Economic Growth in Thailand: The Macroeconomic Context

By

Barry Bosworth

August, 2005

This survey of economic growth accounting in Thailand was prepared for a World Bank project on the investment climate, firm competitiveness and growth in Thailand.

Economic Growth in Thailand: The Macroeconomic Context

By
Barry Bosworth[1]

Thailand has long been included with a group of economies in East and Southeast Asia, who, because of their outstanding growth performance, have been at the center of the research and discussion of the determinants of economic growth. Much of the debate has revolved around an effort to partition growth between the contributions of increased factor inputs (extensive growth) and improvements in the efficiency with which those factors are employed (intensive growth). This issue is important to resolving questions of the future sustainability of the growth process, and the direction that should be taken by government policies. How important are efforts to stimulate innovation and competition, which are believed to be linked to gains in the efficiency of resource use, versus expansion of educational opportunities and incentives for greater capital formation.

A concern with these issues has stimulated a large body of economic research aimed at identifying the proximate sources of growth, in both Thailand and other economies of the region. This research has included studies that use an econometric approach of estimating the parameters of an aggregate production function and those that rely on growth accounting to decompose the growth in output into the contributions of increased quantities of the factor inputs and a residual measure of improvements in total factor productivity (TFP). Both of these methodologies have been applied to Thailand's situation, but one consequence has been a wide variation in the conclusions of the individual studies.

The purpose of this paper is to review some of the major productivity studies of Thailand and attempt to identify the sources of their differences. The chapter also includes the construction of a set of growth accounts at the level of the total economy and three major sectors -- agriculture, industry and services. These growth accounts provide the framework for a discussion of the data issues that arise in the context of efforts to measure Thailand's productivity performance.

---

[1] I am indebted to Kirida Bhaopichitr of the World Bank and Piyanuch Wuttisorn and Khun Suppasit of the National Economic and Social Board for their extensive efforts to obtain the data used in this report. Starynee Adams, Lisa Bell, and Dan Theisen of the Brookings Institution provided computational assistance.

The following section contains a brief overview of Thai economic growth and the structural changes that have occurred. The second section presents a short summary of the primary methodological approaches to productivity analysis. Section 3 presents a review and comparison of the major growth studies of Thailand that have been completed over the past decade. The fourth section uses the results and lessons from the prior analyses to present a consistent set of growth accounts for the period of 1977 to 2002 using the most recent data.

1. Growth and Structural Change, 1970-2003

Thailand's economic growth averaged 7.5 percent per year in the quarter century that preceded the 1997 financial crisis (table 1). However, output fell sharply in both 1997 and 1998 and did not recover to its 1996 level until 2002. The severity of the crisis will have a major effect on any analysis of Thailand's growth experience. As shown in figure 1, the output losses, relative to Thailand's prior growth path, appear to be permanent; that is, the growth rate has recovered but along a lower path than existed prior to 1997. Furthermore, a long term growth in employment averaging less than half that of output implied substantial labor productivity gains in the years prior to the 1997 crisis, but evidence of significant productivity improvement in subsequent years is largely absent. Over the 1996-2003 period, output growth averaged 1.5 percent per year and employment growth was 1.3 percent.

Like many other economies of the region, Thailand's growth has been relatively capital intensive: the growth of the capital stock has consistently exceeded that of output, but by a relatively modest margin, and the capital-output ratio is still low relative to the industrial economies. Finally, figure 1 highlights the extent to which the 1997-98 output collapse was concentrated in capital investment, and the lack of any significant recovery in the following years. The investment rate averaged 40 percent of GDP in the first half of the 1990s; it has been half that since the crisis.

Thailand's growth has also been accompanied by sizable changes in the structure of the economy, as shown in figure 2. The share of GDP accounted for by industry has doubled from 21 percent in 1970 to 44 percent in 2003. In contrast, the share coming from the agricultural sector fell from 23 to 10 percent. Surprisingly, the role of services, as measured by its output share, has declined slightly. The general picture is one of resources moving out of agriculture and into industry.

A somewhat different perspective is provided by a focus on employment shares in figure 3. Again, the share of employment in industry has roughly doubled since 1977, but it has a far less dominant role than implied by the output share, only 21 percent of total employment in 2003. There are also substantial employment gains in services, implying a drop in labor productivity relative to that in industry. Furthermore, agriculture has a far larger role in the economy when viewed from the employment perspective, but its secular decline is even more evident.

It is also useful to evaluate Thailand's progress in terms of the improvement in labor productivity (GDP per worker) and ultimately living standards as measured by income per capita, and its convergence to the levels of the high-income countries. Both the productivity and income measures are reported in international dollars (PPP) in table 2, and they are also shown relative to the United States to highlight the extent of convergence. As shown below, the gap between output per worker and income per capita can also be related to underlying differences in the proportion of income that accrues to residents, the utilization of the workforce, and the age structure of the population:

$$GNI/capita = (GDP/E) \times (GNI/GDP) \times \left(E/P_{lf}\right) \times \left(P_{lf}/P\right), \text{ where}$$

GDP/E = production per worker,

GNI/GDP = the proportion of income from production that accrues to residents,

E/P_{lf} = the proportion of the population age 16 and over that is employed, and

P_{lf}/P = the proportion of the population that is age 16 and over (demographics).

These determinants of income per capita are reported in international prices for 1975 (column 1) and 2003 (column 2).[2] The average annual rate of change is shown in column (3). The same concepts are reported again in columns 4-6, but relative to the corresponding value for the United States. The progress that Thailand has made is particularly evident in the comparison

[2] The measures of GDP and GNI at international prices are those of the 2004 World Development Indicators. All values are converted to 2000 prices.

to the United States: GDP per worker has increased from 10 percent of the U.S. level in 1975 to 17.5 percent in 2003. In 1975, Thailand's population was also very young. Only about half of the population was of labor force age (15+), compared to about 70 percent for the United States. Today, the proportion of the population that is of working age is nearly identical to that of the United States. The participation rate for those of labor force age is also very high in Thailand, although it has not increased as much as in the United States. The high employment rate is largely due to the very high employment of women. Finally, Thailand has largely financed it's growth out of it own resources with the consequence that Gross National Income (GNI) has remained in the range of 98-99 percent of GDP. Income payments on FDI and foreign debt have been largely offset by wages and remittances of overseas workers. The overall result is a growth in income per capita that has been slightly faster than that of output per worker.

The level of GDP per worker and GNI per capita, relative to U.S. values, are also shown in figure 4 to highlight the severity and importance of the 1997 crisis. By 1996, Thailand had actually succeeded in more that doubling its 1975 relative income position; GNI per capital had reached 21 percent of the U.S. level, but it fell back to 17 percent 1998. Since then, growth in GDP per worker has only matched that of the United States, but there has been some recovery in income per capita due to a rise in the employment to population rate.

2. Basic Methodology of Productivity Analysis

Studies of productivity growth have used a variety of different methodologies, but the research has evolved along two primary paths: growth accounting and direct econometric estimation. Both are based on an underlying concept of an aggregate production function. Growth accounting combines the production function with an assumption of competitive markets that leads to the use of income shares to measure the contribution of the input factors. This method focuses on identifying the contributions of the individual factor inputs and a residual of TFP. In contrast, the econometric approach avoids any assumption about competitive markets, and focuses on exploring alternative functional forms of the production function.

Furthermore, most empirical studies have focused on what might be labeled the proximate causes of growth: measuring the quantity and quality of the capital and labor inputs, and viewing the residual of TFP as representing a combination of changes in efficiency and the production technology. More recently, some researchers have sought to go beyond the

proximate cause to associate the fundamental sources of long-term differences in living standards with differences in institutional and legal arrangements and geography. In these studies, TFP is perceived as the driving force -- the accumulation of physical capital and labor skills is largely endogenous and ultimately induced by changes in TFP – and the focus is on developing a theory of TFP.[3] The focus of this paper is on the proximate causes in that it is primarily concerned with the measurement of the factor inputs and their relative contribution to growth over the past quarter century.

Growth Accounts. Modern productivity analysis follows from the contribution of Solow (1957) that begins with a concept of an aggregate production function that relates output to the contribution of the factor inputs, capital and labor, and a Hicks-neutral shift in the production function:

$$(1) \qquad Q_t = A_t F\left(K_t, L_t\right).$$

By combining the notion of a production function with the assumption of competitive markets where the factors are paid their marginal products, it is possible to derive a simple index number formulation that relates the growth in output to increases in the factor inputs and a residual shift term that is identified with TFP:

$$(2) \qquad d\ln Q = s_k d\ln(K) + s_l d\ln(L) + \Delta\ln TFP,$$

where s_k and s_l are the shares of capital and labor income, respectively.[4] It is also possible to extend this formulation to incorporate factor-augmenting improvements in the quality of the factor inputs, such as improved educational skills of the workforce.

As discussed more fully below, it is often difficult to obtain meaningful time series estimates of factor income shares. Thus, many studies adopt a more restricted Cobb-Douglas production function in which the contribution of each factor is assumed to be constant:

$$(3) \qquad Q_t = A(\left(K_t^{\alpha} L_t^{1-\alpha}\right)^{\gamma}.$$

[3] Examples of this literature are provided by Klenow and Rodriguez-Clare (1997) and Easterly and Levine (2001). In the Thai context, see Ahuja and Moenjak (2002).

[4] The use of income share weights is critical in that it makes it possible to avoid imposing restrictions on the possible functional forms of the production function. In empirical applications, the factor shares are replaced by average between period shares in a Tornqvist discrete time approximation. Thus s_k is replaced by $(s_{kt} + s_{kt-1}) / 2$. A summary of the literature is provided in Hulten (2001), and a detailed manual that elaborates on the major issues is available in OECD (2001).

Again, A represents TFP and γ measures the extent of returns to scale. In this restricted formulation, the s_k and s_l of equation (2) are replaced with constants and many studies have simply assumed returns to scale of unity.

It has also become quite standard to adjust the factor inputs, particularly labor, to reflect changes in quality. There are two common approaches that have been employed. The first seeks to cross-classify the workforce by a number of differentiating characteristics, such as education, age, occupation and gender. This information is combined with data on wage rates to compute each subgroup's share of total compensation, v_i. An adjusted measure of the labor input is then computed as

$$(4) \qquad d \ln L^* = \sum_i v_i d \ln L_i$$

This is a very data intensive process and some analysts object that the wage differentials may measure factors other than productivity differences, such as gender or age discrimination.

The alternative is to use a simple index of educational attainment to adjust for skill differences. For example, an index of the form:

$$(5) \qquad L^* = e^{as} L$$

assumes that each year of schooling, s, raises the average worker's productivity by a constant percentage, a. This formulation also has a ready parallel with a vast number of empirical studies that have used "Mincer regressions" to measure the relationship between wage rates and years of schooling. These studies have been carried out around the world with typical findings on the return to education in the range of 7 to 12 percent.[5]

Quality adjustments can also be made to the capital input although in most cases they are more properly identified as reflecting changes in the composition of the capital stock. The development of Jorgenson's neoclassical investment theory clarified the distinction between the capital stock and capital services. Using his concept of user cost, the rental price of capital services is give by

$$(6) \qquad P_k^s = (i + \delta - \dot{P}_k) \bullet P_k ,$$

where i represents the rate of return, δ the rate of depreciation, and $\dot{P}_k$ the rate of price change. This formulation makes it clear that the flow of capital services will vary with difference in the

[5] Summaries of many of these international studies are available in Psacharopoulos and Patrinos (2002). A specific example for Thailand is provided by Blunch (2004).

rate of capital asset depreciation. Assuming that the real rate of return is constant across asset classes, the capital service term can be used to compute capital income shares with which to aggregate capital of different service lives in a fashion that parallels that of equation (4). The growing importance of short-lived, high-tech capital has made this issue of compositional changes in the capital stock more important. Unfortunately, most countries do not have sufficiently detailed information – particularly at the level of individual industries -- to make these compositional adjustments. Thus, it is common to use an estimate of the capital stock as the index of capital services. The essential difference is that the aggregate of the capital stock is constructed using purchase prices as the relevant weights, while the aggregate of capital services is weighted by the rental prices.

Econometric Analysis. The major alternative to growth accounts is the use of econometric techniques to estimate the parameters of the production function directly. This is fueled in part by the increased flexibility of the functional forms associated with the trans-log production function. It is also stimulated by the development of new growth theories that interpret innovation as an endogenous part of the growth process, in contrast to the neoclassical assumption of exogenous change. Econometric analysis is also more easily adapted to deal with shocks, such as bad weather and financial crises, which distort the production process. However, the estimation of complex production functions normally requires large numbers of observations, and it raises difficult statistical issues. Several of the available studies of productivity growth in Thailand have relied on econometric techniques, but most of the studies that are reviewed below are based on growth accounting.

3. Review of Recent Studies

There have been many studies of Thailand's growth performance. Researchers have used both the growth accounting methodology and a regression analysis. In reviewing the various results it is clear that the most important sources of variation among the studies are in the factor income shares that are attributed to capital and labor and whether or not the studies have included quality change in the measure of the labor input.

Most of the aggregate studies of growth have relied on a common set of data on output and the capital stock from the National Economic and Social Development Board (NESDB).

These data are available with some degree of industry disaggregation; and beyond issues of adjusting for breaks in the data due to the change to the adoption of Revision 3 of the International Standard Industrial Classification (ISIC) in 2001, they are not a significant source of difference in the studies.

Similarly, the employment data must be obtained from a household survey of the labor force; but because the within-year frequency (rounds) of the survey has varied over the years, the studies have differed in their construction of a measure of annual employment. In addition, the survey changed the age definition of the workforce from age 13+ to 15 and over in 2001, and it was also influenced by a 2001 change in the industrial classification.[6] The variation in the frequency of the survey is a more significant problem because the labor force has a pronounced seasonal aspect, peaking in the fall growing season. The household responses as to industry of employment are also probably unreliable below the level of the broad sectors.

Thailand's national accounts include estimates of factor incomes only at the level of the total economy; and because the number of self-employed can equal or exceed the number of employees, a means must be found to allocate the mixed income of the self-employed between their labor and capital income components. The method used to make this adjustment has differed widely and is responsible for most of the wide variation in the relative weights applied to the indexes of growth in the factor inputs.

National Economic and Social Development Board (NESDB). The macroeconomics division of the NESDB regularly prepares growth accounts using their estimates of GDP and the capital stock and employment numbers from the Labor Force Survey of the National Statistical Office. The methodology closely follows that shown in equation (2) above, but for their inclusion of a role for land in the agricultural sector. Estimates are compiled using net and gross measures of the capital stock as well a composite index (with a 75 percent weight on the gross stock). The calculations reported in table 3 are based on the net capital stock. The labor input is not adjusted for quality changes, and the factor shares are computed from the national accounts, assigning all of proprietors' income to capital. The share estimates are smoothed with a 3-year moving average. The result is a very low estimate for the labor share (an average of 31 percent

[6] Thailand's statistical programs shifted to the third revision of the International Standard Industrial Classification (1989).

over the 1981-2003 period) and the assignment of the largest weight to the fast-growing capital input (68 percent).

As shown in the first two columns of table 3, capital accumulation accounts for over 80 percent of the growth in aggregate output since 1980, the contribution of labor is about 10 percent, and improvements in TFP account for less than 10 percent of the gains. Because the quantity of cultivated land has not increased over the period, it has no significant effect on the rate of output growth.

Accounts are also constructed at the level of the three major sectors (agriculture, industry and services). Again, they are based on the estimates of GDP and the net capital stock from the NESDB and employment estimates from the labor force survey. However, in the case of agriculture, the calculation of the factor shares is extreme because employment is dominated by the self-employed and unpaid family workers, but their income is assigned to capital. The labor share of value added averages only 11 percent, while that of capital is 85 percent. As a result, increases in capital account for 114 percent of output growth and changes in the residual of TFP are negative. There is not net growth of employment in agriculture. The accounts for industry and services also indicate a dominant role for the capital factor because its share of factor income is in excess of 60 percent in each case. Over the 1980-2002 period, the contribution of capital accounts for 72 percent of the output growth in industry and 90 percent in services. Improvements in TFP remain positive in the industry sector, but they are consistently negative for services.

Thailand Development Research Institute (TDRI) Study. This study, conducted by Pranee Tinakorn and Chalongphop Susangkarn, was published in 1996, and covers the period 1977-90. It develops a set of growth accounts that cover the total economy and three broad sectors of agriculture, industry and services. The study stands out for the detailed nature of the adjustments that were made to incorporate changes in the quality of labor inputs, reflecting changes in educational attainment, experience (age) and gender. In addition, the authors developed a methodology for allocating proprietors' incomes between capital and labor. This is the most elaborate of the studies that have analyzed Thailand's growth experience.

Over the period of 1977-90, GDP growth averaged 7.6 percent annually (see table 4). They attribute 38 percent of that growth to increases in capital and land, 46 percent to growth in

the labor input (of which 20 percentage points were traced to quality improvements), and only 16 percent to a residual estimate of improvement in TFP. The results are significantly different from the NESDB calculations in allocating a much larger role to the labor input, but improvements in TFP are still quite modest. In addition, the relative contributions varied substantially across subperiods. At the sector level, improvements in TFP were important for agriculture, but were actually negative for industry and services. Increased capital played a large role in industry and services, but not agriculture. Gains in labor quality were most pronounced in services and agriculture.

The authors conclude that their results for Thailand are similar to those for other East Asian economies, such as Korea, in finding that a large portion of overall growth was due to increases in the factor inputs rather than TFP. In addition, larger gains in TFP at the aggregate level than for individual sectors suggests that the reallocation of resources across sectors was also an important contributor to growth.

Much of the data used in this study came from the standard government sources. The output measures were from the national accounts. The capital stocks were also those compiled by the NESDB. The study used both changes in the net capital stock and changes in a composite index to measure the flow of capital services. The composite index has a 75 percent weight on the gross capital stock and 25 percent weight on the net stock. The index of land input is based on the amount of land under cultivation, and because this has changed only modestly over the years, land contributes relatively little to the change in output.

The employment data were from the household labor force surveys. The TDRI study used the employment estimate from the July-September round of the survey, which represents a seasonal peak in agricultural employment. Their employment measure also included individuals age 11 and over compared with the current cutoff of age 15. In some portions of the analysis they converted the labor input measures to hours. Changes in average hours worked had no significant effect on the measure of the change in the labor input over the full 1977-90 period, but the changes in average hours are substantial in some subperiods.

The TDRI study includes two important extensions of the prior research. The first contribution was the construction of an index of changes in the quality of labor. The labor force survey is used to separate workers cross-classified by age, gender and education; and for each of these groups they are able to calculate an average wage rate. With that information, they

construct an index of labor quality that uses relative wages to value changes in the gender, age, and educational level of the workforce. Their calculations imply an improvement in the quality of the labor input for the total economy of 38 percent between 1977 and 1990, or 2.5 percent per year. This is an extraordinary rate of increase, which comes on top of an average rate of growth in labor hours of 3.3 percent annually. When this rapid growth in the adjusted labor input is combined with an 8.9 percent rate of growth in the capital input, the small estimated gains in TFP are not a surprise. Their results for the three major sectors shows the expected pattern of the largest educational gains being outside of agriculture, but the estimated improvements in labor quality within the services sector are extraordinary, 3.8 percent per year. That translates into a 2.2 percentage point contribution to the growth in output. Again, the very high rates of gain in labor quality are an important reason for the finding of a small residual contribution for improvements in TFP.

The second contribution was in the estimate of the factor-income shares. For most growth accounting exercises, the derivation of factor income shares is very difficult. In Thailand, as in many developing countries, a very large proportion of income accrues to unincorporated enterprises, the self-employed. The income of unincorporated businesses averaged about 60 percent of national income in the 1970s, and has remained in the range of 30-40 percent in recent years. It is a mixed income category that includes the returns to capital and entrepreneurship as well as labor. The authors imputed to the self-employed the average wage rate of employees, and computed capital income as a residual. They benchmarked their measures of the wage bill to the 1987 social accounting matrix (SAM). The inclusion of a wage for the self-employed raised the share of labor compensation in aggregate GDP from 24 to 60 percent in 1977, but the labor share declines sharply between 1984 and 1990, from 63 to 49 percent.[7] Their methodology also allowed them to capture the large difference between the wage rates of workers in agriculture and non-agriculture.

The authors of the TDRI study provided an updated analysis in a 1998 report to the NESDB (Tinakorn and Sussangkarn, 1998) that replicated the prior analysis using the new series of GDP based on 1988 prices and covering the 1980-95 period. The basic results are summarized in table 5. In their revision, they significantly lowered the estimate of the labor

[7] The magnitude of the adjustment declines over time as employees grow to represent a larger share of total employment.

income share in agriculture and services, assigning a larger weight to capital. Presumably, that is the result of a switch to the 1995 SAM as the benchmark for their wage calculations. The overall patterns are very similar to the 1977-90 analysis, reporting a negative contribution of TFP growth in both industry and services. However, there is an expanded contribution of capital and a somewhat diminished rate of improvement in labor quality.

Asian Productivity Organization (APO). This study was authored by A. Chandrachai, T. Bangorn and K. Chockpisansin, all of Chulalongkorn Unitversity, and it was published as a chapter in a report of the Asian Productivity Organization in 2004. In most respects, it is an update and extension of the TDRI study with results covering the period of 1977-99. It followed the earlier study in incorporating a quality adjustment for the labor input that adjusts for changes in educational attainment, age, and gender, using wage rates from the Labor Force Survey. In addition, it uses the composite index of growth in the gross and net capital stocks to measure the flow of capital services. The computation of the factor shares is also similar to that in the TDRI study, and, while the actual values are not published, the average value of the labor share is said to be slightly higher than those of the 1978 TDRI study. They ignore any role for change in the input of land.

The basic results of the APO analysis are summarized for over three different periods in table 6. A simple comparison with the original TDRI study is available in column (3) for the 1977-90 period. Outside of some downward revisions in the estimated output growth rate, the most significant change was in the estimate of quality improvements for the labor input; they find a contribution of 0.7 percent per year to growth compared to 1.5 percent in the TDRI study. While the methodologies are similar, the APO group's result seems more plausible. No explanation for the differences is provided in the paper. The change falls through to the estimate of TFP growth which is increased from 1.2 percent per year in the TDRI study to an average of 1.8 percent.

The extension of the analysis to include the 1990s has little impact on the estimated contribution of labor and capital; but the 1997 financial crisis greatly alters the estimate of TFP, which falls to 0.5 percent per year if the analysis is extended through 1999. The authors attempt to adjust for the recession by constructing an index of capacity utilization, and they use it to derive a new measure of the effective capital stock. However, these calculations are shown only

for a separate analysis of eight industries. An alternative is to focus on the period preceding the crisis, as in column (2). Prior to the crisis, the contribution of TFP, 1.6 percent per year, was very much in line with their estimate for the earlier period. Inclusion of the last three years of the 1990s cuts the 22-year average growth of TFP by a full percentage point.

The authors also include an analysis of the performance of productivity at the level of eight industries. However, they do not attempt to adjust for labor quality as with the TDRI study. To make some comparison to the TDRI study, their results are aggregated up to the sector level in columns (4)-(6) of table 6. A comparison with table 4 shows that the extension through to the end of 1990s yields very similar results for TFP growth, but a larger contribution is attributed to capital, which now stands out as the dominant source of growth in industry and services.[8]

Finally, the productivity estimates from the eight industries are used to compute an industry shift effect that will be positive if labor is growing most rapidly in industries with the highest productivity growth. The wage rate is used as a proxy for the productivity of workers in each sector, and they compute a measure of the labor input in efficiency units. They find that the shift effect added almost one percent per year to the growth of output. Since this is an partial alternative to their quality adjustment for labor in the aggregate, the residual estimate of TFP growth is only a few tenths lower than the values reported in columns (1)-(3) of table 6.[9]

Fiscal Policy Research Institute (FPRI) Study. The FPRI report was carried out in 2004. Like the TDRI and APO studies, it examines productivity growth both at the aggregate level and for the major sectors. However, it differs in its measure of capital services, the quality of labor inputs, and the method used to aggregate the contributions of the factor inputs. It also focuses on a very short historical time period, 1993-2002, and uses the results of the historical analysis to make alternative projections of economic growth over the period of 2004-2008.

The output measures are taken directly from the national accounts. The study recognizes a special role for high technology capital by separating computers from other types of capital in a

[8] The authors make reference to a 2001 paper by Pranee Tinakorn, which I could not locate. I believe that paper is basically the same as Tinakorn and Sussangkarn (1998).

[9] From a conceptual perspective, the wage rate should reflect economy-wide gains in productivity, not productivity in the specific sector.

production function framework that incorporates constant returns to scale and two types of capital

$$(7) \qquad Y = A\, K_{(\text{Non-ICT})}^{\alpha 1}\, K_{(\text{ICT})}^{\alpha 2}\, L^{\beta}.$$

The flows of capital services are measured by depreciation. In addition, the study adjusts the workforce for quality changes, but in a very idiosyncratic fashion. The index of labor inputs is constructed by multiplying the number of hours (H) by the average years of schooling (EDU) and the average age of the workforce (EXP):

$$(8) \qquad L = H*EDU*EXP.$$

This assumption of a proportionate relationship between years of education and labor quality implies a very large return to education at low levels of attainment, but a rapid falloff of the marginal gain at higher levels. A more common assumption would infer a relatively constant rate of return to an additional year of schooling.

The production relationship is estimated by regression using quarterly data over the 1993-2002 period. Thus, unlike that of TDRI and AFO, this study incorporates a more restricted production function framework of fixed coefficients with no allowance for a secular component of TFP growth. The result for the aggregate economy is a relationship that assigns a weight of 0.51 to non-IT capital, 0.13 to IT-capital, and 0.36 to labor. The relatively large weight attached to capital is virtually guaranteed by the exclusion of any independent trend or other allowance for changes in TFP: capital is the only right-hand-side variable that is growing at a rate approaching that of output.

As shown in table 7, the results for the major sectors imply an even smaller role for labor inputs in the industry and services sectors. Instead of measuring labor quality with the product of average years of schooling and average age of workers, the sector equations multiply the number of hours by an average nominal wage rate within the sector (a proxy for quality change).[10] In effect, real output of the sector is related to two measures of the real capital input and an estimate of the nominal wage bill. The result is an extremely low elasticity of output with respect to the labor input of only 0.16 for both industry and services.

[10] The sector wage rate is too broad to serve as an effective index of labor quality. Changes in average wage rates reflect a wide range of factors in additional to the quality of the workforce. These include general inflation, economy-wide productivity gains, and shifts in the relative demand and supply of labor at the sector level.

In one respect, this study is similar to that for TDRI in arguing for a relatively minor role for TFP improvement; but in this case, it is by assumption: the formulation of the production function attributes all of the output growth to changes in the factor inputs. This study also greatly expands the relative role of capital accumulation, with the sum of the coefficients on the two forms of capital ranging from 62 percent in agriculture to 84 percent in industry and services.

There is no significant change in the average age of the workforce; and improvements in educational attainment are responsible for a cumulative rise in the effective labor supply of 22 percent over the 10-year period or about 2 per year. However, due to the small overall coefficient on the labor input, the net effect on output is in the range of 0.3 – 0.8 percent.

Bank of Thailand. Several studies published by the Bank of Thailand have included the construction of growth accounts. The most detailed is by Katharit (2001), and it provides calculations of TFP for the total economy, agriculture, non-agriculture, and manufacturing for the period of 1980-96. The growth in the capital input is measured by changes in the net capital stock. The labor input is total work hours as estimated from the survey of the labor force. The author uses the real wage rate in each sector as a proxy for changes in labor quality, multiplying it by hours to obtain an index of total labor input. The result is extraordinary estimates of the improvement in labor quality ranging from 2.6 percent per year in agriculture to 3.6 percent for the overall economy.[11]

The factor shares in each sector are constructed, as in the TDRI and APO studies, by multiplying the number of workers by an estimate of the wage rate. However, the full details of the calculation are not available. The estimated wage shares differ significantly among the studies for the total economy, The BOT study reports a wage share near 60 percent in the late 1970s declining to 44 percent by 1995, whereas the TDRI study uses an wage share that averages 39 percent and rises slightly over the period. The BOT study also uses a higher labor share for agriculture, but the two studies have similar shares for manufacturing.

The resulting growth accounts are shown in Table 8; and, despite the differences in the factor shares, they are quite similar to the previous conclusions from the TDRI and APO studies.

[11] The quality gains are more rapid for the aggregate economy than for any sector because of the compositional shift toward the higher wage industries.

Capital accounts for the largest contribution to output growth, and the growth of TFP is a small positive for the total economy and it is negative in the non-agricultural sectors. The low value for the contribution of TFP is attributable to the high estimate of improvements in labor quality and the assignment of a large weight to growth in the capital input. As with the FPRI study, the use of the wage rate to measure quality change (although it is a real rather than a nominal concept) seems inappropriate.

Second, a 2003 study of the investment situation by BOT staff (Mallikamas and others, 2003) included a set of aggregate growth accounts aimed at evaluating changes in the marginal productivity of capital. The study is notable for its application of two alternative means of estimating the labor share. Their first estimate is based on simply excluding income of the self-employed in calculating the factor income shares from the national accounts. The result is a capital share that rises from about 30 percent in the early 1980s to 44 percent in the mid-1990s before collapsing back to 30-35 percent in the aftermath of the 1997 crisis. This pattern of change in the share is much different, for example, than reported in the TDRI study. The second alternative is based on a method developed by Sarel (1997). He used cross-national data to compute capital shares for sectors with similar capital intensities. These internationally-determined shares are then applied to the sector composition of individual countries. For Thailand this yields a capital share that is basically constant over the period of 1980-2002 at 35 percent.

Using the capital shares from applying Sarel's method, the study of Mallikamas and others finds a strong rise in TFP growth throughout the 1980s (reaching 5.5-6 percent per year by the end of the decade), and a gradual decline in the 1990s prior to the financial crisis (averaging 3.3 percent in 1991-96). They attribute the decline to excess investment in the years leading up to the financial crisis. They report a recovery to a rate near 2 percent in 2001. The high TFP growth compared to the other studies is the result of the relatively low weight assigned to capital and the exclusion of any adjustment for improvements in labor quality.

Summary. In recent years, a substantial number of studies of Thailand's economic growth experience have been published. While they differ in the details, some consistent themes do emerge. Most of the studies argue that, in common with other high-growth economies of East Asia, Thailand's economic advancement has been dominated by exceptionally strong rates of

capital formation. The contribution of improvements in TFP is generally found to be modest, but this is an area of some variation among the research reports. The divergent results can be traced in turn to two major issues. First, there are large differences among the studies in the extent of adjustment of the labor input for improvements in educational and skill quality. Those studies that do incorporate a measure of changes in labor quality show extraordinary large improvements. I remain puzzled about the precise source of those gains because Thailand is normally perceived as having achieved only average improvements in educational attainment.

Second, in accounting for the contribution of growth in the factor inputs there is a wide variation in the relative weight assigned to the fast-growing capital input versus slow-growing labor. This last issue revolves around the question of how to allocate the incomes of the self-employed between their own labor effort and the capital that they may bring to the business. Since the total income of the self-employed is nearly equal to that of employees, and exceeded it by a factor of two in the 1970s, the treatment of the mixed income of proprietors is crucial to the derivation of appropriate factor share weights. Somewhat surprisingly, the studies agree that the largest improvements in TFP have occurred in agriculture, and that TFP growth in services is frequently negative.

4. The Construction of Growth Accounts

The prior literature review provides the basis for a systematic examination of the issues that arise in the construction of growth accounts for the overall economy, the three major sectors (agriculture, industry, and services), and a specific focus on manufacturing, which has played such a large role in Thailand's recent growth.

Output. Thailand's national accounts provide the basis for all of the estimates of production. The national accounts are constructed using a mixture of different methodologies, including expenditures, production and income; but most of the problems of measuring real output are associated with the services sector. In several industries, real output is estimated by projecting employment or by deflation of the nominal values with an estimate of the wage rate. In both instances, significant changes in output per worker are ruled out. This is a particular problem in services. In addition, the inclusion of the imputed estimate of value added from homeownership results in a large output value for which there is little or no associated labor

input and a large capital input. In studies of productivity within OECD countries, the value added of owner occupied housing is often excluded to avoid biasing the conclusions.

These concerns about the output measures however, would appear to be no more important in Thailand than in many other countries. The estimates of output growth should be comparable to those of other countries in the region. All of the output data are from table 4 of the national accounts, at 1988 prices.

Capital Services. As discussed earlier, the ideal method for computing an index of capital services would rely on aggregating across the different types of capital using estimates of the user costs as the weights. This cross-classification of capital by type and industry, however, is not available for Thailand. On the other hand, the NESDB does produce annual estimates of the gross and net capital stock and annual depreciation by economic activity. That suggests that estimates of the user cost by industry and asset could be produced from unpublished data.

Estimates of the gross and net capital stock and annual depreciation have been used to represent the growth in capital services, as well as a composite index based on a weighted average of growth in the gross and net capital stocks. As shown in figure 6, the differences among the various measures was not large prior to the 1997 financial crisis; but it is evident that depreciation is the most sensitive to variations in the rate of capital accumulation. Evidently, the post-1997 decline in investment was concentrated in assets with relatively high rates of depreciation (equipment). Depreciation is generally viewed a poor index of capital services because it ignores half of the user cost, the net return to capital.[12] Until it is possible to develop more elaborate indexes of capital services, an index based on changes in the net or gross capital stock or a composite of the two seems most reasonable. The remainder of this report uses a composite index with a weight of 75 percent on growth in the gross stock and 25 percent on the net stock.

Labor. The labor force survey (LFS) has undergone considerable expansion to the point that it is now conducted on a monthly basis. Since Thailand does not produce an establishment-based survey of employment, all of the information on employment must be obtained from the

[12] The ratio of depreciation to the net capital stock has gradually declined over time, implying that Thailand's capital stock is becoming longer lived. This is contrary to the trend in many other countries where the role of ITC capital, which has a rapid rate of obsolescence, has been expanding.

LFS. The major problems with the use of the survey result from the limited within-year frequency of the survey in the years prior to 1998. For those years, it is difficult to compute an employment estimate that is consistent with the annual average perspective of the national accounts. The studies by TDRI and the APO used the August survey, when agricultural employment is at a seasonal peak; but the studies by the NESDB more frequently relied on an average of the February and August surveys. In census years, there was only the fall estimate. I have followed the NESDB method where possible.

The lack of an establishment survey does raise some concern about the consistency of the employment estimates with the measures of output that are obtained from other sources. The potential inconsistencies are increased at the more detailed industry level because workers may not be knowledgeable about the industrial classification of their employer. For some statistical purposes, however, the independent sources for output and employment data are a distinct advantage.

The LFS also collects information on hours of work, and it has been used in some of the studies to convert the labor input to hours. However, I chose not to use the hours data. There is no major trend change in hours worked per person in Thailand, and for most of the period the measure of hours is restricted to one or two surveys per year, making it a questionable estimate of the annual average.

Educational Attainment. As discussed earlier, divergent estimates of the improvement in labor quality account for much of the difference among prior growth accounting studies. The LFS provides information on educational attainment, gender, and age of the workforce. However, there is considerable doubt about the meaning of the gender and age differences in wage rates, since they could easily be related to discrimination rather than productivity differences. For this reason, many statistical studies limit the adjustment of labor quality to changes in educational attainment and work experience (age).

The TDRI and APO studies used the LFS data to compute indexes of labor quality. The source of the large increases that they report is puzzling, however, because Thailand has not had a particularly rapid increase in the educational attainment of its workforce, and there are only modest changes in the average age and gender composition of the workforce. Average levels of educational attainment are available from the LFS since 1977. Years of schooling of the

employed population have risen from an average of 5 years in 1977 to 8 years in 2003.[13] However, it has been suggested that the return to education may have changed substantially over the period under study.

Empirical studies of the relationship between earnings and educational attainment are widely available. Psacharopoulos and Patrinos (2002) report a range of returns between 7 and 12 percent for a large number of country studies. Those studies typically use micro survey data to estimate the impact of years of schooling on wage rates. Blunch (2004) and Hawley (2004) obtain estimates of the return to education in Thailand in the upper portion of that range using the data from the Social Economic Survey and the LFS for several years in the 1980s and 1990s.

I used the micro data sets from the August LFS of each year from 1977 to 2004 to explore the relationship between education and earnings in greater detail. The surveys vary in size and information on monthly earnings is only available for employees. The usable sample size ranged between 11 and 36 thousand observations. Regressions were estimated for each survey: the log of the monthly wage was related to age, age^2, gender, and years of schooling. A set of categorical variables was also include to adjust for frequency of pay periods (daily weekly, monthly, and other) because of uncertainty about how to convert to a monthly wage.

The coefficient on years of schooling is reported in the top panel of figure 5 for the years of 1977-2004. The return to schooling averages about 9 percent in the late 1970s and the 1980s, and rises to above 10 percent in the early 1990s, before declining back to 9 percent by 2000. There is a change in the coding of the education variable beginning with the 2001 survey, and the reported jump in the return is probably not meaningful. A second formulation used a set of categorical variables to represent the various levels of education, thus dropping the assumption of a linear relationship with years of schooling. The results are reported in the lower panel of figure 5. The excluded category is workers with less than an elementary education, so that university graduates are shown as earning about 140 percent more than those workers. Again, there is some evidence of a modest decline in the return during the 1990s, but the differential between the earnings of secondary and university graduates has remained very stable. The

[13] This measure is computed by assigning the years of schooling shown in the FPRI study to the educational categories of the LFS. However, the number of years associated with a university education was lowered from 18 to 16 and the calculations exclude a small number of individuals in the categories of 'other' and 'unknown'. The NSO and K. Suppasit of the NESDB provided tabulations of educational attainment from the labor force surveys for the period of 1977-2004.

regressions typically accounted for about 50 percent of the variation in the wage rate, with no significant difference between the linear and the categorical versions of the education measure. It is also interesting to note that the wage differential between men and women has declined by about 40 percent over the last quarter century (women currently earn 15-20 percent less than the equivalent male).

Since education can also be expected to be a tool for sorting of persons by native ability, the regressions are likely to overstate the pure return to education. Thus, I have chosen to use a slightly lower estimate of its contribution in constructing an index of labor quality. The specific formulation, given earlier in equation (5), assumes that each year of schooling raises individuals' productivity by a constant 7 percent.[14] The resulting index of labor quality is shown in figure 7, together with that from the TDRI studies. The improvement in education increases the effective labor input by an average of 0.6 percent per year over the 1977-2003 period. The assumption of a 12 percent rate of return would raise the improvement factor to one percent per year. This is in addition to a 2.6 percent annual rate of growth in total employment over the 1977-2004 period. In contrast, the two TDRI studies obtained a 2.8 percent annual rate of quality augmentation over the 1977-96 period. The gains in educational attainment in the major sectors follow a similar pattern. Services employ workers with the highest average level of education and with the largest gains since 1977. Agricultural workers have the least education and the smallest gains. Thus, the sector differences in educational attainment have grown over the past 25 years.

Factor Income shares. The most questionable aspect of the growth accounts revolves around the computation of the appropriate income shares to serve as weights in the aggregation of the capital and labor inputs. Because the total income of the self-employed (employers, own account, and unpaid family workers) equals or exceeds that of wage earners, it is critical to obtain a reasonable distribution of their income between the labor and capital components. The most reasonable method is to increase the estimate of employee compensation in the national accounts by the ratio of total employment to employees. That is equivalent to assuming that the self-employed would earn a wage equivalent to that of employees. Given the large wage

[14] See Bosworth and Collins (2003) for a further discussion.

differentials across sectors, the imputation must be done at the sector level.[15] The work status of employed persons is available at the industry level from the LFS.

Over the full period of 1977-2004, employees account for only 12 percent of total employment in agriculture, 73 percent of industry and 52 percent of services. While the adjustment seems quite reasonable for industry and services, the imputation of the employee wage to the self-employed in agriculture results in an estimated labor compensation that exceeds total value added in several years. It is evident that there continues to be a large reserve of underemployed workers in agriculture, and the employee wage rate cannot be assumed to be representative of the return to other categories of workers in that sector.

An alternative for agriculture is to benchmark the labor share to the 1995 Social Accounting Matrix (SAM), as was done in the TDRI studies. The SAM does include an adjustment for the income of the own account and unpaid family workers, although the details of the adjustment are unclear. The result is a labor share that varies between 40 and 45 percent over the period of 1977 to 2003, compared to an average 10 percent share for employee compensation in the national accounts. Since the return to land accounts for less than 10 percent of value added, the residual estimate of the income accruing to capital is about 55 percent.

The adjusted and unadjusted labor income shares for industry and services are shown in figure 8. The adjusted labor income averages 48 percent of value added in industry and 62 percent for services. In both cases, there is little evidence of a secular trend, although the labor share in industry and manufacturing was rising prior to the 1997 financial crisis and has been falling since then. With similar capital-output ratios, the return to capital has been roughly the same in agriculture and industry, but it is substantially lower in services with a higher labor share, and a much higher capital-output ratio. The data for services, however, are distorted by the inclusion of the capital and imputed income associated with homeownership.[16] Furthermore, the implied rise in the return to capital in industry and manufacturing after 1997 is surprising because it is not consistent with the notion of substantial excess capacity in the aftermath of the financial crisis. Nor is it reflected in any significant recovery of business investment.

[15] The average employee wage in services is 4-5 times that of the wage in agriculture.

[16] Specific service industries are examined in a following section.

Growth Accounts. A summary of the constructed growth accounts is presented in table 9, and a quick overview is shown in figures 9a-e. First, it is apparent that the growth of the overall economy has been dominated by increases in capital and labor. However, the contribution of TFP is strongly influence by the 1997-98 crisis in which much of the decline in output fell through to the residual of TFP. Over the 1977-96 period, gains in TFP contributed an average of 1.6 percent per year. That is small only in the context of the rapid growth of the total. In part, the higher reported gains in TFP, compared to the prior studies, are a direct result of a lower estimate of the gains in labor quality. Improvements in the educational attainment of the workforce add 0.3 percentage points to the average growth rate. The improvement in TFP has been more substantial in the post-crisis years, 2.1 percent annually in the 1999-2004 period. Those gains undoubtedly include a cyclical component; but the reduced contribution of capital is very noticeable.

Output growth in the agricultural sector is largely attributable to increases in capital, particularly in the 1990s. The index of TFP reached a peak in 1989, and employment has declined since 1990. Gains in educational attainment were largely nonexistence until the mid-1990s. The sector also appears to have been largely unaffected by the 1997-98 crisis. It must be borne in mind, however, that the estimates of the factor shares and thus the relative importance of capital and labor are highly uncertain. A growth accounting exercise has limited value for the agricultural sector without a stronger basis for the estimate of the factor shares.

The industrial sector is dominated by manufacturing, so the growth accounts for the two are very similar in that growth has been driven by the increase in the factor inputs. As with agriculture, the contribution of TFP peaked in the early 1990s, and, but for the crisis years, it has been constant since then(figures 9c and 9d). TFP in industry and the subgroup of manufacturing did not return to pre-crisis levels until 2004. A smaller contribution of TFP within total industry relative to manufacturing is consistent with the results for many countries that report constant or declining TFP in construction. Overall, the continued finding of a low TFP contribution can be traced to the relatively large factor share weight assigned to capital. However, it is difficult to argue for a larger adjustment of the compensation data of the national accounts. At least within manufacturing, the various categories of self-employed workers are not that significant.

The service-producing sector has grown more slowly than industry and its growth is very heavily dominated by increases in the labor input. Services display a high capital-output ratio in

this data set, but that is partly due to the inclusion of homeownership. The 1997-98 crisis has it greatest impact on the services-producing industries – particularly, finance – and there is little evidence of a significant recovery. Capital accumulation did slow sharply after 1997, but with an even larger decline in output, the capital-output ratio has increased. The result has been a substantial fall in the return to capital, and a shift of the factor weights toward labor – an increase from 60 percent in 1997 to 69 percent in 2003. Services has also had the greatest improvement in the educational skill of its workforce. Furthermore, the finance industry, a large component of the services sector, suffered the largest disruptions in the aftermath of the 1997-98 crisis. As a result of this multitude of factors, TFP growth in services turned highly negative after 1997. The longer-term prospective, however, may be more accurately measured by a focus on the 1977-1996 pattern of a small positive growth rate, 0.5 percent per year. Uncertainty about the outlook for productivity growth in services is the motivation for a more detailed examination of that sector in the following section.

Finally, it is striking that the estimated rate of improvement in TFP for the aggregate economy, 1.6 percent annually for the 1977-96 period in table 9, exceeds that of any individual sector. In fact, the average annual rate of increase in value added-weighted TFP growth is only 0.5 percent for 1977-96 and it is zero for 1977-2004. The difference, 1.1 percent annually, is a measure of the gains from resource reallocation. That is, the largest portion of the improvement in overall TFP is the result of moving workers from the low-productivity agricultural sector to industry and services.

A Disaggregate View of Services. The service sector has had the lowest rate of long-term growth in both labor productivity and TFP, and it was the most severely affected by the financial crisis. Labor productivity fell sharply after 1996, and the 2004 value is still 20 percent below the 1996 peak. The decline in TFP is an even-larger 25 percent. However, the sector includes a very diverse set of industries, whose output is notoriously hard to measure, and it includes the banking industry which was severely impacted by the 1997-98 financial crisis. The national accounts division of NESDB supplied a more disaggregate breakdown of the sector's value added and capital stock that enabled a more detailed examination. The data are available for a period of 1980-2003, but use the pre-2001 industrial classification, Revision 2 of ISIC. Comparable employment data were obtained from the LFS. The identified industries include: (1)

transportation and communications; (2) wholesale and retail trade, (3) banking, insurance and real estate, (4) ownership of dwellings, (5) public administration, and (6) other services.

The data for the first two industries should be of reasonable quality, and banking is of particular interest. Ownership if dwellings in an unusual industry in which all of the valued added is imputed capital income; and it is separately identified largely for the purpose of excluding it from the productivity calculations. Public administration also raises measurement issues because in the absence of a means of measuring its output, most national account systems simply assume that output changes in line with the labor input, an assumption that labor productivity is constant over time.[17] Other services is a heterogeneous collection of industries such as medical care, business services and personal services, where reliable measures of output and prices are largely unavailable. Thus, the estimate of TFP provides some insight into the severity of the measurement issues. A finding of a sustained negative trend in TFP is suggestive of potential measurement problems.

A projection of future trends in labor productivity and TFP remains very difficult. The service-producing sectors are still in a state of disequilibrium following the financial crisis with a negative reported rate of TFP change. It also seems evident that agriculture still accounts for a substantial level of underemployment; so that fast growth in the other sectors will draw workers out of agriculture and contribute to a positive rate of TFP change within agriculture. In future research, it would be useful to disaggregate the service-producing sector to exclude the highly capital intensive sector of homeownership and to focus more directly on the problems of finance. It is also likely that many services industries, such as public administration, display constant labor productivity by assumption.

The procedures used to compute the growth accounts for these industries are identical to those used previously for the sectors. The ratio of total employment to employees from the LFS is used to adjust the official data on labor compensation. The LFS is also the source of the employment data and the measure of years of schooling.

[17] The standard approach is to use the government wage rate as the price deflator to compute real output, or to use employment as the index of real output. Since value added includes depreciation of public capital, the use of the wage rate as a price deflator will produce some minor variation in the conceptual measure of labor productivity. In addition, the administrative records used to construct the estimate of value added in public administration may be based on a different estimate of employment than that of the LFS. Given the measurement problems, many productivity studies exclude the public sector.

A summary of the growth accounts is provided in table 10. In the years prior to the financial crisis, the services sector experienced strong growth in labor productivity (4.5 percent annually for services less housing) and decent gains in TFP (1.2 percent annually). The growth in labor productivity were large in transportation, trade and finance: but significant gains in TFP were limited to transportation and finance: the rate of increase in TFP for the banking, insurance, and real estate industry averaged a spectacular 6.8 percent over the 1980-96 period. Except for public administration, all of the industries show large contributions from capital. As anticipated, the recorded productivity growth in public administration was near zero. However, because public administration represents only about 10 percent of the output of services, its inclusion has only a small effect on the total.

The impact of the financial crisis is very evident within the services sector. In addition, to banking, there is a very sharp decline of output in the trade sector. The impact is more pronounced than for the industrial sector because services are largely oriented toward the domestic economy, whereas a large portion of industrial output is actual devoted to the export market, which expanded substantially in the aftermath of the crisis. In the three-year period of 1996-99, the output of the banking sector contracted by a startling 60 percent, and even with some subsequent recovery, output in 2003 was still 50 percent below the 1996 peak. Output reductions of that magnitude could not be absorbed through equivalent cuts in the inputs, and the decline in TFP averaged 10 percent per year over the seven-year period, a cumulative loss of 53 percent.

More surprising is the extent of decline within the trade and other services industries. Both of these industries are very large in terms of value added and employment: each accounts for about 30 percent of total services. The output of wholesale and retail trade fell susbstantially in 1997 and 1998, and there has been only modest recovery in subsequent years. The inputs of both labor and capital slowed, but the bulk of the adjustment has been in a sharp contraction of TFP. In other services, the slowing of output growth was less pronounced, but because of continued strong growth in employment, labor productivity is well below its 1996 peak. With data through 2003, there is little evidence of a recovery of TFP in services, and the decline from the 1996 peak is most evident for sub-industries of banking and trade.

5. Regional Comparisons

A final perspective on Thailand's growth performance is provided by a comparison to its regional neighbors. As shown in Table 11, Thailand's aggregate growth performance has been very typical of the East-Asian economies. The methodology used to construct the growth accounts differs slight from that of table 9 because most other countries do not have a detailed employment survey comparable to that of Thailand, and the contributions to growth are based on fixed factor shares. Still, Thailand is very much in the middle of the group with respect to growth in both labor productivity and TFP. In the years before and after the crisis, the rate of TFP growth in Thailand appears to have been slightly higher than neighboring countries. While the rate of gain in education have been comparable to the other countries, the overall level of educational attainment in Thailand is still quite modest relative to Korea and Taiwan.

The APO study, mentioned earlier, also included a comparison of productivity performance among a substantial number of Asian economies. Again, Thailand's performance was very much in the middle of the group for both the growth in TFP and labor productivity. The report a finding similar to this study that Thailand stands out with particularly large TFP gains from resource reallocation. That study also stressed the importance of human and physical capital in accounting for the regions' high growth rate.

6. Conclusion

This paper reviews the major growth accounting studies of Thailand's economy. A substantial amount of research has been done to identify the sources of economic growth in Thailand, and the review focuses on six major studies that are representative of the range of results. Differences in the studies' conclusions can be traced to two principle issues. First, there are substantial variations in the measures of improvement in the quality of the labor inputs. Some studies make no adjustment while others find a very large improvement due to gains in educational attainment. Some of the methodologies, such as the use of changes in the economy-wide average wage rate, seem inappropriate as means of estimating changes in the quality of the workforce.

Second, there are also large differences among the studies in the relative weights attached to growth in the capital and labor inputs. Because a small proportion of employed persons in Thailand are classified as employees, the labor share of value added is quite low in the official national accounts. Thus, most of the weight in a growth accounting exercise, where output

growth is computed as a weighted average of the growth in the factor inputs, is attached to the fast-growing capital input, resulting in a small residual estimate of TFP. Several of the studies adjust the factor shares by imputing a wage to the self-employed (employers, own account and unpaid family members) that results in the reallocation of a large amount income from capital to labor income. Since the growth of the labor input is less than that of capital, the result is a larger residual estimate of TFP.

The second objective of the study is to use the lessons learned from the review to compute a new set of growth accounts for Thailand that addresses the above issues and incorporates the latest available data. The first issue of the extent of improvement in the quality of the labor input is examined in detail. This study uses micro survey data on the earnings and educational attainment of workers in Thailand for the years of 1977 to 2004 to estimate the return to additional years of education. I conclude that returns to education in the form of increased earnings per year of additional education have been consistently in the range of 9 to 10 percent over the period of 1977 to 2004. The resulting index of labor quality suggests that the rate of improvement in Thailand is in the lower portion of the range of experience in other East Asian economies. The labor force survey is also the source of information on the proportion of workers who are employees. That ratio is used to adjust the estimates of labor compensation to increase the relative weight attached to labor in the growth accounting.

The constructed growth accounts confirm the prior finding that the bulk of Thailand's growth can be traced in increases in the labor and capital inputs. Improvements in TFP account for a relatively minor portion of the overall growth. However, while TFP growth appears low in the major sectors of agriculture, industry and services, the improvements in TFP at the level of the aggregate economy have averaged between 1.5 and 2 percent, excluding the crisis years of 1997-99. Most of the gains in aggregate TFP are due to resource reallocation among the sectors. Thailand still has a large number of underemployed workers in agriculture. Thus, strong growth in industry and services raises overall productivity by pulling workers out of the agricultural sector where they are still highly redundant. Labor productivity in agriculture is only about one fifth of the level in the nonagricultural sectors.

It is also evident that the 1997-98 financial crisis had a very large impact on the Thai economy and a major portion of the productivity losses associated with the crisis appear to be permanent, with little evidence of a post-crisis recovery to the old path of GDP. Instead, growth

appears to be resuming on a new growth path, lower but potentially parallel to the old path. Some of the largest effects of the crisis were in services, and a more detailed analysis of that sector found that the largest losses were in banking and wholesale and retail trade where there is little evidence of a recovery of TFP.

Finally, there has been a notable change in the nature of Thailand's growth in recent years. It no longer has a particularly high rate of capital accumulation, and it is still faced with significant problems in the financial sector that limits the potential for output and productivity gains. It does have large reserves of underemployed labor in the rural sector, but it will face increasing competition in low-skills manufacturing. This suggests the need to place increased emphasis on upgrading the skill level of the workforce as a means of sustaining the shift of workers from agriculture to industry and services.

From a supply-side perspective, Thailand should be able to sustain a high rate of growth in future years. Labor force growth will be about 2 percent per year; and improvement in education and skills would augment that by 0.8 (low) to 1.2 (high) percent annually. Furthermore, if the incremental employment growth is concentrated in industry and services, gains from reallocation should continue to contribute to TFP growth in the range of 1.5-2 percent annually. A simple growth model framework suggests a sustainable output growth rate (y) of :

$$y = h + a/(1- \alpha),$$

where h = growth of the quality adjusted labor force,

a = rate of TFP increase, and

$(1-\alpha)$ = labor's share of total income.

The labor share within the total economy averaged 56 percent in 2000-2004, suggesting a future sustainable rate of output growth of 5.5 (low) to 6.8 (high) percent annually.

Sustained output growth, however, requires a matching rate of capital accumulation. In recent years, the capital-output ratio has averaged about 2.7 and the implicit rate of capital depreciation is 5.5 percent per year. That suggests that sustained output growth of 5.5 to 6.8 percent would require a gross investment rate in the range of 29.5 to 33.2. That rate is below the 34 percent average of 1977-96, but substantially in excess of the 22 percent rate achieved in 2004.

References

Achara, Chandrachai, Tubtimtong Bangorn, and Chockpisansin Kamjara. 2004. "Thailand," in *Total Factor Productivity Growth: Survey Report*. Asian Productivity Organization (Tokyo), 297-321.

Ashvin Ahuja and Thammarak Moenjak. 2002. "Economic Arrangements and Long-Term Growth in Thailand," Bank of Thailand Discussion Paper.

Blunch, Niels-Hugo. 2004. "Returns to Education in Thailand: 1994-20002," Background Paper for the *2004 Thailand Social Monitor*, East Asia and Pacific PREM Sector Department, World Bank.

Bosworth, Barry, and Susan M. Collins.2003. "The Empirics of Growth: An Update," Brookings Papers on Economic Activity, 2003:1

Easterly, William, and Ross Levine. 2001. "It's Not Factor Accumulation: Stylized Facts and Growth Models." *World Bank Economic Review* 15(2): 177-219.

Hawley, Joshua. 2004. "Changing Returns to Education in Times of Prosperity and Crisis, Thailand 1985-1998," *Economics of Education Review*, June 2004; 23(3): 273-86.

Hulten, Charles R. 2001. "Total Factor Productivity: A Short Biography." in Charles Hulten, Edward R. Dean, and Michael Harper (editors) *New Developments in Productivity Analysis*, Studies in Income and Wealth Vol. 63, Chicago: University of Chicago Press: 1-54.

Katharit, Sitthikul. 2001. "Thailand's Total Factor Productivity," Working paper 02/2001, Bank of Thailand, Monetary Policy Group (in Thai).

Klenow, Peter, and Andrés Rodriguez-Clare. 1997. "The Neoclassical Revival in Growth Economics: Has It Gone Too Far?" In *National Bureau of Economic Research Macroeconomics Annual 1997*, edited by Ben S. Bernanke and Julio Rotemberg. Cambridge, MA: MIT Press. 73-103.

Mallikams, Roong Poshyananda, Yunyong Thaicharoen, and Danugporn Rodpengsangkaha. 2003. " Investment Cycles, Economic Recovery and Monetary Policy." Paper presented at the BOT symposium (August).

Psacharopoulos, George, and Harry Patrinos. 2002. "Returns to Investment in Education: A Further Update," World Bank Research Working Paper 2881.

Sarel, Michael. 1997. "Growth and Productivity in ASEAN Countries," IMF Working Papers 97/97.

Solow, Robert. 1957. "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, 39 (3): 312-20.

Tinakorn, Pranee and Chalongphop Sussangkarn. 1996. *Productivity Growth in Thailand,* Thailand Development Research Institute Research Monograph No. 5 (Bangkok: TDRI)

_____. 1998. "Total Factor Productivity Growth in Thailand: 1980-95," research report submitted to the National Economic and Social Development Board.

Organization for Economic Cooperation and Development (OECD). 2001. *Measuring Productivity: Measurement of Aggregate and Industry-level Productivity Growth.* OECD Manual, Paris. Available at: http://www.oecd.org/dataoecd/59/29/2352458.pdf.

Table 1. Growth of Thailand's Economy,1970-2003

annual rates of change

Period	GDP	Investment	Capital Stock	Employment
1970-80	6.7	6.4	5.2	2.1
1980-90	7.8	10.9	8.2	4.7
1990-2000	4.5	-2.4	7.9	0.4
1970-1996	7.5	8.9	7.8	2.8
1996-2003	1.5	-8.3	2.0	1.3

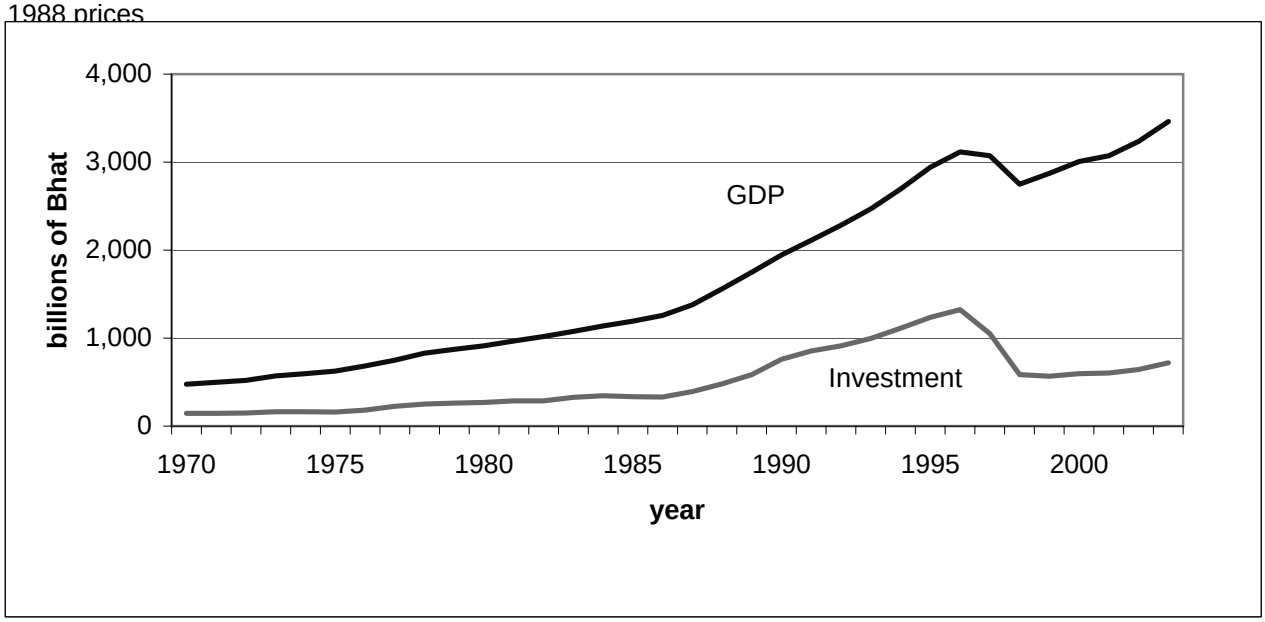
source: NESDB web site.

note: employment data begin in 1971 and are based on the annual average of a varying number of survey rounds.

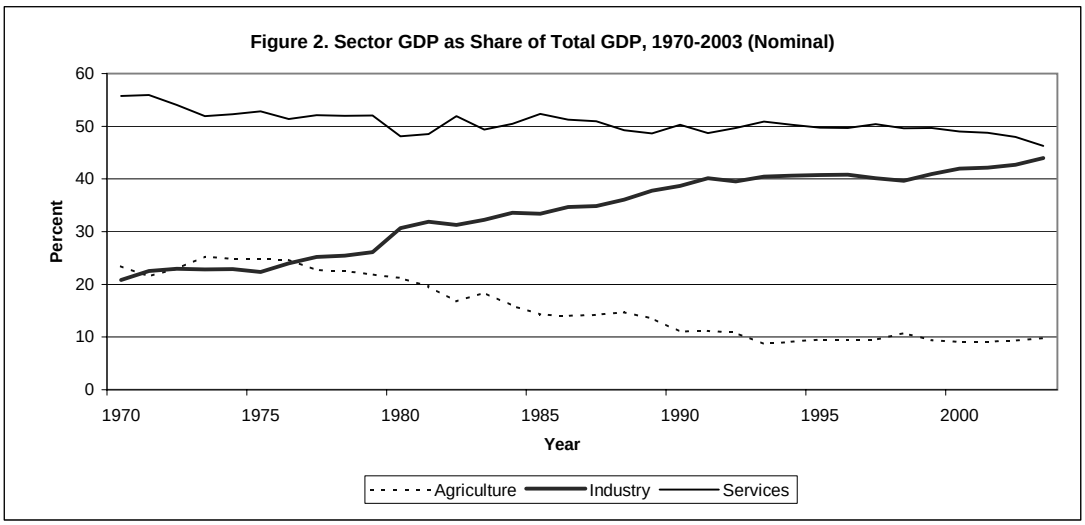
The capital stock is available only through 2002.

Figure 1. GDP and Fixed Capital Formation, 1970-2003

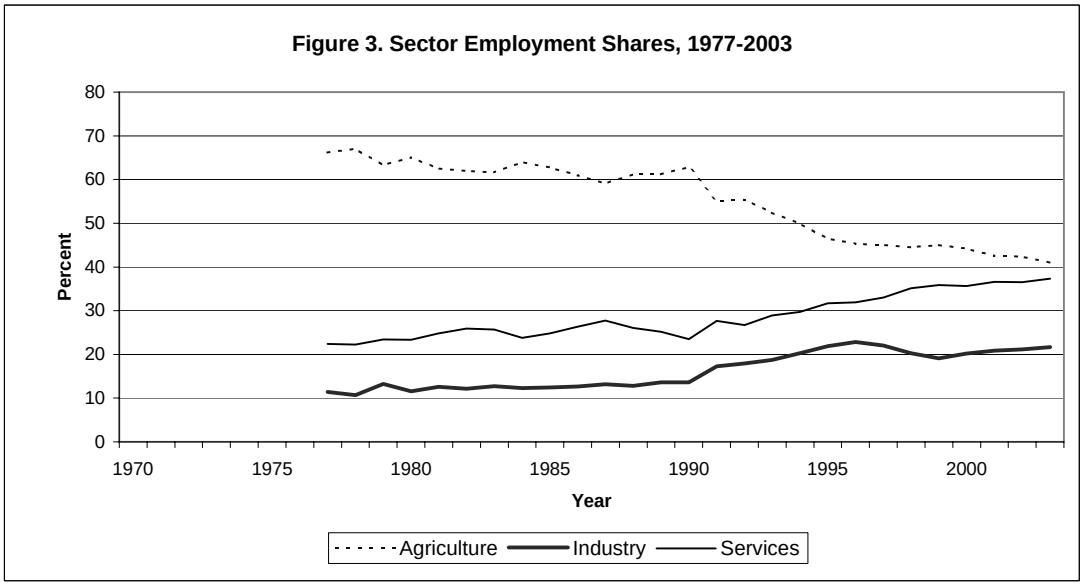
1988 prices



Source: *National Accounts Of Thailand* , NESDB web site.



Source: *National Accounts Of Thailand* , NESDB web site.

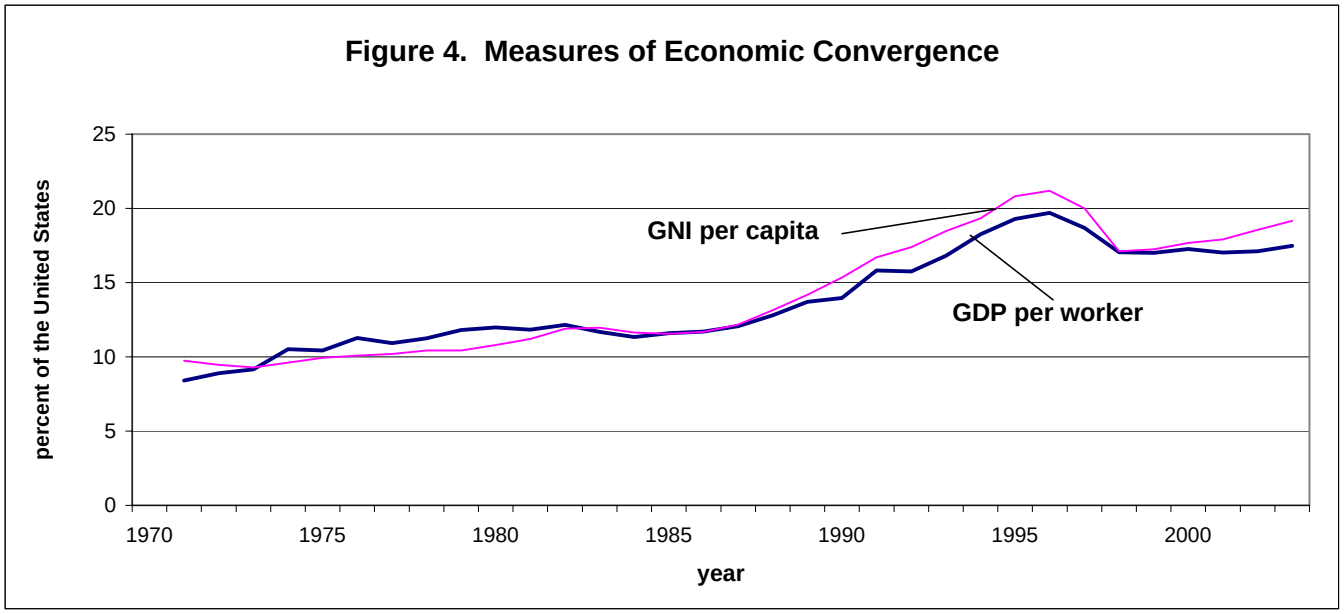


Source: *National Accounts Of Thailand* , NESDB web site.

Table 2. Components of Gross National Income per Capita, Thailand and the United States

	Thailand			*Relative to the U.S.*		
	Inter'l Prices of 2000			*Inter'l Prices of 2000*		
	1975	*2003*	*% Change*	*1975*	*2003*	*% Change*
GDP/ Worker (in thousands of 2000 $)	5.2	13.2	151.3	10.4	17.5	67.5
GNI/GDP	100.5	98.7	-1.8	99.6	98.2	-1.4
Demograpic Effect	54.9	75.5	37.4	77.5	99.3	28.2
Employment / Population 16+	69.2	70.0	1.2	123.5	112.5	-8.9
GNI/capita (in thousands of 2000 $)	2.0	6.9	243.0	9.9	19.2	92.7

Source: *World Development Indicators* and author's calculations



Source: Data of table 2.

Table 3. Sources of Growth, Total Economy and Major Sectors, NESDB Study, 1980-2002

Average annual percentage rate of change

Component	Total Economy		Agriculture		Industry		Services	
	1980-1996	1980-2002	1980-1996	1980-2002	1980-1996	1980-2002	1980-1996	1980-2002
Real Output Growth	8.0	6.0	3.7	3.1	10.2	8.2	8.1	5.7
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Contribution of:								
Labor	0.8	0.7	0.1	0.0	1.8	1.6	1.9	1.6
	(9.7)	(11.1)	(1.5)	(1.1)	(18.)	(19.3)	(23.2)	(27.9)
Capital	6.6	5.2	3.7	3.6	7.8	5.9	6.6	5.2
	(82.9)	(85.9)	(99.3)	(114.)	(76.)	(72.1)	(81.6)	(90.5)
Land	0.0	0.0	0.1	0.1	n.a.	n.a.	n.a.	n.a.
	( )	( )	(2.4)	(2.8)	n.a.	n.a.	n.a.	n.a.
TFP	0.6	0.1	-0.1	-0.6	0.6	0.7	-0.4	-1.1
	(7.2)	(2.5)	-(3.1)	-(17.9)	(6.)	(8.7)	-(4.8)	-(18.4)

Source: NESDB, excel file 'TFP Growth, 1981-2002.'

note: percentage distribution in parentheses.

Table 4. Sources of Growth by Sector, TDRI Study, 1977-1990

Component	Total Economy	Agriculture	Industry	Services and Others
Real Output Growth	7.6 (100.0)	4.0 (100.0)	9.0 (100.0)	8.0 (100.0)
Contribution of:				
Labor	3.5 (45.7)	1.9 (47.6)	3.8 (42.0)	5.0 (62.4)
Employment	2.0 (26.0)	1.3 (31.2)	3.2 (35.7)	2.9 (35.5)
Quality Changes	1.5 (19.8)	0.7 (16.4)	0.6 (6.3)	2.2 (26.9)
Capital	2.8 (37.2)	0.7 (17.9)	5.8 (64.8)	3.3 (40.9)
Land	0.1 (1.2)	0.1 (2.2)	-	-
TFP	1.2 (10.2)	1.3 (32.2)	-0.6 (-6.8)	-0.3 (-3.2)

Source: Tinakorn and Sussangkarn (1996), table 4.12 and 5.21.
note; percentage distribution in parentheses.

Table 5. Sources of Growth by Sector, TDRI Study, 1980-1995

Component	Total Economy	Agriculture	Industry	Services and Others
Real Output Growth	8.1 (100.0)	3.7 (100.0)	10.5 (100.0)	7.8 (100.0)
Contribution of:				
Labor	1.8 (22.2)	0.5 (13.5)	4.0 (37.8)	2.9 (37.4)
Employment	1.0 (11.8)	0.1 (3.8)	2.9 (27.4)	2.1 (26.7)
Quality Changes	0.8 (10.3)	0.4 (9.7)	1.1 (10.4)	0.8 (10.7)
Capital	5.0 (61.7)	2.2 (60.4)	7.2 (68.6)	5.3 (67.7)
Land	0.0 (0.4)	0.0 (1.1)	-	-
TFP	1.3 (15.6)	0.9 (25.1)	-0.7 (6.4)	-0.4 (5.1)

Source: Tinakorn and Sussangkarn (1998).
note; percentage distribution in parentheses.

Table 6. Sources of Growth, APO Study, 1977-1999

Percent per year

Component	Aggregate Economy			Sectors, 1977-96		
	1977-1999	1977-1996	1977-1990	Agriculture	Industry	Services
Real Output Growth	6.0	7.5	7.3	3.5	7.8	7.5
	(100)	(100)	(100)	(100)	(100)	(100)
Contribution of:						
Labor	1.9	2.0	2.5	n.a.	n.a.	n.a.
	(31.7)	(26.9)	(34.7)			
Employment	1.2	1.4	1.8	0.4	1.4	1.9
	(19.4)	(18.4)	(25.4)	(10.5)	(18.3)	(25.7)
Quality Changes	0.7	0.6	0.7	n.a.	n.a.	n.a.
	(12.3)	(8.5)	(9.3)			
Capital	3.6	3.9	3.0	1.3	6.4	5.0
	(59.7)	(52.3)	(40.9)	(37.4)	(81.1)	(67.1)
Land	n.a	n.a	n.a	n.a.	n.a.	n.a.
TFP	0.5	1.6	1.8	1.8	0.0	0.5
	(8.6)	(20.9)	(24.4)	(52.)	(.6)	(6.2)

Source: Achara and others (2004).

Table 7. Factor Weights From Regression Analysis, 1993-2002

	Contribution of:		
Sector	Non-IT Capital	ICT Capital	Labor
Total Economy	0.51	0.13	0.36
Agriculture	0.54	0.08	0.39
Industry	0.61	0.23	0.16
Services	0.67	0.17	0.16

Definitions: Non -IT and IT capital services are measured by depreciation of the capital stocks. The labor input is total hours multiplied by a qualitiy index equal to the average years of schooling and average age of the workforce.
Source: Data supplied by NESDB

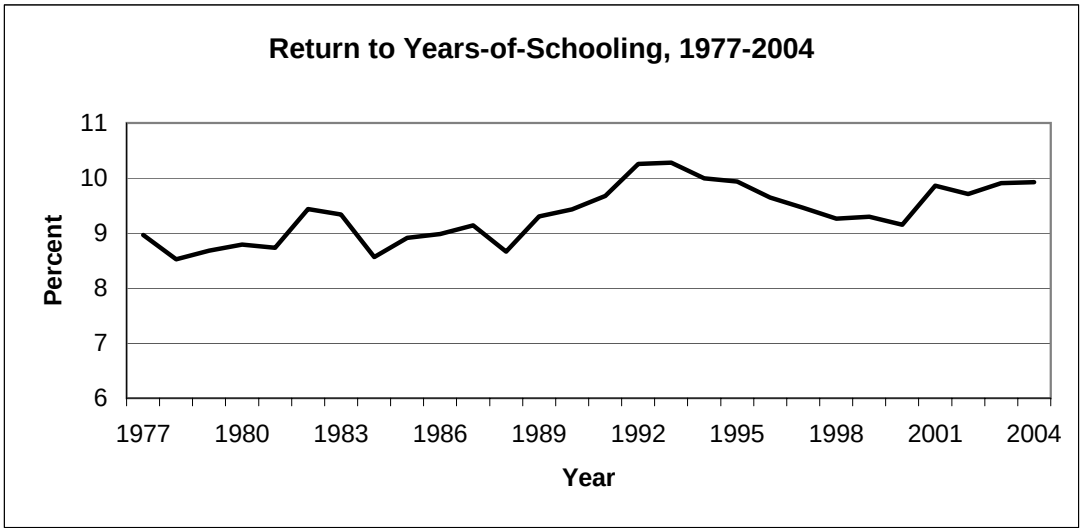
Table 8. Sources of Growth, Katharit Study, 1980-1996

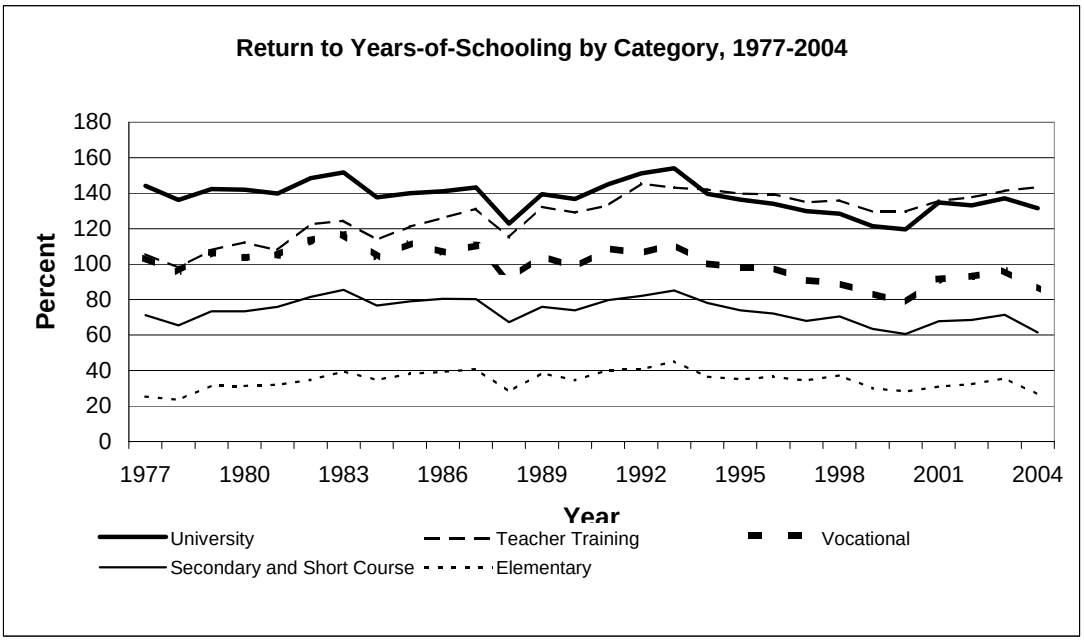
Percent per year

Component	Sector			
	Total	Agriculture	Non-Agriculture	Manufacturing
Real Output Growth	8.0	3.8	8.8	10.1
Contribution of:				
Labor	2.7	1.2	3.7	3.9
	(33.8)	(31.6)	(42.)	(38.5)
Employment	0.9	-0.1	2.5	2.3
	(11.3)	-(2.6)	(28.4)	(22.7)
Quality Changes	1.8	1.3	1.2	1.6
	(22.5)	(34.2)	(13.6)	(15.8)
Capital	4.9	2.3	5.5	6.8
	(61.3)	(60.5)	(62.5)	(67.2)
TFP	0.5	0.2	-0.4	-0.5
	(6.3)	(5.3)	-(4.5)	-(4.9)

Source: Katharit (2001).

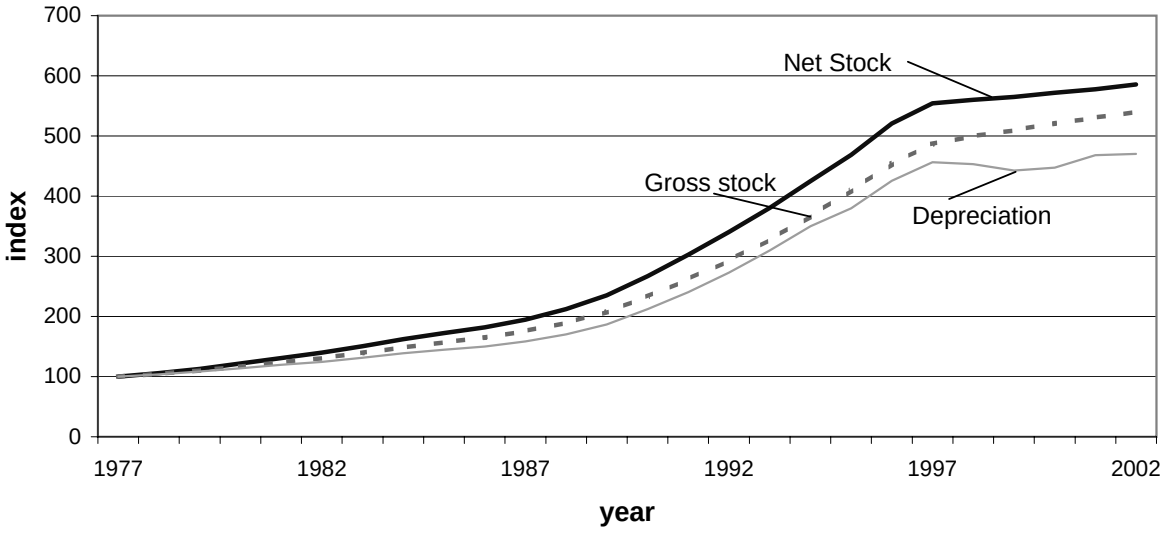
Figure 5. Returns to Education, 1977-2004





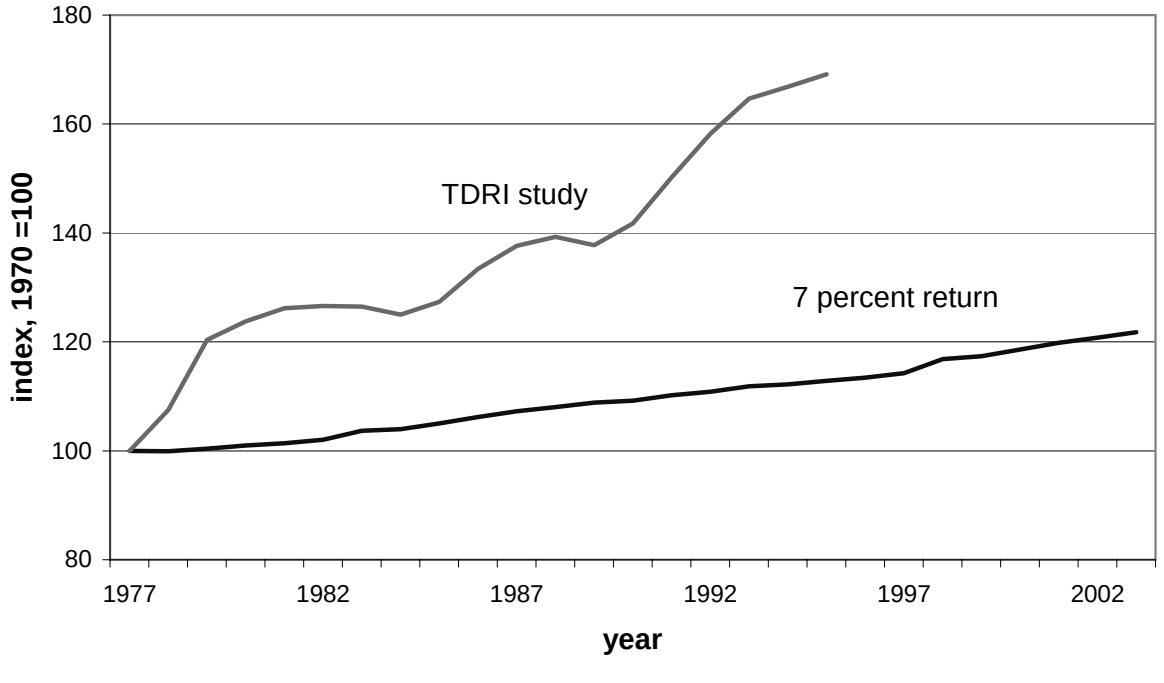
Source: author's calcualtions as explained text. In the top chart, the return is the coefficient on years of schooling from a linear regression using the labor force survey of the indicated year. In the bottom chart, the lines indicate the coefficient on the indicated educational category; the excluded category is those with less than an elementary education.

Figure 6. Alternative Indexes of Capital Services



Source: NESDB and author's calculations

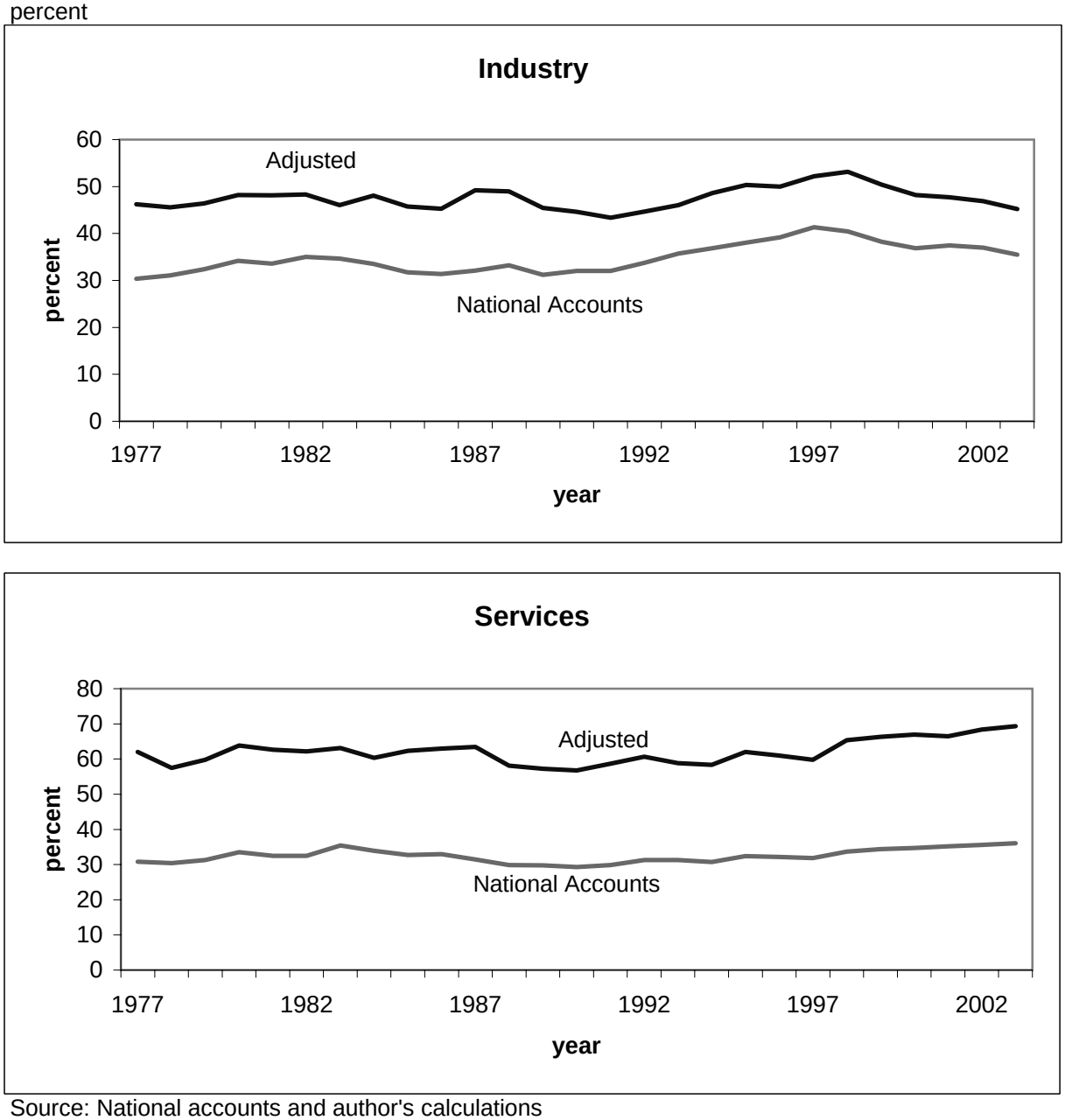
Figure 7. Alternative Indexes of Labor Quality



Source: NESDB and author's calculations as described in text.

Figure 8. Labor Income Shares, Industry and Services, 1977-2003

percent



Source: National accounts and author's calculations

Adjusted share is the estimate from the national accounts multiplied by the ratio of total employment to employees.

Table 9. Sources of Growth, Total Economy and Major Sectors, 1977-2004

Average annual percentage rate of change

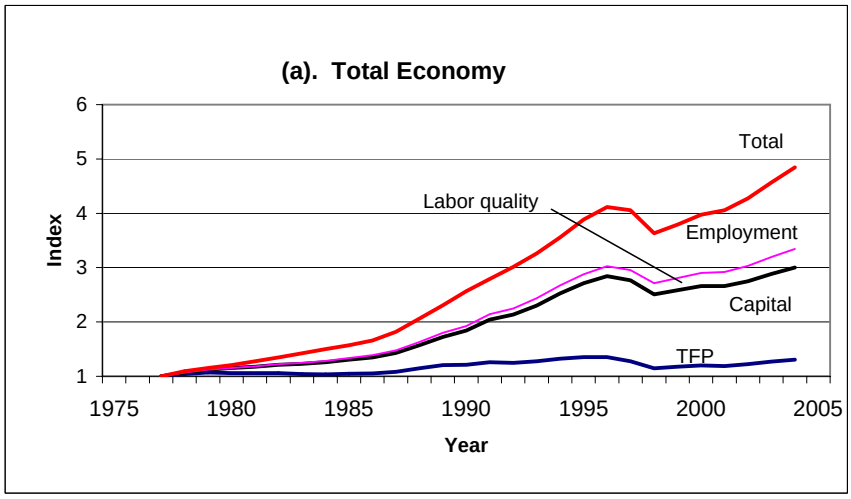
	Total Economy			Agriculture			Industry		
Component	1977-2004	1977-1996	1999-2004	1977-2004	1977-1996	1999-2004	1977-2004	1977-1996	1999-2004
Real Output Growth	6.0	7.7	5.0	2.9	3.3	3.2	8.0	10.2	6.3
Contribution of:									
Labor	1.8	2.0	1.9	0.4	0.5	0.1	2.7	3.5	2.9
	(30)	(25)	(30)	(14)	(16)	(14)	(34)	(34)	(34)
Employment	1.4	1.6	1.4	0.2	0.4	-0.1	2.3	3.2	2.7
	(23)	(21)	(23)	(8)	(12)	(8)	(29)	(31)	(29)
Quality	0.4	0.3	0.4	0.2	0.1	0.2	0.4	0.3	0.4
	(7)	(4)	(7)	(6)	(4)	(6)	(5)	(3)	(5)
Capital	3.1	4.0	0.9	1.9	1.9	1.6	4.7	6.1	1.2
	(52)	(51)	(52)	(68)	(59)	(68)	(59)	(59)	(59)
Land	0.0	0.0	0.0	0.0	0.1	0.0	n.a.	n.a.	n.a.
TFP	1.0	1.6	2.1	0.5	0.7	1.4	0.4	0.4	2.0
	(16)	(21)	(16)	(17)	(23)	(17)	(5)	(4)	(5)

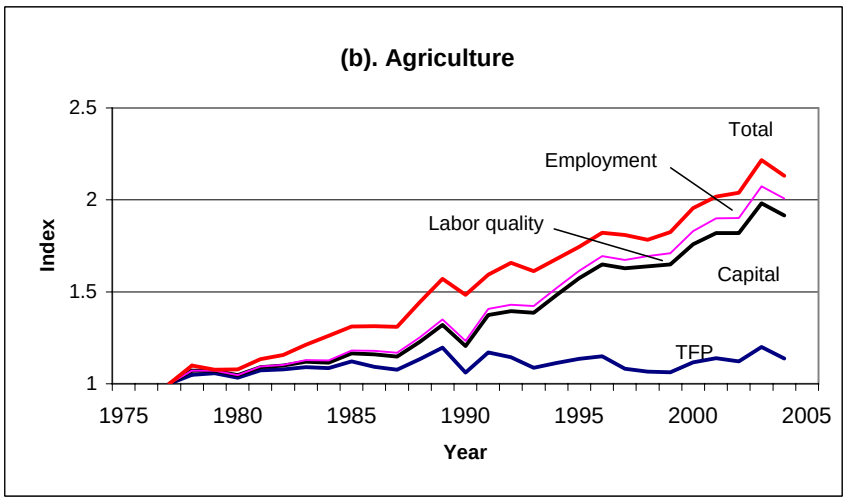
	Manufacturing			Services		
	1977-2004	1977-1996	1999-2004	1977-2004	1977-1996	1999-2004
Real Output Growth	8.4	10.2	6.6	5.4	7.3	4.2
Contribution of:						
Labor	2.8	3.2	2.9	3.4	3.5	3.6
	(34)	(31)	(34)	(63)	(47)	(63)
Employment	2.4	2.8	2.6	2.9	3.1	2.7
	(29)	(27)	(29)	(53)	(42)	(53)
Quality	0.4	0.4	0.4	0.5	0.4	0.5
	(5)	(4)	(5)	(10)	(5)	(10)
Capital	4.1	5.4	0.8	2.5	3.2	0.6
	(49)	(53)	(49)	(46)	(44)	(46)
Land	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
TFP	1.2	1.3	2.7	-0.5	0.5	0.0
	(15)	(13)	(15)	-(9)	(7)	-(9)

Source: Author's calculations as explained in text.

Percentage shares of the total growth are shown in parentheses.

Figure 9. Sources of Output Growth, 1977-2002





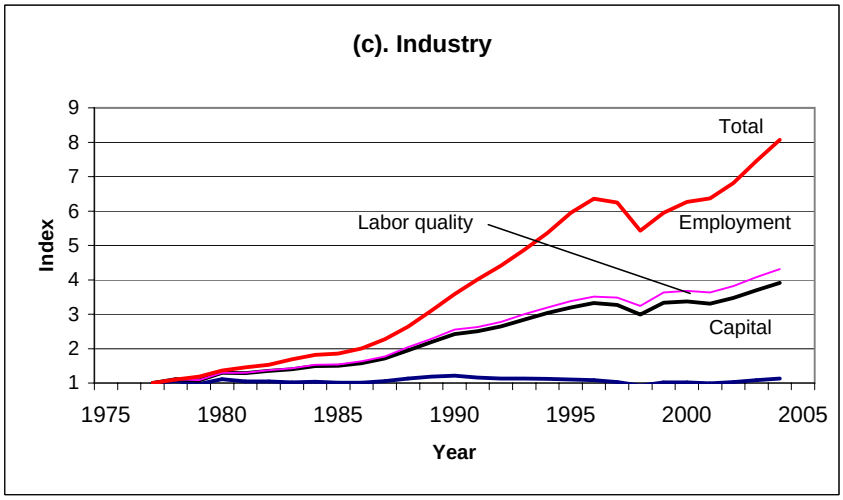
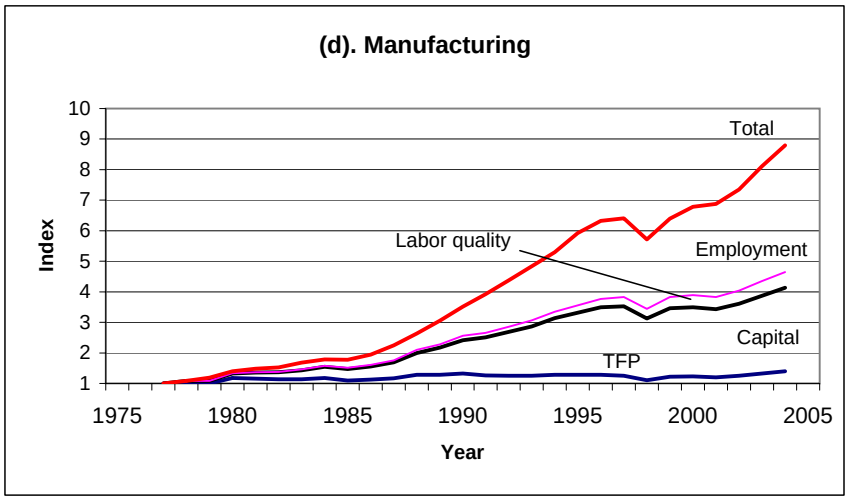


Figure 9. continued



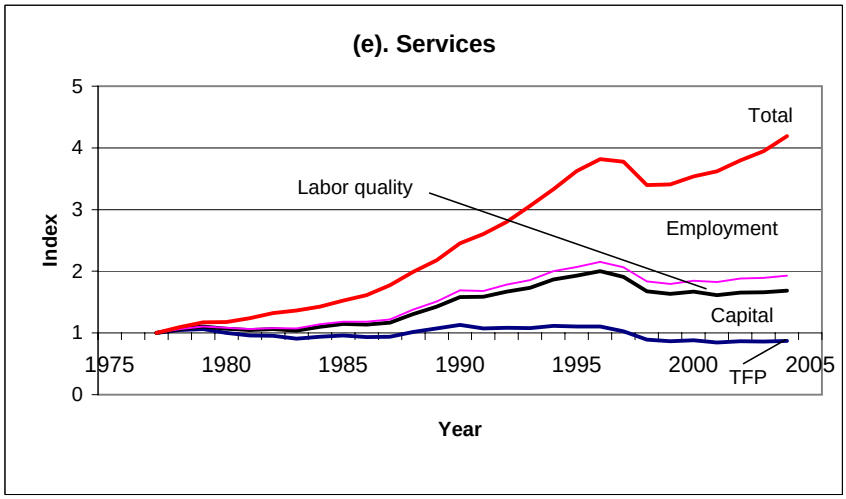


Table 10. Sources of Growth, Major Service Industries, 1980-2003

Average annual pecentage rate of change

	Output	Contribution of:				
		Labor			Capital	TFP
		Total	Employment	Quality		
Transportation and Communications						
1980-1996	9.2	3.6	3.1	0.4	2.6	2.8
1996-2003	3.7	1.4	0.6	0.9	0.9	1.2
1980-2003	7.5	2.9	2.3	0.6	2.1	2.3
Wholesale and Retail Trade						
1980-1996	7.2	3.1	2.7	0.4	3.8	0.2
1996-2003	-1.3	2.0	1.6	0.4	0.2	-3.4
1980-2003	4.5	2.8	2.3	0.4	2.7	-0.9
Banking, Insurance and Finance						
1980-1996	14.1	4.3	4.0	0.3	2.5	6.8
1996-2003	-9.0	0.5	0.2	0.3	1.0	-10.3
1980-2003	6.5	3.1	2.8	0.3	2.0	1.2
Public Administration						
1980-1996	5.0	4.8	4.1	0.7	0.5	-0.3
1996-2003	4.4	1.5	0.1	1.4	0.3	2.6
1980-2003	4.8	3.8	2.9	0.9	0.4	0.6
Other Services						
1980-1996	6.4	3.0	2.8	0.3	3.5	-0.2
1996-2003	3.1	3.1	3.0	0.1	0.8	-0.8
1980-2003	5.4	3.0	2.8	0.2	2.7	-0.4
Total Services less Housing						
1980-1996	7.9	3.4	3.0	0.4	3.2	1.2
1996-2003	0.3	3.0	2.2	0.8	1.0	-3.6
1980-2003	5.5	3.3	2.8	0.5	2.5	-0.3

Sources: Output and capital data were supplied by the national accounts division of NESDB. The measures of employment and educational attainment were calculated from historical data files of the Labor Force Survey, provided by the National Statistical Office.

Table 11. Sources of Growth in East Asian Economies, 1975-2000

average annual percentage change

Region/Period	Output	Output per Worker	Contribution of: Physical Capital	Education	Factor Productivity
China	8.8	6.9	2.5	0.4	3.9
Indonesia	5.8	3.0	2.4	0.5	0.0
South Korea	7.3	4.8	3.0	0.7	1.1
Malaysia	6.9	3.7	2.2	0.6	0.9
Phillipines	3.0	0.2	0.8	0.4	-0.9
Singapore	7.7	4.4	2.1	0.5	1.8
Thailand	*6.5*	*4.1*	*2.1*	*0.5*	*1.4*
Taiwan	7.8	5.5	2.6	0.4	2.4

Source: Bosworth and Collins (2003)