

**Measuring Output and Productivity in
Thailand's Service-producing Industries**

**A Joint Project of
The National Economic and Social Development Board
and
The World Bank**



ACKNOWLEDGMENT

This report is the fruit of excellent collaboration between the National Economic and Social Development Board (NESDB) and the World Bank. It was prepared by a joint NESDB-World Bank team. The World Bank team members were Dr. Barry Bosworth and Dr. Kirida Bhaopichitr. The NESDB team comprised of Wanida Mahakit (Director of National Accounts Office), Wirot Nararak, Apichai Thamsermsukh, Saowanee Phoosakul, Wannapa Khlaisuan, Dr. Piyanuch Wuttisorn, and Suphannada Limpanonda. The teams received overall guidance from Arkhom Termpittayapaisith (NESDB Deputy Secretary-General), and Dr. Kazi Matin (Lead Economist, World Bank). The production of this document was handled by Ruangrong Thongampai at the World Bank.

The report has benefited greatly from the collaboration of representatives from government agencies and private sector in providing invaluable inputs and comments to the study. We are particularly indebted to the staff of the Bank of Thailand, National Statistical Office, Department of Land Transport, Office of the National Telecommunications Commission, and of the domestic airline companies, commercial banks, and telecommunications companies. Without them, we would not have been able to construct the new measures of productivity in the airline, trucking, banking, and telecommunications for Thailand.

Table of Contents

ACKNOWLEDGMENT.....	2
Executive Summary	4
Macroeconomic Overview.....	4
Total Economy.....	5
Major Sectors.....	5
Reallocation Effects.....	6
Output and Productivity in Service-Producing Industries.....	7
Detailed Industries Productivity Performance.....	7
Airlines.....	7
Commercial Banking.....	8
Telecommunications.....	9
Trucking.....	9
Implications and Recommendations.....	10
I. Macroeconomic Overview.....	13
Growth accounts.....	14
Reallocation Effects.....	19
II. Output and Productivity in Services.....	21
III. Detailed Industries Productivity Performance.....	26
Air Transportation.....	27
Commercial Banking.....	35
Telecommunications.....	42
Trucking.....	48
IV. Implications and Recommendations.....	51
References.....	58
Appendix A: Growth Accounting.....	i

Measuring Output and Productivity in Thailand's Service-Producing Industries

EXECUTIVE SUMMARY

The services sector is a substantial and growing component of the Thai economy, accounting for nearly half of aggregate production and 40 percent of national employment. Although government policies in emerging economies tend to focus on the growth of manufacturing, the service-producing industries in Thailand have been the dominant source of new job creation in recent years, expanding by 2.6 million jobs between 2000 and 2005 compared to just 1.6 million in the industrial sector. Yet, Thailand's national statistics paint a sobering picture of the performance of the services sector in recent years. Labor productivity fell sharply during the 1997-98 financial crisis and has remained stagnant ever since. The generally poor productivity performance of the services industry in recent years raises concerns about the potential of this sector to be an engine for gains in the real wages and living standards of Thai workers in the future. However, it is unclear whether these estimates reflect the accurate growth in services productivity, or are a result of the low quality of available data on service-producing industries in Thailand.

Thus, this report has three primary purposes. First, we review the methodology for computing productivity and apply that methodology to various levels of the Thai economy. Second, we construct measures of productivity performance in greater detail for four services industries that can be then be used for benchmarking purposes against other countries. Finally, we examine the procedures for measuring output and productivity in the services sector and suggest areas that are in need of improvement.

Macroeconomic Overview

The growth accounting framework allows us to allocate Thailand's economic growth over the past quarter century among the contributions of changes in factor inputs (labor and capital) and a residual called total factor productivity (TFP), which measures any efficiency changes in the use of those inputs. The growth account estimates provided

below are similar to those published by the National Accounts Office (NAO) of the National Economic and Social Development Board (NESDB), except for the inclusion of improvements in the educational attainment of the workforce, and an increase in the share of income attributed to labor to account for the contribution of the self-employed and unpaid family workers.

Total Economy

The growth accounting analysis for the total economy of Thailand highlights the composition of the slowdown in output growth brought about by the financial crisis of 1997-98. The measure of growth in output per worker (or labor productivity) is particularly important, because it provides a useful efficiency indicator and is similar to a measure of income per capita—the typical indicator of living standards. Output per worker declined from 4.7 percent in the pre-crisis period of 1980-1996 to 2.6 percent during 1999-2005. Thus, the reduced rate of labor productivity growth accounts for two-thirds of the overall growth slowdown in the post-crisis period. If we decompose the changes in output per worker into the contributions from increased physical capital per worker, education, and TFP, we observe a dramatic collapse of physical capital accumulation during 1999-2005. This has been offset by a somewhat higher rate of TFP growth, and the contribution from improvements in the educational level of the workforce has remained largely unchanged.

Major Sectors

Extending our analysis to the major sectors of the economy, we examine the composition of productivity growth for the agricultural, industrial and services sectors. In agriculture, growth in output and productivity appear to be relatively free of any lasting impact from the crisis. Since 1999, output growth has been close to the pre-crisis average while the proportion of the labor force employed in agriculture has steadily declined as workers find better opportunities in industry and services. Improvements in labor productivity have been largely due to increased capital per worker, and the gains in TFP have been small but persistent, averaging one percent per annum in 1999-2005.

In contrast, output growth in the industrial sector has slowed substantially, from an impressive average of 10 percent per year in 1980-96 to 6 percent per annum since 1999. Output per worker fell by one third after the financial crisis, which was predominantly due to a falloff of 3.8 percent per year in the gains attributed to increases in capital per worker. There is however, an offsetting acceleration in the residual calculation of TFP growth for the industrial sector, which suggests that some of the decline in the contribution of capital may be an overstatement.

The services sector experienced an extraordinary decline in both output and productivity as a result of the 1997-98 financial crisis. Although output recovered to exceed the 1996 level by 2003, labor productivity dropped by 10 percent during 1996-99, and has been largely stagnant in subsequent years. As in the industrial sector, the weak labor productivity growth is attributable to a sharp decline in capital accumulation. But unlike the industrial sector, services continue to exhibit a very low rate of gain in TFP: only 0.5 percent per year. Thus, the sector has been achieving very weak efficiency gains, as measured from the perspective of either labor productivity or TFP.

Reallocation Effects

It is important to note that gains to overall growth result not only from increases in labor productivity within each sector, but from movements in labor from low productivity sectors to those with higher productivity. An example of this second process is the movement of workers out of agriculture, where they are often underutilized, and into higher productivity jobs in industry and services. Indeed, this reallocation effect can be a very important source of growth for an economy such as Thailand, where today the level of output per worker in industry averages nine times that of agriculture and that of services is five times higher. Separating the sector gains in output per worker from the reallocation effects, it is clear that reallocation continues to be a strong contributor to the growth in aggregate labor productivity (and hence real incomes) after the crisis. Reallocation effects added 2 percent per year to growth in 1980-96 and 1.6 percent per year in 1999-2005. With a lower overall growth rate after 1999, the reallocation effects account for 60 percent of the total gain in labor productivity.

Output and Productivity in Service-Producing Industries

The services sector has shown the lowest rate of growth in both labor productivity and TFP over the past twenty-five years. In calculating the sources of growth for 10 major service-producing industries, perhaps the most striking feature is the large number of industries with negative rates of growth in labor productivity. Five out of the ten major service-producing industries (wholesale and retail trade, hotels and restaurants, finance, real estate, and health and social work) all displayed negative rates of growth in output per worker during 1993-2005. Given the use of cost-reducing technologies and the accumulation of knowledge that typically contribute to improved efficiency over time, a finding of sustained negative rates of productivity growth within an industry is difficult to rationalize. Overall, the productivity measures of service industries are suggestive of severe measurement problems in the construction of the output estimates and of difficulties in aligning the measures of industry output and employment.

Detailed Industries Productivity Performance

Finally, we analyze the productivity performance at a more detailed level for four key service-producing industries: airlines, commercial banking telecommunications, and trucking. Since all four industries are important parts of the business infrastructure, improvements in their productivity can have substantial benefits for resource allocation and competitiveness in the broader economy. For each industry, we construct measures of output and productivity that facilitate international comparisons of productivity performance, so that Thailand's industries can be benchmarked to those in other countries, particularly those in Southeast Asia.

Airlines

Output growth in Thailand's airline industry declined after the financial crisis, from an exceptional average rate of 10 percent per year during 1993-96 to just 5 percent per annum in 1999-2006. The contribution of employment to output growth declined to 0.7 percent per year, while capital's contribution to output fell to one-third its pre-crisis rate. The airline industry continued to record significant gains in TFP, but at only half

the rate of 1993-96. In relation to Malaysia, Singapore, and the United States, Thailand's airline industry has achieved steady gains in efficiency, but its level of labor productivity and TFP remain below those of Singapore and the U.S. Much of the difference lies in the area of labor productivity, which is to some extent expected as lower wage rates in Thailand create opportunities to improve service through greater use of labor.

Commercial Banking

An evaluation of the productivity and efficiency of the banking industry is particularly important because of the contribution that a strong banking system can make to financial stability and overall economic growth. However, the longstanding debate on how to measure banking output has yielded no conclusive methodology, and most measures focus on various physical indicators of bank services.

We develop two trial indexes of banking output and compare them to the official output index from Thailand's national accounts. Our trial indexes display reasonably similar results, yet both differ substantially from the national accounts' measure, particularly since the beginning of the financial crisis in 1997. The differences result because none of the physical measures used in the trial indexes provide any evidence of a sharp drop in bank activity after 1997. Instead, the output indexes imply that all of the fall in reported bank income was due to capital losses (nonpayment of loans), rather than a reduced flow of bank services. Similarly, the large sustained falls in labor productivity and TFP evident in the official output index seem implausible. Given the fact that both employment and the capital stock are again growing, it is difficult to argue that the industry is still in disequilibrium. It is far more likely that the Thai banking industry has achieved substantial productivity gains under the pressures of the financial crisis and the emergence of new IT technologies.

Regrettably, we were unable to compare the output and productivity of Thailand's banking industry with other Asian economies due to a lack of comparable data. Yet, a simple comparison of operating-expense ratios suggests that Thailand's banks have operating costs similar to banks in India, but higher costs than those in Taiwan or Australia.

Telecommunications

The telecommunications industry in Thailand has been a major source of growth over the past decade, as the explosion of mobile services has brought telephone coverage to nearly 75 percent of the population. Because mobile communications require a much less expensive infrastructure than the traditional fixed-line service, Thailand has been able to upgrade its telecommunications to a level approaching that of higher income countries at a fraction of the cost. As such, labor productivity in Thailand and Malaysia has soared well above that of the United States. Similarly, output per unit of capital has also increased dramatically in Thailand, and is well above that of both Malaysia and the United States. The high output growth in this industry is largely a result of large contributions of capital during the 1993-2000 period. After 2000, output growth is largely driven by increases in TFP as the utilization of the new network increases at a rapid pace. It remains to be seen, however, if the mobile technology will be able to provide the full range of internet and broadband services that are becoming critical parts of the communications infrastructure in higher-income countries.

Trucking

The efficient performance of the logistic industry is critical to enhancing the integration of Thailand's industries into the global economy. Trucking in particular provides an indispensable network between inland production centers and the seaports that provide a link to global trade. Despite its importance, there are severe data limitations on the output, employment, and capital stock of the trucking industry. Using an output index based on a freight-tonnage measure from the Ministry of Transport, we calculate upper bound estimates of growth in labor productivity and TFP. There has been substantial growth in labor productivity, averaging about 3 percent per year during the 1991-2005 period. Given the rapid increase in the stock of trucks, however, the growth in TFP has remained modest, at about one percent per year. This appears to result largely from the shift toward larger trucks, rather than just an increase in the number being utilized.

Implications and Recommendations

The frequency with which we found negative rates of growth in labor productivity in the service-producing industries suggests that the growth of output in these industries is being underestimated in Thailand's national accounts. Thus, it is equally likely that the rate of growth of total GDP is being underestimated as well. An alternative explanation for the negative rates of productivity change is a systematic over-estimation of the growth of employment in these industries. However, there is no obvious reason for the employment estimates provided by the labor force survey to be overstated.

The analysis is most suggestive of an underestimation of output growth for the industries that displayed strong negative trends in productivity: trade, hotels and restaurants, finance, and business services. In contrast, we obtained significantly positive estimates of productivity growth in the public administration and education industries. Since the typical methodology for these industries should have produced a constant level of labor productivity, a review of the productivity growth estimates for these industries should be considered in future work.

The problems of estimating output and productivity in the service-producing industries arise largely because of the lack of basic survey information on these industries that could be used in the construction of the national accounts. Measures of the economic performance of the service sector are underrepresented in the statistical systems of many countries. The reasons for the bias in favor of agriculture and industry are several. First, there are unique difficulties in defining and measuring the intangible output of some service-producing industries. Second, attitudes toward the production of services were strongly influenced in the early stages of industrialization, when the focus was on the need to increase the production of food and other material necessities of life. Finally, as few services were historically tradable across national borders, they could not be used to finance the purchase of advanced capital equipment and other products that were unavailable in the domestic economy.

As such, the statistical systems of many countries continue to underinvest in information on the service-producing industries. Thailand is no exception in this regard. We have highlighted below a number of data or measurement problems that limit the statistical system of Thailand to generate quality measures of productivity performance in the services sector, along with some proposed solutions.

Data or Measurement Problem	Proposed Solution
Thailand has no comprehensive economic census for the services industries and annual surveys are limited to a few select industries. Information on employment is limited.	A series of regular surveys of the service industries, building on the Business Trade and Services Survey conducted by the NSO.
Assuring completeness of coverage is difficult due to the large informal sector.	Utilize a ‘labor input’ method supplemented with special surveys that examine the value added of informal workers in more detail.
The output price deflators employed for services do not accurately distinguish between price and quality changes.	Build on the experience of other countries in developing effective models for measuring price change in service-producing industries.
Need for detailed explanation of the sources and methods used to construct the national accounts	Information is available on the web site of the National Accounts Office of the NESDB, but only in Thai.

Measuring Output and Productivity in Thailand's Service-Producing Industries

The services sector accounts for nearly half of aggregate production and 40 percent of employment in Thailand. It is also the dominant source of new job creation. Between 2000 and 2005, employment expanded by 2.6 million in the service-producing industries compared to 1.6 million in the industrial sector. Yet, services are frequently disparaged as a source of low-wage, low productivity jobs, and they are characterized as industries with limited opportunities for growth and innovation. Government policies in many emerging economies have consistently been directed at promoting the growth of industry, and often at the expense of services.

These attitudes are beginning to change, however, as both the public and government policy-makers come to appreciate the wide diversity of industries within the service sector and the opportunities that services offer for employment growth. Some service industries have emerged as major areas of innovation, principally as users of information technology and communications (ITC) capital. Others provide a critical logistics infrastructure that supports the growth of manufacturing. Services also include the provision of public services, particularly the rapidly growing areas of education and health. Furthermore, the expansion of international competition in the provision of services in the aftermath of the General Agreement on Trade in Services (GATS) has increased interest in evaluating the performance of service industries. The efficiency of Thailand's services sector will be an important determinant of its success in an emerging competition to be a primary business center for the global production system.

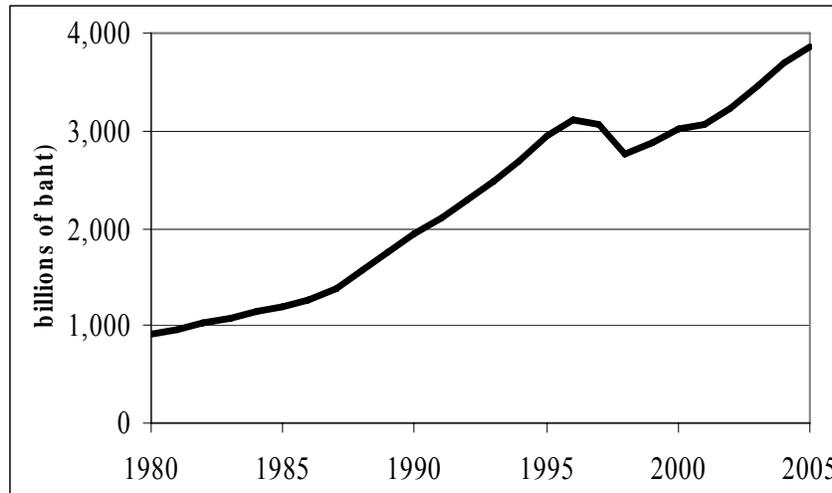
At the same time, there are reasons to be concerned about the performance of Thailand's services sector. While it is the sector of fastest employment growth, labor productivity fell sharply during the 1997-98 financial crisis and has remained stagnant in subsequent years. The sector's generally poor productivity performance raises concerns about the potential for future gains in the real wages and living standards of Thai workers. We are uncertain, however, that the estimates of low productivity growth in services are indicative of the reality; perhaps they are an artifact of the low quality of the available data on service-producing industries.

Hence, this project has three primary objectives. First, we review the methodology for computing labor productivity and total factor productivity and apply it to an analysis of productivity trends at the level of the total economy, three major sectors, and the principle service-producing industries. Second, we use the available data on four industries (airlines, communications, banking and trucking) to construct measures of productivity performance in Thailand that can be compared or benchmarked to the industry performance in other countries. Finally, in a concluding section we use the results of the analysis to evaluate the procedures used to measure output and productivity in the service-producing industries, and suggest areas that are in the greatest need of improvement.

I. Macroeconomic Overview

Thailand has had a very limited economic recovery from the 1997-98 financial crisis. As shown in Figure 1, GDP fell in both 1997 and 1998 and did not recover to the level of 1996 until 2002. Output growth averaged 8 percent per year over the period of 1980-96, but only 5 percent per annum for 1999-2005. The output loss was particularly severe in services where it fell by 11 percent between 1996 and 1998, and has been growing at an average of only 4 percent per annum since 1999. In the next section, a set of growth accounts, covering the total economy and the three major sectors of agriculture, industry, and services, is used to highlight some key features of growth in recent years.

Figure 1. Total Economy: GDP Growth, 1988 prices



Source: NESDB, National Income of Thailand, various years.

Growth accounts

The growth accounting framework allows us to allocate Thailand's economic growth over the past quarter century among the contributions from changes in its factor inputs (capital and labor) and a residual, typically called total factor productivity (TFP). In this context, TFP is best interpreted as a measure of improvements in the efficiency with which the factor inputs are used.

The methodology is explained in more detail in Appendix A, but essentially indexes of the growth in the capital and labor inputs are combined into a single index using shares of capital and labor income weights, and the excess of the growth in output relative to that of the inputs is attributed to TFP. The measures of output (value added) and the capital stock are published by the National Accounts Office (NAO) of the National Economic and Social Development Board (NESDB) and the employment estimates are obtained from the labor force survey of the National Statistical Office (NSO). The growth account estimates for the total economy are similar to those published by the NAO in its annual volume on the capital stock, except for the inclusion of improvements in the educational attainment of the workforce, and an increase in the share of income attributed to labor to account for the contribution of the self-employed and unpaid family workers.

The adjustment for educational attainment is illustrated in the appendix. It assumes that the earnings (productivity) of workers in Thailand rise by an average of seven percent for each year of schooling. The second adjustment to labor's share is required because the national accounts include only the wages paid to employees as labor compensation. The incomes of the self-employed and family businesses are classified as mixed income since they represent both returns to labor and capital. Since employees still constitute a relatively small share of Thailand's workforce, their share of national income greatly understates the contribution of labor to production. Within the industry and services sectors, we used the ratio of total employment (including the self-employed and unpaid family workers) to the number of employees to scale up the published data on the share of income paid to workers. In effect, the labor input of non-employees is valued the same as employees. The published labor shares are increased by about 20 percent in industry and doubled in services.¹ However, the self-employed and unpaid family workers are so dominant in agriculture that information on employee wages provided very little guidance to the contribution of labor. We relied instead on estimates of factor income shares from various Social Accounting Matrixes (See TDRI, 1998).

Total economy. A summary of the result for the total economy are shown in Table 1 with a focus on three periods: the full 25-year span from 1980 to 2005, the pre-crisis years up to 1996, and a post-crisis interval that skips over the worst years of the crisis and begins with 1999. The first row shows the average annual rate of growth in total GDP. Not only did output growth not rebound from the 1997-98 crisis, but the rate of growth in subsequent years, 5 percent per annum, has been much below the 8 percent pace of the pre-crisis years.

¹ Additional detail on the data sources and adjustments are provided in the data appendix that accompanies this report.

Table 1. Sources of Growth, Total Economy

	1980-2005	1980-1996	1999-2005
Output	5.9	8.0	5.0
Employment	2.6	3.3	2.4
Output per worker	3.3	4.7	2.6
Contribution of:			
Capital	2.0	2.7	0.0
Education	0.4	0.4	0.5
Factor Productivity	0.9	1.6	2.2

Source: Author's calculations are explained in text.

As shown in the second row, a significant portion of the growth slowdown has been absorbed in a lower rate of employment growth, about one percent less per year compared to the average of 1980 to 1996. However, most of this change can be traced to a reduced rate of growth in the population of working age, rather than a lessening of employment opportunities.²

The growth in output per worker is shown in the third row. Much of the following discussion focuses on this performance measure – both because it provides a useful indicator of efficiency, and because it is similar to a measure of income per capita – the typical indicator of living standards. In this instance, it shows that a reduced rate of labor productivity growth accounts for two-thirds of the overall growth slowdown in the years after the crisis.

The remaining rows of table 1 decompose the gains in output per worker into the contributions from increased physical capital per worker, education (human capital per worker), land and TFP (a broader measure of the efficiency of using both capital and labor). The most dramatic aspect is the post-crisis collapse of physical capital accumulation. Its contribution falls from an annual average of 2.7 percent in 1980-96 to zero in the years after 1999. Previous growth in Thailand was dominated by strong capital accumulation, but that is no longer true. The investment rate fell sharply during

² At the level of the total economy changes in employment will largely reflect demographic factors or variations in the labor force participation rate because unemployment is not a realistic alternative for most workers. Furthermore, the labor force did grow at a very slow rate in the first half of the 1990s.

the financial crisis and has yet to recover to its prior level. There has been a partial offset of a somewhat higher rate of TFP growth and the contribution from improvements in the educational level of the workforce has remained unchanged.

Major sectors. The extension of the growth accounts to each of the three major sectors of the economy provides some additional insights into the patterns of growth before and after the 1997-98 crisis. The agricultural or primary sector includes farming, forestry and fishing. The industrial sector consists of mining, manufacturing, construction and public utilities. Services is a residual collection of very diverse industries, including trade, transportation, and the output of the public sector.³

As shown in Table 2, the agricultural sector appears to be relatively free of any lasting impact of the crisis. Since 1999, output growth has been close to the pre-crisis average and the proportion of the labor force employed in agriculture has steadily declined as workers find better opportunities in industry and services. Improvements in labor productivity can be largely attributed to increased capital (mechanization) per worker. The gains in TFP have been small but persistent, averaging one percent per annum in 1999-2005.

Table 2. Sources of Growth, Agriculture

	1980-2005	1980-1996	1999-2005
Output	2.8	3.4	2.9
Employment	0.5	1.0	-0.2
Output per worker	2.3	2.4	3.1
Contribution of:			
Capital	1.9	1.6	1.9
Education	0.2	0.2	0.2
Factor Productivity	0.2	0.6	1.0

Source: Author's calculations as explained in text.

The results for the industrial sector are reported in Table 3. Output growth has slowed substantially – from a spectacular average of 10 percent per year in 1980-96 to 6 percent per annum since 1999 – and improvements in labor productivity have averaged

³ The agriculture (or primary) sector encompasses those activities grouped within the International Standard Industrial Classification (ISIC) codes 1-5, industry includes all activities within 6-45, and services covers the activity codes of 50-95.

only a third of the pre-crisis rate. Most notably, there is a very sharp falloff, 3.8 percent per year, in the gains attributed to increases in capital per worker. There is, however, an offsetting acceleration in the residual calculation of TFP growth.⁴

Table 3. Sources of Growth, Industry

	1980-2005	1980-1996	1999-2005
Output	7.6	10.1	6.1
Employment	4.9	7.0	5.1
Output per worker	2.7	3.1	1.0
Contribution of:			
Capital	1.9	2.5	-1.2
Education	0.4	0.3	0.3
Factor Productivity	0.4	0.2	2.0

Source: Author's calculations as explained in text.

The services sector experienced an extraordinary decline in both output and productivity in the 1997-98 financial crisis. But while output recovered to exceed the 1996 level by 2003, labor productivity dropped by 10 percent between 1996 and 1999 and it has been largely stagnant in subsequent years. The performance of TFP has been even worse: it declined by 21 percent between 1996 and 1999 and the 2005 index value was still 21 percent below that of 1996. As summarized in table 4, the post-1999 slowing of output growth is only marginally less pronounced than that of industry, an average annual growth of 4.3 percent since 1999 relative to 7.6 percent in the 1980-96 period. The weak labor productivity growth, as with industry, is attributable in turn to a sharp falloff in capital accumulation. Unlike the industrial sector however, services continue to exhibit a very low rate of gain in TFP, only 0.5 percent per year. Thus, the sector has been achieving very weak efficiency gains, as measured from the perspective of either labor productivity or TFP. The failure of productivity to recover to prior levels well after the crisis is puzzling. It can no longer be attributed to cyclical factors.

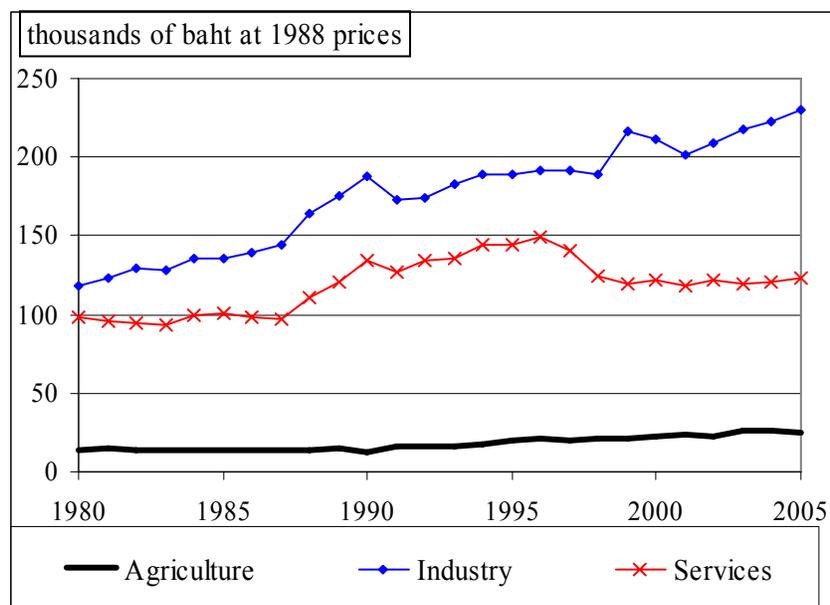
⁴ Because TFP is computed as a residual, it is possible that it is a reflection of an overstatement of the large falloff in capital accumulation. Perhaps capital equipment has not been retired as rapidly as implied by the estimates of the capital stock. This concern with measurement errors would diminish if the TFP gains are sustained in future years.

Reallocation Effects.

Gains to overall growth result not only from increases in labor productivity within each sector, but from movements in labor from low productivity sectors to those with higher productivity. An example of this second process is the movement of workers out of agriculture where they are often underutilized into higher productivity jobs in industry and services. Indeed, this reallocation effect has been a very important source of growth for economies, such as Thailand, with a large initial share of the workforce in agriculture. The process can be illustrated by focusing first on sector differences in the level of labor productivity.

Figure 2 shows the evolution of output per worker by sector for the period of 1980-2005. The level of output per worker in industry has averaged nine times that of agriculture and that of services is five times higher. Obviously, the shift of workers out of agriculture into the other sectors will have a large impact on economy-wide labor productivity even without productivity growth within the sectors. The share of the labor force in agriculture has declined from 63 percent in 1980 to 40 percent in 2005, implying a substantial gain from labor reallocation.

Figure 2. Value added per Worker, by Major Sector, 1980-2005



How much of the aggregate economic growth can be attributed to sector gains in output per worker versus reallocation effects? A simple measure of the contribution from each sector is provided by the sector's growth rate (shown in Table 2, Table 3, Table 4), weighted by its share in total value added.⁵ The difference between total growth and the sum of the weighted sector contributions provides a (residual) measure of the effects due to labor reallocation. The results of that calculation are presented in

⁵ More formally, the increase in economy-wide labor productivity, LP, is given by

$$d \ln LP^V = \left[\sum_i w_i d \ln LP_i^V \right] + \left[\sum_i (w_i - e_i) d \ln L_i \right]$$
, where w_i is the share of value added in industry i , e_i is the employment share, and L_i is employment. The reallocation effect will be large if employment growth is concentrated in high value-added industries.

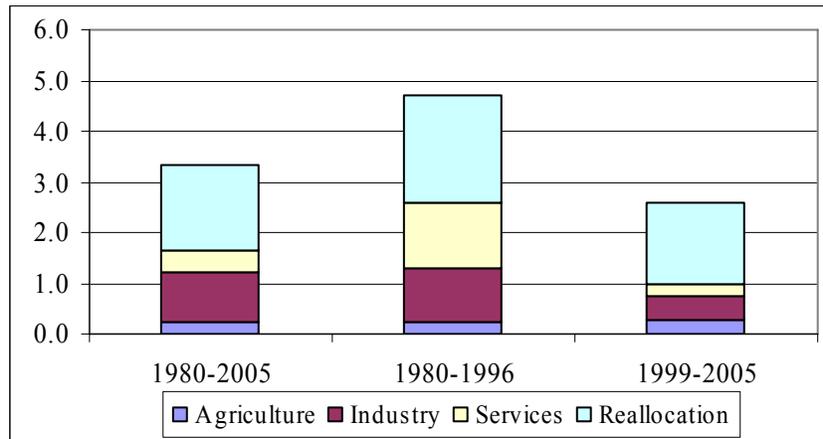
Figure 3. In contrast to the sharp falloff of productivity growth within industry and services, labor reallocation continues to be a strong contributor to the growth in aggregate labor productivity (and hence real incomes) after the financial crisis. Reallocation effects added 2 percent per year to growth in 1980-96 and 1.6 percent per year in 1999-2005. With a lower overall growth rate after 1999, the reallocation effects account for 60 percent of the total.

Table 4. Sources of Growth, Services

	1980-2005	1980-1996	1999-2005
Output	5.4	7.6	4.3
Employment	4.5	5.0	3.8
Output per worker	0.9	2.6	0.5
.....			
Contribution of:			
Capital	0.9	1.6	-0.5
Education	0.4	0.3	0.6
Factor Productivity	-0.4	0.7	0.5

Source: Author's calculations as explained in text.

Figure 3. Reallocations and Sector Contributions to Labor Productivity Growth



Source: Author's calculations as explained in text.

Overall, Thailand has experienced a substantial slowing of growth in the years since the financial crisis. The slowdown is evident in both the industrial and services sectors of the economy where gains in labor productivity have been disappointing. In both sectors, a substantial portion of the falloff in productivity growth can be traced to a much reduced rate of capital accumulation, which never recovered to pre-crisis levels. In addition, the services sector stands out with negative rates of change in TFP over the full 25-year span and only small gains in both labor productivity and TFP in recent years. The next section addresses this concern by providing a more detailed analysis of productivity in the service-producing industries.

II. Output and Productivity in Services.

The services sector has had the lowest rate of growth in both labor productivity and TFP over the quarter century of 1980-2005. It also was the most severely affected by the 1997-98 financial crisis. In this section, the sources of the poor productivity performance are explored in more detail. Value added estimates are published in Thailand's national accounts for 10 service-producing industries, providing an opportunity to identify the specific industries that have contributed to the poor productivity performance. However, data organized on the ISIC Rev.3 classification system are published only beginning with

1993.⁶ Employment estimates for these industries are also available from the labor force survey (LFS) of the NSO.⁷ These data are used to construct the estimates of labor productivity for the 10 industries shown in Table 5.

Table 5. Sources of Growth, Major Service Industries, 1993-2005

Average annual percentage rate of change

	Share of GDP (1)	Annual Growth Rate			Contribution of:		
		Output (2)	Employment (3)	Output per worker (4)	Capital	Education	TFP
					(5)	(6)	(7)
Wholesale and Retail Trade	29.5	1.9	3.9	-1.9	-0.4	0.3	-1.8
Hotels and Restaurants	12.1	2.7	5.6	-2.7	-1.6	0.1	-1.2
Transportation, Storage and Communications	17.7	6.0	1.8	4.1	2.1	0.4	1.7
Transportation and Storage	14.1	4.6	1.9	2.7	1.8	0.5	0.5
Communications	3.6	8.7	0.5	8.2	4.2	0.1	3.9
Finance	9.6	-1.9	2.0	-3.8	0.7	0.1	-4.6
Real Estate, Renting and Business Activities	6.0	3.6	7.1	-3.3	-3.1	0.0	-0.2
Public Administration and Defense	9.6	4.7	2.6	2.1	0.2	0.8	1.1
Education	8.7	4.3	2.7	1.5	0.3	0.1	1.1
Health and Social Work	4.0	5.1	5.2	-0.1	0.4	0.0	-0.5
Other Services	2.5	8.0	5.5	2.3	0.1	0.8	1.4
Total Services	100.0	3.1	3.9	-0.8	0.3	0.4	-1.5

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. the methodology is described in Append A.

At the industry level, output can be measured either by gross output or value added.⁸ An accounting system that provides separate measures of gross output, value added and purchased inputs aligns more clearly with the concept of a production process that transforms inputs into outputs. It can also explicitly account for changes in the degree of outsourcing of parts of the production process. However, the accounting also involves more detailed data requirements for the separate measurement of the volume of output and purchased inputs. At this stage of our analysis, we opted for the simpler framework in which output is measured by value added.

⁶ The shift between ISIC 2 and ISIC 3 resulted in few significant classification changes across the boundaries between the three major sectors and it had only minor effects on the classification of industries within agriculture and industry. It does result in significant classification changes within services.

⁷ It is important to note that a household survey is seldom a reliable source of the distribution of employment by industry because the respondents are unlikely to have detailed knowledge of the industry of employment for all members of the household. The issue of the quality of the estimates is discussed more extensively below.

⁸ At the level of major sectors or the total economy, most growth accounting studies emphasize value added because gross output involves an excessive degree of double counting of the gross transactions of the underlying industries.

The percentage composition of value added among the ten service-producing industries is shown in column (1) of the table. Wholesale and retail trade is the largest single industry group (30 percent), and three industries dominated by government (public administration and defense, education, and health) account for another 22 percent. Transportation and hotels and restaurants are other large categories.

Column (2) reports the growth of output of each industry for the period of 1993 - 2005. The concentration of the 1997-98 crisis in finance is clearly evident in the negative growth rate for that industry. In addition, the low rate of growth in the trade sector, 1.9 percent per annum, is a bit of a surprise given the 3.6 percent annual rate of growth in private consumption expenditures over the same period. The trade sector is normally viewed as a margin industry, buying goods at wholesale and reselling to consumers. Thus, its growth would normally be roughly proportionate to that of total consumption. The reported low growth rate implies a substantial decline in the gross trade margin (sales less cost of goods sold) over the 12-year period. Some of the narrowing of the margin might be attributed to increased competition; but it also reflects inconsistencies between the measurement of retail price changes in the consumer price index and wholesale price changes as reported in the producer price index.

The strong growth of output in communications is a reflection of the telecommunications revolution that has swept through Thailand in recent years with widespread adoption of cellular phones. The data on real estate are not particularly meaningful because they are dominated by the imputations for output of owner-occupied housing. Unfortunately, information is not available to construct measures of the output of business services separate from that of real estate. Output in the three public-sector industries has also exceeded the growth in the total economy by about one percent per year.

Estimates of employment growth from the LFS are shown in column (3) and used to compute the estimates of growth in labor productivity set out in column (4). The most striking feature is the large number of industries with negative rates of growth in labor productivity. The -3.8 annual rate of change for finance is not surprising, but the -3.2 rate of change for real estate and business services is unexpected. We believe that it reflects

the lack of reliable data on the output of business services, rather than a decline in productivity growth. If owner-occupied housing is subtracted from the total for this industry, the residual, which should be composed largely of business services, shows very little growth over the 12-year period. That contrasts with the very rapid employment growth reported in the LFS survey. The negative rates of growth for trade and hotels and restaurants are even more striking because they represent large shares of the output and employment of the services sector. Again, the report of very strong employment growth in these industries by the LFS contrasts with the weak reported gains in output.

A finding of sustained negative rates of productivity growth within an industry or firm is difficult to rationalize. The use of cost-reducing technologies and the accumulation of knowledge typically contribute to improved efficiency and positive productivity growth over time. It could be questioned how firms could continue to survive in the market in the situation of continual declines in their efficiency. Instead, negative rates of productivity change may indicate possible measurement problems, either because the output growth is underestimated or the industry classification of output and employment are not well aligned.

Strong productivity growth is reported only for transportation and communications. The result seems plausible since telecommunications, in particular, has experienced large technological innovations with the spread of mobile phones. Transportation has also benefited from significant increases in the quality of the capital stock. These are also industries where it is possible to construct good measures of real output because of the existence of well-defined measurement units.

Finally, it is surprising that the industries dominated by the public sector exhibit significant positive growth in labor productivity. Lacking meaningful measures of prices and real output for these type of services, most national accounts offices (and Thailand is no exception) elect to construct estimates of real output based on the assumption of no productivity growth. Either employment is used to extrapolate the index of physical output or a wage rate is used to deflate the employee compensation share of value added. The NAO in Thailand uses the wage rate as a deflator. The sustained positive growth

shown in the table suggests that the LFS estimates of employment do not match well with the employment data that underlies the construction of the government sector accounts.⁹

Some data on the number of government employees are available from administrative sources for categories such as public administration, and the ministry of education and public health. However, those data do not resolve the puzzle since the growth of employment over the past 12 years is slower than reported in the LFS. Hence, they imply even larger increases in labor productivity. This is a statistical puzzle that should be resolved in future work on the national accounts.

Columns (4)-(6) show the results of some preliminary efforts to extend the growth analysis to include the contribution of capital per worker and TFP, using the same methodology as for the aggregate sectors. However, the results should be viewed only as illustrative because the estimates of the capital stocks have not yet been converted to the new industrial classification, and there are major problems with obtaining reasonable estimates of the factor shares to use in aggregating the capital and labor inputs. Because a large proportion of the workforce in industries such as trade, hotels and restaurants, and personal services are not regular scheduled employees, the labor shares require large adjustments. The measures of TFP change largely parallel those for labor productivity, with a disproportionate number of industries with negative changes.

Overall, the productivity measures of services industries are suggestive of severe measurement problems in the construction of the output estimates and difficulties of aligning the industry classification of output and employment from the LFS. In fact, it seems reasonable to conclude that the output of the service sector is biased downward, on the basis that a finding of consistent negative change in the productivity measures is not a plausible outcome. The low quality of the measures is not a surprise, given the lack of underlying source data on the service industries in Thailand.

⁹ There are significant private producers in education and health, but as with the public producers, there is no simple technique for measuring the price change.

III. Detailed Industries Productivity Performance

In this section we undertake an analysis of productivity performance at a more detailed level for four key service-producing industries: airlines, communications, banking, and trucking. All four industries are important parts of the business infrastructure, providing logistics and other forms of support to the rest of the economy – particularly manufacturing. Because they are important intermediate sectors, improvements in their productivity can have substantial benefits for resource allocation and competitiveness in the broader economy. Except for banking, these are also industries where it is feasible to construct measures of output that circumvent the general lack of price deflators for services output. Output can be defined directly in terms of physical units, such as passenger/ton kilometers. Banking is a more challenging case because it is difficult to define a meaningful measure of output; and at the international level, the definition of bank output has been a subject of substantial debate. However, the banking system was at the center of the 1997-98 financial crisis, and it is important to assess its performance since that time.

A major objective is to construct measures of output and productivity that will facilitate international comparisons of productivity performance. We describe and illustrate a methodology with which Thailand's industries can be benchmarked to performance in other countries, particularly those in Southeast Asia.

International comparisons of productivity levels are more complex than the more normal comparisons of changes over time within a single economy. A focus of changes over time permits a simple conversion of the data on output and the inputs to indexes, eliminating concerns about units of measurement. In contrast, the comparison of productivity levels requires maintaining information on the measurement units and the international dimension raises the issue of how to convert national output data to a common currency.

We can distinguish three broad methods for cross-national comparisons. The first simply uses commercial exchange rates to convert the data into a common currency. It is appropriate for comparing goods that are traded extensively in international markets where we could expect a cross-border equalization of prices. Examples might be various

basic commodities.¹⁰ The vast majority of national production, however, is composed of goods and services that trade across borders in limited amounts or not at all.

A second approach, used at the level of the aggregate economy, uses Purchasing Power Parity (PPP) exchange rates that have been constructed on the basis of a broad sample of products, matched across countries. Such estimates are available for the aggregate GDP of most countries, but there are few reliable estimates of the PPP exchange rate at the level of individual industries. PPP vary widely across product groups and industries, depending in part on their exposure to international trade. In addition, most of the underlying price comparisons of the PPP are based on goods rather than service prices. Efforts have been made to construct PPPs at the level of individual industries, but they are largely limited to manufactured products (Ark and Timmer, 2006).

The third method uses quantity indicators that can be directly compared across countries, and it thereby avoids the problem of currency conversions. This method has been used for transportation and telecommunications, industries where output can be defined in terms of ton-kilometers (transport) and subscriber lines (communications). The problem is that the output of only a few service-producing industries can be summarized with a simple count of physical units. This method is employed in the international comparisons presented in the following sections.

Air Transportation

Thailand's air transport is dominated by the national air carrier, Thai Airways International. There other small airlines operating out of Bangkok -- Bangkok, Orient-Thai, and Nok Airlines are the most prominent – but they have a small share of the domestic market. There is greater competition on the international routes, but it is still not a fully competitive market because of extensive government control of the routes. Bangkok's primary airport has consistently been one of the world's twenty busiest.

¹⁰ The use of commercial exchange rates might also be justified when the analysis is limited to services that are being provided to international business firms.

Output and Productivity. We have been able to compile data on airline operations in Thailand covering the period of 1993-2006. Initially, we constructed measures of productivity performance in the industry using the same basic methodology as in the prior discussion of performance in the major sectors. Revenue shares in passenger and freight transport were used to compute a Tornquist index of output based on a weighted average of passenger revenue kilometers, and freight-ton kilometers.¹¹ Our constructed index of output closely parallels the estimate used by the NAO in the national accounts. The employment measure is employees of the airlines and excludes airport employees, and the factor income shares were supplied by the NAO.

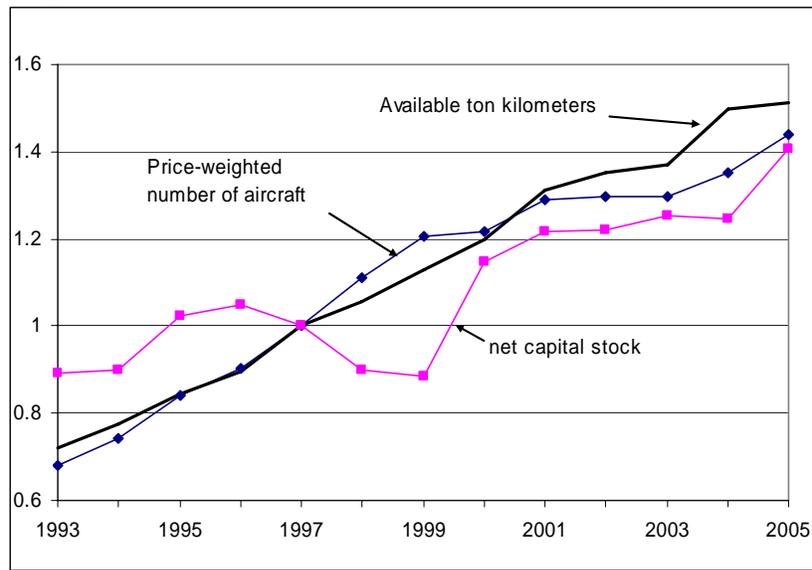
We experimented with several different measures of the capital input. The first was an estimate of the net capital stock of the airlines constructed by the staff of the NAO from information on investment and assumed rates of depreciation. This is a perpetual inventory method based on purchase of aircraft and an assumed rate of depreciation. The concern was that this measure may not reflect the growing practice of leasing aircraft and it is difficult to include maintenance expenditures that offset some of the normal depreciation. The second estimate was based on a simple aggregate of the number of planes in the fleet using relative prices of 2000-2005 as weights to add up different models. A third is available ton miles (capacity offered for sale multiplied by kilometers flown), which is a common capacity measure used by the airlines.¹² As shown in

¹¹ The Tornquist output index is a weighted geometric mean of the passenger and freight measures using average revenue shares of the two adjacent years.

¹² The capacity measure was only available for Thai Airlines.

Figure 4, the net capital stock estimate shows a decline in 1996-99 that is not evident in the other measures. The divergence may reflect delays in the retirement of aircraft during the crisis years. We based the productivity estimates on the price-weighted number of aircraft, believing that the price weights would capture some of the variation in aircraft size and quality.

Figure 4. Alternative Indexes of Airline Capital, 1993-2005



Source: National Accounts Division of NESDB and computations explained in text.

A summary of the productivity estimates is provided in

Table 6. The airline industry expanded rapidly in the years prior to the financial crisis, with an average real output growth rate of 10 percent per year in 1993-96; but in recent years output growth has been more volatile and has averaged a lower 5 percent per annum in 1999-2006.¹³ The deceleration of growth was also apparent in employment, which slowed from a 5 percent rate of increase in 1993-96 to 3 percent in 1999-2006. Its contribution to output growth was a modest 0.7 percent per year. The contribution of capital decreased as well to two percent per year, a third of its prior rate. The industry continued to record significant gains in TFP, but at only about half the rate of 1993-96.

¹³ Growth was negative in 2003 and was severely affected by the tsunami in 2005.

Table 6. Sources of Growth in Air Transport, Thailand
annual rates of change

	1993-2005	1993-1996	1999-2006
Real Output Growth	7.0	10.1	5.0
Contribution of:			
Labor	1.2	1.6	1.0
Employment	1.0	1.6	0.7
Quality	0.2	0.0	0.3
Capital	4.2	6.6	2.1
TFP	2.0	3.6	1.9

Source: Data compiled by National Accounts Division, as described in text. Output is a weighted average of passenger revenue kilometers and freight-ton kilometers. Employment is number of employees from company reports. The measure of capital inputs is a price-weighted summation of the number of aircraft of different models.

International Comparisons. At the international level, we relied on data obtained from individual company reports. In addition to Thai Air, we obtained information for Malaysian Airlines, Singapore Air, and the average of a group of 10 major U.S. airlines, covering the period of 1991-2006. Both Malaysian Airlines and Singapore Air are major competitors for Thai Air in Southeast Asia, and the U.S. airlines provide a useful international benchmark.

Compared to the prior analysis, the international data required some changes in the analytical framework. First, there are large differences in the average length of flights that highlighted the fact that our prior reliance on passenger revenue kilometers as the sole measure of output understated the costs associated with embarkations. For the U. S. sample we had data on revenues, number of passengers, and the distance traveled that allowed the estimation of a regression relating revenues to the total number of passengers and passenger revenue kilometers. In a competitive market, the coefficients can be interpreted as the relative marginal costs of passengers and passenger kilometers. For a data set covering the 10 U.S airlines over the period of 1990-2006 (170 observations), we obtained relative weights of 0.6 (passengers) and 0.4 (passenger kilometers). We used those weights to compute fixed weight Laspeyres indexes for all of the airlines based on the number of passengers and the total number of ton-miles.¹⁴ In a second stage calculation, the passenger measures were combined with the data on freight ton miles,

¹⁴ For those airlines that reported data in the form of passenger kilometers, the data was converted to ton kilometers, by assuming a weight of 0.2 tons for each passenger and associated luggage.

again using average revenue shares.¹⁵ We believe that this revised measure, by accounting for both the fixed and variable components, is a superior measure of industry output.

Second, we were not able to obtain income statements for all years, so we use fixed factor shares in the growth accounts. The available data suggested similar shares of labor compensation in total costs for the three Asian airlines, and we used 0.45 for the labor share for those three. For the U.S. airlines, the average labor share was 0.65.¹⁶ Third, the capital input was measured as available capacity in tons because we could not obtain data on the aircraft fleets of each airline.¹⁷ Furthermore, we have kept all of the data in level form with common units of measurement across the comparison groups, rather than converting to indexes or rates of change.

The comparison of labor productivity is shown in **Figure 5**. In all four cases, labor productivity has improved substantially over the 15-year period; but Thai Air and Malaysian Air lag behind the average of the U.S. carriers and Singapore Air. To some extent this result is expected as the latter two airlines have much lower average wage rates and should make greater use of labor to improve service. There is however, some evidence that the gap is increasing in recent years, as Thai Air has failed to match the gains of Singapore Air and the United States carriers. In 2006, labor productivity for Thai Air was 40 percent of the average of the U.S. carriers.

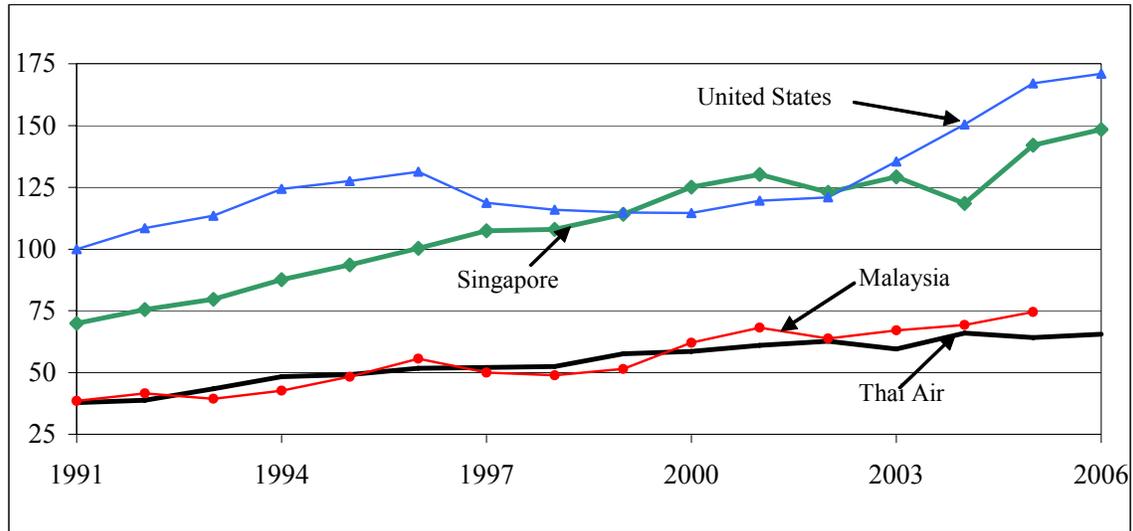
¹⁵ The shares of passenger revenues in the total were: 0.74 for Singapore Air, 0.83 for Thai and Malaysian Air and 0.95 for the U.S. carriers. We did not have the annual revenue data from passenger and freight transport needed to construct Tornquist indexes.

¹⁶ We assumed constant returns to scale for air transport; thus, the weight assigned to capital is just one minus the labor share.

¹⁷ The conversion of the capacity measure from ton kilometers to tons had the largest impact on Singapore Air because it has longer flights than the other airlines.

Figure 5. Relative Labor Productivity for Selected Airlines, 1990-2006

United States 1991 = 100

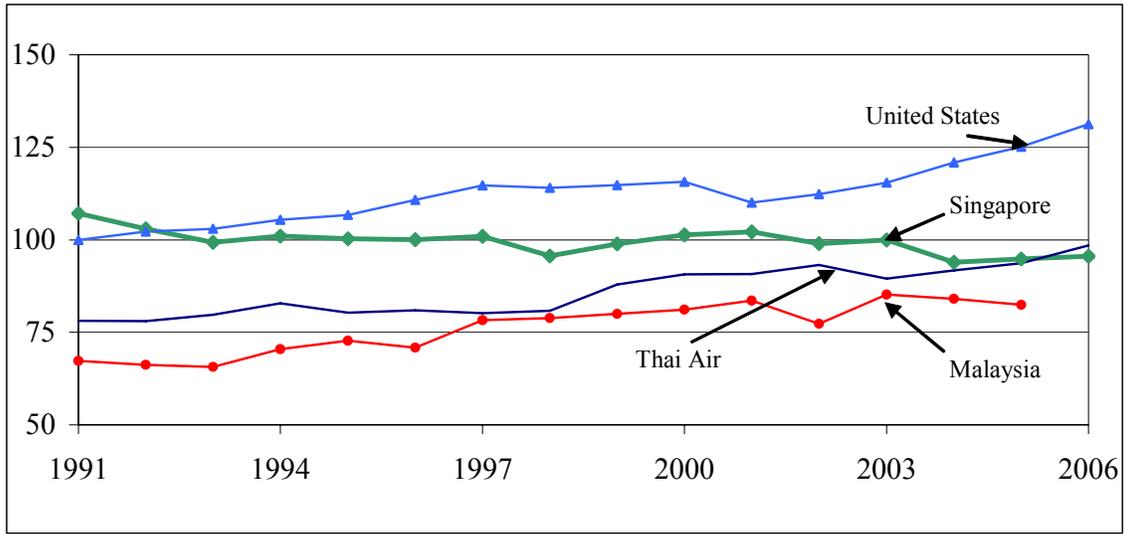


Source: Calculations based on airline financial and operating reports. See text for details

The relative performance of capital productivity is summarized in Figure 6. Our measure of output per unit of capital corresponds most closely to the industry concept of load factor, or utilization of available seats. Again, the U.S. airlines are highest and have been improving their performance over time. Meanwhile, Singapore Air has experienced deterioration in its utilization of capital and has been surpassed by Thai Air. Malaysian Air appears to have the lowest rate of capital utilization. It is also notable that the range of variation for capital productivity is less than for labor productivity: an outcome that may reflect the fact that all of the airlines pay similar prices for the airplanes.

Figure 6. Relative Capital Productivity of Selected Airlines, 1990-2006

United States 1991 = 100

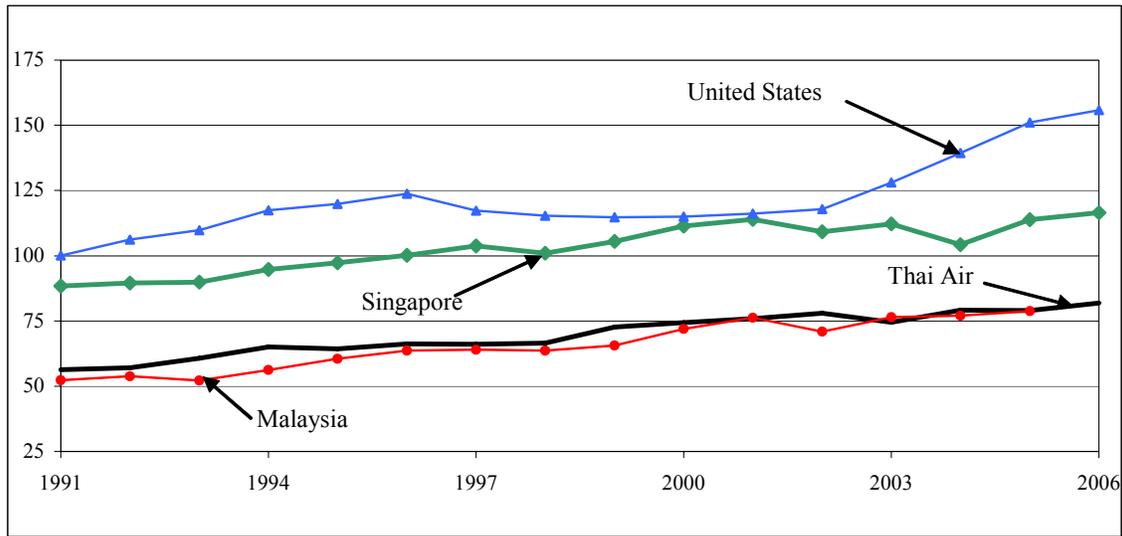


Source: Calculations based on airline financial and operating reports. See text for details

Finally, levels of total factor productivity, efficiency in the combined use of capital and labor, are exhibited in Figure 7. The U.S. airlines show a strong gain in TFP since 2001, which was a crisis year for the industry with record rates of reported losses. After approaching U.S. rates of efficiency in 2000/01, Singapore Air has seen its overall rate of productivity decline slightly. Thai Air has experienced steady gains in TFP, but its performance relative to the U.S. standard peaked at 65 percent in 2002, and has since fallen back to 50-55 percent. Overall, Thai Air and Malaysian Air have very similar rates of productivity performance.

Figure 7. Relative Total Factor Productivity of Selected Airlines, 1990-2006

United States 1991 = 100



Source: Calculations based on airline financial and operating reports. See text for details

In summary, Thai Air has achieved steady gains in efficiency, but its level of labor productivity and TFP are below those of the most efficient international airlines. Much of the difference lies in the area of labor productivity where it makes sense to have a lower rate, given the wage rate differences. Average wage cost per employee in 2006 for Thai air were only 35 percent of those of the U.S. airlines and about 40 percent of those for Singapore Air. Importantly, our comparisons suffer from the lack of any measure of the quality of the air travel. U.S. airlines have gained efficiency in terms of passengers flown per employee, but the recent gains have been accompanied by deterioration in many quality indicators.¹⁸ There are various international measures of airline quality, but they tend to be subjective or apply only to specific classes of service. We are unaware, however, of any objective measure of the quality of service for international airlines.

¹⁸ A quality report is prepared for U.S. airlines based on on-time performance, rates of lost baggage, flight cancellations, and customer complaints. More details are available at: <http://www.aqr.aero/index.htm>

Commercial Banking

Thailand's banking system consists of 16 commercial banks with total deposits of 5.7 trillion Baht at the end of 2005. In addition, there are 18 branches of foreign banks, but they account for less than 10 percent of total deposits. The industry was at the center of the 1997-98 financial crisis, bank profits fell from 93 billion baht in 1996 to a loss of 360 billion baht (8 percent of the nation's GDP) in 1998. Furthermore, employment in the industry declined by a third between 1996 and its low point at the end of 2002. An evaluation of the productivity and efficiency of the banking system is important because of the contribution that a strong banking system can make to financial stability. Recent research also supports the view that financial development is a positive contributor to overall economic growth. Well-functioning banks can also spur technological innovation by identifying and funding entrepreneurs who are perceived to have the best chances of developing new products and innovative production processes.

There is, however, no clear agreement on how to measure the contribution of the banking industry to aggregate GDP; and there has been a long international debate about how to best measure the output of the banking industry. The primary function of banks is to channel funds from depositors to borrowers, hence the reference to banks as financial intermediaries; but they also provide a wide range of transactions services to both client groups. Some of these services are not directly priced, as banks use the services to attract customers. Depositors implicitly pay for some of these services, however, by receiving a lower rate of interest on their deposits than they would otherwise earn. In the national accounts, a service charge is imputed for the services that banks furnish without payment in order to provide a meaningful measure of their value added and gross output as well as to keep gross domestic product (GDP) invariant to whether banking services involve an explicit or implicit service charge.

There are also significant differences in the methods used to partition the change in nominal output between its price and volume components. At present, for example, the national accounts of Thailand adjust only for general inflation by using changes in the overall consumer price index and a proxy for changes in the price of bank services. The assumption that the costs of bank services have gone up in step with the general price

level seems questionable in view of the large technological changes that have so dramatically altered the structure of the financial payments system. Yet, it is difficult to envision a price index for financial services that could accurately incorporate changes in the implicit prices paid for bank services.

Therefore, most efforts to develop measures of real output have focused on various physical indicators of bank services. One approach that grew out of the focus on banks as financial intermediaries, assumes that the flow of services is proportionate to the stock of bank assets and liabilities. A second approach, applied by the U.S. Bureau of Labor Statistics (Kunze and others, 1998), focused on measuring the flow of transaction services. The U.S. Bureau of Economic Analysis opted to incorporate the transactions approach in the U.S. national accounts because it was believed to most accurately capture the growth in bank output (Moulton, 2000). We have developed estimates of banking output in Thailand based on both the assets and liabilities framework and the transactions approach. These can be compared with the current estimates of the national accounts.

Data. Data on output and employment for the banking industry were obtained from the Bank of Thailand (BOT). However, we also benefited from interviews with several banks in Thailand in developing the output indexes. First, the asset/liabilities measure of output uses end-of-year data on total deposits and loans of commercial banks measured in billions of baht. Both series are converted to midyear averages and deflated by the GDP price deflator from the national accounts. The deposit and loan measures are then converted to indexes and combined together with equal weights as a simple Laspeyres index. The equal weighting of deposits and loans reflects a consensus from our interviews with individual banks. Thus, the assumption is that the flow of banking services is proportionate to the combined measure of deposits and loans.

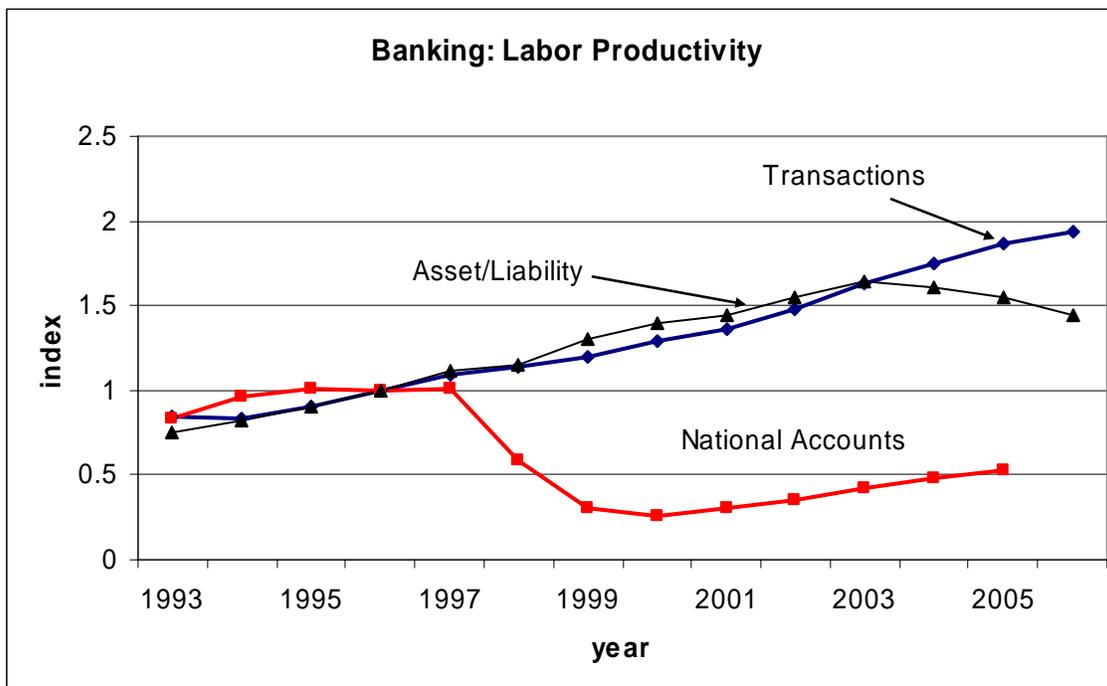
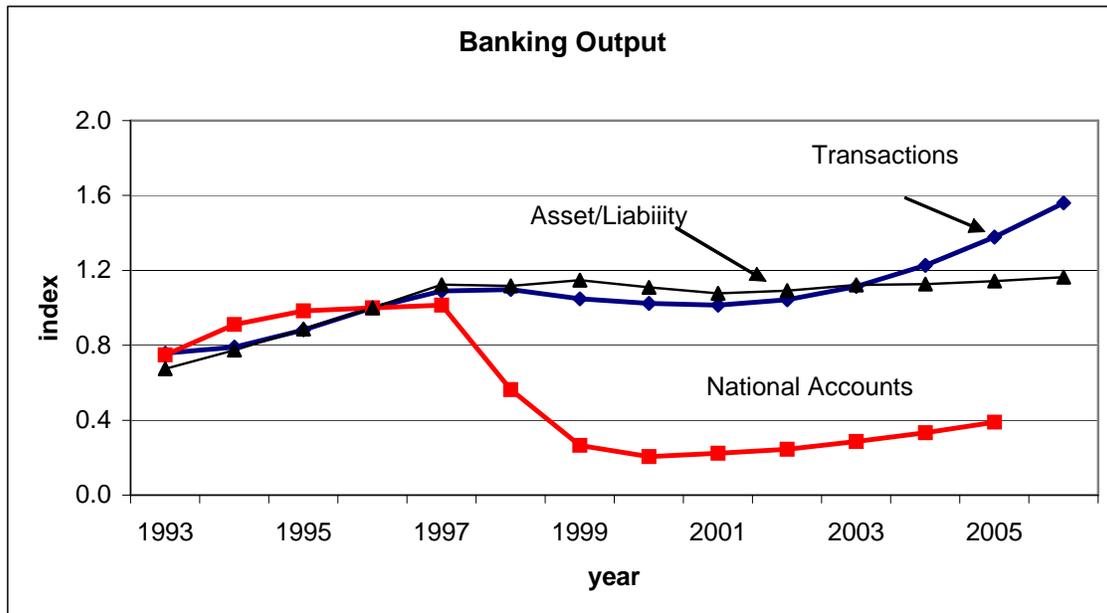
The transaction measure combines information obtained from interviews with banks in Thailand and the available data on various types of transactions as reported by the Bank of Thailand (BOT). We obtained data from the BOT on the number of checks processed, the number of ATM transactions, and the total number of deposit accounts. Because checks are not a common payment medium in Thailand, we used the total number of bank deposit accounts as an indicator of a broader range of transactions that

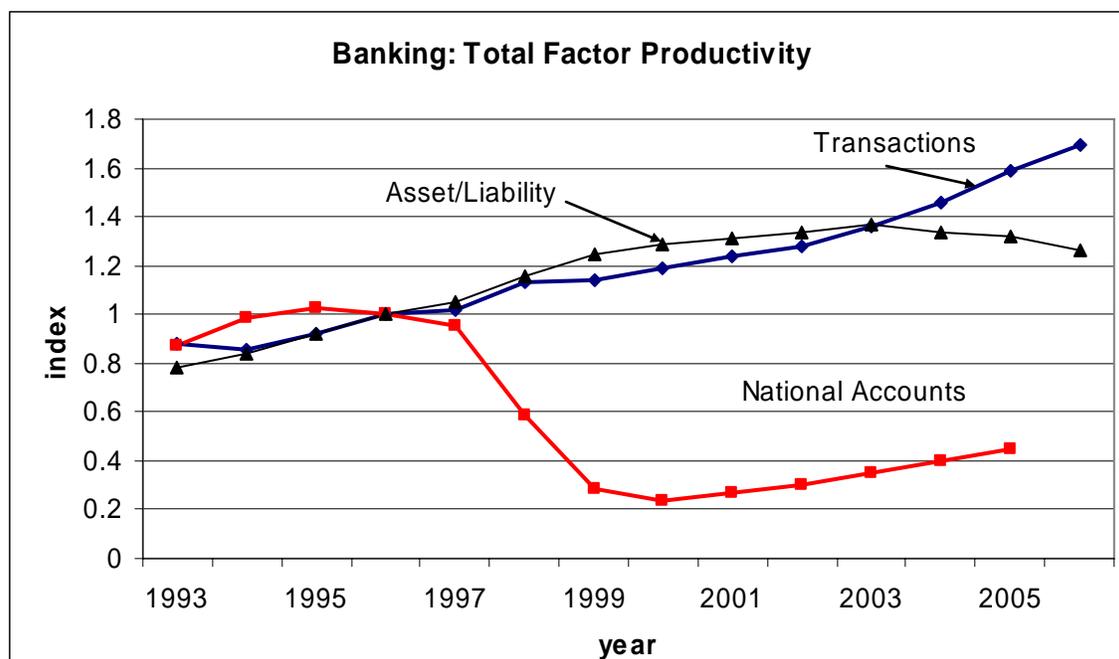
pass through banks. Based on the interviews with individual banks, we assigned weights of 10 percent to both checks and ATM transactions and 80 percent to the broad indicator. On the loan side information was available on the number of loan accounts and the number of credit cards in use.¹⁹ The index utilizes a 90 percent weight on the number of loan accounts and 10 percent for credit cards in use. As with the asset/liability measures, we combined the deposit and lending indexes using equal 50/50 weights.

Analysis. The two trial indexes of bank output are shown in the top panel of Figure 8, together with the estimate currently used in the national accounts. The two trial indexes are similar up to 2003, but the transactions measure is growing at a significantly faster rate in recent years. Both indexes, however, differ substantially from the national accounts' measure of bank output. The official measure declined to only 20 percent of its 1997 value by 2000 and slowly recovered to 40 percent by 2004. As a result, there are very large differences among the alternative estimates of bank output between 1997 and 1999. The differences result because none of the physical measures of bank deposits or loans provide any evidence of a sharp drop in bank activity after 1997. Instead, the output indexes imply that all of the fall in reported bank income was due to capital losses (nonpayment of loans), rather than a reduced flow of bank services.

¹⁹ Prior to 2003, we used a series on the number of loan customers with loan balances in excess of 5 million baht. The two series were spliced using the average ratio in 2003-06. A serious break was introduced in the last half of 1997 when the classification of large loan customers was changed from those with a loan ceiling in excess of Bt 5 million to those with a loan balance in excess of Bt 5 million. We adjusted the series using data on the value of loans at the time of transition.

Figure 8. Alternative Measures of Bank Output and Productivity, 1993-2006
 Index 1996 = 1.0





Sources: Computations as described in text.

A very good measure of commercial bank employment is available from the income and expense reports of the Bank of Thailand. Total employment declined by 30 percent between 1997 and 2002, leveled out, and then rose by 15 percent between 2004 and 2006. From an employment perspective, the adjustment to the negative shock of the financial crisis would seem to be complete. Banks are again expanding their employment. The middle panel of Figure 8 shows the estimates of labor productivity implied by the three alternative output indexes. The official measure indicates that productivity declined by 75 percent during the crisis and remains at a level only about half of the 1997 value. In contrast, the two trial measures indicate that labor productivity continued to grow throughout the crisis. Some differences emerge in recent years when the asset/liability concept implies a slow decline in labor productivity, while the transactions measure implies continued growth.

It is also possible to compute total factor productivity using estimates of the net capital stock from the NAO. The net capital stock fell by about 20 percent between 1997 and 2001, but it has been growing in recent years. We set labor's share of value added at a constant 40 percent of value added obtained as an average of the values for the period

before 1998 and after 2000.²⁰ The results are reported in the bottom panel of Figure 8. Given the similarity of changes in the capital stock and employment, the pattern of TFP change is very akin to that for labor productivity. Again, the difference between the trial indexes and the official measure is very large. The transaction index indicates a steady rise in TFP of 4-5 percent per year, whereas the asset/liability index turns negative after 2003. TFP as measured by the official output index, however, is still less than half the 1996 level.

In summary, the differences among the three measures of the real value of banking output are disconcertingly large. However, the large sustained falls in labor productivity and TFP using the official output index seem implausible. It is difficult to argue that the industry is still in disequilibrium when both employment and the capital stock are again growing. Also, a sustained reduction in the ratio of real financial services to GDP seems equally unlikely. Other economies continue to show the output of financial services expanding in line with overall GDP. Instead, it is more likely that the Thai banking system has achieved significant productivity gains under the pressures of the crisis and the emergence of new IT technologies. In addition, it appears that the financial crisis eliminated significant oligopolistic rents that were most evident in the very high profit share prior to 1997. Both of these developments would be reflected in a sharp fall in the effective price of bank services.

International Comparisons. Thus far, we have not been able to obtain comparable data on banking for other Asian economies. Unlike the BOT, many central banks do not publish information on the income and expenses of the banking system; and while many of the series that we used to compute the output measures are available as part of reports on countries' payment systems, the published information is less complete. Employment in commercial banks is also not a regularly reported item. The United States national accounts use a method similar to the transactions approach presented above and it indicates a growth in labor productivity of 15 percent over the decade of 1996-2006, less than half the rate computed for Thailand. However, we lack a means of

²⁰ The precise share of each weight matters little because employment and the capital stock expand and contract at similar rates over the period we are focusing on.

comparing the level of productivity in the two countries because the output measures are not exactly equivalent and a conversion based on the commercial exchange rate seems inappropriate for a largely domestic service-producing industry.

International comparisons of the efficiency of bank operations are largely limited to computing operating expenses as a share of total bank assets.²¹ The ratio is not directly comparable to productivity; but because the dominant element is staff expenses, low labor productivity will translate into high operating costs. Furthermore, because the ratio is free of currency units, it can be used for cross-national comparisons. As shown below, the operating-expense ratio has changed little for Thailand over the past decade – another result that does not support the notion of large productivity losses. Published data are available for only a few other countries, and they suggest that Thailand’s banks have higher operating costs than banks in Taiwan and Australia, but they are about the same as in India. Notably bank operating costs seem particularly high in the United States, and the difference relative to Thailand can be traced to substantially higher employment costs.²²

**Commercial Bank Operating Costs
(Percent of Total Assets)**

	1994-96	2004-06
Thailand	2.0	2.2
Taiwan	–	1.3
India	–	2.1
United States	3.7	3.2
Australia	–	1.8

²¹ Operating expenses are defined as non-interest expenses excluding provisions for loan losses.

²² There are some issues of comparability across countries in how the accounting systems measure non-interest operating expenses. Employment and property costs could be separately identified for Thailand and the United States, but not the other countries. Thus, there is some uncertainty about the items included in operating expenses.

Telecommunications.

Like many emerging-market economies, Thailand has been through a revolution in telecommunications service. In the early 1990s, telephone subscribers represented only 2-3 percent of the population; but with the introduction of mobile phone service, the penetration rate (subscribers per 100 inhabitants) soared to 72 percent in 2006. Nearly all of this growth has been from the expansion of mobile services, and the fixed line penetration rate has stagnated at about 10 percent. Within a decade, Thailand has been able to upgrade its telecommunications to a level approaching that of higher income countries, but at a fraction of the cost. Mobile communications require a much less expensive infrastructure to provide basic service.

Thailand's traditional fixed line service was provided by two government corporations, Telephone Organization of Thailand (TOT) for domestic service, and the Communications Authority of Thailand (CAT) for international service. The restructuring and modernization of the industry has been complicated by a constitutional mandate requiring state ownership of the infrastructure. In recent years, both TOT and CAT have expanded their private-sector linkages through multiple build-transfer-operate concessions with private firms. The concessions are used to provide mobile service and to expand the network of fixed lines.²³ Mobile service is provided through several of these arrangements, but the three largest providers are AIS, DTAC, and True.

Data. The telecommunications industry is not separately identified in Thailand's national accounts where it is combined with postal services.²⁴ Most of the data for this study were obtained from the International Telecommunications Union (ITU). However, the submission for Thailand has been incomplete and inconsistent in its coverage since about 2000. The staff of the National Accounts Office updated the information on the basis of annual reports from the five largest telecom companies. The data on subscribers are believed to be quite accurate; but that for employment and investment is more

²³ In addition to TOT, there are now two major private fixed-line providers, True in Bangkok and TT&T in the rural areas. With a strong focus on fixed line service, TT&T has suffered from revenue losses in recent years.

²⁴ In the ISIC system, telecommunications are in group 642 with broadcasting. Post and courier services are included in 641. Together, they comprise division 64.

problematic, and it is not certain that the ITU revenue reports correctly account for a large volume of inter-company concession payments.

The growing diversity of telecommunication services complicates the computation of a meaningful measure of output. Previously, the choice was between the number of subscribers and total number of minutes, but current measures of output need to reflect both fixed and mobile services and the growing importance of the internet and broadband. This study is limited to statistics on the number of fixed and mobile subscribers because information on internet and broadband usage is very incomplete in the ITU data set. This may not be a major problem for the historical data, but the expansion of the output measure to incorporate internet and broadband usage will be increasingly important in future years.

Since mobile and fixed line subscriptions are growing at dramatically different rates, it is important in computing a measure of overall output to use up-to-date revenue weights to combine the two types of service. The output index is constructed as a Tornquist index over the period of 1993 to 2006 using the average shares of revenue for fixed and mobile service as the weights. The employment data are particularly questionable because the only source of information is company reports. CAT is also responsible for postal services, and separate information on employment in the telecomm component is not available for all years. In addition, the data supplied to the ITU vary in the extent to which they include the employment of the private telecomm companies. We used individual company reports to measure employment changes after 2000.

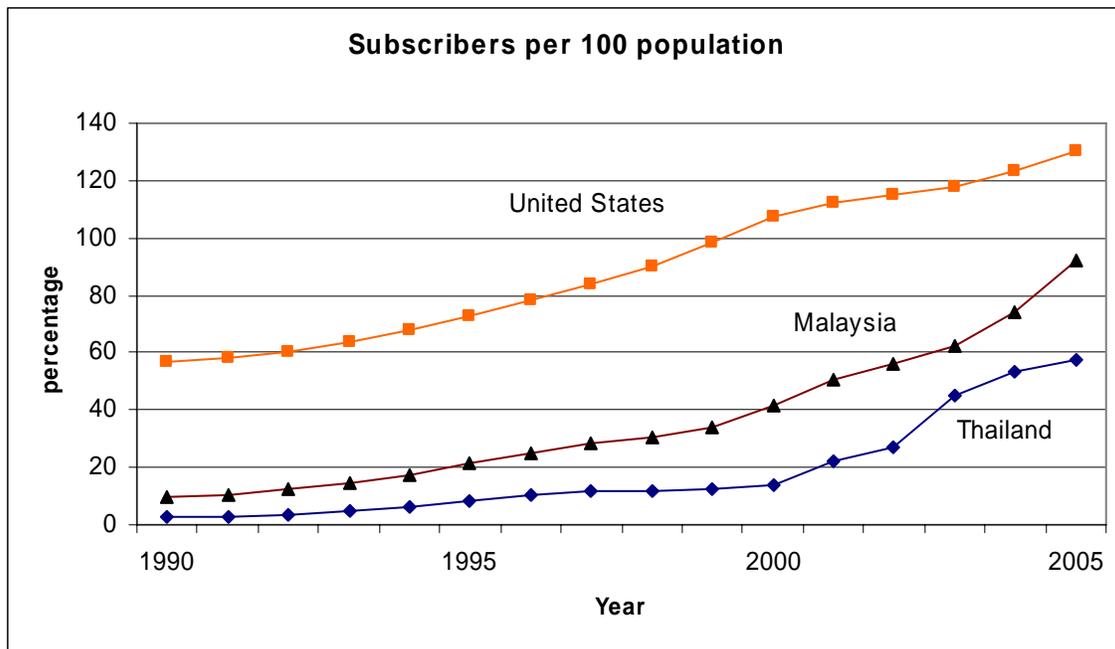
Similar problems arise with the data on investment. We used the information from the ITU supplemented by company data for 2003-2005. A perpetual inventory model with an assumed annual geometric rate of depreciation of 12.5 percent was used to construct the capital stock.²⁵ For purposes of international comparisons, the analysis of

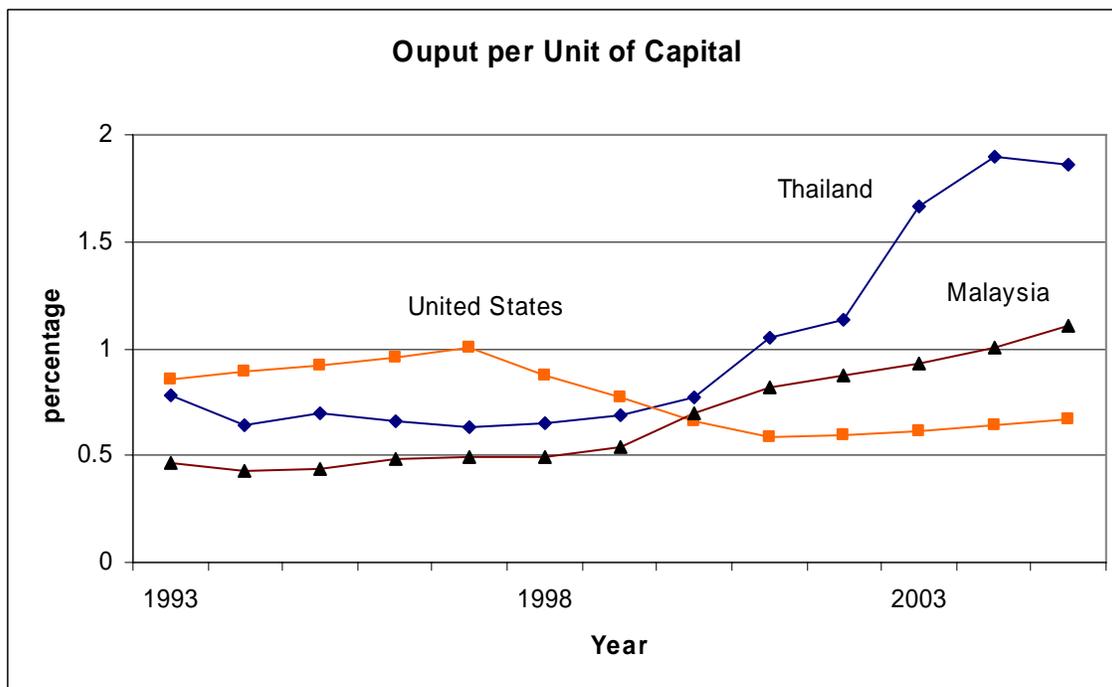
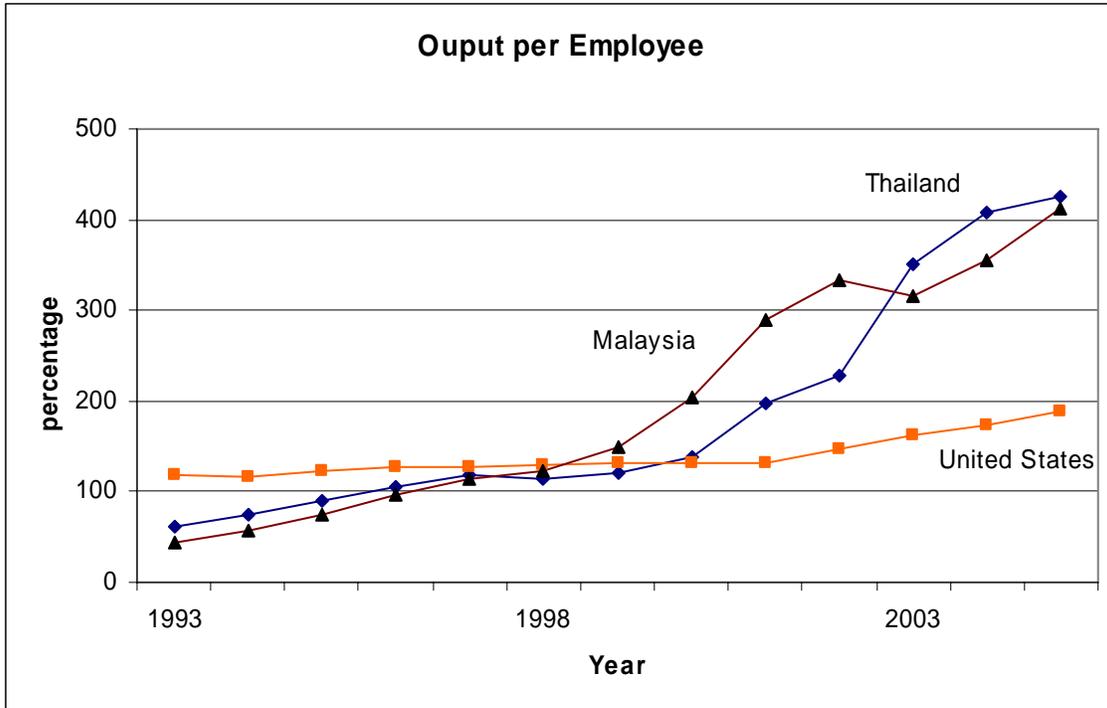
²⁵ Each country's investment series was converted to U.S. dollars of 2000, using the commercial exchange rate and the price deflator for communications investment in the U.S. national accounts. The initial capital stock in 1998 was computed as the depreciated sum of investment in prior years back to 1976. We have used this methodology of computing values in U.S. dollars because most telecommunications equipment is purchased internationally and should be based on an international price.

the data for Thailand was supplemented by similar information for the United States and Malaysia.

Analysis. As shown in the top panel of Figure 9, the market for telephone services has expanded at a furious pace over the last decade. Starting from a very low penetration rate of 2.5 subscribers per capita in 1990, telephone usage has soared to reach over 70 percent of the population by the end of 2006. We have comparable data for other countries only through 2005; however, the data for Malaysia further illustrates that the growth of the mobile phone system has been a common phenomenon of many emerging markets. The impact is less evident for high-income countries, such as the United States, that had elaborate pre-existing fixed-line systems. For Thailand, growth has been particularly rapid in 2000-06 with annual rates of increase in excess of 30 percent.

Figure 9. Output and Productivity in Telecommunications, 1990-2005





Source: Computatations explained in text.

The estimates of labor productivity, shown in the middle panel of Figure 9, illustrate an important feature of the mobile technology: its low cost relative to fixed-line service. Thus, labor productivity in Thailand and Malaysia has soared well above that of

the United States. Since the fixed-line system had not progressed as far in the emerging-market economies, they were able to leap over the older technology and construct networks that are lower cost than those of the high-income countries. It remains to be seen, however, if the mobile technology will be able to provide the full range of internet and broadband services that are becoming critical parts of the future communications infrastructure. At present it is largely a voice-based system.

The wireless systems are also less capital intensive as shown in the bottom panel of Figure 9. Output per unit of capital has soared in Thailand in recent years and is well above that of Malaysia and the United States.²⁶ The high capital productivity might reflect errors in our estimate of investment for Thailand, but we have direct estimates in recent years from the five largest providers. An alternative explanation is that Malaysia and the United States have continued to make large investments in the fixed line system as part of their efforts to expand broadband access. The decline in the estimate of capital productivity in the United States, for example, is related to the stock market bubble of the late 1990s that led to excessive internet investments and the subsequent collapse. In contrast, investments in Thailand's fixed line system have been modest in recent years.

The ITU data set does not contain any information on labor compensation in the telecommunications industry. In the national accounts of Thailand, labor's share of value added in the overall communications industry averages 20 percent in the period of 1990-2005 with a modest decline over time. The U.S. national accounts report a higher share averaging about 35 percent for telecommunications alone. The computation of the growth in TFP in Thailand will be sensitive to the specific factor shares assigned to capital and labor because they are growing at much different rates. Our calculations are based on the income shares for the aggregate communications industry in Thailand's national accounts.

²⁶ Capital productivity is measured as output per unit of capital where the latter is measured in U.S. dollars of 2000. We have some continuing concerns about the estimate of the capital stock for Thailand because we are not certain that we have captured all of the investment in mobile and broadband technologies. The current statistical system, for example, does not capture the activities of internet service providers.

Table 7 provides a breakdown of the sources of growth in the telecommunications industry over the period of 1993 to 2006. The period is separated into the intervals before and after 2000, because it appears that the first period was largely devoted to the construction of the wireless network. Thus, there is a large contribution of capital to output growth in the 1993-2000 period, but it slows after 2000. Instead, there are large post-2000 increases in TFP as the utilization of the new network increases at a rapid pace. Output expanded an average of 30 percent per year in the 2000-2006 period. Employment growth has been a relatively modest contributor, averaging one percent per year. The rapid pace of growth may slow in future years as congestion is a growing problem.

Table 7. Sources of Growth in Telecommunications
annual rates of change

	1993-2006	1993-2000	2000-2006
Real Output Growth	22.7	18.4	27.9
Contribution of:			
Labor	1.0	1.2	0.7
Employment	0.9	1.1	0.5
Quality	0.1	0.1	0.1
Capital	10.8	14.5	6.7
TFP	9.7	2.2	19.0

Source: Computations explained in text.

In summary, the telecommunications industry has been a major source of growth over the past decade, and it has succeeded in a dramatic expansion of telephone service to the general population. In future years, it will be equally important to build the broadband network required both as a vital infrastructure for the general economy and as a mechanism for delivering an increasingly wide range of consumer services. Although we have been able to construct reasonable operating measures for basic telephone service, Thailand has little or no systematic system for collecting statistics on the industry's operations. This is likely to be an increasingly serious problem for policy in future years. Thus, the construction of a solid statistical reporting system to provide guidance for future policy decisions ought to be a major goal for the relevant agencies. It is of added urgency because the telecommunications industry faces a particularly

uncertain regulatory environment at a time that it must commit to another round of substantial capital investment.

Trucking

The efficient performance of the logistics industry is critical to enhancing the integration of Thailand's industries into the global economy. The trucking industry is an important component of that logistics system as it provides the link between inland production centers and seaports. It is also the primary means of moving freight throughout the country since the rail system is largely used for passenger travel. Despite its importance, however, very little information is collected on the operation of the industry.²⁷

In the past, limited surveys were undertaken by the Department of Land Transport to measure the flow of freight between the major metropolitan centers, but no surveys have been conducted in recent years.²⁸ The industry's output is estimated by extrapolating the earlier surveys using the estimated production of the industries that they serve. The meaning of the output indexes is limited as well by the lack of any information on the fares charged for moving different types of commodities. Shifts in the commodity mix dominate movements in the output index. The number of trucks can be estimated from registrations data. However, nothing is known about the number of enterprises, their size, value added, or the number of employees. Individuals employed in the trucking industry are identified in the LFS of households; but the broad classification (including intra-city delivery as well as inter-city freight haulers, plus drivers for businesses whose primary activity is in other industries) does not provide a useful measure of employment in the inter-city component.

The estimated annual rate of growth of trucking output (1988 prices) in the national accounts averages less than one percent over the 1995-2005 period. That growth

²⁷ As with other major service industries, Thailand has not developed a statistical reporting system for the component industries of the logistics sector. The required surveys are not complex, but they require the systematic development and maintenance of a business registry or sampling frame. Currently, no such list of businesses in the land transport sector exists.

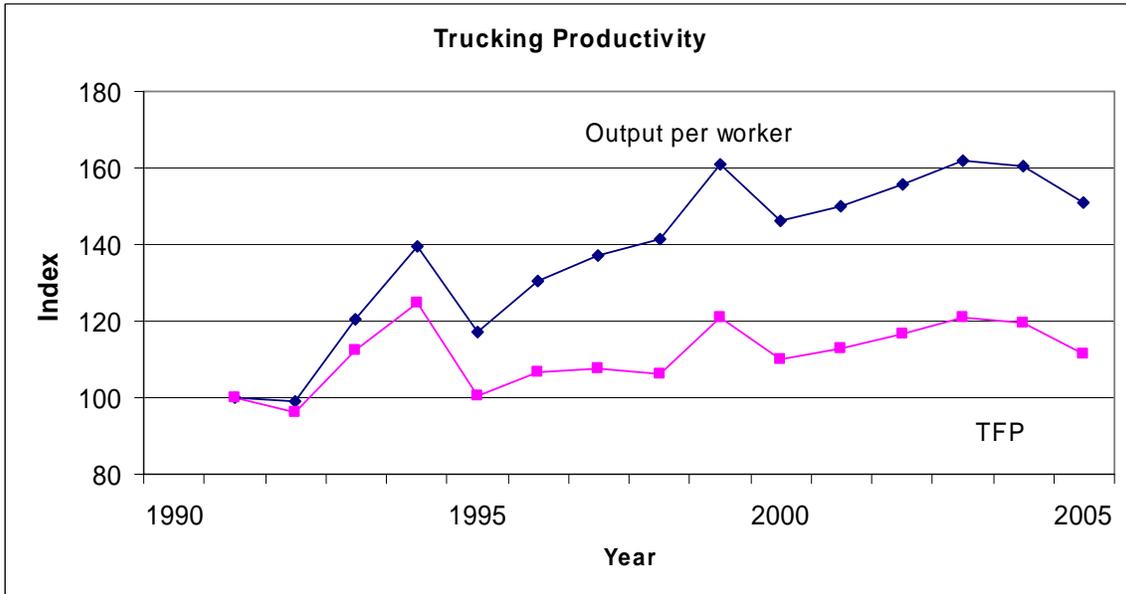
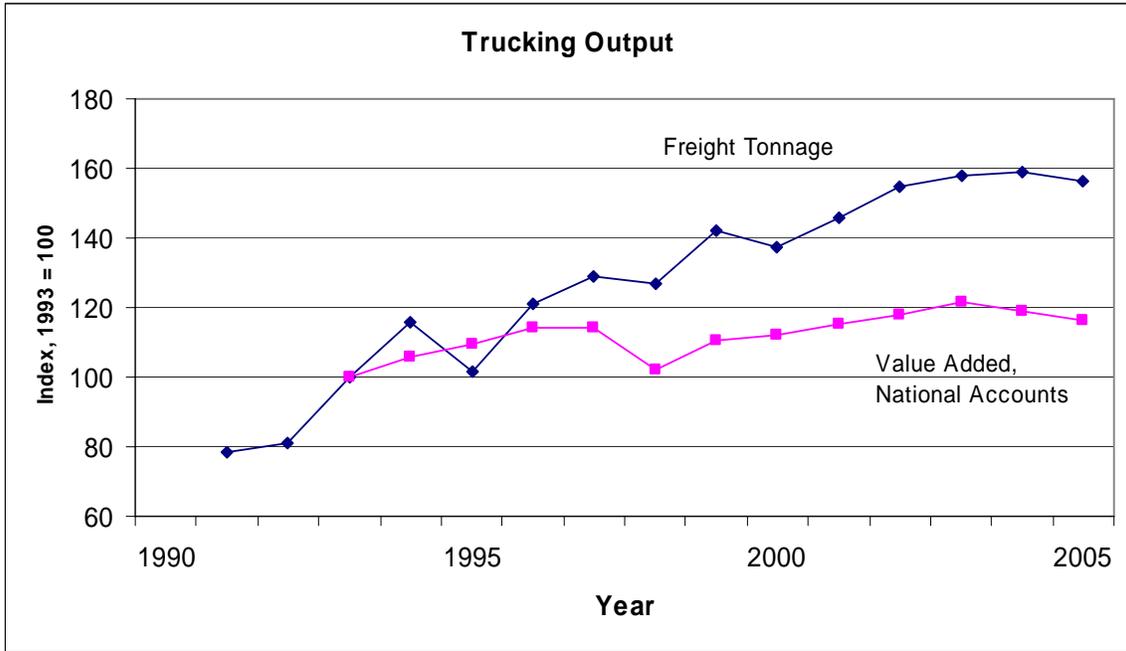
²⁸ The surveys were undertaken by establishing checkpoints along major intercity routes and measuring the number of trucks and their contents.

seems extraordinarily low in comparison to the growth of the goods-producing industries over the same period. It is also substantially below the 4.8 percent growth rate for the index of freight tonnage reported by the Ministry of Transport. It is difficult to identify any innovation that could account for such large economies in the use of transportation services.²⁹

There is no satisfactory current estimate of the output of the trucking industry given the absence of a statistical reporting system. However, we have used an index of freight ton-kilometers of the Ministry of Transport to construct some very tentative measures of output and productivity. The index is based on an earlier survey of intra-city freight movements by major commodity grouping that has been extended in subsequent years on the basis of production of the commodities. In addition to the reliance on extrapolations of the data, the index is very inexact because the commodity groupings are not weighted by freight revenue. Therefore, the index does not capture the effects of changes in the mix of the freight between low value (stone) and high value (manufactures) items. The output index, shown in the top panel of figure 10, grows at a rate very similar to that for manufacturing over the 1995-2005 period, 4.7 percent per year compared to 4.5 for manufacturing. However, it is much more rapid than the 0.5 percent rate recorded for trucking value added in the national accounts. In addition the tonnage measure is very volatile from year to year, particularly in 1994-95. Both measures indicate a slowing of growth in recent years

²⁹ Much of the problem appears to be associated with a very high rate of price inflation in the national accounts since growth in the nominal measure is closer to that for nominal GDP.

Figure 10. Output and Productivity of Trucking Industry



The LFS is the only source of information on employment, but the annual estimates are highly volatile and undoubtedly reflect well-known problems of asking households to identify narrow industries of employment. The data may reflect occupation rather than being limited to the intra-city freight component. We smoothed

the employment estimate by computing averages of the number of commercial trucks and using the number of trucks to compute the annual changes.³⁰

We have two estimates of the capital stock. The first, constructed by the NAO, uses data on new truck registrations as the measure of investment and uses a traditional perpetual-inventory model to construct an estimate of the net capital stock. The second uses data on annual registrations of all trucks by size and estimates of the relative price of different size trucks to compute a measure of capacity in the industry. The primary difference is that the first explicitly takes account of the depreciation on trucks of different vintages, whereas the capacity concept treats new and old trucks equivalently. The two measures have similar long-term trends, but the net capital stock is more cyclical, rising more rapidly before 1997 and declining in 1997-2001.

Our estimates of productivity are shown in the lower panel of

³⁰ The ratio declines from 0.5 in 1991 to 0.33 in 1999 and is held constant thereafter.

Figure 10. Because the output index is based on the tonnage measure, these are upper bound estimates of the growth in both labor productivity and TFP. There is substantial growth in labor productivity, averaging about 3 percent per year over the 1991-2005 period. With the rapid increase in the stock of trucks, however, the growth in TFP is estimated to be only about one percent per year.³¹ This appears to result largely from the shift toward larger trucks, rather than just an increase in the number being utilized.

IV. Implications and Recommendations

The frequency with which we found negative rates of growth in labor productivity and TFP in the service-producing industries suggests that the growth of output in these industries is being underestimated in Thailand's national accounts. Thus, it is equally likely that the rate of growth of total GDP is being underestimated as well. An alternative explanation is that the negative rates of productivity change are due to systematic over-estimation of the growth of employment in these industries. However, the labor force survey is a comprehensive employment estimate whose methods and procedures compare favorably with similar surveys in other countries. While a household survey cannot accurately measure employment at the level of detailed industries, we believe it is reliable for the broad industry groups. In addition, there is no obvious reason that it would overstate the growth of employment,

The analysis is most suggestive of an underestimation of output growth for trade, hotels and restaurants, finance, and business services. These were industries with strongly negative trends in productivity. Furthermore, the negative results for finance and business services cannot be attributed to errors in the employment estimates. While trade was not an area of detailed analysis, the slow reported growth of value added is puzzling in view of the strong gains in consumption spending shown on the expenditure side of the national accounts.

³¹ The national accounts indicate that the share of labor is only about 20 percent in the trucking industry, but it is probably a low estimate because of the substantial number of drivers who own their own trucks. We used a constant labor share of 0.4. The national accounts values would reduce the growth of TFP to about 0.5 percent per annum.

In contrast, we obtained significantly positive estimates of productivity growth in public administration and education. Within the SNA, the output of these sectors is normally computed with an input-based price deflator, such as the wage rate of public employees. That methodology should produce a constant level of labor productivity. Small variations in labor productivity could result from shifts in the mix of employment between high and low-wage job categories, but productivity would not rise on a sustained basis. Questions about the estimate of productivity growth in these industries should be resolved in future work. Consistent estimates of public sector employment from administrative records would also provide a useful indicator of changes in efficiency within the public sector.

The problems of estimating output and productivity in the service-producing industries arise largely because of the lack of basic survey information covering these industries that could be used in the construction of the national accounts. Measures of the economic performance of the service sector are under-represented in the statistical systems of many countries. The bias in favor of agriculture and industry has been due in part to difficulties of defining and measuring the intangible output of some service-producing industries. In addition, attitudes toward the production of services were strongly influenced in the early stages of industrialization and growth by the need to increase the production of food and other material necessities of life. Only goods could be traded internationally and used to finance the purchase of advanced capital equipment and other products that were unavailable in the domestic economy. Few services were tradable across national borders. These attitudes about the value of services were particularly prominent in the development of national statistical and accounting systems, such as the Gross Material Product system used in many socialist states.

However, the national accounts of market-based economies are kept according to the standardized System of National Accounts (SNA), which was developed and modified under the auspices of the United Nations. Under this system, the market value of services production is added to that of goods production to derive measures of national income and production. Spending on goods and services provide equivalent value to consumers and therefore to national output. Nevertheless, the statistical systems of many countries continue to under-invest in information on the service-producing industries.

Thailand is no exception in this regard. The government undertakes a decennial census of manufacturing, supplemented by regular annual surveys. There also exists an extensive system of statistical reporting for the agricultural regions.³² In contrast, Thailand has no comprehensive economic census for the services industries and annual surveys are limited to a few select industries. Thus, the construction of the services portion of the national accounts relies on a wide variety of indirect methods of estimation. The lack of basic information seems evident in Thailand's national accounts which use 1988 as the base year for its national accounts³³.

In addition, information on employment within the service-producing industries is very limited. The LFS is conducted on a monthly basis and yields high-quality estimates of total employment, but the respondents cannot be expected to provide accurate information on the detailed industry in which family members are employed. Thus, the information on the industry of employment is unreliable below the level of the three major sectors.

Many of these problems could be substantially reduced with a series of regular surveys of the service industries, comparable to those now undertaken for manufacturing. Annual surveys of establishments, for example, could provide both the production data needed for the estimates of GDP, and measures of establishment employment that would augment the employment data currently obtained from the LFS on the household side.

A beginning has been made with the Business Trade and Services Survey conducted by the NSO. The 2003 survey covered wholesale and retail trade, hotels and restaurants, a wide range of business services, entertainment, and personal services. The corresponding 2001/2 business census was a major step in developing a business registry that can provide the dimensions of the survey universe for future annual surveys. It is

³² The accuracy and timeliness of some of the surveys of crop production have been criticized, but Thailand devotes a large amount of statistical resources to measuring the economic output of agriculture and the system compares favorably with that of other countries. See for example, the discussion and presentations at the <http://www.fao.org/ES/ess/meetings/apcas21.asp>, and Proceedings of the National Seminar on the System of Food and Agriculture Statistics in Thailand, Bangkok, 19 December 2001, available at http://www.fao-apcas.org/thailand/No.2_THA.pdf.

³³ The National Accounts Office is now in its final phase of developing the new national accounts series based on the chained volume measure index with 2002 as the reference year.

also important to note that the surveys need not be as extensive as those used for manufacturing because the desired information is much less – total revenues, purchased inputs, value added, labor compensation, persons engaged, employment and a measure of fixed assets constitute the core coverage. A short and simple survey is critical to achieving high rates of compliance.

However, the large role of informal enterprises has created problems for using the business and trade surveys for preparation of the national accounts. The surveys do not provide complete coverage because of the difficulties of creating and maintaining a business registry that includes informal production units. Informal sector production is defined as those productive activities conducted by unincorporated enterprises in the household sector that work outside the formal administrative networks that cover the formal sector.³⁴ The large number of persons in the informal portion of the agricultural sector is not a severe statistical problem because of the reliance on crop statistics to measure output. However, an NSO report that used the LFS to estimate total employment and allocated it between formal and informal production units suggests that the informal sector represents 15-20 percent of employment in industry, but in excess of 50 percent in services and over two-thirds for retail trade and hotels and restaurants. The 2003 Business Trade and Services survey included establishments down to the level of one person, which was a major expansion relative to the cutoff of 5 employees used in 1999. However, it still excluded large numbers of vendors with no fixed address and home-based workers.

Assuring completeness of coverage is a problem for many countries' statistical systems, but the large size of the informal sector makes it especially difficult in developing economies. The issue has been a topic of several international conferences and the OECD recently published a manual aimed at identifying and promoting best international practices for measuring the "non-observed" portion of the economy (OECD,

³⁴The boundary between formal and informal production is admittedly somewhat arbitrary, but it could be drawn at the level of enterprises with at least one employee because that is the definition used for inclusion of workers in the social security program. Alternatively, the NSO survey now draws from a registry of all establishments with a fixed address.

2002). The most effective method involves as a first step the careful comparison of household and establishment employment data to partition each industry between its formal and informal components with a size breakdown.

A 'labor input' method can then be used to estimate the output of informal sector workers who are missing from the enterprise surveys. The value-added per worker estimates from similarly-sized enterprises in the formal sector are applied to employment in the informal sector to construct the estimate of industry output. The method has the advantage of ensuring that some output is attributed to every person who reports being in the labor force. Therefore, it assures completeness of coverage. The basic problem lies with the imputation of a level of output per worker, which may in practice be quite different from that of similarly-sized enterprises in the formal sector. It is possible to supplement the method, however, with special surveys that examine the value added per worker of informal enterprises in more detail. Among industrial countries, this technique is used extensively in the Italian national accounts where tax avoidance creates a large underground economy. Among developing economies, it is the primary method used for the nonagricultural sector in India, which has an even larger informal share of the economy than Thailand. More broadly, the labor input method can be useful as part of an exercise aimed at assessing the completeness of the national accounts.

Services are a particularly difficult group of industries for which to develop output price deflators that accurately distinguish between price and quality changes. Direct measurement of price change is generally preferred to a reliance on physical indicators of changes in output because the price indexes offer greater potential for adjusting for quality change. However, the survey system required to construct price indexes at the industry level can be a difficult undertaking, and high-income countries, such as the United States, only began to extend their industry price programs into the area of services in the 1990s. Alternatively, many countries will continue to rely on a mixture of physical indicators and price deflation. At present, Thailand's producer price index completely neglects the service-producing industries, and the coverage of services in the

consumer price index is limited to rent, transportation, and communications. No effort is made to adjust explicitly for quality change.³⁵

Thailand can, however, benefit greatly by building on the experience of statistical agencies in other countries that have done much of the initial work of developing effective models for measuring price change in service-producing industries. The Voorburg Group (See their homepage at <http://stds.statcan.ca/english/voorburg/2004-index.htm>), for example, is a particularly active forum for sharing experiences on collecting services data. Thus, Thailand could begin to implement a price program for services at relatively low cost.

Finally, the NAO should publish an English version of its explanation of the sources and methods used to construct the national accounts. A Thai language version is currently published on the website. Since the national accounts are often the most significant starting point for data on a country's economic performance as used by international businesses, such a document can add important clarifications and transparency to the interpretation of economic statistics.

³⁵ A description of the methodology is available at: http://www.price.moc.go.th/web4_e/cpi/handbook/desc/cpi2002.pdf. According to Puntumeka and Orapin (2001), model changes are introduced by linking *price levels*, i.e. the price difference between the models is counted as part of the price change. The more standard international practice would be to link the *price changes* using a month of overlapping prices between the two models, effectively treating the price difference a quality change. The method they describe is likely to impart a positive bias to the price indexes.

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APPENDIX A: GROWTH ACCOUNTING

Modern productivity analysis, following from the contribution of Solow (1957), 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:

$$(1) \quad Q_t = A_t F(K_t, L_t).$$

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:

$$(2) \quad d \ln Q = v_k d \ln(K) + v_l d \ln(L) + \Delta \ln TFP,$$

where v_k and v_l are the shares of capital and labor income, respectively. 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 v_k is replaced by $(v_{kt} + v_{kt-1})/2$.³⁶

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:

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

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.³⁷

Quality Adjustment. 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 used. 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

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

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:

³⁶ The only restriction on the production function is the assumption of constant returns-to-scale. 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).

³⁷ This may not be a very important restriction, since income shares seldom show strong trend changes in those countries where they can be estimated with reasonable precision.

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

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.³⁸

A quality adjustment can also be made to the capital input, although in most cases it should more properly be identified as reflecting changes in the composition of the capital services. Neoclassical investment theory clarifies the distinction between the capital stock and capital services. The rental price of capital services is given by

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

where i represents the nominal 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 rate of capital asset depreciation. Assuming that the real rate of return is constant across asset classes, the capital services term can be used to aggregate across capital with different rates of depreciation. 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 a simple 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.

Income Shares. The empirical application of the above framework encounters one additional complication. The use of income shares assumes that total value added is composed of labor and capital income, but the national accounts are based on classifying income among three categories of wages, capital, and mixed income. The last category refers to the self-employed and family businesses in which the income is a combination of returns to capital and labor. It is a particularly important component of national income in developing countries because of the large role of the agricultural sector, but also because family run businesses, with large numbers of unpaid relatives, are common in many service-producing industries, such as trade, restaurants and personal services. Thus, a means must be found to partition the mixed income into its capital and labor constituents.

The simplest means of splitting mixed income between its labor and capital components is to assume that the self-employed and unpaid family workers earn the same wage as employees in the same industry. However, the adjustment can yield implausible outcomes in which the imputed wage exceeds the total income payment. An alternative is to average the wage rate assumption with an assumption that the business earns the same rate of return on capital as in the corporate sector of the economy, but this approach

³⁸ Summaries of many of these international studies are available in Psacharopoulos and Patrinos (2002). A specific example for Thailand is provided by Blunch (2004).

requires a larger amount of data on the capital stock and returns than is available in most countries.

The difficulties of obtaining plausible income shares in the presence of a large mixed-income component often leads to the alternative of assuming fixed exogenous shares. As mentioned above, the assumption comes at the cost, however, of being based on a more restricted formulation of the production function.