eltis's proposition that the growth of the manufacturing sector in developing countries depends crucially on the availability of an infinitely elastic supply of labor at subsistence wages [4]. Thus, contrary to the general belief that the rate of growth of capital and/or the growth of productivity determine the variation in the rate of growth of manufacturing output, it is the rate of growth of labor in the manufacturing sector that is most

strongly associated with the rate of growth of manufacturing output. In developing countries, the supply of labor force to the manufacturing sector is often made possible by taking unemployed and underemployed out of the agricultural and service sectors. From this view point, there is great potential for growth and industrialization in the labor surplus economies.

D. *Service*

The service sector in the present context is a very heterogeneous grouping. Besides commercial, social, and personal services, it also includes construction, public utilities, transportation, and communication. However, this heterogeneous group seems to be homogeneous in one important sense; it supports the activities of two other sectors discussed above, agriculture and manufacture. The calculations of the sources of growth of the service sector are shown in Table V. In all three cases, total factor productivity explains roughly 50 per cent of the growth of output for the period under study as a whole (1960–70 for Korea and 1955–70 for Japan and Taiwan). This is similar to the case of the aggregate economy. In absolute terms, total factor productivity grows at a rather high rate,, 5.4 per cent in Taiwan, 5.1 per cent in Japan, and 4.6 per cent in Korea. In Korea and Taiwan, the contribution of capital to growth is much less than that of labor. This is most likely due to the fact that in the service sector of these two countries there still exists a relatively large traditional subsector which is by and large labor-intensive. In addition, the service sector often constitutes the reservoir to which surplus labor flows when the manufacturing sector is unable to absorb it all. Because of the more sophisticated nature of the service sector in Japan, the contribution of capital to growth is greater than that of

TABLE V

SOURCES OF GROWTH IN REAL INCOME: SERVICE SECTOR

Country	Period	Explanation of Sources of Growth			
		Capital Input	Labor Input	Total Factor Productivity	Income Growth Rate
Korea	1960–66	0.38 (7.8)	3.43 (70.6)	1.05 (21.6)	4.86
	1966–70	0.60 (27.4)	3.47 (26.4)	6.09 (46.3)	13.16
	1960–70	1.36 (14.5)	3.43 (36.5)	4.62 (49.1)	9.41
Japan	1955–60	2.54 (26.0)	2.04 (20.9)	5.20 (53.2)	9.78
	1960–66	4.34 (41.3)	2.25 (21.4)	3.92 (37.3)	10.51
	1966–70	3.55 (27.9)	2.05 (16.1)	7.14 (56.0)	12.74
	1955–70	3.68 (33.6)	2.15 (19.6)	5.13 (46.8)	10.96
Taiwan	1955–60	0.88 (15.3)	2.10 (36.5)	2.78 (48.3)	5.76
	1960–66	1.23 (10.3)	2.14 (17.9)	8.56 (71.8)	11.93
	1966–70	2.43 (21.8)	5.62 (50.6)	3.06 (27.6)	11.10
	1955–70	1.37 (14.1)	2.98 (30.6)	5.38 (55.3)	9.73

Note: Percentage points with percentages distribution in brackets.

labor. Over successive periods there is a general trend for capital's contribution to growth to rise. This, to a considerable extent, is a reflection of the process of modernization taking place in the service sector. As with other sectors, the rate of growth of output in the service sector on the various sources of growth is regressed.[16]

$$\dot{Y}=4.772+0.991\hat{X}. \qquad R^2=0.354. \qquad (16)$$
$$(0.546)$$

$$\dot{Y}=6.256+1.573\hat{K}. \qquad R^2=0.537. \qquad (17)$$
$$(0.608)$$

$$\dot{Y}=9.585+0.137\hat{L}. \qquad R^2=0.003. \qquad (18)$$
$$(1.002)$$

$$\dot{Y}=5.279+0.995\dot{A}. \qquad R^2=0.639. \qquad (19)$$
$$(0.305)$$

It appears that both total factor productivity and rate of growth in capital are important determinants of the rate of growth of output in the service sector. Comparatively speaking, total factor productivity is the more dominant. Thus, to some extent, the service sector resembles the agricultural sector in explaining variations in the rate of output growth.

III. PATTERNS OF SOURCE OF GROWTH: AN INTERPRETATION

There are some important contrasts in the patterns of sources of growth between developed and developing countries. The experience of the developed Western countries shows that irrespective of the rate of growth of output, a large proportion of output growth, say well above 50 per cent, is explained by total factor productivity. The relatively minor role of factor inputs in explaining growth of output can largely be accounted for by the following:

(1) In most developed Western countries, the rate of population growth is low and, as a result, the contribution of labor growth to output growth is small.

(2) Given a growth rate of capital greater than that of labor (usually the case in the developed and the fast-growing developing countries), a smaller capital share in income (the weight used in calculating the percentage point contribution of capital to growth) will give rise to a lower weighted sum in the growth rate of inputs,[17] and hence a higher total factor productivity. Generally speaking, developing countries tend to have a higher capital share in income than developed countries because of their higher marginal product of capital. Developing countries usually have capital shares within the range of 0.4–0.5 while the corresponding range for developed countries tends to be 0.25–0.3. The higher marginal

[16] There are eight observations involving the same countries and the same subperiods as in the case of the agricultural sector.

[17] For example, given that $\dot{K}=5.0$, $\dot{L}=3.0$, when capital share is 0.5, $\hat{X}=4.0$, and, when capital share is 0.3, $\hat{X}=3.6$.

product of capital in the developing countries can be explained by the fact that there exist numerous "gaps" in the capital structure of the developing countries. To a considerable extent, investment represents efforts to fill in these gaps, i.e., to add to the extensiveness of the capital structure. In the developed countries with an already extensive capital structure, investment is usually more in the form of replacing and duplicating existing capital. In this latter case, new capital as such is expected to add less to the capacity of the economy since it is just replacing capital already there.

Moreover, in the developed Western countries, there is a close association between the rate of growth of output and total factor productivity, i.e., countries experiencing higher total factor productivity are also those with higher rate of growth of output. According to Denison's study, the advance of knowledge (defined as the "residual" of total factor productivity) is only a minor component of total factor productivity. It is the reallocation of labor from agriculture to nonagriculture and economies of scale (which, for Denison, result from expansion of the national market, and independent expansion of local markets) that are the dominant components of total factor productivity. Furthermore, the relative gains by and large from resource reallocation and economies of scale determine the relative growth rates of developed Western countries. It then seems that the models of labor surplus economies are not only applicable to the developing countries but also to the contemporary growth experience of Western countries [12]. From this point of view, there seems to exist a general theory of growth which can be used to describe developed as well as developing economies.

In developing countries, on the other hand, the source-of-growth patterns are characterized by a greater importance that the factor inputs contribute to growth. Among the developing countries for which source-of-growth data is available, two subgroups can be identified: those with a relatively higher and those with a relatively lower contribution of total factor productivity to growth. The former group is comprised of the five economies under study plus Venezuela and Peru, and the latter group includes Israel, USSR, Brazil, and the Philippines. With the exception of Israel, the rate of growth of the former group is greater than the latter. This observation seems to suggest that among the developing countries, those with a higher contribution of total factor productivity to growth are those which have enjoyed faster rates of growth. In this respect, the experience of the developing countries is similar to that of developed nations. However, since it is unlikely that scale economies are of great importance in the growth of the selected Asian group of economies, the major component of total factor productivity in developing countries should be advances of technical knowledge and gains from resource reallocation. In sum, the results suggest that while total factor productivity could be both necessary and sufficient for rapid growth in developed nations, it is only necessary for developing countries.

Commenting briefly on the differences in source-of-growth patterns among the individual sectors; the results indicate that these differences are striking. In the agricultural sector, the variations in the rate of output growth are largely due to variations in total factor productivity. In the manufacturing sector, it is

explained by the rate of growth of input, in particular labor inputs. In the service sector, the rate of growth of output is mainly determined by total factor productivity and to a lesser extent by the rate of growth of capital. The results tend to suggest that in those sectors where a relatively large traditional subsector still exists (such as agriculture and services in the developing countries), the rate of growth of output can be increased most effectively by promoting total factor productivity. This means that new techniques of production should be introduced and resources be encouraged to move from the lower to the higher productive branches within the sector itself. Very often, this may mean structural change within an individual sector of the economy; for instance, the shift from rice crops to cash crops and the shift from entrepôt trade to regional financial services. On the other hand, in the manufacturing sector, the rate of growth depends very much on a very elastic supply of labor. In Japan, Korea, and Taiwan, such a supply of labor has been made possible by movement of workers out of the agricultural sector, and to some extent out of the service sector. In Hong Kong, it is made possible by the inflow of workers from the mainland; in Singapore by the inflow of workers from the Malaysia region.

The pattern of sources of growth in the individual sectors of the economy discussed above should be taken as a transitionary pattern in developing countries in the process of growth. Eventually, the traditional subsectors in the agricultural and service sectors will be modernized and the rate of the growth of inputs will be increasingly important in determining the rate of output growth. Similarly in the manufacturing sector, total factor productivity should become increasingly important as the process of sophistication of products takes place. It is therefore expected that the source-of-growth pattern in the individual sectors in the developed Western countries is substantially different from that revealed by the five economies under study. Moreover, the pattern might also be different in the other developing countries. There is evidently a vast need and scope for further research into the sources of growth in individual economic sectors. The existing source-of-growth studies has given too much attention to the aggregate economy.

REFERENCES

1. ABRAMOVITZ, M. A. "Resource and Output Trends in the United States since 1870," *American Economic Review,* May 1956.
2. CORREA, H. "Sources of Economic Growth in Latin America," *Southern Economic Journal,* July 1970.
3. DENISON, E. F. *Why Growth Rates Differ* (New York: Brookings Institution, 1967).
4. ELTIS, W. A. "Capital Accumulation and the Rate of Industrialization of Developing Countries," *Economic Record,* June 1970.
5. FEI, J. C. H., and RANIS, G. *Development of the Labor Surplus Economy: Theory and Policy* (Homewood, Ill.: Richard D. Irwin, 1964).
6. GAATHON, A. L. *Capital Stock, Employment and Output in Israel, 1950–59* (Jerusalem: Bank of Israel, 1961).
7. ———. *Economic Productivity in Israel* (New York: Praeger Publishers, 1971).
8. HICKS, J. R. *Capital and Growth* (London: Oxford University Press, 1965).

9. ISHIKAWA, S. *Economic Development in Asian Perspective* (Tokyo: Kinokuniya, 1967).
10. JORGENSON, D. W. "The Development of a Dual Economy," *Economic Journal,* June 1961.
11. KALDOR, N. *Causes of the Slow Rate of Economic Growth of the United Kingdom* (London: Cambridge University Press, 1966).
12. KINDLEBERGER, C. P. *Europe's Postwar Growth: The Role of Labour Supply* (Cambridge, Mass.: Harvard University Press, 1967).
13. LAMPMAN, R. J. "The Sources of Post-war Economic Growth in the Philippines," *Philippine Economic Journal,* No. 2 (1967).
14. LEWIS, W. A. "Economic Development with Unlimited Supplies of Labour," *Manchester School of Economics and Social Studies,* May 1954.
15. PSACHAROPOULOS, G. *The Anatomy of a Rate of Growth* (Honolulu: University of Hawaii, 1969).
16. SOLOW, R. M. "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics,* August 1957.
17. WILLIAMSON, J. G. "Dimensions of Philippine Postwar Economic Progress," *Quarterly Journal of Economics,* February 1969.
18. ————. "Relative Prices Changes, Adjustment Dynamics, and Productivity Growth: The Case of Philippine Manufacturing," *Economic Development and Cultural Change,* July 1971.

APPENDIX A

DATA SOURCES

Hong Kong:

Output data 1960–70, from L. C. Chau, "Estimates of Hong Kong's Gross Domestic Product," *Hong Kong Economic Papers,* September 1972; for data before 1960, K. R. Chou, *The Hong Kong Economy* (Hong Kong: Academic Press, 1966). Capital data for the economy as a whole, estimated by assuming that the capital-output ratio in the medium year of the period under consideration was equal to the average ICOR over the entire period; investment data are from K. R. Chou, *Hong Kong Economy,* and Census and Statistics Department, *Estimates of Gross Domestic Product, 1961–73* (Hong Kong: Government Printer, 1975). Capital data for the manufacturing sector, from N. C. Owen, "The Decline of Competition with Industrial Maturity," Working Paper, Centre of Asian Studies, University of Hong Kong (1971). Labor data, from Hong Kong Government, *Census Reports,* 1961, 1966, 1971.

Japan:

Output and labor data, from Statistics Bureau, Prime Minister's Office, *Monthly Statistics of Japan,* various issues. Capital data from K. Ohkawa and H. Rosovsky, *Japanese Economic Growth* (London: Oxford University Press, 1973), p. 314.

Korea:

Output and labor data, from Bank of Korea, *Monthly Statistics,* various issues. Capital data, estimated by assuming that the capital-output ratio in the medium year of the period under consideration was equal to the average ICOR over the

entire period; investment data are from Bank of Korea, *Monthly Statistics*.

Singapore:

Output data, from Department of Statistics, *Singapore, Statistical Yearbook,* various years. Labor data for the manufacturing sector, from the same source; labor data for the economy as a whole, from State of Singapore, *Report on the Census of Population, 1957* (Government Printer, 1964), and Singapore Government, *Annual Budget Statement* (1973). Capital data, estimated as in the case of Korea, and investment data are from Department of Statistics, *Singapore Statistical Yearbook*.

Taiwan:

Output and labor data, from Executive Yuen, *Taiwan Statistical Yearbook, 1973* (Taipei: Planning Council, 1974). Capital data 1955–65, from S. W. Kuo, "The Economic Development of Taiwan—An Overall Analysis," in *Economic Development in Taiwan,* ed. K. Chang (Taipei: Cheng Chung, 1968), and this capital series is extended to 1970 by using the available data on capital formation (from Executive Yuen, *Taiwan Statistical Yearbook, 1973*) and allowing an 8 per cent annual depreciation rate.

APPENDIX B

METHOD OF CALCULATING THE CONTRIBUTION OF RESOURCE REALLOCATION TO INCOME GROWTH

Denison has proposed a method to quantify the contribution of labor reallocation between the A and non-A sectors estimating the amount by which the initial year national income would have been higher if the final year employment pattern had prevailed during a given period of study. The amount is calculated as (1) the gain in non-A national income from reducing the percentage of resources devoted to agriculture minus (2) the offsetting loss in agricultural national income resulting from the same cause. The detailed procedure in arriving at the results given above in Table II in the text, is shown in Appendix Table I.

(1) Line 1 is the decline in percentage of employment (points).

(2) Line 2 is decline in agriculture percentage as percentage of non-A employment percentage; it gives the percentage by which the non-A employment in the initial year would have been higher if the non-A percentage of total employment in the initial year is the same as the final year of the period under study.

(3) It is generally true that the decline in capital input in the A sector is less than labor and that the reallocated non-A workers are usually less efficient when than labor and that the reallocated non-A workers are usually less efficient than the existing non-A workers, and we assume that the percentage increase in total non-A inputs resulting from the shift out of agriculture was 0.6 of the percentage increase in non-A employment.[a] It is further assumed that constant returns pre-

[a] Denison assumes 4/5 for northwest Europe and 3/4 for the United States and Italy.

APPENDIX TABLE I

METHOD OF CALCULATING THE CONTRIBUTION OF LABOR REALLOCATION TO GROWTH

		Hong Kong	Japan	Korea	Singapore	Taiwan
1955–60	1		7.70	1.74		5.50
	2		12.88	8.58		14.32
	3		7.73	5.15		8.59
	4		5.97	2.73		5.10
	5		19.15	17.31		8.93
	6		3.83	2.16		1.79
	7		0.87	1.02		0.72
	8		5.10	3.64		4.38
	9		1.00	1.71		0.86
	10		9.14	4.22		5.24
	11		10.90	40.50		16.4
1960–66	1	2.60	8.30	8.00	3.58	11.00
	2	2.83	12.30	23.46	3.86	25.06
	3	1.70	7.38	14.08	2.32	15.03
	4	1.64	6.30	8.84	2.18	9.91
	5	32.10	25.54	12.14	49.45	19.61
	6	6.42	5.11	2.43	9.89	3.92
	7	0.22	0.75	0.90	0.60	1.34
	8	1.42	5.55	7.94	1.58	8.57
	9	0.24	0.90	1.28	0.17	1.38
	10	10.57	8.94	6.91	5.36	9.28
	11	2.30	10.10	18.50	3.20	14.9
1966–70	1	1.20	6.80	7.40	3.16	6.20
	2	1.27	8.97	17.58	3.28	11.29
	3	0.76	5.38	10.55	1.97	6.78
	4	0.74	4.79	6.77	1.88	4.89
	5	21.82	28.10	12.78	86.34	13.75
	6	4.36	5.62	2.56	17.27	2.75
	7	0.09	0.61	0.92	0.78	0.76
	8	0.65	4.18	5.85	1.10	4.13
	9	0.16	1.03	1.43	0.27	1.02
	10	6.90	12.04	10.11	11.64	8.07
	11	2.30	8.60	14.10	2.30	12.6

vail, i.e., a given percentage increase in non-A input would raise non-A output proportionately. Thus, line 3 is obtained by multiplying line 2 by 0.6 giving the estimated percentage increase in non-A national income due to reallocation.

(4) Line 4 is equal to line 3 times non-A percentage of national income and is equal to the gain of total national income due to reallocation.

(5) Line 5 is the decline in agriculture as a percentage of agricultural employment.

(6) It is usually true that the reduction in agricultural employment has relatively little effect on agricultural output, especially in economies with substantial

surplus labor in the A sector. It is therefore assumed that in the case of Japan, Singapore, and Hong Kong, a 1 per cent fall in agricultural employment would reduce agricultural output by 0.2 per cent, and in Korea and Taiwan by 0.125 per cent, taking into account the different degree of underemployment in the A sector. Line 6 is equal to line 5 times 0.2 or 0.125, and is also the estimated percentage reduction in agricultural national income due to labor reallocation.

(7) Line 7 is line 6 times the agricultural percentage of national income and is therefore equal to the percentage loss of total national income due to labor reallocation.

(8) Line 8 is line 4 minus line 7, giving the net gain of percentage points in national income due to reallocation.

(9) Line 9 is the gain due to reallocation per annum during the period under consideration, calculated on the basis of compound rates.

(10) Line 10 is the growth rate of national income per annum.

(11) Line 11 is line 9 divided by line 10 and is therefore the percentage contribution of labor reallocation to income growth.