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Total Factor Productivity: Estimates for Philippine Economy

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Philippine Institute for Development Studies

Total Factor Productivity: Estimates for the Philippine Economy

Caesar B. Cororaton and Ma. Teresa D. Caparas

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Total Factor Productivity: Estimates for the Philippine Economy

Revised Final Report, June 1998

**Caesar B. Cororaton
Maria Teresa Duenas-Caparas**

**Submitted to:
TWG-Productivity Indicators and
Monitoring System**

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Executive Summary

One of the major objectives of the study is to develop and construct a database for total factor productivity (TFP) estimation. After reviewing all possible sources of information, the paper attempted to develop a set of procedures for TFP database construction at the aggregate, national level and at nine major sectors which are (1) agriculture, (2) mining, (3) manufacturing, (4) construction, (5) utilities, (6) transportation, (7) trade, (8) finance and dwellings, and (9) other service sector.

One of the major lessons learned during the database construction was that the existing sources of historical information are inadequate, especially for the estimation of the capital stock series at the sectoral level. In particular, the absence of official sectoral investment makes the estimation of sectoral capital stock extremely difficult. This is probably the reason behind the limited number of sectoral TFP estimates in the literature. Because of this problem, the study had to apply a number of assumptions. Assumptions are all discussed in detail in the Appendix.

The strategy adopted during the database construction was to start at the national, aggregate level, utilizing information from the national income accounts (NIA). From the national level, data for the sectoral level analysis were constructed using appropriate distribution shares. This strategy was adopted because the NIA is updated regularly. Thus, with regular updates of the NIA, it is possible to come up with regular TFP updates also. This strategy has also another advantage of reducing the possibility of accumulated error at the national level TFP estimates. If it were from the other end, and start from the sectoral and up to the national, then data errors that may be committed at the sectors may add up and the national level data may end up having big accumulated error. Furthermore, the estimation covers the period from 1980 to 1996. It would have been better to extend the coverage far back to the 1970s and 1960s to get a longer-term perspective of the TFP movement.

However, because of data constraints this would be difficult, especially that factor payment shares at the sectoral level, an important information in the TFP estimation, extends only down to 1980.

At the national level, the indicators used were gross domestic product (GDP), total employment, gross domestic capital formation (GDCF), and factor payment shares. Using the perpetual inventory method, and together with the estimated capital depreciation rate and the estimated initial capital stock (1980), GDCF was used to construct the capital stock series. All time series data used, except factor shares, were expressed in 1985 prices using appropriate implicit price indexes. Employment, however, was not adjusted for average hourly work.

The capital stock series was adjusted for capacity utilization using a constructed capacity utilization index. The capacity utilization index was derived using the “peak-to-peak” method on real GDP.

At the sectoral level, sectoral gross value added (GVA), sectoral employment, the derived sectoral investment, and the sectoral factor payment shares were used. With the estimated sectoral capital depreciation rate, estimated sectoral initial capital stock (1980), the sectoral capital stock series was constructed using the same perpetual inventory method. The estimated sectoral capital stock series was adjusted for capacity utilization using a constructed sectoral capacity utilization index. The same “peak-to-peak” method was applied on sectoral GVA. Similar to the national level analysis, sectoral employment was not adjusted for average hourly work.

Four methodologies were used to compute for the TFP estimates: the traditional growth accounting, the Divisia-Translog, econometric, and stochastic frontier approach. The first two methods generated TFP estimates which moved in the same general direction. The second two methods generated period averages. For purposes of the discussion here, the results of the first two methods will be used.

Based on the estimates, TFP improved right after the crisis in the mid-1980s. It was highest during the early years of the Aquino government. However, the improvement was not sustained. TFP dipped in the early 1990s and has not improved significantly since then. In fact, TFP in the last six years has been below zero.

Focusing on the last six years, there were differences in TFP estimates across sectors. Based on the sectoral results, the poor TFP performance of the service-related sectors was the one which pulled down the national average. Surprisingly, TFP was positive on the average in the last six years for the agriculture sector, as well as for the manufacturing sector. In the latter, however, the decline in TFP the last two years is evident.

TFP was derived using a residual method. Thus, the results may be sensitive to changes in the data on GVA and factor inputs. Sensitivity analysis will still have to be conducted on how TFP would vary as assumptions used in the construction of the database are changed.

The paper is divided into three major parts. Part I is devoted largely to the survey of literature on TFP. The survey focused on TFP methodologies and TFP estimates in different countries including the Philippines. It can be observed from the survey that there were big differences in the sources of growth between the developed countries and the developing countries, especially the high-growth developing countries. While technological change was the major source of the growth in the former, it was capital in the latter. One of the possible explanations which has been advanced in the literature to explain this is that today's developing countries are taking advantage of the technologies available in the developed countries. Technologies flowed into the developing countries through capital which is largely imported. Thus, to a large extent, technologies are embodied in capital. If this is true, then the source of growth due to technical change is reduced drastically and TFP estimates would be smaller. In fact, TFP estimates of some

papers for the high growth East-Asian are nil or nearly zero. This should be taken into account when interpreting the TFP results of the present study.

Part II of the report focuses on the methodologies adopted in the present study which have already been discussed above. Lastly, Part III is devoted to important issues on how the construction of the TFP indicators can possibly be institutionalized. One of the major issues is the recent effort of the NSCB to construct time series for sectoral investment. Indeed, this is a welcome development. It can largely reduce the difficulties that are usually encountered during the construction of sectoral capital stock. Furthermore, there is an issue of collecting more information on the qualities of factor inputs like different categories of labor, and different types of investments. This set of information would further enrich the analysis of TFP. The collection of information can better be done by the NSO, in coordination with the NSCB.

Total Factor Productivity: Estimates for the Philippine Economy¹

**Caesar B. Cororaton and
Maria Teresa Duenas-Caparas²**

The objectives of the study are: (i) to conduct a review of literature regarding the general methodologies and approaches to total factor productivity (TFP) measurement; (ii) to compare TFP estimates of different countries including the Philippines; (iii) to develop a methodology for TFP estimation for the Philippines (both national and sectoral level); (iv) and to apply the methodology to existing Philippine data in order to arrive at new TFP estimates. The report is divided into three major parts. Part I discusses some general approaches to TFP estimation in the literature. It also presents TFP estimates for different countries and compares them with the existing estimates for the Philippines. Part II presents a detailed, step-by-step procedure used in establishing the data base for TFP estimation. It also presents the TFP estimates both at the national and sectoral level calculated using five different approaches to TFP estimation. And finally, Part III gives some insights and recommendations on how to institutionalize the procedure developed in this paper so as to generate regular updates of TFP estimates.

¹Study on the Establishment of Productivity Indicators And Monitoring System in the Philippines, A project of the TWG-PIMS which is chaired by NEDA.

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Part I : Review of TFP Literature

I.1 Introduction

The economic success of East Asian economies for the last three decades brought forth a new challenge in the global market. The so called Asian Miracle tested the traditional concept of growth, and triggered numerous attempts to explain the Asian economic success. The World Bank study (1993) stresses the importance of getting the prices right as the main factor contributing to the high and sustainable economic growth of East Asian economies. This neo-classical view adopted by the World Bank has been supported by many mainstream economists but, at the same time, highly criticized by the revisionists who believe that the role of government is very significant. Basically, the debate on East Asian economic growth is narrowed down to two schools of thought - the neoclassical and the revisionist. The former believes that the laissez-faire policy, together with the liberalization and deregulation policies, propelled the economic growth of economies like Hong Kong. The latter, however argues that it was due to an active, market-friendly intervention policy which caused the successful transition of economies in Taiwan and South Korea. Combining both views simply means that the East Asian success story is a result of the government mixing optimally fundamental and selective interventions for the purpose of (1) accumulating human and physical capital, (2) allocating this capital to high-yielding investments, and (3) promoting productivity growth (Case and Fair, 1996).

There is now a general consensus that one of the most important reasons for the East Asian economic success is the adoption of an export-oriented industrial strategy. Many developing countries persisted with their import-substitution policy that hindered the growth potential of their economies. But for the East Asian economies, they switched from import-substitution to export-promotion policy. A more important question is how these economies managed to successfully implement this policy considering that they were only at the early stages of economic development and could not possibly have competitive edge over more advanced developing countries in manufactured

products (Chen 1997). A necessary condition for economic growth is adopting the right policies. Complementary to this is setting a favorable institutional framework which will implement these policies, and can readily adopt a change of policies at the right time. Institutional factors such as culture and political structure play an important role in fulfilling the necessary and sufficient conditions. The failure of the Indian government to switch from an import-substitution policy could be influenced by cultural factors, whereas the switching of industrial policies of the Taiwanese government could be due to political factors. It has been shown in the literature that non-economic factors account for the East Asian miracle. Why did the miracle not happen earlier? Chen (1988) answered this question by arguing that first, an interaction between economic and non-economic factors is necessary, and second, a model cannot be universally true but is only applicable to the early stage of export orientation.

The literature on economic growth is focused mainly on the supply-side factors of production. Specifically, the main question being addressed now is which among the factors of production can be considered most important in maintaining long-run sustainable growth. In the earlier growth models advocated by Harrod-Domar, Ranis-Fei, Rostow, and the Big Push theory, investment and savings were considered the main propellers of growth. During the 60's and 70's when the neoclassical models were predominant in the literature, neoclassical economists treated technological change as the main ingredient of growth. Corollary to this view is the belief that growth convergence could be achieved between developed and developing countries over time since capital and technology are mobile across countries. In this growth model, output level and growth depend on the country's resource endowment and the productivity of the factors of production (TFP). In the early 80s, new growth theories surfaced (Romer 1986, Lucas 1988) and emphasized the importance by which investment derives from increasing returns to scale. Knowledge was regarded as the most important form of capital, and investment in human capital was considered vital in enhancing economic development. Further, the new growth theory predicted a divergence of growth between developed and developing countries over time because capital accumulation is more rapid in developed countries and is subject

to increasing returns (Chen 1997). The implication of the new growth theory was challenged by the empirical findings of Young (1992, 1995). His study pointed out that Hong Kong and Singapore experienced similar rates of high economic growth despite the latter having a higher rate of capital accumulation. From this, technological change became once again the main determinant of long-term sustainable economic growth.

The relevance of capital and technological change in economic growth goes far beyond theoretical discussions. It also borders on policy formulations and prospects for developing countries in the long run. The recent paper of Krugman (1994) drew much reaction when he suggested that the growth of East Asian economies is not sustainable. Using a growth accounting methodology, he identified the source of growth and implied that its mainly input-driven and not technology-based. He likened the case of East Asia to that of the Soviet experience. Krugman's paper is just one of the many papers that mushroomed in attempting to explain the Asian miracle. These papers used various methodologies, diverse data set, and different time periods. However, the locus of their studies is total factor productivity. The objective of this paper is to provide a survey of methodologies in estimating TFP and argue that the importance of technological change largely depends on how TFP is defined and estimated, and how factor input data are measured. Further, this paper will also provide various estimates of TFP for the Philippine economy.

I.2 Total Factor Productivity

TFP in its simplest definition is the ratio between real product and real factor inputs. It is a neoclassical concept which means first, TFP is a measure of productivity which takes into account all the factors of production³, and second, TFP is associated with the aggregate production function, a neoclassical tool. The concept of TFP originates way back in the early 50s with the work of Tinberger, a German economist. Many others followed suit but TFP

³In contrast with the classical Ricardian labor theory of value which states that labor is the only factor input in production.

started to become a popular concept only through the growth model of Solow in 1957.

Productivity is a technical concept measuring efficiency. When only a single input is referred, say labor, the notion of productivity does not pose any problem. One simply need to get the ratio between the output and that single input to obtain efficiency estimates. However, complication arises when there is more than one factor of production, say labor and capital. Specifically, the problem is how to weight the contribution of each factor. Standard forms of productivity ratio are

$$A = \frac{Q}{L^{\alpha} K^{\beta}} \quad (1)$$

$$A = \frac{Q}{\alpha L + \beta K} \quad (2)$$

where (1) is an arithmetic index and (2) is geometric. A is a measure of productivity index, Q is output, L and K represents labor and capital, and α and β are the weights. The problem of weighing is solved using an aggregate production function. In its simplest form, the production function can be written as

$$Q_t = F [K_t, L_t, t] \quad (3)$$

which expresses output as a function of stock of capital, employment, and time⁴. If time can be separated from L and K, then

$$Q_t = A_t F [K_t, L_t,] \quad (4)$$

and

⁴The time variable is a proxy for productivity and technical progress.

$$A_t = \frac{Q_t}{F[K_t, L_t]} \quad (5)$$

A_t now measures how output changes as time elapses with the input bundle held constant (Felipe 1997). Productivity is an index of other factors of production besides labor and capital not explicitly accounted for but considerably contributing to output. Some of these factors may be research and development, managerial competence and diffusion of technology.

There are two general ways of estimating TFP. The first one discrete data for national accounting or the growth accounting approach, while the second uses an aggregate production function or the econometric approach.

1.2.a Growth Accounting Approach

The growth accounting approach of estimating TFP was first ventured by Stigler and popularized by Kendrick (1961) and Denison (1962). It uses factor shares in national income as weights in combining the individual factor inputs forming an index of TFP. The weights are also used to define that part of output growth which cannot be defined by the factor inputs. This approach provides more room in decomposing the contribution of factor inputs and technological change to output growth.

A general neo-classical production function is assumed given by

$$Y = F(K, L, t) \quad (6)$$

where Y is output, K is capital, L is labor and t is time. Differentiate equation 6 with respect to time and rearrange, we get the following;

$$\frac{dY/dt}{Y} = \frac{(\delta F/\delta K)K}{Y} \cdot \frac{dK/dt}{K} + \frac{(\delta F/\delta L)L}{Y} \cdot \frac{dL/dt}{L} + \frac{(\delta F/\delta t)}{Y} \quad (7)$$

where $(\delta F / \delta t) / Y$ is the proportional rate of shift of the production function. This represents technological change, or TFP. The $(\delta F / \delta L)L / Y$ and $(\delta F / \delta K)K / Y$ are factor shares of labor and capital respectively. Simplifying the equation using Y , K , and L , for growth, and S_k and S_l to represent the share of capital and labor to income, equation 7 becomes

$$Y = S_k K + S_l L + \text{TFP} \quad (8)$$

or conversely,

$$\text{TFP} = Y - S_k K - S_l L \quad (9)$$

Equation 9 can now be used to calculate the sources of economic growth. Similarly, the contribution of labor, capital and technological change can be identified.

Neoclassical economics assumes perfect competition and profit maximization. This implies price elasticity of demand is infinite, and factor elasticities equal factor shares in output. An alternative of equation 9 is

$$\text{TFP} = Y - \alpha K - (1-\alpha)L \quad (10)$$

This is the Solow residual⁵. Growth accounting implicitly assumes a well-behaved neoclassical production function that facilitates the decomposition of sources of growth. It becomes important to bear in mind that TFP using this approach is treated as a residual. It proxies as a "catch all" variable and embodies that part of output growth which cannot be explained by increases in factor inputs. It therefore becomes an index of ignorance (Chen 1997).

Equation 10 can be further modified with the use of discrete data using the Tornqvist index. It can be shown that

⁵ Recall the Y , K , and L are growth rates.

$$\theta_{t,t-1} = \ln \frac{Q_t}{Q_{t-1}} - \Phi_L \ln \frac{L_t}{L_{t-1}} - \Phi_K \ln \frac{K_t}{K_{t-1}} \quad (11)$$

where

$$\Phi_L = \frac{\omega_L L + \omega_{L-1}}{2} \quad \Phi_K = \frac{\omega_K + \omega_{K-1}}{2}$$

denote the share of each aggregate factor in total factor payments.

1.2.b Econometric Approach

A specification of a production function, usually in the form of Cobb-Douglas constant returns to scale, is the starting point of the econometric approach. This is given by

$$Y_t = A_t K_t^\beta L_t^{1-\beta} \quad (12)$$

where Y_t , K_t , and L_t are output, capital and labor input at time t . A_t is a technology parameter representing the shift in production function. β is the output elasticity for capital and $1-\beta$ is the output elasticity of labor. The technology parameter, A_t can be defined as

$$A_t = A_0 e^{\lambda t} \quad (13)$$

which implies technology grows at a constant exponential rate of λ . Substituting (13) to (12), we can get

$$Y_t = A_0 e^{\lambda t} K_t^\beta L_t^{1-\beta} \quad (14)$$

Taking the logarithms of both sides will yield the following;

$$\ln Y_t = \ln A_0 + \lambda t + \beta \ln K_t + (1-\beta) \ln L_t \quad (15)$$

Given a time series data for Y , K , and L , the output elasticities, as well as the technology coefficient λ can be easily estimated. Upon knowing λ , the contribution of technological change to output growth can be ascertained. However, it is very important to understand that λ is disembodied, exogenous and Hicks-neutral.

- ◇ ***Disembodied technological change*** means that it is not embodied in factor inputs. It is akin to a manna from heaven taking the form of better methods and organization that improve the efficiency of both new and old factor inputs. Any technological change embodied in the factor input is assumed to be properly specified and accounted for in the production function.
- ◇ ***Exogenous technical change*** means that its occurrence is independent from the other factors of production. This implies that time is the only factor. In contrast to endogenous growth models, technological change is influenced by research and development expenditure, experience, education, investment activities and the like.
- ◇ ***Hicks-neutral technological change*** means technology increasing the efficiency of both capital and labor inputs to the same extent. The other forms of technological change are (1) Harrod-neutral technological change which is labor-augmenting, and (2) Solow-neutral technological change which is capital-augmenting.

The qualifications stress the point that λ should be interpreted with caution. A small λ could mean that the production function may be mis-specified and could fail to take into account the endogenous aspect of technological change. Neither could it mean that the contribution of technology to output growth is low due to embodied technological change. Conversely, a large λ can be due to significant effects of economies of scale and resource allocation.

Bias can also persist when important variables like research and development (R&D), and education are not explicitly defined in the production function.

A variation of the econometric approach is the stochastic approach. Equation 15 is based on a production function that expresses the maximum obtainable output from a given set of inputs. However, empirical models using ordinary least squares estimation can only obtain the average production functions. For the best practice or production frontier methodology, an unobservable production is assumed and this represents the set of maximum attainable output level for a given combination of inputs. This approach decomposes changes in TFP into technical progress and technical efficiency change. Technical progress is associated with the best practice production frontier, while the technical efficiency change is related to learning by doing, improved managerial practice and changes in efficiency when a known technology is applied (Kalirajan 1994).

I.3 Some Methodologies

Data availability and reliability differ among countries. Hence, a comparable TFP estimate for international countries is close to impossible. Added to this, the measurement of TFP depends on three things;

- I. specification of the relationship between input and output
- II. proper measurement of the factor inputs
- III. weights assigned to the different categories of an input in the aggregation of sub-inputs

In the earlier literature, Cobb-Douglas, CES, and VES⁶ were the widely used production functions in estimating TFP. Recent development in the growth literature shows that the most popular form of production function is the transcendental logarithmic production function, or simply the translog production function. This is specified as follows;

⁶ CES is Constant Elasticity of Substitution and VES is Variable Elasticity of Substitution.

$$\begin{aligned}
Y = \exp [& \alpha_o + \alpha_L \ln L + \alpha_K \ln K + \alpha_T T \\
& + \frac{1}{2} \beta_{KK} (\ln K)^2 + \beta_{KL} \ln K \ln L + \beta_{KT} T \bullet \ln K \\
& + \frac{1}{2} \beta_{LL} (\ln L)^2 + \beta_{LT} \ln L \bullet T + \Omega \beta_{TT} T^2] \quad (16)
\end{aligned}$$

The production function states that output is an exponential function of the logarithms of the inputs. The translog function is a more generalized form of the Cobb-Douglas and CES, and is much more favorable to use because (1) it is not constrained by the restrictions similar in CES; and (2) it provides a theoretical justification for the use of average factor shares in the calculation of productivity growth.

The translog form can further be extended to treat aggregate output as a function of its components. The translog form has provided justification for the use of the growth accounting approach. However, problems in the estimation still exist and these can be attributed to the measurement of factor input.

I.4 Factor Input Measurement

The studies of Young (1992) and Krugman (1994) were the first of a series of studies that dispelled the Asian miracle. Specifically, they stressed that much of the output growth is driven by capital accumulation and not by technological change and productivity. The relatively small TFP growth estimated by these authors could be reflective of the biases in the measurement of factor inputs.

Complications in the labor data may arise due to aggregation problems. Each worker values labor quality differently. To account for the changes in average work quality, adjustments are made using the age, sex, and education of the labor force. These adjustments can partially explain the decline in the growth of output per hour of labor input.⁷ Another issue that should be

⁷ See Clark (1979) for a detailed discussion of labor data adjustments.

addressed in the labor data is the effect of capital intensity on the growth of labor productivity. Using “hours worked” as the standard measure of labor input, it would be possible that adjustments for full-time equivalence can account for the decline in the workweek of capital. Lastly, a distinction should be made between number of hours and number of employees for labor data. Differences between the two can arise into two situations; first, increases in part-time workers, and second, decline of capital intensity of production.

Between capital and labor, the measurement for capital is more problematic. There are basically three possible issues in the measurement of capital.

- A. **Composition of Capital Input.** There are numerous items that can be classified as capital goods like land, inventories, consumer goods and durable goods. A consistent decision should be made as to what items should be included in the composition of capital input. This is very important since the content of capital input will affect the type of price deflators that is needed in making quality adjustments. Value shares have to be estimated as weights, hence factor prices need to be known.
- B. **Adjustment for capacity utilization.** Capital input is subject to the business cycle. During recession, it is clear that there is excess capacity in the use of capital. To adjust for capacity utilization, two indices could be used--unemployment rate as a measure of under-utilization of capital, and power utilization rate.
- C. **Choice between Net or Gross Capital.** It is argued that the use of net capital (net of depreciation) has the tendency to overstate depreciation because obsolescence is the dominant feature of depreciation, rather than physical deterioration. Capital becomes obsolete in the economic context because it has outlived its physical usefulness. However, it is still capable of contributing to production (Chen 1997). Ideally, capital should

be adjusted for depreciation but not obsolescence. In reality, this is impossible to practice. Thus, any over-depreciation will overstate the residual or TFP estimate.

The measurement of TFP is marred by conceptual and measurement errors. Its interpretation largely depends on which methodology was used, and how factor inputs were measured.

I.5 TFP Estimates: Some Empirical Findings

I.5.a Regional Estimates

Numerous studies mushroomed analyzing the sources of growth for both the developed and developing countries. In most cases, the contribution of TFP to output growth for developed countries is significantly high. Table 1 presents a regional summary of sources of growth published by the World Bank (WB) in 1991. The WB Team used a Cobb-Douglas production function and used differential calculus to arrive at the following⁸;

$$r_Q = r_T + \alpha r_K + \beta r_L \quad (17)$$

where r_Q is the growth rate of output, r_T is the growth rate of technical progress, r_K is the growth rate of capital and r_L is the growth rate of labor. From equation 17, they were able to decompose the sources of growth into contribution of capital, labor and technological progress. The results are consistent with those obtained in the earlier studies. In the developing countries, the most important source of output growth is increases in capital stock. For the entire region, accumulation of capital contributes 65 percent to output growth, followed by labor contribution at 23 percent and lagging behind is the contribution of technical progress at 14 percent. These findings sharply contrast with that of the developed countries. According to the estimates, technical progress largely accounts for the growth of output - a case where efficiency in inputs is more relevant than accumulation of factors

of production. However, within the confines of the East Asian region⁹, the sources of growth conform more to the pattern of the developed region, i.e. technical progress plays a significant role in output growth.

1.5.b Newly Industrialized Economies¹⁰

Among the Asian economies, Japan is the most favored country for TFP analysis. Its exceptional growth in the past years made it one of the strongest economies to reckon. Many economists believe that Japan's remarkable output growth is due to technological progress or TFP. Table 2 shows a summary of major studies about the Japanese economy. The five authors used different time periods yet their results are quite consistent with each other - TFP is the main contributor of output growth. This considering the fact that each time period yielded different average growth rates and underwent major structural changes.

Table 1: Sources of Growth, %*

Region	Capital	Labor	Technical Progress
<i>Developing Countries, 1960-87</i>	65	23	14
Africa	73	28	0
East Asia	57	16	28
Europe, M. East, . Africa	58	14	28
Latin America	67	30	0
South Asia	67	20	14
<i>Selected Developed Countries, 1960-85</i>			
France	27	-5	78
West Germany	23	-10	87
Japan	36	5	59
United Kingdom	27	-5	78
United States	23	27	50

*some rows do not sum up to 100 due to rounding errors.
Reprinted from Lim, 1994.

Next to Japan, the newly industrialized economies (NIEs) take the center stage in the sources of growth literature. Given the differences in measurement, its growth performance stands out. Added to this, the NIEs have

⁸ This is a similar methodology discussed in the Section 2.

⁹ Consists of countries like Indonesia, Malaysia, Thailand and the Philippines.

also managed to excel in two crucial indicators of development: income distribution and the quality of life. Taiwan, Singapore, South Korea and Hong Kong now boast of having been able to fight and reduce the poverty level in a span of 30 years and improve their way of living. Indicators of these would be (1) life expectancy at birth, (2) percentage of the age group enrolled in secondary education, (3) employment and wages growth, and (4) number of doctors per capita. The performance of the NIEs, as far as these indicators are concerned, was way above those achieved by some developed countries.

Table 2: Summary of Major TFP Studies for Japan

Author	Published Study	Period of Study	Contribution of TFP to output growth, %
Chen	1977	1955-70	55.1
Oshima	1987	1953-71	4.9*
Kanamori	1992	1955-60	60
World Bank	1993	1960-89	3.5*
Takenaka	1997	1970-92	2.2*

*In annual averages

Reprinted from Chen 1997

With the exception of Philippines and China, the four economies performed extremely well. Table 3 presents a summary of the studies done on East Asia. There are six major studies conducted since 1974. All six studies used the same methodology but differed in time periods and adjustments in the data. Hence, the estimation results are not entirely comparable.

Table 3: TFP estimates (whole economy): Asia NIEs

NIEs	Chen, 1977 (1955-70)	WB, 1993 (1960-89)	Drysdale and Huang, 1995 (1950-88)	Young, 1995 (1966-90)	Takenaka, 1995 (1970-92)	Kim and Lau, 1994 ^a
Hong Kong	4.3 (46.5)	3.6 (43.9)	3.1 (34.4)	2.3 (31.5) ^b	3.1 (46.3) ^c	2.4 (35.0)
Korea	5.0 (56.4)	3.1 (36.9)	2.1 (28.4)	1.7 (16.5)	0.8 (9.3)	1.2 (14.0)
Singapore	3.6 (55.2)	1.2 (15.0)	0.8 (10.4)	0.2 (2.3)	-2.4 (...)	1.9 (23.0)

¹⁰ Included in the NIEs are Hong Kong, Korea, Singapore and Taiwan.

Taiwan	4.3 (53.6)	3.7 (42.0)	2.9 (33.7)	2.6 (27.7)	1.8 (20.9)	1.2 (15.0)
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^A Hong Kong, 1966-90; Korea, 1960-90; Singapore, 1964-90; Taiwan, 1953-90.

^B 1966-91.

^C 1978-92.

Numbers in parenthesis are the percentage contribution of TFP to output growth.

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There were major differences in the usage of the data. In Chen, he made no adjustments with the official data but had to determine the capital stock data using accumulated investment and applied it to base year. Moreover, the residual estimate he obtained was further identified into its resource allocation component. Thus, in analyzing TFP, the effects of resource allocation is included. In his study, the output growth of three economies were approximately 50 per cent attributed to TFP. By assumption, this consists of quality changes in factor inputs which includes quality changes in capital not reflected by the official price deflator, the quality change of labor, the effects of resources reallocation and economies of scale, and interaction of factor inputs.

In contrast, the WB study used labor data which was adjusted for educational attainment, and capital input deflated by a modified deflator. The estimated TFP excluded most of the quality changes in factor inputs, reflecting the concept of disembodied technological change. In the study of Young, the statistical data on factor inputs were all adjusted to reflect quality changes. For capital, it was divided into five categories¹¹, and labor into seven categories. This means that the TFP estimates obtained by Young do not reflect quality improvements in factor inputs. Similar to the WB study, he used the concept of disembodied technological change. The other three studies did not mention any adjustments they made in the data. Presumably, any adjustments must be implicitly made.

Among the six studies, the ones conducted by Young, and Kim and Lau were most controversial. They contradicted the importance attached to TFP as the main source of growth in East Asia for the last three decades. Using their definition and estimation, they came to the conclusion that the

¹¹ Land not included.

main driving force of the Asian miracle, it ever there was one, was capital accumulation. Young used the growth accounting approach and computed for the Solow residual for Singapore, Hong Kong and Korea. The main findings of his studies were (1) the average growth of TFP for the three economies was zero implying that the role of technical progress was negligible, (2) using different time periods and data adjustments, he still obtained consistent negative TFP estimates for Singapore, (3) capital accumulation explained 117 per cent of the increase in output per worker in Singapore during the period 1970-90, and (4) over the years, Singapore suffered a declining rate of return to capital. Table 4 summarizes the results of Young's estimate for East Asia.

Table 4: Summary of Young's Findings

Economy	Period	Annual Rate of TFP, %	% of Output Growth
Indonesia	1970-85	1.2	...
Malaysia	1970-85	1.0	...
Thailand	1970-85	1.9	...
Hong Kong, China	1961-66	3.5	32.1
	1966-71	2.3	35.4
	1971-76	3.9	48.1
	1976-81	2.2	22.2
	1981-86	0.9	15.5
	1986-91	2.4	38.1
	1966-91	2.3	31.5
Korea	1960-66	0.5	6.5
	1966-70	1.3	9.0
	1970-75	1.9	20
	1975-80	0.2	2.2
	1980-85	2.4	28.2
	1985-90	2.6	24.3
	1966-90	1.7	16.5
Singapore	1966-70	4.6	35.4
	1970-80	-0.9	-10.2
	1980-90	-0.5	-7.2
	1966-90	0.2	2.3
Taipei, China	1966-70	3.4	30.6
	1970-80	1.5	14.6
	1980-90	3.3	42.3
	1966-90	2.6	27.6
Japan	1970-85	1.2	...

... not available.

Reprinted from Felipe 1997.

Kim and Lau used a different methodology in estimating TFP. They adopted a meta-production function¹² which is a production function that can represent the input-output relationship of a given industry in all countries. For the empirical analysis, they used a translog production function with the time variable representing technical efficiency. Their production function was modeled to determine if technical progress can be an augmenting factor or not. The production function was expressed as

$$\ln Q_t^* = \ln Q_0 + a_K \ln K_{it}^* + a_L \ln L_{it}^* + \frac{B_{KK}}{2} (\ln K_{it}^*)^2 + \frac{B_{LL}}{2} (\ln L_{it}^*)^2 + B_{KL} (\ln K_{it}^*) (\ln L_{it}^*) \quad (18)$$

where

$$Q_{it}^* = A_{i0} (1 + \lambda_{i0})^t Q_{it} \quad i = 1 \dots n$$

$$X_{ijt}^* = A_{ij} (1 + \lambda_{ij})^t X_{ijt} \quad j = 1 \dots m$$

and

A_{i0} , A_{ij} , are constants referred to as augmentation level parameters; λ_{i0} , λ_{ij} are constants referred to as augmentation rate parameters; m and n are inputs and countries respectively.

Kim and Lau also considered the share of labor costs to the value of output represented by $w_{it} L_{it} / p_{it} Y_{it}$, where w is the nominal wage and p is the nominal price of output. They assumed a perfectly competitive market and firms are profit maximizers. This implies that the elasticity of output with respect to labor is the same as the share of labor in total output. On the other hand, the implication of the profit maximizing condition is that the parameters obtained in the production function should be identical to the share equation. The share equation is given by

¹² Uses a regression procedure which results to estimating a regression pooling time-series

$$\frac{w_{it} L_{it}}{p_{it} Y_{it}} = a_{Li}^{**} + B_{KLi} \ln K_{it} + B_{LLi} \ln L_{it} + B_{Lti} t \quad (19)$$

The two equation system was estimated using nonlinear instrumental variables in the order of first differences. The main findings of their study were (1) productivity growth for the NIEs is zero, (2) the assumptions¹³ of growth accounting methodology does not hold true, and (3) technical progress is capital-augmenting. Table 5 presents a summary of the TFP estimates of Kim and Lau.

Table 5: Summary of TFP Estimates of Kim and Lau

Country	Period	Annual Rate of TFP, %	% of Output Growth
Hong Kong, China	1966-90	2.4; 2.0	35; 27
Korea	1966-90	1.2; -0.5	14; -6.0
Singapore	1966-90	1.9; 0.4	23; 5.0
Taipei, China	1966-90	1.2; 0	15; 9.0
Japan	1966-90	2.9; 1.0	46; 15

Reprinted from Chen 1997.

The results and views of Young, and Kim and Lau became very influential in the development of sources of growth literature, particularly for the unraveling of the mystery behind the Asian miracle. Their studies point out to one basic conclusion: TFP is not a major source of growth in Asia. Famous economists like Krugman, Rodrik, and Lucas even predicted the development pattern of the Asian economies. Krugman suggested that the high economic growth achieved by the Asian economies is not sustainable, and compared it to that of the Soviet Republic where economic downfall is the next mostly likely occurrence.

This view, however was highly contested by some economists. Chen(1997) in his recent article, provided some explanations for the low TFP estimates obtained by Young. According to Chen, the relatively small TFP

and cross-section data for several countries (Felipe 1997).

¹³ Standard assumptions of the growth accounting methodology are constant return to scale, neutral technological progress and profit maximization.

estimate Young obtained in his computations does not necessarily imply that technological change is an insignificant source of growth. A more appropriate explanation, as Chen suggested, would be disembodied technological change did not play an important role in the economic growth but embodied technological change added with quality improvements could have been the more important player of growth for developing countries. Further, he claims that what can be inferred from these studies is that embodied technological change is more relevant for developing countries while disembodied technological change is the major player for developed countries. He contradicted the views of Krugman by claiming that technological change, in the embodied form, has been significant in East Asia (Chen 1997).

1.5.c Southeast Asia¹⁴

There are only very few studies made for Southeast Asia, and some of the earlier studies were TFP estimates for the Philippines. In the recent studies, the four countries were categorized into forces that push for output growth. Indonesia and Thailand are classified as productivity-driven economies because TFP contributes for more than 25 per cent of economic growth. For Indonesia, studies showed that its industrial sector has grown significantly over time. For Philippines and Malaysia, these economies are classified as investment-driven growth where there is little or no productivity growth at all. Table 6 shows a summary of the studies conducted for Southeast Asia.

1.5.d Philippines

During the 80s when Asian economies were experiencing high levels of growth, the Philippines was struggling from economic bondage and was forced to implement structural adjustments dictated by the World Bank and the International Monetary Fund. The adjustment policies were aimed at correcting the balance of payment deficit and reducing the fiscal deficit which unfortunately led to a deterioration of the living standards of the Filipinos and large drop in

¹⁴ Southeast Asian economies include Indonesia, Malaysia, Philippines, and Thailand.

economic growth (Kajiwara 1994). Aside from macroeconomic imbalance, the low productivity level of the Philippine economy was considered one of the significant factors which led to the failure of attaining industrialization. Based on the literature, only a handful of studies were conducted pertaining to the productivity of the Philippine economy. In spite of the differences in the methodology, time frame and data set used in all these studies, each arrived at the same conclusion: a declining productivity estimate. Recent papers on productivity were conducted by Cororaton et al (1995, 1997), Austria and Martin (1992) and Patalingjug (1984). Cororaton attributed the declining TFP from poor acquisition of technology while Austria and martin delved into the different trade and investment policies. Table 7 presents a summary of the various studies conducted for the Philippine economy.

Table 6: TFP Estimates in Southeast Asia

Country	Drydale and Huang (1995), 1950-88	Kawai (1995) 1970-90	WB (1993) 1960-89
Indonesia	2.1 (31.3)a	1.5 (24.2)	1.2 (23.1)
Malaysia	-0.5 (-8.3)	1.6 (23.9)	1.1 (17.5)
Philippines	0.2 (4.1)	-0.7 (-19.4)
Thailand	1.7 (29.3)	1.9 (27.1)	2.5 (36.8)
China	2.0 (28.2)b	1.9 (24.4)	...

Numbers in parenthesis are percentage contribution to output growth.

a 1962-88.

B 1960-88.

Reprinted from Chen 1997.

Cororaton and Abdula (1997) conducted an extensive study on the Philippine manufacturing industries and attempted to calculate sectoral TFP estimates, and identify macroeconomic variables that could have influenced the productivity level of the industry sector. Based on their estimates, productivity for manufacturing industry only grew by 0.052 per cent for the period 1958-91 and this partially accounts for the stagnating technological advancement. The study identified factors like foreign direct investment, inflation, and research and development, wage rates, tariff rates, export and import as possible macroeconomic factors that influence productivity. All the variables, except for wages, were statistically significant suggesting that indeed, these factors could

influence productivity growth. These results entail policy implication. A sound macroeconomic environment would stimulate investment and improve productivity. Stabilization policies like low inflation and reduced budget deficits are attractive to investors.

Table 7: Sources of Growth for the Philippine Economy

Author	Time Period	Capital	Labor	Land	Education	Technical Progress	GDP Growth
Williamson (1969)	1947-55	9	33	3	N.A.	55	7.3
Williamson (1969)	1955-65	25	54	5	N.A.	15	4.5
Sanchez (1983)	1960-73	24	52	N.A.	N.A.	24	4.6
Patalingjug (1984)	1960-82	48	23	N.A.	6	23	5.5
Austria and Martin (1992)	1950-87	87	24	N.A.	N.A.	-11	4.6

Reprinted from Cororaton et al, 1995.

Part II : New TFP Estimates for the Philippines

II.1 Sectoral Breakdown

The TFP estimation was done at the aggregate, national level and at 9 major sectors. These 9 major sectors are: (1) agriculture; (2) mining; (3) manufacturing; (4) construction; (5) utilities; (6) transportation; (7) trade; (8) finance and dwellings; and (9) services. The detailed description, as well the listing of the finer sub-sectors within these major sectors is shown in Appendix B.

II.2 Concepts and Terms

The following items are used in the discussion below. Some of these items and concepts may have already been discussed in Part I above.

II.2.a Total Factor Productivity. In principle, the growth of output can be decomposed into two major groups: (i) the growth in factor inputs, and (ii) the growth in factor productivity. The focus of this study is to establish an indicator system of the second group. Operationally, in the growth accounting approach the indicator for the growth of factor productivity

is computed residually¹⁵. That is, if the indicator of output growth is the growth of real GVA, then factor productivity (or total factor productivity growth) is calculated as the difference between the real growth in GVA and the weighted sum of the growth of the primary factor inputs which are labor and capital¹⁶. As such, TFP is calculated as a growth rate, since it is the difference between two growth rates. Normally, it is not derived in monetary units or in levels.

Why focus on the growth in factor productivity? The growth in the primary factors (commonly called as factor accumulation) is subject to diminishing returns. Therefore, the growth in output due to factor accumulation will eventually taper off, making the growth process unsustainable in the long run. However, the growth in factor productivity has increasing returns characteristics. That is, there is no limit to the growth in output that is due to factor productivity.¹⁷

Theoretically, factor productivity growth can be decomposed into major sub-groups: technical efficiency and technical progress which are discussed below.

II.2.b Technical Efficiency. Technical efficiency is defined as the degree of effectiveness of the operation of the organisation in being able

¹⁵ TFP indicator may also be derived econometrically. Under such approach the coefficient of one of the variables in the regression of the production function is an estimate of TFP. However, the TFP result will be an average over the regression period. Year-to-year variation of TFP may not be analyzed in this case.

¹⁶ Some studies consider different skill levels of labor and different qualities of capital. Others also include land. The present study, however, does not consider different labor skills and capital qualities and land. In effect, the effect of improvements in the quality of factor inputs are all lumped up in the TFP estimate. An interesting area for research is to include the different input characteristics. In principle, this should reduce the size of TFP.

¹⁷ As discussed in Part I, there are generally two schools of thought about the things that propel factor productivity growth: the old neoclassical school which states that the production frontier of developing countries approaches or converges naturally to that of the developed countries in the long run. In the new school, which is called the endogenous growth theory, convergence may not happen naturally and automatically. In fact, it requires active policy intervention in areas like education, population, research and development, trade reforms, market reforms, foreign direct investment, transfer of technology, etc..

to produce an output level that is at its potential, given its present capacity. Simply put, technical efficiency measures how near the organisation is operating from its production frontier. There are a number of things that can affect the technical efficiency of an organisation. One would be the effectivity of management. Another would be the efficiency of the structure of the organisation. However, the important point to consider here is that the improvement in output due to the improvement in technical efficiency is realised not through an additional investment, but through an improvement in the existing set-up of the organisation, e.g., effective management, efficient production operation, etc.

II.2.c. Technical Progress. Technical progress is defined as the improvement in the output potential itself of the organisation. Theoretically, it is defined as the upward shift in the production frontier itself, as opposed to technical efficiency defined above as the movement towards the present production frontier. The factors that may affect such shifts include: technology transfer, investment in human capital, investment in research development, etc.

Thus, the TFP indicator, as a productivity indicator, captures changes in technical efficiency and technical progress.

II.3 Data Base

The TFP estimation in the study was done both at the national and the sectoral level. The strategy followed was to start at the national level, utilising information from the national income accounts (NIA). From the national level, data for the sectoral level analysis were constructed using appropriate distribution shares. This strategy was adopted because NIA is updated regularly. Thus, with regular updates of the NIA, regular TFP updates can also be done. Furthermore, this strategy has another advantage of reducing the possibility of accumulated error at the national level TFP

estimates. If it were from the sectoral up to the national, then data errors that may be committed at the sectors may add up so that the accumulated error at the national level may be huge.

Because of data constraints the TFP estimation covers only the period 1980 to 1996. It would have been better to extend the analysis further back to the 1970s and 1960s to get a longer-term perspective of the TFP movements. However, one of the major set of information used in the estimation of TFP, which is the factor payment shares at the sectoral level, is available only starting from 1980. A detailed, step-by-step procedure used to construct the data base is shown in Appendix B.

Gross value added. The indicator of value of output used in the estimation is gross value added (GVA). The reason for doing this is that gross domestic product (GDP) in the NIA is the sum of sectoral GVA. Since updates for both GDP and sectoral GVA come out regularly, it is possible to do regular updates for the TFP indicators at both levels. Furthermore, factor payments to labor and capital (wage compensation, and mixed income and operating surplus, respectively) at sectoral level are also available regularly on an annual basis. Thus, with GVA, the effects coming from the raw materials are not accounted for in the TFP estimates.

Both GDP and sectoral GVA were expressed in real prices using their respective implicit price indexes, which are also available from the NIA. The price indexes are in 1985 prices.

Labor. Data on employment, both at the national and sectoral level are published regularly. Thus, in the TFP estimation, the data series on the number of employment generated by the Department of Labor and Employment (DOLE) were utilised as labor factor input. In principle, labor service, not the level of employment, is the one that is relevant in the analysis. The common practise is to adjust the employment data with some

information on average working hours. However, a good time series for the “weekly average hours work” is not available. Because of this problem, the employment data were not adjusted. For the time being, this presents one weakness in the estimation, which can be easily modified and adjusted after a good and consistent “weekly average hours work” time data series has been established.

Capital Stock. Usually, one of the major problems encountered in TFP estimation is the unavailability of capital stock series both at the national and sectoral level. In the Philippines, the problem is aggravated by the unavailability of sectoral investment data series. Appendix B shows a detailed procedure used to construct capital stock series at the national and sectoral level. In essence, the procedure started with the gross domestic capital formation GDCF (investment at the national level) which is available from the NIA. This GDCF series was distributed into sectoral investment using a set of derived sectoral investment shares computed using the sectoral gross additions to fixed assets (GAFA) from the Annual Survey of Establishment (ASE) of the National Statistics Office (NSO). The capital stock series were derived using the perpetual inventory method¹⁸.

Capacity Utilisation Capital services are the ones needed in the analysis, instead of the level of capital stock. To arrive at this set of information, the derived capital stock series were adjusted by capacity utilisation. In the study capacity utilisation index was derived using the peak-to-peak method on both real GDP and real sectoral GVA. A detailed analysis appears in Appendix B.

II.4 TFP Methodologies Used.

¹⁸The task of computing for the sectoral investment would have been a lot easier and the result would have been more accurate if sectoral investment were available. However, there is an ongoing effort in the National Statistical Coordination Board (NSCB) to construct a time series for sectoral investment. The derived investment series in this paper can be checked

There are a number of approaches to estimating TFP available in the literature. As discussed above, the different approaches fall under (a) the growth accounting approach, and (b) the production function and the econometric estimation approach. In the present study few methodologies under each approach were applied. For the first approach two methodologies were used: the traditional growth accounting methodology (Method 1) and the translog index method (also called the Tornquist Method, Method 2). For the second approach, a Cobb-Douglas production function was estimated econometrically (Method 3), as well as the stochastic frontier (Method 4). Each of these methods are discussed below.

Growth Accounting Method (Method 1). The traditional growth accounting approach was applied both on the annual changes in value added and factor inputs, and on the three-year moving averages of these changes. The latter was done to smooth out the annual variability of the changes of the value added and factor input series. To reiterate, growth accounting approach uses the following formula:

$$(\text{TFP growth})_i = (\text{value added growth})_i - \Theta_{Li} * (\text{employment growth})_i - \Theta_{Ki} * (\text{capital services growth})_i \quad (20)$$

growth where value added growth was computed using data in Table A1 in Appendix A; employment growth computed using Table A3, capital services growth computed using the product of capital stock series (Table A7) and capacity utilization (Table A6), and Θ_{Li} and Θ_{Ki} are factor payment shares in Table A2. One should note that the employment data was not adjusted for average hours of work in order to derive the appropriate labor services. This is because of the unavailability of a consistent series on average hours of work. However, the derived capital stock series was adjusted for capacity utilization to get capital services. The advantage of using this approach is that it is straight forward to apply. The usual problems in regression analysis

against these numbers when they come out officially. If there are significant deviations, then the estimates of this paper will be revised accordingly.

are not encountered. However, the test of statistical significance of the estimates cannot be conducted.

Translog Index Approach (Method 2). The translog index approach is

$$\begin{aligned} \text{TFP}_i = & [\ln Q_i(t) - \ln Q_i(t-1)] - v_{iL} * [\ln L_i(t) - \ln L_i(t-1)] - \\ & v_{iK} * [\ln K_i(t) - \ln K_i(t-1)] \end{aligned} \quad (21)$$

$$\text{where } v_{iL} = \frac{1}{2} * (v_{iL}(t) - v_{iL}(t-1))$$

$$v_{iK} = \frac{1}{2} * (v_{iK}(t) - v_{iK}(t-1))$$

where \ln is natural logarithm operator, Q_i value added of sector i , v_{iL} , v_{iK} average factor shares, L_i employment, and K_i is capital service. This method is also straight forward to apply. It can generate annual estimates of TFP, thus can easily be monitored. However, similar to Method 1, the results cannot be tested for statistical significance.¹⁹

Econometric Method (Method 3). This method uses a regression analysis on a Cobb-Douglas production function specification. That is

$$\ln Q_i = \text{CONST} + a t + \alpha \ln L_i + \beta \ln K_i + e_i \quad (22)$$

where Q_i is value added of sector i , CONST is a constant term in the regression, a is the coefficient of the time trend, t , (which is interpreted as the average TFP for sector i over the regression period which is 1980-1996), α coefficient of labor, L_i (which is also the labor factor share under perfect competition), β coefficient of capital, K_i (capital factor share), and e_i an error term with the usual properties.

This specification was applied on the constructed data using two ways: (i) without imposing the assumption of constant returns to scale (CRS) on the data; and (ii) with CRS. CRS implies $\alpha + \beta = 1$.

The advantage of this method is that the result can be tested for statistical significance. However, the result will only give an estimate of the

¹⁹The advantage of Method 2 over 1 is that, under certain conditions, the production

average TFP over the regression period. The annual variations of the TFP cannot be analysed, thus difficult to monitor.

Frontier Approach (Method 4). This is also an econometric-based method. However, the analytics behind this method is different from that of Method 3. In Method 3, one of the major assumptions is that the sector is operating at its potential. That is, it is operating along its production frontier. Therefore, the issue of technical efficiency is not considered explicitly. In Method 4 this is accounted for in the specification of the estimating function.

In the study, Method 4 is applied not for the purpose of computing for TFP estimates but for generating estimates of sectoral technical efficiency, in the form of coefficients, of the 9 sectors. The coefficient indicates how well the sector performs relative to the best practise frontier. If the coefficient is 100 percent, it means that the sector operates along the frontier. However, if the coefficient is below 100, for example 50 percent only, it means that it is producing an output level which is 50 percent below its potential. The best practise frontier was computed using sectoral data on value added and factor inputs.²⁰

The best practice, production function can be represented as

$$Q_t^F = f[X_t, t] \quad (23)$$

technology of 2 is more flexible, being translog, than 1 which is Cobb-Douglas.

²⁰This method, as applied in the present context, has a major weakness. In principle, this method is appropriate to firm-level data or to an industry with more or less similar technology. However, in the present study, this may not be so since it is applied to 9 broad sectors, which may or may not have similar or comparable technology. The present technology in agriculture, for example, may be totally different from the level of technology in the manufacturing sector. In other words, the production frontier of agriculture may not be comparable with the current frontier of the manufacturing sector. Ideally, the technology of a particular sector, say manufacturing, is compared across countries. The best practise frontier is calculated using the manufacturing performance of other countries, particularly efficient developed countries. The Philippine manufacturing is compared against this frontier, as in World bank, 1993. However, this cannot be done at this point. Because of this, the results under this approach should be considered with great care.

where Q_t^F is the potential output level on along the frontier production function at any particular time t , and X_t is the vector of factor inputs. The usual regularity conditions are assumed to be satisfied in $f[\cdot]$, i.e., $f' > 0$, and $f'' < 0$.

Using (3), any actual or observed output Q_t can be expressed as

$$Q_t = Q_t^F * \exp(u_t) = f[X_t, t] * \exp(u_t) \quad (24)$$

where $u_t > 0$ and $\exp(u_t)$ (with $0 < \exp(u_t) < 1$) is the level of technical efficiency at the observed output Q_t . The variable u_t represents the combined effects of various non-price and organizational factors which constrain the industry from obtaining its maximum possible output Q_t^F .

When there are no socio-economic constraints affecting the industry, u_t takes the value of zero. On the other, when the industry faces constraints, u_t takes the value of less than zero. The actual value of u_t depends on the extent to which the industry is affected by the constraints. Thus, a measure of technical efficiency of the i^{th} industry can be defined as

$$\exp(u_t) = Q_t / Q_t^F \quad (25)$$

$$= (\text{Actual Output}) / (\text{Maximum possible output})$$

This equation is the basic model that is generally used for measuring technical efficiency. In this model, the numerator is observable, but the denominator is not. Various methods using different assumptions have been suggested in the literature to estimate the denominator. This the present study a maximum likelihood estimation (MLE) procedure, using time varying method, was used to calculate the technical efficiency coefficients of

the sectors. The MLE procedure was computed using the program FRONTIER 4.1 (Coelli, 1994).

II.5 TFP Estimates

Table 8 shows the results of the growth accounting method using 3-year moving averages of the value added and the factor input series, while Table 9 shows the results of the same method without moving averages. Table 10 shows the results of the translog method. Table 11 shows the results of Method 3 without CRS assumption. The relevant result is the coefficient of t which is α . This particular coefficient is an estimate of the average TFP over the regression period, which is 1980-1996. Note that there are two sets of results for this particular method. The first set are the results of the regression without correction for serial correlation, while the second are the results with correction. Note also that the results in the second set have slightly improved DW statistics. Table 12 shows the results with CRS assumption. Based on the regression, the results in Table 12 are better than Table 11²¹. Table 13 shows the technical efficiency coefficients of the sectors calculated using the stochastic frontier method.

The annual TFP estimates of both Methods 1 and 2 are shown in Figures 1 to 10 for the entire economy and for the rest of the 9 major sectors. Note that the trend of the TFP estimates using these two methods move in the same general direction, although there are few annual variations.

TFP improved right after the crisis in the mid-1980s (Figure 1). It was highest during the early years of the Aquino administration. However, the improvement was not sustained. TFP dipped down in the early 1990s,

²¹Multi-collinearity and other time series problems created problems in regression without CRS assumption. These problems show up in the t-test of alpha and beta which are either statistically insignificant or wrong sign. Thus, the results with CRS assumption are slightly better.

and has not improved since then. In fact, in the last six years, TFP of the entire economy has been below zero.²²

There are differences in the TFP performance at the sectoral level. One surprising result concerns the TFP of agriculture (Figure 2). In the last five years, TFP of agriculture is positive on the average. This is contrary to the common perception of low productivity in this sector. It may be difficult to pinpoint the factors behind this, but one reason may probably be that technology is not embodied in capital input. It may be disembodied. In such a case, technological change or improvement may probably be captured in the residual, which is TFP. Thus a relatively higher TFP.

The TFP of the mining sector (Figure 3) declined to below zero in 1995 and 1996. Before these years, TFP has been positive, although small in magnitude.

TFP of the manufacturing sector registered an impressive growth in the second half of the 1980s (Figure 4). It was averaging 5 percent per year in 1987 to 1989. In the early 1990s, TFP slowed down to almost zero, but recovered after that until it reached another peak in 1993 and 1994. In the last two years it slowed down again. It even registered negative TFP in 1996.

The construction sector has not been performing well in terms of TFP growth (Figure 5). In the last five years, TFP estimates are negative. However, the utilities sector are in better shape in terms of TFP. It has been positive since 1989 (Figure 6).

The TFP picture for the transportation sector has not been very encouraging. Its TFP is negative in the last 5 years (Figure 7). Similar trend is seen in finance (Figure 9) and services (Figure 10).

²²The result of Oguchi also showed negative TFP from 1990 to 1994.

On the whole, the TFP for the whole economy has not been very encouraging especially in the last 5 years. However, at the sectoral level, there are big differences. The agriculture sectoral seems to be better than expected. The manufacturing sector has been doing relatively good, except in the last two years 1995 and 1996. The utilities sector also has been doing better relative to the other sectors, but the service-related sector has been doing very poorly. In fact, based on the estimates, these sectors are the ones which pulled the average of the entire economy below zero.

The results in Table 12 using a different methodology confirm this general trend both at the economy level and at the sectoral level, as shown by the magnitude and the sign of the α parameter, which is interpreted as the average TFP.

It is possible to investigate the factors behind this trend in TFP. One way is to conduct a regression analysis relating TFP growth of the economy and the major sectors with some indicators of market reforms, trade reforms, research and development, etc. However, this has not been done in the present paper. This could be another interesting research extension.

Part III : General Insights and Some Recommendations

The major goal of the study was to develop a methodology for constructing a data base for TFP estimation at the national as well as at the sectoral level. The study attempted to develop a methodology which allowed for the estimation of TFP at both levels. The strategy adopted was to start with NIA data because it is regularly updated. With regular updates of the NIA, the data base can be updated accordingly, and TFP estimated. Thus, changes in TFP can be monitored.

There were a lot of problems encountered in the process of constructing the data base. The major problem was the unavailability of investment data at the sectoral level. If there were errors committed during the data construction, they may have arose from the estimation of sectoral investment. However, it is a welcome development that the NSCB is currently exerting effort to construct sectoral investment data. It would be of great help if NSCB would extend the estimation of this sectoral investment data back to the 1970s, so that the analysis of TFP can also be extended backward. This would allow for a longer-term perspective of the TFP performance. Better still, it would be a fruitful exercise if the NSCB would extend the data construction to sectoral capital stock estimation. The statistical system of other countries allows for a regular publication of official data on sectoral capital stock. One good example is Thailand.

Furthermore, since the National Statistics Office (NSO) is the official agency in-charge of gathering information, NSCB and NSO should coordinate closely on the variables that have to be collected. One good effort is to gather enough information on different types of investment, or gross additional to fixed assets at the sectoral level, or even at a finer PSIC level. For example, sectoral investment on building, capital equipment and machineries, etc. are very important in TFP analysis. Moreover, in the present study, the indicator used for labor input was sectoral employment. It would be a good exercise to break this down into different skill levels. However, indicators of output, labor and capital have to be consistent on a per sector level. It is therefore recommended that NSO, in coordination with the NSCB, to collect consistent data at the sectoral unit on output, different labor input types as well as different investment types.

The paper applied the constructed data base to a number of TFP methodologies. These methodologies include the traditional growth accounting method (using both simple and Divisia-translog index methods), the econometric method, and the frontier method. Based on the discussion of the results and methodologies, the use of the traditional growth accounting approach (either simple or Divisia-translog method) is recommended. This methodology can

generate better TFP estimates on an annual basis than the other available methods. Also, since the capital input was adjusted for capacity utilization, the business cycle effects on productivity are netted out. Therefore the resulting annual TFP estimates are indicators of output growth not accounted for by the growth in employment and capital.

There are a host of factors that may have contributed to changes in TFP over the years. These factors include: the quality of factor inputs (like better education resulting in better-abled workforce, newer capital equipment with the latest or state-of-the-art technology); macroeconomic environment conducive to productivity-enhancing programs (like stable economy with low inflation rates and interest rates); research and development and science and technology (good R&D infrastructure and right institutions which would promote more R&D investment specially from the private; this would usually require adequate patent and intellectual property rights laws); product and factor market characteristics (well functioning and efficient markets both for the product and factor markets); population, and etc. There is a wide literature on these topics. While it is very important to look into these issues; i.e., on how they have effected productivity performance, it is beyond the scope of the present paper. This could in fact be a good area for further research as they offer rich policy implications for long-term economic growth of the Philippines.

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Table 8: TFP Estimates Using Growth Accounting Method and Moving Averages

[illegible]

Table 9: TFP Estimates Using Growth Accounting Methods

	Economy	Agriculture	Mining	Manufacturing	Construction	Utilities	Transportation	Trade	Finance	Services
1980										
1981	-1.90	-17.96	3.91	-0.34	-8.62	4.47	-3.72	-9.78	-7.00	1.16
1982	-2.11	-14.18	0.47	0.32	-7.65	9.74	-2.40	-11.44	-9.79	-2.12
1983	-3.03	0.31	-54.54	-8.78	-59.31	-24.17	-0.05	-4.91	-44.72	14.45
1984	-2.36	21.60	-3.02	-2.65	-25.34	7.60	-6.31	-12.48	-6.57	-11.06
1985	0.30	8.25	35.27	0.08	-2.18	3.07	4.73	9.08	4.37	0.29
1986	2.93	14.26	9.28	5.30	11.13	3.30	4.36	-4.00	-2.31	-2.63
1987	3.66	-11.24	-9.12	3.96	6.54	-3.58	0.73	0.74	-2.81	0.51
1988	2.89	-11.39	8.59	5.52	6.63	16.63	-0.40	-7.80	-2.25	-11.60
1989	1.84	-11.52	-2.17	1.86	4.05	8.03	3.77	-11.95	-4.20	5.11
1990	-0.04	-33.15	-0.30	1.31	-40.96	5.30	3.21	-4.08	2.63	0.39
1991	-0.83	4.67	-2.11	-0.10	-12.04	5.29	-0.42	-13.14	-35.83	-7.17
1992	-1.01	-7.95	16.29	1.77	3.43	6.77	-1.50	-6.85	-4.44	-8.70
1993	-0.27	10.34	4.80	3.57	-3.90	2.39	-2.65	-28.13	-7.01	-7.73
1994	-0.40	-2.41	2.95	2.30	-2.19	3.53	-9.12	-5.46	-4.68	-4.88
1995	-0.69	5.20	2.00	1.29	1.51	7.76	-2.59	-6.81	-6.70	-2.60
1996	-0.84	4.30	-4.04	-0.38	-2.98	6.17	-2.71	10.28	-3.74	-2.85

Table 10: TFP Estimates Using Translog Index (percent)

	Economy	Agriculture	Mining	Manufacturing	Construction	Utilities	Transportation	Trade	Finance	Services
1980										
1981	-1.820	-15.837	3.833	-0.319	-6.883	4.529	-3.412	-9.056	-7.211	1.701
1982	-0.819	-12.402	0.525	0.317	-6.742	8.244	-2.248	-9.979	-8.750	-1.482
1983	-3.450	0.548	-32.590	-7.572	-41.046	-16.478	1.898	1.509	-28.231	19.258
1984	-4.728	25.749	-3.127	-3.014	-26.512	6.562	-6.246	-12.667	-7.179	-11.066
1985	0.970	8.816	29.712	0.337	-0.482	4.630	4.936	9.857	4.907	0.538
1986	4.575	15.179	8.938	5.540	12.233	3.161	4.745	-3.591	-2.169	-2.541
1987	3.426	-10.284	-9.525	3.957	5.193	-1.040	0.699	0.720	-2.474	0.486
1988	2.838	-10.402	7.922	5.102	6.940	15.463	-0.382	-7.176	-1.791	-10.233
1989	2.037	-10.535	-2.222	1.923	0.929	7.968	3.449	-10.581	-3.679	5.282
1990	0.405	-27.482	-0.292	1.476	-21.803	5.808	3.154	-3.765	2.672	0.368
1991	-2.645	4.930	-2.147	-0.095	-13.396	5.108	-0.405	-12.264	-30.572	-6.739
1992	-0.189	-7.567	17.132	1.764	3.397	6.900	-1.235	-6.514	-4.337	-8.118
1993	-0.187	10.646	4.966	3.605	-3.613	2.721	-2.594	-24.012	-6.626	-6.945
1994	-0.374	-1.843	3.773	2.215	-1.044	3.241	-8.367	-5.078	-4.335	-4.523
1995	-0.557	5.317	2.073	1.218	1.465	7.371	-2.459	-6.219	-6.200	-2.425
1996	-1.027	4.288	-3.986	-0.339	-2.645	5.939	-2.462	10.303	-3.396	-2.509

**Table 11: TFP Estimates: Econometric Estimation Without imposing CRS assumption on the data
(i.e. without imposing: $\alpha + \beta = 1$)***

Unadjusted for Serial Correlation									
Sector	constant	a	alpha	beta	R2bar	DW	No. Obs	Period	
Economy (t-stat)	-8.9 -1.701	-0.034 -1.912	1.436 2.668	0.595 5.139	0.918	0.908	17	1980-96	
Agriculture (t-stat)	10.741 20.116	0.011 5.203	0.047 0.734	0.087 3.322	0.909	0.881	17	1980-96	
Mining (t-stat)	-7.444 -4.926	0.179 11.051	0.234 8.18	1.195 10.506	0.903	2.143	17	1980-96	
Manufacturing (t-stat)	0.935 0.353	0.027 6.388	-0.064 -0.594	0.825 5.781	0.896	0.539	17	1980-96	
Construction (t-stat)	6.583 5.077	-0.056 -4.734	-0.026 -0.117	0.649 4.991	0.659	0.841	17	1980-96	
Utilities (t-stat)	-1.383 -2.101	0.073 22.175	-0.029 -1.554	0.867 15.984	0.986	0.766	17	1980-96	
Transportation (t-stat)	7.694 5.622	0.021 4.706	-0.044 -0.415	0.266 2.177	0.949	0.562	17	1980-96	
Trade (t-stat)	9.283 13.329	0.013 1.661	0.051 1.832	0.157 2.05	0.95	1.428	17	1980-96	
Finance (t-stat)	7.726 5.792	0.005 0.344	-0.068 -1.407	0.348 2.903	0.877	1.26	17	1980-96	
Services (t-stat)	8.889 9.579	0.011 1.168	-0.004 -0.057	0.21 2.609	0.964	1.013	17	1980-96	
Adjusted for Serial Correlation									
Sector	constant	a	alpha	beta	R2bar	DW	AR	No. Obs	Period
Economy (t-stat)	-0.966 -0.216	-0.004 -0.261	0.629 1.525	0.58 2.756	0.956	1.142	0.673 2.323	16	1981-96
Agriculture (t-stat)	10.772 23.453	0.016 2.374	0.083 1.733	0.044 1.084	0.945	2.361	0.68 2.396	16	1981-96
Mining (t-stat)	-4.19 -6.035	0.122 7.235	0.025 1.483	1.09 27.393	0.986	1.821	0.862 17.889	16	1981-96
Manufacturing (t-stat)	1.63 0.556	0.026 4.058	0.032 0.305	0.712 3.366	0.949	0.859	0.7 2.509	16	1981-96
Construction (t-stat)	6.033 5.004	-0.02 -0.329	0.205 1.137	0.442 2.57	0.792	1.076	0.734 2.318	16	1981-96
Utilities (t-stat)	-1.819 -3.615	0.072 9.042	-0.048 -1.92	0.916 26.417	0.99	1.18	0.808 3.59	16	1981-96
Transportation (t-stat)	6.508 4.979	0.018 2.398	-0.016 -0.17	0.361 3.244	0.969	0.813	0.756 3.771	16	1981-96
Trade (t-stat)	9.492 9.386	0.014 1.253	0.017 0.41	0.161 1.536	0.943	1.556	0.436 1.375	16	1981-96
Finance (t-stat)	7.338 4.744	0.003 0.144	0.011 0.175	0.329 1.988	1.529	0.897	0.529 1.842	16	1981-96
Services (t-stat)	8.755 8.209	0.011 1.041	0.065 0.628	0.17 1.79	0.965	1.635	0.368 1.418	16	1981-96

* CRS is constant returns to scale

Table 12: TFP Estimates: Econometric Estimation With CRS assumption on the data
(i.e. with : $\alpha + \beta = 1$)*

Unadjusted for Serial Correlation									
Sector	constant	a	alpha (derived)	beta	R2bar	DW	No. Obs	Period	
Economy (t-stat)	1.121 2.126	-0.0003 -0.092	0.425	0.575 4.569	0.817	0.485	17	1980-96	
Agriculture (t-stat)	4.522 53.332	-0.009 -2.249	0.752	0.248 3.423	0.432	1.667	17	1980-96	
Mining (t-stat)	-2.432 -12.861	0.126 29.8	0.176	0.824 27.577	0.982	1.322	17	1980-96	
Manufactur (t-stat)	-1.858 -6.286	0.025 7.192	0.034	0.966 17.392	0.969	0.514	17	1980-96	
Constructio (t-stat)	4.104 43.452	-0.07 -6.762	0.32	0.68 4.831	0.748	0.805	17	1980-96	
Utilities (t-stat)	-3.322 -21.236	0.08 25.836	-0.02	1.02 44.52	0.995	0.612	17	1980-96	
Transportat (t-stat)	0.692 1.48	4.04E-05 0.012	0.276	0.724 5.025	0.673	0.481	17	1980-96	
Trade (t-stat)	1.83 12.129	-0.065 -6.801	0.077	0.923 10.993	0.896	0.746	17	1980-96	
Finance (t-stat)	1.091 5.165	-0.061 -13.056	0.084	0.916 14.922	0.971	1.092	17	1980-96	
Services (t-stat)	1.96 8.608	-0.046 -3.946	0.381	0.619 4.694	0.586	0.579	17	1980-96	
Adjusted for Serial Correlation									
Sector	constant	a	alpha (derived)	beta	R2bar	DW	AR	No. Obs	Period
Economy (t-stat)	1.074 1.375	0.003 0.664	0.426	0.574 2.913	0.908	0.994	0.694 2.824	16	1981-96
Agriculture (t-stat)	4.513 54.29	-0.005 -1.116	0.788	0.212 3.057	0.325	1.646	0.017 0.066	16	1981-96
Mining (t-stat)	-2.717 -4.529	0.101 4.34	0	1 64.227	0.998	1.21	0.881 17.254	16	1981-96
Manufactur (t-stat)	-1.607 -3.691	0.025 5.328	0.09	0.91 10.064	0.981	0.805	0.676 3.138	16	1981-96
Constructio (t-stat)	3.861 11.844	-0.046 -1.683	0.448	0.552 3.599	0.794	1.311	0.618 2.713	16	1981-96
Utilities (t-stat)	-3.178 -21.109	0.076 15.893	0.001	0.999 43.529	0.996	1.47	0.756 3.607	16	1981-96
Transportat (t-stat)	0.722 1.304	-0.012 -0.445	0.244	0.756 6.693	0.823	1.582	0.866 3.915	16	1981-96
Trade (t-stat)	2.005 7.146	-0.06 -4.149	0.156	0.844 8.756	0.908	1.869	0.663 3.071	16	1981-96
Finance (t-stat)	1.079 3.597	-0.059 -6.609	0.088	0.912 9.562	0.967	1.837	0.476 1.837	16	1981-96
Services (t-stat)	2.04 6.18	-0.063 -2.696	0.333	0.667 4.878	0.691	2.429	0.769 3.378	16	1981-96

* CRS is constant returns to scale

Table 13: Technical Efficient Coefficients (Using Stochastic Frontier)

	Agriculture	Mining	Manufacturing	Construction	Utilities	Transportation	Trade	Finance	Services
1980	0.9813	0.0499	0.1136	0.4235	0.0575	0.1224	0.278	0.1916	0.1771
1981	0.9814	0.0503	0.1143	0.4245	0.0579	0.1231	0.2789	0.1925	0.1779
1982	0.9814	0.0507	0.115	0.4255	0.0584	0.1238	0.2799	0.1934	0.1788
1983	0.9815	0.0511	0.1157	0.4265	0.0588	0.1245	0.2809	0.1942	0.1796
1984	0.9815	0.0515	0.1164	0.4275	0.0593	0.1252	0.2819	0.1951	0.1805
1985	0.9816	0.052	0.1171	0.4285	0.0598	0.1259	0.2829	0.196	0.1813
1986	0.9816	0.0524	0.1178	0.4295	0.0602	0.1266	0.2838	0.1969	0.1822
1987	0.9817	0.0528	0.1184	0.4305	0.0607	0.1274	0.2848	0.1978	0.183
1988	0.9817	0.0532	0.1191	0.4315	0.0612	0.1281	0.2858	0.1986	0.1839
1989	0.9818	0.0537	0.1198	0.4325	0.0616	0.1288	0.2868	0.1995	0.1848
1990	0.9818	0.0541	0.1205	0.4335	0.0621	0.1295	0.2878	0.2004	0.1856
1991	0.9819	0.0545	0.1212	0.4345	0.0626	0.1303	0.2888	0.2013	0.1865
1992	0.9819	0.055	0.1219	0.4355	0.0631	0.131	0.2898	0.2022	0.1873
1993	0.982	0.0554	0.1227	0.4365	0.0635	0.1317	0.2907	0.2031	0.1882
1994	0.982	0.0559	0.1234	0.4375	0.064	0.1325	0.2917	0.204	0.1891
1995	0.9821	0.0563	0.1241	0.4385	0.0645	0.1332	0.2927	0.2049	0.1899
1996	0.9821	0.0568	0.1248	0.4395	0.065	0.1339	0.2937	0.2058	0.1908
Average	0.9817	0.0533	0.1192	0.4315	0.0612	0.1281	0.2858	0.1987	0.1839
Technical Efficient Coefficient	Sector								
Maximum	0.9817	Agriculture							
Minimum	0.0533	Mining							

Figure 1: TFP Estimates

Economy

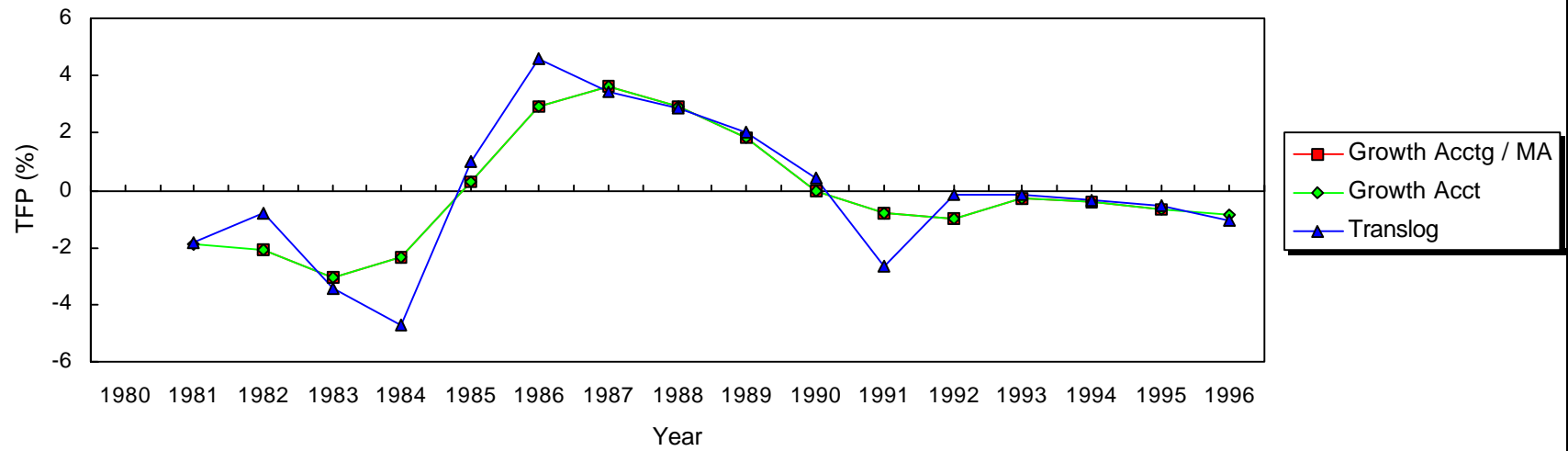


Figure 2: TFP Estimates

Agriculture

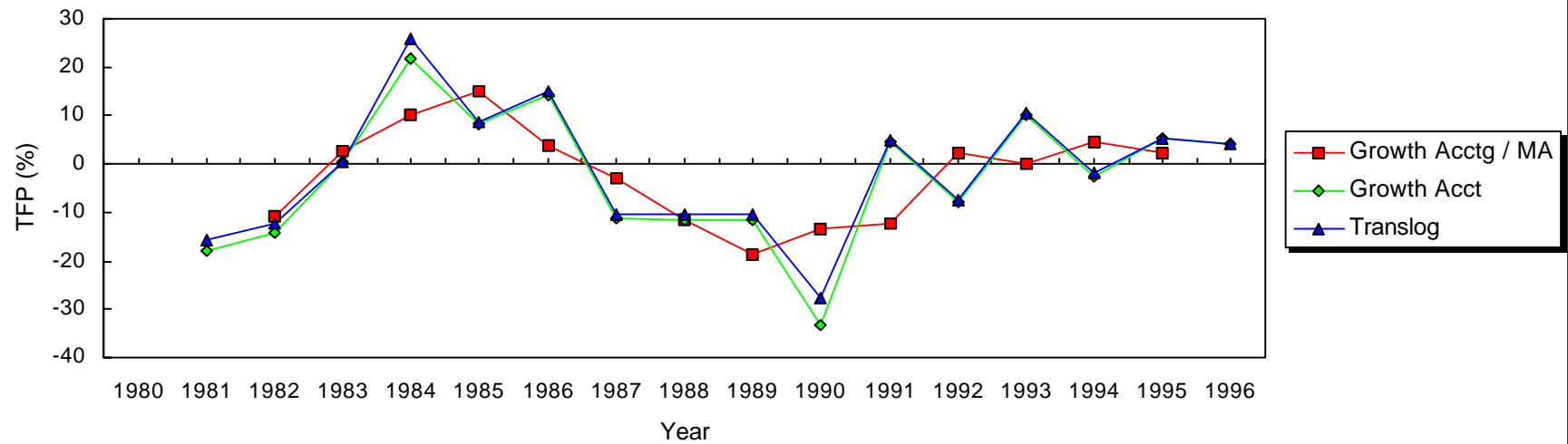


Figure 3: TFP Estimates

Mining

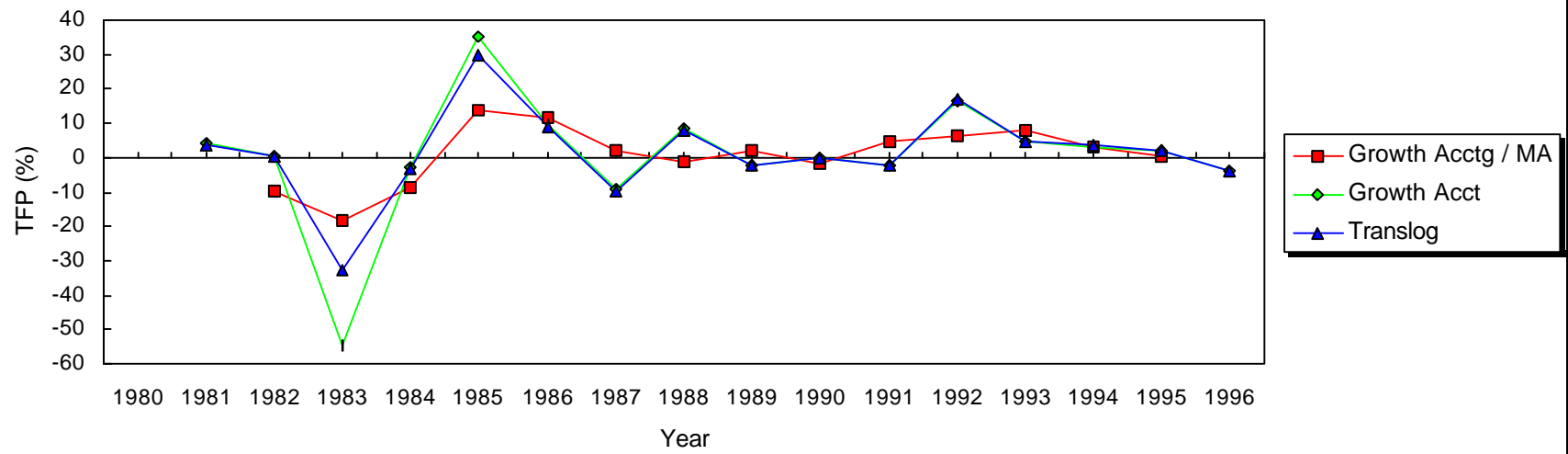


Figure 4: TFP Estimates
Manufacturing

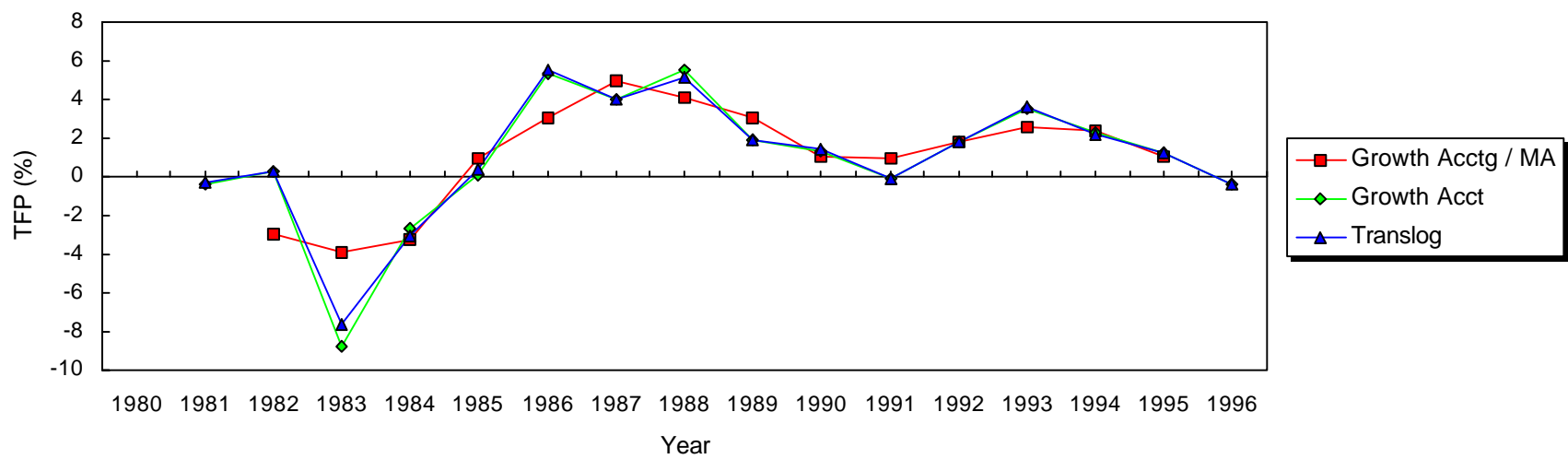


Figure 5: TFP Estimates

Construction

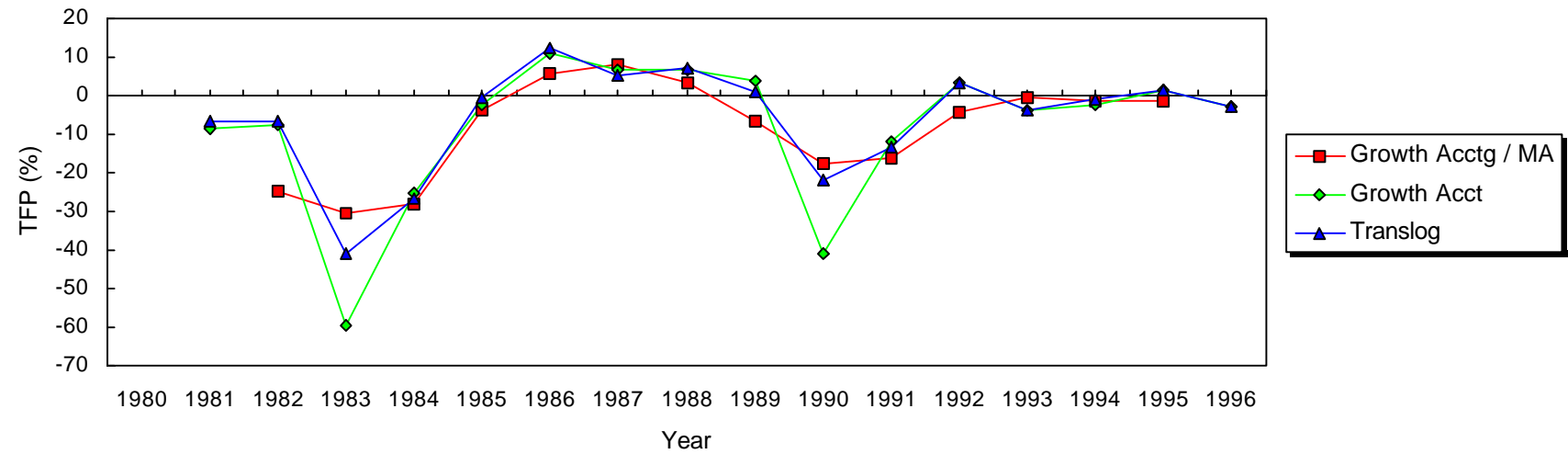


Figure 6: TFP Estimates
Utilities

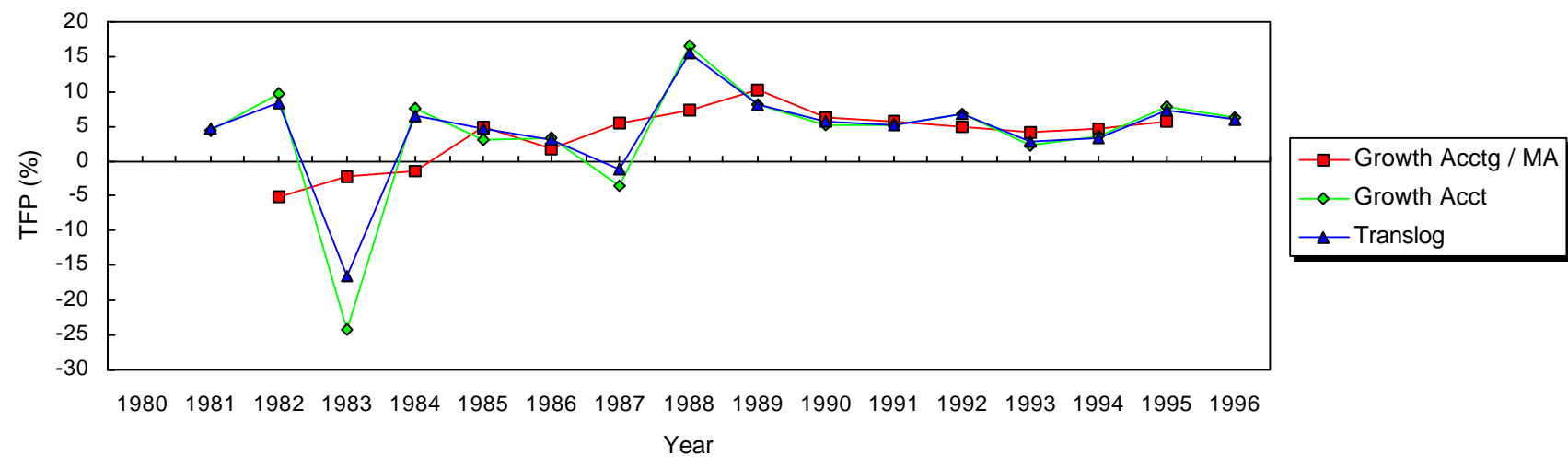


Figure 7: TFP Estimates

Transportation

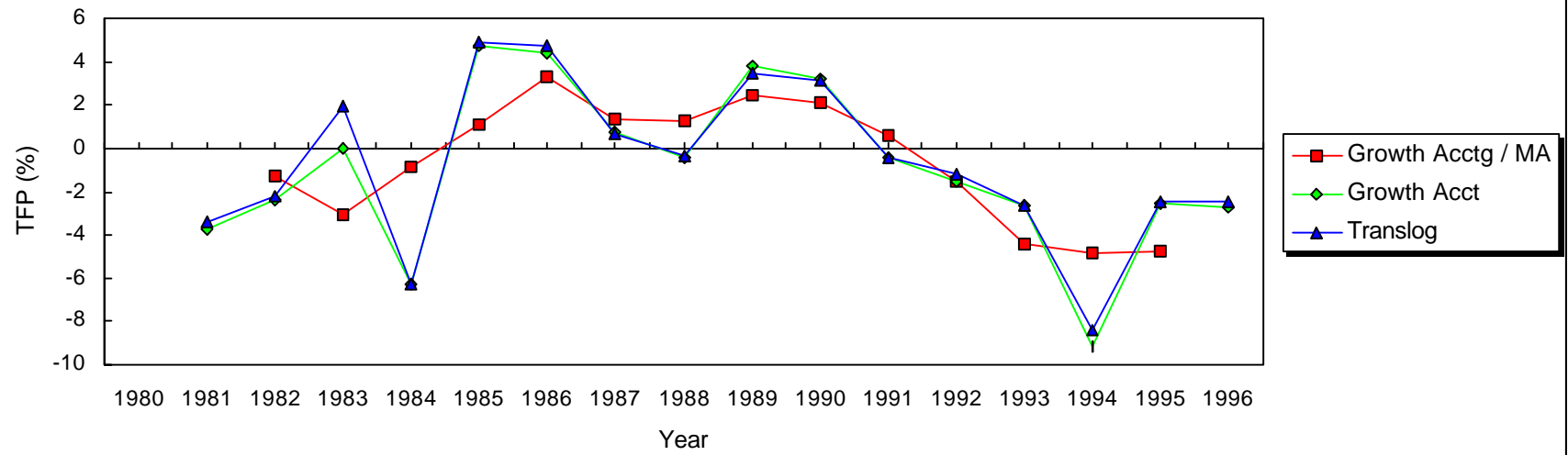


Figure 8: TFP Estimates

Trade

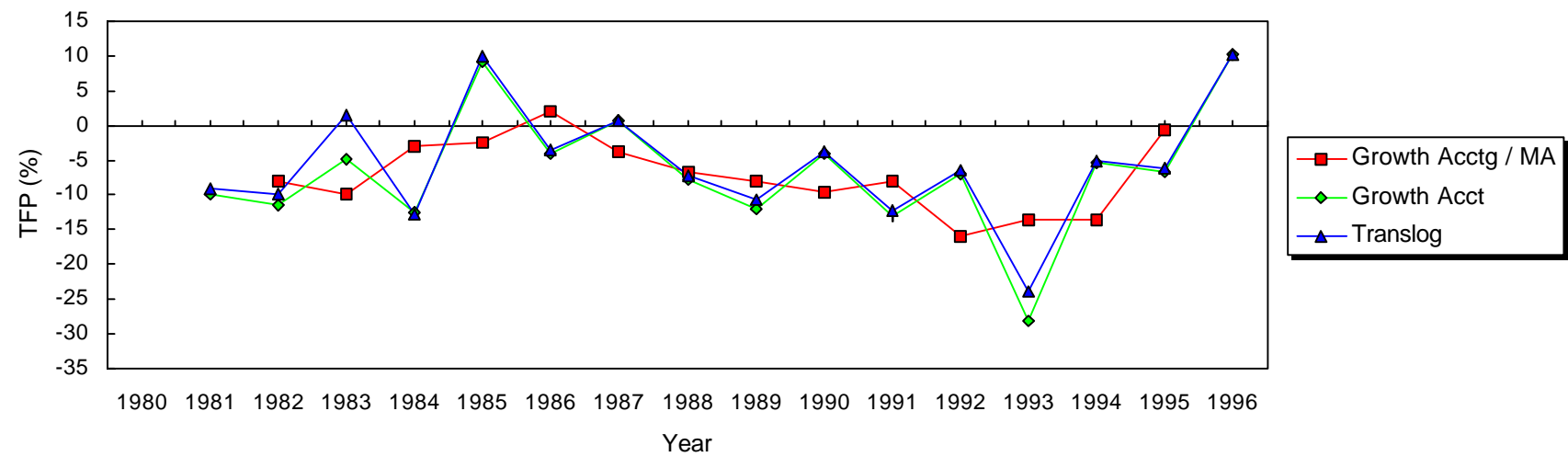


Figure 9: TFP Estimates

Finance

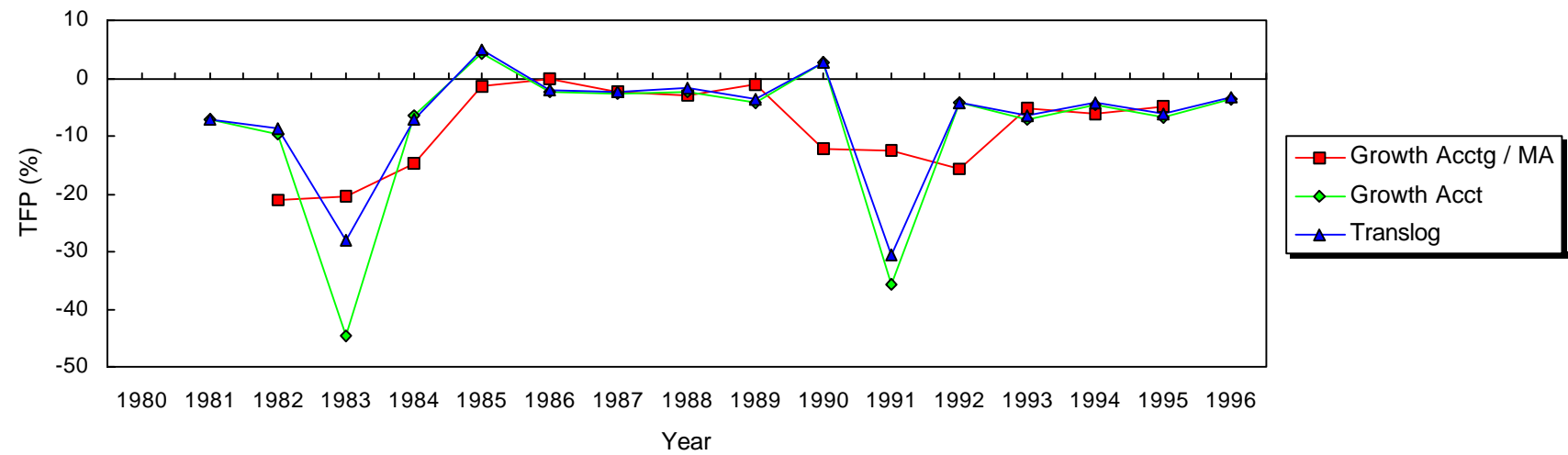
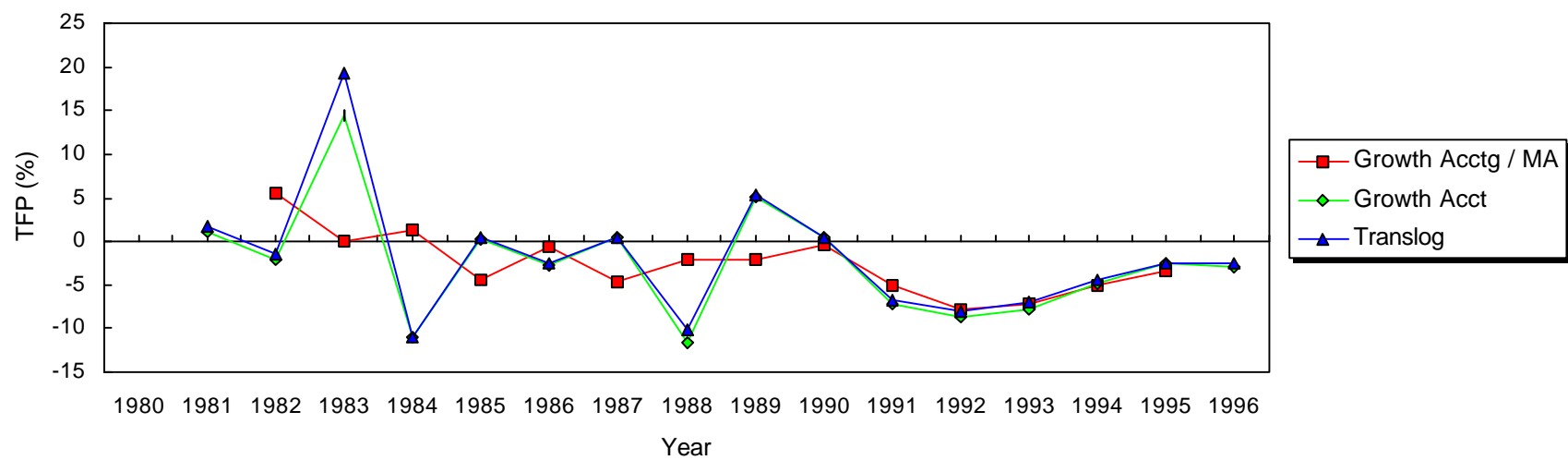


Figure 10: TFP Estimates

Services



Appendix A

Methodology Used for Computing Output and Factor Inputs

The sector coverage of the Total Factor Productivity (TFP) estimation in the study includes the entire economy and 9 major sectors. The 9 sectors are (for a detailed description and industry breakdown of these sectors see Table B1 of Appendix B): (1) agriculture; (2) mining; (3) manufacturing; (4) construction; (5) utilities; (6) transportation; (7) trade; (8) finance and dwellings; and (9) services.

The basic strategy adopted by the study was to start the analysis at the economy level using data from the National Income Accounts (NIA) and total employment from the Labor Statistics. The reason for doing this was that both NIA and employment updates come out regularly, and hence TFP estimates can therefore be updated regularly. The analysis at the economy level was then brought down to the 9 major sectors listed above using data from the National Statistics Office (NSO), in particular the Annual Survey of Establishment (ASE) and other relevant data from the Labor Statistics. The latter set of data was used to generate distribution shares to break down data from the NIA and total employment into the major sectors. In this manner, a consistent set of data is generated from the economy level using NIA and total employment, and to the major sectors, using the distribution shares.

NIA-Based Data

The following variables were sourced from the NIA:

1. Total Gross Domestic Products (GDP), sectoral GDP, their respectively implicit price deflators (IPI), 1985=100.
2. Compensation, total and sectoral
3. Mixed income, total and sectoral

4. Net operating surplus, total and sectoral
5. Depreciation, total and sectoral

The complete time series of these variables officially available covers the period 1980 and 1996. Accordingly, the data base established for the study covers the same period.

For purposes of TFP estimation, mixed income and net operating surplus were lumped to form as payment to capital input. Since only labor and capital were considered as factor inputs in the analysis, depreciation were deducted from GDP so as to satisfy the accounting identity that the sum of payment to labor and payment to capital is output (value added), i.e.,

$$Q = w*L + r*K$$

where Q is output (value added), L employment, w wage, K capital, and r rate of profit.

Both total value added and sectoral value added were deflated by their respectively 1985 IPI deflators to convert all of them into 1985 prices (Table A1). The sectoral breakdown of value added into compensation and surplus is shown in Table A2.

Another important economy level data in the NIA is the Gross Domestic Capital Formation (hereafter referred to as investments). One of the biggest problems encountered in the study was how to break down total investment into sectoral investment. Sectoral investment is important in deriving the capital stock series in the TFP estimation. A detailed discussion of the methodology used here is shown in the next few sections.

Labor Statistics-Based Data

Total employment was used as indicator of the labor factor input. In the labor statistics, the longest time series available on sectoral employment covers only establishments with 10 or more employees. Sectoral employment data covering all establishments are available only in recent years, in particular in the 1990s. Thus, to break down total employment into sectoral employment, the sectoral employment shares covering establishments with 10 or more employees were applied. The derived employment series are shown in Table A3.

ASE/NSO-Based Data

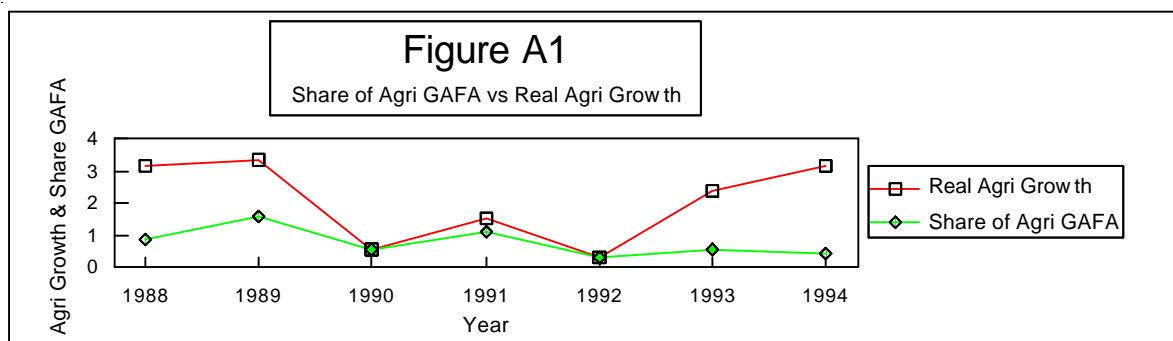
As mentioned above, one of the biggest problems encountered in establishing the data base for the TFP estimation in this study was the unavailability of sectoral investment. Sectoral investment is relevant in the estimation of sectoral capital stock series.

There are available information in the ASE though which can be used to estimate sectoral investment shares, which in turn can be applied to break down total investment at the economy wide to sectoral investment. One of the relevant information is the Gross Addition to Fixed Assets (GAFA) at the sectoral level. However, in the ASE, data on GAFA are not comparable across sectors because the number of establishments vary across sectors and through time. To solve this, GAFA data were normalized using information on the number of establishment. The normalization rule applied is

$$(\text{Normalized ASE - GAFA data})_i^t = (\text{GAFA}_i^t * N_i^t) / N^t$$

where N_i^t is the number of establishments in sector i during period t . These normalized ASE – GAFA data were used to derive the sectoral investment shares.

Another problem encountered was that ASE for the agriculture sector covers the period from 1988 to 1994 only. Thus, there was the problem of extending the series backwards to earlier years. The methodology applied was through a regression analysis. The normalized GAFA data on the agriculture sector was regressed against the real growth of the agriculture sector for the period covering 1988 and 1994. This regression analysis was based on the fact that the movement of the normalized GAFA for agriculture follows closely the movement of real growth of agriculture during the period, especially the turning points (Figure A1).



Using the regression results the share of GAFA of the agriculture sector for the earlier years were derived as predicted values.²³

Another problem encountered was that ASE were not available from 1980 to 1983 and 1995 and 1996. Four-year moving averages were applied on available data during the preceding and succeeding years.

These computed investment shares were applied to the total investment (in 1985 prices) to derive sectoral investment. Sectoral investment is shown in Table A4.

²³ The regression results are shown below.

$$\begin{aligned}
 (\text{share of agri. GAFA}) &= 0.4534 + 0.1627^* (\text{real growth of agri}) \\
 &\quad (t=1.066) \quad (t=1.20) \\
 R^2 &= 0.2239 \quad \text{No of observation} = 7
 \end{aligned}$$

The regression results are not very good. This can probably be modified when a

Another important variable used in the estimation of the capital stock series is the sectoral rate of depreciation. There is no readily available information on this variable. However, there are information in the ASE which can be utilized to derive the sectoral rate of depreciation. These variables are the sectoral book value of fixed assets and the depreciation expenses. In the ASE, information on these variables are reported as end-of-year values. Given this, the average sectoral depreciation rates (i.e. average for the entire period) were computed using the formula

$$d_i = 1/T \{ \sum (\text{Dep}_i^t / \text{NOE}_i^t) / ((\text{BV}_i^{[t-1]} - \text{LD}_i^{[t-1]}) / \text{NOE}_i^{[t-1]}) \}$$

where i is sector, t year, depreciation rate, T number of years in the period, Dep depreciation expense available in the ASE, NOE number of establishments, BV total book value of fixed assets, and LD land value. The depreciation rate for the entire economy was derived as the weighted of these computed sectoral depreciation rates, where the weights were derived as the normalized value sectoral of the difference between the book value of fixed assets and land value for the period 1988 and 1994. The normalization rule used was the sectoral number of establishments, as in above.

Table A5: Average Depreciation

Economy	0.1308
Agriculture	0.1821
Mining	0.1133
Manufacturing	0.1352
Construction	0.1998
Utilities	0.0780
Transportation	0.0866
Trade	0.1411
Finance	0.1280
Services	0.1071

Indicators of Sectoral Capacity Utilization rate

In the TFP analysis, in principle the relevant capital input data is capital services, not capital stock. However, there are no available information on capital services. In empirical work, the usual method is to derive a capital stock series and adjusted this with capacity utilization. The derivation of the capital stock series is discussed in the next section, while the derivation of the capacity utilisation index is discussed here.

Sectoral capacity utilization rate was derived using the peak-to-peak method. The steps involved were:

1. Regress the sectoral value added in constant real prices against a trend variable.
2. Based on the results of the regression, compute for the trend.
3. Divide the sectoral value added by the computed trend value of the variable to get the cyclical/irregular component of the series.
4. Connect the peak points of item #3 and develop a straight line out of these peak points. Points along this straight line are considered 100 percent capacity utilisation.
5. Derive the results of item #3 with the results of item #4 to get the annual capacity utilisation rate.

The result of these steps are shown in Table A6.

Derivation of Sectoral Capital Stock Series

There were two steps involved in the derivation of the capital stock series, sectoral and economy-wide:

1. Estimation of initial capital stock
2. Estimation of the capital stock series

Initial Capital Stock. The used here was adopted by Martin and Warr (1990) and Austrian and Martin (1995). Following these two papers, the logarithm of the derived investment series (Table A4) was regressed against a time trend to obtain its average growth and a trend value of investment at the

beginning of the sample, 1980, I_0 . Making the conventional assumption that capital stock was in a steady state at time t_0 , initial capital stock at the sectoral level, K_{0i} , can be computed using the following formula

$$K_{0i} = I_{0i} / (g_i + d_i)$$

where g_i is the period average sectoral investment growth and d_i period average depreciate rate. This formula was used to derive both sectoral and economy-wide initial capital stock.

Capital Stock Series. The traditional method of computing for capital stock series is the perpetual inventory method, i.e., sectoral capital stock is derived as

$$K_{ti} = K_{t-1,i} * (1 - d_i) + I_{ti}$$

where K_t is capital stock in year t , K_{t-1} capital stock in previous year, d_i average depreciation rate, and I_t investment in year t . For the 1980, the initial capital stock is K_{0i} . This formula was used to derive capital stock series. The results of the computations are shown in Table A7.

Table A8 shows ratios of capital-output computed in the present study. The output variable used in the ratio is value added. One can observe that mining, utilities are most-capital intensive industries. Indeed, these are capital-intensive industries. However, their capital intensity declined through time.

How does the capital-output ratio computed in the present study compare with the estimates done by other analysts for other countries? Table A9 compares the capital-output ratios of the study for the whole economy and the manufacturing sector with the estimates of Paderanga (1989) for the entire Philippine economy and the manufacturing sector and for a few Asian

countries. It also compares the ratio of Hooley (1985) for the Philippine manufacturing sector.

The computed ratios do not deviate very much. In fact, the ratios for some Asian countries during the 1970s are close to the computed ratios for the Philippines in the present study at around 2. For the manufacturing sector, the estimate of Paderanga is also close to the present estimate. However, the estimates of Hooley do differ a lot. One of the major reasons behind the difference is the use of gross value of output in Hooley's capital-output ratio for the manufacturing sector, while in the present study it is gross value added.

Table A1: Gross Value Added, Million 1985 prices

	Economy	Agriculture	Mining	Manufacturing	Construction	Utilities	Transportation	Trade	Finance	Services
1980	559,109	134,703	7,762	154,580	49,066	9,121	25,469	75,143	52,041	50,706
1981	579,241	139,970	8,108	158,562	53,895	9,308	27,142	75,633	48,904	56,663
1982	601,518	140,725	7,993	161,445	55,806	11,574	28,040	82,285	52,059	60,578
1983	602,886	135,623	7,228	161,027	53,018	10,527	29,230	85,659	56,249	64,959
1984	562,423	134,717	6,927	146,409	42,312	12,924	28,956	79,201	49,512	61,419
1985	524,104	132,395	9,466	134,517	22,312	11,638	28,447	78,237	46,104	60,988
1986	541,338	137,139	10,252	137,040	21,479	12,953	29,173	82,162	48,492	62,611
1987	568,044	141,752	9,351	143,459	27,740	9,968	30,791	85,292	52,938	65,915
1988	608,964	146,256	9,572	160,274	28,909	12,058	33,247	88,736	57,340	71,153
1989	646,640	151,175	9,054	169,082	34,693	12,790	35,377	95,467	62,910	74,023
1990	671,438	152,000	8,920	175,895	37,727	12,574	36,251	101,199	66,174	78,381
1991	664,797	154,288	8,660	172,686	31,376	13,384	36,857	101,633	65,240	79,325
1992	668,783	154,820	9,196	172,178	32,677	13,578	36,386	103,327	65,295	79,972
1993	683,320	158,463	9,257	173,316	34,504	13,339	36,100	105,874	66,013	84,177
1994	711,536	163,522	8,610	182,033	38,850	14,659	37,268	110,071	68,104	85,894
1995	745,413	165,357	8,544	194,033	41,378	15,988	39,441	116,182	71,215	89,049
1996	790,171	170,531	8,418	204,932	45,886	17,104	42,762	122,476	77,006	94,873

Table A2 : Distribution of Value Added into Compensation and Surplus

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Economy																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.28008	0.28193	0.28227	0.27040	0.24482	0.24932	0.25789	0.26339	0.25414	0.28849	0.27930	0.27194	0.26798	0.27178	0.27341	0.27994	0.28283
Surplus	0.71992	0.71807	0.71773	0.72960	0.75518	0.75068	0.74211	0.73661	0.74586	0.71151	0.72070	0.72806	0.73202	0.72822	0.72659	0.72006	0.71717
Agriculture																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.20388	0.19655	0.20702	0.21668	0.21240	0.19758	0.20020	0.20463	0.20352	0.19379	0.19310	0.19281	0.19232	0.18637	0.19028	0.18890	0.18886
Surplus	0.79612	0.80345	0.79298	0.78332	0.78760	0.80242	0.79980	0.79537	0.79648	0.80621	0.80690	0.80719	0.80768	0.81363	0.80972	0.81110	0.81114
Mining																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.18544	0.19148	0.19704	0.38209	0.40937	0.33298	0.35216	0.35219	0.51465	0.51796	0.51635	0.51638	0.52498	0.52501	0.52502	0.52503	0.52501
Surplus	0.81456	0.80852	0.80296	0.61791	0.59063	0.66702	0.64784	0.64781	0.48535	0.48204	0.48365	0.48362	0.47502	0.47499	0.47498	0.47497	0.47499
Manufacturing																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.23550	0.23993	0.24055	0.23615	0.19404	0.21182	0.23030	0.23632	0.16378	0.20449	0.16951	0.16434	0.14834	0.15306	0.15071	0.15449	0.14921
Surplus	0.76450	0.76007	0.75945	0.76385	0.80596	0.78818	0.76970	0.76368	0.83622	0.79551	0.83049	0.83566	0.85166	0.84694	0.84929	0.84551	0.85079
Construction																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.42674	0.42187	0.38817	0.40599	0.40599	0.55360	0.48672	0.40910	0.43654	0.71059	0.58800	0.59720	0.58928	0.58928	0.53247	0.53247	0.53247
Surplus	0.57326	0.57813	0.61183	0.59401	0.59401	0.44640	0.51328	0.59090	0.56346	0.28941	0.41200	0.40280	0.41072	0.41072	0.46753	0.46753	0.46753
Utilities																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.29729	0.27932	0.25896	0.21731	0.15840	0.18843	0.21903	0.33798	0.30746	0.31580	0.33278	0.31616	0.30841	0.31916	0.29462	0.31383	0.30407
Surplus	0.70271	0.72068	0.74104	0.78269	0.84160	0.81157	0.78097	0.66202	0.69254	0.68420	0.66722	0.68384	0.69159	0.68084	0.70538	0.68617	0.69593
Transportation																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.29781	0.28483	0.26582	0.18015	0.14433	0.14532	0.17265	0.19698	0.22021	0.27796	0.25837	0.22821	0.26349	0.27513	0.26490	0.29308	0.28702
Surplus	0.70219	0.71517	0.73418	0.81985	0.85567	0.85468	0.82735	0.80302	0.77979	0.72204	0.74163	0.77179	0.73651	0.72487	0.73510	0.70692	0.71298
Trade																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.13457	0.12170	0.14263	0.12203	0.11260	0.11814	0.10792	0.10762	0.10334	0.13308	0.15334	0.15051	0.15112	0.15122	0.15088	0.15123	0.14226
Surplus	0.86543	0.87830	0.85737	0.87797	0.88740	0.88186	0.89208	0.89238	0.89666	0.86692	0.84666	0.84949	0.84888	0.84878	0.84912	0.84877	0.85774
Finance																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.18116	0.19881	0.18651	0.17539	0.16007	0.14452	0.14651	0.13896	0.13941	0.13711	0.14300	0.13440	0.13671	0.14469	0.14549	0.14709	0.14607
Surplus	0.81884	0.80119	0.81349	0.82461	0.83993	0.85548	0.85349	0.86104	0.86059	0.86289	0.85700	0.86560	0.86329	0.85531	0.85451	0.85291	0.85393
Services																	
Value-Added	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Compensation	0.73681	0.70820	0.68690	0.61310	0.61909	0.62766	0.64229	0.63711	0.65924	0.66532	0.67486	0.66854	0.65612	0.64814	0.65825	0.66630	0.67478
Surplus	0.26319	0.29180	0.31310	0.38690	0.38091	0.37234	0.35771	0.36289	0.34076	0.33468	0.32514	0.33146	0.34388	0.35186	0.34175	0.33370	0.32522

Table A3: Employment, '000

	Economy	Agriculture	Mining	Manufacturing	Construction	Utilities	Transportation	Trade	Finance	Services
1980	15,900	934	316	4,792	638	177	1,312	4,127	542	3,062
1981	16,595	1,272	325	5,038	659	189	1,425	3,976	520	3,191
1982	16,808	1,088	294	5,165	678	208	1,468	4,033	581	3,293
1983	17,791	1,160	640	7,058	1,519	462	1,185	1,584	1,731	2,451
1984	18,292	1,202	622	7,227	1,322	509	1,301	1,709	1,827	2,573
1985	18,136	1,201	648	7,322	826	559	1,218	1,782	1,914	2,667
1986	18,836	1,257	630	7,659	709	637	1,360	1,726	2,096	2,763
1987	20,040	1,347	636	8,269	870	638	1,431	1,759	2,191	2,899
1988	21,205	1,436	559	8,710	909	581	1,399	2,206	2,002	3,404
1989	21,908	1,599	524	9,436	984	600	1,360	2,144	2,081	3,181
1990	22,212	1,566	512	9,009	1,044	604	1,393	2,389	2,378	3,318
1991	22,915	1,321	504	9,334	1,027	648	1,417	2,585	2,583	3,495
1992	23,696	1,335	407	9,629	1,014	626	1,526	2,747	2,711	3,703
1993	24,382	1,252	375	9,167	1,127	654	1,603	3,019	3,140	4,044
1994	25,032	1,583	304	9,330	1,187	708	1,702	3,089	3,013	4,117
1995	25,677	1,434	288	9,458	1,280	708	1,776	3,251	3,235	4,246
1996	27,186	1,487	302	9,678	1,469	728	1,947	3,440	3,688	4,447

Table A4: Investment, Million 1985 prices

	Economy	Agriculture	Mining	Manufacturing	Construction	Utilities	Transportation	Trade	Finance	Services
1980	161,059	1,151	1,226	130,471	330	7,775	5,119	4,393	5,989	4,605
1981	165,633	1,638	1,311	128,844	328	10,304	5,194	5,366	7,047	5,602
1982	179,594	791	1,204	138,600	362	10,782	6,166	6,405	8,762	6,522
1983	191,058	-453	2,983	146,881	851	11,720	6,895	7,298	7,475	7,410
1984	120,396	294	485	107,712	99	2,416	2,959	1,603	3,013	1,815
1985	82,047	59	777	48,957	106	12,196	1,949	5,707	6,394	5,902
1986	90,303	845	158	64,770	190	3,764	4,381	4,528	7,374	4,293
1987	108,084	973	255	73,853	96	2,356	6,091	6,509	8,342	9,609
1988	123,956	1,078	185	91,268	352	316	4,341	9,684	9,087	7,644
1989	149,313	2,376	142	121,879	1,420	1,129	3,180	7,403	5,095	6,689
1990	172,948	986	322	112,038	663	3,458	5,204	11,938	26,218	12,122
1991	143,051	1,614	186	93,859	469	3,317	4,563	10,767	13,038	15,238
1992	154,250	537	98	87,141	509	4,384	5,834	23,874	14,786	17,086
1993	169,889	941	64	97,703	760	7,537	10,675	15,339	16,606	20,263
1994	180,795	848	188	112,549	393	3,914	8,287	17,569	18,475	18,573
1995	186,235	748	61	129,146	530	3,622	8,232	3,767	16,478	23,651
1996	216,723	860	110	109,154	549	4,955	8,650	56,203	16,428	19,815

Table A7: Derived Capital Stock (perpetual inventory method), million 1985 prices

	Economy	Agriculture	Mining	Manufacturing	Construction	Utilities	Transportation	Trade	Finance	Services
1980	1,044,197	3,400	271,408	1,121,280	903	251,843	30,424	14,636	24,379	16,240
1981	1,093,961	3,932	234,787	1,139,622	1,053	239,965	32,909	16,963	27,247	19,106
1982	1,142,996	4,854	203,358	1,154,504	1,171	231,544	35,254	19,935	30,806	22,661
1983	1,200,765	4,761	176,205	1,177,653	1,299	224,258	38,368	23,526	35,624	26,756
1984	1,263,841	3,442	154,616	1,206,769	1,891	218,478	41,941	27,504	38,539	31,301
1985	1,249,533	3,109	133,541	1,193,804	1,612	203,846	41,269	25,225	36,619	29,764
1986	1,198,400	2,602	115,696	1,123,380	1,396	200,135	39,645	27,371	38,325	32,478
1987	1,160,973	2,973	99,720	1,075,813	1,308	188,282	40,594	28,036	40,792	33,292
1988	1,145,316	3,405	86,070	1,042,084	1,142	175,946	43,171	30,589	43,913	39,336
1989	1,147,200	3,863	74,253	1,029,143	1,266	162,532	43,774	35,956	47,379	42,768
1990	1,174,240	5,535	64,041	1,048,108	2,434	150,978	43,164	38,284	46,409	44,876
1991	1,222,033	5,513	55,432	1,055,335	2,610	142,654	44,631	44,819	66,686	52,192
1992	1,234,835	6,123	47,889	1,043,661	2,557	134,839	45,330	49,261	71,188	61,840
1993	1,257,472	5,545	41,309	1,026,436	2,556	128,702	47,239	66,183	76,862	72,303
1994	1,293,335	5,476	35,612	1,021,496	2,806	126,196	53,825	72,182	83,628	84,823
1995	1,336,281	5,327	30,834	1,031,895	2,638	120,262	57,452	79,563	91,398	94,311
1996	1,380,091	5,105	26,596	1,057,852	2,641	114,499	60,709	72,102	96,176	107,862

Table A8: Capital Stock-Output Ratio

	Economy	Agriculture	Mining	Manufacturing	Construction	Utilities	Transportation	Trade	Finance	Services
1980	1.87	0.03	34.97	7.25	0.02	27.61	1.19	0.19	0.47	0.32
1981	1.89	0.03	28.96	7.19	0.02	25.78	1.21	0.22	0.56	0.34
1982	1.9	0.03	25.44	7.15	0.02	20.01	1.26	0.24	0.59	0.37
1983	1.99	0.04	24.38	7.31	0.02	21.3	1.31	0.27	0.63	0.41
1984	2.25	0.03	22.32	8.24	0.04	16.9	1.45	0.35	0.78	0.51
1985	2.38	0.02	14.11	8.87	0.07	17.52	1.45	0.32	0.79	0.49
1986	2.21	0.02	11.29	8.2	0.07	15.45	1.36	0.33	0.79	0.52
1987	2.04	0.02	10.66	7.5	0.05	18.89	1.32	0.33	0.77	0.51
1988	1.88	0.02	8.99	6.5	0.04	14.59	1.3	0.34	0.77	0.55
1989	1.77	0.03	8.2	6.09	0.04	12.71	1.24	0.38	0.75	0.58
1990	1.75	0.04	7.18	5.96	0.06	12.01	1.19	0.38	0.7	0.57
1991	1.84	0.04	6.4	6.11	0.08	10.66	1.21	0.44	1.02	0.66
1992	1.85	0.04	5.21	6.06	0.08	9.93	1.25	0.48	1.09	0.77
1993	1.84	0.03	4.46	5.92	0.07	9.65	1.31	0.63	1.16	0.86
1994	1.82	0.03	4.14	5.61	0.07	8.61	1.44	0.66	1.23	0.99
1995	1.79	0.03	3.61	5.32	0.06	7.52	1.46	0.68	1.28	1.06
1996	1.75	0.03	3.16	5.16	0.06	6.69	1.42	0.59	1.25	1.14

Table A9: Capital - Output* Ratio of Selected Countries

Philippines (Paderanga**)	1957-69	1970-79	1980-86	
National	4.2	3.6	3.5	
Manufacturing	15.2	9.3	8.7	
Philippines (Hooley***)	1956-69	1970-80		
Manufacturing	1.1	1.8		
Taiwan (Paderanga)	1952-69	1970-79		
	3.8	2.1		
Korea (Paderanga)	1953-69	1970-73		
	2.3	1.9		
Singapore (Paderanga)	1960-69	1970-74		
	1.4	1.3		
Hongkong (Paderanga)	1961-69	1970-74		
	1.4	1.3		
Philippines (This Study)			1980-89	1990-96
National			2	1.8
Manufacturing			7.4	5.7

* Output is value added

** Source: Paderanga, 1988 "Employment in Philippine Development"

UPSE Dis. Paper 8905

*** Source: Hooley, 1985 "Productivity Growth in Philippine manufacturing:

Retrospect and Future Prospects" PIDS Monograph Series No 9

Note: Hooley used gross value of output instead of gross value added. Thus, his ratios are smaller.

Annex B

Sources of Information

The objective of the study is to formulate various estimates of total factor productivity for 37 sectors of the Philippine economy. These sectors are identified in Table B1. To arrive at these estimates, data indicating output, land, labor and capital are necessary requirements. Ideally, these estimates should be constructed using data obtained from the National Income Accounts (NIA) to facilitate the generation of TFP estimates for the following years. Unfortunately, the NIA does not provide a consistent and ideal set of information, particularly for the capital data. As such, data coming from other sources need to be standardized to obtain a data series consistent with that of the NIA.

Table B1: Philippine Standard Industrial Classification of 1977 and the Sectors

General Industry Code	PSIC	Category
10	11-15	<i>Agriculture, Forestry and Fishery</i>
	11	Agricultural Crops Production
	12	Production of Livestock, Poultry and Other Animals
	13	Agricultural Services
	14	Fishery
	15	Forestry
20	21-22	<i>Mining and Quarrying</i>
	21	Mining
	22	Quarrying
30	31-39	<i>Manufacturing Sector</i>
	31	Manufacture of Food, Beverages and Tobacco
	32	Textile, wearing Apparel and Leather Industries
	33	Manufacture of Wood and Wood Products Including Furniture and Fixtures
	34	Manufacture of Paper and Paper Products; Printing and Publishing
	35	Manufacture of Chemicals, Petroleum, Coal, Rubber and

		Plastic Products
	36	Manufacture of Non-Metallic Mineral Products, Except Products of Petroleum and Coal
	37	Basic Metal Industries
	38	Manufacture of Fabricated Metal Products. Machinery and Equipment
	39	Other Mnft'g Industries
40	41-43	<i>Energy (Electricity, Gas and Water)</i>
	41	Electricity
	42	Steam heat and Power Supplies
	43	Water works and supplies
50	50	<i>Construction</i>
60	61-62	<i>Retail and Wholesale Trade</i>
	61	Wholesale Trade
	62	Retail Trade
70	71-73	<i>Transportation, Communication and Storage</i>
	71	Transportation Services
	72	Water Transport
	73	Communication
80	81-85	<i>Financing, Insurance,. Real Estate and Business Services</i>
	81	Banks
	82	Investment Institutions
	83	Insurance Companies
	84	Real Estate
	85	Professional, legal, Accounting Services
90	91-98	<i>Community, Social and Personal Services</i>
	92	Sanitary Services
	93	Educational Services
	94	Health Services
	95	Other Social and Related Services
	96	Recreational and Cultural Services
	97	Personal Services
	98	Restaurants

A major hindrance in the TFP estimation is the data on capital. The National Statistical and Coordination Board²⁴ classifies the total capital expenditure into various types of capital but not into the sources of capital. Table B2 provides a picture of how the data is reported in the NIA.

²⁴ The NSCB is the government agency responsible for constructing the National Income Accounts.

Table B2: Capital Expenditure Data as presented in the NIA

Capital Formation
A. Fixed Capital
1. Construction
2. Durable Equipment
3. Breeding Stock and Orchard Development
B. Changes in Stock

For the estimation study, the preferred format of the capital data would be to indicate the sources of capital expenditure. This is presented in Table A3.

Table A3 Sources of Capital Expenditure

Capital Formation
Agriculture
Manufacturing ²⁵
Non-manufacturing
Service

This type of data format is not available at NSCB, nor can it be generated during the time the study is being conducted. Hence, a substitute indicator was used for the capital data.

The period of study is from 1983 to 1995. The major task is to approximate the capital expenditure per industry for this time period using data from the Annual Survey of Establishments (ASE), Census of Establishments (CEO), and Industry Trade Statistics Division of the National Statistical Office. Once the capital expenditure per sector is determined (ASE-based capital data), its share will be applied to the NIA-based capital formation data. To derive the ASE-based capital data, 12 factors were needed. These are shown in Tables B4, B5, and B6.

Table A4: ASE/CEO/NSO Variables Explained

VARIABLES	EXPLANATION/REPRESENTATION
1. Year	*Year of Reference

²⁵ The manufacturing sector should also be broken down into its subsectors.

2. IC	*Industry Code based on the 1977 PSIC
3. NOE	*Number of Establishments
4. GAFA	*Gross Addition to Fixed Assets
5. TBV	*Total Book Value (gathered from the Table of Fixed Assets)
6. TLV	*Total Land Value (from the same table mentioned above)
7. TDV	*Total Value of Depreciation (from the Table of Depreciation of Fixed Assets) *The actual value for the Depreciation, represented by the variable, D_{ac} , in the ECR formula
8. ECR	*Error Correction Rate, the values are obtained from the formula: $ECR = \frac{D_{es} - D_{ac}}{D_{ac}} \times 100\%$
9. TE	*Total Number of Employment, obtained from getting the mean employment for the whole year (estimates made by the NSO)
10. PE	*Total Number of Paid Employees, obtained from getting the mean no. of paid employees for the whole year (estimates made by the NSO)
11. TC	*Total Compensation, obtained from getting the mean amount of compensation received by the paid employees for the whole year (estimates made by the NSO)
12. THW	*Total Hours Worked, obtained from getting the mean no. of hour worked by the employees for the whole year (estimates made by the NSO, variables 10-13 are gathered from the Table of Summary Statistics)

Table A5: Columns for Corrective Measure

VARIABLES	EXPLANATION/REPRESENTATION
1. TDV/TBV	<p>*Ratio of the total depreciation value and total book value</p> <p>*The ideal ratio should be < 1, to ensure that all encoded figures came from only one type of establishment, only large or only all.</p>
2. Discrep	<p>*Discrepancy, the difference between the values of TDV and ECR</p> <p>*The ideal difference should be a + number , to ensure the accuracy of the figures encoded in the TDV column</p>

Table B6: Modified Variables Column

VARIABLES	EXPLANATION/REPRESENTATION
1. B-L	<p>*The difference between the total book value (TBV) and the total land value (TLV)</p> <p>*The estimated depreciation value, represented by the variable, D_{es}, in the ECR formula</p> <p>*The book value of fixed assets in the ASE/CEO are characterized by variables with: 1) depreciating (other fixed assets) and, 2) speculative or appreciating values (land). However, to normalize the condition that the values of capital (k), considered in the TFP estimation, depreciate in time, it is but necessary to deduct the TLV from the TBV.</p>
2. ECR	<p>*Error Correction Rate, values are obtained from the formula:</p> $ECR = \frac{D_{es} - D_{ac}}{D_{ac}} \times 100\%$

Considerations, Bias and Selection

Two major deterrents were encountered in the encoding of data; first was the unavailability of some ASE/CEO/NSO values for some sectors, over a certain period/s of time; and second was the existence of different table formats of ASE/CEO/NSO for some sectors, over a certain period of time. This led to a series of processes before arriving at a single value for a particular variable. For these reasons, some considerations were made while validating, reviewing, and processing the obtained figures.

1. From 1983-1987, the ASE/CEO had the same table formats and bases for computing and determining the values encoded therein. However, from 1988-1995, the bases were altered, and brought forth a new table format. From the ASE/CEO 1983-1987, the presentation was based on the sizes of the establishments, i.e. *large, small or all establishments*. Accordingly, these were determined through the income earnings of the surveyed establishments. The figures in the ASE/CEO 1988-1995 were determined according to and on the basis of the average employment size of these establishments for one year: *establishments with an average employment of ten or more, less than 10 or 9 and below, or all establishments*.

This arrangement led to an inconsistent ASE/CEO figures. For this matter, the category of industry establishments were placed in a matrix (please see Matrix, Annex “B”), to finalize which of the values are to be picked out: *large or establishments with employment of 10 or more, or all establishments*. Small establishments or establishments with an average employment of less than 10, were disregarded based on the opinion that their contribution to the to the total output is generally negligible..

Although ASE/CEO/NSO figures for all establishments, for the years 1994-1995 are available, the study opted to get the large establishments-related figures. For the said years, the survey questionnaire was reformulated. This reformulation directly affected the mode of presenting the values of the TBV and its related components. Values of the TBV components (including the TLV) were lumped together. The TLV of small establishments could not be exacted due to this.

2. For the manufacturing sector, data for the years 1989-1993 were very fragmented. NSO utilized the 3-digit PSIC code, instead of the conventional 2-digit PSIC code presentation. To get the 2-digit PSIC values, all the figures in 3-digit PSIC were summed up *en masse*.

Table A7: Two Different PSIC Presentations

2 Digit PSIC	3 Digit PSIC
31	311 312 313 314
32	322 323 324
33	331 332
34	341 342
35	351 352 353 354 355 356
36	361 362 363
37	371 372
38	381 382 383 384 385

	386
39	390

3. For some ASE years, the total number of hours worked by production workers (THW) were not lumped together as shown in the ASE table format: *total number of hours worked by 1) male and 2) female production workers*. The THWs were determined by summing up the values of 1 and 2.

Table B8: Number of Hours Worked by Production Workers

Year	IC		Male	Female
1990	33	331	86,548,480	7,941,391
		332	60,279,823	19,638,647
		Total	146,828,293	27,388,041
			THW	174,407,334

4. For the year 1995, the industries with **IC 60-85** have no available figures due to suppression, which is a normal procedure that the NSO undertakes.
5. For the years 1983-1987, no data were available for the agricultural sector. The NSO temporarily stopped the survey in 1981 but resumed in 1988, and launched the Census of Agriculture and Forestry publication.