Measuring Productivity Across Nations Using a Data Envelopment Analysis

by

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A DISSERTATION

Submitted in partial fulfillment of the

requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1997

Approved by:

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Abstract

A data envelopment analysis was used to measure efficiency and productivity across nations. Multi-output and multi-input nonparametric models were used to measure efficiency (i.e., pure technical, overall technical, and scale efficiency) and productivity (i.e., efficiency change, technical change, and productivity growth) of a sample of African, Asian, and Latin American nations. The outputs consisted of agriculture, industry, and services whereas inputs included capital, labor, and land. Tobit and ordinary least squares (OLS) models were used to determine potential factors associated with nations' efficiency and productivity. The results of this dissertation revealed that the average pure technical efficiency index for the world sample was 1.4212, 1.3333, and 1.2966 in 1983, 1992, and for the period 1983-1992 respectively whereas the average overall technical efficiency index was 1.6551, 1.4707, and 1.4710 for the same periods. While Latin America and Asia's pure and overall technical efficiency indices were generally below the world sample's average, those of Africa were above the world's average (i.e., implying poorer levels of efficiency). Overall, the results on pure and overall technical efficiency indicated that Latin America performed more efficiently than Asia and Africa. Asia ranked second. With regard to nations' productivity, the overall results showed, on average, that productivity increased slightly over the 1983-1992 time period. The Malmquist productivity index of 1.4% per year (for the world sample as a whole) was mostly due to technical advances (1%) and efficiency change (0.4%). The Tobit regression analysis indicated that food aid per capita, gross domestic saving per capita, IMF intervention per capita, inflation, infrastructure, trade balance per capita, access to safe water, and length of time since independence were associated with pure technical efficiency. Nations' overall technical efficiency, on the other hand, was influenced by the same factors except gross domestic saving per capita, and trade balance per capita. The length of time since independence was positively associated with nations' pure technical efficiency whereas the same factor negatively influenced nations' overall technical

efficiency. Based on these sources of nations' inefficiency, external debt, food aid, inflation, and population growth should be discouraged whereas IMF programs, infrastructure, and access to safe water should be promoted in order to increase nations' pure technical, and overall technical efficiency. Finally, the OLS regression results revealed that inflation was the most important determinant of efficiency change. Higher inflation also decreased nations' productivity. Technical change and productivity were positively associated with trade balance per capita, and literacy. Hence, inflation should be brought under control in order to generate efficiency gains and productivity growth. Education, and international trade should be promoted so as to generate technical improvements, and productivity growth.

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Acknowledgments

I wish to express my gratitude to Dr. David Norman, my major professor, for his assistance, guidance, and support during the course of my graduate studies at Kansas State University. I very much appreciate Dr. Norman's expertise, promptness, direction, and encouragement in the completion of this dissertation. I thank him for providing funds (through his grants) that allowed me to complete my graduate work and gain further research experience under his supervision.

I wish to thank my committee members: Dr. Allen Featherstone, Dr. Bryan Schurle, Dr. Andrew Barkley, and Dr. Leniel Harbers for providing me with technical, scientific, and moral support during my research training. Their help and encouragement during my studies at Kansas State University are greatly appreciated.

Many thanks go to Dr. Allen Featherstone again, Dr. Orlan Buller, and Dr. Dan Bernado for granting and extending my graduate assistantship that enabled me to complete my doctorate program in the Department of Agricultural Economics. My gratitude also goes to Dr. David Darling for his full and unconditional support when I needed it the most.

Special acknowledgments go to my parents Etienne Lunkamba and Bena Mputu, the Zairian Students of America' s officials (Dr. Kisangani Emizet, Kevin Dayo, Colette Anderson, Benita Kilula, Lumana Mukasa, and Serge Tubene), my colleagues, and the Congolese community of Manhattan, Kansas for their spiritual, moral, and material support.

Stephan Lunkamba Tubene

Dedications

To my loving wife, Yvonne Tshibombi Tubene and our children;
To Pierre Mulume Ntumba and André Tshibombi wa Tshibombi;
The Lord is my shepherd, I shall not be in want (Psalm 23:1).

Chapter 1

Introduction

1.1 Problem Statement

In the past two decades, African nations have experienced economic and technological decline while other continents have seen their economies grow faster and stronger. According to the World Bank, 16 of the 20 poorest countries are located in Africa. In the 1960s, Africa was a net exporter of food. It now imports eight million tons of food each year. This figure is likely to increase, as projections indicate a net population growth of 3.1-3.2% annually. The International Food Policy Research Institute (IFPRI) has estimated that by the end of the century, Africa's net imports of basic food staples may be seven times higher than that of the early 1980s (Hibbler, 1988).

The causes of the present crisis as discussed by Rose (1992) are both physical (climatic and soils) and socio-political in nature. Agricultural growth has been slow, population has grown fast and real per capita output has declined since 1973 (World Bank, 1989). If efficient decisions are not made on a day-by-day basis by African leaders, the situation will only become worse by the turn of the century.

Asian and Latin American[1] countries on the other hand, have experienced sustained

[1] *Latin America* and *Central/South America* are used interchangeably in this dissertation and they include the Caribbean.

economic growth. Factors that may have contributed to this growth include their unique historical past, the Green Revolution era, political stability, good policies and better decision making processes. Even though much has been done in these parts of the world, Asian and Latin American countries need to do more in order to sustain their development.

These differences suggest that some countries seem to be operating more efficiently than others. One may therefore ask a number of questions, such as: why some countries are doing better than others? Why do discrepancies and differences exist among nations? What can be done to improve the situation of the countries lagging behind? These questions basically led to this investigation.

Most research has focused on farmers' efficiency at the micro level. Much has been done in this area while less research has emphasized the countries' public sectors. Nevertheless, several issues related to productivity have begun to receive recent attention. Economists and policy makers are interested in productivity given the fact that productivity growth is a major source of economic growth and welfare improvement. Since productivity gains consist of efficiency gains and technical advances, these two factors should be examined. This investigation will address productivity across nations at the macro level. It applies nonparametric techniques to measure nations' efficiency, and productivity.

Unlike other studies, this study measures productivity in low income countries (LICs)[2].

[2] *Low and high income countries* will be used in this study as a substitute for *developing and developed nations.* Following Norman (1994), development is a complex concept that includes not only the notion of income but also social values. A country may have achieved high income but not necessarily a high standard of social values and thus, cannot be termed developed.

Since most research on efficiency and productivity has addressed high income countries (HICs) issues, this investigation is a modest contribution to a growing literature on efficiency and productivity measurement in LICs.

1.2 Objectives of the Study

The measurement of technical, allocative, scale and overall efficiency is a useful tool to those responsible for helping farmers evaluate their current production efficiency, make efficient production decisions, and determine areas in which improvement is needed. In this study, the measurement of productivity and its comparison across African, Asian, and Central/South American countries is intended to help these nations evaluate and examine their own technical efficiency, scale performance, efficiency gains, and technical change.

First, pure technical efficiency, overall technical efficiency, and scale efficiency will be determined for each selected country using a production function approach and Data Envelopment Analysis (DEA).

Second, the productivity (i.e., efficiency change and technical advance) of African, Asian and Latin American countries in the last decade (1983-1992) will be measured from distance functions evaluated using nonparametric programming methods.

Lastly, the relationship between nations' socio-economic characteristics, and efficiency will be assessed using parametric methods (Tobit and Ordinary Least Square (OLS) models).

1.3 Organization of the Dissertation

The remainder of the dissertation is organized as follows. Chapter two summarizes current studies on efficiency and productivity. Chapter three presents the theoretical framework for DEA, and the model specification (efficiency and productivity measurement, Tobit and OLS regression analysis) for this study.

Data and methodologies are discussed in chapter four. More specifically, this chapter highlights data sources, sampling methods, output and input data, and socio-economic data, and methodologies used to analyze data. Chapter five presents the results for pure technical, overall technical, and scale efficiency; and discusses efficiency implications. Chapter six reports the productivity measurement findings (i.e., efficiency, technical, and productivity changes for each country).

The relationship between the efficiency indices and countries' characteristics are discussed in chapter seven. This chapter examines possible factors associated with nations' efficiency and productivity. Finally, Chapter eight presents conclusions, policy recommendations, and suggestions for future research.

Chapter 2

Literature Review

Literature on productivity and efficiency analyses is too extensive to be reviewed comprehensively in this chapter. The purpose of this chapter is to discuss briefly recent studies on efficiency and productivity both at the micro and macro level. This literature review will also provide some economic background on the continents and nations included in our study.

2.1 Empirical Research on Efficiency and Productivity

2.1.1 Research at the Micro Level

Much research has focused on the economic efficiency of agricultural production at the micro level whereas less has examined the public sector at the macro level. Efficiency analysis has mostly addressed technical, allocative, economic, scale, and overall efficiency of farm production.

Issues related to the structure of agriculture, the survival of the family farm and the effects of agricultural policy on farmers seem to be controversial. For example, early studies on South Asian farmers found that Indian farmers were economically, technically and allocatively efficient (Lau and Yotopolous, 1971, 1973). In their further studies, Lau and Yotopolous (1973) also found that Indian farmers not only faced constant returns to scale but

also small farmers were economically more efficient than large farmers. Small Indian farmers were also found to be more technically efficient than large farmers. The authors attributed this technical efficiency success to direct and own management of small farms in India by the farmers themselves.

On the other hand, some empirical studies have contradicted Lau and Yotopolous (1973)'s findings. Studies by Sidhu (1974), Khan and Maki (1980) indicated that small and large farmers were not significantly different with respect to technical, allocative and relative economic efficiencies in both traditional and modern agriculture. In addition, both studies rejected the hypothesis of constant returns to scale in favor of increasing returns to scale. Further empirical evidence has also suggested that small farms were as efficient as larger farms (Garcia, Sonka, and Yoo, 1982; and Kalirajan, 1981).

Färe and Grosskopf (1985) developed a nonparametric cost approach to scale efficiency. They provided the option of using cost rather than input data within the nonparametric framework.

Grabowski, and Pasurka (1988) estimated relative technical efficiency of northern and southern U.S. farms in 1860 using data envelopment analysis. In the 1970s, Fogel and Engerman conducted a similar study which concluded that southern agriculture was technically more efficient than northern agriculture. Their methodology consisted of specifying an index of total factor productivity using 1860 census data. Unlike Fogel and Engerman (1971), Grabowski and Pasurka (1988) used a more sophisticated measure of technical efficiency. The application of a nonparametric approach resulted in conclusions

different from those found by Fogel and Engerman (1971). Grabowski and Pasurka's results indicated that there was no statistical difference between the technical efficiency of northern and southern farms. This conclusion was still valid when the source of technical inefficiency was disaggregated into pure technical and scale.

Chavas and Aliber (1993) applied a nonparametric technique to a sample of Wisconsin farmers to estimate technical, allocative, scale and scope efficiency of these farmers. They found that important economies of scale existed for very small farms whereas some diseconomies of scale existed for the larger farms. Most farms were found to exhibit substantial economies of scope, but such economies tended to decline sharply with the size of the enterprises. They also found significant linkages between the financial structure of the farms and their economic efficiency.

Reddy (1993) studied productivity levels and profits of various farm size categories for the local rice crop in different regions of India using data from the 1971-1978 time period. He concluded from his investigation that small farmers were more productive than large farmers in modern agriculture. However, this conclusion may not be universal. He also concluded that modernization of agriculture increased productivity and employment vis-a-vis small farms.

Featherstone, Moghnieh, and Goodwin (1995) investigated the optimizing behavior of a sample of 289 Kansas farms under profit-maximization and cost-minimization hypotheses using both deterministic and stochastic nonparametric tests. The results of their study indicated that the deterministic findings did not support strict adherence to either optimization hypothesis. The stochastic tests however, suggested that all 289 farms failed the profit-

maximization hypothesis, whereas 171 farms failed the cost-minimization hypothesis. Also, allowing for non-regressive technical change did not alter the basic results. They found that the evidence against cost-minimization behavior seemed to be far less substantial than that against profit-maximization behavior.

Featherstone, Langemeier, and Ismet (1997) estimated efficiency of a sample of Kansas beef cow farms. The results of their analysis indicated that on average, the beef cow farms were 78 percent technically efficient, 81 percent allocatively efficient, and 95 percent scale efficient. Beef cow farms' overall inefficiency was significantly related to herd size and the degree of specialization. They also found that veterinary services, utility and fuel costs, and miscellaneous expenses, had a smaller impact on inefficiency than capital costs, feed costs and labor costs.

Shah and Featherstone (1995) applied a nonparametric technique to a sample of farms from the Punjab Province of Pakistan. They found that on average, 40 percent of potential output was lost due to Farrell (i.e., overall technical) inefficiency; 30 percent due to pure technical inefficiency, and 7 percent due to scale efficiency. Most farmers were scale inefficient, mainly due to small holdings. Farm sizes and educational levels had significant impact on scale efficiency. Results of this study implied that technological forces in the long run would encourage increased farm size in Punjab Province.

Besides efficiency analysis, other empirical studies have included issues related to productivity. For example, Tauer (1996) studied the productivity of New York dairy farms using the distance functions estimated with nonparametric programming methods. He

decomposed the productivity of individual dairy farms into efficiency and technological changes. The results of his investigation showed that average productivity increased 2.8 percent each year for the 1985-1993 period. Half of the 2.8 percent was due to efficiency gains and the other half due to technological changes. About 25 percent of the farms failed to increase productivity sufficiently to offset the decreased ratio of output to input prices.

2.1.2 Research at the Macro Level

Several authors have applied the DEA approach to the public sector. The broad applicability and acceptance of a DEA approach is illustrated by the diversity of empirical work emerging in the literature.

The topics that have been investigated in the public sector using DEA and efficiency analyses have addressed several issues such as: DEA and ratio efficiency analyses for public institutions of higher learning in Texas (Ahn et al., 1989); evaluation of bank branches by means of DEA (Al-Faraj, et al., 1993); excellence and efficiency in Texas public schools (Arnold et al., 1994); nonparametric analysis of technical and allocative efficiencies in the educational production (Banker, and Maindiratta, 1988); estimation of returns to scale of local prisons using DEA (Banker and Thrall, 1992); banking efficiency in the Nordic countries (Berg et al., 1993); Malmquist indices of productivity growth during the deregulation of Norwegian banking, 1980-89 (Berg, et al., 1992); measuring the efficiency of decision-making units in English local education authorities (Charnes, Cooper and Rhodes, 1979) and comparisons of DEA and existing ratio and regression systems for effecting

efficiency evaluations of regulated electric co-operatives in Texas (Charnes et al., 1989).

Besides education and banking issues, the DEA approach has also been used in several studies including defense, health care, and prisons. Bowlin (1987, and 1995), for example, has evaluated the efficiency and financial conditions of the United States (U.S.) air force. Clarke (1992) also investigated the U.S. air force vehicle maintenance productivity over time using the DEA approach. Banker, Conrad, and Strauss (1986); Grosskopf, and Valdmanis (1987); Chirikos, and Sear (1994) have completed studies of hospital efficiency and productivity. Ganley and Cubbin (1987) examined the prison service while Tulkens (1990) investigated efficiency of municipalities.

Recent dissertations in DEA models have covered broad subjects including: public efficiency through total quality management (Bailey, 1993); linearity and separability assumptions in cost accounting (Chang, 1994); organizational effectiveness in U.S. and Spanish electricity distribution: the impact of contextual variables (Dean, 1993); priorities in health care, a resource allocation method and empirical investigation (Gaisford, 1993); efficient set relations among data envelopment analysis models and resource use efficiency in manufacturing (Heimerman, 1993); and finally data envelopment analysis models and structures and their use in the management of army recruitment (Pitaktong, 1993).

More generally the DEA approach is being applied to the analysis of both private sector and public sector services. However none of the above studies has investigated nation-wide efficiency issues related to LICs as developed in this study.

A few studies have addressed the issue but with a different approach. For example,

Costello (1993) examined a cross-country, cross-industry comparison of productivity growth for industrialized countries. Costello's investigation provided new information pertaining to the international nature of productivity growth by studying the behavior of Solow residuals for five major manufacturing industries in six industrialized countries (i.e., Italy, Canada, Germany, United Kingdom, United States, and Japan). He found that output growth is more correlated across countries than is the case with respect to productivity growth. Using an error-components model, he found that a substantial fraction of changes in annual productivity can be attributed to nation-specific factors that are common across industries.

McCarty, and Yaisawarng (1993) examined technical efficiency in New Jersey School districts using a DEA approach. Their results suggested that Jersey City and Paterson exhibit higher levels of technical inefficiency than would the average district whose students have the same socioeconomic status. Students' socioeconomic status was also examined using Tobit models. Results were in favor of the two-stage Tobit models. The authors concluded that each model had advantages and disadvantages. Either or both may be appropriate depending on the particular research questions being investigated.

When analyzing the productivity growth in Norwegian ferries, Forsund (1993) found that the productivity over a five year period was declining. But he argued that five years was not long enough to generate much change in productivity for a business with levels of fixed capital such as is the case with ferries. However, when decomposing productivity change into efficiency and technical change, he found that technology had been almost stationary, and the decline was due to a gradual falling behind in efficiency.

Färe, Grosskopf, Norris, and Zhang (1994) estimated productivity growth, technical progress, and efficiency change in 17 industrialized countries over the period 1979-1988 using a nonparametric programming method. They decomposed Malmquist productivity indexes into technical and efficiency changes and found that U.S. productivity growth was slightly higher than average, all of which was due to technical change. Japan's productivity growth was the highest in the sample, with almost half due to efficiency change.

Kinoshita (1997) measured the growth in total factor productivity in agriculture for selected countries utilizing frontier production techniques. He also compared the growth levels of the total factor productivity in agriculture of two different frontier production techniques so as to see if the two frontier approaches (i.e., the stochastic production frontier and DEA) tracked similar trends in productivity growth and technical change. The results of his study suggested an increase in the agricultural productivity growth rate for the developed countries and a decrease in the agricultural productivity growth rates for less developed countries. However, the rank correlation results suggested that productivity growth and efficiency changes on a country basis varied depending on the frontier production technique applied. Finally, he concluded that the problems in modeling and estimating a stochastic production frontier make the alternative frontier production technique of DEA very attractive. However, a disadvantage of DEA is its inability to make statistical inferences from the derived results. If somehow a statistical component could be integrated into the DEA technique so as to derive statistical inferences, then DEA could gain even wider credibility and acceptance.

2.1.3 Final Thoughts on Empirical Research

Empirical research on efficiency and productivity at the micro and macro levels has been discussed in this chapter. From this review, four specific points are summarized as follows.

Recently DEA has become a widely used technique in both the public and private sectors. DEA has been applied to broad issues including prison, health care, education, banks, municipalities, fast food restaurants, and a country's performance. DEA has been more widely used at the micro than the macro levels. Nevertheless, there is a growing literature on macro issues as more researchers are becoming interested in the subject.

Nonparametric analyses are praised for not relying on parametric specification of the production, cost or profit functions and therefore, not imposing a priori parametric restrictions on the underlying technology. In addition, the Malmquist productivity index technique has the advantage of decomposing productivity into efficiency and technical changes. However, DEA is unable to make statistical inferences from derived results. One has to add an additional step which consists of a statistical approach in order to derive statistical inferences.

Because of the advantages of DEA over conventional parametric analyses, it is becoming increasingly necessary to look for ways and means of integrating a statistical component into DEA techniques. If this could be done, then DEA could gain even greater credibility and acceptance.

Even though the DEA approach has been extensively used by researchers, most studies have focused on HICs rather than LICs. More investigations are still to be done in the area and

on issues related to the LICs of Africa, Asia, and Latin America. Previous studies have addressed efficiency and productivity in industrialized nations (Canada, France, Germany, Italy, Japan, United Kingdom, United States, etc.) while this study is evaluating and comparing efficiency, and productivity across the African, Asian, and Central\South American nations.

2.2 Regional Grouping and Continent Background

Three regions examined in this study include Africa, Asia, and Latin America. This research focuses only on LICs. Therefore, HICs are not included in this investigation. The driving force behind this is that less substantial research has been done in these regions at the macro level.

In order to help understand the context and interpretations of our results later in this study, an overview of the three regions (Africa, Asia, and Latin America) for the 1983-1992 period of our investigation, is provided below.

2.2.1 Africa

In Africa, 1960 and subsequent years were known as independence years. The continent experienced a power transfer from the colonizers to the nationals. This power transfer period was characterized by turmoil and/or civil wars in some cases. Crisis was mostly followed by State building policies and countries' economic growth. Whereas colonial development had focused on agriculture, independent governments identified

development with industrial growth and the expansion of formal education (Williams, 1993).

As discussed by Sparks (1993), contrary to recent popular impressions, sub-Saharan Africa (SSA) has achieved a measure of aggregate economic growth since the mid-1980s, possibly due not only to policies implemented by African governments but also to events outside governmental control. The African continent continued to make steady, and slow-paced economic progress in the 1980s. In 1991, Africa's economic performance improved for the fourth successive year. The region's GDP increased by 3.6 percent at constant prices. However, it did not register significant gains in per capita terms. According to the World Bank, the region's GDP will increase by 3.3 percent annually between 1990-2000 and only by 0.1 percent in per capita terms given a population increase projected at 3.2 percent annually (Sparks, 1993).

According to Sparks (1993), despite the improvement in economic performance, SSA generally performs less well than other developing regions. SSA has the lowest GDP per capita growth rate, the lowest life expectancy, the lowest access to safe water percentage, and the highest percentage of people living under the international poverty line compared to other developing groups which include East Asia, South Asia, and Latin America.

As shown in Table 2.1, SSA also has the highest population growth rate of 3.2 percent between 1980 and 1990. Infant mortality was also the highest in the region for both 1960 and 1992 (about 165 and 101 children out of every 1,000 died before reaching the age of five years in 1960 and 1992 respectively). Adult literacy was the lowest in 1970 (i.e., 28 percent in 1970). It was, however, higher (51 percent) in 1990 than that of South Asia (47 %) in the

Table 2.1: Regional Trends in Population and Human Development (1960-92)

Variable	Sub-Saharan Africa	South Asia	South-East Asia	Latin America
Population growth (av. annual %)				
1980-90	3.2	2.3	-	-
Life expectancy (years)				
1960	40.0	43.8	45.3	56.0
1992	51.1	58.5	62.9	67.7
Infant mortality (per 1,000 live births)				
1960	165.0	164.0	126.0	105.0
1992	101.0	94.0	55.0	47.0
Adult literacy (%)				
1970	28.0	33.0	67.0	76.0
1990	51.0	47.0	86.0	86.0
Access to safe water (%)				
1975-80	25.0	-	15.0	60.0
1988-91	45.0	-	53.0	79.0
Overall school enrollment (%)				
1980	39.0	36.0	51.0	59.0
1990	35.0	45.0	54.0	62.0
Malnourished children under five (%)				
1975	31.0	69.0	46.0	17.0
1990	31.0	59.0	34.0	10.0

Sources: The United Nations Development Programme. *Human Development Report*. New York: Oxford University Press, 1994 (p.207).

same year. In terms of malnourished children (under five years), SSA ranked second (with lower percentage of malnourished children) in both 1975 and 1990 after Latin America (with 17 and 10 percent in both years respectively).

Table 2.2 indicates that economic performance trends were lower in SSA than in Asia and Latin America. For example, GNP per capita growth rate and growth rate of exports/GDP were the lowest in SSA over the 1980-1992 time period.

Williams (1993) indicated that from 1972 to 1974, nations in Sahel and East Africa were confronted with a severe drought followed by the sharp rise in the price of oil in 1973. Food aid and food imports increased rapidly in 1974 and again in the 1980s. Since the severe droughts in the Sahel in the early 1970s, Africa has been thought of as a continent in crisis, ravaged by problems of famines, repressive and corrupt governments, and wars. World Bank analyses identify two main sources of these problems including the combination of excessive government intervention in the economy with inadequate administrative capacities and the rapid population growth over the last three decades (Williams, 1993).

According to Hodd (1991), African economies comprise various groupings. The groupings discussed below include geographical region, and economic zone.

Geographical groupings of African economies have become a common point of reference. They comprise the West, East, Central, and Southern Regions (Table 2.3). Central Africa was the most urbanized region with 39% of the population living in towns in 1985 whereas Southern Africa was the least urbanized with only 24% of the population living in towns. Population density was highest in West Africa (31 persons per square kilometer),

Table 2.2: Regional Trends in Economic Performance (1980-92)

Variable	Sub-Saharan Africa	South Asia	South-East Asia	Latin America
1992 GNP growth rate	2.6	5.5	5.7	1.8
GNP per capita growth rate				
1965-80	1.5	1.4	2.6	3.8
1980-91	-1.1	3.0	3.1	-0.1
Annual rate of inflation				
1980-91	14.7	8.20	6.40	208.1
1992	24.5	9.7	6.2	442.4
Growth rate of exports/GDP	-0.9	4.3	0.6	-0.1

Sources: The United Nations Development Programme. *Human Development Report*. New York: Oxford University Press, 1994 (p.212).

followed by East Africa (24 persons per square kilometer). Central and Southern Africa densities were significantly lower at around 11 persons per square kilometer.

In terms of income, West Africa had the highest average in 1986 at 510 U.S. dollars per person followed by Central and Southern Africa with about 400 U.S. dollars. East Africa had the lowest average income of 250 U.S. dollars per capita.

In terms of overall economic performance during the 1980-86 period, positive annual expansion of Gross Domestic Product (GDP) was achieved by Central (4.2 percent a year) and East Africa (1.6 percent a year) while declines were experienced in West (-2 percent per

Table 2.3: Africa: Geographical Regions and Economic Zones

Countries[1]	Geographical Regions	Economic Zones
Benin	West	Franc
Burkina Faso	West	Franc
Burundi	East	Other
Cameroon	West	Franc
Central African Republic	Central	Franc
Chad	Central	Franc
Comoros	East	Franc
Congo	Central	Franc
Cote d'Ivoire	West	Franc
Egypt	Arabic	Other
The Gambia	West	Anglophone
Ghana	West	Anglophone
Kenya	East	Anglophone
Madagascar	East	Other
Malawi	Southern	Anglophone
Mali	West	Franc
Mauritania	West	Other
Mauritius	East	Anglophone
Morocco	Arabic	Other
Namibia	Southern	Anglophone
Nigeria	West	Anglophone
RDC (former Zaire)	Central	Other

Table 2.3: Africa: Geographical Regions and Economic Zones (continued)

Countries[1]	Geographical Regions	Economic Zones
Rwanda	East	Other
Senegal	West	Franc
Sierra Leone	West	Anglophone
Swaziland	Southern	Anglophone
Togo	West	Franc
Tunisia	Arabic	Other
Zambia	Southern	Anglophone
Zimbabwe	Southern	Anglophone

[1]Countries reported in Table 2.3 are those included in our study.

Sources: Michael Hodd. *The Economies of Africa: Geography, Population, History, Stability, Structure, and Performance Forecasts*. Aldershot: Dartmouth Publishing Company, 1991 (pp.27 and 31).

year) and Southern Africa (-3.7 percent per year).

All three sectors (agriculture, industry and services) grew during the 1980-86 period in East and Central Africa. In West Africa, agriculture grew whereas industry and services declined between 1980 and 1986. Southern Africa experienced declines in all three sectors (Hodd, 1991).

Economic zone (Table 2.3) groupings include the Franc, the Anglophone, and the Other zone. The Franc zone consists of countries in which the CFA franc circulates and is used as the main currency. As discussed by Hodd (1991), this zone is distinguished by convertability of the currency, budgetary and monetary discipline imposed by France as condition of the convertability.

The Anglophone zone includes countries administered or protected by the British during the colonial period. The third group, known as Other, comprises the remaining nations. In terms of population size, the Anglophone zone is the biggest (53 percent), followed by the Other zone (31 percent). The Franc zone is the smallest with 16 percent of Africa's population.

The Franc zone was more prosperous than the two other zones, with a GDP per capita of 598 U.S. dollars in 1987. The Anglophone and Other zones had a GDP per capita of 275 and 214 U.S. dollars respectively. GDP expanded at 3.1 percent per year during the 1980-87 period in the Franc zone, at 1.4 percent in the Other zone, and at only 0.1 percent in the Anglophone nations.

As discussed by Sparks (1993), despite the improvements achieved during the late

1980s and early 1990s, almost every sub-Saharan African economy has declined during the past three decades when expressed in per capita terms. By 1991, per capita GDP was 15 percent below its level a decade earlier. Per capita income also decreased.

The poorer African nations were even poorer in 1990 than they were at their independence in the 1960s. While some East African countries have twice doubled their incomes per capita, 19 nations in SSA were poorer in 1993 than a generation ago. Africa lost the ability to feed itself during the 1980s. Food aid also increased during that period, from 0.9 to 4.8 millions tons of cereals. Countries such as Liberia, Mozambique, Somalia, Sudan and Ethiopia faced critical food shortages in 1992 (Sparks, 1993).

Finally, following Sparks (1993), the factors underlying Africa's economic conditions can be categorized as external and internal. External factors include adverse movements in the terms of trade and declines in foreign aid and foreign investment whereas internal factors include poor soils, widely variable and unfavorable biophysical production environments, poor human and physical infrastructure, rapid urbanization and population growth, unstable and repressive political structures, and inappropriate public policies. Unfortunately, African governments have limited control over many of these factors, particularly the external ones.

2.2.2. Asia

While most SSA nations were engaged into a struggle for independence, most Asian countries were already independent. Some Asian countries were not colonized by the West. For example, Japan had substantial autonomy in economic affairs compared to other Afro-

Asian nations despite inequitable treaties with the West from 1858 to 1899 (Nafziger, 1992).

Economic and social indicators during the 1960-92 period indicate that Asia has performed better than SSA. Asia mostly ranks second after Latin America in terms of life expectancy, infant mortality, access to safe water, adult literacy, and overall school enrollment (Table 2.1). South Asian countries had a life expectancy of 44 years in 1960 and 59 in 1992 whereas Latin America had the highest life expectancy of about 56 and 68 years in 1960 and 1992 respectively. SSA had the lowest figures.

Table 2.1 also shows that in South Asia, the infant mortality rate was 164 in 1962 and 94 in 1992. Infant mortality was even lower in South-East Asia (126 in 1960 and 55 in 1992). Latin America had the lowest infant mortality rate of 105 (in 1960) and 47 (in 1992). Even though access to safe water was lower (only 15 percent) in South-East Asia during 1975-80 than it was in SSA (25 percent), the 1992 figures indicate that South-East Asia improved its access to safe water to 53 percent during the 1988-91 period (against only 45 percent in SSA).

Overall school enrollment rate was lower in South Asia in 1980 than in SSA the same year. However, it increased to 45 percent in South Asia against only 35 percent in SSA in 1990. South-East Asia's overall school enrollment was higher than SSA in both 1980 (about 51 percent) and 1990 (54 percent). Latin America again ranked first. Finally, South Asia and South-East Asia ranked last in terms of percentage of malnourished children under five years old. Latin America ranked best in 1975 and 1990 (with 17 and 10 percent respectively) followed by SSA.

In addition, Table 2.2 indicates that economic performance trends were better in Asia

than in SSA. During 1992, South-East Asia had the highest GNP growth rate of about 6 percent, followed by SSA with about 3 percent. GNP per capita growth rate was 3.1 percent in South-East Asia from 1980 to 1991, but negative (-1.1 percent) in SSA making Asia first, then Latin America second (-0.3 percent). South-East Asia had the lowest average annual rate of inflation. In 1992, South-East Asian nations' annual inflation rate was maintained at 6.2 percent whereas in SSA, the annual inflation rate was 24.5 percent.

In 1992, growth rate of exports/GDP was higher in both South (4.3 percent) and South-East Asia (0.60 percent) than in SSA (-0.90 percent).

These figures indicate that Asia is ahead of SSA and much needs to be done in order to pull SSA out of its crisis.

2.2.3 Latin America

Latin America is different from Africa and Asia. In contrast to African and Asian nations, most Latin American countries have had their independence in the 1880s. They have gone from a period of civil wars and military unrest to a period of relative stability and economic recovery.

According to Chapman (1988), Latin America and the Caribbean countries have, collectively, achieved a level of economic development that places the region between industrialized and developing nations. However, between 1980 and 1983 the worst recession since 1931 occurred with a modest recovery in 1984 and 1985.

Most Latin American economies were very healthy by 1994 compared to the situation

10 years before. Servicing the external debt had become less onerous in relation to output and export revenues. Inflation also seemed to be under control except in Brazil. The region's economies became more open to international trade and foreign investment. Markets were liberalized and inefficient state enterprises were privatized (Hojman, 1995).

Table 2.1 indicates that Latin American nations ranked favorably in terms of human development trends between 1960 and 1992. These trends include life expectancy, infant mortality, adult literacy, access to safe water, overall school enrollment and malnutrition.

In addition, Table 2.2 shows that overall Latin American countries have performed well economically from 1965 to 1980. In fact, Latin American nations ranked first in 1965-80 in terms of real GNP per capita growth rate (3.8 percent). However, Latin America performed poorly from 1980 to 1991 in terms of inflation (208.1 percent), and GNP per capita growt rate (-0.1 percent).

Latin American economic and social development has been the subject of considerable attention since the problem of servicing the external debt surfaced in early 1980's. Chapman (1988) argues that the origins of economic difficulties in 1988 were due to interacting factors, mostly external to the region, including the rapid increase of petroleum prices after 1973 and the abandonment of the gold exchange standard. Regional GDP increased, in real terms, by an annual average of 5.1 percent in 1974-80, then stagnated in 1981, declined by 1.0 percent in 1982. Real GDP also declined by 3.1 percent in 1983. However, a real annual growth of 3.2 percent was recorded in both 1984 and 1985. The region's external debt increased by 318 percent (real terms) between 1975 and 1985. Drastic adjustment measures in 1983-85 resulted

in lowering of living standards and widespread economic insecurity. Erratic monetary and fiscal policies contributed to the acceleration of inflation in the region's economies rising from 84.5 percent in 1981 to 275 percent in 1985.

As discussed by Hojman (1995), the prospects for most Latin American economies in the mid-1990s were highly positive except for Brazil and Venezuela. Many Latin American countries occupied high positions in the Human Development Index of the United Nations Development Program. These countries also made some progress in the fight against corruption. There were however, dangers in the region for foreign investors. From 1990 to 1994, the value of shares (in real terms) on the stock-market grew by about 300 percent in Argentina and Mexico, and by 400 percent in Chile and Venezuela. Nevertheless, the region's stock-markets were in general thinly traded and poorly regulated.

Latin American nations responded to the 1982 external-debt crisis by opening their economies to international trade (Hojman, 1995). In 1991, the region achieved the highest value of actual exports compared with prior to the debt crisis. However, export performance was uneven in the region. For example, actual exports increased by 114 percent in Chile, 99 percent in Paraguay, 84 percent in Colombia, and only 13 percent in Mexico. On the other hand, by the early 1990s the exports of the other nations in the region had not yet recovered from the crisis.

External debt is the second economic issue that was described in the late 1980s as critical. By 1994 external debt was no longer the problem it was in the 1980s. The external-debt burden can be conventionally measured in terms of debt-service-ratio, which is defined

as the sum of interest and repayments of all external debt, as a share of exports. Between 1986 and 1992 this ratio fell from 76 to 37 percent in Argentina, from 43 to 26 percent in Brazil, and from 55 to 21 percent in Mexico (Hojman, 1995). The debt-service ratio was 45 percent in 1986 for Latin America as a whole. The International Monetary Fund (IMF) predicted that it would fall to 30 percent by the end of 1994.

Finally, inflation, which was not an issue in the previous decade, had become another theme in the 1990s. The inflation rates were falling everywhere in the region except in Brazil. In Argentina for example, the annual average inflation rate fell from about 3,000 (in 1989) to 11 percent (in 1993). In Chile, inflation fell from 26 percent per year (in 1990) to 13 percent (in 1993). However, in Brazil, inflation was not defeated. The average annual inflation rate in this country fell from 3,000 percent (in 1990) to 1,000 percent (in 1992), but increased again to 2,000 percent in 1993.

2.2.4 Concluding Remarks

Throughout the above discussion, it was shown that overall, the economies of Africa have deteriorated during the period of our investigation (1983-92) whereas those of Asia and Latin America had improved during the same period. Economic and social indicators showed that SSA has generally performed less well than any other developing region during the 1983-92 period.

According to Sparks (1993), Africa's economic performance has been influenced by two main issues: external (i.e., adverse movements in the terms of trade and declines in

foreign aid and foreign investments) and internal factors (i.e., poor soils, widely fluctuating and harsh climates, poor human and physical infrastructure, rapid urbanization and population growth, unstable and repressive political structures, and inappropriate public policies). Even though African nations may be able to handle these factors; some, especially external, are hard to bring under control.

Nafziger (1994) also argues that technical change can be viewed as a prolonged learning process based on experience and problem solving when nationals supervise new capital projects. Each successive piece of capital equipment is more productive given that learning advances are embodied in new machines. In addition, learning takes place in research, educational, training institutions, and by using capital equipment as well.

Nations that have established a well known development agenda or economic development model have succeeded in their attempt to bring about internal development. Following the Japanese and the Korea-Taiwanese development models, much was done in building infrastructure, providing tax incentives and subsidized credit for export manufacturing industries, and investing heavily in primary education and other human capital (Nafziger, 1990).

SSA may therefore learn from these successful models by adapting what is feasible in its context in order to improve its economic performance.

On the other hand, the advocates of dependency theory argue that the economic development of the rich countries contributes to the underdevelopment of the poor. Following Frank (Nafziger, 1990), LICs are economic satellites of HICs of Northern America and

Western Europe in the international capitalist system. The Afro-Asian and Latin American nations most weakly integrated into the system tend to be the most highly developed. Japan is a good example in the sense that it was never a capitalist satellite.

Frank (1969) argues that the most underdeveloped regions today are those that have had the closest ties to Western capitalism in the past. Finally, Furtado (1970) explains dependency theory in terms of peripheral capitalism, a capitalism that is unable to generate innovations but is dependent for transformation upon decisions from the outside. According to Furtado (1970), this peripheral capitalism is made up of African, Asian and Latin American nations which specialized in primary products in an enclave controlled by foreigners while importing consumer goods. Such a policy benefitted only a small ruling class and its allies who cooperated with the HICs to achieve economic development among a modernizing minority.

Following Nafziger (1990), in a sense, colonies paid dearly for economic dependency under foreign rule. In fact, development was not self-directed. Production was directed toward external rather than domestic needs, economic policies inhibited local industrial activity and led to uneven ethnic and regional economic progress, and an elite oriented to foreign interests arose. These costs, however, were offset in part by the development of schools, roads, railroads, and an administrative service under the colonial powers.

Dependency theory alone is unable to justify the underdevelopment of most Afro-Asian and Latin American nations. African nations have suffered most from colonial power but yet Africa has had time to prove itself. Several economic development theories may help

to some extent explain better backward performance of developing regions and especially SSA. These include not only dependency theory but also many others such as ecological-evolutionary theory, Rostow's precondition stage for sustained industrialization, etc. Ecological-evolutionary theory for example, asserts that the characteristics of human societies (including the degree of development) are the product of both internal and external forces (Lenski and Nolan, 1991). Therefore, to ignore or neglect either is to misunderstand and misinterpret the complex process of societal development.

Rostow's stages of economic growth suggest that the precondition stage for sustained industrialization includes radical changes in three nonindustrial sectors: transport investment, revolution in agriculture, and an expansion of imports. These changes, according to Rostow, require a political elite interested in economic development. This interest may be instigated by a nationalist reaction against foreign domination or the desire to have a higher standard of living. The lack of either of these preconditions may have caused developing regions's economic performance to deteriorate.

Finally, the solution to the dependency theory is not withdrawal from the world capitalist system as recommended by Frank (Nafziger, 1990) but rather, a more selective policy in dealing with capitalist countries. Trade, economic aid, and technological borrowing from developed countries should be such that investment is directed into priority industries. This selective policy possibly includes encouraging domestic enterprise, preventing heavy debt burdens, and avoiding foreign political interference.

It has been argued that LICs' development is likely to occur through the development

of the agricultural sector since this sector absorbs most of the country's unemployed labor. Based upon this principle and following Norman (1994), growth of agriculture is critically important for rapid national economic development to occur.

As opposed to the beliefs that national development plans and investment should concentrate on the non-agricultural sector (due to the fact that economic growth requires more rapid growth in the industrial and service sectors than in the agriculture), it is now recognized that improvement in agricultural productivity is a necessary step to ensure a sustained economic development in LICs. According to Norman (1994), higher agricultural productivity and therefore higher standards of living, may be created through technological change, institutional change, investment in human capital, and investment in research and extension services.

Chapter 4

Data and Methodology

4.1 Data Sources and Sampling Methods

The nonparametric approach will be applied to macro-level data for 55 countries. The data used in the analysis include information from the World Bank data base compiled into a CD ROM (World Data, 1995).

The available data is time series data from 1983 to 1992. After elimination of countries that had missing data, nations[1] were further selected based on their respective gross national product (GNP) per capita. Countries that had an average GNP per capita of less than or equal to 2,500 U.S. dollars over the 1983-1992 period were selected. The per capita GNP range was chosen to avoid discrepancies and big gaps across nations and regions when referring to the world frontier or best practice frontier as discussed in this chapter (Section 4.4. Methods). The 10 year period (1983-1992) was selected not only because of the availability of continuous data but also due to the fact that this period covers some structural adjustment (even though this adjustment is still in progress).

Therefore, the usable data consist of observations on 55 countries from 1983 to 1992.

[1]Countries that were deleted based on their GNP per capita include African nations (Algeria, Seychelles, and South Africa), Asian nations (Hong Kong, Japan, and Singapore),and Latin American countries (Argentina, Barbados, Trinidad and Tobago, and Venezuela).

There are 30 African countries, 11 Asian and 14 Latin American nations (Table 4.1).

Hence, the data used in this investigation includes 550 observations; that is, 55 countries for a 10 year period (1983-1992). As efficiency measures will be evaluated for each country on a yearly basis, the data are grouped by year for all 55 countries included in the sample. The 55 countries make up a sample which will be referred to as the world sample. Therefore, the world sample will be estimated once for every year.

4.2 Output and Input Data

Three sectors (all measured in real quantities: U.S. dollars) including agriculture, industry, and services are used to measure output for each country.

As an example, the value added for agriculture, industry and services is measured by taking the value of goods and services produced by the individual sector (gross output) and deducting the cost of goods and services used up by the sector in the production process (World Data 1995). The agricultural sector includes agricultural and livestock production and services, fishing, hunting, logging, and forestry. The industry sector comprises mining, and quarrying, manufacturing, construction, electricity, gas and water. The service sector includes all service activities (i.e., transport storage and communications, wholesale and retail trade, banking, insurance, real estate, ownership of dwellings, public administration and defense, and other services).

On the World Bank CD ROM, figures for agriculture, industry, and services are expressed in current U.S. dollars and constant 1987 U.S. dollars. To obtain a measure of

Table 4.1 Regions and Countries Included in the Sample

Regions	Countries
Africa	Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Egypt, The Gambia, Ghana, Kenya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Namibia, Nigeria, Rwanda, Senegal, Sierra Leone, Swaziland, Togo, Tunisia, RDC, Zambia, and Zimbabwe.
Asia	Fiji, India, Indonesia, Nepal, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Syrian Arab Republic, Thailand and Turkey.
Latin America	Belize, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Nicaragua, Panama, Paraguay, and Uruguay.

of relative price changes, the current U.S. dollars figures for each year were divided by the constant U.S. dollars figure for that year. The relative prices for each year were then "normalized" in terms of agriculture through giving a weight of 1 for agriculture (i.e., dividing the relative price of agriculture by itself) and dividing the relative price of industry and services by the relative price of agriculture. The constant 1987 U.S. dollar value for each sector for each year was then divided by the "normalized" price for that year (i.e., always 1 in the case of agriculture). This in essence expresses the figures for agriculture, industry, and services in real quantity terms[1].

The inputs used in this analysis include three categories: capital, labor, and land. Gross domestic fixed investment is used as a capital proxy. Gross domestic fixed investment comprises all outlays (purchases and own account production) on additions of new and imported durable goods of the stocks of fixed assets, less the proceeds of net sales of similar secondhand and scrapped goods. Outlays by government on durable goods primarily for military purposes are excluded[2] (World Data, 1995). The labor is retrieved from the total labor force which is defined by the World Bank as being the economically active population ten years of age and older. This labor includes the armed forces and the unemployed, but

[1]An analogous approach was used in the case of capital, since on the World Bank CD ROM this is also expressed in dollar terms.

[2]Outlays on durable goods for military purposes were excluded in the case of capital while the labor variable included the armed forces. This is the way the data was compiled by the World Bank (World Data, 1995), nothing could be done.

excludes homemakers and other unpaid caregivers. Following World Data (1995), the land variable used in the analysis is defined as surface area which includes land area, major rivers and lakes.

Capital is expressed in real U.S. dollars while labor and land are total labor force and square kilometers respectively. Capital is obtained from the ratio of gross domestic fixed investment (in constant 1987 U.S. dollars) to normalized capital price. The relative capital price was obtained by dividing current gross domestic fixed investment (in current U.S. dollars) by constant gross domestic fixed investment (in constant 1987 U.S. dollars). Then, relative price for capital was normalized using the price of agriculture.

A summary of the output and input data for African, Asian, and Latin American countries is presented in Tables 4.2, 4.3, 4.4 and 4.5.

4.3 Factors Associated with Efficiency and Productivity

Economic, education, health, social, and other data are used in the Tobit and OLS models (Equations 16 and 17) to examine the relationship between the efficiency, and productivity indices and the countries' characteristics. These data categories are described below.

Countries' economic characteristics include external debt per capita (PCEXTDBT), food aid per capita (PCFDAID), gross domestic saving per capita (GDSVGPC), International Monetary Fund (IMF) intervention per capita (PCIMFUSE), inflation (INFLT), infrastructure (INFRAST), and trade balance per capita (PCTRDBLC).

Table 4.2: Data Summary for a Sample of 30 African Countries: Output and Input Variables

Variable and Measurement Unit	Mean[1] (Standard Deviation)	Minimum Value	Maximum Value
Output Variable			
Agriculture (1987 real dollars)	1,468.77 (2,173.76)	57.61	12,380.60
Industry (1987 real dollars)	1,552.03 (2,591.39)	6.76	15,011.74
Services (1987 real dollars)	2,522.14 (3,986.96)	77.85	23,645.94
Input Variable			
Capital (1987 real dollars)	1,087.09 (2,041.63)	20.54	15,977.55
Labor (numbers)	4.64 (7.27)	0.19	44.32
Land (square kilometers)	0.483 (0.516)	0.002	2.34

[1]Mean, minimum, and maximum values in Tables 4.2, 4.3, 4.4, and 4.5 are in millions.

Sources: World Data 1995: World Bank Indicators on CD-ROM, 1995

Table 4.3: Data Summary for a Sample of 11 Asian Countries: Output and Input Variables

Variable and Measurement Unit	Mean (Standard Deviation)	Minimum Value	Maximum Value
Output Variable			
Agriculture (1987 real dollars)	13,054.98 (21,745.77)	203.67	89,813.71
Industry (1987 real dollars)	15,377.74 (20,238.33)	168.23	91,282.52
Services (1987 real dollars)	21,705.46 (28,099.34)	473.57	129,772.50
Input Variable			
Capital (1987 real dollars)	11,979.95 (16,378.17)	146.69	68,943.71
Labor (numbers)	45.18 (85.76)	0.221	335.17
Land (square kilometers)	0.769 (0.949)	0.018	3.29

Sources: World Data 1995: World Bank Indicators on CD-ROM, 1995

Table 4.4: Data Summary for a Sample of 14 Latin American Countries: Output and Input Variables

Variable and Measurement Unit	Mean (Standard Deviation)	Minimum Value	Maximum Value
Output Variable			
Agriculture (1987 real dollars)	1,392.39 (1,597.08)	45.17	7,858.31
Industry (1987 real dollars)	2,382.15 (2,977.01)	52.06	12,638.89
Services (1987 real dollars)	4,318.43 (4,529.47)	88.11	23,682.80
Input Variable			
Capital (1987 real dollars)	1,454.77 (1,663.18)	28.53	6,979.41
Labor (numbers)	2.28 (2.36)	0.051	10.88
Land (square kilometers)	0.239 (0.318)	0.011	1.14

Sources: World Data 1995: World Bank Indicators on CD-ROM, 1995

Table 4.5: Data Summary for a Sample of 55 Countries (African, Latin American and Asian): Output and Input Variables

Variable and Measurement Unit	Mean (Standard Deviation)	Minimum Value	Maximum Value
Output Variable			
Agriculture (1987 real dollars)	3,766.57 (10,895.63)	45.17	89,813.71
Industry (1987 real dollars)	4,528.47 (10,808.44)	6.76	91,282.52
Services (1987 real dollars)	6,816.04 (15,056.61)	77.85	129,772.50
Input Variable			
Capital (1987 real dollars)	3,359.26 (8,652.45)	20.54	68,943.71
Labor (numbers)	12.15 (42.01)	0.051	335.17
Land (square kilometers)	0.478 (0.617)	0.002	3.29

Sources: World Data 1995: World Bank Indicators on CD-ROM, 1995

The education variable is represented by literacy (LITRCY) whereas the health variable is measured in terms of access to safe water (SAFEW). The social variable comprises the population growth rate.

Other countries' characteristics are regional differences (REGDIF), and the number of years since independence (YRINDP). Descriptive statistics of countries' characteristics are reported in Table 4.6. The rationale for inclusion of the factors associated with nations' inefficiency and productivity are reported in Tables 4.7 and 4.8.

The nations' characteristics used in this study are defined following World Data (1995). Economic variables are defined first, followed by education, health, social and other variables. Economic variables that are defined below include external debt per capita, food aid per capita, gross domestic saving per capita, IMF intervention per capita, inflation, infrastructure, and trade balance per capita.

External debt per capita (PCEXTDBT) is defined as total debt encountered by borrowing countries. It is expressed in constant 1987 U.S. dollars per capita.

Food aid per capita (PCFDAID) covers the per capita wheat and flour, coarse grains, and the cereal component of blended foods in metric tons. It is based on data for crop years reported by donor countries and international organizations, including the International Wheat Commission and the World Food Programme.

Gross domestic saving per capita (GDSVGPC) is defined as the per capita gross domestic product minus total consumption. It is expressed in terms of constant 1987 U.S. dollars per capita.

Table 4.6: Data Summary for a Sample of 55 Countries (African, Latin American and Asian): Sources of Inefficiency

Variable and Measurement Unit	Mean (Standard Deviation)	Minimum Value	Maximum Value
Economic Sources of Inefficiency			
External debt per capita: PCEXTDBT (constant 1987 U.S. dollars)	6,179.96 (22,076.22)	1.46	153,612.77
Food aid per capita: PCFDAID (metric tons)	4.39E-05 (1.13E-04)	0.00	7.53E-04
Gross domestic saving per capita: GDSVGPC (constant 1987 U.S. dollars)	2,474.73 (11,935.8)	-40.35	96,848.0
IMF intervention per capita: PCIMFUSE (constant 1987 U.S. dollars)	210.02 (945.67)	0.00	8,060.70
Inflation: INFLT (annual percentage change)	33.04 (219.55)	-53.59	4,129.17
Infrastructure: INFRAST (length of road per square kilometer)	0.19 (0.22)	0.007	1.707
Trade balance per capita: PCTRDBLC (constant 1987 U.S. dollars)	-499.47 (2421.43)	-21,577.04	2,770.097

Table 4.6: Data Summary for a Sample of 55 Countries (African, Latin American and Asian): Sources of Inefficiency (continued)

Variable and Measurement Unit	Mean (Standard Deviation)	Minimum Value	Maximum Value
Education Variable			
Literacy: LITRCY (percentage)	54.00 (24.68)	8.00	98.00
Social Sources of Inefficiency			
Population growth rate: POPGR (percentage)	2.62 (0.78)	0.21	5.27
Other Sources of Inefficiency			
Regional differences: REGDIF (dummy variables *D1* and *D2*)	-	-	-
Years of independence: YRINDP (years)	66 (53.09)	16	187

Sources: World Data 1995: World Bank Indicators on CD-ROM, 1995

Table 4.7: Efficiency and Productivity: Hypothesized Relationship Rationale

Variable	Acronym	Rationale
Economic Variables		
External debt per capita	PCEXTDBT	External debt tends to have a future negative effect on efficiency and productivity by lowering current capital that could be used for future investment. However, it is not clear whether or not external debt influences the current country's efficiency and productivity unless the concerned nation is committed to reimbursing its debt in the short run.
Food aid per capita	PCFDAID	Food aid is believed to have a negative impact on a country's economic welfare by increasing food supply and thus decreasing food price within the country unless it is distributed to people who have no purchasing power in order to consume. Consumer surplus will increase while producer surplus will decrease. This may effect both efficiency and productivity.
Gross domestic saving per capita	GDSVGP	Savings allow a country to increase its future consumption by lowering current consumption. GDSVGPC is likely expected to improve both efficiency and productivity.
IMF intervention per capita	PCIMFUSE	IMF intervention is a complex issue. It is normally suggested that over time, structural adjustment will payoff. Consequently, IMF intervention is positively associated with efficiency and productivity.

Table 4.7: Efficiency and Productivity: Hypothesized Relationship Rationale (continued)

Variable	Acronym	Rationale
Economic Variables (continued)		
Inflation	INFLT	Inflation makes savings and investment worthless due to uncontrolled increases in prices of goods and services. Inflation, therefore, negatively affects efficiency and productivity.
Infrastructure	INFRAST	Infrastructure (length of road per square kilometer) facilitates the flow of goods and services within the country. Hence, infrastructure is most likely associated with improvement in countries' efficiency and productivity.
Trade balance per capita	PCTRDBLC	Trade balance is the difference between export and import of goods and non-factor services. A positive TRDBLC means a country is exporting more than it imports. A higher TRDBLC is most likely associated with improvement in both efficiency and productivity.
Education Variable		
Literacy	LITRCY	Education is believed to free people's minds and expose them to more critical thinking, analysis and problem solving situations. An educated populace means a more productive nation. Therefore, education will most likely bring about improvement in both efficiency and productivity.

Table 4.7: Efficiency and Productivity: Hypothesized Relationship Rationale (continued)

Variable	Acronym	Rationale
Health Variable		
Access to safe water	SAFEW	Access to safe water is a measurement of health. The more people have access to safe and clean water, the healthier they are. This variable is positively associated with nations' efficiency and productivity.
Social Variables		
Population growth rate	POPGR	An increase in population annual growth is most likely to negatively affect efficiency and productivity. This may occur if the population growth is not checked by the government. However, a reasonable population growth rate may help provide needed labor which may improve country's efficiency and productivity.
Other Variables		
Regional differences	REGDIF	Regional difference is determined using dummy variables (i.e., *D1* represents Asia, and *D2* indicates Latin America). In this study, it is hypothesized (H_0) that Asian and Latin American nations are more efficient and more productive than African countries.
Years of independence	YRINDP	It is normally argued that the longer the period of independence, the more prosperous the country becomes. Hence, YRINDP is most likely expected to improve both efficiency and productivity. This assumes good and responsible leadership.

Table 4.8: Factors Associated with Inefficiency and Productivity: Hypothesized Signs

Variable	Acronym	Relationship	
		Inefficiency	Productivity
Economic Variables			
External Debt per capita	PCEXTDBT	?	?
Food aid per capita	PCFDAID	+	-
Gross domestic saving per capita	GDSVPC	-	+
IMF intervention per capita	PCIMFUSE	-	+
Inflation	INFLT	+	-
Infrastructure	INFRAST	-	+
Trade balance per capita	PCTRBLC	-	+
Education Variable			
Literacy	LITRCY	-	+
Health Variable			
Access to safe water	SAFEW	-	+
Social Variable			
Population growth rate	POPGR	+	-
Other Variables			
Regional differences (H_0: Asia and Latin America are more efficient and productive than Africa)	REGDIF (dummy variables *D1* and *D2)*	Asia and Latin America are less inefficient than Africa	Asia and Latin America are more productive than Africa
Years of independence	YRINDP	-	+

IMF intervention per capita (PCIMFUSE) is defined as the use of IMF credit or resources excluding those resulting from drawings in the reserve tranche. PCIMFUSE is measured is terms of 1987 U.S. dollars per capita.

Inflation (INFLT) is calculated as annual percentage change in the consumer price index. Consumer price index reflects changes in the cost of acquiring a fixed basket of goods and services by the average consumer.

Infrastructure(INFRAST) is measured in terms of length of roads per square kilometer.

Trade balance per capita (PCTRDBLC) is the difference between the export and import of goods and non-factor services. PCTRDBLC is expressed in per capita terms. Export of goods and non-factor services represent the value (in constant 1987 U.S. dollars per capita) of merchandise exports plus amounts receivable from non residents for the provision of non-factor services (i.e., transportation, travel, insurance and other non-factor services such as government transactions and various fees). Import of goods and non-factor services include the value (in constant 1987 U.S. dollars per capita) of merchandise imports plus amounts payable to non-residents for the provision of non-factor services to residents.

Literacy (LITRCY) was used as an education variable. It is defined as the proportion of the population 15 years of age and older who can both read and write a short simple statement on everyday life. Since the data for this variable was not continuous for every country included in our study, a cumulative method was used to interpolate missing records. An incremental value (%) was added to each subsequent literacy value for each nation that did not have all records on literacy. The incremental value was obtained by subtracting

literacy value (%) in year *t* from that of year *t+4* for example, then by dividing that value (%) by 3 in this case since 3 is the difference between 4 (which stands for year *t+4*) and 1 (which indicates year *t*).

The health variable was measured in terms of access to safe water (SAFEW). This variable shows the percentage of population by residence with a reasonable access to a safe water supply (i.e., treated surface waters or untreated but uncontaminated water such as that from springs, sanitary wells, and protected boreholes).

Population growth rate (POPGR) is the annual growth rate (percentage) calculated from mid-year population estimates. POPGR was used as a social variable.

Other characteristics include years of independence (YRINDP) and regional differences (REGDIF). YRINDP represents the number of years a country has been independent whereas REGDIF is defined as the difference in performance (i.e., efficiency and productivity) based on geographic location (Africa, Latin America, and Asia). Regional difference is determined using dummy variables (i.e., *D1* for Asia, and *D2* for Latin America). Since two other regions will be compared to Africa, two dummy variables were created to represent such a difference.

4.4 Methods

The efficiency of each country in the sample was investigated. The optimal objective functions were calculated from the solution of the corresponding LP problems (Models 2, and 3) using GAMS software. Pure technical efficiency, overall technical, and scale efficiency were measured for each country.

The Tobit and OLS models (Equations 16 and 17) were used to examine the relationship between the efficiency indexes and countries' characteristics. SHAZAM and TSP econometric computer packages were used to estimate the models. Possible factors associated with inefficiency were discussed in Section 4.3.

Finally, the productivity (efficiency, technical and productivity changes) of each country was determined using Equations (9), (10), (11), (12), and (14). The GAMS software was used to estimate the nations' productivity changes.

When using GAMS, each model was solved for each observation and for each year. The approach used in this research constructs a best practice frontier from the data in the sample. That is, a world frontier was constructed, and then individual countries were compared to that frontier. Technology in a given period was represented as an output distance function (Färe, Grosskopf, Norris, and Zhang, 1994). In our case, the frontier production function is a multi-output distance function since we have three outputs (agriculture, industry, and services). This frontier gives maximum feasible outputs given the set of inputs (land, labor and capital).

Since our sample includes 550 observations for a 1983-1992 time period (55 countries by year), efficiency measures will be estimated year by year for the world sample. The efficiency indexes obtained from this study are specific to the world sample only. Including or excluding any observations from the studied sample may affect the overall efficiency measures.

Chapter 5

Estimated Efficiency Indexes Across Nations

This chapter presents and discusses the results of pure technical, overall technical and scale efficiency. The Färe, and Grosskopf (1994) models described in Chapter 3 are used to estimate efficiency indexes. Models (2), (3), and (4) are used to estimate pure technical efficiency (PTE), overall technical efficiency (OTE) and scale efficiency (SE) respectively.

5.1 Efficiency Measures for Individual Countries and Regions

5.1.1 Results for Beginning (1983) and Ending (1992) Years

Measures of pure technical, overall technical and scale efficiency are reported for the beginning and ending years of the data set (Table 5.1). Data were grouped by year (1983-1992) for all 55 countries (the world sample) and models were estimated on a yearly basis. Values of one imply that the country is on the world frontier in that particular year, meaning that the country is technically efficient. A country is technically inefficient when efficiency indexes' values exceed unity. By the same token, a country is scale efficient if its scale efficiency index is one.

As stated earlier, these measures capture performance relative to the best practice in the sample. The best practice in this case represents the world frontier and the world is referred to the 55 countries included in the sample.

Table 5.1 reports results for the beginning (1983) and the ending period (1992), and

Table 5.1 Pure Technical (PTE), Technical (TE) and Scale Efficiency (SE) for Years 1983 and 1992: The World Sample

	Year 1983			Year 1992		
Country	PTE	TE	SE	PTE	TE	SE
Belize	1.0000	1.0371	1.0371	1.0000	1.0000	1.0000
Benin	2.9033	2.9621	1.0202	1.4996	1.5004	1.0006
Burkina Faso	1.0530	1.1506	1.0926	2.1865	2.3945	1.0951
Burundi	1.7140	1.7327	1.0109	1.1812	1.2154	1.0290
Cameroon	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Central African Republic	3.0202	3.1505	1.0431	1.2123	1.3842	1.1419
Chad	1.0000	1.0000	1.0000	1.1027	1.3048	1.1832
Chile	1.0693	1.3912	1.3010	1.0000	1.0000	1.0000
Colombia	1.0000	1.3743	1.3743	1.0000	1.3428	1.3428
Comoros	1.0000	1.3758	1.3758	1.0000	1.0000	1.0000
Congo	2.2915	2.2951	1.0016	1.6138	1.6432	1.0182
Costa Rica	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Cote d'Ivoire	1.0015	1.4664	1.4642	1.0000	1.0000	1.0000
Dominican Republic	1.0733	1.2365	1.1521	1.1795	1.3852	1.1743
Ecuador	1.0000	1.0000	1.0000	1.5957	1.6822	1.0542
Egypt, Arab Republic	1.0362	1.8371	1.7729	1.0000	1.3080	1.3080
El Salvador	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Fiji	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Gambia, The	1.0000	2.0738	2.0738	2.1837	2.1848	1.0005
Ghana	1.1598	1.6123	1.3901	1.3326	1.4430	1.0828
Guatemala	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.1 Pure Technical (PTE), Technical (TE) and Scale Efficiency (SE) for Years 1983 and 1992: The World Sample (continued)

	Year 1983			Year 1992		
Country	PTE	TE	SE	PTE	TE	SE
Honduras	1.5511	1.5511	1.6711	1.5624	1.5631	1.0004
India	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Indonesia	1.1118	1.8505	1.6644	1.0916	2.1005	1.9242
Jamaica	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Kenya	1.9709	3.2859	1.6672	1.7927	2.4796	1.3832
Madagascar	1.2181	1.2638	1.0375	1.8973	1.9713	1.0390
Malawi	4.0360	4.0831	1.0117	3.0129	3.0168	1.0013
Mali	1.8580	1.8634	1.0029	2.0639	2.4475	1.1858
Mauritania	2.8408	2.8510	1.0036	2.3206	2.3550	1.0148
Mauritius	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Morocco	1.0000	1.3422	1.3422	1.1233	1.4593	1.2991
Namibia	1.4624	1.4701	1.0052	1.7568	1.8045	1.0272
Nepal	1.5560	1.9169	1.2319	1.2816	1.5887	1.2396
Nicaragua	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Nigeria	1.6896	2.6294	1.5562	1.0000	1.3814	1.3814
Pakistan	1.1407	2.0819	1.8252	1.0000	1.3982	1.3982
Panama	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Papua New Guinea	1.6459	1.7818	1.0826	1.4879	1.4956	1.0052
Paraguay	1.5089	1.5262	1.0114	1.1859	1.2400	1.0456
Philippines, The	1.0000	1.1697	1.1697	1.0000	1.0574	1.0574
RDC (former Zaire)	1.4101	2.0959	1.4864	1.0000	1.0000	1.0000

Table 5.1 Pure Technical (PTE), Technical (TE) and Scale Efficiency (SE) for Years 1983 and 1992: The World Sample (continued)

	Year 1983			Year 1992		
Country	PTE	TE	SE	PTE	TE	SE
Rwanda	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Senegal	1.3024	1.3140	1.0089	1.1217	1.1731	1.0458
Sierra Leone	2.5348	2.8773	1.1351	2.5953	2.8172	1.0855
Sri Lanka	1.0959	1.4290	1.3040	1.0555	1.1227	1.0636
Swaziland	2.0192	2.5968	1.2861	1.2504	1.9670	1.5730
Syrian Arab Republic	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Thailand	1.0989	1.7817	1.6213	1.0000	1.6230	1.6230
Togo	1.5938	1.7264	1.0832	1.8635	1.8955	1.0172
Tunisia	1.1157	1.1790	1.0567	1.3150	1.3707	1.0424
Turkey	1.0000	1.1968	1.1968	1.0000	1.1523	1.1523
Uruguay	1.0000	1.0000	1.0000	1.0363	1.0837	1.0458
Zambia	1.4429	1.4442	1.0009	1.0000	1.0000	1.0000
Zimbabwe	2.6384	2.9072	1.1019	2.4272	2.5333	1.0437
Overall average	1.4212	1.6551	1.1833	1.3333	1.4707	1.1114

mean of our investigation. Since the study covers a 10 year period, all results are not reported in this chapter. Our attention was directed to years 1983 and 1992 in order to discuss the (efficiency) performance trend that existed across countries and continents throughout these years. An appendix of detailed results is given at the end of this dissertation.

Table 5.1 indicates that about 22 nations out of 55 countries in 1983, and 25 in 1992 were pure technically efficient whereas 15 countries out of 55 nations in 1983, and 18 in 1992 were (overall) technically efficient.

Among the 22 purely technically efficient nations (in 1983), 7 countries (23%) out of 30 nations were African, 5 (45%) out of 11 nations were Asian, and 10 (71%) out of 14 were Latin American countries (Table 5.2).

The 25 nations that were purely technically efficient in 1992 included 10 (33%) African nations, 7 (64%) Asian, and 8 (57%) Latin American nations.

Among the 15 technically efficient countries (in 1983), there were 4 (13%) African (Cameroon, Chad, Mauritius, and Rwanda), 3 (27%) Asian countries (Fiji, India, and Syria), and 8 (57%) Latin American (Costa Rica, Ecuador, El Salvador, Guatemala, Jamaica, Nicaragua, Panama, and Uruguay).

The other 18 countries that were technically efficient in 1992 included 7 (23%) African nations (Cameroon, Comoros, Cote d'Ivoire, Mauritius, RDC, Rwanda, and Zambia), 3 (27%) Asian nations (Fiji, India, and Syria), and 8 (57%) Latin American countries (Belize, Chile, Costa Rica, El Salvador, Guatemala, Jamaica, Nicaragua, and Panama).

With respect to scale efficiency, 15 nations out of 55 (13 % of African nations, 27%

Table 5.2: Efficiency Indexes for the World Sample: Regional Comparison

	1983		1992		1983-1992[1]	
Region and parameter	PTE	TE	PTE	TE	PTE	TE
Africa						
Mean	1.6771	1.9529	1.5284	1.6684	1.4683	1.6738
Std	0.7896	0.8261	0.5787	0.6126	0.4624	0.5172
Minimum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Maximum	4.0360	4.0831	3.0129	3.0168	2.7420	2.8131
%[2] of values =1	23.33	13.33	33.33	23.33	10.00	6.67
Asia						
Mean	1.1499	1.4735	1.0833	1.3217	1.0999	1.3277
Std	0.2303	0.4174	0.1589	0.3540	0.1672	0.3127
Minimum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Maximum	1.6459	2.0819	1.4879	2.1005	1.5054	1.7844
% of values =1	45.46	27.27	63.64	27.27	45.46	18.18
Latin America						
Mean	1.0859	1.1597	1.1114	1.1641	1.0832	1.1492
Std	0.1901	0.2354	0.2086	0.2380	0.1550	0.1844
Minimum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Maximum	1.5511	1.6711	1.5957	1.6822	1.5109	1.5488
% of values =1	71.43	57.14	57.14	57.14	57.14	42.86
World Sample						
Mean	1.4212	1.6551	1.3333	1.4707	1.2966	1.4710
Std	0.6587	0.7292	0.4915	0.5376	0.4023	0.4731
Minimum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Maximum	4.0360	4.0831	3.0129	3.0168	2.7420	2.8131
% of values =1	40.00	27.27	45.46	32.72	29.09	18.18

[1]PTE and TE for 1983-1992 are the mean values of the average measures of efficiency
[2]% indicates the percentage of efficient nations for each region

of Asian countries, and 57% of Latin American nations) were scale efficient in 1983 while 18 nations (23% of African nations, 27% of Asian countries, and 57% of Latin American nations) were scale efficient in 1992.

A descriptive statistics of the efficiency indexes for the world sample is presented in Table 5.2. The results of this analysis show that in 1983, the pure technical efficiency index varied from 1 to 4.0360 with an average of 1.6771 for African nations. Pure technical efficiency varied from 1 to 1.6459 with an average of 1.1499 for Asian nations in 1983 whereas pure technical efficiency varied from 1 to 1.5511 with an average of 1.0849 in the same year.

The average pure technical efficiency measures for African nations, Asian, and Latin American countries included in our sample in 1983 respectively were 1.6771, 1.1499, and 1.0859. Therefore, on average, outputs could have been increased by 68 percent, 14 percent, and 9 percent respectively if African nations, Asian and Latin American nations had been purely technically efficient in 1983.

In the same year (1983), the mean values of the overall measure of technical efficiency for African countries, Asian, and Latin American nations were 1.9529, 1.4735, and 1.1597 respectively. This indicates that on average if these countries had been operating on the frontier, their outputs could have been increased by 95 percent (for Africa), 47 percent (for Asia), and only by 16 percent (for Latin America).

In 1992, the mean values of the pure technical efficiency for African countries, Asian, and Latin American nations were 1.5284, 1.0833, and 1.1114 respectively. Thus, on average, outputs could have been increased by 53 percent, 8 percent, and 11 percent respectively if

these countries had been purely technically efficient.

The mean values of the overall measure of technical efficiency were 1.6684 (for African nations), 1.3217 (for Asian nations), and 1.1641 (for Latin American nations) in 1992. This implies that if these countries had been operating on the frontier, their outputs could have increased by 67 percent, 32 percent, and 16 percent respectively.

Results were also reported for the 1983-1992 time period (Table 5.2). The results of this analysis systematically showed that Latin American countries on average were closer to the frontier than African and Asian nations. African nations, on the average, were the most purely and technically inefficient.

The nations' efficiency was also analyzed by regions for years 1983 and 1992 (Table 5.2). The findings revealed that 23 percent, 45 percent, and 71 percent of African nations, Asian, and Latin American nations respectively were purely technically efficient in 1983 whereas 13 percent, 17 and 57 percent were technically efficient in the same year. Results also indicated that in 1992, 33 percent of African nations, 64 percent of Asian countries, and 57 percent of Latin American countries were purely technically efficient while in the same year (1992), 23 percent of African nations, 27 percent of Asian countries, and 57 percent of Latin American countries were technically efficient.

This cross continent comparison shows that in both 1983 and 1992, Latin America was generally doing better than Asia and Africa. While Latin America ranked first (in terms of PTE and TE) in 1983, Asia was second, and Africa ranked last.

This finding seems to be consistent with the discussion of Chapter 2 (Section 2.2) where the three regions (Africa, Asia, and Latin America) were compared. In fact, the 1960-

1992 socio-economic indicators (population growth, life expectancy, infant mortality, adult literacy, access to safe water, overall school enrollment, and children malnutrition) indicated that Latin America, was ahead of Africa, and Asia.

While it is known that social and economic characteristics may be the sources of inefficiency, the nature of these sources must be identified. Unfortunately, as discussed in Chapter 2 (Section 2.1.3), DEA is unable to make statistical inferences from derived results. Therefore, a further step is needed to assess the impact of nations' socio-economic characteristics on nations' efficiency and productivity. This is fully addressed in Chapter 7.

The above discussion has focused on nations' efficiency. The following report is a discussion on countries' inefficiency. Results indicated that 22 countries (40%) out of 55 nations, and 25 (45%) out of 55 were purely technically efficient in 1983 and 1992 respectively. This is an indication that 33 countries (60%) and 30 nations (55%) were purely technically inefficient in both 1983 and 1992 respectively.

In addition, results showed that 15 countries (27%) were both technically and scale efficient in 1983 and 18 (33%) were both technically, and scale efficient in 1992. In other words, there were 40 (73%) and 37 (67%) nations technically and scale inefficient in 1983 and 1992 respectively.

Malawi was the most technically inefficient country in both 1983 (4.0831) and 1992 (3.0168) respectively. This indicates that if Malawi was operating on the frontier, its output could have quadrupled in 1983, and tripled in 1992. With respect to the scale measure of efficiency, the Gambia (2.0738), and Indonesia (1.9242) were the most scale inefficient nations in 1983, and 1992 respectively. Hence, output could have almost doubled in these

two countries if they were operating at constant returns to scale.

5.1.2 Average Measures (1983-1992) of Nations' Efficiency

Tables 5.2, and 5.3 summarize average measures of pure technical, technical and scale efficiency for all 55 countries over a 10 year period (1983-1992). Based on the world sample, 16 countries (29%) out of 55 nations were purely technically efficient during the 1983-1992 time period whereas only 10 nations were technically and scale efficient.

The 16 purely technically efficient nations included 3 (10%) African nations, 5 (45%) Asian nations, and 8 (57%) Latin American nations (Table 5.2). Among the 10 technically efficient countries, 2 (7%) were African countries (Mauritius, and Rwanda), 2 (18%) were Asian countries (India, and Syrian Arab Republic), and 6 (43%) were Latin American countries (Costa Rica, El Salvador, Jamaica, Nicaragua, and Panama).

Again, at this point, factors associated with inefficiencies are unknown. Therefore, no statistical inferences can be made to determine the sources of nations' inefficiency. This is done in Chapter 7 where a parametric model provides statistical inferences.

A statistical analysis of the efficiency indexes for the 1983-1992 time period (Table 5.2) indicated that the pure technical efficiency's mean values for Africa, Asia, and Latin America were 1.4683; 1.0999; and 1.0832 respectively. This shows that on the average, if African, Asian, and Latin American countries were purely technically efficient, they could have increased their outputs by 47 percent, 10 percent, and 8 percent respectively.

The mean values for the overall measure of technical efficiency for Africa, Asia, and Latin America were respectively 1.6738; 1.3277; and 1.1492. Consequently, their outputs

could have increased by 67 percent, 33 percent, and 15 percent if they were operating on the frontier.

The cross continents comparison indicated that 10 percent, 45 percent, and 57 percent of African nations, Asian, and Latin American nations respectively were purely technically efficient over the 10 year period while 7 percent, 18, and 43 percent of African, Asian, and Latin American countries were technically efficient. From this analysis, it can be concluded that Latin America has performed in a more (pure technical, and technical) efficient manner than Asia and Africa during the 1983-1992 time period. This cross continents comparison was also consistent with the comparative study for the beginning (1983) and the ending period (1992) of our study. This also corroborates the 1980-1990 performance of the Latin American region discussed in Chapter 2 (Section 2.2). Therefore, Latin America ranked first (in terms of pure technical, and technical efficiency), Asia came second and Africa ranked last.

The nations' inefficiency was also examined in this study. As reported in Table 5.3, the most pure technically inefficient country was Malawi (with an index of 2.7420). This indicates that if Malawi was purely technically efficient, it could have more than doubled its output. Malawi was also the most technically inefficient country over the 10 year period.

Table 5.3: Pure Technical, Technical and Scale Efficiency: Average Measures (1983-1992)

Country	Pure Technical	Technical	Scale
Belize	1.0000	1.0646	1.0646
Benin	1.5115	1.5389	1.0193
Burkina Faso	1.9124	2.0696	1.0822
Burundi	1.2189	1.2674	1.0398
Cameroon	1.0208	1.1329	1.1093
Central African Republic	1.6833	1.7464	1.0412
Chad	1.1398	1.1979	1.0458
Chile	1.0069	1.1539	1.1449
Colombia	1.0000	1.3506	1.3506
Comoros	1.0000	1.0504	1.0504
Congo	1.6625	1.6914	1.0195
Costa Rica	1.0000	1.0000	1.0000
Cote d'Ivoire	1.0021	1.1354	1.1326
Dominican Republic	1.1205	1.2888	1.1503
Ecuador	1.2192	1.3254	1.0844
Egypt, Arab Republic	1.0292	1.6534	1.6092
El Salvador	1.0000	1.0000	1.0000
Fiji	1.0000	1.0088	1.0088
Gambia, The	1.5722	2.0113	1.4154
Ghana	1.0896	1.1864	1.0825
Guatemala	1.0000	1.0000	1.0000
Honduras	1.5109	1.5488	1.0246
India	1.0000	1.0000	1.0000

Table 5.3: Pure Technical, Technical and Scale Efficiency: Average Measures (continued)

Country	Pure Technical	Technical	Scale
Indonesia	1.0424	1.7844	1.7057
Jamaica	1.0000	1.0000	1.0000
Kenya	1.7037	2.7192	1.5893
Madagascar	1.4869	1.7132	1.1164
Malawi	2.7420	2.8131	1.0287
Mali	2.1243	2.3431	1.1027
Mauritania	2.4681	2.5270	1.0250
Mauritius	1.0000	1.0000	1.0000
Morocco	1.1176	1.4608	1.3047
Namibia	1.5351	1.6019	1.0448
Nepal	1.3417	1.5381	1.1473
Nicaragua	1.0000	1.0000	1.0000
Nigeria	1.1304	1.5260	1.3296
Pakistan	1.0464	1.7339	1.6498
Panama	1.0000	1.0000	1.0000
Papua New Guinea	1.5054	1.5814	1.0515
Paraguay	1.2921	1.3341	1.0352
Philippines, The	1.0000	1.0356	1.0356
RDC (former Zaire)	1.2652	1.8649	1.4361
Rwanda	1.0000	1.0000	1.0000
Senegal	1.2709	1.3783	1.0836
Sierra Leone	1.8289	2.0753	1.1442
Sri Lanka	1.0856	1.2171	1.1202

Table 5.3: Pure Technical, Technical and Scale Efficiency: Average Measures (continued)

Country	Pure Technical	Technical	Scale
Swaziland	1.3562	1.9146	1.4244
Syrian Arab Republic	1.0000	1.0000	1.0000
Thailand	1.0778	1.5529	1.4481
Togo	1.9447	2.0041	1.0320
Tunisia	1.1683	1.2644	1.0838
Turkey	1.0000	1.1529	1.1529
Uruguay	1.0151	1.0218	1.0063
Zambia	1.0697	1.0737	1.0035
Zimbabwe	1.9937	2.2524	1.1328
Overall average	1.2966	1.4710	1.1402

Results also show that Indonesia (1.7057) was the most scale inefficient country over the 1983-1992 period implying that if Indonesia was operating at constant returns to scale, it could have increased its output by 71 percent.

5.2 Efficiency Measures and Income Groupings

5.2.1 Results for Years 1983 and 1992

Countries' efficiencies were compared by different income groupings. In order to facilitate this comparison, countries were grouped into five categories as follows. Categories I, II, III, IV, and V included countries with a GNP per capita ranging from 0 to 499 U.S. dollars, 500 to 999 U.S. dollars, 1,000 to 1,499 U.S. dollars, 1,500 to 1,999 U.S. dollars, and from 2,000 to above respectively. This breakdown was chosen not only to facilitate ranking and comparison among different income groupings but also to better present and discuss the results.

Following this income grouping (Table 5.4), it was found that in 1983 only 5 (23%) countries out of 22 nations, 6 (38%) out of 16, 7 (70%) out of 10, 2 (20%) out of 5 and 2 (100%) out of 2 nations that were purely technically efficient were respectively classified in category I, II, III, IV, and V whereas only 3 (14%) countries (Chad, Rwanda, and India) that were technically efficient were found in category I, 4 (25%) nations (El Salvador, Nicaragua, Cameroon, and Costa Rica) were in category II, 4 (40%) nations (Mauritius, Guatemala, Jamaica, and Ecuador) were in category III, 2 (40%) countries (Fiji and Syria) in category IV, and 2 (100%) nations (Uruguay, and Panama) in category V.

Table 5.4: Nations' Income Grouping: Efficiency Measurement

	1983		1992		1983-1992[1]	
Income grouping	PTE (%)[2]	TE (%)	PTE (%)	TE (%)	PTE (%)	TE (%)
Category I	22.73	13.64	25.00	20.00	13.64	9.09
Category II	37.50	25.00	41.67	25.00	14.29	7.14
Category III	70.00	40.00	45.45	36.36	44.44	33.33
Category IV	40.00	40.00	33.33	0.00	71.43	28.57
Category V	100.00	100.00	88.89	77.78	66.67	66.67

[1]the 1983-1992 values are the average values (over the 10 year period) of the efficient nations
[2]% indicates the percentage of efficient nations for each income category

In 1992, the income grouping indicated that 5 (25%) countries, 5 (42%), 5 (46%), 1 (33%), and 8 (89%) nations that were purely technically efficient were found in category I, II, III, IV, and V respectively. In the same year, only 4 (20%) technically efficient nations (India, RDC, Rwanda, and Zambia) were classified in income category I, 3 (25%) nations (Cameroon, Comoros, and Cote d'Ivoire) were in category II, 4 (36%) countries (El Salvador, Jamaica, Guatemala, and Syria) were in category III, no country was found in category IV, and 7 (78%) nations (Belize, Chile, Costa Rica, Fiji, Mauritius, Nicaragua, and Panama) were in category V.

From this analysis, it can be concluded that income grouping is linked to nations' efficiency. In fact, results showed that category V (income ranging from 2,000 U.S. dollars to above) had the highest percentage of efficient nations in both 1983 and 1992.

In addition, Pearson correlation coefficient analysis between incomes and nations' efficiency (Table 5.5) showed that pure technical, technical efficiency, and incomes were negatively correlated. As shown in Table 5.5, all observed correlation coefficients were greater than the table correlation coefficient (0.273) at 5% level of significance (Snedecor, and Cochran, 1967). Consequently, the null hypothesis was rejected. Therefore, all observed correlation coefficients (in 1983, and 1992) were statistically significant.

Positive values of two correlation coefficients indicate a tendency of their corresponding variables to increase together whereas negative values indicate that large values of one variable are associated with small values of the other variable (Snedecor, and Cochran, 1967). Since the values of pure technical, and technical efficiency indices were positively correlated with income, large values of income were associated with higher levels of pure technical, and technical efficiency. This is consistent with the previous finding that income grouping was linked to nations' efficiency.

5.2.2 The 1983-1992 Time Period Results

A further cross nation comparison was made using different income groupings for the 1983-1992 time period. It was determined that 3 (14%) nations, 2 (14%), 4 (44%), 5 (71%)

Table 5.5: Correlation Coefficients between Nations' Incomes and Efficiency

	1983		1992		1983-1992	
Income	PTE	TE	PTE	TE	PTE	TE
GNP per capita	0.318 (0.018)[1]	0.401 (0.002)	0.389 (0.003)	0.423 (0.001)	0.449 (0.001)	0.519 (0.000)

[1]values in parentheses indicate the probability level

and 2 (67%) nations that were purely technically efficient were associated with category I, II, II, IV, and V respectively (Table 5.4).

Results also revealed that only 2 (9%) countries (India and Rwanda) were technically efficient and these nations were a part of category I with income ranging from 0 to 500 U.S. dollars. In category II (income ranging from 500 to 1000 U.S. dollars), only 1 (7%) country (El Salvador) was found technically efficient. Among countries of category III, 3 (33%) nations (Guatemala, Jamaica, and Syria) were efficient whereas only 2 (29%) nations (Costa Rica and Mauritius) of category IV were efficient. Finally, 2 (67%) countries (Nicaragua, and Panama) of category (income ranging from 2000 U.S. dollars to above) were technically efficient (Table 5.4).

It can be seen that category IV (income group ranging from 1,500 to 1,999 U.S. dollars) had the highest percentage of purely technically efficient nations during the 1983-1992 time period whereas category V (income group ranging from 2,000 U.S. dollars to above) had the highest percentage of technically efficient nations during the same period. This finding corroborates the previous one where category V in years 1983 and 1992 had

the highest percentage of efficient nations. However, this was not the case for pure technical efficiency in the 1983-1992 period (where category IV had the highest percentage of efficient nations).

Correlation coefficient analysis revealed that Pearson correlation coefficients between countries' efficiency (i.e., pure technical, and technical efficiency) and incomes were all positive and statistically significant for the 1983-92 time period (Table 5.5). This is consistent with previous results of the correlation coefficient analysis (1983, and 1992). Therefore, higher values of income were associated with higher levels of nations' efficiency.

5.2.3 Concluding Remarks

It can be concluded that income grouping is linked to nations' efficiency. In fact, results showed that category V (income ranging from 2,000 U.S. dollars to above) had the highest percentage of purely technically and technically efficient nations in both 1983 and 1992.

This finding was also consistent with efficiency measurement and income groupings for the 1983-92 time period where income category V had the highest percentage of technically efficient nations during the same years. However, this was not consistent with the results for pure technical efficiency in the 1983-1992 period where category IV (income ranging from 1,500 to 1,999 U.S. dollars) had the highest percentage of purely technically efficient nations.

Correlation coefficient analysis, on the other hand, revealed that pure technical, and technical efficiency and incomes were positively correlated in 1983, 1992, and during the

1983-92 time period. This indicates that large values of income were associated with higher levels of pure technical,and overall technical efficiency. This corroborates the finding that income grouping was linked to nations' efficiency (pure technical, and technical efficiency).

Chapter 6

Productivity Measurement Across Nations

This chapter reports productivity measures for 55 countries over a 10 year period (1983-1992). The models (9, 10, 11, 13, and 14) used to evaluate productivity were discussed in Chapter 3.

Since productivity consists of efficiency gains and technical improvement within a technology set (i.e., because of the estimation procedure used), efficiency gains and technical change were estimated separately. Malmquist productivity indexes as well as efficiency and technical changes for each country are reported and discussed in this chapter. Since these indexes are based on specific time periods, each country will have an index for each pair of years.

Efficiency change, technical change and Malmquist productivity indexes for years 1983/84 and 1991/92 are presented in Tables 6.1, and 6.2 respectively. For similar reasons discussed in Chapter 5, beginning (1983) and ending (1992) period's results are reported and discussed below. Detailed results are reported in an appendix at the end of the dissertation for interested readers. In the meantime, the following section discusses a 9 year trend of different nations.

The Malmquist productivity index or the total factor productivity index is the product of efficiency and technical changes. A country's productivity index is expected to be unity or

greater than one. Any value less than unity implies deterioration in performance. Values greater than one denote improvements in performance. Again, these efficiency measures capture performance relative to the best practice in the world sample.

6.1 Productivity Measures for Individual Nations and Regions

6.1.1 Beginning and Ending Years' Results

Table 6.1 reports Malmquist productivity indexes for years 1983/84. These indices include efficiency change (EFCHG), technical change (TECHG), Malmquist productivity (MLMQST), and productivity growth rate (PRODGR). MLMQST is the product of EFCHG and TECHG whereas PRODGR is obtained by subtracting MLMQST from one.

Results presented in Table 6.1 show that Belize had the highest efficiency rate of 17.50 percent in 1983/1984. This indicates that Belize showed improvements in efficiency compared to other nations and therefore was catching up relative to other nations in the sample during that period of time. In the same year, Chad had the highest technical improvement rate of 75 percent followed by RDC (66 percent). This suggests that both Chad and RDC had acquired more innovation than any other countries in the sample during the 1983/84 period of time.

The highest Malmquist productivity index for years 1983/84 was recorded in Cameroon (1.5228). This shows that productivity growth in Cameroon was 52 percent in 1983/1984 and most of it was due to technical change.

Countries that had the lowest indexes in 1983/84 include RDC (with an efficiency change index of 0.6484), Chile (with a technical change index of 0.8185), and Ghana (with

Table 6.1: Productivity Indexes for Years 1983/1984

Country	EFCHG 1983/1984	TECHG 1983/1984	MLMQST 1983/1984	PRODGR 1983/1984
Belize	1.1750	0.9564	1.1237	0.1237
Benin	0.6583	1.0539	0.6938	-0.3062
Burkina Faso	0.9903	1.2629	1.2506	0.2506
Burundi	0.8198	1.2870	1.0551	0.0551
Cameroon	1.0000	1.5228	1.5228	0.5228
Central African Republic	0.8129	1.2489	1.0152	0.0152
Chad	1.0000	1.7458	1.7458	0.7458
Chile	1.0509	0.8185	0.8601	-0.1399
Colombia	1.0831	0.9499	1.0288	0.0288
Comoros	0.8012	1.1342	0.9087	-0.0913
Congo	0.8945	1.0188	0.9113	-0.0887
Costa Rica	1.0000	1.0301	1.0301	0.0301
Cote d'Ivoire	0.8744	1.0559	0.9233	-0.0767
Dominican Republic	1.0210	1.0185	1.0398	0.0398
Ecuador	1.1075	0.9312	1.0313	0.0313
Egypt, Arab Republic	0.9464	1.0160	0.9616	-0.0384
El Salvador	1.0000	1.0534	1.0534	0.0534
Fiji	1.0000	0.9357	0.9357	-0.0643
Gambia, The	0.9022	1.1018	0.9940	-0.0060
Ghana	0.6202	1.0700	0.6636	-0.3364
Guatemala	1.0000	0.9592	0.9592	-0.0408
Honduras	0.9892	1.0469	1.0356	0.0356
India	1.0000	1.1068	1.1068	0.1068

Table 6.1: Productivity Indexes for Years 1983/1984 (continued)

Country	EFCHG 1983/1984	TECHG 1983/1984	MLMQST 1983/1984	PRODGR 1983/1984
Indonesia	0.8264	1.0263	0.8481	-0.1519
Jamaica	1.0000	1.2322	1.2322	0.2322
Kenya	0.9763	1.0858	1.0601	0.0601
Madagascar	0.7913	1.2817	1.0141	0.0141
Malawi	0.8073	1.1309	0.9130	-0.0870
Mali	1.1168	1.0147	1.1332	0.1332
Mauritania	0.8949	1.0417	0.9322	-0.0678
Mauritius	1.0000	0.9812	0.9812	-0.0188
Morocco	1.0570	0.9657	1.0207	0.0207
Namibia	1.0046	0.8846	0.8886	-0.1114
Nepal	0.7903	1.1594	0.9162	-0.0838
Nicaragua	1.0000	1.1258	1.1258	0.1258
Nigeria	0.7991	1.0320	0.8246	-0.1754
Pakistan	0.9872	1.0280	1.0148	0.0148
Panama	1.0000	1.0878	1.0878	0.0878
Papua New Guinea	0.9433	0.9924	0.9361	-0.0639
Paraguay	0.9415	1.0074	0.9484	-0.0516
Philippines, The	0.9102	1.0321	0.9395	-0.0605
RDC (former Zaire)	0.6484	1.6594	1.0760	0.0760
Rwanda	1.0000	1.3571	1.3571	0.3571
Senegal	1.0210	1.0112	1.0325	0.0325
Sierra Leone	0.7958	1.3112	1.0435	0.0435
Sri Lanka	0.9129	1.1551	1.0545	0.0545

Table 6.1: Productivity Indexes for Years 1983/1984 (continued)

Country	EFCHG	TECHG	MLMQST	PRODGR
Swaziland	0.8771	1.0510	0.9218	-0.0782
Syrian Arab Republic	1.0000	1.1119	1.1119	0.1119
Thailand	0.9796	1.0314	1.0103	0.0103
Togo	1.1456	1.0530	1.2063	0.2063
Tunisia	0.9857	0.9564	0.9427	-0.0573
Turkey	0.9684	0.9753	0.9445	-0.0555
Uruguay	1.0000	0.8582	0.8582	-0.1418
Zambia	0.7500	1.3076	0.9807	-0.0193
Zimbabwe	0.7383	1.2055	0.8900	-0.1100
Overall average	0.9348	1.0996	1.0200	0.0200

a Malmquist productivity index of 0.6636).This implies that RDC, Chile, and Ghana experienced deterioration (in 1983/84) in efficiency performance, technical improvement, and productivity growth respectively compared to other nations included in the sample.

Productivity indexes (i.e., EFCHG, TECHG, MLMQST, and PRODGR) for year 1991/92 are summarized in Table 6.2. As shown in Table 6.2, Sierra Leone had the highest efficiency change index in 1991/92. This implies that Sierra Leone experienced efficiency gains in 1991/92 and was therefore catching up relative to other countries in the sample. India achieved a technical improvement rate of 47 percent in 1991/92 making it the top of all other nations in the sample. Sierra Leone also had the highest productivity growth rate mostly due to improvements in efficiency.

Some countries also experienced deterioration in their performance in 1991/92. For instance, RDC had a negative performance in both efficiency (-62 percent) and productivity growth rate (-60 percent) in 1991/92 whereas Chile performed poorly in technical change (-15 percent) during the same period.

A descriptive statistics summary of the nations' productivity for the world sample (by regions) is reported in Table 6.3. This analysis shows that the mean values of the efficiency change for African nations, Asian, and Latin American nations in 1983/84 were 0.8910, 0.9380, and 1.0263 respectively.

The technical change's mean values for African nations, Asian, and Latin American nations in 1983/84 were 1.1616, 1.0504, and 1.0054 respectively whereas the production

Table 6.2: Productivity Indexes for Years 1991/1992

Country	EFCHG	TECHG	MLMQS	PRODGR
Belize	1.0000	0.8982	0.8982	-0.1018
Benin	1.0682	1.0795	1.1531	0.1531
Burkina Faso	0.9055	1.0524	0.9530	-0.0470
Burundi	0.8485	1.1348	0.9629	-0.0371
Cameroon	0.8202	1.0696	0.8774	-0.1226
Central African Republic	0.8766	1.0775	0.9446	-0.0554
Chad	0.9742	1.0124	0.9862	-0.0138
Chile	1.0000	0.8536	0.8536	-0.1464
Colombia	0.9797	1.0560	1.0345	0.0345
Comoros	1.0000	1.1438	1.1438	0.1438
Congo	0.9791	0.9384	0.9188	-0.0812
Costa Rica	1.0000	0.9929	0.9929	-0.0071
Cote d'Ivoire	0.9339	1.0615	0.9913	-0.0087
Dominican Republic	1.1147	1.0162	1.1328	0.1328
Ecuador	1.0242	1.0127	1.0372	0.0372
Egypt, Arab Republic	0.7329	1.2976	0.9510	-0.0490
El Salvador	1.0000	1.0983	1.0983	0.0983
Fiji	1.0000	0.9959	0.9959	-0.0041
Gambia, The	0.9673	1.1301	1.0931	0.0931
Ghana	1.0117	1.1655	1.1791	0.1791
Guatemala	1.0000	1.0365	1.0365	0.0365
Honduras	0.9797	1.1867	1.1625	0.1625
India	1.0000	1.4699	1.4690	0.4690

Table 6.2: Productivity Indexes for Years 1991/1992 (continued)

Country	EFCHG 1991/1992	TECHG 1991/1992	MLMQST 1991/1992	PRODGR 1991/1992
Indonesia	0.9267	1.0341	0.9583	-0.0417
Jamaica	1.0000	1.0340	1.0340	0.0340
Kenya	0.8841	1.1458	1.0130	0.0130
Madagascar	1.0889	1.0573	1.1512	0.1512
Malawi	0.8904	1.1168	0.9945	-0.0055
Mali	0.8787	1.0373	0.9115	-0.0885
Mauritania	0.9562	1.0719	1.0249	0.0249
Mauritius	1.0000	0.9825	0.9825	-0.0175
Morocco	0.8862	1.0710	0.9491	-0.0509
Namibia	1.0833	1.1065	1.1987	0.1987
Nepal	0.9026	1.1671	1.0534	0.0534
Nicaragua	1.0000	1.1690	1.1690	0.1690
Nigeria	0.8292	1.1752	0.9745	-0.0255
Pakistan	0.7937	1.2261	0.9731	-0.0269
Panama	1.0000	1.0911	1.0911	0.0911
Papua New Guinea	0.8922	1.0580	0.9440	-0.0560
Paraguay	1.0205	0.9897	1.0099	0.0099
Philippines, The	0.9935	1.0213	1.0147	0.0147
RDC (former Zaire)	0.3843	1.0446	0.4015	-0.5985
Rwanda	1.0000	0.9958	0.9958	-0.0042
Senegal	0.8021	1.2129	0.9729	-0.0261
Sierra Leone	2.2350	1.1581	2.5885	1.5885
Sri Lanka	1.0083	1.0077	1.0161	0.0161

Table 6.2: Productivity Indexes for Years 1991/1992 (continued)

Country	EFCHG 1991/1992	TECHG 1991/1992	MLMQST 1991/1992	PRODGR 1991/1992
Swaziland	0.8216	1.1999	0.9858	-0.0142
Syrian Arab Republic	1.0000	1.0869	1.0869	0.0869
Thailand	0.9529	1.0108	0.9632	-0.0368
Togo	0.8312	1.1774	0.9786	-0.0214
Tunisia	0.9654	0.9963	0.9619	-0.0381
Turkey	0.9796	0.9717	0.9519	-0.0481
Uruguay	0.9552	0.9897	0.9454	-0.0546
Zambia	1.0000	1.0456	1.0456	0.0456
Zimbabwe	0.8734	1.2211	1.0666	0.0666
Overall average	0.9646	1.0810	1.0414	0.0414

Table 6.3: Productivity Indexes for the World Sample: Regional Comparison

	1983/84		1991/92		1983-1992[1]	
Region and parameter	EFCHG	TECHG	EFCHG	TECHG	EFCHG	TECHG
Africa						
Mean	0.8910	1.1616	0.9509	1.0993	1.0081	1.0143
Std	0.1357	0.2055	0.2761	0.0810	0.0462	0.0308
Minimum	0.6202	0.8846	0.3843	0.9384	0.9541	0.9318
Maximum	1.1456	1.7459	2.2351	1.2976	1.1372	1.1019
%[2] of values ≥1	30.00	83.33	30.00	83.33	53.33	73.33
Asia						
Mean	0.9380	1.0504	0.9500	1.0954	0.9928	1.0006
Std	0.0723	0.0733	0.0665	0.1460	0.0147	0.0250
Minimum	0.7903	0.9357	0.7937	0.9717	0.9635	0.9589
Maximum	1.0000	1.1594	1.0083	1.4699	1.0197	1.0409
% of values ≥1	18.18	54.55	36.36	81.82	54.55	63.64
Latin America						
Mean	1.0263	1.0054	1.0053	1.0303	1.0043	1.0085
Std	0.0595	0.1064	0.0357	0.0906	0.0226	0.0288
Minimum	0.9415	0.8185	0.9552	0.8536	0.9773	0.9604
Maximum	1.1750	1.2322	1.1147	1.1867	1.0750	1.0588
% of values ≥1	85.71	71.43	78.57	64.29	57.14	57.14
World Sample						
Mean	0.9348	1.0996	0.9646	1.0810	1.0041	1.0099
Std	0.1222	0.1770	0.2065	0.1017	0.0367	0.0292
Minimum	0.6202	0.8185	0.3843	0.8536	0.9541	0.9318
Maximum	1.1750	1.7459	2.2351	1.4699	1.1372	1.1019
% of values ≥1	41.82	74.55	43.64	78.18	54.55	67.27

[1]EFCHG and TECHG for 1983-1992 are the mean values of the average measures of productivity
[2]% indicates the percentage of nations (for each region) that have experienced efficiency gains and technical improvements

Table 6.3: Productivity Indexes for the World Sample: Regional Comparison (continued)

	1983/84	1991/92	1983-1992[1]
Region and parameter	PRODGR	PRODGR	PRODGR
Africa			
Mean	1.0288	1.0450	1.0226
Std	0.2181	0.3227	0.0633
Minimum	0.6636	0.4015	0.9228
Maximum	1.7459	2.5885	1.1795
%[2] of values ≥1	46.67	36.67	60.00
Asia			
Mean	0.9835	1.0389	0.9932
Std	0.0832	0.1498	0.0210
Minimum	0.8481	0.9440	0.9589
Maximum	1.1119	1.4699	1.0409
% of values ≥1	54.55	45.45	27.27
Latin America			
Mean	1.0296	1.0354	1.0127
Std	0.1011	0.0932	0.0315
Minimum	0.8582	0.8536	0.9386
Maximum	1.2322	1.1690	1.0588
% of values ≥1	71.43	71.43	64.29
World Sample			
Mean	1.0200	1.0414	1.0142
Std	0.1721	0.2494	0.0510
Minimum	0.6636	0.4015	0.9228
Maximum	1.7459	2.5885	1.1795
% of values ≥1	54.55	47.27	54.55

[1]EFCHG and TECHG for 1983-1992 are the mean values of the average measures of productivity
[2]% indicates the percentage of nations with a positive productivity growth rate for each region

growth rates for the same nations were respectively 1.0288, 0.9835, and 1.0296 (Table 6.3).

In 1991/92, the mean values of the efficiency change indexes for Africa, Asia, and Latin America were 0.9509, 0.9500, and 1.0053 respectively. The technical change's mean values in 1991/92 were 1.0993, 1.0954, and 1.0303 whereas the productivity growth rates' mean values were 1.0450, 1.0389, and 1.0354.

The nations' productivity was also analyzed by regions for years 1983/84 and 1991/92. Results of the analysis are presented in this section (Table 6.3). The 1983/84 productivity results revealed that 9 African countries (30%) compared to 2 Asian (18%) and 12 Latin American countries (86%) had an efficiency change index greater or equal to one. Hence, Latin America was ahead of Africa and Asia. This implies that in 1983/84, most Latin American countries experienced improvements in efficiency compared to other African and Asian nations. Latin America was therefore catching up in efficiency in 1983/84 relative to

Africa and Asia. A descriptive statistics of the nations' productivity by regions for years 1983/84, 1991/92 and the 1983-1992 time period was summarized in Table 6.3.

In terms of technical change, 25 African nations (83%) had a technical change index greater or equal to one during the 1983/84 period compared to 6 Asian (55%) and 10 Central/South American countries (71%). Africa was thus ahead of Asia and Latin America. When comparing the three regions in terms of productivity growth, it was found that most Latin American nations (71%), and around half of the countries in the other nations had a positive production growth rate.

This comparative study was extended to the 1991/92 productivity results and the

finding was consistent with that of 1983/84. Latin America ranked first in both efficiency gains (79%) and productivity growth (71%) while Africa was first in terms of technical improvements (83%).

This is an indication that Africa was catching up in terms of technical improvements in both 1983/84 and 1991/92 whereas Latin America showed more gains in efficiency and productivity growth than Africa and Asia. This suggests that African nations have to improve their efficiency in order to increase their productivity since productivity is the product of efficiency and technical changes. Asian nations also may have to improve both technical and efficiency changes. Adopting new technologies may help increase technical gains whereas additional education and training, right size of the operation, and better decision making processes may help improve a nation's efficiency.

6.1.2 Average Measures of Nations' Productivity

Finally, a summary description of the average performance of each country over the entire 1983-1992 time period is reported in Table 6.4. Results indicated that 31 countries experienced gains in efficiency. Sierra Leone had the highest gain in efficiency rate of 14 percent per year in the sample over the 10 year period. Benin had the lowest efficiency change index (0.9541) in the sample. Benin has, therefore regressed in efficiency whereas Sierra Leone has been catching up over the 1983-1992 time period. Table 6.4 also reveals that 37 nations have technically improved over the 10 year period. The highest technical improvement over the 10 year period was recorded in Chad (1.1019) whereas the lowest

Table 6.4: Productivity Across Nations: Average Annual Changes (1983-1992)

Country	EFCHG	TECHG	MLMQST	PRODGR
Belize	1.0003	0.9837	0.9840	-0.0160
Benin	0.9541	0.9923	0.9468	-0.0532
Burkina Faso	1.1058	1.0210	1.1291	0.1291
Burundi	0.9696	1.0081	0.9775	-0.0225
Cameroon	1.0102	1.0207	1.0311	0.0311
Central African Republic	0.9569	1.0249	0.9807	-0.0193
Chad	1.0547	1.1019	1.1622	0.1622
Chile	0.9773	0.9604	0.9386	-0.0614
Colombia	0.9992	0.9844	0.9837	-0.0163
Comoros	0.9677	0.9920	0.9599	-0.0401
Congo	0.9903	0.9318	0.9228	-0.0772
Costa Rica	1.0000	0.9993	0.9993	-0.0007
Cote d'Ivoire	0.9619	1.0081	0.9696	-0.0304
Dominican Republic	1.0186	1.0207	1.0397	0.0397
Ecuador	1.0750	0.9694	1.0421	0.0421
Egypt, Arab Republic	0.9698	1.0259	0.9950	-0.0050
El Salvador	1.0000	1.0588	1.0588	0.0588
Fiji	1.0008	0.9924	0.9932	-0.0068
Gambia, The	1.0270	1.0275	1.0552	0.0552
Ghana	1.0012	1.0210	1.0223	0.0223
Guatemala	1.0000	1.0283	1.0283	0.0283
Honduras	0.9979	1.0322	1.0300	0.0300
India	1.0000	1.0409	1.0409	0.0409

Table 6.4: Productivity Across Nations: Average Annual Changes (continued)

Country	EFCHG	TECHG	MLMQST	PRODGR
Indonesia	1.0197	0.9696	0.9887	-0.0113
Jamaica	1.0000	1.0207	1.0207	0.0207
Kenya	0.9857	1.0463	1.0314	0.0314
Madagascar	1.1088	1.0197	1.1306	0.1306
Malawi	1.0125	0.9957	1.0082	0.0082
Mali	1.0625	1.0292	1.0935	0.0935
Mauritania	0.9850	1.0298	1.0144	0.0144
Mauritius	1.0000	1.0016	1.0016	0.0016
Morocco	1.0166	0.9763	0.9925	-0.0075
Namibia	1.0264	0.9958	1.0220	0.0220
Nepal	0.9875	1.0191	1.0064	0.0064
Nicaragua	1.0000	1.0320	1.0320	0.0320
Nigeria	0.9542	1.0105	0.9642	0.0358
Pakistan	0.9635	1.0146	0.9776	-0.0224
Panama	1.0000	1.0287	1.0287	0.0287
Papua New Guinea	0.9855	1.0222	1.0074	0.0074
Paraguay	0.9822	1.0193	1.0012	0.0012
Philippines, The	0.9897	1.0030	0.9926	-0.0074
RDC (former Zaire)	0.9930	1.0473	1.0400	0.0400
Rwanda	1.0000	1.0006	1.0006	0.0006
Senegal	1.0067	1.0566	1.0637	0.0637
Sierra Leone	1.1372	1.0372	1.1795	0.1795
Sri Lanka	0.9775	1.0118	0.9891	-0.0109

Table 6.4: Productivity Across Nations: Average Annual Changes (continued)

Country	EFCHG	TECHG	MLMQST	PRODGR
Swaziland	0.9851	0.9755	0.9610	-0.0390
Syrian Arab Republic	1.0000	0.9589	0.9589	-0.0411
Thailand	0.9939	1.0011	0.9950	-0.0050
Togo	1.0163	1.0250	1.0417	0.0417
Tunisia	1.0202	0.9678	0.9873	-0.0127
Turkey	1.0024	0.9734	0.9757	-0.0243
Uruguay	1.0100	0.9808	0.9905	-0.0095
Zambia	0.9659	1.0034	0.9692	-0.0308
Zimbabwe	0.9965	1.0274	1.0238	0.0238
Overall Average	1.0041	1.0099	1.0140	0.0140

record was found in the Congo (0.9318). This makes Chad the top country with a positive technical change rate of 10 percent per year over the 1983-1992 period.

On average, productivity increased slightly over the 1983-1992 period. In fact, as shown in Table 6.4, the overall average change in the Malmquist productivity index was about 1.4 percent per year for the world sample as a whole. The 1.4 percent growth were due to both innovation (TECHG), which accounted for about 1 percent and improvements in efficiency (EFCHG) for about 0.4 percent.

The results also indicated that Sierra Leone had the highest total factor productivity change in the world sample at almost 18 percent per year on average. Almost 14 percent of it is due to improvements in efficiency and 4 percent is due to innovation. Congo had the lowest productivity change in the sample (0.9228). Finally, 24 countries out of the 55 had their total factor productivity change higher than the sample average.

The nations' productivity was finally analyzed by regions for the 1983-92 time period. The results of this analysis (Table 6.3) showed that 16 (53%) African nations (over 30 nations) had at least an efficiency change index of unity against 6 (55%) Asian (over 11 nations) and 8 (57%) Latin American countries (over 14 nations) making Latin America the top region with a high percentage of countries that had a positive efficiency change index over the 10 year period.

In terms of technical improvement, Africa came first with 22 (73%) nations against 7 (64%) Asian and 8 (57%) Latin American nations. Latin America was first in terms of productivity growth rate with 9 (64%) nations against 18 (60%) African and 3 (27%) Asian

nations (Table 6.3).

Again, this finding is consistent with the 1983/84 and 1991/92 results. In fact, results indicated that Africa acquired more technical improvements than any other regions in the world sample during the 1983-92 time period as well as in years 1983/84 and 1991/92.

In addition, the Latin American region experienced more gains in efficiency and productivity growth than African and Asian regions. The nations' productivity by regions (in percentage) for years 1983/84, 1991/92 and average annual rate of change for 1983-1992 were summarized in Table 6.3. Analysis of the determinants of these is provided in Chapter 7.

Nevertheless, there is reason to believe that improved socio-economic conditions in Latin America (as discussed in Chapter 2) may have influenced such an outcome.

6.2 Productivity Measures and Income Groupings

6.2.1 Results for Years 1983 and 1992

Countries were compared based on income groupings. During 1983/84, 6 nations (27%) out of 22, 5 (31%) out of 16, 7 (70%) out of 10, 4 (80%) out of 5, and 2 nations (100%) out of 2 that experienced efficiency gains were associated with income categories I, II, III, IV, and V respectively (Table 6.5). This analysis shows that category V (nations with income ranging from 2,000 U.S. dollars to above) had the highest percentage (100%) of nations with positive efficiency gains in 1983/84.

Table 6.5 indicates that in 1991/92, income category V had the highest percentage of

Table 6.5: Nations' Income Groupings: Efficiency Change (EFCHG) and Technical Change (TECHG)

	1983		1992		1983-1992	
Income grouping	EFCHG (%)[1]	TECHG (%)	EFCHG (%)	TECHG (%)	EFCHG (%)	TECHG (%)
Category I	27.27	100.00	35.00	95.00	50.00	86.36
Category II	31.25	87.50	23.08	100.00	42.86	78.57
Category III	70.00	30.00	55.56	77.78	55.56	44.44
Category IV	80.00	40.00	66.67	50.00	85.71	14.29
Category V	100.00	50.00	71.43	28.57	100.00	66.67

[1]% indicates the percentage of nations with positive efficiency gains and technical improvements for each income category

nations (71%) with positive efficiency changes. This is consistent with the results of the nations' efficiency and income groupings (discussed in Chapter 5) for both 1983 and 1992.

With respect to technical change, income category I had the highest percentage of nations (100%) that experienced technical improvements in 1983/84 whereas category II had the highest percentage of nations (100%) that had positive technical improvements in 1991/92.

Table 6.6 reports the nations' income groupings for productivity growth. In 1983, 13 (68%) nations (Burkina Faso, Burundi, Central African Republic, India, Kenya, Madagascar,

Table 6.6: Nations' Income Groupings: Productivity Growth Rate

	1983	1992	1983-1992
Income grouping	PRODGR (%)[1]	PRODGR (%)	PRODGR (%)
Category I	68.18	45.00	68.18
Category II	43.75	53.85	50.00
Category III	50.00	66.67	44.44
Category IV	20.00	33.33	28.57
Category V	50.00	28.57	66.67

[1]% indicates the percentage of nations with a positive productivity growth rate for each income category

Pakistan, Rwanda, Senegal, Sierra Leone, Sri Lanka, Togo and RDC); 7 (44%) nations (Cameroon, Costa Rica, El Salvador, Honduras, Morocco, Nicaragua, and Thailand), 5 (50%) nations (Belize, Colombia, Dominican Republic, Ecuador, and Jamaica), 1 (20%) country (Syria) and 1 (50%) country (Panama) were found in categories I, II, III, IV, and V respectively. All these countries experienced productivity gains in 1983/84.

In 1991/92, several countries also achieved positive productivity growth rate. They were also grouped into income categories as follows (Table 6.6). About 9 (45%) nations

(Benin, India, the Gambia, Ghana, Kenya, Madagascar, Nepal, Sierra Leone, and Zambia) were identified with income category I, 7 (54%) nations (Comoros, Guatemala, Honduras, Mauritania, Sri Lanka, The Philippines, and Zimbabwe) with category II, 6 (67%) countries (Colombia, Dominican Republic, Ecuador, El Salvador, Paraguay and Syria) with category III, only 2 (33%) nations (Jamaica, and Namibia) with category IV and 2 (29%) countries (Nicaragua and Panama) with category V.

Therefore, income category I had the highest percentage of nations that experienced a positive productivity growth in 1983/84 while income category III had the highest percentage of nations with a positive productivity growth rate in 1991/92.

Correlation coefficient analysis (Tables 6.7 and 6.8) between income and nations' productivity indices revealed that efficiency change and income were positively correlated and statistically significant in 1983/84 whereas the 1991/92 results were not statistically significant (i.e., table correlation coefficient (0.273) was greater than the observed correlation coefficient (0.051)). Hence, higher incomes were associated with bigger efficiency change indices. The 1983/84 result is consistent with the previous finding that income category V had the highest percentage of nations with positive efficiency gains.

Technical change and incomes were negatively correlated and statistically significant in both 1983/84, and 1991/92. This indicates that small incomes were associated with big values of technical change. This corroborates previous findings that income category I, and II had the the highest percentage of nations with positive technical improvements in 1983/84, and 1991/92 respectively.

With respect to productivity growth rate, correlation coefficient analysis indicated

that

Table 6.7: Correlation Coefficients: Efficiency and Technical Change, and Income

	1983/84		1991/92		1983-1992	
Income	EFCHG	TECHG	EFCHG	TECHG	EFCHG	TECHG
GNP per capita	0.385 (0.004)[1]	-0.498 (0.000)	0.051 (0.714)	-0.431 (0.001)	-0.104 (0.450)	-0.407 (0.002)

[1]values in parentheses indicate the probability level

incomes and productivity growth rate were not correlated for years 1983/84, and 1991/92. In fact, correlation coefficient results for 1983/84 and 1991/92 were not statistically significant (i.e., 0.273 greater than 0.184 and 0.130).

Table 6.8: Correlation Coefficients: Productivity Growth Rate and Income

	1983/84	1991/92	1983-1992
Income	PRODGR	PRODGR	PRODGR
GNP per capita	-0.184 (0.179)[2]	-0.130 (0.344)	-0.314 (0.020)

[2]values in parentheses indicate the probability level

6.2.2 The 1983-92 Time Period Results

The income grouping analysis revealed that during the 1983-92 period, 11 (50%) nations out 22; 6 (43%) out 14; 5 (56%) out of 9; 6 (86%) out of 7; and 3 (100%) out of 3 that had positive efficiency changes were associated with income categories I, II, III, IV, and V respectively (Table 6.5). This indicates that income category V had the highest percentage of nations with positive efficiency gains.

With respect to technical change, results (Table 6.5) show that income category I had the highest percentage of nations (86%) that experienced technical improvements during the 1983-92 time period.

Finally, Table 6.6 indicates that about 15 (68%) nations (13 African and 2 Asian) that had a positive productivity growth rate were associated with income category I whereas 7 (50%) nations (Cameroon, El Salvador, Dominican Republic, Honduras, Papua New Guinea, Senegal, and Zimbabwe), 4 (44%) Latin American countries (Ecuador, Guatemala, Jamaica, and Paraguay), 2 (29%) African (Mauritius and Namibia) and 2 (67%) Latin American nations (Nicaragua and Panama) were associated with income categories II, III, IV, and V respectively (Table 6.6).

In addition, a correlation coefficient analysis (Tables 6.7 and 6.8) revealed that technical change, productivity growth rate, and incomes were negatively correlated and statistically significant for the 1983-1992 time period. This indicates that small incomes were associated with big values of technical change and productivity growth rate. This seems to be consistent with previous findings (i.e., Tables 6.5, and 6.6) where the highest percentage of

nations with positive technical improvements and productivity growth rate were found between income categories I and III. Efficiency change and incomes were not correlated during the 1983-92 time period.

6.2.3 Concluding Remarks

From this analysis, it can be concluded that only income category V had kept the highest percentage of nations with positive efficiency gains in 1983/84, 1991/92, and during the 10 year period (1983-92). This is consistent with our findings on nations' income groupings and efficiency measurement where it was concluded that income category V (income ranging from 2,000 U.S. dollars to above) had the highest percentage of efficient nations.

However, technical change and productivity growth were not associated with a specific income category during these years. Technical change fluctuated between income categories I and II while productivity growth was associated with income categories I and III.

Correlation coefficient analysis indicated that efficiency change and incomes were positively correlated for years 1983/84 only. Technical change and incomes were negatively correlated in 1983/84, 1991/92, and during the 1983-1992 time period. Productivity growth rate and incomes were negatively correlated for the 1983-1992 time period only. These results were consistent with the findings on nations' income groupings (i.e., Tables 6.5, and 6.6)

Chapter 7

Analysis of Factors Affecting Efficiency and Productivity

This chapter reports and discusses the impact of the nations' socio-economic characteristics on efficiency and productivity. A parametric approach, as discussed in Chapter 3 (Section 3.3.5), was used to identify and explain different factors associated with nations' efficiency, and productivity. Since DEA techniques do not include a statistical component, this further step is necessary in order to identify these factors.

Therefore, a Tobit model (Equation 16) was used to determine the relationship between efficiency indexes (technical and scale efficiency) and the countries' socio-economic characteristics whereas OLS (Equation 17) was used to determine the relationship between productivity indexes (efficiency change, technical change and productivity) and nations' socio-economic characteristics.

The variable depicting nations' characteristics were discussed in Chapter 4 (Section 4.3). They comprise economic, education, health, social and others. Economic characteristics include external debt per capita (PCEXTDBT), food aid per capita (PCFDAID), gross domestic saving per capita (GDSVGPC), IMF intervention per capita (PCIMFUSE), inflation (INFLT), infrastructure (INFRAST) and trade balance per capita (PCTRDBLC). The education variable is measured by literacy (LITRCY). The health variable is represented by access to safe water (SAFEW). The social variable includes the population growth rate (POPGR). Finally, other characteristics include regional differences (*D1* and *D2* standing for dummy variables representing Asia and Latin America respectively), and the number of years

since independence (YRINDP).

7.1 Factors Affecting Nations' Efficiency

The results of the Tobit analysis for pure technical inefficiency are reported in Table 7.1. Food aid per capita, IMF intervention per capita, infrastructure, and access to safe water were statistically significant at 1%. Trade balance per capita and regional differences (*D2* for Latin America) were statistically significant at 5% whereas gross domestic saving per capita, inflation, and the number of years since independence were statistically significant at the 10% level.

Hypotheses were tested in this model using the chi square test. Chi square was calculated from likelihood functions as -2(LLR - LLU) where LLR indicates log of likelihood for restricted models and LLU stands for log of likelihood for unrestricted models. In this model, chi square was 379.266 while the critical value for a chi square with 13 degrees of freedom and at 5% of statistical significance was 22.36. Since the model's chi square was greater than the chi square's critical value, the pure technical ineffciency regression was therefore highly significant.

The results of this study suggest that pure technical inefficiency were positively associated with increases in food aid per capita. This is consistent with the predicted sign as hypothesized earlier in Chapter 4 (Table 4.7). It is believed that food aid has a negative impact on a country's economic welfare by increasing food supply and consequently causing food

Table 7.1 Tobit Results for Pure Technical Inefficiency: The World Sample (1983-1992)

	Coefficient estimate	t-statistics
Economic variables		
External debt per capita (PCEXTDBT)	-0.000003	-0.9834
Food aid per capita (PCFDAID)	804.131	4.5656
Gross domestic saving per capita (GDSVGPC)	-0.000030	-1.4677
IMF intervention per capita (PCIMFUSE)	-0.000216	-2.5129
Inflation (INFLT)	0.000119	1.6073
Infrastructure (INFRAST)	-0.887911	-5.9579
Trade balance per capita (PCTRDBLC)	-0.000028	-2.1751
Education variable		
Literacy (LITRCY)	-0.000468	-0.6408
Health variable		
Access to safe water (SAFEW)	-0.002095	-2.5268
Social variable		
Population growth rate (POPGR)	0.022934	1.0344
Other variables		
Dummy variable for Asia (D1)	0.022064	0.1566
Dummy variable for Latin America (D2)	-0.106088	-2.2583
Years of independence (YRINDP)	-0.001581	-1.5132
Other parameters		
Constant	0.4252	4.6388
Number of observations	450	
Degrees of freedom	13	
Log Likelihood Unrestricted (LLU)	-119.492	
Log Likelihood Restricted (LLR)	-309.125	
Chi Square	379.266	

price to decrease. This may be good for consumers because they will buy food at lower price. However, it is not good for producers (especially producers in the agricultural sector) who are most likely to make less benefits due to low food prices. Consequently, consumers benefit from increased consumer surplus while producers lose due to a decrease in their producer surplus. This may negatively affect food producers' incentive to produce and therefore explains the fact that countries' technical efficiency is related to increases in food aid per capita.

Food aid is reasonable for a country on humanitarian grounds. Food aid dumping policy should be discouraged for the reasons discussed above. However, policies aimed at receiving food aid for reason of emergencies (i.e., drought or natural calamities) and distributing it to the population in exchange of labor for example may be encouraged. In addition, food aid does not necessarily have to be negatively associated with nations' technical efficiency. This mostly depends on how food aid is given and how it is distributed. If it is dumped into the market, then the above discussion is relevant. However, when food aid is distributed to people who do not have any purchasing power for their own consumption, it may not influence the food prices and therefore is not linked to nations' efficiency.

Increases and improvements in gross domestic saving per capita, IMF intervention per capita, infrastructure, trade balance per capita, access to safe water, and number of years since independence were negatively related to pure technical inefficiency (i.e., positively associated with pure technical efficiency). These five variables had the hypothesized signs.

It was argued that gross domestic saving per capita was highly recommended for

sustained development within a country. Gross domestic saving per capita increases nations' future consumption by lowering current consumption. Countries' savings may be used to pay for projects and investments. These positive effects of savings appear to improve pure technical efficiency. In this study, gross domestic saving per capita was actually positively associated with countries' pure technical efficiency.

IMF intervention per capita was a controversial variable in this analysis. Those in favor of IMF intervention believe that over the long run, structural adjustment will payoff. Hence, IMF intervention may bring about improvement in pure technical efficiency. However, critics on IMF intervention are based on the fact that IMF often intervenes when a country's economic situation has already deteriorated. It is literally too late and any subsequent decisions would have disastrous outcome on the overall economy.

Ideally, as internal and external difficulties emerge, adjustment policies should be implemented before the economy deteriorates to the point where the country loses its capacity to repay loans and debts and the lending agencies have to be approached. Forced adjustment is likely to be very disruptive. Therefore, many believe that IMF is most likely to succeed when it intervenes before the economic situation becomes very serious.

This study, however, has shown that increases in IMF intervention per capita were negatively associated with pure technical inefficiency suggesting that there may be some advantages associated with the use of IMF services. Given the concern over IMF issues, further analyses would be desirable in the future to sort out the impact of IMF intervention in regard to the timing of the IMF programs.

As expected, improvements in infrastructure were negatively associated with nations'

pure technical inefficiency. In fact, it was hypothesized that infrastructure would improve the flow of goods and services within a nation and therefore improve nations' efficiency and productivity. In most LICs, infrastructure is very often neglected. Roads and telecommunications are essential for bringing about internal development. Nations that have established sound economic models (for instance, the Japanese, and the Korea-Taiwanese models) and have heavily invested in infrastructure, primary education, and other human capital are today classified as HICs (Nafziger, 1990). Therefore, infrastructure should be promoted and not discouraged.

Improvements in accessibility to safe water variable were negatively associated with nations' pure technical inefficiency to decrease implying that the more people have access to safe and clean water, the healthier they are. This is an indication that healthier people may positively influence pure technical efficiency of their country. It would be almost impossible for people who do not meet their daily basic needs to help develop their nation. Therefore, leaders of nations should promote policies aimed at providing their citizens with necessary basic needs such as safe and clean water as discussed in this study.

A positive trade balance per capita was negatively related to countries' pure technical inefficiency (i.e., improved pure technical efficiency). The rationale behind trade balance per capita as factor associated with efficiency was that the more a country is open to international trade, the better off it might be. This is linked to the notion of comparative advantage (Krugman, and Obstfeld, 1994). Experiences have shown that countries which do not have an open economy are worse off than those which do. These findings are consistent with subsequent results (technical change, and productivity) of this study. Therefore, a country's

openness to the world is to be encouraged.

Length of time since independence was negatively associated with pure technical inefficiency. This finding was consistent with the hypothesized sign. It was argued that the longer the period of independence, the more prosperous the country becomes. Therefore, the length of time since independence was expected to be positively related to countries' pure technical efficiency. This is true especially when sound fiscal, monetary, and socio-economic policies as well as good governance are implemented within the country.

Inflation had the predicted sign. Increases in inflation were positively associated with nations'pure technical inefficiency. It was argued that inflation makes savings and investment worthless due to uncontrolled increases in prices of goods and services.

Dummy variable (*D2*) for regional differences indicated that Latin America was more technically efficient than Asia and Africa. This is consistent with the discussion of Chapter 2 (Section 2.2) and the results of our study discussed in Chapter 5 where facts and findings revealed that Latin America was ahead of Asia and Africa.

Since this chapter's objective is to determine the factors associated with nations' efficiency, it can be concluded that technical inefficiency was explained by countries's economic and social characteristics such as food aid per capita, gross domestic saving per capita, IMF intervention per capita, infrastructure, trade balance per capita, access to safe water, inflation, and the number of years since independence. Regional differences also confirmed through the dummy variable (*D2)* that Latin America performed better (pure) technically efficiently than Africa, and Asia.

So far the discussion of the results has focused on pure technical inefficiency. The

following section will discuss the results of the Tobit analysis for overall technical inefficiency (Table 7.2).

Hypotheses were tested using the chi square test. Chi square was calculated as follows -2(LLR - LLU). In this model, chi square was 374.5 whereas the critical value for a chi square with 13 degrees of freedom and at 5% of statistical significance was 22.36. Therefore, the technical inefficiency regression was highly significant.

Five parameters (food aid per capita, IMF intervention per capita, infrastructure, access to safe water, and dummy variable *D2* for Latin America) were statistically significant at 1% whereas 4 parameters (external debt per capita, inflation, population growth rate, and the number of years since independence) were statistically significant at 10%.

Food aid per capita, IMF intervention per capita, inflation, infrastructure, access to safe water, population growth rate, and dummy variable *D2* had the predicted signs. However, the number of years since independence variable did not.

Increases and improvements in IMF intervention per capita, access to safe water, and infrastructure were negatively associated with technical inefficiency (i.e., improved overall technical efficiency).

Increases in IMF intervention per capita were negatively related to technical inefficiency. This was consistent with the finding on pure technical efficiency. This indicates

Table 7.2 Tobit Results for Technical Inefficiency: The World Sample (1983-1992)

	Coefficient estimate	t-statistics
Economic variables		
External debt per capita (PCEXTDBT)	0.000002	1.2823
Food aid per capita (PCFDAID)	777.629	5.0032
Gross domestic saving per capita (GDSVGPC)	0.000001	0.3767
IMF intervention per capita (PCIMFUSE)	-0.000258	-3.5893
Inflation (INFLT)	0.000094	1.5756
Infrastructure (INFRAST)	-0.806043	-6.8142
Trade balance per capita (PCTRDBLC)	0.000002	0.2513
Education variable		
Literacy (LITRCY)	0.000359	0.5535
Health variable		
Access to safe water (SAFEW)	-0.001718	-2.4606
Social variable		
Population growth rate (POPGR)	0.030922	1.5885
Other variables		
Dummy variable for Asia (D1)	-0.000867	-0.0214
Dummy variable for Latin America (D2)	-0.364241	-2.7906
Years of independence (YRINDP)	0.001258	1.3052
Other parameters		
Constant	0.333456	4.1274
Number of observations	450	
Degrees of freedom	13	
Log Likelihood Unrestricted (LLU)	-81.3895	
Log Likelihood Restricted (LLR)	-268.6884	
Chi Square	374.5	

that IMF intervention is beneficial to the nation since it increased both nations' pure technical and technical efficiency. Therefore, IMF intervention should be recommended. However, the timing of the IMF programs is another issue that needs further research.

Improvements in infrastructure were positively related to technical efficiency. As discussed in the case of pure technical efficiency, infrastructure improves the flow of goods and services in the country and thus, improves the nation's technical efficiency. This finding is consistent with previous results (i.e., pure technical efficiency). Therefore, nations should heavily invest in infrastructure.

Improvements in the accessibility to safe water variable were negatively associated with both pure technical and technical inefficiency. It was hypothesized that access to safe water was most likely to increase nations' efficiency and productivity. Hence, nations's health conditions should be improved.

Regional differences have also indicated that Latin American nations performed at a more technically efficient level than Asian and African nations. Even though Asia seemed to be ahead of Africa (in terms of technical efficiency), the Tobit analysis showed that this difference was not statistically significant.

Increases in external debt per capita, food aid per capita, inflation, population growth rate, and the number of years since independence were associated with increases in technical inefficiency.

Higher levels of external debt per capita were expected to have future negative effect on nations' efficiency by lowering the level of funds that would be used for future investments. In addition, it was not clear whether or not high levels of external debt would

influence current productivity within the nations unless these nations were committed to repaying their debts in a short run. The results of this analysis indicated that increases in external debt per capita were negatively associated with technical efficiency. This may be due to the fact that borrowed money was not used to enhance existing technology. Another reason may be that money was allocated to inefficient public sectors (i.e., African nations) rather than lending it to efficient private sectors (i.e., Latin American countries) which could implement needed innovation, and technology within the country.

Increases in food aid per capita were positively related technical inefficiency. As discussed earlier, this may be due to the fact that producers (especially those involved in the agricultural sector) are discouraged by low prices of agricultural products created by high food supply.

Inflation had the predicted sign. Increases in inflation were positively related to nations' technical inefficiency. It was argued that inflation makes savings and investment worthless due to uncontrolled increases in prices of goods and services.

Higher population growth rates and length of time since independence were positively associated with technical inefficiency. While population growth rate had the hypothesized sign, years of independence did not. It was hypothesized that an increase in population growth rate would most likely increase countries' technical inefficiency. This is true in the sense that a higher population growth rate decreases investments and countries' savings per worker thereby influencing efficiency.

The number of years since independence did not have the hypothesized sign. It was argued that the longer the period of independence, the more prosperous the country becomes. Therefore, years of independence was expected to decrease countries' technical inefficiency. Unfortunately, the results of this analysis indicated that years of independence was associated with deterioration in technical efficiency. This is not surprising in the case of some countries where conditions have deteriorated since independence because of poor governance. However, there may still be some concern for the nations that have made significant progress since independence and were included in the world sample. A political stability variable included in the Tobit analysis was expected to clarify the issue. Unfortunately, the political rights variable used as a degree of political stability proxy was negatively associated with technical inefficiency (instead of being positively related). Therefore, more research is needed to sort out this controversial issue.

In fact, political rights[1] was a controversial issue in this study. According to Freedom House (1989), political rights are rights that enable people to participate freely in the political process. These rights also include people's freedom from domination by military, foreign powers, totalitarian parties or other powerful groups. Political rights are rated on an integer scale basis ranging from 1 to 7 with the higher figures indicating fewer political rights. A larger value is most likely to bring about deterioration in both efficiency and productivity

[1]This study tried to incorporate political rights. However, the results were inconclusive and are not reported in this dissertation.

within a country. Following the Freedom House's definition of political rights, nothing is said about people's ability to decide on their economic development policies, economic systems, productivity, or efficiency. However, there is reason to believe (from experiences) that repressive governments are often associated with disrupting economic development, increasing inefficiency, and thus lowering productivity.

A previous study, however, has shown that a deterioration in political rights was positively associated with nations' technicalefficiency implying that there may be some advantages associated with political rights abuse! This indicates that even though some countries have repressive policies toward their citizens, they may be concerned about technical efficiency. Obviously, further analysis is needed before drawing definitive conclusions. One problem may be deficiencies in the variable itself. What would be preferable is a variable reflecting the degree of political instability.

7.2 Factors Affecting Countries' Productivity

This section presents OLS results for efficiency change, technical change and productivity. OLS results for efficiency change are summarized in Table 7.3. Results indicated that inflation was statistically significant at 1%. Overall OLS results have a low R-square due to time series data used in this study.

Inflation had the predicted sign. Increases in inflation were negatively associated with nations's efficiency change. It was argued that inflation makes savings and investment worthless due to uncontrolled increases in prices of goods and services.

Table 7.3: OLS Results for Efficiency Change: The World Sample (1983-1992)

	Coefficient estimate	t-statistics
Economic variables		
External debt per capita (PCEXTDBT)	-0.76E-07	-0.0825
Food aid per capita (PCFDAID)	24.2368	0.2416
Gross domestic saving per capita (GDSVGPC)	0.10E-06	0.0564
IMF intervention per capita (PCIMFUSE)	0.000006	0.2577
Inflation (INFLT)	-0.000259	-2.9530
Infrastructure (INFRAST)	-0.014841	-0.2377
Trade balance per capita (PCTRDBLC)	0.000003	0.4973
Education variable		
Literacy (LITRCY)	0.559544	1.0545
Health variable		
Access to safe water (SAFEW)	0.000378	0.6672
Social variable		
Population growth rate (POPGR)	0.005776	0.3831
Other variables		
Dummy variable for Asia (D1)	-0.034330	-1.0389
Dummy variable for Latin America (D2)	-0.019533	-0.2601
Years of independence (YRINDP)	-0.000060	-0.1039
Other parameters		
Constant	0.964819	15.7131
Number of observations	405	
Degrees of freedom	391	
R-square	0.028	

Regional differences (dummy variables *D1* and *D2*) on the other hand, were not statistically significant. It was not known a priori which region would perform the best in terms of productivity. Even though results seemed to indicate that Latin America performed better than Asia and Africa, these results were not statistically significant. This finding is not consistent with the results of Chapter 6 where it was concluded that Latin America experienced more gains in efficiency and productivity than Africa and Asia in 1983/84, 1991/92 and 1983-92 time period.

Table 7.4 gives OLS results for technical change. OLS R-square for technical change was also low (about 0.10). This is also due to the use of time series data in the study. From this analysis, literacy was statistically significant at 1% whereas external debt per capita, trade balance per capita, and access to safe water were statistically significant at 5%.

As expected, literacy, trade balance per capita, and access to safe water had positive signs meaning that increases in these three variables were positively related to nations' technical change.

Higher levels of external debt per capita were positively associated with nations' technical change while increases in the same variable (i.e., external debt per capita) were negatively associated with nations' technical efficiency (Table 7.2). This controversial finding suggests that even though technical improvements may be achieved through borrowing abroad, the accumulation of foreign debt may hurt nations' technical efficiency in the long run. Another argument may be that borrowed money is not being used in an efficient manner. Much of it may be going to inefficient public sectors instead of being used by efficient private

Table 7.4: OLS Results for Technical Change: The World Sample (1983-1992)

	Coefficient estimate	t-statistics
Economic variables		
External debt per capita (PCEXTDBT)	0.000001	1.9136
Food aid per capita (PCFDAID)	-63.4117	-0.8066
Gross domestic saving per capita (GDSVGPC)	-0.000001	-0.8374
IMF intervention per capita (PCIMFUSE)	0.000019	1.0875
Inflation (INFLT)	0.000028	0.4091
Infrastructure (INFRAST)	0.018773	0.3836
Trade balance per capita (PCTRDBLC)	0.000010	1.9521
Education variable		
Literacy (LITRCY)	0.001277	3.0696
Health variable		
Access to safe water (SAFEW)	0.000832	1.8724
Social variable		
Population growth rate (POPGR)	-0.014676	-1.2420
Other variables		
Dummy variable for Asia (D1)	0.011197	0.4324
Dummy variable for Latin America (D2)	0.043532	0.7396
Years of independence (YRINDP)	-0.000033	-0.0760
Other parameters		
Constant	1.14466	23.7866
Number of observations	405	
Degrees of freedom	391	
R-square	0.056	

sectors. However, further research is needed to sort out the controversial effect of external debt on nations' technical efficiency and technical change.

Improvements in the trade balance per capita were positively associated with countries' technical change. A successful open economy facilitates sustained development. The results of this analysis are consistent with previous findings. Both pure technical efficiency and technical change increased with an improved (positive) trade balance per capita.

Literacy was used as a variable depicting education. Experiences have shown that countries that have invested in education are better off in the long run. Education frees people's minds and expose them to critical thinking, and problem solving situations. Educated people are able to discover new ideas and technologies and hence, contribute to the development of their country. This study indicated that improvements in literacy were positively associated with technical change. Thus, education should be encouraged and available to all.

As hypothesized, improvements in the accessibility to safe water variable were positively associated with pure technical, technical efficiency, and technical change. Thus, health conditions should be improved.

Finally, OLS regression results for nations' productivity are summarized in Table 7.5. Results showed that inflation was statistically significant at 1%. Literacy, and trade balance per capita were significant at 5% while external debt per capita was statistically significant at 10%. OLS R-square for productivity was 0.1.

Three variables (i.e., inflation, literacy, and trade balance per capita) had the

Table 7.5: OLS Results for Productivity: The World Sample (1983-1992)

	Coefficient estimate	t-statistics
Economic variables		
External debt per capita (PCEXTDBT)	0.000001	1.4733
Food aid per capita (PCFDAID)	-40.1809	-0.4423
Gross domestic saving per capita (GDSVGPC)	-0.000001	-0.6839
IMF intervention per capita (PCIMFUSE)	0.000025	1.2240
Inflation (INFLT)	-0.000235	-2.9607
Infrastructure (INFRAST)	0.012588	0.2226
Trade balance per capita (PCTRDBLC)	0.000013	2.0926
Education variable		
Literacy (LITRCY)	0.000812	1.6896
Health variable		
Access to safe water (SAFEW)	0.000253	0.4928
Social variable		
Population growth rate (POPGR)	-0.012792	-0.9367
Other variables		
Dummy variable for Asia (D1)	-0.013017	-0.4349
Dummy variable for Latin America (D2)	0.032837	0.4828
Years of independence (YRINDP)	-0.000083	-0.1678
Other parameters		
Constant	1.09476	19.6862
Number of observations	405	
Degrees of freedom	391	
R-square	0.052	

hypothesized signs. Inflation usually makes savings and investment worthless decreasing therefore productivity. Consequently, implementing innovation becomes very costly. This study indeed revealed that higher levels of inflation were negatively associated with nations' productivity.

Improvements in literacy were positively related to countries' productivity. Education is essential for sustained economic development. As people enhance their educational skills, they become better prepared for innovations and skilled job opportunities. Consequently, their nations may benefit from their expertise and knowledge. Therefore, education is important.

Trade balance per capita is an economic variable representing nations' openness to external trade. Experiences have shown that countries which practice international trade are better off than those which do not. The comparative advantage issue always comes into play when such a trade takes place. This analysis showed that a positive trade balance per capita was significantly associated with improvements in nations' productivity. Therefore, it is highly recommended that nations implement open international trade policies.

Increases in external debt per capita were positively related to increased nations' productivity. These results are analogous to previous findings with references to technical efficiency, and technical change. In fact, results indicated that increases in external debt were positively associated with nations' productivity. The reason may be that external debt generates capital that might be used in the short run to invest more in productive sectors in order repay at a later date once benefits have resulted.

Chapter 8

Conclusions, Policy Recommendations, and Suggestions for Further Research

8.1 Overview

Measuring efficiency and productivity across nations was the topic of this study. Efficiency measurement of farmers has been the focus of study since efficiency analysis started in the 1950s. Since then, much has been done in the agricultural sector at the micro level. Nevertheless, records show that several issues related to productivity (i.e., efficiency gains, and technical advances) at the macro level have begun to receive recent attention. The area that actually needs further attention is efficiency analysis in LICs since most recent research has focused on HICs.

This study addressed not only countries' public sector issues but also efficiency issues related to LICs. It applied parametric and nonparametric techniques to a set of data on African, Asian, and Latin American nations in order to measure their efficiency and productivity. It also identified factors that could be associated with efficiency and productivity.

Efficiency and productivity can be measured using two approaches: parametric and nonparametric. The parametric approach involves specification of a functional relationship between inputs and outputs whereas the nonparametric method does not require such a specification. The parametric approach imposes a priori parametric restrictions on the technology while nonparametric methods do not impose such restrictions. Now the question is, which of these methods is better? This issue of a better approach has remained

controversial. Different approaches give different results depending on what needs to be accomplished, the available resources, and the underlying theory behind the studied subject. This study used the nonparametric approach or Data Envelopment Analysis (DEA).

Multi-output and multi-input nonparametric models were used to measure nations' efficiency and productivity. The data used in this analysis included information from the World Bank data set compiled into a CD ROM. This data consists of time series information from 1983 to 1992. The outputs (real U.S. dollars) consisted of three sectors: agriculture, industry, and services. They were the ratio of agriculture, industry, and services' value added (constant 1987 U.S. dollars) to their respective normalized prices. The inputs used in this study included three categories: capital, labor, and land. Capital (real U.S. dollars) was obtained from the ratio of gross domestic fixed investment (constant 1987 U.S. dollars) to normalized capital price. Labor and land were the total labor force and square kilometers respectively.

Efficiency and productivity were measured for each country included in our sample of 55 countries. Nations' efficiency (pure technical, overall technical, and scale) indices were estimated using a production function approach whereas nations' productivity was calculated following the Malmquist productivity approach. Since productivity consists of efficiency change and technical advances, these two components were also examined in this study. The Malmquist productivity approach first formulated by Malmquist (1953) and then developed by Färe et al. (1994) within a DEA framework made it possible to decompose productivity indexes into two components: efficiency gains and technical change. This is a major advantage of the Malmquist productivity approach over the Turnquist index method (Färe,

Grosskopf, Norris, and Zhang, 1994). In addition, the Malmquist approach allows for a multi-output modeling and does not impose any parametric restrictions on the technology.

One of the weaknesses of DEA is that DEA is unable to make statistical inferences from derived results. A further step which consists of statistical approach is needed to derive statistical inferences. This is the reason why parametric models (i.e., Tobit and OLS regression models) were used in this study. These models were used to determine factors associated with nations' efficiency and productivity.

The explanatory variables for Tobit and OLS regression models were economic, education, health, social and others. Economic factors included external debt per capita (PCEXTDBT), food aid per capita (PCFDAID), gross domestic saving per capita (GDSVGPC), IMF intervention per capita (PCIMFUSE), inflation (INFLT), infrastructure (INFRAST) and trade balance per capita (PCTRDBLC). The education variable was measured by literacy (LITRCY). The health variable was represented by access to safe water (SAFEW). Social variables include population growth rate (POPGR). Other factors comprised regional differences *(*dummy variables *D1* and *D2* for Asia and Latin America respectively) and the number of years since independence.

8.2 Summary of the Findings

8.2.1 Findings on Countries' Efficiency

Three measures of efficiency (i.e., pure technical, overall technical, and scale efficiency) were examined in 55 countries. Results were presented and discussed for the beginning of the study (1983) and the ending year (1992) of the investigation. Our attention

was directed to years 1983 and 1992 in order to show the performance trend across countries during these years. The findings on countries' efficiency are presented below.

(1) The overall results indicated that over the 10 year period (1983-1992) of our study, Latin America performed more efficiently than Asia and Africa. About 57 percent (against 45% of Asian and 10 % of African nations) of Latin American nations were purely technically efficient whereas 43 percent (against 18 % of Asian, and 7 % of African countries) were technically efficient during the 1983-92 time period. This cross continent comparison (Chapter 5) was also consistent with the comparative study for the beginning (1983) and the ending period (1992) of our study where Latin America ranked first followed by Asia. This was also consistent with the 1980-1990 performance of the Latin America and the Carribean region. In fact, the 1960-1992 socio-economic indicators (population growth, life expectancy, infant mortality, adult literacy, access to safe water, overall school enrolment, and children malnutrition) showed that Latin America was ahead of Africa and Asia.

(2) Statistics depicting the efficiency indexes for the world sample indicated that on average Latin American countries were closer to the world frontier than Asian and African nations in 1983, 1992, and during the 1983-1992 time period. Latin America's average technical efficiency indices were 1.1597 (in 1983), 1.1641 (in 1992) and 1.1492 (in 1983-1992) whereas those of Asia and Africa were all higher in these years (Table 5.2).

(3) The results of this study showed that 15 (27%) countries were both technically and scale efficient in 1983 whereas 18 (33%) were efficient in 1992. This implies that 40 (73%) and 37 (67%) nations out of 55 nations were technically and scale inefficient in 1983 and 1992

respectively. Malawi was the most technically inefficient nation in both 1983 and 1992. With respect to the scale measure of efficiency, the Gambia and Indonesia were the most scale inefficient nations in 1983 and 1992 respectively. For the 10 year period (1983-1992) of our study, Malawi was the most technically inefficient country whereas Indonesia was the most scale inefficient.

(4) Nations were also compared following their different income groupings. Results of a correlation coefficient analysis between income, and efficiency indices showed that pure technical, overall technical efficiency indices, and incomes were positively correlated in 1983, 1992, and during the 1983-92 time period. This indicated that large values of income were associated with higher levels of pure technical, and overall technical efficiency.

(5) Finally, due to the limitations of the DEA, no statistical inferences were made regarding the sources of countries' inefficiency. Parametric models were used to make such inferences.

8.2.2 Findings on Countries' Productivity

The productivity of 55 countries included in our sample was evaluated. Since productivity consists of efficiency gains and technical advances within a technology set, efficiency change and technical change were also estimated. The productivity indexes are based on specific time periods. Therefore, each country's productivity index was calculated for every pair of years.

Results were also discussed for the beginning (1983), the ending (1992), and the 10 year period of the study in order to follow up the performance trend of the nations during these

years. The findings are presented as follows.

(1) The overall results showed that on average, productivity increased slightly over the 1983-1992 period. In fact, the Malmquist productivity index was about 1.4% per year for the world sample as a whole. This 1.4% growth rate was due to both technical advances (1%) and efficiency change (0.4%).

(2) In 1983/84, Belize had the highest efficiency rate (17.5%) whereas Chad had the highest technical improvement rate (75%). The highest productivity index was achieved by Cameroon in 1983/84. Sierra Leone recorded both the highest efficiency change index and productivity growth rate (mostly due to the efficiency gains) in 1991/92. India achieved the highest technical improvement rate in 1991/92. The 1983-92 time period results showed that Sierra Leone still achieved both the highest efficiency rate and productivity growth rate. The highest technical improvement over the 10 year period was recorded in Chad.

(3) While several countries achieved the highest records in efficiency gains, technical improvements, and productivity growth rate, some nations had the lowest records. For instance, in 1983/84, RDC, Chile, and Ghana had the lowest efficiency change, technical change, and productivity growth rate respectively. In 1991/92, RDC again recorded the lowest performance in both efficiency and productivity changes while Chile had the lowest technical change. Results also indicated that over the 10 year period (1983-92), Benin achieved the lowest performance in efficiency change whereas Congo recorded the lowest performance in both technical change, and productivity.

(4) Correlation coefficient analysis between income and productivity indices revealed that efficiency change and incomes were positively correlated for years 1983/84 only. This

indicated that higher values of income were associated with higher levels of efficiency change. Technical change and incomes were negatively correlated in 1983/84, 1991/92, and during the 1983-92 period. Finally, productivity growth rate and incomes were negatively correlated for the 1983-92 period only. This indicated that lower values of income were related to higher levels of technical change, and productivity growth rate.

8.2.3 Findings on Tobit and OLS Regression Analysis

The factors associated with nations' efficiency, and productivity were determined in this study. Nations' characteristics used in this study were discussed earlier. They included external debt per capita, food aid per capita, gross domestic saving per capita, IMF intervention per capita, inflation, trade balance per capita, literacy, access to safe water, population growth rate, regional differences (dummy variables *D1* and *D2)*, and the number of years since independence. The findings of this analysis are presented below.

(1) Sources of Pure Technical and Technical Inefficiency: The results of the Tobit analysis for pure technical inefficiency indicated that increases in food aid per capita, and in inflation were positively associated with technical inefficiency. Results also showed that pure technical inefficiency was negatively related to increases and improvements in IMF intervention per capita, infrastructure, gross domestic saving per capita, trade balance per capita, access to safe water, and the number of years since independence as predicted. Dummy variables for regional differences revealed that Latin America was more purely technically efficient than Africa, and Asia. This finding was also consistent with previous results.

The factors associated with overall technical inefficiency were examined. The Tobit

regression results suggested that increases and improvements in IMF intervention per capita, infrastructure, and access to safe water were negatively related to nations' technical inefficiency whereas increases in food aid per capita, inflation, population growth rate, and the number of years since independence were positively associated with technical inefficiency. These factors had the predicted signs except for the number of years since independence. Latin America performed more technically efficiently than Asia and Africa. This finding also corroborated previous results.

(2) Factors Affecting Nations' Productivity: Factors affecting nations' efficiency change, technical change, and nations' productivity were evaluated. The OLS results for efficiency change showed that nations' efficiency gains were negatively associated with inflation as expected. Regional differences were not statistically significant meaning that the OLS results were not consistent with the finding that Latin American nations achieved more efficiency gains than Asian and African nations.

Nations' technical change was positively associated with improvements in trade balance per capita, and access to safe water as predicted by the hypothesized signs. Increases in external debt per capita were negatively related to countries' technical efficiency whereas the same factor was positively associated with nations' technical change. This controversial finding suggested that even though technical improvements were achieved by borrowing abroad, increases in external debt per capita negatively influenced nations' technical efficiency. This indicated that borrowed money was not being used to acquire new technology. This could also mean that most of money was used by inefficient public sectors rather than

efficient private sectors. Nevertheless, further research may be needed to resolve this controversial issue.

Finally, the OLS results for nations' productivity growth indicated that increases and improvements in external debt per capita, trade balance per capita, and literacy were positively associated with nations' productivity as predicted whereas higher inflation was negatively linked to nations' productivity. Dummy variables (*D1* and *D2*) for regional differences were not statistically significant for both technical change and productivity.

8.3 Policy Recommendations

The objectives of this study were to evaluate nations' efficiency and productivity, and then to determine the factors associated with efficiency and productivity. Several policies may be suggested from this study. Policies related to nations' efficiency are suggested first, then recommendations on nations' productivity (efficiency change, technical change, and productivity) follow.

First, in order to become more pure technically, and technically efficient, the nations included in this study need to improve factors that were significantly associated with nations' inefficiency. These factors are external debt per capita, food aid per capita, gross domestic saving per capita, IMF intervention per capita, inflation, infrastructure, trade balance per capita, access to safe water, population growth rate, and the number of years since independence.

More specifically, external debt per capita could be reduced. Even though technical improvements were achieved by borrowing abroad, increases in external debt per capita

negatively influenced nations' technical efficiency. Therefore, nations should be encouraged to look into internal ways and means of improving their efficiency. This can be achieved through personal and national savings rather than through foreign debts. External debt could also be used in an efficient manner (i.e., investing into efficient sectors).

Food aid per capita may be reduced since it was negatively associated with both pure technical, and technical inefficiency. This policy is relevant in the case where the population has the purchasing power since increases in food aid may lower the prices of food, and therefore discourage producers to produce food. However, in the case of emergencies (i.e., severe drought or natural calamities), or in the case people do not have purchasing power, food aid is very much needed.

Since increases in gross domestic saving per capita (GDSVPC) were negatively associated with pure technical inefficiency, GDSVPC should be increased. This strategy will help create more savings and investment within the country and possibly improve nations' efficiency.

Increases in IMF intervention per capita were negatively associated with both pure technical, and technical inefficiency. Therefore, IMF programs should be implemented when needed.

Higher inflation was negatively associated with nations' pure technical efficiency. Therefore, inflation should be brought under control. This can be accomplished by implementing budget controls, and income policies such as wages, prices, and exchange rate programs.

Since improvements in infrastructure were negatively associated with both nations'

pure technical, and technical inefficiency, creating decent infrastructure should be encouraged. Thus, nations should heavily invest in infrastructure in order to bring about internal development.

Policies aimed at encouraging a positive trade balance are highly recommended. In fact, nations' pure technical efficiency was positively related to a positive trade balance. Therefore, international trade should be encouraged. Keeping the exchange rate at the market-clearing rate and avoiding export taxes are to be recommended.

Access to safe water was used as a health variable. Results of this study showed that improvements in access to safe water were positively associated with both pure technical, and technical efficiency. Therefore, health conditions should be improved.

As an increase in population growth rate was positively associated with technical inefficiency, population growth should be discouraged within the country. Population growth has become a major concern lately since it presents challenges to future generations including increased urbanization and congestion, high dependency burdens, rapid labor force growth, and growing unemployment. Thus, sound decisions must be made to reduce population growth before it becomes too late. Policies that may be used to reduce population growth rate include birth control programs, and programs promoting social and economic development (i.e., education, increasing job opportunity, female labor force participation, and reduced income inequality).

Number of years since independence was expected to be negatively associated with pure technical, and technical inefficiency. This hypothesis was consistent with the findings on pure technical efficiency. However, results for technical efficiency showed that the longer the

period of independence, the more technically inefficient the nations become.

Even though the political rights variable was used to sort out the effect of the number of years since independence on nations' efficiency, it was not conclusive, implying that a better political variable (such as the degree of political stability) may help resolve the issue. The poor performance of some countries suggests that the leaders of these nations should implement sound economic programs and improve their governance ability. They should improve, and promote factors associated with nations' inefficiency as previously discussed.

Last, factors associated with nations' productivity (i.e., efficiency change, technical change, and productivity growth) need to be improved in order to increase countries' productivity. These factors are external debt per capita, inflation, trade balance per capita, literacy, and access to safe water.

External debt should be decreased, or used in an efficient manner in order to improve productivity of nations. In fact, increases in external debt per capita were positively associated with both technical change and productivity. Increasing nations' savings and investments would be the better alternative. Borrowing may also occur within the country through private savings rather than borrowing through external financial institutions.

Since inflation was negatively related to nations' efficiency change and productivity growth, it should be brought under control.

Positive trade balance per capita was positively related to nations' technical change and productivity. Therefore, international trade should be encouraged in the studied countries.

Improvements in literacy were positively associated with both nations' technical change and productivity. This is true since educated people are exposed to critical thinking,

and innovations. They have the ability to discover new technologies and hence, contribute to the development of their country. Therefore, education is highly recommended and should be made available to all.

Access to safe water was used as a health variable. Improvements in access to safe water were positively associated with technical change. Thus, health conditions should be improved.

8.4 Limitations of the Study

The limitations of this study are discussed in this section.

(1) The data included in our study is a time series information from 1983 to 1992. Results of this study might be influenced by major structural changes (that have occurred in the years covered by this study) in the global economy.

(2) Due to a high level of data aggregation, the efficiency and productivity measures might have been influenced by not only the aggregation procedures but also by measurement errors.

(3) The land variable (measured in quantity terms) in this study does not reflect quality differences which are related to variation in the biophysical factors.

(4) Similarly the capital variable does not reflect qualitative differences.

(5) The efficiency and productivity measures obtained from this study are specific to this sample only. Including or excluding any observations from the studied sample may affect the overall outcome.

8.5 Suggestions for Further Research

It was not possible to exhaust every avenue of this study due to time, data, and budget constraints. However, additional research may be undertaken to address several unsolved issues as well as broad subjects related to this study.

(1) Variables such as degree of political instability, access to financial institutions and the like were not included in our models since they were not available. Our suggestion is that such factors be included in the future research in order to determine their relationships with nations' efficiency and productivity.

(2) Factors that were controversial (external debt per capita, political rights, and the number of years since independence) deserve further attention to evaluate whether or not their effects on efficiency and productivity may be replicated. External debt is used differently depending on the country. For example, African nations allocate external debt to public sectors while Latin American nations distribute their external debt to private sectors. Thus, external debt per capita could be replaced by an appropriate variable depicting credit wortheness.

(3) Since some measures of efficiency were not analyzed in this study, it may be appropriate to evaluate nations' allocative efficiency, overall efficiency, and countries' scope economies. The relationships between these efficiency measures and countries' socio-economic characteristics may also be evaluated in order to determine the sources of countries' inefficiency.

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Appendix

The results of nations' efficiency and nations' productivity were discussed in Chapter 5 and Chapter 6 respectively. Since the study covers a 10 year period, results were discussed for the beginning (1983) and ending (1992) years of the data set. Results were also discussed for the 1983-1992 time period. This was done to show the performance trend that existed across nations and regions throughout these years.

The following section is an appendix of detailed results of this study. It reports the results of countries' technical and scale efficiency for 8 years (i.e., from 1984 to 1991) as well as those of nations' productivity (efficiency change, technical change and productivity growth) for 7 years (i.e., from 1984 to 1990).

Tables 1, 2, and 3 summarize the results of nations' efficiency for years 1984, 1985, 1986, 1987, 1988, 1989, 1990 and 1991 whereas Tables 4, 5, 6, 7, 8, 9, and 10 present the results of countries' productivity for years 1984/85, 1985/86, 1986/87, 1987/88, 1988/89, 1989/90 and 1990/91.

Table 1: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1984, 1985, and 1986

	Year 1984		Year 1985		Year 1986	
Country	TE	SE	TE	SE	TE	SE
Belize	1.2186	1.2186	1.1242	1.1242	1.2049	1.2049
Benin	1.9500	1.0297	1.1887	1.0633	1.0131	1.0131
Burkina Faso	1.1394	1.0636	1.7672	1.0082	2.1553	1.0020
Burundi	1.4205	1.0149	1.2364	1.0142	1.0557	1.0314
Cameroon	1.0000	1.0000	1.0523	1.0523	1.3550	1.3550
Central African Republic	2.5611	1.0104	2.2528	1.0076	1.4234	1.0788
Chad	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Chile	1.4620	1.4620	1.0551	1.0551	1.0000	1.0000
Colombia	1.4885	1.4885	1.3233	1.3233	1.3200	1.3200
Comoros	1.1024	1.1024	1.0000	1.0000	1.0261	1.0261
Congo	2.0530	1.0106	2.0082	1.0070	1.2771	1.0097
Costa Rica	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Cote d'Ivoire	1.2823	1.2823	1.3631	1.3374	1.1353	1.1353
Dominican Republic	1.2625	1.1711	1.1472	1.0499	1.3819	1.1943
Ecuador	1.1075	1.1075	1.0000	1.0000	1.0000	1.0000
Egypt, Arab Republic	1.7387	1.5429	1.5843	1.4131	1.4267	1.4159
El Salvador	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Fiji	1.0000	1.0000	1.0008	1.0008	1.0000	1.0000
Gambia, The	1.8710	1.8710	1.7282	1.7282	1.9902	1.8184
Ghana	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Guatemala	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 1: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1984, 1985, and 1986 (Continued)

	Year 1984		Year 1985		Year 1986	
Country	TE	SE	TE	SE	TE	SE
Honduras	1.6531	1.0310	1.5372	1.0225	1.4559	1.0069
India	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Indonesia	1.5293	1.5293	1.6375	1.6375	1.4712	1.4712
Jamaica	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Kenya	3.2080	1.7988	3.2055	1.8101	2.2105	1.4287
Madagascar	1.0000	1.0000	3.0833	1.0118	1.0000	1.0000
Malawi	3.2961	1.0263	2.9780	1.0194	1.5704	1.0603
Mali	2.0810	1.0157	3.0105	1.0025	2.0891	1.0041
Mauritania	2.5514	1.0455	2.3550	1.0046	2.5653	1.0065
Mauritius	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Morocco	1.4187	1.3402	1.1864	1.1809	1.3880	1.2835
Namibia	1.4768	1.0445	1.5599	1.0374	1.5988	1.0527
Nepal	1.5150	1.0297	1.6742	1.0992	1.3667	1.0460
Nicaragua	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Nigeria	2.1011	1.4714	1.6568	1.3961	1.0000	1.0000
Pakistan	2.0553	1.7972	2.1238	1.8837	1.7446	1.6583
Panama	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Papua New Guinea	1.6807	1.1102	1.5371	1.0914	1.5074	1.0954
Paraguay	1.4369	1.0402	1.3078	1.0008	1.4705	1.0654
Philippines, The	1.0647	1.0647	1.0000	1.0000	1.0000	1.0000
RDC (former Zaire)	1.3591	1.0967	1.3298	1.1025	1.2913	1.0911

Table 1: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1984, 1985, and 1986 (Continued)

	Year 1984		Year 1985		Year 1986	
Country	TE	SE	TE	SE	TE	SE
Rwanda	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Senegal	1.3416	1.0143	1.5055	1.0037	1.1820	1.0004
Sierra Leone	2.2899	1.2120	2.3113	1.1064	2.2094	1.0950
Sri Lanka	1.3045	1.1938	1.1003	1.0613	1.2132	1.1483
Swaziland	2.2776	1.4250	1.7629	1.2903	1.6740	1.2688
Syrian Arab Republic	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Thailand	1.7453	1.3901	1.4860	1.1938	1.5486	1.3351
Togo	1.9777	1.0746	2.1897	1.0366	2.1260	1.0105
Tunisia	1.1621	1.0718	1.0856	1.0705	1.2948	1.0773
Turkey	1.1590	1.1590	1.0000	1.0000	1.2696	1.2696
Uruguay	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Zambia	1.0831	1.0233	1.2096	1.0113	1.0000	1.0000
Zimbabwe	2.1463	1.0455	1.7762	1.1924	1.8708	1.1074

Table 2: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1987, 1988, and 1989

	Year 1987		Year 1988		Year 1989	
Country	TE	SE	TE	SE	TE	SE
Belize	1.0000	1.0000	1.0614	1.0614	1.0000	1.0000
Benin	1.0752	1.0167	1.1347	1.0444	1.5831	1.0046
Burkina Faso	1.7703	1.0041	2.0311	1.1200	2.6634	1.2665
Burundi	1.0835	1.0061	1.0000	1.0000	1.1493	1.0406
Cameroon	1.3698	1.1342	1.2105	1.2105	1.1223	1.1223
Central African Republic	1.0513	1.0251	1.2501	1.0356	1.0000	1.0000
Chad	1.0574	1.0350	1.0000	1.0000	1.7793	1.0791
Chile	1.3079	1.3079	1.3230	1.3230	1.0000	1.0000
Colombia	1.2835	1.2835	1.3684	1.3684	1.2849	1.2849
Comoros	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Congo	1.8420	1.0344	1.4052	1.0345	1.2104	1.0577
Costa Rica	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Cote d'Ivoire	1.0000	1.0000	1.0358	1.0358	1.0000	1.0000
Dominican Republic	1.3119	1.1246	1.4390	1.1604	1.1980	1.1948
Ecuador	1.5076	1.1413	1.2154	1.1889	1.4862	1.1083
Egypt, Arab Republic	1.5127	1.5127	1.7542	1.7542	1.7819	1.7819
El Salvador	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Fiji	1.0000	1.0000	1.0867	1.0867	1.0000	1.0000
Gambia, The	1.3432	1.3432	1.9404	1.3105	2.1774	1.0067
Ghana	1.0000	1.0000	1.0000	1.0000	1.0914	1.0914
Guatemala	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1987, 1988, and 1989 (Continued)

	Year 1987		Year 1988		Year 1989	
Country	TE	SE	TE	SE	TE	SE
Honduras	1.2241	1.0084	1.4954	1.0005	1.6835	1.0851
India	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Indonesia	1.5734	1.5734	1.6350	1.6350	1.7556	1.6959
Jamaica	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Kenya	1.8491	1.2370	2.6038	1.6981	2.8000	1.6127
Madagascar	1.0105	1.0105	1.9314	1.1059	3.0667	1.5063
Malawi	1.3738	1.0430	2.2443	1.0132	2.9854	1.0200
Mali	1.5431	1.0039	2.3141	1.1687	2.6596	1.3063
Mauritania	2.2299	1.0445	2.4241	1.0377	2.2269	1.0158
Mauritius	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Morocco	1.4439	1.2682	1.3496	1.2171	1.6768	1.3625
Namibia	1.3814	1.0456	1.5345	1.0891	1.7184	1.0386
Nepal	1.2823	1.0151	1.3596	1.0725	1.4269	1.1562
Nicaragua	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Nigeria	1.0000	1.0000	1.0000	1.0000	1.2564	1.2564
Pakistan	1.5057	1.5057	1.3848	1.3848	1.5891	1.5891
Panama	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Papua New Guinea	1.3317	1.0061	1.6344	1.0073	1.6050	1.1093
Paraguay	1.3091	1.0001	1.4701	1.0096	1.1999	1.1622
Philippines, The	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
RDC (former Zaire)	1.3122	1.1780	1.8173	1.5133	3.1480	2.1708

Table 2: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1987, 1988, and 1989 (Continued)

	Year 1987		Year 1988		Year 1989	
Country	TE	SE	TE	SE	TE	SE
Rwanda	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Senegal	1.0000	1.0000	1.4529	1.2850	1.7379	1.2405
Sierra Leone	1.0000	1.0000	1.2723	1.2723	2.7428	1.1118
Sri Lanka	1.3294	1.1530	1.2773	1.1040	1.2185	1.0568
Swaziland	1.6350	1.2148	1.6589	1.3313	1.5366	1.4039
Syrian Arab Republic	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Thailand	1.4336	1.4066	1.2768	1.2768	1.3927	1.3927
Togo	1.9683	1.0092	1.9593	1.0037	1.8095	1.0401
Tunisia	1.2767	1.0621	1.2780	1.1562	1.3281	1.1889
Turkey	1.1182	1.1182	1.2230	1.2230	1.1157	1.1157
Uruguay	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Zambia	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Zimbabwe	1.8329	1.0854	1.9242	1.1570	2.2535	1.1646

Table 3: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1990, and 1991

	Year 1990		Year 1991	
Country	TE	SE	TE	SE
Belize	1.0000	1.0000	1.0000	1.0000
Benin	1.5769	1.0004	1.4047	1.0002
Burkina Faso	2.9793	1.0100	2.6443	1.1596
Burundi	1.3478	1.1074	1.4325	1.1435
Cameroon	1.0000	1.0000	1.2192	1.2192
Central African Republic	1.8113	1.0281	1.5791	1.0417
Chad	1.4985	1.1055	1.3394	1.0553
Chile	1.0000	1.0000	1.0000	1.0000
Colombia	1.3496	1.3496	1.3707	1.3707
Comoros	1.0000	1.0000	1.0000	1.0000
Congo	1.5017	1.0068	1.6782	1.0146
Costa Rica	1.0000	1.0000	1.0000	1.0000
Cote d'Ivoire	1.0000	1.0000	1.0708	1.0708
Dominican Republic	1.2834	1.1698	1.2426	1.1118
Ecuador	1.6126	1.1867	1.6425	1.0574
Egypt, Arab Republic	1.8061	1.8061	1.7846	1.7846
El Salvador	1.0000	1.0000	1.0000	1.0000
Fiji	1.0000	1.0000	1.0000	1.0000
Gambia, The	2.5452	1.0009	2.2587	1.0007
Ghana	1.2913	1.1248	1.4263	1.1360
Guatemala	1.0000	1.0000	1.0000	1.0000

Table 3: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1990, and 1991 (Continued)

	Year 1990		Year 1991	
Country	TE	SE	TE	SE
Honduras	1.6094	1.0122	1.5956	1.0019
India	1.0000	1.0000	1.0000	1.0000
Indonesia	2.0241	1.8537	2.2665	2.0724
Jamaica	1.0000	1.0000	1.0000	1.0000
Kenya	2.7453	1.6245	2.8046	1.6333
Madagascar	2.9555	1.2626	1.8105	1.1905
Malawi	3.0902	1.0000	3.3880	1.0913
Mali	2.6700	1.1613	2.7853	1.1760
Mauritania	2.5514	1.0238	2.4630	1.0536
Mauritius	1.0000	1.0000	1.0000	1.0000
Morocco	1.6962	1.3505	1.6467	1.4026
Namibia	1.8083	1.0023	1.6658	1.1052
Nepal	1.4906	1.2630	1.7601	1.3199
Nicaragua	1.0000	1.0000	1.0000	1.0000
Nigeria	1.5686	1.5686	1.6660	1.6660
Pakistan	1.6938	1.6938	1.7616	1.7616
Panama	1.0000	1.0000	1.0000	1.0000
Papua New Guinea	1.5643	1.0045	1.6762	1.0030
Paraguay	1.1658	1.0002	1.2151	1.0166
Philippines, The	1.0000	1.0000	1.0643	1.0643
RDC (former Zaire)	2.6933	1.8155	2.6018	1.9066

Table 3: Nations' Technical (TE) and Scale Efficiency (SE) for Years 1990 and 1991 (Continued)

	Year 1990		Year 1991	
Country	TE	SE	TE	SE
Rwanda	1.0000	1.0000	1.0000	1.0000
Senegal	1.6132	1.1601	1.4626	1.0769
Sierra Leone	1.9725	1.1634	1.2605	1.2605
Sri Lanka	1.0626	1.0626	1.1134	1.0546
Swaziland	1.6429	1.6188	2.3941	1.8317
Syrian Arab Republic	1.0000	1.0000	1.0000	1.0000
Thailand	1.5384	1.5384	1.7032	1.7032
Togo	2.1081	1.0173	2.2805	1.0277
Tunisia	1.2485	1.0555	1.4199	1.0565
Turkey	1.1180	1.1180	1.1763	1.1763
Uruguay	1.0000	1.0000	1.1345	1.0174
Zambia	1.0000	1.0000	1.0000	1.0000
Zimbabwe	2.3791	1.2344	2.9004	1.1957

Table 4: Nations' Productivity for Years 1984/1985

Country	EFFCHG	TECHG	MLMQST	PRODGR
Belize	0.9226	1.0944	1.0096	0.0096
Benin	0.6096	0.9524	0.5806	-0.4194
Burkina Faso	1.5511	1.0293	1.5966	0.5966
Burundi	0.8704	0.9685	0.8430	-0.1570
Cameroon	1.0523	1.0426	1.0971	0.0971
Central African Republic	0.8796	0.9919	0.8725	-0.1275
Chad	1.0000	1.3957	1.3957	0.3957
Chile	0.7217	1.3306	0.9603	-0.0397
Colombia	0.8891	1.1037	0.9813	-0.0187
Comoros	0.9071	1.0518	0.9541	-0.0459
Congo	0.9782	1.0024	0.9805	-0.0195
Costa Rica	1.0000	1.0662	1.0662	0.0662
Cote d'Ivoire	1.0630	1.0100	1.0736	0.0736
Dominican Republic	0.9087	1.1460	1.0414	0.0414
Ecuador	0.9029	1.1575	1.0451	0.0451
Egypt, Arab Republic	0.9112	1.0508	0.9575	-0.0425
El Salvador	1.0000	1.0893	1.0893	0.0893
Fiji	1.0008	1.1281	1.1291	0.1291
Gambia, The	0.9237	0.9608	0.8875	-0.1125
Ghana	1.0000	1.0163	1.0163	0.0163
Guatemala	1.0000	0.9273	0.9273	-0.0727
Honduras	0.9299	1.0372	0.9645	-0.0355
India	1.0000	1.3245	1.3245	0.3245

Table 4: Nations' Productivity for Years 1984/1985 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Indonesia	1.0707	0.9511	1.0183	0.0183
Jamaica	1.0000	1.0814	1.0814	0.8140
Kenya	0.9992	0.9257	0.9249	-0.0751
Madagascar	1.1225	0.9912	1.1126	0.1126
Malawi	0.9354	0.9703	0.9076	-0.0924
Mali	1.4310	0.9139	1.3078	0.3078
Mauritania	1.1800	1.0079	1.1893	0.1893
Mauritius	1.0000	1.2332	1.2332	0.2332
Morocco	0.8363	1.1825	0.9889	-0.0111
Namibia	1.0562	0.9472	1.0005	0.0005
Nepal	1.1051	0.9238	1.0209	0.0209
Nicaragua	1.0000	1.0526	1.0526	0.0526
Nigeria	0.7886	1.0554	0.8322	-0.1678
Pakistan	1.0333	0.9478	0.9794	-0.0206
Panama	1.0000	1.0193	1.0193	0.0193
Papua New Guinea	0.9146	1.0056	0.9197	-0.0803
Paraguay	0.9102	1.0849	0.9874	-0.1260
Philippines, The	0.9392	1.0543	0.9903	-0.0097
RDC (former Zaire)	0.9784	1.1152	1.0912	0.0912
Rwanda	1.0000	0.9677	0.9677	-0.0323
Senegal	1.1222	0.8650	0.9706	-0.0294
Sierra Leone	1.0093	1.0460	1.0558	0.0558
Sri Lanka	0.8435	1.0594	0.8936	-0.1064

Table 4: Nations' Productivity for Years 1984/1985 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Swaziland	0.7740	1.0542	0.8160	-0.1840
Syrian Arab Republic	1.0000	0.9609	0.9609	-0.0391
Thailand	0.8514	1.1675	0.9941	-0.0059
Togo	1.1072	0.9208	1.0196	0.0196
Tunisia	0.9345	1.0959	1.0241	0.0241
Turkey	0.8628	1.0936	0.9436	-0.0564
Uruguay	1.0000	1.0711	1.0711	0.0711
Zambia	1.1168	1.0153	1.1339	0.1339
Zimbabwe	0.8276	0.9180	0.7597	-0.2403

Table 5: Nations' Productivity for Years 1985/1986

Country	EFFCHG	TECHG	MLMQST	PRODGR
Belize	1.0717	0.9519	1.0202	0.0202
Benin	0.8523	1.3295	1.1331	0.1331
Burkina Faso	1.2196	1.0188	1.2426	0.2426
Burundi	0.8538	1.0034	0.8568	-0.1432
Cameroon	1.2877	1.0580	1.3623	0.3623
Central African Republic	0.6318	1.2393	0.7830	-0.2170
Chad	1.0000	1.2147	1.2147	0.2147
Chile	0.9478	0.8467	0.8025	-0.1975
Colombia	0.9975	0.9099	0.9076	-0.0924
Comoros	1.0261	0.9559	0.9809	-0.0191
Congo	0.6359	0.8699	0.5532	-0.4468
Costa Rica	1.0000	0.8995	0.8995	-0.1005
Cote d'Ivoire	0.8329	1.1405	0.9499	-0.0501
Dominican Republic	1.2046	0.8476	1.0210	0.0210
Ecuador	1.0000	0.8452	0.8452	-0.1548
Egypt, Arab Republic	0.9006	0.9588	0.8635	-0.1365
El Salvador	1.0000	0.9407	0.9407	-0.0593
Fiji	0.9992	0.8687	0.8680	-0.1320
Gambia, The	1.1516	1.2726	1.4655	0.4655
Ghana	1.0000	0.9422	0.9422	-0.0500
Guatemala	1.0000	1.3489	1.3489	0.3489
Honduras	0.9471	1.0057	0.9525	-0.0475
India	1.0000	0.7614	0.7614	-0.2386

Table 5: Nations' Productivity for Years 1985/1986 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Indonesia	0.8985	1.0825	0.9726	-0.0274
Jamaica	1.0000	0.7959	0.7959	-0.2041
Kenya	0.6896	1.4865	1.0251	0.0251
Madagascar	0.8909	1.3579	1.2097	0.2097
Malawi	0.5093	1.2220	0.6225	-0.3775
Mali	0.7015	1.5450	1.0839	0.0839
Mauritania	0.8521	1.1335	0.9659	-0.0341
Mauritius	1.0000	0.7608	0.7608	-0.2392
Morocco	1.1699	0.9086	1.0630	0.0630
Namibia	1.0250	0.9628	0.9868	-0.0132
Nepal	0.8164	1.1158	0.9109	-0.0891
Nicaragua	1.0000	1.2421	1.2421	0.2421
Nigeria	0.6036	0.9208	0.5557	-0.4443
Pakistan	0.8214	1.1538	0.9478	-0.0522
Panama	1.0000	0.6739	0.6739	-0.3261
Papua New Guinea	0.9807	1.0400	1.0199	0.0199
Paraguay	1.1244	0.9499	1.0681	0.0681
Philippines, The	1.0000	0.9966	0.9966	-0.0034
RDC (former Zaire)	0.9711	1.0812	1.0499	0.0499
Rwanda	1.0000	0.9524	0.9524	-0.0476
Senegal	0.7851	1.5778	1.2387	0.2387
Sierra Leone	0.9559	1.2334	1.1791	0.1791
Sri Lanka	1.1025	0.9376	1.0337	0.0337

Table 5: Nations' Productivity for Years 1985/1986 (contiinued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Swaziland	0.9496	0.8514	0.8085	-0.1915
Syrian Arab Republic	1.0000	0.9594	0.9594	-0.0406
Thailand	1.0421	0.9173	0.9559	-0.0441
Togo	0.9709	1.2228	1.1873	0.1873
Tunisia	1.1924	0.8399	1.0014	0.0014
Turkey	1.2696	0.8467	1.0750	0.0750
Uruguay	1.0000	0.9659	0.9659	-0.0341
Zambia	0.8267	0.9105	0.7527	-0.2473
Zimbabwe	1.0532	1.0170	1.0712	0.0712

Table 6: Nations' Productivity for Years 1986/1987

Country	EFFCHG	TECHG	MLMQST	PRODGR
Belize	0.8300	1.0471	0.8690	-0.1310
Benin	1.0613	1.1777	1.2499	0.2499
Burkina Faso	0.8214	1.2898	1.0594	0.0594
Burundi	1.0263	1.0857	1.1143	0.1143
Cameroon	1.0110	1.0632	1.0749	0.0749
Central African Republic	0.7386	1.2545	0.9266	-0.0734
Chad	1.0574	1.0586	1.1194	0.1194
Chile	1.3079	0.7810	1.0215	0.0215
Colombia	0.9724	0.9568	0.9303	-0.0697
Comoros	0.9745	0.9427	0.9187	-0.0813
Congo	1.4424	0.8047	1.1607	0.1607
Costa Rica	1.0000	1.0576	1.0576	0.0576
Cote d'Ivoire	0.8808	1.0936	0.9633	-0.0367
Dominican Republic	0.9493	1.1091	1.0529	0.0529
Ecuador	1.5076	0.9193	1.3859	0.3859
Egypt, Arab Republic	1.0602	0.9940	1.0501	0.0501
El Salvador	1.0000	1.2142	1.2142	0.2142
Fiji	1.0000	1.0973	1.0973	0.0973
Gambia, The	0.6749	1.2206	0.8238	-0.1762
Ghana	1.0000	1.2844	1.2844	0.2844
Guatemala	1.0000	1.0703	1.0703	0.0703
Honduras	0.8408	1.2067	1.0146	0.0146
India	1.0000	1.0725	1.0725	0.0725

Table 6: Nations' Productivity for Years 1986/1987 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Indonesia	1.0694	0.9409	1.0062	0.0062
Jamaica	1.0000	1.0771	1.0771	0.0771
Kenya	0.8365	1.2112	1.0131	0.1310
Madagascar	1.0105	1.1366	1.1485	0.1485
Malawi	0.8748	1.1247	0.9839	-0.0161
Mali	0.7386	1.2231	0.9034	-0.0964
Mauritania	0.8693	1.1419	0.9926	-0.0074
Mauritius	1.0000	1.0577	1.0577	0.0577
Morocco	1.0402	1.0141	1.0549	0.0549
Namibia	0.8640	1.1775	1.0173	0.0173
Nepal	0.9382	1.1407	1.0701	0.0701
Nicaragua	1.0000	1.2014	1.2014	0.2014
Nigeria	1.0000	1.2824	1.2824	0.2824
Pakistan	0.8631	1.0928	0.9432	-0.0568
Panama	1.0000	1.4051	1.4051	0.4051
Papua New Guinea	0.8834	1.1695	1.0332	0.0332
Paraguay	0.8902	1.0879	0.9685	-0.0315
Philippines, The	1.0000	0.9883	0.9883	-0.0117
RDC (former Zaire)	1.0162	1.1061	1.1240	0.1240
Rwanda	1.0000	1.0364	1.0364	0.0364
Senegal	0.8460	1.1981	1.0136	0.0136
Sierra Leone	0.4526	1.0922	0.4943	-0.5057
Sri Lanka	1.0958	1.0451	1.1452	0.1452

Table 6: Nations' Productivity for Years 1986/1987 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Swaziland	0.9767	1.2111	1.1829	0.1829
Syrian Arab Republic	1.0000	1.0925	1.0925	0.9250
Thailand	0.9257	1.0737	0.9939	-0.0061
Togo	0.9258	1.0555	0.9772	-0.0228
Tunisia	0.9860	0.9706	0.9570	-0.0430
Turkey	0.8808	0.9801	0.8633	-0.1367
Uruguay	1.0000	0.9776	0.9776	-0.0224
Zambia	1.0000	1.0003	1.0003	0.0003
Zimbabwe	0.9798	1.1517	1.1284	0.1284

Table 7: Nations' Productivity for Years 1987/1988

Country	EFFCHG	TECHG	MLMQST	PRODGR
Belize	1.0614	0.9047	0.9602	-0.0398
Benin	1.0553	0.6201	0.6544	-0.3456
Burkina Faso	1.1473	0.7450	0.8548	-0.1452
Burundi	0.9229	0.8605	0.7942	-0.2058
Cameroon	0.8837	0.8281	0.7318	-0.2682
Central African Republic	1.1892	0.6682	0.7946	-0.2054
Chad	0.9457	0.7522	0.7113	-0.2887
Chile	1.0116	1.0337	1.0456	0.0456
Colombia	1.0661	0.9600	1.0234	0.0234
Comoros	1.0000	0.9458	0.9458	-0.0542
Congo	0.7629	1.0064	0.7677	-0.2323
Costa Rica	1.0000	0.9774	0.9774	-0.0226
Cote d'Ivoire	1.0358	0.8946	0.9266	-0.0734
Dominican Republic	1.0969	1.0187	1.1173	0.1173
Ecuador	0.8062	0.9913	0.7992	-0.2008
Egypt, Arab Republic	1.1597	0.9563	1.1090	0.1090
El Salvador	1.0000	1.0548	1.0548	0.0548
Fiji	1.0867	0.8917	0.9690	-0.0310
Gambia, The	1.4446	0.7730	1.1167	0.1167
Ghana	1.0000	0.9289	0.9289	-0.0711
Guatemala	1.0000	1.0225	1.0225	0.0225
Honduras	1.2216	0.9009	1.1005	0.1005
India	1.0000	0.9017	0.9017	-0.0983

Table 7: Nations' Productivity for Years 1987/1988 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Indonesia	1.0392	0.9965	1.0355	0.0355
Jamaica	1.0000	1.0988	1.0988	0.0988
Kenya	1.4082	0.7148	1.0066	0.0066
Madagascar	1.9113	0.6485	1.2395	0.2395
Malawi	1.6337	0.6702	1.0949	0.0949
Mali	1.4997	0.6711	1.0065	0.0065
Mauritania	1.0871	0.9032	0.9819	-0.0181
Mauritius	1.0000	1.0585	1.0585	0.0585
Morocco	0.9347	0.9835	0.9193	-0.0807
Namibia	1.1109	0.8936	0.9927	-0.0073
Nepal	1.0603	0.8975	0.9516	-0.0484
Nicaragua	1.0000	0.6829	0.6829	-0.3171
Nigeria	1.0000	0.9478	0.9478	-0.0522
Pakistan	0.9197	0.9844	0.9053	-0.0947
Panama	1.0000	0.8489	0.8489	-0.1511
Papua New Guinea	1.2273	0.9167	1.1251	0.1251
Paraguay	1.1230	0.8294	0.9314	-0.0686
Philippines, The	1.0000	1.0090	1.0090	0.0090
RDC (former Zaire)	1.3849	0.7880	1.0914	0.0914
Rwanda	1.0000	0.9004	0.9004	-0.0996
Senegal	1.4529	0.6587	0.9571	-0.0429
Sierra Leone	1.2723	0.8371	1.0650	0.0650
Sri Lanka	0.9608	1.0044	0.9650	-0.0350

Table 7: Nations' Productivity for Years 1987/1988 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Swaziland	1.0147	1.0178	1.0328	0.0328
Syrian Arab Republic	1.0000	0.8207	0.8207	-0.1793
Thailand	0.8907	1.0584	0.9427	-0.0573
Togo	0.9954	0.9927	0.9881	-0.0119
Tunisia	1.0010	1.0014	1.0024	0.0024
Turkey	1.0937	0.9227	1.0091	0.0091
Uruguay	1.0000	1.0019	1.0019	0.0019
Zambia	1.0000	1.2164	1.2164	0.2164
Zimbabwe	1.0498	0.9768	1.0255	0.2550

Table 8: Nations' Productivity for Years 1988/1989

Country	EFFCHG	TECHG	MLMQST	PRODGR
Belize	0.9421	0.9827	0.9258	-0.0742
Benin	1.3951	0.7023	0.9798	-0.0202
Burkina Faso	1.3113	0.7897	1.0356	0.0356
Burundi	1.1493	0.9871	1.1344	0.1344
Cameroon	0.9271	0.8641	0.8011	-0.1989
Central African Republic	0.7999	0.6342	0.5073	-0.4927
Chad	1.7793	0.6734	1.1982	0.1982
Chile	0.7558	1.0778	0.8147	-0.1853
Colombia	0.9389	0.9943	0.9336	-0.0664
Comoros	1.0000	0.8985	0.8985	-0.1015
Congo	0.8613	0.9809	0.8449	-0.1551
Costa Rica	1.0000	1.0183	1.0183	0.0183
Cote d'Ivoire	0.9654	0.8048	0.7769	-0.2231
Dominican Republic	0.8325	1.0358	0.8623	-0.1377
Ecuador	1.2228	0.9430	1.1531	0.1531
Egypt, Arab Republic	1.0158	0.9753	0.9908	-0.0092
El Salvador	1.0000	1.1184	1.1184	0.1184
Fiji	0.9202	0.9882	0.9094	-0.0906
Gambia, The	1.1222	0.8825	0.9902	-0.0098
Ghana	1.0914	0.9051	0.9879	-0.0121
Guatemala	1.0000	0.9966	0.9966	-0.0034
Honduras	1.1258	0.9198	1.0356	0.0356
India	1.0000	0.9391	0.9391	-0.0609

Table 8: Nations' Productivity for Years 1988/1989 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Indonesia	1.0737	0.9383	1.0075	0.0075
Jamaica	1.0000	0.9238	0.9238	-0.0762
Kenya	1.0753	0.8946	0.9620	-0.0370
Madagascar	1.5878	0.6256	0.9933	-0.0067
Malawi	1.3302	0.8083	1.0752	0.0752
Mali	1.1493	0.7708	0.8859	-0.1141
Mauritania	0.9359	0.9863	0.9230	-0.0770
Mauritius	1.0000	0.9622	0.9622	-0.0378
Morocco	1.2424	0.8409	1.0448	0.0448
Namibia	1.1198	0.9921	1.1110	0.1110
Nepal	1.0495	0.9443	0.9910	-0.0090
Nicaragua	1.0000	0.7722	0.7722	-0.2278
Nigeria	1.2564	0.8698	1.0928	0.0928
Pakistan	1.1475	0.8396	0.9634	-0.0366
Panama	1.0000	0.9549	0.9549	-0.0451
Papua New Guinea	0.9820	1.0323	1.0138	0.0138
Paraguay	0.8162	1.1973	0.9772	-0.0228
Philippines, The	1.0000	1.0409	1.0409	0.0409
RDC (former Zaire)	1.7323	0.6772	1.1730	0.1730
Rwanda	1.0000	0.9829	0.9829	-0.0171
Senegal	1.1961	0.8702	1.0409	0.0409
Sierra Leone	2.1558	0.6486	1.3983	0.3983
Sri Lanka	0.9540	1.0061	0.9598	-0.0402

Table 8: Nations' Productivity for Years 1988/1989 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Swaziland	0.9263	0.9104	0.8433	-0.1567
Syrian Arab Republic	1.0000	0.9731	0.9731	-0.0269
Thailand	1.0907	0.9135	0.9964	-0.0036
Togo	0.9236	0.9745	0.9000	-0.1000
Tunisia	1.0392	0.9772	1.0155	0.0155
Turkey	0.9123	1.0670	0.9734	-0.0264
Uruguay	1.0000	1.0435	1.0435	0.0435
Zambia	1.0000	0.6622	0.6622	-0.3378
Zimbabwe	1.1712	0.8910	1.0435	0.0435

Table 9: Nations' Productivity for Years 1989/1990

Country	EFFCHG	TECHG	MLMQST	PRODGR
Belize	1.0000	1.0189	1.0189	0.0189
Benin	0.9961	1.0153	1.0114	0.0114
Burkina Faso	1.1186	0.9889	1.1061	0.1061
Burundi	1.1727	0.8270	0.9698	-0.0302
Cameroon	0.8911	0.9739	0.8678	-0.1322
Central African Republic	1.8113	1.1358	2.0572	1.0572
Chad	0.8422	1.0968	0.9237	-0.0763
Chile	1.0000	1.0091	1.0091	0.0091
Colombia	1.0504	0.9375	0.9847	-0.0153
Comoros	1.0000	0.8862	0.8862	-0.1138
Congo	1.2407	0.8985	1.1148	0.1148
Costa Rica	1.0000	1.0094	1.0094	0.0094
Cote d'Ivoire	1.0000	0.9862	0.9862	-0.0138
Dominican Republic	1.0713	0.9969	1.0679	0.0679
Ecuador	1.0850	0.9731	1.0559	0.0559
Egypt, Arab Republic	1.0136	1.0136	1.0274	0.0274
El Salvador	1.0000	0.8716	0.8716	-0.1284
Fiji	1.0000	1.0242	1.0242	0.0242
Gambia, The	1.1689	0.9456	1.1053	0.1053
Ghana	1.1832	0.9439	1.1168	0.1168
Guatemala	1.0000	0.9176	0.9176	-0.0824
Honduras	0.9559	0.9960	0.9522	-0.0478
India	1.0000	0.9240	0.9240	-0.0760

Table 9: Nations' Productivity for Years 1989/1990 (continued)

Country	EFFCHG	TECHG	MLMQST	PRODGR
Indonesia	1.1530	0.8840	1.0192	0.0192
Jamaica	1.0000	0.9963	0.9963	-0.0037
Kenya	0.9805	0.9734	0.9544	-0.0456
Madagascar	0.9638	1.1043	1.0642	0.0642
Malawi	1.0351	0.9806	1.0150	0.0150
Mali	1.0039	1.0378	1.0419	0.0419
Mauritania	1.1247	0.9822	1.1046	0.1046
Mauritius	1.0000	0.9825	0.9825	-0.0175
Morocco	1.0116	0.9212	0.9318	-0.0682
Namibia	1.0523	1.0278	1.0816	0.0816
Nepal	1.0447	0.8723	0.9113	-0.0887
Nicaragua	1.0000	1.0904	1.0904	0.0904
Nigeria	1.2485	0.8918	1.1134	0.1134
Pakistan	1.0659	0.9384	1.0002	0.0002
Panama	1.0000	1.1055	1.1055	0.1055
Papua New Guinea	0.9747	0.9986	0.9733	-0.0267
Paraguay	0.9716	1.0372	1.0078	0.0078
Philippines, The	1.0000	1.0035	1.0035	0.0035
RDC (former Zaire)	0.8556	1.0688	0.9145	-0.0855
Rwanda	1.0000	0.9085	0.9085	-0.0915
Senegal	0.9283	1.0688	0.9921	-0.0079
Sierra Leone	0.7192	1.0910	0.7846	-0.2154
Sri Lanka	0.8720	0.9417	0.8212	-0.1788

Table 9: Nations' Productivity for Years 1989/1990 (continued)

Country	EFFCHG 1989/1990	TECHG 1989/1990	MLMQST 1989/1990	PRODGR 1989/1990
Swaziland	1.0691	0.8603	0.9198	-0.0802
Syrian Arab Republic	1.0000	0.8926	0.8926	-0.1074
Thailand	1.1046	0.9501	1.0496	0.0496
Togo	1.1650	0.9097	1.0598	0.0598
Tunisia	0.9401	1.0065	0.9462	-0.0538
Turkey	1.0021	0.9429	0.9448	-0.0552
Uruguay	1.0000	0.9843	0.9843	-0.0157
Zambia	1.0000	0.9190	0.9190	-0.0810
Zimbabwe	1.0557	0.9506	1.0035	0.0035

Table 10: Nations' Productivity for Years 1990/1991

Country	EFFCHG 1990/1991	TECHG 1990/1991	MLMQST 1990/1991	PRODGR 1990/1991
Belize	1.0000	0.9989	0.9989	-0.0011
Benin	0.8908	1.0001	0.8909	-0.1091
Burkina Faso	0.8876	1.0120	0.8982	-0.1018
Burundi	1.0628	0.9187	0.9764	-0.0236
Cameroon	1.2192	0.7640	0.9314	-0.0686
Central African Republic	0.8718	0.9741	0.8492	-0.1508
Chad	0.8938	0.9677	0.8649	-0.1351
Chile	1.0000	0.8925	0.8925	-0.1075
Colombia	1.0156	0.9920	1.0075	0.0075
Comoros	1.0000	0.9692	0.9692	-0.0308
Congo	1.1175	0.8664	0.9682	-0.0318
Costa Rica	1.0000	0.9420	0.9420	-0.0580
Cote d'Ivoire	1.0708	1.0254	1.0980	0.0980
Dominican Republic	0.9683	0.9979	0.9663	-0.0337
Ecuador	1.0185	0.9516	0.9693	-0.0307
Egypt, Arab Republic	0.9881	0.9743	0.9628	-0.0372
El Salvador	1.0000	1.0885	1.0885	0.0885
Fiji	1.0000	1.0019	1.0019	0.0019
Gambia, The	0.8875	0.9602	0.8521	-0.1479
Ghana	1.1045	0.9330	1.0305	0.0305
Guatemala	1.0000	0.9763	0.9763	-0.0237
Honduras	0.9914	0.9897	0.9812	-0.0188
India	1.0000	0.8684	0.8684	-0.1316

Table 10: Nations' Productivity for Years 1990/1991 (continued)

Country	EFFCH 1990/1991	TECHG 1990/1991	MLMQST 1990/1991	PRODGR 1990/1991
Indonesia	1.1198	0.8731	0.9777	-0.0223
Jamaica	1.0000	0.9468	0.9468	-0.0532
Kenya	1.0260	0.9793	1.0004	0.0004
Madagascar	0.6126	0.9741	0.5967	-0.4033
Malawi	1.0964	0.9376	1.0279	0.0279
Mali	1.0432	1.0487	1.0939	0.0939
Mauritania	0.9653	0.9996	0.9649	-0.0351
Mauritius	1.0000	0.9961	0.9961	-0.0039
Morocco	0.9708	0.8993	0.8730	-0.1270
Namibia	0.9212	0.9697	0.8933	-0.1067
Nepal	1.1808	0.9508	1.1227	0.1227
Nicaragua	1.0000	0.9517	0.9517	-0.0483
Nigeria	1.0621	0.9192	0.9763	-0.0237
Pakistan	1.0401	0.9203	0.9572	-0.0428
Panama	1.0000	1.0717	1.0717	0.0717
Papua New Guinea	1.0716	0.9869	1.0575	0.0575
Paraguay	1.0423	0.9904	1.0323	0.0323
Philippines, The	1.0643	0.8806	0.9372	-0.0628
RDC (former Zaire)	0.9660	0.8856	0.8555	-0.1445
Rwanda	1.0000	0.9039	0.9039	-0.0961
Senegal	0.9066	1.0469	0.9491	-0.0509
Sierra Leone	0.6390	0.9171	0.5860	-0.4140
Sri Lanka	1.0479	0.9491	0.9945	-0.0055

Table 10: Nations' Productivity for Years 1990/1991 (continued)

Country	EFFCHG 1990/1991	TECHG 1990/1991	MLMQST 1990/1991	PRODGR 1990/1991
Swaziland	1.4573	0.6233	0.9083	-0.0917
Syrian Arab Republic	1.0000	0.7318	0.7318	-0.2682
Thailand	1.1072	0.8876	0.9827	-0.0173
Togo	1.0818	0.9184	0.9936	-0.0064
Tunisia	1.1373	0.8658	0.9847	-0.0153
Turkey	1.0521	0.9602	1.0103	0.0103
Uruguay	1.1345	0.9345	1.0602	0.0602
Zambia	1.0000	0.9538	0.9538	-0.0462
Zimbabwe	1.2191	0.9152	1.1157	0.1157