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Labor Productivity and Inter-Sectoral Reallocation of Labor in Singapore (1965-2002)*

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Abstract

This paper investigates the impact of the shifts of labor across sectors on aggregate productivity growth through a decomposition of aggregate productivity growth in Singapore over the period 1965-2002. The static shift-share analysis is utilized to for this purpose. The results show that the shifts of labor paid off well in terms of their contribution to labor productivity especially for manufacturing in the 1985 era which was characterized by interventionist labor market policies of the government. On the other hand, the impact of labor shifts is negative in the post-1985 era which is characterized by a more liberalized labor market.

I. Introduction

Long-run economic growth can be sustained by continuous increases in productivity. Economic growth also brings about changes in the input composition of the economy. Scarce resources are shifted from less productive activities to more productive activities.

The impact of the shifts of resources across the sectors of the economy on economic growth and productivity has recently attracted attention of many researchers. Now, there is a large literature on the impact of changes in sectoral labor composition on aggregate productivity for developing as well as developed countries (e.g. Salter 1960, Syrquin 1984 and 1986, and Timmer and Szirmai 2000). These studies focus on the shift of labor and capital from primary sectors (e.g. agriculture) to manufacturing and services sectors. They specifically point to the positive contribution of resource reallocation from low-productivity sectors (most likely agriculture and traditional manufacturing industries such as textile manufactures) to sectors and industries that exhibit higher productivity (such as electronics, basic metals, and transport equipment industries). It is found, however, that the shifts of resources for most developing countries are not conducive for productivity growth. Somewhat similar evidence was found in Akkemik (2005) in a study covering Japan, Korea, and Singapore for the last three decades of the 20th century.

In Singapore industrialization was initiated by the government and sustained economic growth has been a major concern for the government. Being involved deeply in economic decision-making, the government has directed the shifts of resources towards more productive areas. It is important

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to investigate how the shifts of resources impacted on productivity, the long-run determinant of growth. This issue is of great importance to the policymakers, because a slow adjustment of productivity bears a cost in the long-run as foregone growth. Labor is a scarce and very important resource for the Singapore economy. The purpose of this paper is to analyze the impact of inter-sectoral shifts of labor on aggregate productivity growth in Singapore. The hypothesis that shifts of resources have a positive effect on aggregate productivity growth as supposed by Syrquin (1995) will be tested. The study covers all productive activities in Singapore classified into nine major sectors and nineteen manufacturing industries and the analysis covers the period 1965-2002. The methodology is adopted from the instructive paper by Timmer and Szirmai (2000).

This paper is organized into six sections including the introduction. The second section reviews labor market policies of the government. The third section explains the data construction and periods of analysis. Trends in labor productivity and real wages constitute the fourth section. The fifth section lays the methodology and the results of analysis. Conclusions with policy discussions are provided in the sixth section.

II. Labor Market Policies of the Singaporean Government[1]

The government in Singapore has actively been involved in the working of the economy throughout its development process since independence was gained in 1965. Labor market, especially, has been the area where the involvement of the government in decision-making has been the most important. Its involvement in the labor market has evolved through three distinct stages, namely 1965-1978 (early post-independence rapid growth years), 1979-1985 (economic restructuring), and post-1985 (post-recession era). Labor market policies of the government closely follow the economic development of Singapore, as explained below.

In the first period (1965-1978), the immediate problems for the government were to solve the problem of high unemployment rate (above 10 percent) and ensure continuous economic growth. The government's responses to these challenges were twofold. The first of these was the promotion of export-oriented labor-intensive industries (especially textiles industry and the assembly-based electrical machinery and appliances industry) as part of its export-oriented development strategy. Its second response was the use of abundant unskilled labor for this purpose. The government's efforts brought unemployment down to 4 percent by 1973, bringing the economy to a point where full employment is achieved. The economy grew rapidly in this period and the problem of unemployment was solved through this process. Labor, then became scarce in some fast-growing sectors and the government replied to this new challenge by increasing the female labor force participation and allowing in foreign unskilled labor, mainly from neighboring Malaysia. The signs of a tight labor market led the government to revise its labor market policy. Consequently, the government established the National Wage Council (NWC)[2] in 1972 in order to bring wage

settlement and labor-management relations under control. NWC was given the authority to recommend on annual wage increases, which were closely followed by the companies. In the early 1970s, NWC opted for wage restraint (i.e. wage increases lower than the increase in consumer prices) where real wages were put under pressure in order to cushion the destructive effects of the oil shocks that could bring in high inflation to the country. Until the second half of the 1970s the growth rate of the real wages generally fell below that of labor productivity (see Figure 1).

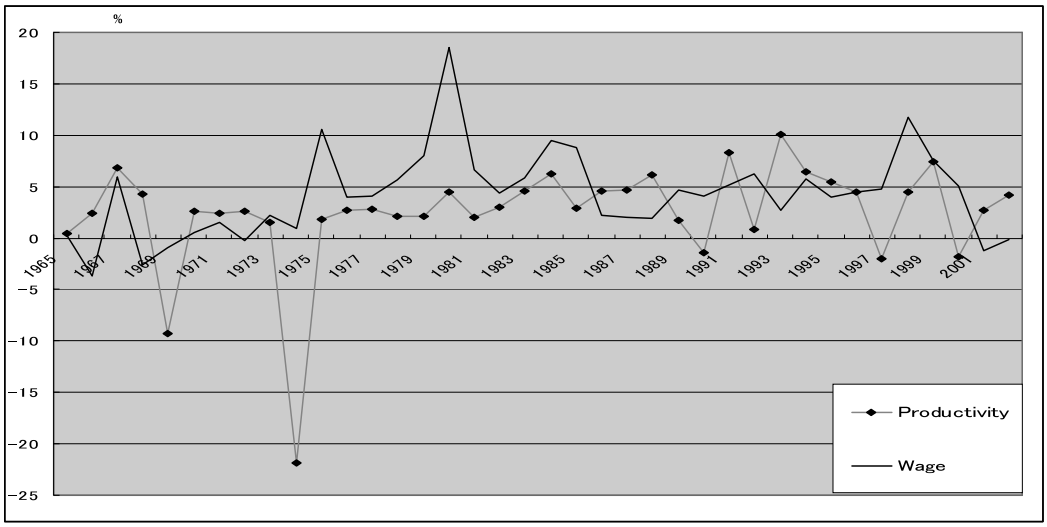
The government changed its policy of promoting labor-intensive industries towards promoting higher value-added economic activities in the late-1970s. This came with a restructuring plan in which the labor market policy played a major role. In 1979, the government initiated a "high-wage policy" where wages were deliberately increased at high rates through the NWC (see Figure 1). This was due to the government's perception that "correcting" the restrained wages and letting them approach to their market-clearing levels would help increase labor costs and reflect labor-scarcity and consequently lead the producers to shift to higher value-added productive activities. The government also put in place some measures to help improve labor skills by establishing the Skills Development Fund (SDF), where employers and employees contributed equally (2 percent of the wage in 1979, later rose to 4 percent in 1980). In addition, the government announced additional financial assistance schemes for companies to assist them in improving the skills of their workers.

As a result of the wage rises and some other shocks (e.g. decline in the world demand for Singapore's main export industries, ending of the construction boom which kept the economic growth high for some years, etc.), the economy fell into a deep recession in 1985. The government established the Economic Committee to investigate the reasons of the recession and the ways to escape its adverse effects. The committee delivered its recommendations in a report to the government in 1986. Those related to the labor market emphasized a cut in labor costs by reducing the contribution rates of employees and employers to the Central Provident Fund (CPF)[3] and freezing of wages for two years. These recommendations were soon put in action by the government.

Labor market policies of the government changed drastically after the recession (post-1985 era). A committee under the NWC recommended in 1986 the introduction of a flexible wage system rather than mandatory announcing of annual wage increases by the NWC. This reform was put in effect from 1987. Flexible wage system divides the wage into three parts: (i) a basic component, (ii) supplement to the wage in the amount of a month's wage or so which can be adjusted in times of distress, and (iii) a performance bonus which is variable depending on the performance of the workers and the company, i.e. company profits and productivity. The flexible wage system is definitely a move towards the liberalization of the labor market policies of the government. NWC annual wage increases were abandoned from 1987 on and were replaced by qualitative guidelines (i.e. providing recommendations on wage increases taking into account the relation between wages and productivity) In addition, SDF and the government's policy of helping the companies improve

their labor quality were resumed in the post-1985 period.

Figure 1 Growth rates of real wages and labor productivity of the economy (unit: percentage)



Source: Author's calculations using the data whose sources are explained in the text

III. Data Construction

Before starting an analysis of productivity, this part classifies economic activities, briefly describes data and their sources, and finally introduces the periods for which the analyses are conducted.

1. Industrial Classification

The analyses are conducted at two levels. At the first level, the analyses are conducted for major sectors of the economy. At the second level, only the manufacturing sector is considered and the analyses are conducted for individual manufacturing industries. For these purposes, economic activities are divided into nine major sectors: agriculture, mining, manufacturing, utilities, construction, commerce (i.e. wholesale and retail trade, hotels, and restaurant services), transport and communications services, financial and business services, and other services (i.e. government services, community, personal, and social services, and all other services not classified). Manufacturing sector is further divided into 19 industry groups. In total, economic activities are classified into 27 different groups of production activities. The results of the analyses below are presented in two tiers. First, the sectoral analysis is presented and then the analysis concerning only the manufacturing industries within the boundaries of the manufacturing sector is presented. In the tables, major industries are noted by block capital letters. The list of industries with abbreviations is presented in Table 1.

2. Description and Sources of Data

Labor productivity (LP) is measured by dividing output (Q) by labor (L):

$$LP = \frac{Q}{L} \tag{1}$$

What is of interest in this study is the change in productivity rather than its level. Growth of labor productivity can be computed as follows:

Table 1 List of sectors and industries

AGR	Agriculture, hunting, forestry, and fishing
MIN	Mining and quarrying
MANUF	Manufacturing industries
Food	Food, beverages, and tobacco
Tex	Textiles and textile manufactures
Wear	Wearing apparel except footwear
Leat	Leather, leather products & footwear
Wood	Wood and wood products except furniture
Furn	Furniture, except metal furniture
Paper	Paper and paper products
Pub	Publishing, printing, and reproduction of recorded media
Chem	Chemicals and chemical products
Petr	Refined petroleum products
Rub	Rubber and plastic products
Non-met	Non-metallic mineral products
Met	Basic metals
Fab-met	Fabricated metal products
Mach	Machinery and equipment
Elec	Electrical machinery, electrical apparatus, electronic products, and electronic components
Prec	Medical, precision instruments, optical instruments, watches, and clocks
Tran	Transport equipment
Oth-man	Other manufacturing industries, recycling of metal and non-metal waste, and scrap
UTIL	Electricity, gas, and water
CONST	Construction
COM	Wholesale trade, retail trade, restaurants, and hotels
TR-COM	Transport, storage, and communication
FIN-BUS	Financial, insurance, real estate, and business services
OTH-SERV	Community, social, and personal services, government services, and other services

Note: The same notations are used for industries and sectors in the forthcoming tables and figures

$$\frac{\Delta LP}{LP} = \frac{\Delta Q}{Q} - \frac{\Delta L}{L} \tag{2}$$

The operator Δ denotes change in the relevant item. Equation (2) describes the growth rate of labor productivity as the difference between the growth rates of output (Q) and labor input (L).

Labor input can be represented by the number of employees or working hours. Although which one to use depends on the availability of data, the use of working hours is preferred because workers may be working for different hours depending on the business cycle, especially in the manufacturing sector. In this study, output is represented by real value-added for manufacturing industries and by gross output in real terms for the nine major sectors. Value-added data for the services sectors were available only for a few years and hence gross output appears to be the only measure that can be used to represent Q in equation (1). I used both labor hours and number of employees to represent L. Consequently, four measures for labor productivity are derived: gross output (or value-added) per worker (Q/N) and gross output (or value-added) per working hour (Q/H), where Q, N, and H stand for real output (or value-added), number of employees, and working hours, respectively.

Sectoral gross output data are obtained from the annual issues of Singapore Yearbook of Statistics and the national accounts statistics. Gross output data for the nine major sectors are normalized by the sectoral GDP deflators with 1990 as the base year to calculate real output. Sectoral GDP deflators are obtained from the national accounts. Value-added data for the manufacturing industries are obtained from the annual issues of the Report on the Census of Industrial Production. The most appropriate method to compute real value-added is to use the double deflation method where intermediate inputs deflated by its relevant price index is deducted from the gross output deflated by its relevant price index. However, the unavailability of the price indices for the intermediate inputs in Singapore does not allow us to use this method. As a consequence, value-added data of the manufacturing industries are normalized by the Singapore Manufactured Price Indices (SMPI) which is available in detail in the annual statistical yearbook. SMPI is selected among a number of available price indices as it is the closest to be chosen as a wholesale price index.

Finally, wage data for the major sectors and manufacturing industries are collected from the annual statistical yearbook. In order to compute real wages, these wage figures are deflated by the GDP deflator for the major sectors and by the abovementioned wholesale price indices for the manufacturing industries.

3. Periods of Analysis

The analyses are conducted for three separate periods. Such periodization is necessary in order to create a link between the government's labor market policies as explained above and the results of the analyses. The periodization naturally follows the periodization related to the government's labor

market policies as explained in section II above and the analyses are conducted for the three periods, 1965-78, 1979-1985, and 1986-2002. The data were collected for all years between 1965 and 2002, where 2002 is the last year for which the data were available. Post-1985 period refers to 1986-2002.

IV. Trends in Labor Productivity and Real Wages

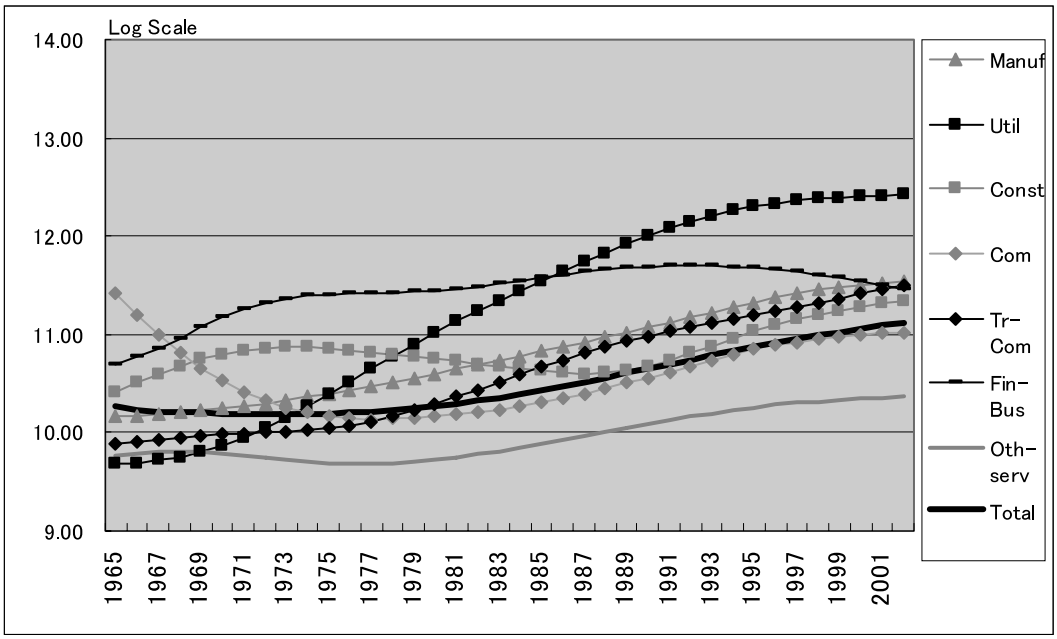
In this section I take a look at the trends in labor productivity and real wages. Both labor productivity and real wages are computed using the equation (1) and later smoothed by the so-called Hodrick-Prescott Filter,[4] developed by Hodrick and Prescott (1997). This filter allows us to separate out the influence of the business cycle from the original series and provides us with the long-run movements of real wages and productivity.[5]

To see the relations between the long-run movements in labor productivity and in real wages, the long-run movements of productivity and real wages are presented in Figures 1 to 6. In figures 1, 3, and 5 the long-run trends of average labor productivity and real wages at the sectoral level are presented. Agriculture and mining sectors are excluded in these tables due to their unimportance for the economy. Figures 2, 4, and 6 provide the same figures for major manufacturing industries, i.e. food, chemicals, petroleum refining, electrical and electronic machinery and appliances, precision equipment, and transport equipment industries. All values in these figures are smoothed with the Hodrick-Prescott filter. For convenience, the values in the figures are presented in natural logarithm. If labor productivity is calculated as value-added per employee, then aggregate labor productivity for the entire economy remained almost stable until the late 1970s when the government initiated a large-scale restructuring in order stimulate higher-value-added production through deliberate increases in wages in large scale. From then on, average labor productivity has an ever increasing trend. This needs to be compared with the trend of real wages at the sectoral level as seen in Figure 6. Real wages have increased only slightly until the late 1970s and from then on they have an ever increasing path. The large increases from the late 1970s to the mid-1980s are a result of the high-wage policy. From the mid-1980s on, the increasing trend of real wages follows a uniform increasing path with the rate of increase getting slightly lower in the 1990s. In the post-1985 period, the increases in real wages reflect gains in labor productivity. As seen in Figures 1 and 3, labor productivity increased at a slowing rate after the mid-1980s and the movement in real wages replicated this trend.

Sectoral and industry-level figures for the growth rate of the two measures of labor productivity are presented in Table 2. Table 2 presents the growth of labor productivity measured as output per labor and as output per working hour. These tables reveal that in the long periods selected (i.e. 1965-1985, 1986-2002, and 1965-2002) the growth rates of labor productivity using any of the two measures are very similar. In short periods (e.g. 1979-1985), however, the growth rates of the two measures tend to be different. The remarkable productivity growth performance of the chemicals

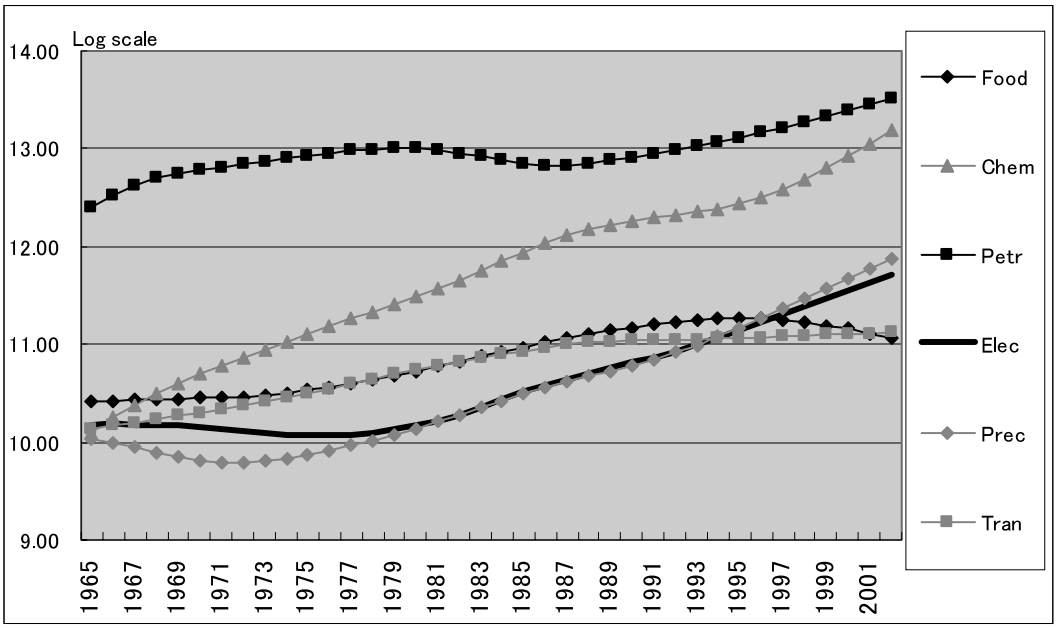
industry is observable from both tables. This performance was accompanied in some periods by the precision equipment and electrical and electronic machinery industries.

Figure 2 Labor productivity (labor: number of employees) of major sectors (1965-2002)



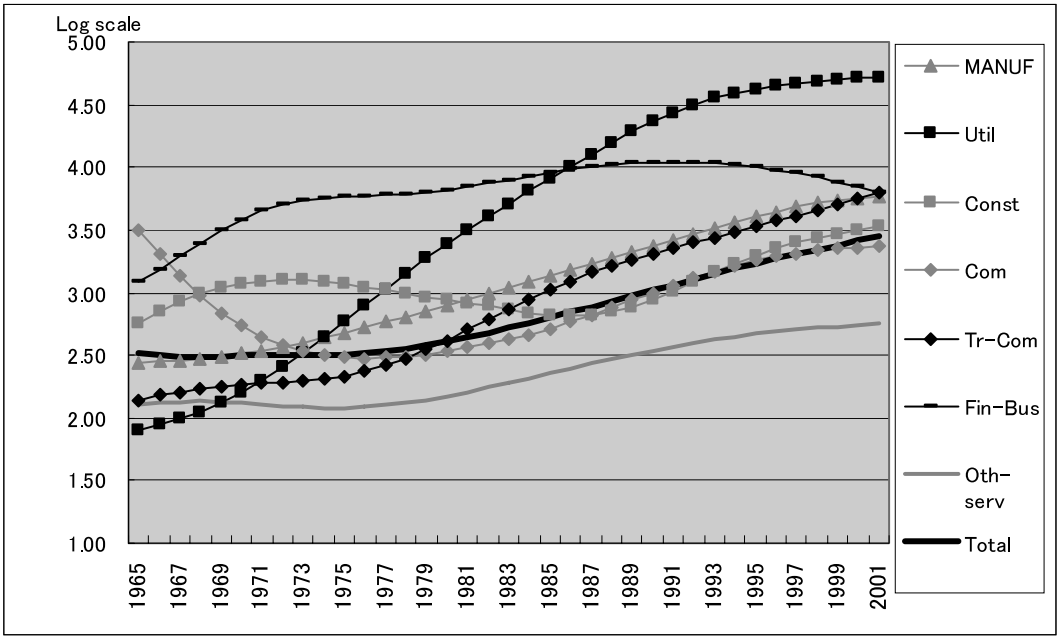
Note: The data are smoothed with Hodrick-Prescott filter.
Source: Author's calculations

Figure 3 Labor productivity (labor: number of employees) of major manufacturing industries (1965-2002)



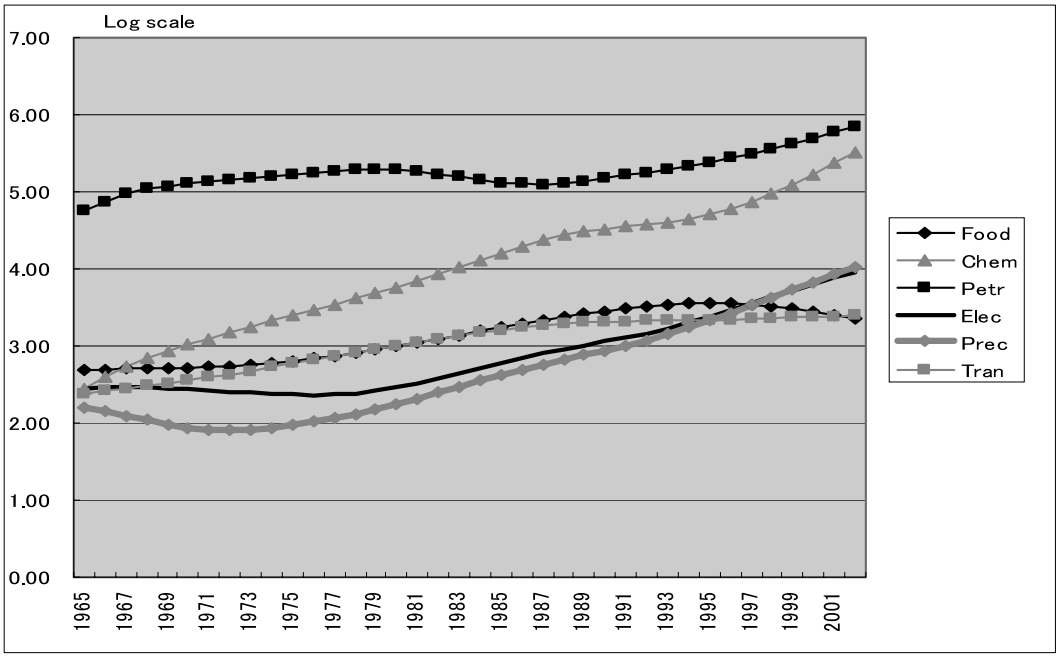
Note: The data are smoothed with Hodrick-Prescott filter.
Source: Author's calculations

Figure 4 Labor productivity of major sectors (labor: working hours) (1965-2002)



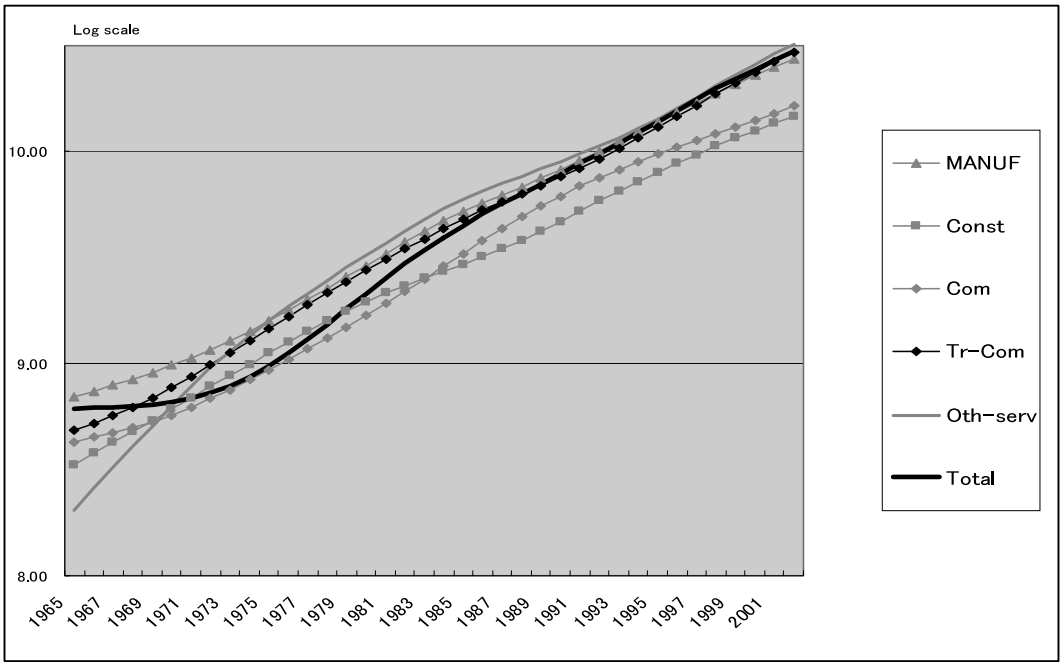
Note: The data are smoothed with Hodrick-Prescott filter.
Source: Author's calculations

Figure 5 Labor productivity (labor: working hours) of major manufacturing industries (1965-2002)



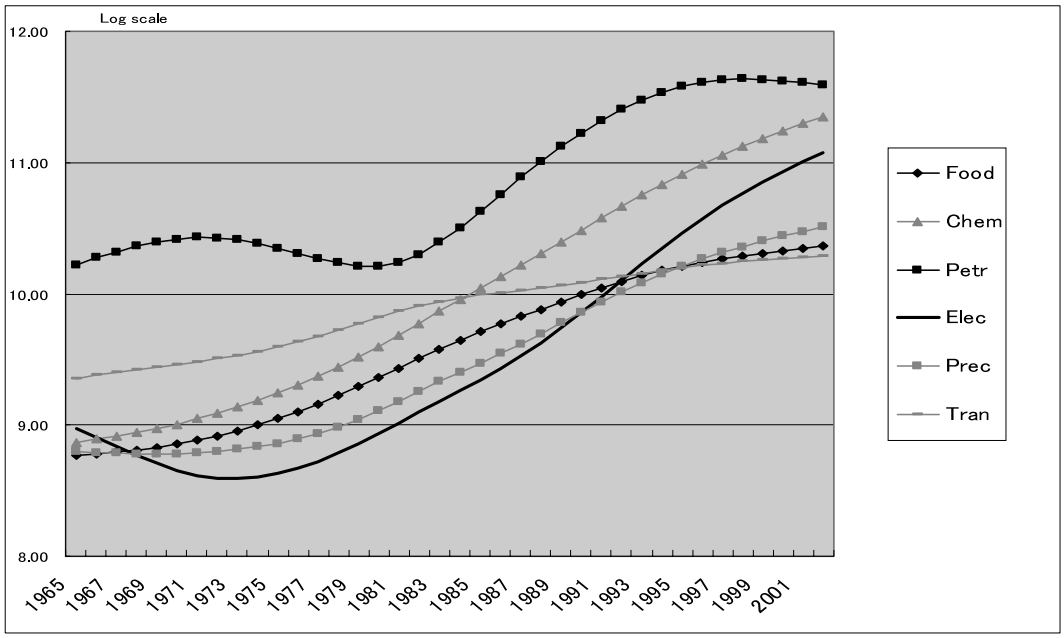
Note: The data are smoothed with Hodrick-Prescott filter.
Source: Author's calculations

Figure 6 Real wages of major sectors (1965-2002)



Note: The data are smoothed with Hodrick-Prescott filter.
Source: Author's calculations

Figure 7 Real wages of major manufacturing industries (1965-2002)



Note: The data are smoothed with Hodrick-Prescott filter.
Source: Author's calculations

Table 2 Labor productivity growth rates (percentage average annual growth rate)

	Real value-added per employee					Real value-added per working hour				
Sectors / industries	1965-1978	1979-1985	*1965-1985*	*1986-2002*	*1965-2002*	1966-1978	1979-1985	*1965-1985*	*1986-2002*	*1965-2002*
AGR	-16.3	9.2	*-6.5*	*-2.6*	*-4.8*	-17.0	9.3	*-7.1*	*-3.0*	*-5.3*
MIN	9.3	6.5	*7.1*	*-5.7*	*1.4*	8.8	8.3	*7.3*	*-6.0*	*1.3*
MANUF	0.0	3.8	*2.3*	*5.5*	*3.8*	2.7	4.9	*3.2*	*3.1*	*3.2*
UTIL	10.5	9.1	*9.3*	*4.9*	*7.3*	11.3	9.4	*9.8*	*5.2*	*7.7*
CONST	2.8	1.8	*2.7*	*2.6*	*2.7*	2.8	1.2	*2.4*	*2.7*	*2.5*
COM	-4.8	1.0	*-2.6*	*3.1*	*0.0*	-4.7	1.3	*-2.4*	*3.2*	*0.1*
TR-COM	2.7	7.7	*4.4*	*4.7*	*4.5*	2.6	9.2	*5.4*	*4.6*	*5.0*
FIN-BUS	5.6	4.9	*5.5*	*-1.7*	*2.0*	5.9	5.1	*5.7*	*-1.7*	*2.3*
OTH-SERV	-0.5	2.4	*0.4*	*2.6*	*1.4*	0.1	3.3	*1.0*	*2.2*	*1.6*
TOTAL	0.0	3.0	*1.0*	*4.0*	*2.3*	0.1	3.6	*1.3*	*3.9*	*2.4*
Food	1.9	4.7	*2.9*	*-0.5*	*1.4*	1.4	5.0	*3.3*	*-0.5*	*1.6*
Tex	4.1	3.8	*2.5*	*2.9*	*2.7*	3.6	4.0	*2.2*	*2.8*	*2.4*
Wear	5.0	-1.1	*1.6*	*4.2*	*2.7*	4.6	-0.7	*1.6*	*3.8*	*2.6*
Leat	1.0	3.0	*0.2*	*3.7*	*1.7*	0.1	3.4	*-0.3*	*3.4*	*1.4*
Wood	5.8	-2.1	*2.6*	*1.6*	*2.2*	5.1	-1.2	*2.5*	*1.8*	*2.2*
Furn	-1.8	4.8	*-0.6*	*-5.4*	*-2.8*	2.2	5.7	*-0.8*	*-5.4*	*-2.8*
Paper	3.0	13.3	*7.8*	*-1.1*	*3.8*	2.4	13.9	*7.5*	*-1.2*	*3.6*
Pub	0.7	5.7	*2.7*	*2.3*	*2.5*	0.1	6.3	*2.4*	*2.3*	*2.4*
Chem	8.4	5.4	*7.9*	*9.7*	*8.7*	7.6	5.7	*7.5*	*10.0*	*8.6*
Petr	2.6	-5.9	*0.7*	*5.7*	*2.9*	1.8	-5.6	*0.3*	*5.8*	*2.8*
Rub	3.5	3.4	*2.5*	*1.6*	*2.1*	2.7	3.7	*2.1*	*1.3*	*1.7*
Non-met	5.6	-0.5	*3.1*	*0.8*	*2.1*	4.4	-0.1	*3.0*	*0.8*	*2.0*
Met	6.8	-0.7	*3.6*	*-0.7*	*1.6*	6.0	-0.5	*3.3*	*-0.7*	*1.5*
Fab-met	1.8	3.0	*2.4*	*1.5*	*2.0*	1.6	3.2	*2.5*	*1.1*	*1.9*
Mach	4.3	1.6	*4.8*	*1.5*	*3.3*	4.0	1.5	*4.7*	*1.5*	*3.2*
Elec	-1.2	8.0	*1.6*	*5.9*	*3.5*	-1.2	8.7	*1.9*	*5.5*	*3.5*
Prec	-1.1	7.8	*2.0*	*6.0*	*3.8*	-1.8	9.0	*2.1*	*6.0*	*3.8*
Tran	5.3	4.0	*3.7*	*0.8*	*2.4*	5.4	4.2	*3.8*	*0.9*	*2.5*
Oth-man	2.6	15.8	*8.2*	*-3.7*	*2.9*	3.3	15.9	*8.2*	*-4.5*	*2.5*

Source: Author's calculations

To understand the differences between productivity growth rates across industries, one should consider the fact that international trade is a major economic activity in Singapore. As pointed out by MTI (2001), the degree of competition and openness for each sector is highly important in this respect. The sectors with inferior productivity growth rates (such as agriculture, mining, other services, and construction) are by nature producers of non-tradable goods and services and are

inward-oriented. However, others with high productivity performances such as manufacturing sector, especially electrical and electronics appliances and machinery industry, are open to free trade and hence they are subject to competition with foreign rivals. This is a stimulant for upgrading and restructuring in these sectors which is a factor that ensures improvements in productivity.

The trends in real wages point to tight labor market characteristics in Singapore. The increase in real wages accelerates from the early 1970s when Singapore achieved full employment. It is important to note that the speed of real wage increases continued in a slower pace after the mid-1980s. There seems to be a strong relation between real wages and labor productivity, especially in the manufacturing sector. The initial suppression of wages during the early industrialization period (until the restructuring efforts of the late-1970s) as represented by relatively little real wage gains in Figures 5 and 6 was followed by the government's adjustment policies in the labor market to stimulate higher value-added activities facilitated further gains in real wages. The change in real wage trends towards an increasing one from the late-1970s was not accompanied by a rising trend in labor productivity. The trends in productivity were rather favoring stable or slight increases with the growth rate being slower than real wages. These findings suggest a somewhat existing but weak relation between gains in labor productivity and real wage earnings. Thus, the strong influence of the government in wage determination until the mid-1980s and governmental efforts in improving labor productivity went hand in hand and reinforced each other. Following the restructuring efforts, in the post-1985 period, the trends in productivity gains and real wage gains allowed the producers to offset the costs of production brought about by increases in real wages to a large extent.

V. Reallocation of Labor and its Impact on Labor Productivity

1. Methodology

This section investigates the contribution of labor shifts across sectors to productivity growth. For this purpose, I use the static shift-share method as presented by Timmer and Szirmai (2000). This method has recently been used extensively to analyze the impact of labor shifts on labor productivity (e.g. Fagerberg, 2000; Timmer and Szirmai, 2000; Jalava et al, 2002; van Ark and Timmer, 2003). Below, aggregate labor productivity growth is decomposed into its components using the static shift-share method.

I start with the following equation:

$$LP_t = \frac{Q_t}{L_t} = \sum_i \frac{Q_{i,t}}{L_{i,t}} \cdot \frac{L_{i,t}}{L_t} \qquad (3)$$

where LP stands for aggregate labor productivity, L for total employment, Q for total output in the relevant sector or industry i, and the subscript t for time. This equation describes aggregate labor productivity as a weighted sum of the labor productivities of individual industries, the weights being the share of each industry in total labor. Note that labor input is represented by total number of

workers here. Terms without subscripts refer to aggregate (entire economy) measures. The term $L_{i,t}/L_t$ in equation (3) refers to labor share of the sector or industry i in total labor and the term $Q_{i,t}/L_{i,t}$ refers to labor productivity for the same industry. Renaming the former as sl_i and the latter as LP_i, equation (3) can be rewritten as follows:

$$LP = \sum_i LP_i \cdot sl_i \tag{4}$$

Next, I consider changes in labor productivity for any time period [0,1], where 0 and 1 stand for the beginning and the end years of the period, respectively. The change in labor productivity level can be written simply by subtracting the level of labor productivity at the end of the period (1) from that of the beginning of the period (0):

$$LP_1 - LP_0 = \sum_i LP_{i,1} \cdot sl_{i,1} - \sum_i LP_{i,0} \cdot sl_{i,0} \tag{5}$$

Rearranging with some algebraic manipulations and dividing each side by LP_0 to rearrange equation (5) in growth terms, the following is obtained:

$$\begin{aligned} \frac{LP_1 - LP_0}{LP_0} = {} & \frac{1}{LP_0}\sum_i \left(LP_{i,1} - LP_{i,0}\right)\cdot sl_{i,0} + \frac{1}{LP_0}\sum_i \left(sl_{i,1} - sl_{i,0}\right)\cdot LP_{i,0} \\ & + \frac{1}{LP_0}\sum_i \left(sl_{i,1} - sl_{i,0}\right)\cdot \left(LP_{i,1} - LP_{i,0}\right) \end{aligned} \tag{6}$$

The first term on the right-hand side in equation (6), i.e. labor share of the beginning year of the period multiplied by labor productivity change during the period, describes internal productivity growth within individual industries and measures “intra-industry productivity growth.” Sectoral labor shares are used as weights. Therefore, intra-industry effect measures the change in aggregate labor productivity growth if the labor shares remained constant over time. The second term (change in labor share multiplied by the labor productivity of the beginning year of the period) measures labor shift based on the labor productivity level of the beginning of the period. In other words, this effect measures the changes in aggregate labor productivity resulting from the movements of labor across industries with differing productivity levels had the labor productivity levels of individual industries remained constant over time. When the employment shares of industries with high productivity levels rise, this means a reallocation of labor towards industries whose productivity is growing rapidly. Following Timmer and Szirmai (2000), I name this the “static shift effect.” The third term, that measures the cross-effects of the changes in both labor productivity and labor shares, is the most difficult one to interpret. When the industries with high productivity growth rates also increase their share of employment, this means a reallocation of labor towards industries with rapid growth in productivity. Since it takes into account both labor productivity and labor share changes at the same time in the selected period, this term will be named the “dynamic shift effect”, again following Timmer and Szirmai.[6]

The two shift effects measure the impact of structural change on aggregate labor productivity. One can measure the impact of sectoral shifts of labor on the aggregate productivity level in alternative ways as well (e.g. Syrquin 1986). However, the adopted method here provides further details about the impacts of these shifts. If the sum of the two shift effects is positive and considerably large, labor shifts have a positive impact on aggregate labor productivity. Increases in labor quality reflect not only the improvement in the quality of labor due to in-house training by firms or restructuring within the firms, but also the changes in available capital per labor. Higher capital-labor ratio leads to higher labor productivity level. In turn, we can expect that the shift effects reflect the restructuring efforts of the government starting from 1979 aiming at the reallocation of resources in order to increase capital intensity of local industries. Note that the shift effects are related to average productivity, not marginal product of labor. It is assumed here, for simplicity, that all workers in the same sector have the same productivity, i.e. average productivity remains unchanged by inter-sectoral employment shifts. In addition, labor is assumed to be homogenous.[7] Under these assumptions, I am interested in average productivity changes.

2. Results

The results of the decomposition exercise are presented in Table 3. The analysis is conducted for the entire economy first and later confined to manufacturing industries to investigate the impact of labor shifts across manufacturing industries on aggregate manufacturing labor productivity. The results show that the shift effects are positive for both the manufacturing sector and the entire economy for the two periods preceding 1985 and negative for the post-1985 period. The contributions of the shift effects to manufacturing productivity before 1985 are large, around 50 percent, pointing to substantial gains from labor shifts across manufacturing industries. The results here are comparable to a similar study by MTI (2001) which used the same method adopted in this study in order to measure the effects of sectoral labor shifts on aggregate labor productivity for the period 1985-2000. This period largely overlaps with the post-1985 era in this study. The results of the MTI's study are very close to the findings of this study with the shift effects in the period 1985-2000 being negative.

Table 4 presents the contributions of major sectors to the sources of productivity growth. It is seen from the table that before 1985 much of the intra-industry productivity growth came from the construction and transport and communications sectors. The contributions of the manufacturing industries are presented in Table 5. Within the manufacturing sector, petroleum refining industry is a large contributor. In the post-1985 period, the best performer is the manufacturing sector (in particular, electrical and electronic appliances, chemicals, and petroleum refining industries), followed by the construction, transport and communication, and commerce sectors. Financial and business services sector, however, exhibits a big decline in its contribution with a negative figure.

Shift effects, overall, are negative for the post-1985 period and positive for the preceding period. There is a need to interpret the meaning of the positive and negative shift effects for both periods. Before 1985, the sum of the shift effects are 21.3 (1965-78) and 6.2 percent (1979-85) respectively for the entire economy and more than 50 percent for the manufacturing sector. Dynamic shift effects regarding major sectors are large only in the period 1965-78 (see Table 4). In other periods, they are negligibly small. For the 1965-78 period, the largest contributors to the shift effects are the commerce and financial and business services sectors. For the 1979-85 period, the largest contributors are construction and financial and business services sectors whereas the contribution of the manufacturing sector runs in the opposite direction. Before 1985, productivity growth rates of all industries except agriculture, commerce, and other services sectors were larger than the economy average (see Table 2). The productivity growth rate of the other services sector is negligibly small. The share of this sector in employment also decreased over the period. This gave rise to a largely negative contribution rate to shift effects by this industry. Overall, the general impact of the shifts of labor across sectors before 1985 on aggregate labor productivity is positive.

Table 3 Decomposition of aggregate labor productivity (1965-2002)

			1965-1978	1979-1985	1986-2002
Entire economy	Aggregate productivity growth rate (%)		0.0	3.0	3.8
		Intra-industry productivity (%)	78.7	93.8	135.5
		Static shift effects (%)	83.0	8.5	-22.5
		Dynamic shift effects (%)	-61.7	-2.3	-13.0
Manufacturing	Aggregate productivity growth rate (%)		2.9	4.2	5.2
		Intra-industry productivity (%)	40.2	50.8	115.7
		Static shift effects (%)	62.3	48.9	-10.8
		Dynamic shift effects (%)	-2.5	0.3	-4.9

Source: Author's calculations

Among the manufacturing industries, electrical and electronic appliances, petroleum, transport equipment, and basic machinery industries account for a large portion of the shift effects for the pre-1985 era (see Table 5). The shifts of labor across the manufacturing industries and towards rapid growing industries such as electrical machinery and petroleum refining industries ensured gains from productivity in the rapid growth period (1965-78). The contributions of the traditional industries to the shift effects generally worked in the negative direction. In the restructuring period (1979-85) the shift of labor towards higher value-added activities (e.g. electronics industry) impacted positively to aggregate manufacturing productivity. In other words, shifts of labor across manufacturing industries throughout the restructuring process worked in favor of productivity gains and facilitated gains from productivity. To put in other words, the government's strong hand in

labor allocation and strong control of the labor market emerged as an extra source of labor productivity growth in Singapore manufacturing.

In the post-1985 period, however, shift effects are negative 35.5 percent for the entire economy and minus 15.7 percent for the manufacturing sector. Dynamic shift effects are negligible and shift effects result almost entirely from the static shift effects (see tables 4 and 5). This fact has an important implication about the shifts of labor. Negative static shift effects arise when those sectors with productivity growth rates higher than the economy average face declining employment shares. In other words, negative static shift effects point to the allocation of labor towards industries with lower productivity levels. The employment share of the manufacturing sector, which exhibits the highest productivity growth rate in this period, has declined from 24.7 percent in the period 1979-85 to 20.8 percent in the post-1985 period (see Table 6). On the other hand, the financial and business services sector which had lower productivity growth rates than the average, has increased its employment share from the period 1979-85 to 1986-97. Among the manufacturing industries, chemicals industry accounts for the large portion of the positive shift effects in the post-1985 era whereas that of the electrical and electronic appliances and petroleum refining industries account for the large part of the negative shift effects in the post-1985 period.

However, these findings beg for interpretation. The negative shift effects found for the post-1985 period suggests that throughout the restructuring process some labor was shifted from the more productive manufacturing sector to less productive sectors that were mostly domestic-oriented and thus were not exposed to international competition. A possible explanation can be made by looking at the exposure of these sectors to competition. As pointed out in MTI (2001), manufacturing sector is exposed to competition through free trade more than other sectors and this stimulates continuous restructuring, which requires improvements in the quality of labor in order to enhance international competitiveness. Governmental efforts such as Productivity Action 21 and SME 21 plans address the low-productivity performance problem of the services sectors and the need to improve their productivity performances (see MTI 2001).

An alternative explanation provided by MTI (2001) goes as follows: The theoretical explanation that shifts of labor towards sectors with higher productivity levels brings about an extra source of aggregate productivity growth, suggests that more jobs will be created in such sectors and wages will increase. However, this is not happening in Singapore most probably because the labor force that is shifted do not possess the relevant skills required in the more productive sectors, or are reluctant to change jobs. This problem points to the need for skills upgrading to induce higher value-added generation in Singapore, an issue that was always raised up in official reports. One of the main targets in the post-1985 labor market policies of the government was therefore upgrading of the skills of the laborforce employed in the services sectors, which absorb the labor released from the manufacturing sector in the 1990s.

Table 4 Percentage contributions of sectors to aggregate labor productivity (1965-2003)

	1965 - 1978			1979 - 1985			1986 - 2002		
	Intra-ind	*Stat. sh.*	*Dyn. sh.*	*Intra-ind*	*Stat. sh.*	*Dyn. sh.*	*Intra-ind*	*Stat. sh.*	*Dyn. sh.*
AGR	2.6	7.4	-5.0	2.1	-1.4	-1.1	-0.1	0.8	-0.7
MIN	0.3	1.0	-1.7	-0.6	1.8	0.1	-0.4	-0.5	-0.6
MANUF	1.6	21.6	-5.2	20.5	-20.3	0.4	42.0	-43.3	-2.0
UTIL	19.4	-3.3	-2.2	3.7	-0.4	-0.9	5.0	-2.0	-3.0
CONST	27.3	-31.7	-16.0	10.0	10.7	-2.9	35.4	14.3	-2.7
COM	8.1	42.1	-7.8	0.0	2.0	-0.3	26.3	-11.7	-1.1
TR-COM	15.7	-11.3	-3.1	22.5	1.2	-1.1	28.9	-6.3	-1.4
FIN-BUS	-35.0	80.2	-11.7	26.8	14.7	3.5	-15.7	14.2	-1.4
OTH-SERV	38.7	-23.0	-9.0	8.8	0.1	-0.1	14.1	11.8	-0.2
TOTAL	78.7	83.0	-61.7	93.8	8.5	-2.3	135.5	-22.5	-13.0

Note: *Intra-ind*: Intra-industry productivity, *Stat. sh.*: static shift effect, *Dyn. Sh.*: dynamic shift effect

Source: Author's calculations

VI. Conclusion and Policy Discussions

In this paper I reviewed the labor market policies of the Singaporean government and investigated the impact of the shifts of labor across sectors on aggregate labor productivity. I found for the entire economy that the shifts of labor impacted positively but in small amounts before 1985 and negatively in the post-1985 era. On the other hand, in the manufacturing sector, which was the primary target of the government's direct intervention in the labor market, labor shifts across manufacturing industries impacted positively on manufacturing labor productivity accounting for half of it whereas its impact in the post-1985 era was negative as in the case of the whole economy.

The results of the analysis should be compared with the changing labor market policies of the government. The two periods before 1985 (1965-78 and 1979-85) where the labor shift effects on aggregate manufacturing productivity are large and that of the general economy is positive though small, are characterized by a highly interventionist and strict labor market policy of the government. In the first period (1965-78), the government aimed at the mobilization of the labor force towards labor-intensive industrialization as part of its export-oriented development strategy based on labor-intensive export industries. For this purpose the government adopted a wage restraint policy with strict controls on wage increases in order to maintain cost competitiveness. In the second period (1979-85), the government's aim of industrial restructuring with the abandonment of the promotion of the labor-intensive manufacturing industries, was associated with the encouragement of the firms to shift towards higher value-added activities and improve the quality of their labor for this purpose. The results of these policies that aimed at an allocation of labor towards first labor-intensive export

industries and then a restructuring of this labor among the existing sectors are twofold. First, there was a substantial shift[8] of labor towards the manufacturing sector, the main engine of growth. Second, the shift of labor across manufacturing industries was towards certain high-performing industries such as electrical and electronic machinery industry away from the traditional labor-intensive industries such as textiles. Such reallocation of labor brought about a "bonus" for labor productivity, i.e. shifted labor was used in more productive areas which had a positive impact on manufacturing labor productivity.

In the post-1985 era, however, the results of the analysis show that the impact of the shifts of labor on aggregate labor productivity at both the whole economy and manufacturing levels is negative. This means that the shifts of labor worked against aggregate labor productivity. Post-1985 period is characterized by relatively liberalized labor markets with wage reforms of the government toward the introduction of a flexible wage policy and the abandonment of the controls on wage increases. In this period, the government aimed at industrial diversification with an emphasis on financial and business services sector as a new engine of growth along with the manufacturing sector. Due to these adjustments, there was a shift of labor away from the manufacturing sector to other services sectors, especially the financial and business services sector. This shift acted as a negative factor for aggregate labor productivity. Similarly, the shifts of labor within the manufacturing sector across the manufacturing industries did not provide a "bonus" to manufacturing labor productivity.

Previous research in the development economics literature has emphasized the positive role of the shifts of labor from less productive areas to more productive areas as a positive factor for productivity. This study shows that before 1985, the government could effectively realize such a gain by mobilizing the labor force. However, a more liberalized labor market and the target set as economic diversification after 1985 led to the shift of labor towards less productive areas and negative gains from productivity by this shift.

In conclusion, the most important issue to investigate appears to be the reversal of the impacts of the shifts of labor from in the post-1985 period. In the liberalized labor market of the post-1985 era, one can expect the labor to move to areas where the wage levels are higher. Financial and business services sector, for example, offers higher wages than the manufacturing sector. Wage differences across sectors largely explain the shifts of labor in a liberalized market. Why such shifts have a negative impact on aggregate labor productivity is a problem to be treated carefully. One possibility is that the labor market is moving towards a point where it will work normally with the relief of the labor market from long years of strong government intervention. In other words, the labor market may be moving to equilibrium after a long period of disequilibrium. Such a move may bring in negative shift effects since workers will be shifting across sectors in search for better pay for their services. Finally, the general tendency for the labor to shift toward services sectors when the

economy reaches maturity applies also to Singapore.

Table 5 Percentage contributions of manufacturing industries to aggregate manufacturing labor productivity

	1965 - 1978			1979 - 1985			1986 - 2002		
	Intra-ind	Stat. sh.	Dyn. sh.	Intra-ind	Stat. sh.	Dyn. sh.	Intra-ind	Stat. sh.	Dyn. sh.
Food	-4.4	-36.8	0.3	3.4	-0.3	0.0	-0.9	-0.7	-0.2
Tex	1.5	-12.5	-0.6	-1.9	0.2	0.0	0.2	-0.2	-0.2
Wear	3.4	-10.1	0.0	-2.4	-1.6	0.0	0.5	-1.1	0.5
Leat	-0.3	3.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
Wood	0.9	-52.5	-1.4	-3.7	2.0	0.0	0.2	-0.3	0.0
Furn	-1.6	-1.5	0.0	0.7	0.4	0.0	-0.8	-0.3	0.0
Paper	1.1	0.1	-0.1	-5.0	1.8	0.0	-0.5	-0.1	0.0
Pub	-1.6	-2.7	0.1	-4.7	-2.1	0.0	2.5	-0.1	-0.5
Chem	9.5	15.1	0.1	-13.0	-1.7	0.0	37.9	2.8	0.6
Petr	19.8	118.7	1.8	49.6	2.8	0.0	16.1	-1.5	-0.7
Rub	4.4	-14.8	-0.3	-2.1	4.4	0.0	0.8	0.3	0.2
Non-met	0.5	-4.8	-1.1	2.2	-5.3	0.1	1.4	0.2	-1.2
Met	-2.2	-41.2	-0.5	0.8	0.3	-0.1	-0.5	-0.3	1.0
Fab-met	-1.3	-6.9	-0.1	-2.2	3.7	-0.1	1.2	0.1	2.2
Mach	2.0	144.6	-0.3	29.6	-8.8	0.0	2.3	-0.5	-0.5
Elec	2.8	-257.8	-0.4	-14.4	27.2	0.0	50.4	-10.2	-0.1
Prec	0.1	-31.8	0.0	0.3	6.8	0.0	4.3	-0.1	-0.2
Tran	7.9	252.3	-0.3	14.7	7.9	0.3	-0.8	1.2	-4.7
Oth-man	-2.4	1.7	0.1	-0.8	11.2	0.1	1.2	0.0	-1.0
Total	40.2	62.3	-2.5	50.8	48.9	0.3	115.7	-10.8	-4.9

Note: Intra-ind: Intra-industry productivity growth, Shift eff: shift effect
Source: Author's calculations

Table 6 Annual percentage share of sectors and industries in total employment

	1966-1978	1979-1985	1986-2002
AGR	1.2	1.1	0.4
MIN	0.3	0.2	0.0
UTIL	2.4	0.8	0.5
CONST	5.3	7.2	7.4
COM	21.2	23.8	22.9
TR-COM	10.3	11.7	10.8
FIN-BUS	7.8	8.3	14.2
OTH-SERV	25.7	22.2	22.9
MANUF	25.8	24.7	20.8
Food	9.3	5.0	4.2
Tex	4.9	2.3	0.7
Wear	10.5	10.4	5.5
Leat	0.6	0.4	0.2
Wood	6.7	2.7	0.6
Furn	1.4	2.4	1.8
Paper	1.9	1.5	1.4
Pub	5.3	4.7	4.9
Chem	2.8	2.5	3.6
Petr	1.4	1.3	1.0
Rub	6.4	4.2	5.2
Non-met	3.3	2.2	1.8
Met	1.4	0.8	0.6
Fab-met	6.3	7.2	9.2
Mach	5.1	7.7	8.9
Elec	15.4	30.4	36.8
Prec	2.0	2.4	2.5
Tran	11.1	9.7	9.1
Oth-man	4.3	2.2	1.7

Note: The figures for manufacturing industries refer to their share in the manufacturing sector only.
Source: Author's calculations based on the data whose sources are described in the text

Notes

1 The information here is largely extracted from Carling (1995).

2 NWC consisted of representatives from the government, labor unions, and employees. In this way, the government could effectively control the industrial relations.

3 Central Provident Fund (CPF) is the national pension fund of Singapore. Both employers and employees compulsorily contribute to the employee's account in CPF. Singaporean government collects the "forced

savings" of its citizens by this way. The CPF account is used by the account holder to pay for education, health, and housing expenses of himself or his family. The account holder earns an interest on his savings in his CPF account. Therefore, CPF acts more like a saving institution, rather than simply a pension fund.

4 Hodrick-Prescott filter can be explained as follows. When original series x_t is composed of a trend component $\tau_t\left(\{\tau_t\}_{t=1}^{T}\right)$ and a cyclical component $c_t\left(\{x_t-\tau_t\}_{t=1}^{T}\right): x_t=\tau_t+c_t$, where t denotes time ($t = 1, 2, T$). Hodrick and Prescott (1997) suggest that with the following minimization method, the cyclical component c_t can be isolated from the original series x_t.

$$\min_{\{\tau_t\}_{t=1}^{T}}\left[\sum_{t=1}^{T}\left(x_t-\tau_t\right)^2+\lambda\sum_{t=2}^{T-1}\left[\left(\tau_{t+1}-\tau_t\right)-\left(\tau_t-\tau_{t-1}\right)\right]^2\right]$$

where λ is the smoothing parameter (also named penalty parameter). The first term in this minimization function, the sum of the squares of deviations, penalizes the variance of c_t. The second term, the summation of the second differences of the trend component τ_t multiplied by the smoothing parameter λ, places a penalty to the lack of smoothness in τ_t, i.e. a penalty on the variations in the growth rate of the trend component with the degree of penalization directly proportional to the value of the parameter λ chosen. Although the Hodrick-Prescott filter is easy to use, the selection of the appropriate value for the smoothing parameter appears as the major drawback. If λ approaches to 0, the trend component is almost equal to the original series, and if diverges to an infinitely large number, a linear trend is achieved. Hodrick and Prescott (1997) recommend setting the value of λ to 100 for annual data. I follow this tradition.

5 The inspiration in searching for long-run trends in labor productivity and wages here comes from a study by Voyvoda and Yeldan (1999) on Turkey.

6 Using the same methodology for an analysis of the productivity slowdown in the US, Beebe and Haltmaier (1980) name the intra-industry and shift effects as "rate" and "level" effects, respectively.

7 Timmer and Szirmai (2000) report some shortcomings of the shift-share analysis. For example, the shift of low-productivity and low-skilled agricultural labor into industry leads to an increase in the average productivity in agriculture. In the shift-share analysis, this increase in agricultural labor productivity is included in the intra-industry productivity growth effect, but in fact it was caused by labor shift. This may lead to an underestimation of shift effects. Productivity levels may be dependent also on the quality of labor. If labor shifts towards industries with higher productivity due to higher labor skills, shift effects includes improved labor quality which results in overestimation of shift effects.

8 To avoid confusion about the word "shift," note that the shift of labor does not necessarily mean physical transfer of labor from one sector to another. Total labor force may be growing but some sectors may be receiving more labor than the others.

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