Past, Present, and Prospects for Thailand's Growth: A Labor Market Perspective*

Sra Chuenchokesan and Don Nakornthab

Bank of Thailand

June 2008

Abstract

Using growth accounting and econometric estimation methodologies, we investigate Thailand's growth developments from 1972 to 2007 and project forward Thailand's supply-side long-term potential growth till 2035. Our analysis is framed in terms of labor productivity and labor market developments. In this respect, the macroeconomic impact of Thailand's ageing population is also highlighted. Our findings suggest that priority should be given to the resuscitation of capital accumulation or Thailand will fall to a permanent lower growth path.

JEL classification: O4
Keywords: productivity growth, growth accounting, demographic changes, Asia, Thailand

* Paper prepared for ESAM08: Markets and Models: Policy Frontiers in the AWH Phillips Tradition, Wellington, New Zealand, July 9-11, 2008. All correspondences should be addressed to donn@bot.or.th. The views expressed herein are our own and not necessarily those of the Bank of Thailand.

1. Introduction

Twenty years ago, the story of Thailand's growth was a remarkable one. Between 1987 and 1995, the lowest GDP growth registered by the Thai economy was 8.1% in 1992 and that was during a global economic slump. The spectacular growth performance put Thailand under the global spotlight as the next East Asian Tigers after Hong Kong, Singapore, South Korea and Taiwan.

Thailand's remarkable growth journey came to an abrupt end in 1997 with the eruption of the Asian financial crisis. The aftermath of the devastating event was Thailand's deepest economic contraction since the Second World War. It took nearly five years for the economy to get back on a solid growth path. Real GDP growth averaged 5.5% between 2002 and 2007 with a prospect of reaching 6% growth in 2008 before world crude oil prices surpassed the USD120 mark.

Today, a 6% annual growth rate is generally considered highly robust for the Thai economy. This stands in sharp contrast to the pre-crisis years when a 5.9% growth rate in 1996 was considered dismal. Certainly, these assessments are based on the prevailing domestic and external environment. Still, they also reflect the perceived growth potentials of the economy which in turn are influenced by growth performance during the preceding years.

This paper aims to provide a systematic evaluation of past performance and future prospects of Thailand's economic growth from the perspective of labor productivity developments and demographic changes. While there have been numerous studies on Thailand's economic growth, few have looked at it from the angle of labor productivity and labor market developments and fewer have attempted to assess the economy's future long-term potential growth.[1]

Our study is divided into two major parts. In the first part, we look at Thailand's actual growth experience from 1972 to 2007 with particular attention to contributions of different components of aggregate employment and labor productivity. To arrive at the contributions of the immediate determinants of labor productivity growth (capital deepening, growth in labor quality, and aggregate total

[1] For a comprehensive review of major studies on Thailand' growth, see Bosworth (2005). Warr (2007) represents one of the latest additions to this literature.

factor productivity growth[2]), we employ both growth accounting and econometric (parametric) methodologies. A high-level sectoral analysis of Thailand's structural change is also provided.

In the second part, we combine these results with Thailand's demographic projection to project forward the economy's potential growth over the next three decades. In this respect, the paper also represents an assessment of the macroeconomic impact of Thailand's demographic changes. Like many countries in the world, Thailand is facing a problem of ageing population. With the demographic dividend of the baby boom generation expected to end by 2015, there is clearly a strong implication for the country's future potential growth prospect.

Admittedly, projecting economic growth for periods longer than a couple years is fraught with great uncertainty not to mention that in this case the variable of interest is unobservable. Nevertheless, a ballpark estimate of the economy's long-term potential growth rate is central to many policy areas. For fiscal authorities, it serves as a critical input for long-term budget planning as well as fiscal sustainability assessment. For central banks, it represents the "speed limit" of which the economy can grow for an extended period without upward inflationary pressure. Given a capital-output ratio and the rate of capital depreciation, one can also impute the necessary investment rate needed to match the sustained output growth

The framework we use to analyze sources of Thailand's past economic growth and its long-term potential in this paper is based on a textbook Solow growth model. Despite the proliferation of endogenous growth models in the literature, the neoclassical framework on which the Solow model is based remains the primary tool for long-term economic growth projection. There are empirical reasons for this. First, it is no less difficult, if not impossible, to forecast the driving factors in the endogenous growth models, be market power, technology diffusion or R&D activity, than to forecast the exogenous technological progress assumed in the neoclassical growth models. Furthermore, empirical works such as Mankiw, Romer, and Weil (1992) and Islam (1995), in the cross-country context, and Jorgenson (1990), in the U.S. context, have shown that appropriately-specified Solow growth models do

[2] Most of the earlier studies on Thailand's economic growth go directly to analyses of total factor productivity (TFP) growth developments. Unlike labor productivity, TFP is not observable and its estimation is subject to model uncertainty.

perform reasonably well in explaining economic growth over an extended period. Given these reasons, it is no surprise that variations of the neoclassical approach have been adopted by several national authorities to forecast their countries' long-term potential GDP growth. See, for example, Treasury of the Australian Commonwealth (2007), the U.S. Congressional Budget Office (2008), and Musso and Wassermann (2005). At the extreme, Social Security Administration (2008) provides seventy-five-year "long-range" estimates of U.S. GDP growth through year 2082.

The rest of the paper is organized as follows. Section 2 describes the conceptual and theoretical framework used in the analysis of this paper. Section 3 analyzes the proximate sources of Thailand's economic growth from 1972 to 2007. Section 4 presents our projections of Thailand's long-term potential growth. Section 5 discusses some policy implications of our results. Section 6 concludes.

2. The framework

We begin with a simple identity

$$Y_t = \left(\frac{Y_t}{H_t} \right) \cdot H_t , \tag{1}$$

where Y is aggregate output and H is total hours worked. The ratio Y/H defines average labor productivity (ALP) or simply labor productivity. In cases where data on hours worked are not available or are of low quality, an alternative definition of labor productivity with hours worked replaced by the number of person employed is used. Thus, at the highest level, output growth can be decomposed into growth in labor productivity and growth in hours worked when labor productivity is defined in terms of hours or into labor productivity and employment growth when labor productivity assumes the alternative definition. All of these calculations can be done easily with national accounts and employment data.

To gain a deeper insight, one can decompose further the two components of output growth. For hours worked, the decomposition is relatively simple. Hours worked can be expressed as the product of hours worked per employee (also known as average hours worked), the employment rate, the labor force participation rate, the share of working-age population to total population, and total population.

There are several ways to decompose labor productivity growth. The most common decomposition relies on the aggregate production function approach that

relates aggregate output to the primary inputs, capital and labor, and the level of technology.[3] Most empirical applications further assume that the aggregate production takes the Cobb-Douglas form with constant returns to scale:

$$Y_t = A_t K_t^{a} L_t^{1-a}, \tag{2}$$

where A is Hicks-neutral (or output-augmenting) technology, K is flow of capital services, L is flow of labor services or (quality-adjusted) labor input, and α and $1-\alpha$ are output elasticities of capital and labor, respectively. Under the assumption of competitive factor markets where capital and labor inputs are paid the values of their marginal products, a and $1-a$ also equal capital's and labor's shares of income, respectively. In the literature, A is often referred to as total factor productivity (TFP). The other names for A are multi-factor productivity (MFP; used by the U.S. Bureau of Labor Statistics) and the Solow residual in honor of Robert Solow who popularized the concept.

Given the above production function, labor productivity (Y/H) can be expressed as

$$\frac{Y_t}{H_t} = A_t \left(\frac{K_t}{H_t}\right)^{a} \left(\frac{L_t}{H_t}\right)^{1-a}. \tag{3}$$

The ratio of capital services to hours worked (K/H) and its change are commonly referred to as capital intensity and capital deepening, respectively. The ratio of (quality-adjusted) labor input to hours worked (L/H) is referred to as labor composition or labor quality.

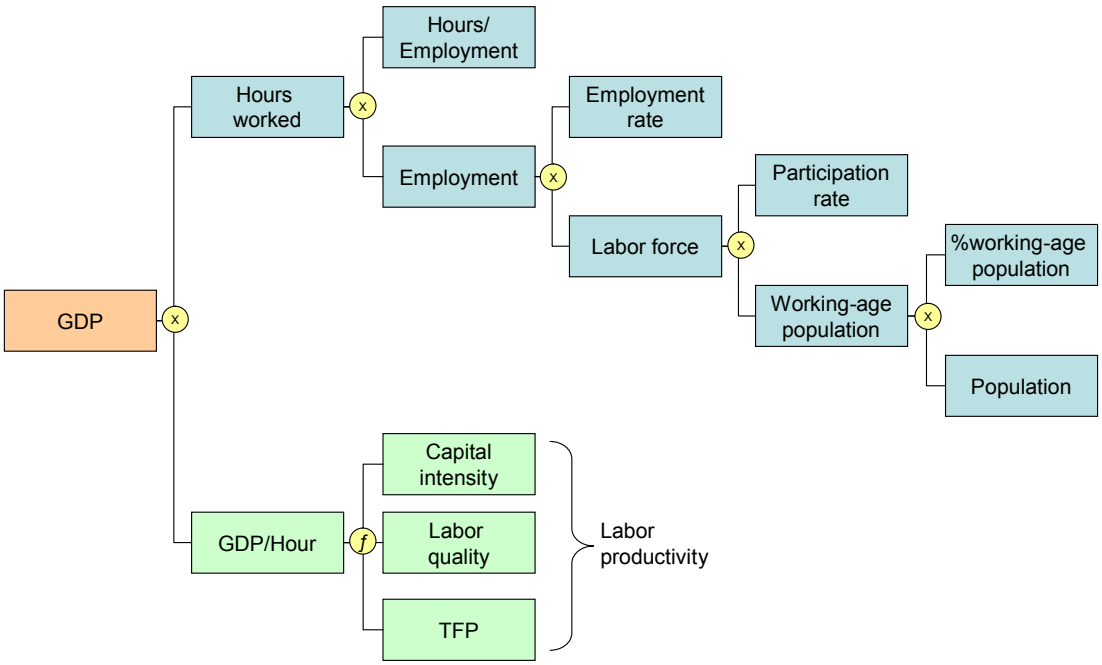
According to equation (3), labor productivity growth comes from three immediate sources – capital deepening, growth in labor quality, and TFP growth. The use of the word immediate here is to stress the difference with the fundamental determinants of labor productivity growth such as years of schooling, innovation, and R&D spending, which in turn depend on institutional factors and preferences. Figure 1 schematically summarizes the decomposition of output (real GDP) used in this paper.

The economic interpretation of equation (3) is intuitive. Workers are generally more productive when they have more physical capital to work with.

[3] As an example of alternative decompositions, Gordon (2000) separates U.S. labor productivity growth into trend and cyclical components

Improvement in labor quality, a reflection of changes in the composition of the workforce such as education and experience, adds further to labor productivity growth. The remaining portion of labor productivity growth is accounted for by TFP growth. Presumably, TFP growth captures the impacts of things like reallocation of resources to more productive uses, de-bottlenecking, and organizational and management improvements in addition to pure technological progress. In practice, however, TFP also reflects measurement errors as well as anything not captured in the definitions of the inputs used. As an example of the latter, if labor input is measured in terms of total hours worked, then estimated TFP growth will pick up the effect of changes in labor quality, leading to overestimation of its impact on economic growth.

Figure 1. Schematic decomposition of real GDP



To assess the contribution of each immediate determinant of labor productivity growth, one needs to have estimates of the growth rates of A, K, L and the parameter α. We refer the estimation of K and L to Appendix A and focus here on the estimation of the growth rate of A or TFP growth and α, given estimates of K and L.

There are essentially two approaches to this problem, both of which have their own pitfalls.[4] The first and perhaps the more popular approach is that of growth accounting. The advantage of this approach is that it is not restricted to any particular form of the aggregate production function as long as the neoclassical assumptions are

[4] See, for example, Hulten (2001).

satisfied. Specifically, growth accounting combines the neoclassical production function with the assumptions of constant returns to scale and competitive factor markets. As mentioned previously, this leads to output elasticity of each factor input being equal to its respective income share. Unlike the constant elasticity parameters embedded in the Cobb-Douglas production function, income shares do not have to be constant over time, for they can vary when businesses change their input proportions and when relative prices change. In most empirical work, income shares are calculated from national income accounts data. This leaves TFP as the only remaining unknown element.

Growth accounting thus provides a mechanical way to derive TFP growth. Following standard practice, we calculate estimated TFP growth as the residual from the following Tornqvist discrete time approximation of the growth rates of aggregate output and aggregate inputs:

$$\Delta \ln Y_t = \Delta \ln A_t + \bar{\alpha}_t \cdot \Delta \ln K_t + (1 - \bar{\alpha}_t) \cdot \Delta \ln L_t , \tag{4}$$

where $\Delta x_t \equiv x_t - x_{t-1}$ and $\bar{\alpha}_t \equiv \frac{\alpha_t + \alpha_{t-1}}{2}$.

The second approach is direct econometric estimation of the aggregate production function. In this paper, the following regression equation is adopted,

$$\Delta \ln Y_t = \beta_1 \cdot \Delta \ln K_t + \beta_2 \cdot \Delta \ln L_t + \varepsilon_t . \tag{5}$$

The use of the log-difference specification is to circumvent the unit root problem. By not imposing the restriction that the coefficients on changes in capital services and labor input add up to one, we allow for the possibility of nonconstant returns to scale. Under this specification, the first two terms of (5) represent, respectively, the contributions of capital and labor to output growth and the associated residuals correspond to TFP growth.

In addition to requiring a sizable data sample, the above econometric specification implicitly assumes that the output elasticity terms are constant over time. This assumption is less likely to be valid for the Thai economy which has gone quite a structural transformation during the past thirty years. For these reasons, we only apply direct econometric estimation to Thailand's quarterly data which started in 1993.

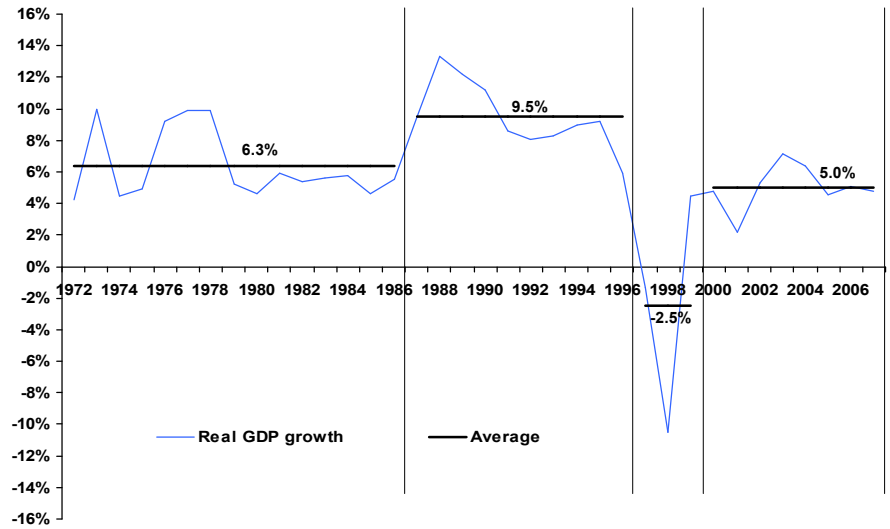
3. The historical record, 1972-2007

A historical evolution of past performance is important not only for understanding what had happened, but also for assessing the assumptions underlying the forward-looking projections. This section analyzes Thailand's real GDP growth developments from 1972 to 2007 based on the decomposition scheme shown in Figure 1. The choice of 1972 as the starting point of our analysis is constrained by the availability of Thailand's employment data. Unlike data on real GDP which goes back to 1951 (annual series; quarterly series is available from 1993), data on employment became available on a consistent annual basis in 1971 with the launch of the labor force survey (LFS). Appendix A provides description of the LFS data set which has undergone changes in both frequency and coverage over the years along with the adjustments we make to the data in our analysis.

3.1 The big picture

Figure 2 plots Thailand's annual real GDP growth rates during the period as well as their averages in the four sub-periods – 1972-1986 (pre-boom), 1987-1996 (boom), 1997-1999 (crisis) and 2000-2007 (present-day) – identified by most researchers as breaks in Thailand's modern growth developments. In what follow, we use these sub-periods as benchmarks for developments in each of the decomposed components of real GDP

Figure 2. Real GDP growth, 1972-2007



Source: NESDB

Between 1972 and 1986, the period which includes two oil shocks and the developing world's debt crisis, the Thai economy grew on average 6.3% per annum.

In four out of fifteen years covered in this time span, the economy expanded between 9.2% and 10.0%. The respectable growth performance during these pre-boom years was however pale in comparison to what would follow.

From 1987 to 1996, the Thai economy took a different course. The average real GDP growth rate during this period was 9.5%. Before a "slowdown" in 1996, the lowest growth rate registered by the Thai economy was 8.1% in 1992 and that was during a global economic slump. The spectacular growth performance during these boom years put Thailand under the global spotlight as the next East Asian Tiger after Hong Kong, Singapore, South Korea, and Taiwan.

The Asian financial crisis that erupted in June 1997 brought an end to the remarkable growth story. The Bank of Thailand was forced to abandon an exchange rate peg it had maintained since the founding of the Bank in 1942. Within six months after its float, the Baht lost about a half of its value. The exchange rate shock caused the balance sheet of the unhedged corporate sector to deteriorate sharply and the inability of the sector to honor its ballooning debt obligation took a toll on the financial sector in the form of rising non-performing loans (NPLs). To prevent their asset portfolio from further deterioration, banks tightened lending, resulting in a severe credit crunch for otherwise viable firms. As a result, the economy underwent its first contraction in forty-some years and the deepest since the Second World War. A number of firms went bankrupt. Almost two millions of people were unemployed as the unemployment rate nearly doubled. At one point, the banking system was on a verge of a systemic collapse and much of the country was in a state of despair.

The Thai economy nonetheless managed to recover. A solid economic expansion between 2002 and 2004 put the economy back on a firm growth path. The average GDP growth rate from 2000 to 2007, which we term the present-day period, was 5.0%. While respectable, this average was below the 6.3% figure recorded during the pre-boom period, not to mention the 9.5% figure during the boom years. This "sub-par" performance leaves open question whether it is a reflection of "convergence", population slowdown, a permanent downward shift in trend productivity growth, or some combinations of them.

One way to partially answer this question is to decompose real GDP growth rates during the four sub-periods into growth in labor productivity and growth in

employment/hours worked. Table 1 reports the results of this decomposition. Because quality hours worked data is available only from 1985 onward, we choose to perform the decomposition involving hours worked only for the last three sub-periods.

Table 1. Average annual percentage changes in real GDP, total employment, total hours worked, and labor productivity by sub-periods

Sub-period	Real GDP	Total employ-ment	Real GDP per employed person	Total hours worked	Real GDP per hours
1972-1986	6.3%	3.7%	2.7%	N/A	N/A
1987-1996	9.5%	2.4%	7.0%	2.0%	7.4%
1997-1999	-2.5%	-0.1%	-2.5%	-1.0%	-1.6%
2000-2007	5.0%	2.0%	3.0%	1.3%	3.7%

Note: Simple averages; data for 1972-1986 are for employment age 11+; the rest are for age 15+
Source: NESDB; LFS; authors' calculation

Three important conclusions emerge from this table. First, employment growth accounted for more than half of Thailand's growth during the pre-boom period. On average, total employment grew by 3.7% per annum during the span of fifteen years compared to 2.7% for growth in real GDP per employed person.[5] Absent strong employment growth, growth of the Thai economy during this period would probably be mediocre.

Second, Thailand's spectacular growth performance during the boom years was driven mainly by labor productivity growth regardless of how it is measured. It is this extraordinary surge in labor productivity growth that has made the story of Thailand's growth a subject of extensive studies over the past twenty years.

Third, the average productivity growth (per employment) in the present-day period, while less than half of the boom period's, was slightly higher than the corresponding figure during the pre-boom period. The reason the average real GDP growth this period was lower than the pre-boom period is due to the fact that the average employment growth was almost two percentage point lower.

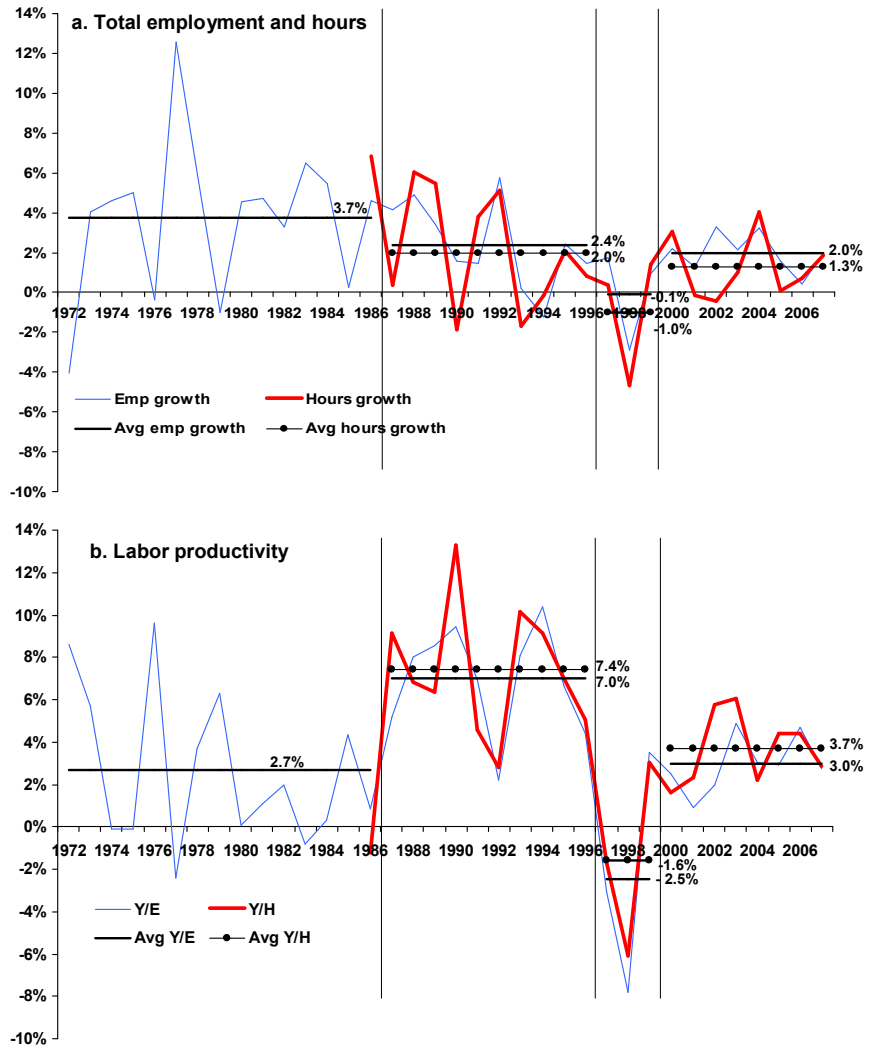
Figure 3 plots the annual data behind the calculation of the averages in Table 1. The top panel (panel a) reveals that while employment growth and hour growth tended to move together, the latter exhibited higher volatility. Considering that firms in general prefer increasing overtime for existing workers to hiring new ones and

[5] These numbers are arithmetic averages. The geometric averages (compound growth rates) of total employment and real GDP per employed person this period were 3.6% and 2.6%, respectively.

keeping part-time workers on payroll to firing them, the higher volatility in total hours worked is expected. Consequently, labor productivity growth is more volatile when it is measured in terms of hours worked (panel b).

Another important observation from Figure 3 is that the average growth rates of total hours worked in the last three sub-periods were lower than growth in total employment. The difference became much more pronounced after the 1997 crisis. This means that any labor productivity analysis based on employment data especially during the present-day period will understate the contribution of labor productivity to economic growth.

Figure 3. Annual percentage change in total employment, hours worked, and labor productivity, 1972-2007



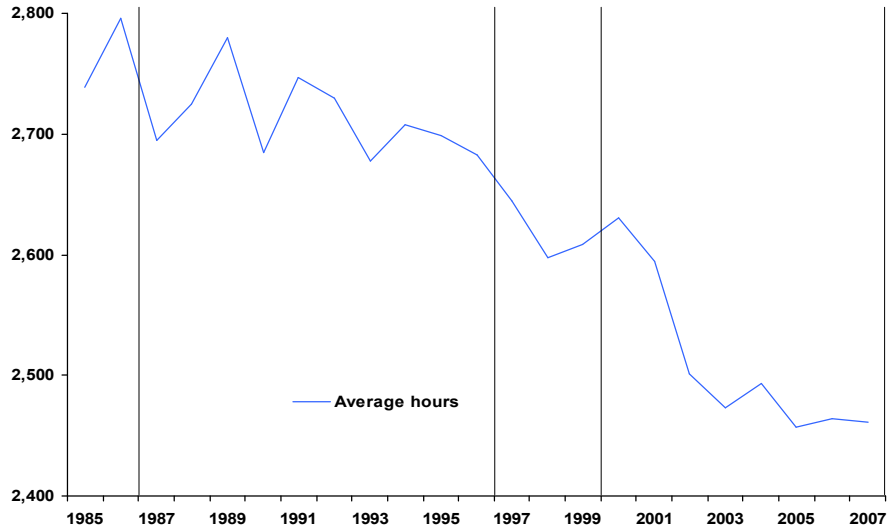
Source: NESDB; LFS; authors' calculation

3.2 Employment developments

The fact that total hours worked have grown more slowly than an aggregate employment indicates that average hours worked per person employed must have been falling. Figure 4 shows that average hours have indeed been on a declining trend since quality data on hours worked became available in 1985.

At the most fundamental level, the trend in average hours reflects the ageing of the workforce. Old-aged workers on average work fewer hours than young workers who are more likely to put in overtime. As a matter of fact, falling average hours have been observed in most countries largely for this reason. During the last three years, however, the tight labor market has resulted in a falling proportion of part-time workers which in turn offset the impact of the ageing workforce.

Figure 4. Average hours per employed person, 1985-2007



Source: LFS; authors' calculation

We turn next to trends in factors that make up aggregate employment, beginning with total population. From Table 2, Thailand's population growth became successively lower during the four sub-periods studied. The slowdown in population growth reflects largely the decline in fertility rate. In 2006, Thailand's total fertility rate was 1.6 children born per woman, down from 2.1 in 1996 and significantly from 4.9 in 1975, a result often credited to a highly successful nation-wide family planning program. On the other hand, better sanitary conditions and healthcare system enable people to live longer, leading to increases in the share of working-age (age 15+) population to total population. As a result, growth in working-age population, though also falling, has been consistently higher than that of the total population.

Table 2. Average annual percentage changes in working-age population, share of working-age population, and population by sub-period

Sub-period	Working-age population	% working age	Population
1972-1986	3.5%	0.8%	2.7%
1987-1996	2.8%	1.3%	1.4%
1997-1999	1.6%	0.6%	1.0%
2000-2007	1.4%	0.6%	0.8%

Note: Averages for 1972-1986 are based on data for age 11+.
Source: LFS; authors' calculation

Older people, however, tend to participate less in the labor force. At the end of 1986, Thailand's labor force participation rate was 81%. Ten years later, it was 74%, a decline of nearly one percent a year. The 1997 crisis contributed further to this decline by discouraging people to look for work. Since 2000, however, Thailand's labor force participation rate appeared to stabilize around 72%.[6] The stabilization of the labor force participation rate in the present-day period ended the stretch of period where labor force growth had lagged behind growth of the working-aged population (Table 3).

Table 3. Average annual percentage changes in labor force, labor force participation rate, and working-age population by sub-period

Sub-period	Labor force	Parti-cipation rate	Working-age population
1972-1986	3.5%	0.0%	3.5%
1987-1996	1.9%	-0.9%	2.8%
1997-1999	0.7%	-0.9%	1.6%
2000-2007	1.5%	0.1%	1.4%

Note: Averages for 1972-1986 are based on data for age 11+.
Source: LFS; authors' calculation

Finally, total employment can be expressed as a product of the average employment rate and the labor force. In general, the employment rate along with average hours worked is the most sensitive to cyclical economic conditions. For much of Thailand's modern economic history, changes in the employment rate have been a boon to growth in total employment, the fact that is evident from Table 4

[6] The labor force participation rate for persons aged 15-64 is 77%. Although lower than the Scandinavian countries' which are above the 80-percent mark, this level is higher than the OECD average of 70% (OECD, 2007) despite the fact that the official retirement age in Thailand is 60. One of the main reasons for Thailand's high participation rate is the country's long history of women employment.

which separates growth in total employment into growth in employment rate and the labor force.

Table 4. Average annual percentage changes in total employment, employment rate, and labor force by sub-period

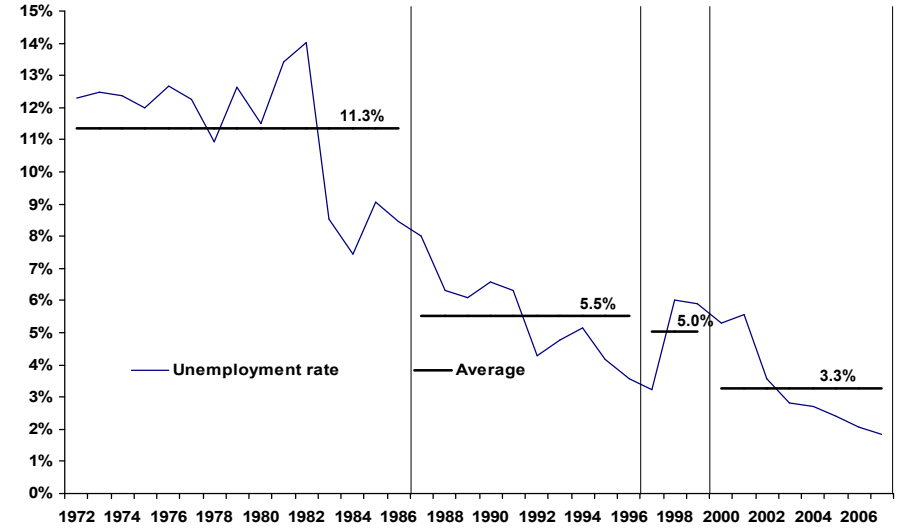
Sub-period	Total employ-ment	Employ-ment rate	Labor force
1972-1986	3.7%	0.2%	3.5%
1987-1996	2.4%	0.5%	1.9%
1997-1999	-0.1%	-0.8%	0.7%
2000-2007	2.0%	0.5%	1.5%

Note: Averages for 1972-1986 are based on data for age 11+.
Source: LFS; authors' calculation

It is worth to examine the developments of the employment rate in Thailand in more detail. This is often done by examining its counterpart, the unemployment rate. Figure 5 plots the evolution of Thailand's average annual unemployment rate (calculated as the sum of unemployed and seasonally-unemployed persons divided by the labor force) over the 1972-2007 period. A sharp break in the data occurred in 1983 when the unemployment rate suddenly fell from 14% in 1982 to 8.7%. As a result, total employment in 1983 jumped 6.5% at the time that the labor force expanded by only 0.1%. Although domestic demand accelerated that year (Bank of Thailand, 1992), it was not enough to explain the large decline in the unemployment rate. A closer inspection of the 1982 and 1983 LFS reveals major changes in survey questions particularly those related to seasonally employed status. For this reason, employment figures prior to 1983 are generally not comparable to the rest.[7] Nevertheless, assuming that real GDP growth in 1983 came entirely from labor productivity growth or using the labor force figure in place of total employment does not alter our conclusion that employment growth was the main driving force of the Thai economy during the pre-boom period.

[7] Perhaps because of this data issue, our review of the existing literature on Thailand's growth finds that most studies use the labor force figures instead of employment figures as their raw labor inputs. These studies however misleadingly use the term employment for what actually should have been referred to as the labor force.

Figure 5. Unemployment rate (include seasonal unemployment), 1972-2007



Note: Data for 1972-1986 are for age 11+. Overlapped data for years 1985-1988 shows that the switch from age 11+ to age 15+ decreased the unemployment rate by less than 0.1%.
Source: LFS; authors' calculation

From 1987 to 1996, the unemployment rate was for the most part on a decline, reflecting the robust economic expansion. The 1997 crisis reversed this downward trend. The unemployment rate nearly doubled from 3.2% in 1997 to 6.1% in 1998 as the crisis deepened. After hovering in the 5-6% range for four years, the unemployment rate dropped noticeably in 2002 as the economic recovery gained momentum. Thereafter it continued to drop, reaching a historical low of 1.8% at the end of 2007.[8] An important implication of this ultra low level of the unemployment rate is that, going forward in the medium term, employment growth will have to rely mainly on growth of the labor force. If anything, it is more likely that changes on the employment rate will exert a neutral, if not negative, impact on employment growth.

3.3 Labor productivity growth developments

The surge in labor productivity in Thailand during the boom period has been a subject of extensive studies over the past twenty years.[9] These studies differ by methodologies, factor inputs used, treatments of data, periods of study, as well as conclusions. Despite the variations, there appears to be a consensus that capital

[8] The data suggest also a permanent downward shift in the level of the natural rate of unemployment. Section 5 attributes this shift to changes in relative prices accompanying the weaker Baht that have favored labor over capital inputs.
[9] All the major studies we have reviewed do not talk about labor productivity growth explicitly, for they adopt a standard decomposition of GDP growth into contributions from TFP and factor inputs. Nevertheless, one can infer conclusions about labor productivity growth from their results.

deepening was the largest driver of labor productivity growth during this period. The disagreements lie in the relative contributions of labor quality and TFP.

The analysis in this subsection differs from previous studies in three major aspects. First, we use hours worked as raw labor input as opposed to employment in most studies. The use of hour data instead of employment data allows us to construct labor input appropriately. The downward trend in hours worked observed in Figure 4 suggests that the use of employment as a proxy for hours worked could be misleading particularly when analyses span a long period. The drawback of using hours worked however is that we can only go back to 1985 due to data constraint.

Second, we employ both growth accounting and econometric estimation methodologies in our analysis as opposed to relying on a single methodology. We have two motivations for doing this. One is to assess the sensitivity of our results to different methodologies. The other is that we would like to have a range of estimates for use in our projection of future growth.

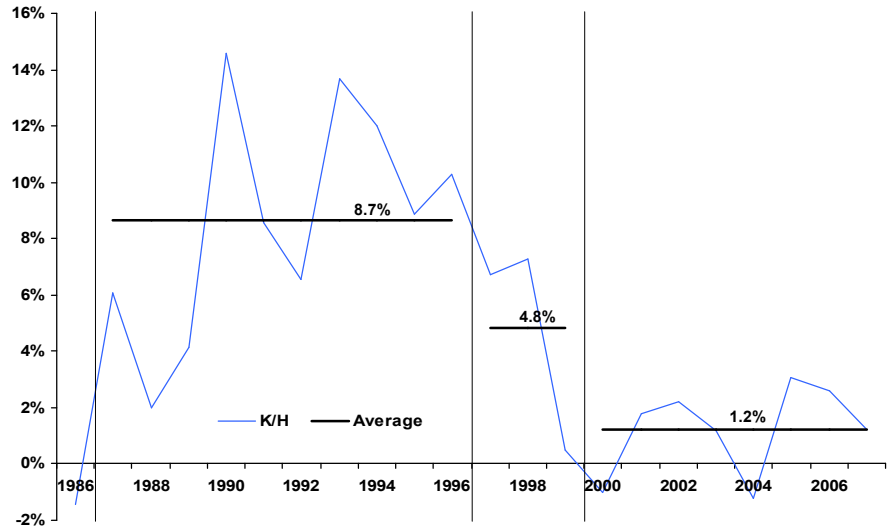
Third, we do not attempt to probe deeper into the fundamental factors behind TFP growth. Previous studies on Thailand's growth revealed determinants of TFP growth such as growth of degree of openness of the economy, growth in the share of employment in the nonagricultural sectors, and the ratio of FDI to gross fixed capital formation among others. On the other hand, a priori important factors like public investment and R&D spending were found to play no role in driving Thailand's TFP growth. Aside from the small sample size issue associated with the Thai data, we are of a view that the existing empirical literature (internationally, not just for Thailand) does not offer a unified conclusion of what drive TFP growth and therefore do not make any attempts to explain where TFP growth in Thailand came from.

We begin with capital deepening or growth in capital intensity, defined as the ratio of capital services to hours worked. The standard practice in measuring capital services calls for the use of "constant-quality" price deflators for assets whose quality rapidly change over time (Herman, 2001) and rental prices for the aggregation of different types of capital (Jorgenson and Griliches, 1996). Unfortunately, the cross-classification of capital by type and industry needed for these procedures is not available for Thailand. With this constraint, most studies on Thailand's growth resort to the NESDB estimates of the gross capital stock, the net capital stock, a weighted

composite index of the two, or depreciation as a proxy for an index of capital services in their analysis. In this paper, we follow Bosworth (2005) who argues that the use of the composite index seems most appropriate in the case of Thailand.

Figure 6 shows the rate of capital deepening in Thailand from 1986 to 2007. Although somewhat below the levels that Singapore, South Korea, and Taiwan had achieved between 1966 and 1980 (Young, 1995), the average capital deepening rate of 8.7% during the boom period was extraordinary. After the crisis, the rate of capital deepening came down precipitously.[10] The average capital deepening rate during the present-day period stood in sharp contrast with the pre-crisis figure. Without any calculation, the figure thus suggests a material role capital deepening played in bringing down Thailand's post-crisis productivity growth.

Figure 6. Capital deepening, 1986-2007



Source: NESDB; LFS; authors' calculation

The next immediate determinant of labor productivity growth is growth in labor quality, commonly defined as the ratio of quality-adjusted measure of labor input to total hours worked. To be precise, what the literature means by growth in labor quality is the difference between growth of the weighted sum of hours worked that takes into account different marginal products of different types of workers (proxied in this paper by their wage rates) and growth of the un-weighted sum of hours worked. Growth in labor quality therefore captures the effect of the changing

[10] The main culprit of this decline has been the marked slowdown in investment activities. From 1998 to 2007, the composite index of the capital stock grew in the range of 1.6% to 3.3% per year. The observed pickup in capital deepening in 1998 was due mainly to a contraction in hours worked.

composition of workers. By construction, labor quality increases when the shares of workers with higher marginal products (supposedly those with more education and experiences) increase. This means also however that labor quality tend to accelerate in recession as firms fire unskilled and low-experience workers first (the composition of the remaining workers improves). On the other hand, the influx of unskilled migrants will tend to lower labor quality. Appendix A provide specific details on how growth in labor quality is computed in this paper

Over the study period (1986-2007), our constructed index of labor quality grew at an average compound annual growth rate of 2.7% per annum. While our number fall in the high end of the estimates from earlier studies, for example, Bosworth (2005; 0.6% for 1977-2003), Sitthikul (2001; 2.8% for 1980-2000), Tinakorn and Sussangkarn (1996; 2.5% for 1977-1990), Tinakorn and Sussangkarn (1998; 2.1% for 1980-1995), and Warr (2007; 2.5% for 1980-2002), a closer inspection of the methodologies and the underlying data used by these studies finds that it is not out of line however. First, if we separate out the result of Bosworth (2005), who uses a constant exponential growth methodology as opposed to the others which employ similar weighting schemes to ours, all numbers are higher than 2.0%. Second, with the exception of Sitthikul (2001)[11], all the cited studies use employment figures instead of hours worked in the construction of their labor quality indices. That labor quality based on hours worked grew faster than labor quality based on employment figures follows directly from the fact that the shift in distribution of educational attainment has been more pronounced for hours worked than for employment during the period under study.

In adopting a different methodology for his labor quality index, Bosworth (2005) argues that estimates of labor quality growth in the range of two percent are too high relative to the estimated return to education in Thailand (Blunch, 2007). He thus assumes that each year of schooling raises the average worker's productivity by a constant 7 percent which gives rise to an annual rate of labor quality augmentation of 0.6% over the 1977-2003 period. Nevertheless, we note that improvement in labor quality includes not just pure return on education but also the changing distribution of workers. Aside from the rapid increase in their relative wage rates, the share of hours

[11] Sitthikul (2001)'s data on hours worked from 1980 to 1984 was obtained from an undisclosed source from the National Statistical Office who claimed no accountability for the accuracy of the data.

worked by post-secondary school workers in Thailand more than doubled from 6.2% in 1986 to 15.8% in 2007. (The corresponding employment shares were 9.0% and 18.0%, respectively.) While impressive, these shares are still low by international standards. On the bright side, this means that the high rate of growth in labor quality (as defined by the above definition) can probably be sustained for quite some time.

The final immediate determinant of labor productivity growth is TFP growth, computed as the residual once the other determinants are known. The size of TFP growth in Thailand during the boom period is perhaps where the largest disagreement in the literature lies. This often has to do with the estimated labor's share, whether from the growth accounting or the econometric methodologies. When the labor's share used is low, high weight is placed on the fast-growing capital intensity and little is left for TFP growth. As a general observation, studies with an estimated labor's share smaller than 0.4 often find the average TFP growth during the boom period below 1% a year.

Under the growth accounting approach, there are several ways to measure the labor's share. The naïve estimate of the labor's share is the ratio of compensation of employees either to GDP at factor costs. Such an estimate however ignores labor income of the self-employed. Previous studies of Thailand's growth have tried to deal with this underestimation by adjusting the naïve estimate upward using either the ratio of total employment to employees or imputed wage payments from the Social Accounting Matrix. Even then, in the majority of studies, the adjusted labor's shares are still less than 0.5. The problem with such low labor income shares is that internationally it is rare to find a country with an adjusted labor's share of below one half (Golin, 2002).

This paper takes a different route and adopts the calibration of labor's share from a macroeconomic perspective along the line of Cooley and Prescott (1995).[12] This is also the approach the Bank of Thailand uses in the calibration of its dynamic stochastic general equilibrium (DSGE) model. Used by many macroeconomic modelers, the Cooley-Prescott approach allocates the "ambiguous" income in the

[12] Gommes and Rupert (2004) provide further discussions of the approach. Despite its popularity among macroeconomists, the approach has a drawback that it applies only to the level of aggregate output.

national accounts to labor and capital in the same proportions they represent in the remainder of the economy.

Specifically, let *b* denote the share of labor in GDP at factor cost. Then,

Total labor income = *b**(GDP at factor cost)

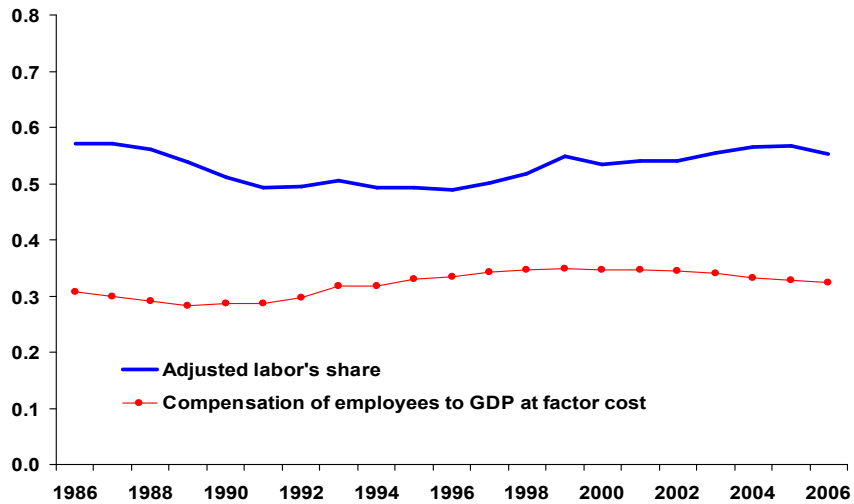
= Unambiguous labor income + *b**(Ambiguous income).

This equation can be solved for b:

$$b = \frac{\text{Unambiguous labor income}}{\text{GDP at factor cost} - \text{Ambiguous income}}$$

In Thailand's case, the ambiguous components of GDP at factor cost consist of income from unincorporated enterprises, direct taxes on corporations, interest on the public debt, interest on consumers' debt, and net factor income payments from the rest of the world. Figure 7 plots the ratio of the adjusted labor's share calculated using this method along with the unadjusted share from national income accounts from 1986-2006.[13] Over this period, the average adjusted labor share is 0.53 compared to 0.32 for the unadjusted share. It is noteworthy that while the adjusted share may be viewed as being roughly constant over the entire period and therefore consistent with one of Kaldor (1963)'s "long-run growth facts," it does exhibit some significant short-run variations. In particular, the adjusted labor's share dropped continuously during the first four years of the boom period. The crisis period then saw the labor's share steadily went back up before settling down slightly below the beginning-period level.

Figure 7. Adjusted and unadjusted labor's shares, 1986-2006



Source: NESDB; authors' calculation

[13] 2007 national income accounts data is not yet available.

Table 5 decomposes labor productivity growth during the last three sub-periods into growth of its three immediate determinants. In the absence of national income data, we assume the 2006 value for the 2007 adjusted labor's share. Note that TFP growth adds to labor productivity growth point for point and hence the last column of Table 5 also represents period-averages of TFP growth.

Table 5. Average annual labor productivity growth and contributions from capital intensity, labor quality, and TFP by sub-period

Period	Real GDP per hours growth	Capital deepening	Labor quality growth	TFP growth
1987-1996	7.4% (100%)	4.3% (57%)	1.3% (18%)	1.8% (25%)
1997-1999	-1.6%	2.4%	2.7%	-6.7%
2000-2007	3.7% (100%)	0.5% (15%)	1.2% (32%)	2.0% (53%)

Source: Authors' calculation

Table 5 confirms what have been found in virtually all previous studies on Thailand's growth. That is, capital accumulation was the main driving force behind Thailand's pre-1997 growth miracle. We note that our estimated boom-year TFP growth of 1.8% puts us among a group of researchers who find a material role of TFP growth in Thailand's modern economic developments.

It is interesting to see how the assumed values of labor's share affect the results in Table 5. It turns out that estimated TFP growth during the boom period is sensitive to the size of the assumed labor income share. Using the naïve labor's share series instead of the adjusted one, we find our estimate of boom-period TFP growth plummets from 1.8% to 0.6%. At the other end of the spectrum, when we apply an alternative approach to labor's share estimation developed by Sarel (1997)[14] which for Thailand yields labor's share estimate that is roughly constant at 0.65 over the past twenty years, the average boom-year TFP growth rate rises to 2.6%.

During the crisis years, both capital intensity and labor quality continued to register positive growth while TFP growth turned highly negative during this period. As mentioned in footnote 11, the decline in aggregate hours worked contributed to

[14] Sarel (1997) uses a panel data of ASEAN countries to estimate capital's share of nine different economic activities/sectors and constructs a country's aggregate capital's share as their weighted average. His main assumption is that the same type of activity, such as agriculture and manufacturing, requires fundamentally the same capital intensity across countries and across time.

positive capital deepening. The spike in labor quality growth was due mainly to the firing of low education and low experience workers. Among other things, the negative TFP growth picked up the effect of reduced capital utilization not taken care by our definition of capital input. Also, with output growth during this period being primarily demand determined, the residual TFP growth should be interpreted as a temporary shift in the production function rather than a decline in the rate of technological progress.

The present-day period saw the revival of Thailand's TFP growth. From 2000 to 2007, annual TFP growth averaged 2.0% per year, slightly higher than its pre-crisis average. But with capital intensity hardly growing and labor quality growth reverting back to its pre-crisis level, TFP growth has now become the largest determinant of labor productivity growth. It is noteworthy that the closeness of the average TFP growth rates during the boom and the present-day periods indicates the near-constancy of *trend* TFP growth in Thailand. It will be interesting in future research to investigate the extent to which the use of ICT investment has impacted the general efficiency of the economy.

In contrast to the boom-period TFP growth, the magnitude of TFP growth during the present-day period is rather insensitive to the assumed labor's share. With the naïve labor's share and with labor's share from the Sarel (1997) method, the estimated present-day TFP growth is also 2.0%. It is thus no surprise that more recent studies on Thailand's growth have converged to 2.0% +/- finding of present-day TFP growth despite the vast differences in the assumed labor's shares. For example, Bosworth (2005) reports Thailand's post-crisis TFP growth of 2.1.[15] Unlike our results, however, it is quite challenging for studies with low labor's shares to explain the post-crisis "jump" (a doubling or sometimes even tripling) in trend TFP growth.

We turn now to TFP growth and labor's share estimate from econometric estimation of regression equation (5). Our estimation sample runs from 1994 Q1 to 2007 Q4. Table 6 reports the estimated coefficients on labor input and capital input growth, both of which are statistically significant at the 0.5% level. It is noteworthy that although we do not constrain our regression specification for constant returns to

[15] It is important to distinguish studies that adjust for labor quality from ones that do not. For example, NESDB (2007) finds 2000-2006 average TFP growth of 2.9. If one assumes the same labor quality growth contribution in this paper and the NESDB income share, presumably the naïve income share, their TFP would come down to about 2.2.

scale, the results nicely satisfy that condition. With constant-returns-to-scale restriction, the estimated labor's share would be 0.57.

Table 6. Linear regression of GDP growth on labor input and capital input growth[16]

Variable	Coefficient	P-value
Labor input growth	0.620	0.004
Capital input growth	0.430	0.003

Source: Authors' calculation

Table 7 reports the decomposition of labor productivity growth during the present-day period. The use of quarterly data lowers average productivity growth from 3.7% to 3.5%. This discrepancy owes mainly to the fact that we use averages of the first and third quarters for the annual figures for hours worked (see Appendix A). Hence, the quarterly figure is more accurate and it is this figure that we will use in our analysis of projected potential GDP growth. In any case, the contributions from capital deepening, labor quality growth and TFP growth are on a similar scale to those reported for annual data in Table 5.

Table 7. Average annual percentage changes in labor productivity and contribution from capital intensity, labor quality, and TFP, 2000 Q1 to 2007 Q4

Period	Real GDP per hours growth	Capital deepening	Labor quality growth	TFP growth
00 Q1 – 07 Q4	3.5% (100%)	0.4% (11%)	1.1% (32%)	2.0% (57%)

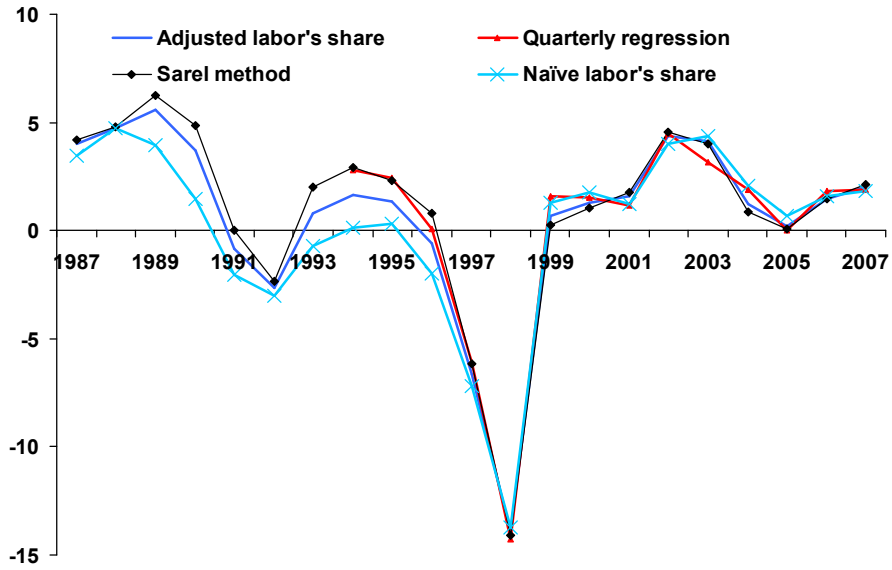
Source: Authors' calculation

Figure 8 plots the estimated annual TFP growth from econometric estimation along with those obtained from growth accounting. Although their magnitudes vary, all series moved more or less in tandem. Since both econometric estimation and the Sarel method give high values of labor's shares, they result in high estimates of TFP growth in the boom period. The figure also shows that estimated TFP growth was higher during the first three years of the boom period than the rest, a result qualitatively consistent with what have been reported in many previous studies. We note here that the timing of the surge in Thailand's TFP growth coincided with the initial wave of Japanese investment into Thailand following the post-1985 Plaza Agreement appreciation of the Japanese yen although we have no formal evidence to

[16] We ran a regression as in equation (5) with a crisis dummy variable covering the period between 1997Q3 -1999Q2 to obtain TFP growth and labor income share.

support the causality. Finally, the insensitivity of present-day-period TFP growth to the estimated labor's share is apparent. All four series appeared to track one another very closely compared the boom period.

Figure 8. TFP growth rates from econometric estimation and growth accounting



Before we leave this subsection, we would like to touch briefly on the issue of foreign or migrant workers in Thailand. These workers are not included in the Labor Force Survey. Many people believe that their presence lead to overestimation of labor productivity growth based on the LFS figure. This is certainly true for the *level* of productivity. According to the registration statistics from the Office of Foreign Worker Administration Department of the Ministry of Labor, there were 800,000 of such workers in Thailand as of April 2008. However, it is widely believed that the actual number of migrant workers ranges between 2-2.5 millions or about 7% of the labor force. Aside from their large number, the fact that the majority of these workers are from unskilled and uneducated means our calculated labor quality is also overestimated. Nevertheless, it is unclear how the inclusion of foreign workers would affect labor productivity *growth*. Only when the number of migrant workers increased at a greater rate than that of the native workers did, would our calculated rates of labor productivity growth overestimate their true values. There is virtually no time series data on migrant worker trend to objectively assess the impact of foreign workers on labor productivity growth. Nevertheless, it should be kept in mind that the 2.5-million migrant workers did not show up overnight, but was the result of a long process that went back to the beginning of the boom period. Finally, a simple calculation shows that even if there was an acceleration of migrant workers in recent

years, true labor productivity growth is expected not to differ significantly from our reported figures.

Specifically, growth of true labor productivity between period *t-1* and *t* is simply $\left(\frac{Y_t}{Y_{t-1}}\right)\left(\frac{E_{t-1}+E'_{t-1}}{E_t+E'_t}\right)-1$, where Y is real GDP, E is native employment, and E' is migrant employment. Here, productivity is defined in terms of employment for ease of exposition. Let $E_t = E_{t-1}\cdot(1+\Delta E_t)$ and $E'_t = E'_{t-1}(1+\Delta E_t)$. Then, one can rewrite growth in labor productivity as

$$\left(\frac{Y_t}{Y_{t-1}}\right)\cdot\frac{1}{(1+\Delta E_t)+\frac{E'_{t-1}}{E_{t-1}+E'_{t-1}}(\Delta E'_t-\Delta E_t)}.$$

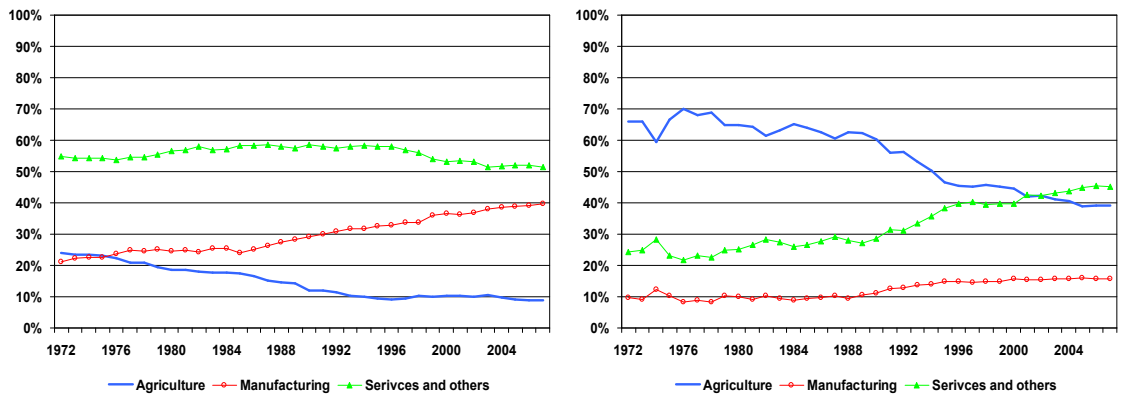
Suppose native employment in 2008 grows by 2% (its present-day period average) and migrant employment by 8% (equivalent to 200,000 additional workers in one year!), then the 2008 productivity growth rate including migrant employment will be approximately 0.07*(8%-2%) = 0.4% less than the native-only productivity growth figure.

3.4 Sectoral perspective

This subsection analyzes Thailand's past growth developments at the sectoral level. Over the past thirty years, the Thai economy has undergone quite a structural transformation. Figure 9 vividly illustrates the evolution of sector shares of aggregate economy and employment for agriculture, manufacturing, and services and others (construction, mining, public administration, wholesale and retail trade, etc.) from 1972 to 2007.

Figure 9. Sector shares of aggregate economy, 1972-2007

a. Real GDP shares **b. Employment shares**

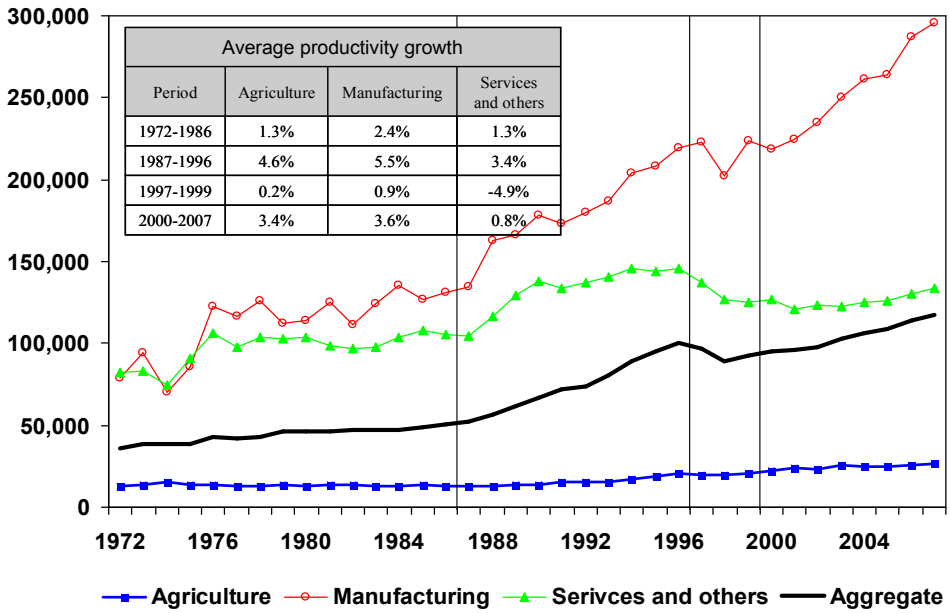


Source: NESDB; LFS; authors' calculation

In 1972, agriculture accounted for approximately one-fourth of Thailand's real GDP. A marginally smaller share was occupied by manufacturing while services and others took up the rest. Over the next twenty years, agriculture's share of GDP steadily dropped to slightly below 10% in 1993 where it has hovered around since. Filling in the gap was the manufacturing sector whose share of real GDP has risen to 40% in 2007. On the employment side, Thailand is no longer an agricultural society where more than two-thirds of workers used to be in the sector. The majority of workers are now in the service sector. The rise in service employment was actually faster than manufacturing employment despite its larger base. It is noteworthy that compared to the changes in GDP shares, the shifts in employment shares have been a relatively recent phenomenon, starting only in 1990.

Figure 10 traces labor productivity (per employment) of agriculture, manufacturing, and services and others from 1972 and 2007. Also reported in Figure 10 is the average annual labor productivity growth of the three sectors in the four sub-periods. Of the three sectors, manufacturing consistently displayed the highest labor productivity growth while services and others displayed the lowest. Consequently, the productivity gap between the two sectors has widened markedly. Meanwhile, because of its small base, agricultural productivity remained the lowest of the three despite its respectable growth.

Figure 10. Sectoral productivity (real GDP at 1988 prices per employed persons), 1972-2007



Average productivity growth

Period	Agriculture	Manufacturing	Services and others
1972-1986	1.3%	2.4%	1.3%
1987-1996	4.6%	5.5%	3.4%
1997-1999	0.2%	0.9%	-4.9%
2000-2007	3.4%	3.6%	0.8%

Source: NESDB; LFS; authors' calculation

The surge in labor productivity growth during the 1987-1996 period was evident in all three sectors although there are some underlying differences. All sectors benefited from increases in the capital input with manufacturing being the largest beneficiary. On the other hand, a significant portion of productivity gain in agriculture during this period was due to the fact that employment had been growing at a much smaller rate than output, however. Finally, services and others experienced the largest improvement in educational attainment of its workforce.

The 1997 economic crisis hit the Thai economy extremely hard. None of the three sectors was spared from real output losses, not even agriculture which was supposedly the most immune.[17] All three sectors saw a sharp slowdown in their labor productivity growth, but the largest toll was on services and others whose productivity growth turned negative.

It took a couple years for agriculture and manufacturing to rebound. Both agriculture and manufacturing posted solid numbers for average labor productivity growth in the present-day period. While lower than their boom-year averages, these numbers compared favorably to their pre-boom figures. In contrast, productivity in services and others registered the lowest average growth rate in the three non-crisis periods. As a matter of fact, productivity level of services and others hardly recovered from their 1998 level. Although real GDP growth of services and others averaged 4.4% per annum between 2000 and 2007, it was a disappointment in light of the continued increase in its workforce.

The sub-par performance of services and others during the present-day period reflects the export-led nature of Thailand's economic recovery. The sector is largely oriented towards the domestic economy as opposed to the manufacturing sector whose large portion of output is destined to export markets. While manufacturing saw their productivity level skyrocketed, services and others suffered a prolonged productivity slump. It was not until 2004 that services and others began to see a pickup in their labor productivity. To put some numbers in perspective, the average labor productivity growth of services and others during the last four years (2004-2007) of

[17] At a more detailed industry level, only three sectors– public administration, education, health and social work (altogether about 7% of total GDP) – experienced increases in real output throughout the crisis period.

the present-day period was 2.1% compared to -0.4% during the first four years (2000-2003).

To assess the effect of structural change on the economy's overall productivity growth, we decompose aggregate labor productivity growth into growth coming from productivity growth in individual sectors and growth coming from the reallocation of resources among sectors with differing labor productivity. In particular, it can be shown that

$$\dot{Q}/Q = \sum_i s_i \cdot (\dot{Q}_i/Q) + \sum_i r_i \cdot \left(\frac{p_i Q_i}{pQ} - 1 \right) \cdot (\dot{L}_i/L_i - \dot{L}/L), \qquad (6)$$

where a dot over a variable denotes differentiation with respect to time, the subscript i denotes sector i, Q is labor productivity, L is the number of employed persons, p is GDP deflator, s_i is the share of sector i in *nominal* GDP, and r_i is the employment share of sector i. The first term on the right-hand side is the "within effect" or the contribution of productivity growth within sectors. The second term is the "reallocation effect." It is positive if employment is shifting towards sectors with a high *level* of labor productivity. Oulton and Srinivasan (2005) provide details.

Equation (6) holds exactly in continuous time. For discrete time approximation, we simply take the reallocation effect as the difference between aggregate labor productivity growth and the nominal-GDP-weighted sum of sector labor productivity growth rates. Table 9 reports the results of this decomposition.

Table 9. Average contributions to labor productivity growth (per employed person) of different sectors by sub-period

Period	Agriculture	Manufacturing	Services and others	Reallocation	Total
1972-1986	0.3%	0.5%	0.7%	1.2%	2.7%
1987-1996	0.5%	1.5%	2.0%	3.0%	7.0%
1997-1999	0.0%	0.3%	-3.0%	0.2%	-2.5%
2000-2007	0.3%	1.2%	0.5%	1.0%	3.0%

Source: Authors' calculation

Prior to the present-day period, services and others contributed the most to aggregate labor productivity growth in both good and bad ways due to their large share of value added. Over the last eight years, manufacturing has taken the leading role away from services and others. This owes to the fact that manufacturing share of GDP is now only a distant behind services and others while its labor productivity growth has been much higher.

As would be expected from Figure 9b, the reallocation effect was very strong during the boom period, accounting for nearly a half of aggregate labor productivity growth. That is, the largest portion of labor productivity improvement this period was due to migration of workers from low-productivity agriculture to higher-productivity manufacturing and services and others. The positive reallocation effect continued into the present-day period at the rate comparable to the pre-boom period. Given the large proportion of aggregate employment still remains in agriculture, we expect the reallocation effect to continue to provide support to Thailand's overall labor productivity growth in a foreseeable future.

4. Long-term potential growth projections, 2008-2035

This section presents our projections of Thailand's potential growth of real GDP over the next three decades based on underlying projections of growth in hours worked and trend labor productivity growth. We split our projection timeframe into three sub-periods: 2008-2015, 2016-2025, and 2026 -2035 to highlight the impact of demographic changes. The use of eight to ten years for the length of sub-periods is to abstract from business cycle fluctuations. Thus, the resulting projected growth rates should be thought as average levels around which actual output growth will fluctuate in each sub-period if the economy is to grow at its potential.

4.1 Total hours worked projection

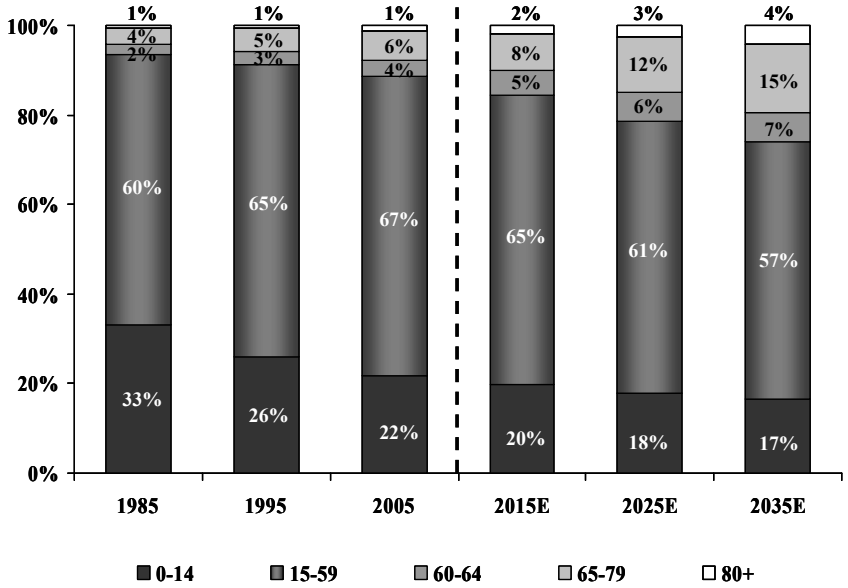
The growth rate of total hours worked captures the impact of changes in demographic structure as Thailand moves towards aging population. Recall from Section 2 that hours worked can be decomposed into four parts: hours worked per employment, the employment rate, the labor force participation rate and the working-age population. Projections of these four variables are required to forecast total hours worked. For the rest of this section, we focus on how these variables are forecasted and combine them to project the growth rate of total hours worked going forward.

We split working-age population into 4 subgroups: 15-59, 60- 64, 65-79 and 80+ age groups. Unlike most countries, Thailand's official retirement age is 60 rather than 65. As will be discussed in Section 5, an increase of the official retirement age is one possible and concrete measure to raise Thailand's future potential growth. To obtain a projection of total hours worked, we use the formula:

$$H_t = \sum_j \left(\frac{H}{E}\right)_{j,t} \left(\frac{E}{LF}\right)_{j,t} \left(\frac{LF}{WA}\right)_{j,t} WA_{j,t}, \quad (7)$$

where the subscript j denotes the j^{th} age group. H/E is average hours worked per employed person, E/LF is the employment rate, LF/WA is the labor force participation rate, and WA is the number of people in each age group.

Figure 11. Proportion of Thailand's population in different age groups



Source: NSO (1985-2005); United Nations' World Population Prospects: The 2006 Revision Population Database (2015E-2035E)

Figure 11 shows both the historical and the projected distributions of Thailand's total population from 1985 to 2035. The projected population is taken from the United Nations' World Population Prospects database. The end of the demographic dividend of the baby boom generation is evident when one compares the proportion of age 15-59 in total population between 2005 (its peak year) and 2015. The figure also highlights the continuing growth in the proportion of older people. In particular, the proportion of those aged 65 and over is projected to reach 19% in 2035, up from 7% in 2005. A direct implication of this ageing demographic trend is a downward pressure on future growth in hours worked. Intuitively, total hours worked decline as the population composes of more and more older people for two reasons: older people work fewer hours per week and older people participate less in the labor force.

Using historical *quarterly* data from the labor force survey, we assume the following:

1. Average hours worked per employed person (*H/E*) for each subgroup equals the 2001-2007 average. This gives 48.1 hours per week, 44.3 hours per week, 41.6 hours per week and 39.2 hours per week for 15-59, 60- 64, 65-79 and 80+ age groups, respectively.

2. The employment rate (*E/LF*) for each subgroup equals the 2001-2007 average. This implies ratios of 0.969, 0.984, 0.989 and 0.991 for 15-59, 60-64, 65-79 and 80+ age groups, respectively. In principle, one would need here estimates of the non-accelerating-inflation rate of unemployment (NAIRU) for each age group. This is a rather formidable task given past data behavior particularly for the first two age groups. While the unemployment rates of the 65-79 and the 80+ age groups have been relatively stable over the past fifteen years, the unemployment rates of the 15-59 and the 60-64 age groups very much paralleled the patterns observed in Figure 5, i.e., there appeared to be a significant shift in the natural unemployment rates for these two subgroups. With this consideration, we decide to use the average unemployment rates during the past seven years as our best guess of their NAIRUs.

3. The labor force participation rates (*LF/WA*) for the 15-59 and the 60-64 age group are 0.78 and 0.58, respectively (both used 2001-2007 average). For age group 65-79, we used the 2003- 2007 average ratio of 0.32 as there seemed to be a new trend of labor force participation established since 2003. For age group above 80 however, the labor force participation ratio rose from 0.02 in 1999 to 0.05 and 0.08 in 2003 and 2007, respectively. This rise most likely reflects better health conditions of older people. Using a linear trend on yearly data during 2000-2007 suggests an increasing trend of 0.0072 per year. With this finding, we assume the labor force participation ratio for this age group to continue rising linearly to 0.10, 0.14, 0.17, 0.21 and 0.25 for the year 2010, 2015, 2020, 2025, and 2030, respectively, and cap it at 0.25 thereafter. This cap is meant to be consistent with the observation that older people participate less in the labor force, hence the projected participation ratio for the 80+ age group must be lower than that of the 65-79 age group.

Combining these assumptions with the U.N. population forecasts, we arrive at the average annual growth rates in total hours worked of 0.5%, 0.1%, and -0.2% for 2008-2015, 2016-2025, and 2026-2035, respectively. Among other things, these

numbers imply that Thailand's future growth will have to increasingly rely on labor productivity growth, to which we now turn.

4.2 Labor productivity projections

Our projections of Thailand's future labor productivity growth are based on three different scenarios. The first scenario – "present-day-period trend" – uses the average labor productivity growth rate during 2000-2007 as trend productivity growth going forward. The second scenario – "augmented-present-day-period trend" – adds on top of the first an extra productivity growth contribution from services and others. The third scenario – "balanced growth path" – imposes the condition that output and the capital stock will grow on average at the same rate. All scenarios assume a constant rate of trend labor productivity growth over the projection timeframe, a very strong assumption that may be challenged particularly for the last two sub-periods. Nevertheless, we feel that the best way to highlight the macroeconomic impact of demographic changes is to hold constant projected labor productivity growth. Moreover, we believe that our use of different scenarios yields a projection range that is wide enough for actual future productivity growth to remain within it.

In the first scenario, we simply assume that productivity growth equals to its present-day average. We use quarterly data which gives a more accurate number for productivity growth than the annual data. This gives us projected trend productivity growth of 3.5%. As it turns out, this will be the lower bound of our projection for Thailand's trend productivity growth.

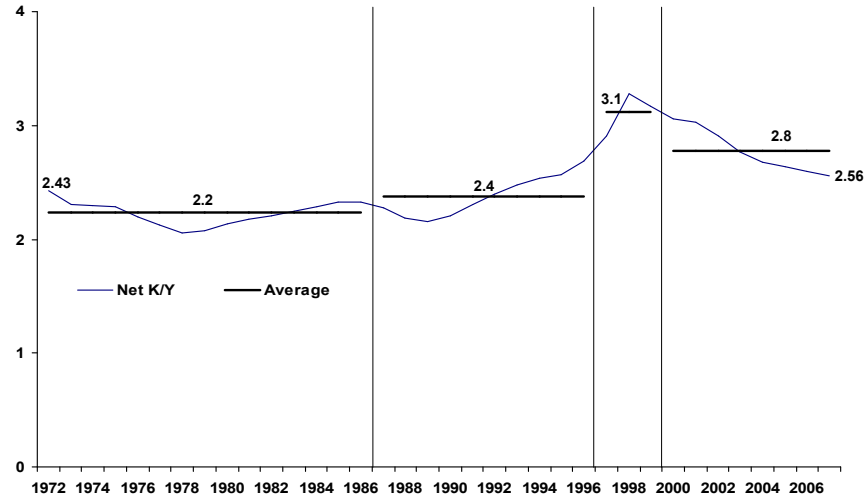
The second scenario takes into account our observation in Section 3.3 that labor productivity growth of services and others differed noticeably in the first and the second half of the present-day period. Hence, using the average labor productivity number which includes below-average performance of services and others is likely to understate future trend productivity growth. To correct for the late recovery of services, we add 0.6% on top of the present-day average productivity growth rate for an augmented trend productivity growth rate of 4.1%. The number 0.6% comes from our observation that average productivity growth of services and others in the second half of the present-day period was about 1.2% higher than its average during the entire period. Multiply this number by services and others' nominal GDP share of 51% yields the sector's extra contribution to aggregate labor productivity growth.

If one also takes labor quality growth and TFP growth to be constant at their present-day (quarterly data) averages of 1.9% and 2.0% per annum throughout the entire projection period, then both the first and the second scenarios imply a falling capital-to-output ratio. To see this, note that we can rewrite equation (4) as

$$\Delta \ln (Y_t / H_t) = \Delta \ln A_t + \bar{a}_t \cdot \Delta \ln (K_t / H_t) + (1 - \bar{a}_t) \cdot \Delta \ln LQ_t . \qquad (7)$$

Assuming further a constant labor's share of 0.6, then the implied rate of capital deepening equals 0.9% in the first scenario and 2.4% in the second scenario. These capital deepening rates correspond respectively to output-capital growth differentials of 2.6% and 1.7% per year. With the rate of growth of the capital stock below the rate of output growth, the capital-to-output ratio must fall. This is exactly what has happened in Thailand since 1999 (Figure 12). Given the above output-capital growth differentials and the ratio of net capital stock to GDP of 2.6 at the end of 2007, the net capital stock-to-GDP ratio will fall to 1.2 and 1.6 at the end of 2035, respectively.[18] Hence, we view the first two scenarios as less likely than our next scenario.

Figure 12. Real net capital stock to real GDP, 1972-2007



Source: NESDB; authors' calculation

Our third scenario imposes a condition that output and the capital stock will hereafter grow on average at the same rate. This scenario thus corresponds to what the academic literature refers to as a balanced growth path. The use of the balanced-growth-path assumption for potential GDP growth projection goes back to Jorgenson,

[18] We note that this conclusion rests on the assumption that TFP growth remains at 2.0% indefinitely. As will be discussed, the assumption of sustained high TFP growth in the face of low capital investment is unrealistic. At some point, TFP growth must fall. With falling TFP growth, constant labor productivity growth of 3.5% and 4.1% may *still* be consistent with balanced growth paths albeit the undesirable ones. See Section 5 for more details.

Ho, and Stiroh (2002) in their projections of trend output and labor productivity growth of the U.S. For an update of their projections, see Jorgenson, Ho, and Stiroh (2007). A look at Figure 12 reveals that this assumption is not unreasonable. For a period of twenty years from 1972 to 1992, the Thai economy could be characterized as evolving along a balanced growth path with the mean capital-to-output ratio of 2.3. What happened thereafter could then be thought of as the buildup of excess and reversion to the mean. Furthermore, the flattening slope towards the end of the graph suggests that the new steady state may soon be reached, if not already. Taking into account the past behavior of the capital-to-output ratio and the structural change the economy has undergone, we think it is very unlikely that the new steady state will be below 2.5.

Plugging $\Delta \ln Y_t = \Delta \ln K_t$ into equation (7) and rearranging yields

$$\Delta \ln (Y_t / H_t) = \frac{\Delta \ln A_t}{(1 - \bar{a}_t)} + \Delta \ln LQ_t \,. \tag{8}$$

In plain language, balanced-growth-path labor productivity growth equals the sum of TFP growth divided by the labor's share and labor quality growth.

As with the first two scenarios, we assume constant labor quality growth of 1.9% and TFP growth of 2.0% (both 2000-2007 averages from quarterly data). While it may be argued that the rate of education attainment will slow down as the concentration of people with post-secondary school education increases, the accelerating ageing trend of the population works in the opposite way.[19] While we cannot pinpoint exactly which force will predominate (for that we need forecasts of future wages), assuming that the two forces completely offset each others is not an unreasonable assumption

In contrast, the assumption of constant 2.0% trend TFP growth going forward is more difficult to defend.[20] Nevertheless, we note that the result of our growth accounting exercise with the adjusted labor's share shows that, at least for the past twenty years excluding the crisis period, assuming unchanged *trend* TFP growth of this magnitude would not be too far from the truth.

[19] By construction, labor quality depends on age and education.
[20] Forecasting TFP growth is beyond the scope of this paper.

From equation (8), the other key assumption for the calculation of labor productivity growth is the labor's share. To allow for uncertainty in labor's share estimation, we compute balanced-growth-path labor productivity growth under three different cases: adjusted labor's share (Cooley-Prescott method), Sarel method, and direct econometric estimation, all of which incidentally yield the same 2000-2007 average TFP growth of 2.0%. For the first two methods, we use their estimated 2000-2007 average labor's shares. For the case of direct econometric estimation, we use a modified version of equation (8) to allow for the difference between elasticity estimates and the factor income shares. Table 10 reports the results of these calculations along with trend productivity growth under the first two scenarios. Note that we disregard the case of naïve labor's share totally, for it yields highly improbable labor productivity growth of 8.1%.

Table 10. Projected labor productivity growth rates under different scenarios

Scenario	Projected labor productivity growth (per hours worked)
Present-day-period trend	3.5%
Augmented-present-day-period trend	4.0%
Balanced growth paths (all with TFP growth = 2.0%)	
Growth accounting: Cooley and Prescott method (labor's share = 0.55)	5.5% (= 3.6%+1.9%)
Growth accounting: Sarel method (labor's share = 0.65)	5.0% (=3.1%+1.9%)
Econometric estimation (α = 0.43, β = 0.62)	5.6% (=3.5%+2.1%)

Source: Authors' calculation

4.3 Real GDP growth projections

From equation (1), real GDP growth can be computed as the sum of productivity growth and the growth rate of total hours worked.[21] Putting all this together, our forecasts of various growth rates can be summarized in Table 11.

[21] To be precise, GDP growth = $\left[\left\{\left(1+\frac{\text{productivity growth}}{100}\right)\left(1+\frac{\text{total working hours growth}}{100}\right)\right\}-1\right]*100$

Table 11. Projections summary

Average annual growth rate	00Q1-07Q4	2008-2015E	2016-2025E	2026-2035E
Total hours worked	1.4%	0.5%	0.1%	-0.2%
Labor productivity	3.5%	3.5%-5.6%	3.5%-5.6%	3.5-5.6%
Real GDP **(balanced growth paths only)**	5.0%	4.0%-6.1% **(5.5%-6.1%)**	3.6%-5.7% **(5.1%-5.7%)**	3.3-5.4% **(4.8%-5.4%)**
Population	0.8%	0.6%	0.3%	0.1%
Real GDP per capita	4.2%	3.4%-5.5%	3.3%-5.4%	3.2%-5.2%

Source: Authors' calculation

The key result here is that going forward the growth rate of total hours worked will be much lower than the present-day period and eventually dampen real GDP growth as it turns negative from the year 2026. The impact of the reduction in growth of hours worked will be felt most hardly during the first sub-period where the contribution to growth from hours worked will be reduced by nearly a percentage point. Furthermore, the lower the projected productivity trend, the worse will be the relative impact of reduced growth in hours worked.

Incidentally, the lower bound of the balance growth path scenario (which we view as more likely than the two simple trend scenarios) of 5.5% is the same as the average growth rate for the Thai economy between 2002 and 2007. The key difference is that to achieve the same growth rate for 2008-2015, an additional contribution of one-and-a-half percentage points from labor productivity growth is needed.

5. Policy implications

The previous section shows that, though unlikely, Thailand's potential growth rate could drop to as low as 3.3% in the next 20 years. GDP per capita growth depicts the same story, implying deterioration in the growth rate of standard of living.[22] In this section, we examine some possible measures to increase Thailand's long-term potential GDP growth, thereby raising the economy's speed limit. Both aspects of promoting total hours and labor productivity are considered.

While it is difficult to encourage workers to work more hours per week without giving them a higher compensation (e.g. increase over-time rate) and the idea

[22] The growth rate of GDP per capita would however pick up after the year 2035 as the population growth turn negative.

of encouraging old people to participate more in the labor force seems illogical, there are a few measures which can mitigate the problem of declining total hours worked.

1. Attract talented foreign workers The effect of attracting talented foreign workers is twofold: it increases total hours worked and improve labor productivity through labor quality channel. Moreover, these foreign workers are likely to create spillover effects by improving the skills of domestic workers. Unskilled foreign workers would also help in terms of man hours but could worsen the inequality problem by suppressing wage rate of the unskilled group in addition to exerting negative impacts on labor quality. Given the AEC Blueprint's objective of free flow of skilled labor among ASEAN countries by 2015, creating appropriate incentive schemes to attract talented foreign workers while retaining domestic ones is therefore something Thailand needs to think about.

2. Lower the natural rate of unemployment Another way to increase total hours worked is to raise the employment rate or equivalently by lowering the natural rate of unemployment which can be done by having a more flexible labor market. In the past, Thai labor was very mobile across agricultural and non-agricultural sector. Indeed during the 1997 crisis, many went back to work in the agricultural sector and the unemployment rate (including seasonal unemployed) only peaked at 6.1% in 1998. Preserving this characteristic of labor mobility is vital while the government should try hard to compromise the strength of labor union, the level of minimum wage and unemployment benefits appropriately.

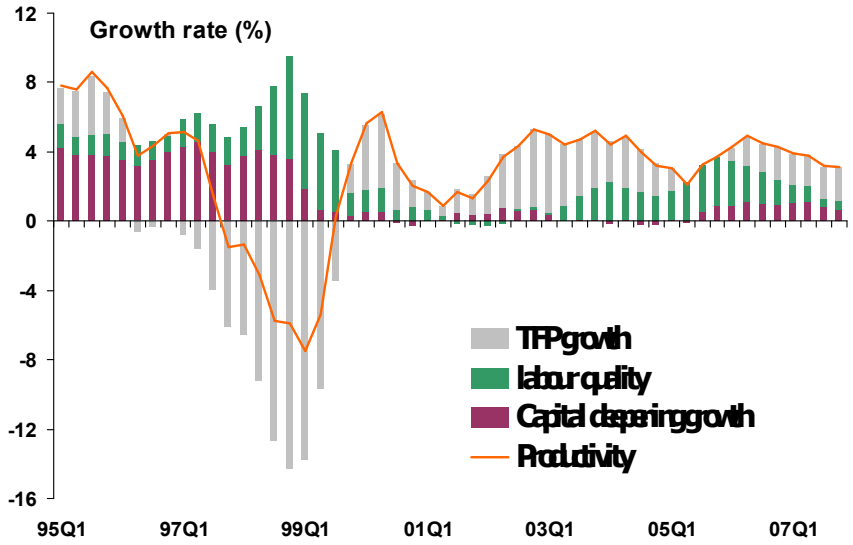
3. Increase the retirement age from 60 to 65 By extending the retirement age, we immediately raise the overall labor force participation and hence total hours worked of the economy. However, this only creates a one time increase in the growth rate of hours worked. Indeed, if we assume a participation ratio for the 60-64 age group of 0.76 (equals the 2001-2007 averages for the 55-59 age group) rather than 0.58 and the same average working hours from 2008 onwards, we get an immediate boost of 0.2% to real GDP growth.

Nevertheless, these solutions have their own limitations. Let alone the difficulty of devising an incentive system that would attract talented foreign workers, talented workers are in general few in number and costly. Lowering the natural rate of unemployment and enforcing a higher retirement age are also limited and only

create a one-time effect. Moreover, our projection of hours worked implies a natural rate of unemployment of around 3% which is already low compares to other countries. Clearly, the solution to increase total hours worked is difficult and unsustainable. We therefore turn for an alternative solution: enhancing labor productivity growth.

4. Increase labor productivity Recall from equation (3) that labor productivity comprises three immediate components. These are TFP, labor quality and capital intensity. Using the data behind the calculation in Table 7, Figure 13 traces the (four-quarter-moving-average) contribution to productivity growth from the three components from 1995 Q1 to 2007 Q4.

Figure 13. Four-quarter-moving-average contributions to productivity growth



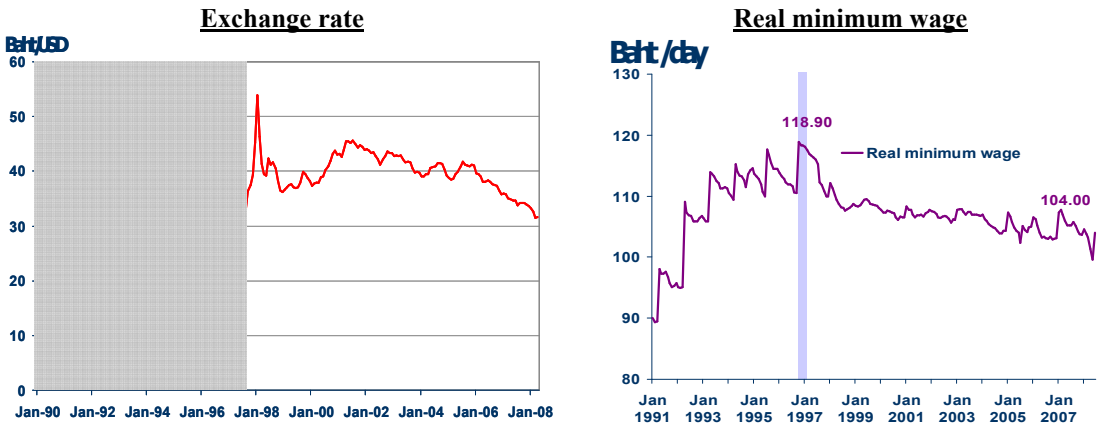
Source: Authors' calculation

One remarkable difference in the pre- and post-crisis contributions to productivity growth which we have already mentioned but made even more visible in Figure 13 lies in the capital deepening component and requires a particular attention. On average, the pre-crisis contribution of capital deepening was as high as 4.1% but dropped sharply afterward to a mere 0.4% in the present-day period. Although the pre-crisis level capital deepening is universally considered to be too high (over-investment) and eventually burst into an economic bubble, one cannot deny that its present-day contribution of 0.4% is far too low.

There are numerous reasons for the dry up of Thailand's post-crisis investment spending including most notably a correction of the past excess. Here,

however, we would like to speculate on one structural cause that not many people have talked about. That is firms' incentive to shift factor of production away from capital input as a result of the exchange rate depreciation. The shift towards labor input is evidenced from the post-crisis increase in the adjusted labor's share. Before the crisis, the Baht was peg to a basket of currencies which came to at about 25 Baht/USD. This made importation of capital goods relatively cheap compared to the post-crisis period during which the exchange rate depreciated and stabilized at around 40 Baht/USD. Thus, the cost of imported capital rose almost by twofold. On the other hand, Thai labor became relatively cheap. This is reflected by a falling trend of real minimum wage after the crisis. Minimum wage acts as a benchmark for wage setting; a falling trend thereby reflects a weakening bargaining power of employee. The bargaining power, especially in the low-skill group, also weakened further by immigrants of foreign worker from neighboring countries such as Laos, Burma and Vietnam. This also provides a potential explanation the unemployment rate falls continuously as the natural rate of unemployment shift downwards.

Figure 14. Exchange rate movements and real minimum wage, 1991-2008



Source: Bank of Thailand, Ministry of Labor, author's calculation.

Regardless of its underlying causes, Thailand's current gross investment rate is inconsistent with the economy's supply-side potential the balance-growth-path scenarios in Table 11 where real GDP and the net capital stock are both projected to grow on average between 5.5% (low) and 6.1% (high) over the next 8 years. A simple way to find the matching investment rate required for sustainable growth under a balance growth path is to apply the following steady-state relationship:

$$\left(\frac{I_t}{Y_t}\right)_{SS} = \left(\frac{K_{t+1} - K_t}{K_t}\right)_{SS}\left(\frac{K_t}{Y_t}\right)_{SS} + \mathrm{d}_{SS}\left(\frac{K_t}{Y_t}\right)_{SS}, \qquad (9)$$

where *SS* denotes steady-state values, *I* is real gross investment, *Y* is real output, *K* is the real net capital stock, and δ is the capital depreciation rate. Using 2.6 as the steady-state capital-to-output ratio and the present-day-period average annual depreciation rate of 5.3%, the gross investment rate for 5.5% potential growth is 28.1%. For 6.1% potential growth, the matching investment rate is 29.6%. (Using 2.5 as the steady-state capital-to-output ratio, the corresponding investment rates are 27.5% and 28.5%, respectively). These numbers are clearly below the 1972-1996 average gross investment rate of 31% and the optimal gross investment rate of 31%-32% for Thailand reported by Mallikamas et al. (2003)[23] but are still way above the 22% rate the economy achieved in 2007.

Thus, to increase labor productivity growth to the level consistent with the economy's supply-side potential, the resuscitation of capital accumulation is a must. Despite the sizable gap between the current investment rate and the implied steady-state investment rates, we note that closing the gap by the end of 2015 and hence achieving potential growth under the above balance growth paths is not out of reach. Going from 22% of GDP in 2007 to 28% of GDP in 2015 requires an incremental increase in this ratio of about 0.8% on average over the next eight years. Given Thailand's past growth record, this is certainly achievable. For example, gross investment rate rose from 22% in 1973 to 30% in 1980 and from 28% in 1982 to 34% in 1989 (See also Figure 12). We note that both of these periods were before anyone has heard of the term overinvestment and the first period included also the first oil shock. More recently, in the span of three years between 2002 and 2005, the gross investment rate rose from 20% to 23%, the positive trend that was unfortunately set back by domestic political uncertainty over the last couple years.

Being cautiously optimistic, we warn what will happen if Thailand fails to increase its investment rate. Most likely, the assumption of sustained high TFP growth of 2.0% will not hold. While more investment may not lead to higher TFP, sub-optimal level of capital stock relative to the aggregate economy is inconsistent with a sustained high level of TFP growth. Intuitively, failure to add new investment to keep up with an expanding economy will leave us with old and outdated machineries and equipments which will eventually slow down the rate of

[23] Mallikamas et al. (2003) only report the optimal private investment rate of 25-26%. We add on top of that the average public investment rate of 6%.

technological progress. In that case, Thailand could still be able to grow sustainably (i.e., consistent with a balanced growth path). But the balanced growth path under reduced TFP growth will be a different one from the 5.5%-6.1% path reported in Table 11.

For concreteness, let trend TFP growth slow to 1.4% (average TFP growth for the U.S, private business for 2000-2007; BLS, 2008), and the constant labor's share be 0.6, then the economy's potential growth under this new balance-growth-path will be 1.4/0.6 + 1.9 + 0.5% = 4.7%. A lower trend TFP growth would imply an even lower long-term potential growth. For example, the 4.0% growth in scenario one and the 4.5% growth in scenario two are consistent with constant trend TFP growth of 1.0% and 1.2%, respectively. This is clearly undesirable if Thailand wants to move to the status of an upper middle income country.

One way to counteract the force of structural change that favors labor over capital is to strengthening the bargaining power of employee to make labor more expensive relative to capital. This however would come at a cost of a higher natural rate of unemployment (lower employment rate) which conflicts our objective of raising potential GDP growth. The Thai government must therefore instead implement other incentive measures such as relaxing import tax on capital goods to promote importation of capital. Meanwhile, the apparent trend of weakening dollar since 2006 is a good opportunities for Thai firms to upgrade their machineries and equipment through imports. Finally, given the current unfavorable external environment, the government will have to take lead in resuscitating gross investment both directly and by stimulating the private sector to do so.

Aside from resuscitating capital accumulation, measures to sustain high TFP and labor quality growth are also essential. Possible measures include, for example, measures which remove infrastructure bottlenecks, deepen financial market, improve educational system, create tax incentive to induce people to attain higher education, increase institutional quality along with creating a more competitive environment, all of which would help promote healthy labor productivity.

6. Concluding remarks

Since the beginning of the boom period in 1987, a major driver of the Thai economy has been labor productivity growth, both in positive and negative ways. This stands in contrast with the earlier period where GDP growth was driven mainly by employment growth. With the ageing population, the role of labor productivity growth will be increasingly more important going forward. We point out that enhancement in productivity growth is the key to maintain Thailand's high growth rate and much more favorable than trying to squeeze out more hours from the aging population.

Our analysis of the immediate determinants of labor productivity growth reveals the hefty role of capital deepening in Thailand's productivity surge during the boom period (1987-1996). However, we also find a sizable contribution from TFP growth whether we use growth accounting or econometric estimation methodologies.

Our forward-looking analysis reveals Thailand's sustainable growth rates in the range of 5.5%-6.1% for the 2008-2015 period. These growth rates require however a matching gross investment rate of 28%-30% of GDP. Although the required investment is substantially below the 2007 level of 22%, closing this gap is achievable given Thailand's past investment records. Yet the failure to do so will likely put the economy's potential growth on a permanently lower path.

Appendix A. Data and estimation labor quality

GDP and capital input data

GDP and capital stock data are taken from the national account which is provided by the National Economic and Social Development Board (NESDB). For capital input, we follow Bosworth (2005) who argues that the use of the composite index seems most appropriate for Thailand. This composite index gives 75% and 25% weights to gross capital stock and net capital stock, respectively. While capital stock data is only available on an annual basis, quarterly data of capital input are constructed linearly for econometric analysis.

Total hours worked and employment data

Data on employment and hours worked are taken from the Labor Force Survey (LFS) which is provided by the National Statistical Office (NSO). Most of the LFS were carried out only in the first and third quarter of the year. A complete four-round survey providing four quarterly data a year did not start until 1998. Moreover, the survey underwent a major revision in 2001. While we did our best to ensure maximum quality of the data, it is important to take note of the following:

1. Labor force population increases from 11+ to 13+ and 15+ in 1995 and 2001, respectively.
2. Employment data starts from 1971 but it seemed that the definition of seasonal unemployment, out of labor force and labor force wasn't consistent until 1983.
3. Reliable data on hours worked starts from 1985. However, since the major revision in 2001, total hours worked structurally shifted downward. The series did not reconcile even when we trace back the total hours with a new labor force population. Nevertheless, employment data didn't appear to be affected, we therefore use elasticity relationship of employment and hours to obtain a pointed estimate in the first quarter of 2001. From this new pointed estimate, which is now higher than the actual data, we preserve its quarter-on-quarter growth characteristic and construct a new series. All analysis with hours worked are base on this constructed series.
4. For annual analysis, we use the average of the first and third quarter through all periods for consistency.
5. For quarterly analysis, we use LFS data between 1993 and 2007. As a complete set of four quarters survey only available since 1998, we estimated 8 missing data (1993Q2, 1993Q4, 1994Q4, 1995Q2, 1995Q4, 1996Q4, 1997Q2 and 1997Q4). For data with a clear seasonal pattern, we simply averaged the percentage difference among quarters within the same year of other surrounding periods to obtain a rough estimate of seasonal percentage differences. For data with unclear pattern, we assume it to be the same as last quarter.

Growth rate of labor quality and labor input

Our construction of Thailand's aggregate labor quality index follows Jorgenson et al. (1987). This is one of the two major approaches to estimate labor quality in the literature. The other is the BLS (1997) econometric estimation approach. The two approaches are conceptually similar. We choose the Jorgenson method simply because of data constraint. Specifically, we categorized labor into fifteen groups consisting of five age groups (below 20, 20-29, 30-39, 40-49 and above 50 age groups) and three educational levels (primary, secondary and post secondary). Post secondary level includes vocational college, teacher-training and university level. The growth rate of labor input is calculated using the formula:

$$\Delta \ln L_t = \sum_{\mathrm{j}} \bar{v}_{\mathrm{j,t}} \Delta \ln H_{j,t}$$

where the weights are value share of labor income:

$$\bar{v}_{j,t} = \frac{1}{2}\left[\frac{w_{j,t}H_{j,t}}{\sum_j w_{j,t}H_{j,t}} + \frac{w_{j,t-1}H_{j,t-1}}{\sum_j w_{j,t-1}H_{j,t-1}}\right]$$

for each *j* group and *t* period where, L = quality-adjusted labor input, H = total hours worked, and W = wage rate (wage plus over-time per hour)

Data on wages is also taken from the LFS. Since labor input is the multiplication of total hours worked and labor quality, the growth rate of labor quality approximately equals the difference between the growth rates of labor input and total hours worked.

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