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Labor Productivity and Economic Prospects in an Aging Society: Empirical Evidence from Thailand and Singapore

Supachet Chansarn*

Introduction

A demographic transition occurs when a largely rural agrarian society with high mortality and fertility rates becomes a predominantly urban industrial society with low mortality and fertility rates (Lee and Mason, 2006). At the early stage of such a transition, falling fertility rates, occurring at a time when the mortality rate is already low, will cause the working-age population (15-64 years old) to grow faster than the dependent population, especially the young-age population (0-14 years old), leading to an increasing proportion of the population becoming part of the working-age group. Such a demographic shift will create better economic prospects for the country concerned since the larger labor force relative to the dependent population will enable economic growth and better living standards for the people in the country. However, falling fertility rates will eventually cause the proportion of the population in the working-age group to decline, while low mortality rates mean that the old-age population (65 years old and older) will live longer, leading to an increasing proportion of the population becoming part of the old-age group. Other things being equal, this demographic shift may be harmful to a country's prospects for economic growth and cause the living standards of the people to deteriorate.

Both Thailand and Singapore have already completed their demographic transition. The proportions of their populations in the working-age group reached their peaks at 70.8 and 74.2 percent of the total population of Thailand and Singapore, respectively, in 2010; thereafter, these proportions are expected to decrease constantly. By 2015, those proportions are expected to decline to 70.5 and 73.6

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percent of the countries' total populations, respectively (United Nations, 2010). Such a demographic shift may eventually have a detrimental impact on the economic growth and the living standards of the people in these two countries due to their smaller labor force relative to the size of the dependent population, especially the old-age population. As a result, it is essential for Thailand and Singapore to find ways to increase their labor productivity in order to compensate for the shrinking size of their respective labor force so that a smaller labor force would be able to create constant economic growth and greater GDP per capita, which would imply a better standard of living for their people.

Consequently, this study is aimed at investigating two issues: first, measuring the labor productivity growth and economic growth rates by the real GDP per capita growth rates of Thailand and Singapore during the period 1971-2008 in order to reflect the labor productivity and economic growth situation in each country; and second, examining the influence of the labor productivity growth rates and the growth rates of the working-age populations on the real GDP per capita growth rates in each country in order to evaluate the economic prospects of these aging societies. In other words, the study is aimed at identifying the contribution of the labor productivity growth rate to offsetting the diminishing proportion of the population in the working-age group so that each country could realize positive growth in real GDP per capita. The information obtained from this study should be very helpful for both Thailand and Singapore in finding appropriate ways to increase labor productivity in order to prepare for the eventual reduction in the proportion of their populations in the working-age group.

Literature review

Labor productivity is normally defined as the average real (inflation-adjusted) output per hour of work (CBO, 2007). In other words, it is simply the average quantity of output produced by a given quantity of labor input (Economic Policy Institute, 2000). Many studies suggest that labor productivity should be regarded as one of the most influential factors which determine the economic growth and standard of living of a society as measured mainly by real GDP or real GDP per capita; that is, higher labor productivity would lead to greater real GDP per capita and, of course, a better standard of living for the

people of a country (Economic Policy Institute, 2000; Fisher and Hostland, 2002; Shaw, 2002; Chansarn, 2009; Diewert et al., 2009).

Thanks to the importance of labor productivity's effect on economic growth and living standards, researchers all over the world have found labor productivity to be one of the most interesting issues to study. Some of their studies have focused on the measurement of labor productivity and labor productivity growth by employing various methods (Scheryer, 2005; Saari, 2006; Chansarn, 2009; Diewert et al., 2009; BLS, 2010), whereas others have focused on the determinants of labor productivity (Speigel, 1994; Choudhry, 2009). Many studies have found a positive relationship between education and labor productivity (Yunhua et al., 2000; Duryea and Pages, 2002; Razzak and Timmins, 2007). Health and longevity have also been found to have a positive relationship with labor productivity (Leroex et al., 2004; Hazan, 2006; Knapp, 2007; Chadha, 2008). Furthermore, technological progress, as measured by total factor productivity and investment in information and communication technology (ICT), have also been found to be positively related to labor productivity (Singh, 2004; Choudhry, 2009; Jajri and Ismail, 2009). Yet another issue concerning labor productivity that is currently in focus is the impact of population aging on labor productivity (Johnson, 2002; Prskawetz et al., 2008).

In our literature review, we found that previous studies focused mostly on labor productivity in developed countries, whereas studies on labor productivity in the countries belonging to the Association of Southeast Asian Nations (ASEAN), including Thailand and Singapore, remain quite limited. Moreover, we did not find any previous study which combined population aging and labor productivity for explaining the standard of living and identifying the contribution of labor productivity growth to offsetting the impact of population aging so that a country could enjoying constant economic growth, which imply would a better standard of living. It is for these reasons that this two-country study was conducted.

Research methodology

The research methodology was divided into two sections: the first explained the analytical method utilized in the study, and the second described the data analyzed in the study and the data sources.

Analytical method

The analytical method was divided into two sections in accordance with the objectives of the study. The first section measured the labor productivity and economic growth rates by the real GDP per capita growth rate of Thailand and Singapore during the 37-year period 1971-2008. The second section examined the economic prospects of Thailand and Singapore by exploring the influences of the labor productivity and working-age population growth rates on economic growth.

Labor productivity growth and economic growth

This section started with the calculation of the labor productivity growth rate based on the method utilized by the U.S. Bureau of Labor Statistics (BLS, 2009). First of all, a labor productivity index was calculated using the following formula:

$$\text{Labor productivity index (LPI}_{t,0}) = \left[\frac{Q_t/Q_0}{L_t/L_0} \right] \times 100 \quad (1)$$

where $\text{LPI}_{t,0}$ = the labor productivity index in the current year compared with the base year,

Q_t/Q_0 = the index of output, as measured by real GDP, in the current year,

L_t/L_0 = the index of labor input, as measured by the labor force, in the current year,

t = the current year,

0 = the base year, which is 1970.

After the labor productivity indices for a particular country had been calculated for every year, the labor productivity growth rates could be calculated by using the following formula:

$$\text{Labor productivity growth rate} = \ln \left[\frac{\text{LPI}_{t,0}}{\text{LPI}_{t-1,0}} \right] \times 100 \quad (2)$$

Nevertheless, it should be noted that in this study immigrant workers were not included as part of the labor force since we assumed that immigrant workers in Thailand and Singapore are mostly unskilled laborers and are characterized by very low productivity, with the effect that the quantity of their output is negligible.

The economic growth rate, as measured by the real GDP per capita growth rate, could be calculated in the same manner as the labor productivity growth rate, as follows:

$$\text{Real GDP per capita growth rate} = \ln \left[\frac{\text{GDP}_t}{\text{GDP}_{t-1}} \right] \times 100 \quad (3)$$

where GDP_t = the real GDP per capita in the current year.

The results obtained from this section would reflect the situation in both countries regarding labor productivity and economic growth.

Economic prospects in an aging society: implications for labor productivity growth

This section started with an investigation of the influences of labor productivity growth and working-age population growth on economic growth by employing regression analyses (separately for each country). The estimation equation was as follows:

$$\text{gdp} = \beta_0 + \beta_1 \text{pl} + \beta_2 \text{wa} + \mu \quad (4)$$

where

- gdp = the economic growth rate as measured by the real GDP per capita growth rate,
- pl = the labor productivity growth rate,
- wa = the working-age population growth rate,
- β_1 = the parameter indicating a change in the real GDP per capita growth rate when the labor productivity growth rate changes by 1 percent,
- β_2 = the parameter indicating a change in the real GDP per capita growth rate when the working-age population growth rate changes by 1 percent.

A significance level of 5 percent was assumed for testing the significance of each parameter. The parameters β_1 and β_2 would indicate the contributions of the labor productivity and working-age population growth rates on the economic growth rate, identifying the contribution of the labor productivity growth rate in offsetting the diminishing proportion of the population in the working-age group so that each country could enjoy constant real GDP per capita growth. Thereafter, the calculated labor productivity growth rate would be

considered in analyzing the economic prospects of Thailand and Singapore.

Data and sources of data

This study relied on secondary time-series data in annual format for Thailand and Singapore during the period 1970-2008, which were obtained from the World Bank (2010). Data analyzed in this study included (1) real gross domestic product,¹ (2) real gross domestic product per capita, (3) size of the labor force, and (4) proportion of the population in the working-age group.

Results and discussion

The study results were divided into two sections. The first section presented the calculated labor productivity growth rates and the real GDP per capita growth rate of Thailand and Singapore, and the second section exhibited the results obtained from the regression analyses, which examined the influences of labor productivity growth and working-age population growth on economic growth and the calculated labor productivity growth rates required to offset the shrinking proportion of the population in the working-age group for both countries.

Labor productivity growth and economic growth

The labor productivity growth rates and the real GDP per capita growth rates of Thailand and Singapore during the period 1971-2008 are presented in Table 1. The findings revealed that during that 37-year period, Thailand had an average labor productivity growth rate of 3.66 percent per annum, whereas that of Singapore was 3.70 percent per annum. Although the average labor productivity growth rates of both countries were very close, it is obvious that Thailand's labor productivity growth rates for every five-year period from 1971 to 2008 were far more volatile than those of Singapore during the same time frame. According to Table 1, Thailand's average labor productivity growth rates ranged from -0.56 to 7.97 percent per annum

¹ Real gross domestic product (GDP) is the gross domestic product measured in constant year 2000 United States dollars.

during the study period, whereas those of Singapore ranged from 1.03 to 5.99 percent per annum. These figures imply that Thailand was unable to efficiently utilize its labor force during the 37-year economic cycle. Perhaps the reason for this is that most of Thailand's laborers are unskilled workers in labor-intensive industries. Such laborers are likely to be unemployed or underemployed during periods of economic recession, thus causing very low labor productivity growth rates during such periods.

It is worth looking at the countries individually. The findings revealed that Thailand's labor productivity growth rates were quite volatile. During the period 1971-1975, the average labor productivity growth rate for Thailand was 2.38 percent per annum; thereafter, during the period 1976-1980 it increased to 4.51 percent per annum before sharply dropping to 1.50 percent per annum during the period 1981-1985. During the next five-year period (1986-1995), Thailand's average labor productivity growth rates exceeded 7.0 percent per annum. However, the 1997 Asian financial crisis caused the average labor productivity growth rate to drop into negative territory at -0.56 percent per annum during the period 1996-2000. During the period 2001-2005, the average labor productivity growth rate of Thailand rose to 3.30 percent per annum. However, during the first few years (2006-2008) of the next period, Thailand's average labor productivity growth rate decreased to 3.04 percent per annum as a result of the global financial crisis stemming from the United States 2007 sub-prime loan crisis in that country's real estate sector.

As for Singapore, the findings of the study revealed that the average labor productivity growth rates were relatively stable and positive in every five-year period from 1971 to 2008. Starting from 4.24 percent per annum during the period 1971-1975, that growth rate ranged from 3.00 to 4.63 percent per annum during the period 1976-1990. The average labor productivity growth rate of Singapore reached its peak at 5.99 percent per annum during the period 1991-1995, although it too dropped as a result of the 1997 Asian financial crisis, that is, to 2.97 percent per annum during the ensuing period 1996-2000. During the period 2000-2005, Singapore's average labor productivity growth rate rose to 3.67 percent per annum; however, the

global financial crisis, which started in the United States, caused the average labor productivity growth rate to decline to 1.03 percent per annum between 2006 and 2008.

Table 1: Labor productivity growth and economic growth rates (percentage) of Thailand and Singapore

Period	Labor productivity growth rate			Real GDP per capita growth rate		
	Thailand	Singapore	Average	Thailand	Singapore	Average
1971-1975	2.38	4.24	3.31	3.04	6.96	5.00
1976-1980	4.51	4.00	4.26	5.43	6.86	6.15
1981-1985	1.50	3.06	2.28	3.19	3.67	3.43
1986-1990	7.14	4.63	5.89	8.30	5.99	7.15
1991-1995	7.97	5.99	6.98	7.08	5.56	6.32
1996-2000	-0.56	2.97	1.21	-0.27	3.46	1.60
2001-2005	3.30	3.67	3.49	3.85	4.19	4.02
2006-2008	3.04	1.03	2.04	3.37	1.88	2.63
Average	3.66	3.70		4.25	4.82	

Source: Author's calculation.

Note: Real GDP per capita growth rate represents economic growth.

In terms of economic growth, we found that Singapore also had a higher average real GDP per capita growth rate than Thailand; according to Table 1, during the period 1971-2008 the average in Singapore was 4.82 percent per annum, whereas that of Thailand was 4.25 percent per annum. Moreover, the findings revealed that Singapore's average real GDP per capita growth rates, ranging from 1.88 to 6.96 percent per annum, were far less volatile than those of Thailand, which ranged from -0.27 to 8.30 percent per annum during the period 1971-2008. With regard to Thailand, the findings showed that the country had impressive real GDP per capita growth rates in every period except the period in which the 1997 Asian financial crisis occurred (1996-2000) when it dropped to -0.27 percent per annum. Growth rates ranged from a low of 3.04 percent per annum during the period 1971-1975 to a high of 8.30 percent per annum during the period 1986-1990. The 1997 crisis caused Thailand's real GDP per capita growth rate to drop sharply to -0.27 percent per annum during the period 1996-2000. By contrast, the global financial crisis which started in the United States in 2007 affected Thailand's economic growth rate just slightly; Thailand's average real GDP per capita growth rate between 2006 and 2008 remained high at 3.37 percent per annum despite the global crisis.

Furthermore, the real GDP per capita growth rates of Singapore were very high and quite stable during the period 1971-2005, ranging from a low of 3.46 percent per annum during the period 1996-2000 to a high of 6.96 percent per annum during the period 1971-1975. However, it seems that Singapore was adversely affected by the recent global financial crisis, which caused that country's average real GDP per capita growth rate between 2006 and 2008 to decline sharply to 1.88 percent per annum. Moreover, it seems that the real GDP per capita growth rate of Singapore generally exhibited a downward trend during the overall period studied.

Economic prospects in an aging society: implications for labor productivity growth

To examine the influences of labor productivity growth and working-age population growth on economic growth, a regression analysis was performed separately for each country. The results of that analysis are presented in Table 2, which shows that no multicollinearity problem arose in the analysis of either country because the variance inflation factors of every explanatory variable in each model (country) were very close to one. In addition, the findings revealed that each estimated regression equation was statistically significant at the 5 percent level. As a result, all estimated equations seemed to be valid.

Table 2: Statistical results from the regression analyses

Variable	Coefficient	Std. error	Standardized coefficient	P-value	Variance inflation factor
Thailand					
Constant	-0.114	0.284	-	0.691	-
Labor productivity growth rate (pl)	0.936*	0.033	0.959	0.000	1.006
Working-age population growth rate (wa)	1.968*	0.479	0.139	0.000	1.006
Observations = 38					
F-stat for overall significance = 419.586*					
P-value for overall significance = 0.000					
Standard error of the estimate = 0.783; adjusted R-square = 0.958					

Table 2: (continued)

Variable	Coefficient	Std. error	Standardized coefficient	P-value	Variance inflation factor
Singapore					
Constant	0.278	0.229	-	0.234	-
Labor productivity growth rate (pl)	0.992*	0.037	0.952	0.000	1.002
Working-age population growth rate (wa)	2.174*	0.282	0.273	0.000	1.002
Observations = 38					
F-stat for overall significance = 382.993*					
P-value for overall significance = 0.000					
Standard error of the estimate = 0.817; adjusted R-square = 0.954					

Note: The dependent variable is the real GDP per capita growth rate (gdp); the explanatory variables are the labor productivity growth rate (pl) and the working-age population growth rate (wa).

* Statistically significant at 5 percent level.

Starting with Thailand, the findings shown in Table 2 reveal that the adjusted R-square equals 0.958, implying that the explanatory variables in the equation could explain 95.8 percent of the variation in the real GDP per capita growth rate. Moreover, the regression coefficients for both the labor productivity growth rate and the working-age population growth rate were significant at the 5 percent level, implying that economic growth was determined by these two factors. The regression coefficients for the labor productivity growth rate and the working-age population growth rate equal 0.936 and 1.968, respectively, meaning that a 1 percent increase in these two factors would lead to increases of 0.936 and 1.968 percent, respectively, in the real GDP per capita growth rates. Additionally, the labor productivity growth rate was considered to have greater influence on the real GDP per capita growth rate than the working-age population growth rate owing to its larger standardized regression coefficient.

The estimated regression equation for Singapore had an adjusted R-square of 0.954, indicating that 95.4 percent of the variation in the real GDP per capita growth rate could be explained by the equation's explanatory variables. In addition, the findings revealed

that both the labor productivity growth rate and the working-age population growth rate had statistically significant influences at the 5 percent level with regard to the real GDP per capita growth rate, with the regression coefficients being 0.992 and 2.174, respectively. These regression coefficients implied that a 1 percent increase in these two factors would lead to increases of 0.992 and 2.174 percent, respectively, in the real GDP per capita growth rates. As was the case for Thailand, the labor productivity growth rate was considered to have a greater influence on the real GDP per capita growth rate than the working-age population growth rate owing to its larger standardized regression coefficient.

The statistical results from the regression analyses described above confirm the results of previous studies: labor productivity is one of the determinants of economic growth. Furthermore, labor productivity will be one of the key factors in the economic growth of the two aging societies, which are faced with eventual reductions in the proportions of their populations in the working-age group. Labor productivity growth is essential for offsetting the diminishing proportion of the population in the working-age group so that the countries could enjoy constant economic growth, which in turn would imply a better standard of living for their people. Based on the regression coefficients, the contribution of the labor productivity growth rate to offsetting the decreasing proportion of the population in the working-age group can be calculated as follows:

Thailand: a 1 percent decrease in the working-age population growth rate must be compensated by a 2.103 percent increase in the labor productivity growth rate.

Singapore: a 1 percent decrease in the working-age population growth rate must be compensated by a 2.192 percent increase in the labor productivity growth rate.

The labor productivity growth rates which Thailand must achieve in order to offset the diminishing proportion of the population in the working-age group, so that it can enjoy constant economic growth during the period 2010-2040, are presented in Table 3, and those needed by Singapore for the same purpose are presented in Table 4. According to Table 3, Thailand's working-age population is expected to decline by 0.30, 1.20, 1.50, 1.60, 1.50 and 1.10 percent during the periods 2010-2015, 2015-2020, 2020-2025, 2025-2030, 2030-2035 and 2035-2040, respectively. Therefore, in order to

maintain its economic growth, Thailand needs labor productivity growth rates greater than 0.126, 0.505, 0.631, 0.673, 0.631 and 0.463 percent per annum during those six respective periods.

According to Table 4, it seems that Singapore would face a tougher situation than Thailand since its working-age population is expected to decline at a far higher rate during the period 2010-2040. Singapore's working-age population is expected to decline by 0.60, 3.50, 5.40, 5.10, 3.30 and 0.90 percent during the periods 2010-2015, 2015-2020, 2020-2025, 2025-2030, 2030-2035 and 2035-2040, respectively. These figures imply that Singapore needs labor productivity growth rates greater than 0.263, 1.534, 2.367, 2.236, 1.447 and 0.395 percent per annum during the six respective periods in order to generate constant economic growth.

Table 3: Thailand's required labor productivity growth rates

Period	Working-age population growth rate during five-year period	Labor productivity growth rate	
		Five-year period	One-year period
2010-2015	-0.30	0.631	0.126
2015-2020	-1.20	2.524	0.505
2020-2025	-1.50	3.155	0.631
2025-2030	-1.60	3.365	0.673
2030-2035	-1.50	3.155	0.631
2035-2040	-1.10	2.313	0.463

Source: Author's calculation.

Note: Working-age population growth rates during the period 2010-2015 are based on United Nations (2010) projections.

Table 4: Singapore's required labor productivity growth rates

Period	Working-age population growth rate during five-year period	Labor productivity growth rate	
		Five-year period	One-year period
2010-2015	-0.60	1.315	0.263
2015-2020	-3.50	7.672	1.534
2020-2025	-5.40	11.837	2.367
2025-2030	-5.10	11.179	2.236
2030-2035	-3.30	7.234	1.447
2035-2040	-0.90	1.973	0.395

Source: Author's calculation.

Note: Working-age population growth rates during the period 2010-2015 are based on United Nations (2010) projections.

According to the calculations shown in Table 3 and Table 4, Thailand still has good economic prospects despite the projected decreases in the proportion of its population in the working-age group, since its historical labor productivity growth rates are far higher than the labor productivity growth rates needed to (a) make up for the shrinking working-age group, and (b) generate constant economic growth during the period 2010-2040. However, the very high volatility of the labor productivity growth rates, which implies that Thailand is unable to efficiently utilize its labor force during entire economic cycles, may pose a vital threat. In other words, Thailand tends to efficiently utilize its labor force in terms of production during times of economic expansion, but inefficiently do so during times of economic downturn, which causes uncertainty about its ability to achieve the needed labor productivity growth rates during recessions. As a result, Thailand's economic prospects remain good even though it is an aging society, but the uncertainty about its economic prospects is also high.

Nevertheless, Singapore seems to face more difficulty than Thailand. Even though Singapore's historical labor productivity growth rates are sufficiently high to compensate for the diminishing proportion of its population in the working-age group and generate constant economic growth during the period 2010-2040, implying good economic prospects in this aging society, the country faces difficulties since its working-age population is expected to decline sharply during that 30-year period. However, Singapore enjoys an advantage arising from its stable labor productivity growth rate; as a result, it is likely that Singapore would achieve the labor productivity growth rate needed to maintain economic growth in the long term. Therefore, Singapore's economic prospects are also good even though it is an aging society.

Conclusion and policy implications

This study reveals the labor productivity growth and economic growth situations in Thailand and Singapore during the period 1971-2008, as measured by the real GDP per capita growth rate, furnish empirical evidence that labor productivity is one of the determinants of economic growth. These results will provide both countries with useful information for initiating appropriate policies to deal with their aging societies and the decreasing proportions of their populations in the working-age group, which, all things being equal, would be

harmful to their economic growth and their people's standard of living. In other words, this study suggests that increases in the labor productivity growth rate are essential to compensate for the eventual and unavoidable reduction in the working-age population growth rates of both countries. Based on the study, both Thailand and Singapore have good economic prospects as aging societies during the period 2010-2040, since their historical labor productivity growth rates are higher than the rates needed to offset the adverse effects of their shrinking working-age populations, and to maintain their economic growth rates.

Nevertheless, both countries face some serious threats. Specifically, Thailand's economic prospects seem to be uncertain due to the high volatility of its labor productivity growth rates; similarly, Singapore also faces difficulty due to the expected sharp decrease in the proportion of its population in the working-age group. Moreover, it is important to note that the labor productivity growth rates shown in Table 3 and Table 4 are just those growth rates needed to maintain the real GDP per capita growth rate at a positive level, implying that the labor productivity growth rates which both countries need to achieve must be higher if they are to realize higher real GDP per capita growth rates. Of course, it will be difficult for both countries to do so. For instance, if Thailand and Singapore set their targeted real GDP per capita growth rates at 3 percent per annum for the period 2020-2025, they will need to achieve labor productivity growth rates of 1.592 and 5.633 percent per annum, respectively. According to the statistics, a labor productivity growth rate of 1.592 percent per annum is not too high for Thailand to achieve, but the country may fail to attain this rate due to the volatility of its labor productivity growth rates. As for Singapore, despite its stable labor productivity growth rates, that country may also fail to achieve the labor productivity growth rate of 5.633 percent per annum. That rate is far higher than the average labor productivity growth rate for Singapore, which is equal to 3.70 percent per annum.

Consequently, both Thailand and Singapore need to develop their human capital resources in order to make their economic prospects sustainable as their societies age. In other words, both countries need to promote human capital formation through education, training, and health promotion in order to enhance their stock of human capital, and improve labor productivity, which would lead to higher economic growth and a better standard of living for the people

of both countries regardless of the decreasing proportions of their populations in the working-age group. A more productive labor force is essential for Thailand as it would reduce the volatility of the labor productivity growth rates during economic cycles, leading to sustainable economic prospects for this aging society. Such labor force development is also necessary for Singapore since it would increase the probability of it overcoming the huge diminishing proportion of the population in the working-age group, and enable Singapore to attain high and sustainable economic growth in its aging society.

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