TESTING THE PREDICTIVE POWERS OF COMMON MEASURES OF TOTAL FACTOR PRODUCTIVITY GROWTH AND CONVERGENCE HYPOTHESIS

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Doctor of Philosophy in Economics

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Declaration of Originality

I hereby declare that this project is entirely my own work and that any additional sources of information have been duly cited.

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Abstract

Sustaining a high economic growth rate in the long run is a key and focused area for economists and policy makers. Theorists and researchers propose several policies for this purpose and some are of the view that a high economic growth rate can be achieved through factor accumulation, but others support the argument that it is possible through enhancing total factor productivity (TFP) growth. TFP growth is described as the unexplained part of economic growth which captures the effects of economies of scale, foreign direct investment, education expenditures, technological growth, and so on. Three methods are commonly used to measure TFP growth: growth accounting, index number and econometric method. If TFP reasonably captures the effects of technological growth then it must induce new investment which may enhance the future economic growth of a country.

The objectives of this study are: 1) to find and discuss the trends of TFP growth measured through the above mentioned three methods, 2) to test the predictive powers of TFP growth in determining future investment and economic growth, and 3) to test the absolute and conditional convergence of economic growth and TFP growth. For these purposes, annual data have been used from 1990 to 2009 for a panel of 35 countries selected from different regions. The results indicate that the trends of TFP growth during the sample period in the selected panel remained cyclical. However, each economy of the selected panel realized positive annual average TFP growth during the sample period according to all of the three TFP measurement methods employed. East Asian and South Asian regions reaped higher growth rates of TFP than Central and East European, African, Latin American, and EU-15 regions. Moreover, the econometric method produced consistent trends of TFP growth relative to those produced through growth accounting and index number methods. The results

of pooled regression and fixed effects panel regression models indicate that the measurement of TFP growth through the growth accounting method is a better predictor of future investment and economic growth than measurement through index number and econometric methods. The study has found evidence of absolute convergence of economic growth among the countries included in the full sample of 35 countries. But, if sub-samples of these countries are selected on a regional basis no evidence of absolute convergence of economic growth is found. Nonetheless, conditional convergence of economic growth in the case of the full sample and each of the sub-samples has been found to be significant.

Last, but not least, the absolute convergence of TFP growth does not exist in the full sample or in the sub-samples of Central and East Europe, Africa, Latin America, and South Asia. However, the conditional convergence of TFP growth in the case of the full sample and all of the sub-samples has been found to be significant. The findings of this study have valuable implications for researchers and policy makers and they are discussed in the last chapter.

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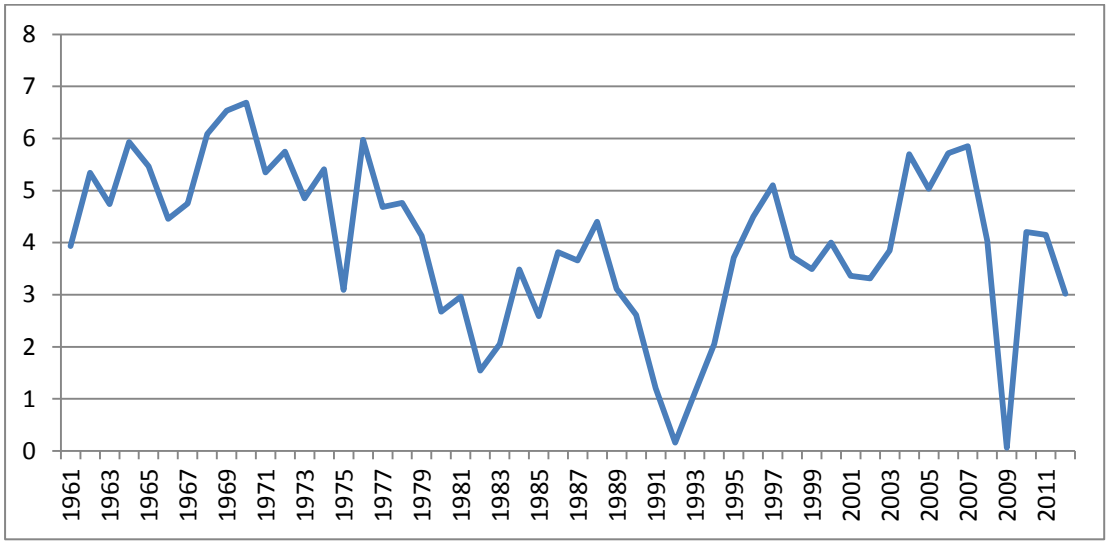
Chapter 1

Introduction

1.1 Background of the Problem

Countries across the globe have experienced remarkable differences in growth rates of real GDP. Some countries have been enjoying quite high growth rates of real GDP, whereas others have been facing low growth rates that are insufficient to fulfill the needs of a growing population. But, the overall growth rate of real GDP has been lower than its potential. The world economies have realized an average real GDP growth rate of 3.86 percent per year during the period 1961 to 2012. Moreover, the average real GDP growth rate of world economies remained at 5.26 percent, 5.04 percent, 3.06 percent, 2.80 percent, 4.10 percent during 1960s, 1970s, 1980s, 1990s and 2000s respectively. Furthermore, during 2010 to 2012 the average real GDP growth rate of the world economies has declined to 3.80 percent per year. In particular, during 2012 the said growth rate remained at just 3.01 percent per year[1].

Figure 1.1 World Economies' Real GDP Growth Trends



[1] The average real GDP per capita growth rates of world economies have been computed by the author using the data obtained from World Development Indicators mark 2013. Only available data have been used for this calculation. The term "world economies" does not include all the economies of the world.

Figure 1.1 represents the average growth trends of real GDP of the world economies. Differences in real GDP growth rates exist not only across countries but also across the time period as shown by Figure 1.1. Such differences invite investigation. Once the factors responsible for these differences are identified, economic policies may be devised that could enhance the growth rates of real GDP. Although in economics an abundant literature on economic growth is available, this issue is still important and current.

Theorists have established various economic models that explain the mechanisms of long-term output growth rates. But, the relative importance of the factors of output growth rates is still disputed. In general, theorists of growth models can be grouped into two main categories: accumulationists and revisionists[2]. Accumulationists believe that output growth is mainly the result of capital accumulation. Conversely, revisionists relate output growth with total factor productivity (TFP) growth. Harrod (1939) and Domar (1946) explained the mechanism of long-term output growth under the assumption of fixed proportions of factors. Unlike these models, Solow (1956) assumed that labor and capital, to a large extent, are substitutable (but not perfectly substitutable) with each other and presented a simple model of economic growth. According to him, physical capital, labor and exogenously determined technology are the sources of output growth. He specified a production function that is called the neoclassical production function and estimated this function using the data on a sample of economically developed countries. He observed that the specified growth model does not explain a large proportion of output growth. The unexplained proportion of output growth is called Solow residual. The same is also known as TFP growth. Since Solow (1956), a large number of researchers have conducted studies to

[2] The accumulationist and revisionist frameworks are discussed in detail in Chapter 2.

identify the factors of output growth. Nonetheless, the idea of TFP growth is still important because besides measuring output growth and cross-country growth differences it determines economic fluctuations and business cycle frequencies (Comin and Gertler, 2006). Studies of TFP growth investigate the reasons for lackluster, volatile and slow output growth. Being a multifaceted mechanism the output growth involves many factors besides capital accumulations and technology. The combined impact of these factors remains behind the concept of TFP, very succinctly brought forth by Solow (1957).

The basic idea of TFP can be better understood by drawing inferences from the different connotations in which the term has been used. Some studies suggest that TFP measures total output produced by given quantities of labor and capital. Further, high levels of TFP are the results of improved technology, higher capital to labor ratio, and larger economies of scale. Other studies view TFP as an economy's productive ability with a given stock of inputs. Therefore, TFP captures the effects of technical growth, human and physical capital growths, research and development expenditures, economies of scale, government policies, international trade policies, remittances, and so on. Another reason for the continual importance of TFP is the scarcity of factors of production. Due to the unavailability of new factors of production, especially in economically developed countries, long-term sustainable output growth is almost impossible through factor accumulations. Alternatively, long-term output growth can be sustained by putting the existing factors of production to more productive and efficient use that necessitates technological growth.

According to neoclassical growth models, a technical advancement pushes the production function of an economy outward. It is worth noting that technical improvement is a multistage process. First, it requires a research process in order to

invent a new technology. Second, it needs discovery and development. After discovering the new technology its diffusion is required. Last, but not least, the adoption of new technology requires heavy investment. TFP measures the effects of many factors, for example economies of scale, trade openness, education and health expenditures, government policies and technical change (TC). However, a good contribution of technical improvement in TFP will raise the marginal productivity of capital per worker (MPk). The increased MPk will attract new investments which would raise the output level. Koeva (2000) highlighted the existence of time lags involved in the process of investment. According to him, investment is a long-term phenomenon that takes 13 to 86 months for its completion. Keeping the whole discussion in mind as given above it can be understood that a technical improvement, which is a constituent of TFP, raises the MPk which attracts new investment. Being a lagged phenomenon new investments affect future real output. Therefore, if TFP growth rightly captures technical growth and it grows mainly due to technical improvements, then it should significantly predict future investment and output growths. The inability of TFP growth to significantly predict future investment and output growths raises one of two points: either technical improvement does not take place or TFP growth is not a right measure of technical growth. In the same line of argument one can reach the conclusion that if TFP is influenced by factors other than technical growth then virtually very low or no investment will ensue. As a result, TFP growth would not be a good predictor for future output growth.

A review of previous studies indicates various methods of measuring the TFP growth rate in an economy: growth accounting method, index number method, and econometric method. Each method is characterized by certain advantages and disadvantages as will be discussed in detail in Chapter 3. These methods are

commonly used in TFP studies to estimate trends of TFP growth. Moreover, a literature review suggests that the majority of the studies have been directed to identify the sources of TFP growth. Studies on testing the powers of TFP growth to predict future investment and output growth are very few. Furthermore, these studies rely on the growth accounting method of TFP growth measurement. I could find no study that compared the three commonly used methods of measuring TFP growth with respect to the predictive powers of TFP growth in determining future investment and output growths. Therefore, a detailed study is needed that compares the three mentioned methods of TFP measurement to identify the method that correctly captures technical growth and is helpful in significantly predicting future investment and output growths.

Neoclassical growth theory (Solow, 1956, 1957) implies that poor countries grow economically faster than rich countries. Therefore, sooner or later, this tendency will equalize per capita real GDP across the nations of the world. This notion is called absolute convergence hypothesis. Conversely, endogenous growth models (Romer, 1986; Lucas, 1988) suggest that the convergence of output growth is conditional on a country's internal systems and characteristics. This is called conditional convergence. Studies regarding convergence investigate whether the tendency for developing countries to grow faster than developed countries exists. The main objective of convergence studies has been to determine the rate at which a developing country can catch up an advanced economy. The idea of convergence has recently received a great deal of attention in the literature of economics. The present study also incorporates the absolute and conditional convergence tests of output growth and TFP growth for a large panel of countries. According to Sachs et al. (1995), a strong conditional convergence exists in the countries that have adopted growth-oriented policies,

whereas it does not exist in the countries that have not adopted these policies. Another interesting concept given by Miller and Upadhyay (2000) is about the absolute convergence test of TFP growth that determines whether technology is a public good or a private good. One view of absolute convergence of TFP growth recommends that technology is a public good that can readily cross international borders. Conversely, if the idea of conditional convergence is more relevant then each economy should bear its own research and development expenditures in order to grow technologically. Therefore, TFP growth convergence tests are meaningful and enhance the fruitfulness of the study.

1.2 Purpose Statement

In a world of scarce resources a noticeable long-term output growth through factor accumulations is not possible. Therefore, it is strongly recommended that the world economies should put their available resources to most efficient use in order to achieve remarkable long-term sustainable output growth. The efficient use of available resources necessitates technical advancements. TFP growth (a proportion of output growth not accounted for by factor accumulations) is conventionally measured to capture the combined contributions of economies of scale, trade openness, technical growth, government policies, education and health expenditures, and so on, in output growth. Researchers commonly use three methods to measure TFP growth: growth accounting method, index number method, and econometric method. The present study aims to empirically compare the three commonly used methods of measuring TFP growth with respect to their ability to predict future investment and output growths for a large panel of countries. Moreover, using the notions of neoclassical growth theory and endogenous growth theory the study intends to

identify whether output growth and TFP growth absolutely converge to their steady-state growth path or conditionally converge.

1.3 Objectives of the Study

The following are the main objectives of the present study:

1. To compare the predictive powers of the three commonly used methods of measuring TFP growth in determining future investment and output growth.
2. To determine whether the economies of a large panel of countries converge to a common steady-state economic growth rate (absolute convergence) or each economy converges to its own steady-state economic growth rate (conditional convergence).
3. To determine whether the economies of a large panel of countries converge to a common TFP growth rate or each economy converges to its own TFP growth rate.

1.4 Organization of the Remaining Chapters

The rest of the study is organized as follows: Chapter 2 reviews the relevant empirical studies of TFP and output growths and convergence tests. Chapter 3 discusses the theoretical foundations of the three measures of TFP growth and the theories on how TFP growth determines future investment growth and output growth. Chapter 4 describes econometric methodology and data. Chapter 5 presents the trends of TFP growth estimated through each method. These trends are presented and discussed for all the economies individually; average trends for the regional and full panels of the 35 selected countries are also presented and discussed. The effects of TFP growth on future investment and economic growths and convergence tests of TFP growth and

economic growth are discussed in Chapter 6. Chapter 7 draws conclusions from the study, presents some important implications of the study and makes recommendations for future research.

Chapter 2

Review of the Literature

This chapter has been divided into three sections. The first section reviews important studies on TFP growth and economic growth. The second section covers the main studies to review the issues of convergence. The third section presents a summary of the reviewed studies.

2.1 Total Factor Productivity Growth and Economic Growth

The discussion on sources of growth took on great importance after the publication of two influential papers: Solow (1956) and Swan (1956). Solow (1956) drew the attention of researchers towards a most important factor behind stable economic growth and termed this factor: TFP. He examined why some countries grew more rapidly than others and acknowledged two main causes of this as follows:

a) Developed countries had higher tendencies to save than developing countries and hoarded physical capital rapidly.

b) These countries used their resources more efficiently.

Because of above two causes the growth rate in these countries generally remained high as compared to others. The second observation as stated above attracted researchers to study the role of TFP growth (TFPG). These studies attempted on the one hand to explain the role of TFPG in the developed world and on the other hand addressed the issues of wavering and slow economic growth in developing countries. Much of the literature on TFPG can be bifurcated into two categories: one which supports the importance of the role of TFPG and one which considers that factor accumulation is more important than TFPG in accelerating economic growth.

The theoretical and empirical literature on the measurement and testing of TFPG has emerged very swiftly and it has gained much importance. As a result, a sufficient literature has been formed on the subject. Han (2003) has rightly stated that "Since Solow (1957), the number of studies attempting to calculate TFPG for various economies have been too numerous to count"[3]. However, this chapter reviews the most important and relevant studies.

On the assumption of substitutability between factors of production, Solow (1956) developed a production function: output growth as a function of capital, labor, and TC. According to Solow, TC only creates impact on the productivity of labor: this is called *Harrod neutral*. The Solow model assumes an exogenous and homogenous diffusion of technology across countries. He noted that even if TC emerges at the same rate, output growth rates may differ in different countries. These differences in output growth rates of different countries correspond to differences in accumulation of capital. His model predicts the possibility of the occurrence of the convergence hypothesis. This states that a country's real per capita GDP (RGDP) growth is negatively correlated with the initial level of income of the respective country.

Neoclassical growth theory has been empirically tested by economists using the growth accounting analysis method. This method has also been used to evaluate the effects of changes in physical capital stock on output growth. The role of capital accumulation in output growth has been questioned by analysts on the basis of the results of the early growth accounting exercises. The Solow model suggests that capital and labor accumulation do not fully explain output growth. There remains a large unexplained residual in total output growth. This unexplained portion is

[3] See page 1 of Han (2003).

generally termed as Solow residual[4]. In the neoclassical framework there is greater emphasis on factor accumulation. Limam and Miller (2004) observed that differences in productivity growth caused by TC are ascribed to the large residual. This deficiency in the neoclassical model renders it unable to explain cross-country differences in RGDP growth and failure of the convergence hypothesis as a result. This model also does not explain the differences in real rates of returns on capital in different countries (Mankiw et al., 1995). Mankiw et al. (1995) devised a new method and defined capital in terms of physical and human capital. This enabled them to conclude that their observations closely resembled the theoretical predictions of the neoclassical model. Works by Barro and Sala-i-Martin (1992, 1995), Mankiw, Romer, and Weil (1992) follow the same line of argument.

Abramovitz (1956) determined the output growth per worker using two data sets for the periods 1869 to 1878 and 1944 to 1953 in the case of the USA. He observed that factor accumulation explained just 10 percent of the output growth per worker. He noted that ninety percent of the output growth was unexplained by the physical factors of production included in his model. Solow (1957) termed the similar unexplained part of output growth as TFP. The findings of Abramovitz (1956) were undoubtedly surprising. Therefore, many researchers determined the role of factor accumulation in output growth in the case of the USA. The work of other researchers reflected that the residual part of output growth was not as much as in the study of Abramovitz (1956). However, it was still significantly high. In this respect the study of Denison and Denison (1962) is very important; they reported that the contribution of TFP was almost 67 percent of the output growth of the USA.

[4] Solow residual is also called total factor productivity (TFP).

Jorgenson and Griliches (1967), Jorgenson et al. (1987) and Jorgenson and Stiroh (2000) argued that traditional measures of TFP growth overestimate it. According to them, the flow of services produced by the capital stock is more important in measuring TFP than the capital stock itself. As an alternative, they used a quality-adjusted measure of labor input. They weighted different groups of labor force according to their attributes, for instance gender, qualification, and age. They found that TFP under this weighted approach of labor and capital inputs remained lower than TFP measured using the traditional approach.

Easterly and Levine (2001) added a new dimension to research on RGDP growth. They discovered four interesting facts in this respect. They suggested that growth economists should focus on TFP and its determinants rather than factor accumulation and its role in growth. They suggested the following steps in this regard.

First, much of the empirical evidence accumulated to date indicates that factor accumulation does not fully explain cross-country output growth in respect of the countries observed.

Second, they were of the view that increasing divergence in per capita income growth hints at TFP with increasing returns to technology. This should be given consideration.

Third, they observed a dichotomy of behavior in the cases of the developing and developed world. On the basis of time-series data they observed that physical capital accumulation has a long life in many countries while per capita output growth does not persist. This fact allowed them to say that steady-state growth may be in accordance with the experience of developed countries, but it is not the experience of many developing countries.

Lastly, they pointed to the localized mobility of factors of production, which causes concentration of these with increased economic activity. Given that situation models

with technological complementarities are more suitable than the neoclassical models which assume homogenous technology.

The interest in the study of productivity as a source of output growth led to the development of new methods. Latter researchers began to analyze output growth on the basis of input(s) and productivity growth.

Given the above background, there exist two schools of thought in the literature on TFPG, especially in the case of East Asian countries. One view is called "accumulationist" view. This viewpoint can also be termed the traditional view because traditionally growth has been linked to the accumulation of resources. The other school of thought is a reaction to this school; it is called "revisionist". The followers of this school of thought argue that factors other than mere accumulation were responsible for the economic miracle of East Asian countries (the Asian tigers).

Hagen and Hawrylyshyn (1969) observed that in the case of developing countries the contribution of factor accumulation is more important for output growth, whereas in the case of developed nations TFP was observed to be more important in accelerating output growth than mere factor accumulation.

Young (1992), and Kim and Lau (1994), conducted the first dynamic research in accumulationist framework. Young (1992) chose Singapore and Hong Kong to estimate TFPG as the Solow residual. In his research he found that in the case of Singapore the TFPG was zero, whereas in the case of Hong Kong it was almost negligible. He concluded that factor accumulation explained much of the economic growth of these countries. Young (1995) in a study that developed his earlier work (Young, 1992) included South Korea and Taiwan, which then were two embryonic and fast growing economies. He made a division of his study into two segments: agricultural and non-agricultural sectors. He concentrated on the growth of the

agricultural sector, perhaps under the inclination that accumulation is more important in the agricultural sector. After this exercise he directed his study to the non-agricultural sector. He reported that TFPG for this sector was respectively 0.2 percent, 1.7 percent, 2.1 percent, and 2.3 percent for Singapore, South Korea, Taiwan, and Hong Kong. He then made a comparative study of developed countries and developing countries to explore the existence of TFPG between the two groups of countries. He used this comparative study to match the results and apply his conclusion regarding the effect of TFPG in the four countries under his study (Singapore, Hong Kong, South Korea, and Taiwan). The developed countries he selected were Canada, France, Germany, Italy, Japan, UK and USA. From the developing countries he selected Brazil, Mexico, and Chile. On the basis of this comparative study he concluded that TFPG in East Asian countries matched that of OECD and Latin American countries[5].

In another study, Young (1994) extended his sample of countries. In this study he included Japan, countries of Europe and Latin America (LA) besides East Asian countries. He ran cross-sectional regression on this extended sample of countries. He measured residuals for the countries under study and used these as a measure of TFPG. The results he reached were as follows. TFPG for South Korea was 1.4 percent, for Hong Kong it was 2.5 percent, 0.1 percent for Singapore, 2.5 percent for Hong Kong, and 3.5 percent for Egypt. Regarding the developed countries his results showed TFPG for Italy was 1.8 percent, for Japan it was 1.2 percent, 0.9 percent for Britain, and 0.4 percent for USA. In this study Young found that TFPG for Hong Kong was higher as compared to other countries. Otherwise, TFPGs in the rest of the East Asian

[5] He observed that TFPG ranged from 0.4 percent to 2 percent in the case of developed countries whereas it varied from 0.8 percent to 1.6 percent in the case of developing countries.

countries were not very much different from the rest of the world. The results were very similar to his other studies Young (1992, 1995).

Kim and Lau (1994) determined the sources of economic growth. They covered East Asian countries and G5 industrialized countries in their sample and collected the data for the post-World War II period. The study was conducted on the assumption that the infrastructure and the production function were both elastic enough to cater for the TC. The TFP was measured over time. The researchers arrived at two different results for the two groups of countries. They found that most of the growth in the East Asian countries was the result of the accumulation of capital and labor. Whereas, technical progress along with innovation were responsible for accelerated growth in the industrialized world.

Cororaton et al. (1995) measured TFP using two commonly used approaches: growth accounting approach and stochastic frontier production function. For their study they used the data of 25 large-scale manufacturing industries of the Philippines and selected the sample period of 1956 to 1992. They observed that TFP had a negative sign in the case of the Philippines. Moreover, the number of industries with negative TFP was increasing over time during the period of study. Findings of TFP under the growth accounting approach reflected that during 1961 to 1965 there were only two industries with a negative sign of TFP in the Philippines. They found that during 1991 and 1992 the number of industries with negative TFP growth increased to 16. Further, they observed that during the late 1980s and early 1990s TFP reduced sharply. They used a trans-logarithmic production function (TL-PF) through the stochastic frontier approach to obtain TFP during the period under study. Although there was a difference between the number of industries with a negative growth rate of TFP measured using this approach and those measured using the growth accounting

approach, the trend was the same: TFP was declining in the large-scale manufacturing industries of the Philippines during the period of study. Findings of TFP measured using the stochastic frontier approach reflected that during the period 1956 to 1970 there were only three industries with negative growth rates which increased to nine and 10 during the periods of 1971 to 1980 and 1981 to 1992 respectively. They also computed the correlation coefficients of TFP estimates for the said three sub-periods. They found that during the first two sub-periods TFP estimates under the two approaches were correlated by 62.5 percent and 53.8 percent respectively. Whereas the correlation coefficient of TFP estimates under growth accounting and stochastic frontier approaches was just 0.262 during the last sub-period 1981 to 1992. However, they opined that the growth accounting approach assumes that industries never deviate from the production frontier so it produces biased TFP estimates.

Krugman (1994) gave a pessimistic view of East Asian economies. He argued that the economic growth of East Asia (EA) had been input driven and not technical based. He advocated that input-driven economic growth is not sustainable in the long run. He drew an analogy with the experience of the Soviet Union. However, his analysis of East Asian economic growth relied on a simplistic interpretation of the sources of growth. Perhaps he was guided by Eurocentric sentiments. He gave too little weight to the potential dynamic changes in EA. He is not correct in concluding that TC or productivity growth has been slow in East Asian economies. These economies have been very quick to welcome and adopt the latest technology. In fact, TC has a significant role in the East Asian miracle. Nevertheless, he would have been right if he had referred to the inability of East Asian economies to maintain double digit growth rates. Certainly no economy can sustain a high or double digit growth rate for

a long period of time. But this has little to do with the question of whether economic growth is or is not input driven[6].

Chen (1997) examined the studies of TFP as a source of growth in East Asian countries. He argued that the importance of TC in economic growth depends largely on how TFP is defined and measured. He argued that the conclusions drawn by Young (1992, 1994) and Krugman (1994) were based largely on the assumption that all TC is TFP.

Rosegrant and Evenson (1995) selected India for the measurement of TFP. They selected the period of 1956 to 1987 for this purpose. During the course of study, they computed TFP indices for 271 districts covering 13 states in India. Besides assessing TFP growth in India they examined the sources of productivity growth, including public and private investment, and estimated the rates of return to public investments in agriculture. Their results showed that significant TFP growth in the Indian crops sector was generated by investments, in research and extension services, marketing, and irrigation. The high rates of return, particularly to public agricultural research and extension, indicated that the Government of India was not over investing in agricultural research and investment. This implied that current levels of public investment could be expanded if they yield profit. They found that substantial productivity gains (as measured by TFP indexes) had been realized in Indian agriculture. Those gains varied somewhat from period to period (being highest in the green-revolution period) but in each period examined India realized gains. The rate of change in TFP was relatively high. TFP growth contributed roughly 1.1 percent growth per year to crop production in India. This growth rate matched the contribution in growth by conventional inputs since 1956. They stated that TFP gains

[6] Edward K.Y. Chen (1997), "The Total Factor Productivity Debate: Determinants of Economic Growth in East Asia", *Asian-Pacific Economic Literature* 11(1),18–38

showed that investments of many kinds were associated with, and have contributed to, TFP growth. Public agricultural research and extension explained nearly 60 percent of TFP growth over the period of 1956 to 1987.

Lederman and Fajnzylber (1999) selected 18 Latin American and Caribbean economies to determine growth rate of TFP. They relied on a series of growth accounting exercises to determine whether the growth rate of TFP measurement is relevant in this part of the world. After specifying their model (controlling for the accumulation of capital per worker) they tried to determine whether economic growth benefited from economic reforms. They used Sachs et al.'s (1995) criteria for the characterization of an economy as open, which they interpreted as concurring with periods of broader economic reforms.[7] They applied growth decomposition analysis and econometric tests to determine whether TFP growth had been significantly higher during periods of economic reforms. Because growth decomposition analysis assumes that the share of capital in output is constant across Latin American countries, the econometric estimates allow for cross-country differences. In ordinary least squares regressions and seemingly unrelated regressions, two alternative dummy variables were used to control the effects of cyclical fluctuations on observed rates of TFP growth. In addition, the seemingly unrelated regressions considered the possibility that Latin American economies face common shocks. For this purpose panel regressions were run. Panel regressions were based on 5-year averages of the growth rates of GDP and capital per worker. The researchers found that, on average, economic reforms had been associated with a 1.5 percent yearly increase in the rate of

[7] Sachs et al. (1995) defined an economy as "open" in a given year if all the following conditions are simultaneously satisfied: (a) the coverage of non-tariff barriers does not exceed 40 percent of foreign trade, (b) the average tariff rate does not exceed 40 percent, (c) the black market premium over the official exchange rate does not exceed 20 percent, (d) the economic system is not socialist, and (e) the state does not have the monopoly on major exports.

TFP growth. But there were important differences across the countries and in some cases economic reforms had been associated with lower TFP growth. Their main finding was that TFP growth was faster in periods when the Latin American countries were "reformed": on average by approximately 1.5 percentage points per year. In fact, the average rate of TFP growth was negative during the non-reform periods and became positive during the reform periods. These results were not reflected in their country-to-country analysis, as the effect of the economic reforms on the rate of growth of TFP in individual countries was not always statistically different from zero. When significant, however, this effect was positive.

Fan, Zhang, and Robinson (1999) developed an analytical framework to account for sources of rapid economic growth in China. For this purpose they gathered data for 18 years from 1978 to 1995. The data covered 28 provinces of China and it included a panel of 504 observations. The researchers did not follow the traditional Solow approach, which includes only two sources: increased use of inputs and TC. Fan, Zhang, and Robinson (1999) expanded the approach to include structural change as a third source of economic growth. The empirical results showed that structural change had contributed to growth significantly by reallocating resources from low productivity to high productivity sectors especially movement of labor from the agricultural sector to rural enterprises. They also found that the returns on capital investment in both agricultural production and rural enterprises were much higher than those in urban sectors, indicating underinvestment in rural areas. However, labor productivity in the agricultural sector remained low; this indicates overemployment of labor in the sector. Therefore, the further development of rural enterprises and increase in inter-sector and intra-sector labor flow across regions was a key source of improvements in overall economic efficiency.

Collins et al. (1996) worked on the lines of Solow (1957) to compute TFPG. To measure it they relied on his growth-accounting technique. This study covered a period of 35 years from 1960 to 1994. It found that TFPG for EA for the period under study was not much higher. For example, it was 1.5 percent for Singapore and South Korea, 1.8 percent for Thailand and 2.0 percent for Taiwan. They found that TFPG for EA matches that of developed countries. They also found that it was better than the developing zones of LA, Africa and the Middle East. Like Young (1992, 1995), this study found that TFPG is also low in many of the developing countries.

In his study, Sarel (1996) used a different technique. He went on to measure the share of capital using the weighted average method in different sectors of the economy. According to Sarel, the role of capital was conspicuous in the determination of TFPG. He determined that TFPG was very high in East Asian countries, for example 3.8 percent in the case of Hong Kong, 3.6 percent for Taiwan, 3.1 percent for South Korea, and 1.8 percent for Singapore. He compared these TFPGs with those of Japan and the USA. He found that TFPG of East Asian countries was much higher than that of the developed countries: 1 percent for the USA and 1.9 percent for Japan. His results differed from previous studies, perhaps due to the fact that he used a different base for his analysis.

Sarel (1996) disagreed with the accumulationist measurement of capital whereas Pritchett (2000) went a step ahead of him in this regard. He pointed towards differences of costs of investment and the actual capital productive value resulting from these investments. This is an important development because the resultant productive value of capital is more important than the accumulation of capital. He was tempted to say that using the capital stock measure of investment may produce incorrect estimates of TFPG.

Nelson and Pack (1999) made an effort to explain investment and the actual capital productive value resulting from these investments. According to them, capital deepening is a result of entrepreneurial response to profit opportunities, which increase with capital intensive modern technologies. Thus more investment takes place. The one-sector model underlying conventional TFPG estimates would overlook this factor and only see capital deepening.

Atkinson and Stiglitz (1969) and Lapan and Bardhan (1997) conducted their studies in favor of the revisionist view. Researchers of the revisionist view conducted their work on the prototype of earlier studies. Atkinson and Stiglitz (1969) and Lapan and Bardhan (1997) observed that technical progress is not evenly spread in all sectors of the economy. Generally it is restricted to few sectors only. Sometimes it is very conspicuous in one sector. This limited technological progress indicates the fact that technical advancement is not all pervasive; it is specific because it involves research with particular combinations of inputs. Successive capital-intensive innovations generate more profit and, as a result, investment in those sectors increases, which has a role in overall output growth. Under the conventional TFPG estimation approach this growth in output is associated to capital deepening hence the role of technical progress remains ignored.

Pham and Wan (1997) followed Atkinson and Stiglitz (1969) and Lapan and Bardhan (1997) and reached similar results. They suggested that if technical progress remains sector-specific then only that sector will observe the growth. They proposed output growth accounting only for one sector. Van, Park, and Ha (2003) studied the nature of technological progress in three East Asian countries – Taiwan, Korea, and Singapore – using the data for the period 1972 to 1992. They noted that technical progress in these countries was sector-specific during the sample period. Comparing their

findings with those of previous studies on the basis of aggregate production function they opined that previous studies might have underestimated the contribution of technology in Korea, Singapore, and Taiwan.

Jorgenson and Griliches (1967) and Jorgenson and Stiroh (2000) picked up the thread at that point, that traditional measures of TFPG underestimate the contribution of technology. They added a new dimension to the study of output growth. They argued that in the measurement of productivity stock of capital does not matter; they viewed that for this purpose capital output ratio is important. Groth et al. (2004) estimated TFP for the period 1980 to 2003. Their work was different from the earlier work. They used both measures of TFP: traditional measure and alternative measure. In the alternative measure of TFP they used the quality-adjusted measure of labor for labor input. They found results under the two approaches were different. The estimates of TFP under the alternative approach were lower than the estimates under the traditional approach. From these results they concluded that the traditional measure of inputs overestimates TFPG.

Conway and Hunt (1998) selected New Zealand for their productivity performance analysis. Their data covered the period from 1985 to 1996, which coincided with an economic reform program. They observed that reforms increased the openness of the New Zealand economy, and exposed it to international competition. They wanted to know the response to reforms and their pressure on New Zealand's productivity performance. They hypothesized that competitive pressures from the world's most advanced countries would encourage domestic firms to adopt superior production technologies. They found that their results were consistent with their expectations. At the beginning of the 1990s they started taking note of TFPG rather than TFP. They observed, the evidence suggests, a positive impact of opening the economy to

competitive forces. This improvement in productivity coincided with a flow of technology for a considerable time into the future.

Miller and Upadhyay (2000) objected to the growth accounting approach on the basis that it treats all possible determinants of output growth as inputs whereas the effect of these determinants may be marginal or indirect. To them, this may be conceptually inaccurate. Rather, these determinants affect the efficiency of the real inputs, physical capital, labor, and possibly human capital. Due to this injection in the form of efficiency, they serve as additional determinants. Consequently, these additional determinants of output growth directly affect TFPG. They used two measures derived from the production function to calculate TFP. For this purpose they used different function specifications that excluded and included human capital as an input. They selected an extensive and representative sample of 83 countries. It covered both developed and developing countries. The study covered the period from 1960 to 1989. After calculating TFP by two measures, they distributed the sample into sub-samples of low-, medium- and high-income countries. After this they explored the convergence in real GDP and in TFP in the three sub-samples. The outcome of their study is that they found evidence of convergence of TFP for the whole sample, as well as for each sub-sample group of low-, middle- and high-income countries. These findings allowed them to state that TFP captures the technical effect of the production process. These findings provide more evidence of convergence of technology than real GDP per worker (Y).

Guha-Khasnobis and Bari (2000) selected South Asia (i.e. Bangladesh, India, Pakistan and Sri Lanka) for their study. They calculated TFP growth in these countries using the growth accounting approach. They selected the period from 1960 to 1996 for their analysis; this period covered varying growth trends along with policy shifts. After

calculating TFP growth they compared these estimates with similar estimates of East Asian countries. Their results showed that not only were the growth trends different but the growth rates of GDP in East Asian countries were higher than those of South Asian countries. They investigated the role of TFP and capital accumulation in both regions. Their results were different for both regions. In East Asian countries the contribution of TFP to GDP was 10 percent against 17% of GDP in South Asian countries. Whereas the share of capital accumulation of the GDP was 70 percent in East Asian countries it was 60 percent in the case of South Asian countries.

Baier et al. (2002) studied the role of TFP in output growth using a large data sample. They included 145 countries in their sample and used data covering a period of 57 years. Their results were surprisingly different from those of Abramovitz (1956) and Denison and Denison (1962). They found that TFP contributes to output growth per worker only by 8 percent.

Arora and Bhundia (2003) estimated TFP through the growth accounting approach in the case of South Africa using time series data from 1980 to 2001. They found that TFP growth contributed more to the GDP growth of the country than factor accumulation. They noticed that the contribution of TFP growth was increasing with the passage of time in the country. It remained zero percent during 1980 to 1993, whereas it was 3.1 percent during 1994 to 2001. They also observed that the contribution of factor accumulation (i.e. growth of capital and labor) to GDP growth was gradually declining during the period of study. It remained 0.9 percent for capital and 0.1 percent for labor during 1980 to 1993, whereas it was 0.6 percent for capital and –0.9 percent for labor during 1994 to 2001. They concluded that trade openness and private investment were the most significant determinants of TFP growth.

Sabir et al. (2003) determined the effect of macroeconomic reforms on TFPG in Pakistan during the period 1973 to 2002. They used the data on GDP and on the sectoral output of agriculture, manufacturing and services sector of Pakistan. They estimated TFP growth through the growth accounting approach and index number approach separately. The findings of their study revealed that macroeconomic reforms introduced in the late 1980s put a negative pressure on TFP in the economy as a whole and on TFP in the manufacturing and services sectors. Nevertheless, due to these reforms TFP increased in the agriculture sector of Pakistan. However, some researchers, for instance Ahmad (2011), criticize the findings of Sabir et al. (2003) on account of the concept of capacity utilization. They argue that during the reform period in Pakistan the productive capacity was underutilized. They suggest that the TFP estimates should have been adjusted for capacity utilization.

Kemal et al. (2002) estimated TFP in Pakistan's manufacturing and agriculture sectors through the growth accounting approach. They covered the period from 1965 to 2001 and found that during this period the growth rate of TFP in Pakistan was 1.66 percent. However, TFP growth remained significantly higher in the manufacturing sector (3.21 percent) than in the agriculture sector (0.37 percent). Further, they found that TFP contributed 9.57 percent and 50.27 percent to agriculture and manufacturing output growth respectively. However, the contribution of TFP in aggregate output growth remained 31.26 percent. The study of Kemal et al. (2002) and that of Sabir et al. (2003) face similar points of criticism: they did not adjust their TFP estimates for capacity utilization. Moreover, they did not adjust labor input for different attributes such as age, education, skills, and so on.

In his study Han (2003) went on to investigate the predictability of TFPG. He selected a large sample of countries to explore the predictive power of measures of TFPG for

the full sample (FS) and sub-samples of countries. He did this to make his work more specific and close to the existing realities. He selected sub-samples of the top 24 OECD countries, top 20 OECD countries, 34 non-OECD (developing) countries and four East Asian countries. Later he went to explore the predictive power of TFPG on future economic growth on the basis of existing economic realities. He ran three regressions to determine the relation between growth and other realities.

In the first regression he investigated the relationship between growth rate of RGDP and TFP growth. In the second regression he explored the relationship between future investment and TFP growth. Finally, in the third regression he tested the association between the marginal product of capital and TFP growth.

In the above three regressions TFP growth was set as an independent variable. In his analysis he assumed that if the measurement of TFPG captures technical progress then it should affect the future investment, marginal product of capital and GDP growth positively and significantly. In the situation when the above relations hold, higher TFPG should be followed by higher future investment at first and higher future output growth later. He developed his study on these grounds and tested the predictive ability of TFP growth for future economic growth. Results of his study showed a positive and significant association between TFPG and future economic growth for the FS, and the sub-sample of OECD countries. He also found weak evidence that TFP growth significantly determines the future economic growth in non-OECD countries. Nevertheless, in the case of East Asian countries the study did not find any significant effect of TFPG on future economic growth. He applied sensitivity tests to check the robustness of his results. For this purpose he used different values of the capital share of output to calculate TFP growth. From these tests he was able to declare that the results were robust for the FS as well as for the sub-samples. On the authority of his

results he testified the existence of predictability of TFP growth for future economic growth. He accepted that the relationship of TFP growth and future economic growth is not universal in its application. In particular this relationship does not hold in the case of East Asian countries. He accepted that his conclusions were consistent with the idea that there can be localized technological progress. This idea provided an argument to researchers that TFP growth calculations fail to capture technical growth in East Asian countries. Here real output growth was ascribed to localized technological progress.

Kumar (2003) estimated the TFP growth rate of the manufacturing sector of India using data from 1965 to 1995. For this purpose he used the growth accounting approach and found that during the period under study the growth rate of TFP in the manufacturing sector of India was slow (1.35 percent per annum) yet consistent. Further, he found that the growth rate of TFP was facing a decline or a marginal increase during the period under study. He divided the data period into three categories; pre-liberalization covering the period from 1969 to 1980, mid-liberalization covering the period from 1981 to 1991, and intensive-liberalization covering the period from 1992 to 1995. He observed that annually TFP had been growing at the rates of –0.264 percent, 2.34 percent and 1.35 percent during the pre-liberalization period, mid-liberalization period and intensive-liberalization period respectively. He noted that during the period of the 1980s the Indian government exercised a deregulatory policy which had a positive effect on the TFP growth of the country's manufacturing sector. During the period of 1990 TFP did not receive any significant effects from intensive-liberalization policies. He based these conclusions on the findings of annual average growth rates of TFP during the three sub-periods as stated above. He concluded from his study that overall TFP was not a significant

source of growth in the Indian economy. Further, capital input was the most important factor of output growth in the Indian economy. Last, but not least, output growth in the manufacturing sector of India depends on factor accumulation rather than TC.

India is considered a potentially large economy and it has had a consistent growth rate for many years. It has been a subject of study with other fast growing Asian countries. Pallikara (2004) estimated TFP growth in India from 1976-77 to 2000-01. The study investigated whether the trend in TFP growth indicated in an earlier Asian Productivity Organization study is continued or not[8]. The study covered the evaluation of the impact of qualitative differences in factor inputs on TFP growth estimates. It also focused on the major determinants of TFP growth in India for the period under study. The author found consistency in Indian TFP growth performance during the 1990s. As a result the Indian economy registered a higher average TFP growth from 1990–91 to 2000–01 than the years before. He accepted that TFP growth is not affected by the quality of factors. The study confirms a higher trend in GDP growth rate during the post-1991 era. He found, unlike in the previous Asian Productivity Organization study, that adjustments for capacity utilization were not present to change the TFP growth estimates. In his view this may be due to the fact that in India cyclical movements in output are not such a serious problem as in economies like the USA. TFP growth contributed substantially to GDP growth, especially after the effects of factor quality differences were removed from the TFP growth measure in many of the years during the 1980s and 1990s. However, the quality differences in capital and labor between the organized and unorganized sectors in India had a negative impact on GDP growth. Further, he found that when the quality effects are not removed from the TFP growth estimates, the estimates tend to

[8] In the earlier Asian Productivity Organization study, Srivastava (1998) reported that the average TFP growth for the macroeconomy from 1973–74 to 1984–85 was only 1.25% whereas that from 1985–86 to 1994–95 was 2.11%.

be lower and hence might underestimate the true contribution of TFP growth to GDP growth. This may also be construed as evidence of the existence of an allocative problem in terms of labor and capital between the two sectors and point to the need for an efficiency-enhancing reallocation of factor resources between the two sectors.

According to Fatima et al. (2003), imports to a country bring technical improvement which is a source of higher and stable economic growth. They took data from 1970 to 2000 and determined the causal relationship between depth of international trade in Pakistan and TFP growth. They found that causality ran from international trade to TFP growth in Pakistan during the period under study.

Kumar et al. (2004) estimated TFP through the Divisia-Tornqvist index method covering the data period from 1981 to 1997. They selected an agro-eco-region and a sub-region of the Indo-Gangetic Plain of India. They observed that during the period of study the growth rate of TFP in the selected regions remained 1.2 percent. In the case of sub-regions the growth rates of TFP were observed to be 3.1 percent, 1.4 percent, 0.9 percent, and 0.4 percent in Lower-Gangetic, Trans-Gangetic, Upper-Gangetic, and Middle-Gangetic Plains respectively. The contribution of TFP to output growth was found to be 33 percent in the selected regions. Further, during the 1980s TFP contributed (42 percent) to output growth which was much more than during the 1990s (14 percent). They also determined that research expenditures, education, and infrastructure development expenditures were the main factors of TFP growth.

Virmani (2004) estimated TFP growth for Indian Net Domestic Product using data for the period 1951 to 2004. He used the growth accounting approach and included rainfalls as an additional argument in the production function. One can understand that the inclusion of such a variable in the agriculture production function may be of relevance but its use in the aggregate production function is not that convincing.

However, he reported that the growth pattern of Indian Net Domestic Product was cyclical during the period of study. Further, he observed that the contribution of TFP growth to growth of output per worker of India decreased from 85% to almost 25% during the period from 1951-52 to 1991-92. However, the contribution of TFP to Indian Net Domestic Product per worker increased sharply to almost 50% during the rest of the period under study. He concluded that investment in capital and changes in protection significantly determined TFP growth during the period under study.

In the case of the large-scale manufacturing sector of Pakistan, Wizarat (2004) estimated TFP and productivity of labor using annual data from 1955 to 1991. She used the neoclassical growth accounting approach and developed index numbers of TFP and labor productivity. A continuous positive growth was observed in both the indices from 1955 to mid-1960s. However, after the mid-1960s both the indices declined consistently. She also estimated these indices in the large-scale manufacturing sectors of the UK, Germany and other European countries as a region and compared these indices with those of Pakistan's large-scale manufacturing sector. She found that in the case of Pakistan these indices remained lower than those of the above stated European countries.

The study of Lipsey and Carlaw (2004) is very important with regards to TFP and TC. They argued that TFP is not the true measure of TC. According to them, TFP measures the level of increasing returns to scale (i.e. the level of returns which exceeds the full opportunity cost of the amount of investment). They pointed out that technical progress bears a certain cost and this cost can be calculated as an accumulation of factors of production. They highlighted that a newer machine is usually more expensive yet more productive than the older one. The investment on the newer machine can be justified as true investment either if the machine is able to

generate net returns just equal to the full cost of it or the machine is smart enough to generate the revenues greater than the cost of the machine. In the first situation TFP remains equal to zero, whereas in the second situation TFP remains greater than zero. But, in both the situations stated above TC has emerged. On the basis of the above argument they stated that zero TFP cannot certify that TC has not emerged. They treat investment in human capital with the same line of argument: investing in human capital involves imparting new technology in human capital rather than in machines. If the returns of increased human capital are greater than the amount spent to increase said level of human capital then TFP remains positive. So, according to Lipsey and Carlaw (2004) none of the currently used approaches of TFP measurement can differentiate between accumulation of pure human capital and accumulation of technical knowledge.

Limam and Miller (2004) conducted a more detailed study of cross-country patterns of economic growth. They performed this task by estimating a stochastic frontier production function for 80 developed and developing countries. They studied output change in the backdrop of factor accumulation, TFP growth, and production efficiency improvement for the period 1960 to 1989. In their paper they also incorporated the quality of inputs in analyzing output growth. In order to incorporate the quality of inputs they used the following productivity criteria:

- Productivity of capital depends on its average age.
- Productivity of labor depends on its average level of education.

They distributed their sample over five geographic regions – Africa, EA, LA, South Asia (SA), and the West in their growth decomposition. They observed the impact of

factor growth, especially capital accumulation. They concluded that the role of capital accumulation is more important than the improved quality of factors or TFP growth in explaining output growth. They found that quality of capital is positive and significantly affects output growth in all groups. Nevertheless, the quality of labor only possessed a positive and significant effect on output growth in Africa, EA, and the West, whereas labor quality had a negative and significant effect in LA and SA. They observed that a negative correlation exists between technical efficiency improvement and TC. These results appear to be consistent with economic theory. The low-growth country groups of Africa and LA explain 100 percent of their average output growth rate with factor accumulation. Technological backwardness is the largest negative factor in economic growth. But in both country groups, technical efficiency improvement contributes positively to economic growth, reducing but not eliminating the negative effect of technical regress on TFP. However, the high-growth country groups of EA and SA exhibited significant technical progress, helping to explain output growth. At the same time, these two country groups also experienced technical efficiency regress, suggesting that technical efficiency trades-off grossly with rapid economic growth. They argued that, in fact, the worsening of technical efficiency is the only negative contributor to output growth in EA. That is, the East Asian growth miracle does depend on factor accumulation and TFP growth, and TFP growth significantly responds to technical progress.

Baier, Dwyer, and Tamura (2006) examined TFP growth across 145 countries. They used human capital instead of labor for measuring TFP growth. They worked on data from 1960 to 2000 and found that the weighted TFP growth (weighted by population) average over all the countries remained at just 0.22%.

Comin, Hobijn and Rovito (2006) put together direct measures of technology adoption for approximately 75 different technologies and show that cross-country differences in technology are approximately four times larger than cross-country differences in income per capita. Further, technology is positively correlated to income per capita.

Jajri (2007) put together standard econometric techniques to estimate the TFP growth and determinants of TFP growth in Malaysia for the time period of 1971 to 2004. He used the data envelopment analysis method in which two decomposed elements (technological change and technical efficiency) of TFP were used. He reported that TFP growth of the Malaysian economy was not encouraging due to the negative effect of technical efficiency. This is due to the immense dependence of the Malaysian economy on physical inputs.

Ozyurt (2007) presented his work on Chinese industrial productivity performance for the time period of 1952 to 2005. He conducted TFP growth analysis using Cobb–Douglas specification with an aggregated annual data set. He worked on some restrictive hypotheses of the new classical growth framework such as competitive market behavior, constant returns to scale production technology and Hicks neutral technological change. He concluded that capital accumulation and TFP played a pivotal role in the economic takeoff. He also found that TFP had shown an accelerating growth pattern since the early 1990s, giving consistent evidence about the sustainability of economic growth in the near future.

Adak (2009) investigated the causal relationship between TFP and economic growth based on the years from 1987 to 2007. He used the Cobb–Douglas method and worked on five proxy measures (i.e. gross saving, saving rates, gross fixed capital formation (GFCF), labor force, and GDP per capita) for TFP and economic growth.

He estimated that there is a significant linear relation between TFP and economic growth rates. He found that the economic growth of developing countries, specifically Turkey, has high TFP output which is not sustainable over a period of time.

Chaudhry (2009) discussed the TFP in Pakistan using the Cobb–Douglas production function (CD-PF) and TL-PF. For the data from 1985 to 2005, he found that the productivity of its economy increased at an average rate of 1.1% per year, but almost three quarters of GDP growth was caused by increases in labor and capital stock. This shows that productivity growth in Pakistan at a sectoral level as well as on an economic level has been slow and this growth is more inclined towards the input-driven approach rather than productivity driven.

Hijzen et al. (2006), using French firm-level data, report that firms that invest in developed countries increase their productivity, whereas firms that invest in developing countries experience no productivity effects. Barba Navaretti et al. (2010) obtained the same result from a sample of French firms. However, in the case of Italy they found exactly the opposite pattern: firms that invest in developing countries experience an increase in TFP, whereas FDI into developed countries has no productivity effects.

2.2 Review of the Literature on Convergence

The concept of convergence was implied in Solow (1957), when he said that poor countries can grow faster than rich countries. That was to say that developing countries can catch up with developing countries during the course of per capita growth rate. He observed that there could be a difference in growth rate and growth trends among the countries of the world. Miller and Limam (2004) accepted the existence of differences in growth rates in different countries. They agreed to the convergence thesis in the neoclassical paradigm. However, they were critical about

the inherent weakness of the neoclassical school, which did not fully explain the differences in growth rate among countries. Research to determine the factors behind the growth in the developing countries gained momentum in the middle of the 1980s. In his study, Baumol (1986) conducted pioneering work on convergence. He selected countries from both the rich and developing world with sufficiently large data for the period 1870 to 1979 to determine the existence of cross-country convergence. He considered technical diffusion to be an important source responsible for the convergence of economic growth in the industrialized world. He believed in the spillovers from the leading to the client economies. According to him the behavior of firms to follow the line of action followed by their rivals paves the way for convergence. He reached the conclusion that convergence was strong enough in the post-World War II period. However, Menbere (1998) did not follow suit. He opined that limited financial resources, lack of knowledge and skill, and technical backwardness make the process of mobility of skills and technology towards the developing world slow. Thus one can say that the situation is not in favor of the developing world as far as convergence is concerned.

Baumol's study was soon undermined by the later studies of Romer (1986) and De Long (1988). These researchers raised a technical objection to the data on the basis of ex-post-World War II selection bias.

Convergence of real Y is categorized as conditional or absolute convergence. Absolute convergence means that developing countries grow faster than developed countries; hence, all the countries converge to the same steady-state real Y. Conditional convergence postulates that each country converges to its own steady-state real Y; hence, the state of the economy determines the steady-state real Y (Miller and Upadhyay, 2000).

There is a long list of researchers, for example De Long (1988), Barro (1991), Mankiw, Romer, and Weil (1992), Barro and Sala-i-Martin (1995), Islam (1995), and Easterly and Levine (2001), who concentrated on endogenous growth models. They worked on the assumption that strong linkages exist between human capital formation and economic growth. Such researchers concluded that there exists evidence of absolute convergence for developed countries only. When developing countries are included in the sample along with developed countries absolute convergence does not exist. However, this situation supports the existence of conditional convergence rather than absolute convergence. This is in contradiction to the study of Solow (1957). On the basis of the above, it can be said that the absence of absolute convergence testifies the applicability of new growth theory. That is to say, developing countries are not growing faster than developed countries, hence, not converging. Yet, the existence of conditional convergence supports the idea that convergence is an area-specific phenomenon rather than a universal phenomenon.

A new dimension to the study emerged when Summers and Heston created a new data set of more than 100 countries.[9] They made their selection of the countries on the basis of the level of GDP with 1960 as the benchmark year.

Sala-i-Martin (1996) worked on the data set provided by Summers and Heston for 110 economies of the world: both OECD and developing countries. He observed that in the 30-year period (1960–1990), the behavior of the economies was not converging; yet, it was converging in the case of OECD countries. He observed that the data on the world economies do not support the existence of absolute convergence; rather the data support the existence of conditional convergence. Hrivnakova (2004) drew a conclusion on the basis of Sala-i-Martin's study (1996) that if governments of

[9] Summers and Heston's data set is also known as Penn World Tables.

different countries adopt different policies, convergence becomes a possibility on the basis of the similarity argument.[10] He observed that government policies do have a very limited role in the process of regional and intraregional convergence.

Barro (1991) selected a large number of countries and data period from 1960 to 1985 to study the growth rate of RGDP. He observed that the growth rate of RGDP was directly related to the initial level of human capital; in contrast, it was inversely related to its own initial level. His observation seems to be consistent with the neoclassical growth model, which assumes diminishing marginal productivity of capital. In this regard, human capital is believed to have an important role because it serves as an intermediary between research, innovations and technical progress.

Mankiw, Romer, and Weil (1992) gave ample weight to the human capital in economic growth along with the physical capital. They ran a cross-country regression to determine the role of human and physical capital. They included a percentage of the working-age population attending secondary school as a proxy variable for human capital accumulation in the form of an explanatory variable. On the basis of their analysis, they reached the conclusion that there is strong evidence to include human capital in the investigation and determination of economic growth and convergence.

Thirlwall (2003) observed that education, research, training and investment in human capital are positively related to economic growth. He declared that these factors never allow the marginal productivity of capital to decrease as more and more capital is inducted into the production process. Thus, these factors can be said to be responsible for making convergence a possibility.

Ben-David (1993) conducted a study to see the impact of trade liberalization on convergence. Ben-David gave consideration to the differences in the economic

[10] The similarity argument postulates that groups of countries and regions with homogenous economic and social conditions behave similarly even under different policies.

structure and composition of a country. He linked these differences to delays in the adoption of new technology. He observed that a strong relationship exists among technical diffusion, trade liberalization and economic growth and convergence. In his opinion, trade liberalization along with economic convergence has been responsible for speedy economic growth among the members of the European Economic Community.

Miller and Upadhyay (2000) investigated the convergence of real Y and the convergence of TFP. They argued that convergence tests of TFP inculcate awareness about the spread, adoption, and convergence of technical advances. They argued that if technology is a public good that can swiftly cross international borders, then evidence of the convergence of TFP should be found. For a large sample of countries they found stronger evidence of convergence of TFP than convergence of real Y. They concluded that convergence of TFP growth is an important phenomenon. On the basis of empirical findings they asserted that technology is a public good that can easily transfer across international borders.

2.3 Summary of the Literature

Solow (1956), in considering the substitutability between factors of production, developed a production function where output is a function of labor, capital, and knowledge. The model indicates that the differences in output growth rate of different countries represent differences in capital accumulation. The model also entails the convergence hypothesis. Growth accounting analysis was used to test the theory. Limam and Miller (2004) found that Solow's model neglects differences in productivity growth and TC captured by large residual. Mankiw (1995) found that Solow's model also fails to explain the differences in real rates of return on capital. Easterly and Levine (2001) explored why factor accumulation explains only a portion

of the observed cross-country output growth. Increasing divergence in per capita income level emphasizes TFP with increasing returns to technology. Physical capital accumulation persists over time in most countries but per capita output growth does not persist. Finally, a tendency exists for the factors of production to flow to the same places, which causes an increased concentration of economic activity. Followers of the "accumulationist" view argue that rapid economic growth in East Asian countries is the result of factors' accumulations. Young (1992, 1994, 1995) calculated TFPG for East Asian countries and found that it was not different from TFPG for OECD and Latin American countries. From his results he concluded that rapid economic growth in East Asian countries is the result of factors' accumulation rather than technological progress. Kim and Lau (1994) investigated the sources of economic growth in the post-World War II period for East Asian and industrially developed countries. They found that economic growth in East Asian countries was the result of accumulation of labor and capital whereas it was the result of technical progress in industrially developed countries. Collins et al. (1996) found that TFPG in East Asian countries is not different from that in developed countries. "Revisionists" disagree with the accumulationists' method of measurement of TFPG. Sarel (1996) used the weighted average method to measure TFPG and found that it was much higher for East Asian countries and much lower for developed countries. Pritchett (2000) pointed towards the differences of cost and actual productive capital value resulting from investments to support the revisionists' view. Nelson and Pack (1999) argued that capital deepening is a result of entrepreneurial responses to profit opportunities in capital intensive techniques. Atkinson and Stiglitz (1969) and Lapan and Bardhan (1997) proposed the idea of sector-specific technological progress. They argued that under the conventional TFPG estimation approach, growth in output is associated to capital

deepening hence the role of technological progress remains ignored. Groth et al. (2004) concluded that the traditional measure of inputs overestimates TFPG. Conway and hunt (1998) examined why competitive pressures from the world's most advanced countries encourage domestic firms to adopt superior production technologies and hence bring technological progress. Miller and Upadhyay (2000) found that TFP captures the technical effect of the production process and they found strong evidence of convergence of TFPG rather than growth of GDP per capita. Han (2003) found a positive and significant association between TFPG and future economic growth for OECD and developing countries. Yet, for East Asian countries he concluded that TFPG calculations may fail to capture technical growth as in these countries sector-specific technological progress seems to be relevant. Pallikara (2004) evaluated the impact of qualitative differences in factor inputs on TFP growth estimates and found that TFPG contributed substantially to GDP growth especially after the effect of factor quality differences were removed from the TFPG measure. Chen (1997) argued that the importance of TC in economic growth depends largely on how TFPG is defined and measured. Rosegrant and Evenson (1995) proposed that TFP gains showed that investments of many kinds contributed to TFP growth in India. Fajnzylber and Lederman (1999) found that the average rate of TFPG was positive during the period of economic reforms whereas it was negative during non-reform periods. Fan, Zhang, and Robinson (1999) included structural change as a third source of economic growth in the Solow approach. They concluded that structural change contributes to growth significantly by reallocating resources. They also concluded that the development of rural enterprises and increase in labor flow among sectors were key sources of improvement in overall economic efficiency. Limam and Miller (2004) examined the cross-country patterns of economic growth by estimating a stochastic

frontier production function and incorporating the quality of inputs. They found that quality of capital positively affects output growth in all groups of countries included in the study whereas the quality of labor only in certain countries. They concluded that TFP growth significantly responds to technical progress, and technical efficiency improvements contribute positively to economic growth.

A large part of the literature on TFP, its measurement, determinants and impacts on economic progress is based on studies conducted for industrially developed and East Asian countries. Such studies for developing countries are few and among those only a very few studies investigated the convergence of TFPG rather they focused on the convergence tests of real output per capita.

The roots of the studies regarding convergence go back to Solow (1957). In his study, Solow (1957) argued that developing countries can grow faster than developed countries and with a faster growth rate they can catch up with developed countries. This concept is known as absolute convergence.

Adding human capital to growth models, researchers of a new growth theory denied the evidence of absolute convergence for developing and developed countries. Their analysis supported the evidence of absolute convergence for developed nations only. Nonetheless, they found that conditional convergence is possible both for developing and developed countries. Conditional convergence postulates that each country converges to its own steady-state real GDP per capita.

This study intends to test the predictive powers of the common measures of TFP growth and convergence of output and TFP growth. For this, the effects of TFP growth on future output growth and investment growth for a panel of 35 countries have been determined. This study will also conduct absolute and conditional convergence tests of TFP growth and real GDP per capita. The convergence test of

TFP growth shows whether technology is a public good or a private good as suggested by Miller and Upadhyay (2000). Sensitivity tests of all the results have also been conducted in this study.

Chapter 3
Theoretical Foundations

The available literature on productivity studies reveals that researchers use different measures of productivity such as labor productivity, capital productivity, multifactor productivity and TFP in growth and productivity studies. The use of labor productivity and capital productivity as the proxy variable of productivity growth has been common. Labor and capital productivities are seen as changes in output per worker and output to capital ratio respectively. However, these variables are not the appropriate proxies of productivity growth. The production functions which are characterized by high elasticity of substitution of factors of production allow easy substitution of one factor for another. In this situation if producers substitute capital for labor keeping the output constant the data would reveal that labor productivity has increased. But, at the same time capital productivity would decline. So, in this case the use of labor productivity as the proxy of productivity growth would present an exaggerated picture of productivity growth, whereas use of capital productivity as the proxy of productivity growth would reflect an underestimation of it. Due to the above mentioned deficiencies of labor and capital productivities researchers tend to use TFP as the proxy of productivity growth.

Three approaches, namely, growth accounting approach, index number approach, and econometric approach are commonly used to measure TFP growth. Each approach, however, suffers from certain problems and is characterized by certain advantages as well. Since the major concern of this study is to determine how good each of these three approaches is in predicting the output growth on an empirical basis, all three of the approaches will be used to measure TFP growth. This chapter sheds light on the

theoretical grounds of these three approaches and discusses the advantages and disadvantages of each approach. The last section of this chapter develops the framework which represents how a measure of TFP growth which covers TC should predict output growth.

3.1 Growth Accounting Method as a Measure of TFPG

The studies of Kendrik (1961) and Denison and Denison (1962) popularized the growth accounting approach of TFP measurement. The starting point of this approach is the neoclassical production function which takes the following form:

$$Y_t = F(K_t, L_t, t) \qquad (3.1)$$

In the above function Y_t, K_t, and L_t represent output in current time period, capital input in current time period and labor input in physical units in current time period respectively whereas, t represents time. The function F is assumed to show the behavior of constant returns to scale. For simplicity, I ignore time subscripts from the above function.

A TC in the above model will cause the function F to shift upward or downward over a period of time. Technical progress will bring a positive or upward shift in the function F whereas technical regress will bring a negative or downward shift in the function F. It is important to mention that technical progress leads to higher output at the given level of inputs.

Solow (1957) assumed that the nature of TC is Hicks-neutral and this phenomenon involves the time period[11]. Assuming that technical progress is Hicks-neutral the above aggregate production function can be rewritten as given in equation 3.2.

$$Y = A(t)F(K, L) \qquad (3.2)$$

[11] Hicks-neutral TC necessitates that the productivity of both the inputs (i.e. labor input and capital input) must increase at the same rate.

In the equation given above A(t) represents the TFP and it measures the shifts of aggregate production function due to the TC which emerges over the time period. Differentiation of the aggregate production function given in equation (3.2) with respect to time, that is (t), gives us equation 3.3 as follows:

$$\frac{\partial Y}{\partial t} = \dot{A}F(K,L) + A\frac{\partial F}{\partial K}\frac{\partial K}{\partial t} + A\frac{\partial F}{\partial L}\frac{\partial L}{\partial t} \qquad (3.3)$$

Let us assume $\frac{\partial Y}{\partial t} = \dot{Y}$, $\frac{\partial K}{\partial t} = \dot{K}$, *and* $\frac{\partial L}{\partial t} = \dot{L}$, and divide both sides of equation (3.3) by Y,

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}F(K,L)}{AF(K,L)} + \frac{A(\partial F/\partial K)\dot{K}}{Y} + \frac{A(\partial F/\partial L)\dot{L}}{Y}$$
$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + A\frac{\partial F}{\partial K}\frac{\dot{K}}{Y}\frac{K}{K} + A\frac{\partial F}{\partial L}\frac{\dot{L}}{Y}\frac{L}{L}$$
$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \frac{\partial Y}{\partial K}\frac{K}{Y}\frac{\dot{K}}{K} + \frac{\partial Y}{\partial L}\frac{L}{Y}\frac{\dot{L}}{L} \qquad (3.4)$$

In the equation 3.4, $\frac{\partial Y}{\partial K} = A\frac{\partial F}{\partial K}$ and $\frac{\partial Y}{\partial L} = A\frac{\partial F}{\partial L}$

Suppose, $S_K = \frac{\partial Y}{\partial K}\frac{K}{Y}$ and $S_L = \frac{\partial Y}{\partial L}\frac{L}{Y}$, where S_K represents the capital elasticity of output or relative share of capital in output and S_L is the labor elasticity of output or relative share of labor in output. Substituting S_K and S_L I have:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + S_K\frac{\dot{K}}{K} + S_L\frac{\dot{L}}{L} \qquad (3.5)$$

The above equation can be rewritten as follows:

$$\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - S_K\frac{\dot{K}}{K} - S_L\frac{\dot{L}}{L} \qquad (3.6)$$

Since I assume that the neoclassical aggregate production function depicts the behavior of constant returns to scale I can write $S_K+S_L=1$ and hence I can use $1-S_K$ instead of S_L in equation 3.5

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + S_K \frac{\dot{K}}{K} + (1 - S_K)\frac{\dot{L}}{L}$$
$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + S_K(\frac{\dot{K}}{K} - \frac{\dot{L}}{L}) + \frac{\dot{L}}{L}$$
$$\frac{\dot{Y}}{Y} - \frac{\dot{L}}{L} = \frac{\dot{A}}{A} + S_K(\frac{\dot{K}}{K} - \frac{\dot{L}}{L})$$

Let, $y = \frac{Y}{L}$ *and* $k = \frac{K}{L}$ where $\frac{Y}{L}$ is per worker output and $\frac{K}{L}$ is per worker capital, I can write the above equation as follows:

$$\frac{\dot{y}}{y} = \frac{\dot{A}}{A} + S_K \frac{\dot{k}}{k} \qquad (3.7)^{12}$$

In equation 3.7 $\frac{\dot{y}}{y}$ and $\frac{\dot{k}}{k}$ represent the growth rate of output per worker and growth rate of capital per worker respectively, whereas $\frac{\dot{A}}{A}$ represents the TFP growth rate. The above equation exhibits the description of the relationship and the same is used to estimate TFP growth under the growth accounting approach. In the above production function I can observe that the growth of output per worker has two sources: one is the growth of capital per worker and the other is the growth of TFP (i.e. technical progress). A little manipulation of the above equation gives equation 3.8 which is used to measure TFP growth in the growth accounting approach. It is given as follows:

$$\frac{\dot{A}}{A} = \frac{\dot{y}}{y} - S_K \frac{\dot{k}}{k} \qquad (3.8)$$

In order to measure TFP growth according to equation 3.8, which has been developed under the growth accounting approach, I need two data series: output per worker growth, capital per worker growth and an estimate of share of capital per worker in output. Han (2003) argued that the share of capital per worker (S_K) in an aggregate CD-PF remains consistent over time. He recommends two methods to determine the

[12] See Appendix 3.1

S_K. One method is to estimate the share of labor (S_L) first due to its easy calculation through the ratio of aggregate wage-bill (WL) to the total output. In the notation (WL), used as an abbreviation of aggregate wage-bill, W represents the average wage rate and L represents total employment. After estimating the share of labor it should be subtracted from 1 which will produce share of capital as $S_K=1–S_L$. However, it should be kept in mind that this method works only under the assumption of constant returns to scale. The second method of estimating S_K is to run regression according to the specification given in equation (3.7). In this equation, S_K is given as the slope coefficient of capital per worker. In the case of a panel study this method is convenient to use for the estimation of S_K. Due to the unavailability of a single source of data to retrieve data on average wage level and total employment for many countries the method of calculating the S_K through the ratio of aggregate wage-bill to the total output is not recommended. However, use of regression method to estimate the S_K necessitates the assumption that all cross-sectional units included in the panel have the same production function and constant capital share. After regressing the output per worker on a constant and capital per worker according to equation (3.7) under the assumptions stated above I can estimate TFP growth following the relationship given in equation (3.8).

Young (1994) employed a cross-sectional regression based on equation 3.7 to estimate TFP growth for 118 countries. He estimated output per worker using a constant term and capital per worker as the independent variable. He found that the world's average TFP growth was –0.21 for the period 1970 to 1985 whereas the coefficient of capital per worker was 0.45[13].

[13] The coefficient of capital per worker based on equation 3.6 is called share of capital.

Since in equation 3.7 only labor and capital are covered as factors of production the model faces omitted variable bias. To avoid this bias Mankiw, Romer, and Weil (1992) included human capital as an additional variable in the production function. In this case equation 3.5 may be extended as

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + S_K \frac{\dot{K}}{K} + S_L \frac{\dot{L}}{L} + S_H \frac{\dot{H}}{H} \qquad (3.9)$$

In the above equation S_H is the share of human capital growth in income and $\frac{\dot{H}}{H}$ represents the growth of human capital, whereas all other symbols have the usual meanings as mentioned before. It is important to note that equation 3.9 is also characterized by constant returns to scale (i.e. $S_K+S_L+S_L=1$). To estimate TFPG using equation 3.9 researchers normally use average schooling years of adult population as the proxy for human capital.

As an alternative to the growth accounting approach used by Young (1994), some researchers (e.g. Collins et al., 1996) use a growth accounting approach based on the CD-PF with labor-augmenting human capital. In their growth accounting approach they include human capital along with physical capital to estimate the growth of output per worker, and they segregate it into the contributions from the factors included in the model and a residual as a measure of change in TFP. They did not estimate capital share using regression analysis to estimate TFP growth rather they simply used values of capital share reported in the existing literature. They used a capital share of 0.35 to estimate output per worker for the period 1960 to 1994. They took this figure of capital share from existing studies. Further, they used capital share of 0.30 and 0.40 to perform sensitivity analysis. According to them this range of capital share is likely to be found on the basis of existing literature. The reason for not

estimating the capital share, according to them, was the problem of distribution of income of self-employed workers between the returns to capital and to labor.

Hahn and Kim (2001) employed growth accounting analysis to test the importance of physical capital accumulation in EA for the period 1960 to 1990. They conducted their study under two assumptions of factor shares. First, they assumed common factor shares across countries. Following Collins et al. (1996), they assumed a capital share of 0.35 when human capital was modeled as a labor quality index. Whereas, following Mankiw et al. (1992), they assumed a physical capital share of 0.4 and human capital share of 0.3 when human capital was considered another factor of production. Second, they allowed cross-country differences in factor income shares. They justified this assumption giving the argument "we allow cross-country differences in factor income shares since the level of physical capital share of income, around 0.3, is based on the findings from industrialized countries".[14]

Kim and Lau (1994) derived a measure of TFP growth in another way. They used a TL-PF to estimate TC in East Asian countries. In such a production function TC is measured using a time trend term. This method also suffers from the assumption of same form of production function for all countries but parameters, for example shares of capital are allowed to be variant country-wise. But this method of using a TL-PF is also has a problem. This form of production function involves a large number of parameters, which require a large number of observations, which are very hard to find especially in this case. Further, a large number of parameters, transformed from each other, may be multicollinear with each other.

[14] Prior to the study of Kim and Hahn (2000), Page (1994) calculated TFPG for several East Asian countries. He also simply used the value of capital share estimated from high-income countries as a representative value for the East Asian countries.

The present study will use equation 3.8 to estimate TFPG and for this I will use our own-estimated value of the capital share to measure it. I will also perform sensitivity analysis using capital shares of 0.3, 0.4, 0.5 and 0.57[15].

Since required data on capital stock per worker (K) is not available from the common sources of data, I will construct this series by dividing capital stock by labor force. To construct the series of capital stock I will use the perpetual inventory method. The perpetual inventory method accumulates the flow of past investment in order to generate the series of capital stock. Capital stock as the accumulation of the flow of past investments is shown as follows:

$$K_t = \sum_{i=0}^{t} I_{t-i}(1-\delta)^i \qquad 3.10$$

In the above equation K_t, I_t and δ represent the capital stock in present time period, investment level in present time period and the depreciation rate of capital respectively. I can write equation 3.10 alternatively as follows:

$$K_t = I_t + I_{t-1}(1-\delta) + I_{t-2}(1-\delta)^2 + ... + I_0(1-\delta)^t \qquad 3.11$$

For the time period t–1 the above equation takes the following form:

$$K_{t-1} = I_{t-1} + I_{t-2}(1-\delta) + I_{t-3}(1-\delta)^2 + ... + I_0(1-\delta)^{t-1} \qquad 3.12$$

Multiplying both sides of the above equation with (1-δ) I get the following equation

$$(1-\delta)\,K_{t-1} = I_{t-1}(1-\delta) + I_{t-2}(1-\delta)^2 + I_{t-3}(1-\delta)^3 + ... + I_0(1-\delta)^t \qquad 3.13$$

Subtracting equation 3.12 from 3.10 I get the following equation:

$$K_t - (1-\delta)K_{t-1} = I_t \qquad 3.14$$

$$K_t = I_t + (1-\delta)K_{t-1} \qquad 3.15$$

[15] In the case of developing countries we could not find any study in which capital share has been used as less than 0.3 or greater than 0.57. See, for example, Harrison (1996) and Han (2003).

The above equation is the key equation to estimate the capital stock in the current time period and it implies that $K_0=I_0$, where K_0 is initial capital stock and I_0 is investment level in the initial time period. Khan (2006) suggested, "The value of investment in the initial period is estimated through a linear regression of the log of investment against time. The fitted value of initial investment is used to calculate initial capital stock." To calculate the initial capital stock he used an equation such as given below:

$$K_{t-1} = \frac{I_t}{(g+\delta)} \qquad 3.16$$

In the above equation g is the rate of growth of output. The problem in estimating the above equation is the selection of depreciation rate δ. However, many researchers, for example Nehru and Dhareshwar (1993), Collins and Bosworth (1997) and Khan (2006), used a 4 percent annual depreciation rate of capital. Following these researchers I will also use the same depreciation rate of capital.

The growth accounting approach is the most widely used approach for the estimation of TFPG on account of its simple and easy method of application and other advantages. This approach is supportive in estimating TFP in situations where data for some periods is missing. Further, when data is available only for limited periods this approach is able to estimate TFP; this approach is able to produce TFPG estimates for each period. Therefore, the trend of TFP growth can be observed using this approach.

Despite the above advantages, this approach has some limitations. This approach assumes that production functions exhibit the behavior of constant returns to scale. But, Lucas (1988), Romer (1986, 1990) and some other researchers argue that due to economies of scale production functions characterized by increasing returns to scale might also exist. Further, the growth accounting approach assumes that the production function is stable. But, in the case of a long run and large sample of countries this may

become instable. The assumption of this approach, referred to as Hicks neutral technical progress, has also been criticized by researchers. This assumption necessitates that the productivity of labor and capital must increase at the same rate due to technical progress. This is very hard to see in the real world. Moreover, TFP growth measured through the growth accounting approach may not be the true measure of technical progress as besides technical progress it covers the effects of economies of scale and trade openness, and so on. In this approach the estimates may not be tested for statistical significance as this approach is parameter free.

3.2 Index Number Method as a Measure of TFPG

The index number method is an alternative growth accounting measure of TFP. This approach resembles the growth accounting approach in a number of ways. Both approaches develop the indices of TFP and both suffer similar problems. However, unlike the growth accounting approach, the index number method is not restricted to using the aggregate production function. Given the specification of production function, researchers use different methods of index numbers to estimate TFP with this approach.

The productivity of a factor of production is the measure of how efficient that factor is in the production of output. In the case of a single output produced by a single input productivity is simply the ratio of output to input. However, practically, production functions involve the production of more than one output using multiple factors of production. In this case the measurement of TFP using a simple output to input ratio is no longer a simple phenomenon. The problem involves the selection of weights for each output to develop an aggregate output index and for each input to develop an aggregate input index. The use of two forms of production function is very common in the literature:

$$Q = AL^{\alpha} K^{\beta} \qquad 3.17$$

$$Q = A(\alpha L + \beta K) \qquad 3.18$$

In both functions, specified as in equations 3.17 and 3.18, Q, L, and K represent output index, labor and capital respectively, whereas *A*, α and β represent TFP, labor elasticity of output and capital elasticity of output respectively.[16] With little manipulation the above functions can be written into the forms of TFP Index.

$$A = \frac{Q}{L^{\alpha} K^{\beta}} \qquad 3.17\text{-A}$$

$$A = \frac{Q}{\alpha L + \beta K} \qquad 3.18 - A$$

The equations 3.17-A and 3.18-A are the manipulated forms of equations 3.17 and 3.18 respectively. Each of the above stated equations represents how the TFP index can be developed. However, the former is a form of geometric index of TFP and the latter is the form of arithmetic index of TFP. According to equations 3.17-A and 3.18-A to develop the TFP index I need data on output index, labor input, capital input, labor share of output (α) and capital share of output (β). Values of α and β can be determined through the estimation of production functions given in equation 3.17 or 3.18 correspondingly.

The important issue in the estimation of the TFP index through the index number approach is the selection of an appropriate index number method. Researchers normally use two approaches to select the appropriate method of index number to

[16] α and β are also called share of labor into output (or simply labor share of output) and share of capital into output (or simply capital share of output) respectively.

develop the TFP index. The first approach is known as the axiomatic approach, whereas the second approach is known as the economic approach.

In the first approach desirable properties of an index number are predefined then different forms of index numbers are studied to find which form best fulfills the desirable properties of the index number. The one which best fulfills the desirable properties is selected as the measure of TFP index.

In the second approach a particular form of index number is used for a given form of production function. In the literature, researchers have highlighted several forms of production functions such as CD-PF, Constant Elasticity of Substitution production function (CES-PF), Variable Elasticity of Substitution production function and TL-PF. Diewert (1976, 1978) cited in Kumar et al. (2004, p. 174) argued that "The Theil-Tornqvist discrete approximation to the Divisia index is consistent in aggregation and superlative for a linear homogeneous trans-logarithmic production function". Due to the above argument the present study uses the Divisia-Tornqvist index number method to develop the TFP index under the index number approach. However, the Divisia-Tornqvist index number method works under certain assumptions. It assumes that the production function is in linear homogeneous and in trans-logarithmic form. Further, it assumes that markets are perfectly competitive and firms seek to maximize their profits under this situation. Under these assumptions the Tornqvist output index takes the following form:

$$Q_t = \prod_{i=1}^{m} \left(\frac{y_{it}}{y_{it-1}}\right)^{(1/2)\left[R_{it}+R_{it-1}\right]} \qquad 3.19$$

In the above function Q_t, Y_{it}, Y_{it-1}, R_{it}, and R_{it-1} represent output quantity index, output of i^{th} commodity in current time period, output of i^{th} commodity in previous time period, share of i^{th} commodity in total revenue in current time period and share of i^{th}

commodity in total revenue in previous time period respectively. In the function given in 3.19 the estimation of R_{it} requires some explanation. This is computed as given in equation 3.20:

$$R_{it} = \frac{p_{it} y_{it}}{\sum_{i=1}^{m} p_{it} y_{it}} \qquad 3.20$$

In the above equation R_{it}, and Y_{it} have the usual meanings as stated above, whereas P_{it} represents price of the i_{th} commodity.

Under the same assumptions as stated above the Tornqvist input quantity index takes the following form:

$$I_t = \prod_{j=1}^{n} \left(\frac{x_{jt}}{x_{jt-1}}\right)^{(1/2)[S_{jt}+S_{jt-1}]} \qquad 3.21$$

In the above equation, I_t, x_{jt}, x_{jt-1}, S_{jt} and S_{jt-1} represent Tornqvist input quantity index in current time period, amount of j^{th} input in current time period, amount of j^{th} input in preceding time period, share of j^{th} input in total cost in current time period and share of j^{th} input in total cost in previous time period respectively. In the equation 3.21 the share of j^{th} input in total cost (S_{jt}) is estimated as given in equation 3.22:

$$S_{jt} = \frac{w_{jt} x_{jt}}{\sum_{j=1}^{n} w_{jt} x_{jt}} \qquad 3.22$$

In equation 3.22 S_{jt} and x_{jt} have the usual meanings as stated in the interpretation of equation 3.21, whereas w_{jt} is the cost of j^{th} input in the current time period.

In the case of measurement of the Tornqvist input quantity index one may have to face the problem of biased estimates. The reason for the above is the non-existence of perfect competition in factor markets in the case of most countries. In this situation the prevalence of equality of factor payments to their marginal products is very

seldom. In this situation the use of factor prices as the proxy of their respective shares in output will produce biased estimates of the TFP index. Besides that stated above, unavailability of reliable data on factor payments poses another problem is the estimation of TFP index. In order to overcome the problems stated above some researchers, for example Wizarat (2002), estimate CD-PF to determine the share of each input into output and replace factor payments by factor shares of output. Substituting factor shares of output in place of factor payments the Tornqvist input quantity index takes the following form:

$$I_t = \prod_{j=1}^{n} \left(\frac{x_{jt}}{x_{jt-1}} \right)^{\alpha_j} \qquad 3.23$$

In the above equation I_t and x_{jt} have the same meanings as stated above in equation 3.21, whereas α_j represents the share of j input into output. It is important to mention again that the value of α_j can be determined through the estimation of CD-PF.

After the estimation of Tornqvist output quantity index and Tornqvist input index the Tornqvist TFP index can simply be calculated as the ratio of the first to the second for each period. This is given in equation 3.24.

$$TFP_t = \frac{Q_t}{I_t} \qquad 3.24$$

The index number approach is characterized by the same advantages as the growth accounting approach.

3.3 Econometric Method as a Measure of TFPG

In the econometric method of TFP estimation appropriate econometric models for the given production functions are specified and then estimated. Various forms of production functions can be estimated through econometric methods. However,

specification and estimation of TL-PF, CD-PF and CES-PF are commonly seen in the literature.

3.3.1 The Trans-logarithmic Production Function

There are two methods to estimate TL-PF: direct method and indirect method. Taking into account just two factors of production, labor and capital, one can estimate TL-PF through a direct method of estimation using the following econometric specification of the function:

$$Q=\exp[\alpha_0 + \alpha_L \ln L + \alpha_K \ln K + \alpha_T T + \tfrac{1}{2}\beta_{KK}(\ln K)^2 + \beta_{KL}\ln K \ln L + \beta_{KT} T \ln K + \tfrac{1}{2}\beta_{LL}(\ln L)^2 + \beta_{LT} T \ln L + \beta_{TT} T^2] + \varepsilon \qquad 3.25$$

In the above equation, Q, L, K and T represent value added, capital stock, labor force, and technology respectively, whereas ln is the notation of natural logarithmic form of a variable and ε represents the error component of the model. Since the above specified model estimates a large number of coefficients the degrees of freedom substantially decrease. Therefore, estimation of the above model requires a very large sample size. Moreover, in the specified model the variables are somehow related to each other and in this situation the problem of multicollinearity may arise.

The second method of estimation of TL-PF is the indirect method. This method requires the estimation of profit or cost function at the first stage then it requires the derivation of fundamental properties of the estimated function using duality theory. In this method residuals are obtained through Ordinary Least Square approach of estimation and then through these residuals co-variances are estimated and then through successive application of Generalized Least Square approach with restriction on the coefficients residuals are minimized. It is important to mention that this procedure assumes that TC is Hicks neutral and the production function exhibits the

behavior of constant returns to scale and firms face perfectly competitive markets. The present study does not estimate TL-PF due to the reasons discussed above.

3.3.2 The Cobb–Douglas Production Function

In growth studies, specification of the production function in Cobb–Douglas form is frequently found. This specification can be easily estimated after transforming it into log-linear form. The specification of the CD-PF takes the following form:

$$Q_t = A_t K_t^{\alpha} L_t^{\beta} \qquad 3.26$$

In the above specification Q_t, K_t, L_t, α, β and A_t represent output value added in current time period, capital stock in current time period, level of labor force in current time period, capital elasticity of output, labor elasticity of output and state of technology respectively. In the above model with the given values of K_t and L_t any technical progress (i.e. increase in value of A_t) will shift the production function upward. Econometric specification of A_t is given as follows:

$$A_t = A_0 e^{\lambda t} \qquad 3.27$$

Substituting the value of A_t from 3.27 into 3.26 I have equation 3.28:

$$Q_t = A_0 e^{\lambda t} K_t^{\alpha} L_t^{\beta} \qquad 3.28$$

In the above model if the sum of α and β is equal to unity, less than unity and greater than unity implies that the production function exhibits the behavior of constant returns to scale, diminishing returns to scale and increasing returns to scale respectively. Hence, specification of the CD-PF allows estimating the production function with variable returns to scale as well rather than just with constant returns to scale like some other specifications of the production function.

Applying logarithms on both sides of the model specified in equation 3.28 I have the log-linear specification of CD-PF as given in equation 3.29:

$$\ln Q_t = \ln A_0 + \lambda t + \alpha \ln K_t + \beta \ln L_t + \epsilon t \qquad 3.29$$

The above log-linear specification of CD-PF can be estimated using the following form:

$$\ln Q_t = \alpha_0 + \alpha_1 t + \alpha_2 \ln K_t + \alpha_3 \ln L_t + \varepsilon_t \qquad 3.30$$

Given the data on three time series (i.e. output value added, capital stock and labor force) I can estimate the above specification of CD-PF. In the above model α_2 and α_3 represent capital elasticity of output and labor elasticity of output respectively and α_{2+} α_3 represents returns to scale. Further, α_1 is the coefficient of technology and it measures the average share of technology into output growth during the period under study. It is important to mention that technology coefficient α_1 implies that technology growth is disembodied, exogenous and Hicks-neutral and it is materialized at a constant exponential rate. However, after estimating the effect of TC on output growth TFP growth can be measured using the following equation[17]:

$$TFPG_t = \alpha_1 + (\alpha_2 + \alpha_3 - 1)(\alpha_2 \dot{L}_t + \alpha_3 \dot{K}_t) \qquad 3.31$$

In the above equation α_1, α_2 and $\alpha 3$ represent the same things as in equation 3.30. However, $\dot{L}_t$ and $\dot{K}_t$ represent annual growth rates of labor force and growth rate of capital respectively. The econometric approach involves the estimation of coefficients according to the specification of the production function. Therefore, this approach requires complete data series without missing values to ensure sufficient degrees of freedom. If data values of variables entered into the model are missing then the estimated coefficients may not be reliable. However, this approach permits the application of statistical significance tests of estimated coefficients. Different restrictions on the production function may also be tested through this approach.

[17] For further reading see Shiu and Heshmati (2006).

3.4 Effect of TFPG on Future Economic Growth[18]

The neoclassical growth model reflects that if there is technical progress, the aggregate production function shifts upward and the economy adjusts to a new steady state. At the initial level of capital per worker (k), output per worker (y) increases, which indicates a higher level of MPk at each level of k. Due to an increase in MPk, investment increases, and this increased investment raises the level of K from its initial level. Capital per worker may increase until MPk reaches its initial level[19]. Increased capital per worker raises the output per worker. This is shown in Appendix 3.2. If TFP growth is the correct measurement of technical progress then positive growth of TFP should raise the level of investment, which should be followed by output per worker growth. The idea of the effect of TFP growth on future economic growth, however, may still be ambiguous for some. The concept of lags involved in capital formation for the time required to complete the investment is helpful to understand the idea of the effect of TFP growth on future economic growth. Koeva (2000) reported that different industries of the USA take 13 to 86 months for the completion of installations of new plants. According to the findings of Koeva (2000) it can be argued that investment cannot be made spontaneously, rather it is a continuous phenomenon which goes reasonably into the future once started in the present.

Neoclassical growth model assumes constant marginal propensity to save, s, and a constant growth rate of labor force, n. Under these assumptions I have

$$S=sY \qquad 3.31$$

$$\text{And} \quad \dot{K} = I - \delta K \qquad 3.32$$

[18] Most of the discussion in this section has drawn upon Han (2003).
[19] This statement is true only under the assumption of constant relative factor price.

Since S=I

$$\dot{K} = sY - \delta K \qquad 3.33$$

Rewriting equation 3.2 Y = A(t)F(K, L)

Dividing both sides by L y = A(t)f(k, 1) 3.34

Since 1 is constant in 3.34, alternatively I can write it as follows

y = A(t)f(k) 3.35

I know $\frac{\dot{k}}{k} = \frac{\dot{K}}{K} - \frac{\dot{L}}{L}$ 3.36[20]

Rearranging above equation $\dot{K} = L\dot{k} + \dot{L}k$ 3.37

From equations 3.33 and 3.37 I have

$$sY - \delta K = L\dot{k} + \dot{L}k$$

$$sL\frac{Y}{L} - \delta K = L\dot{k} + \dot{L}k$$

$$sLA(t)f(k) - \delta Lk = L\dot{k} + \dot{L}k$$

Since $\frac{\dot{L}}{L} = n$

$$sA(t)f(k) - \delta k = \dot{k} + nk$$

$$\dot{k} = sA(t)f(k) - \delta k - nk$$

$$\dot{k} = sA(t)f(k) - (\delta + n)k \qquad 3.38$$

Equation 3.38 is the fundamental equation of the Solow model in the presence of constant growth rate of labor force 'n' and constant depreciation rate of capital' δ '. This equation shows that change in capital per worker $\dot{k}$ is the difference of actual investment per worker $sA(t)f(k)$ and the breakeven investment $(\delta + n)k$. If technical progress appears, then actual investment $sA(t)f(k)$ exceeds the breakeven investment $(\delta + n)k$ and capital per worker increases, which enhances the output per worker. Han

[20] See Appendix 3.1

(2003, p. 20) argued "if TFPG is a good measure of technology growth, then higher TFPG is expected to cause higher future investment and higher future output growth". However he opined that commonly used methods of TFP growth measurement may fail to capture technology growth when economic growth is sector specific. However, he agreed that investment and output growth would still increase due to sector-specific technical gains but in such circumstances the ability of TFP growth to predict output growth breaks down. Van (2003) also reported on sector-specific TC in East Asian countries. He reported that such TC took the form of "learning-by-doing" and initial doing is induced by the relative factor prices. He showed that in this situation TC may exist yet not be measured by conventional measures of TFP growth.

Van and Park (2001) focused on the possibility that East Asian countries' growth is sector specific. They argued, for instance, that in the 1960s and early 1970s the Korean economy specialized in labor-intensive industries, first in textiles and apparel and then in electronics, automobiles and semiconductors simultaneously. So they focused on the idea that technology gains are localized. In such circumstances, according to them, the main conventional methods of growth accounting (i.e. to calculate the Solow residual using data on output and factor inputs and to estimate an aggregate production function for the economy using TL-PF or the more restrictive Cobb–Douglas form) may only reflect capital deepening as new industries use capital more intensively. Yet, such measures would not reflect the fact that these industries may have achieved technical gains to make production feasible.

The present study will use all the three approaches of TFP estimation and will use these estimates to predict future output growth so that the three common measures of TFP growth may be compared with each other, and the measure that best predicts the future output growth of a panel of developing and developed countries can be

determined. However, in order to compare the growth accounting approach and index number approach with the econometric approach, the study will use average estimates of TFP for the period under study and develop a cross-sectional econometric model to determine the effect of TFP on output growth.

Chapter 4

Data and Methodology

4.1 Data and Variables

This study includes a sample of 35 developing and developed countries and covers the period from 1990 to 2009[21]. Three countries have been selected from Central and East Europe (CEE), four countries from Africa, five countries from LA, four countries from SA, four from EA, and 15 countries have been selected from European Union-15 (EU-15). For all countries included in this study, data on different variables have been collected from three sources: The Penn World Tables (PWT) mark 7, The International Financial Statistics (IFS) dated 2011 and World Development Indicators (WDI) dated 2011. The frequency of all variables used in this study is annual. Data on most of the variables included in this study are used from IFS and PWT.

The present study intends to compare the effects of TFP growth measured through the growth accounting approach, index number approach and econometric approach on RGDP. This requires data on two time series: TFP growth and RGDP growth. The present study uses a self-calculated time series of TFP. The measurement of TFP needs three time series: growth rate of capital, growth rate of labor force and growth rate of real GDP. The study accesses data on real GDP growth and GFCF from IFS. The study uses data on GFCF to generate the time series of capital stock using the perpetual inventory method. Following Nehru and Dhareshwar (1993), Collins and Bosworth (1997), Khan (2006), and others, the study uses a four percent annual depreciation rate of capital stock in perpetual inventory method. Time series data on the labor force is used from WDI. Under the growth accounting approach the time series of TFPG are developed according to equation 3.6 using different capital shares

[21] A list of all the countries in the full sample and six sub-samples is given in Appendix 4.1

of output varying from 0.30 to 0.55 to perform sensitivity tests. The study uses equation 3.24 to generate time series data on TFP growth in the index number approach. Data on the input quantity index will be produced using equation 3.23. In order to perform sensitivity analysis this approach will also use different capital shares of output varying from 0.30 to 0.55. In order to have TFP estimates using the econometric approach the study estimates equation 3.29 for the sample of countries.

The theme of this study is based on the idea that TFP growth positively affects the MPk at each level of capital per worker which induces investment which is followed by higher real output. Due to the fact that investment is not completed on the spot, rather it needs time for its completion, TFPG affects future output through future investment. To determine the effect of TFP growth on investment growth I need another time series on investment growth. For this reason, following Han (2003), the study uses two different time series of investment growth: the growth rate of total fixed investment (GFI) and the growth rate of investment share of GDP (GISH).

From the above discussion it is apparent that this study analyses the effect of TFPG on two dependent variables: RGDP and investment (GFI and GISH). To study the effect of TFPG on RGDP the study uses growth rate of real per capita GDP (GRGDP). Time series of GFI were obtained from WDI, whereas time series of GISH and GRGDP were obtained from PWT. I studied the effect of TFPG on future output and investment for the FS of our cross-section and for six sub-samples.

This study uses the first lag of TFPG and GFI or GISH in separate equations as independent variables to estimate the effect of investment and TFPG on GRGDP. Other than investment and TFPG several time-varying control variables, commonly used in growth studies, will also be used as independent variables. The list of these control variables covers growth of INF, government's share of GDP (GOVSH),

population growth rate (GP), and growth rate of trade openness (GTO). Data on three time series; INF, GP and total fixed investment have been obtained from WDI. Data on trade openness, GOVSH, investment share of GDP and RGDP have been obtained from PWT. To test the convergence of real GDP per capita I use one period lagged natural log of RGDP ($LRGDP_{t-1}$).

4.2 Econometric Model

This study uses almost all of the variables in the form of growth rates. Being growth rates, all of the time series are expected to be integrated of order 0 (i.e. I(0)). For the confirmation of these expectations regarding the stationary issues of time series I employ various panel unit root tests, which include Levin, Lin, and Chu (2002), Im, Pesaran, and Shin (2003), and Fisher-type tests using augmented Dickey–Fuller (ADF) and Phillips–Peron (PP) tests. In Levin, Lin, and Chu (LLC) test of unit roots it is assumed that all of the cross-sections face a common unit root process. Contrary to LLC test, the Im, Pesaran, and Shin, and the Fisher-ADF and PP tests assume that the individual unit root processes across cross-sections are included in the sample. All of the unit root tests employed in this study assume the unit root in null hypothesis. Rejection of the null hypothesis leads to the conclusion that the series is stationary.

In order to determine the effects of TFPG on future output growth the study uses two types of econometric models: a pooled cross-section time-series model and a fixed-effects panel data model. In a pooled cross-section time-series model space and time dimensions are disregarded. The pooled econometric model used in this study is of the following form:

$$GRGDP_{it} = \alpha_0 + \alpha_1 TFPG_{it-1} + \alpha_2 LRGDP_{it-1} + \alpha_3 INF_{it} + \alpha_4 GOVSH_{it} + \alpha_5 GP_{it} + \alpha_6 GTO_{it} + U_{it} \quad (4.1)$$

Where "i" represents variations across cross-sections (i.e. from 1 to N) and t represents variation across time periods (i.e. from 1 to T).

On the left-hand side of equation 4.1 $GRGDP_{it}$ appears as a dependent variable and it represents the GRGDP. $TFPG_{it-1}$ represents the first lagged values of TFPG for i^{th} country in t^{th} time period. $LRGDP_{t-1}$ represents the first lag of natural log of RGDP. INF_{it}, $GOVSH_{it}$, GP_{it} and GTO_{it} represent INF, GOVSH, GP and GTO for country i in time period t, whereas U_{it} represents the error term. The model given in equation 4.1 determines the effects of growth rate of TFP on future per capita real output growth. This model also incorporates β-type conditional convergence test of RGDP in the case of the FS of countries and various sub-samples. If the value of β_2 appears as negative and significant then it leads to the notion that each country's RGDP converges to its own level of steady state.

In order to determine the effects of investment growth on future RGDP growth I develop two pooled data models as given in equations 4.2 and 4.3 where each model covers a measure of investment either growth rate of GFI or GISH.

$$GRGDP_{it} = \alpha_0 + \alpha_1 TFPG_{it-1} + \alpha_2 LRGDP_{it-1} + \alpha_3 GFI_{it-1} + \alpha_4 INF_{it} + \alpha_5 GOVSH_{it} + \alpha_6 GP_{it} + \alpha_7 GTO_{it} + U_{it} \quad 4.2$$

Where: i represents variations across cross-sections (i.e. from 1 to N) and t represents variation across time periods (i.e. from 1 to T) and GFI_{it-1} represents first lag of GFI for i^{th} country in t^{th} time period.

$$GRGDP_{it} = \alpha_0 + \alpha_1 TFPG_{it-1} + \alpha_2 LRGDP_{it-1} + \alpha_3 GISH_{it-1} + \alpha_4 INF_{it} + \alpha_5 GOVSH_{it} + \alpha_6 GP_{it} + \alpha_7 GTO_{it} + U_{it} \quad 4.3$$

Where: i=1….N and t=1….T and $GISH_{it}$ represents first lag of GISH for i^{th} country in t^{th} time period.

The study developed a similar pooled econometric model as specified in equation 4.2 in order to determine the effects of TFPG on future investment with little amendment. The study excluded the variables LRGDP and proxies of investment (GIF and GISH) from the models and used the two proxies of investment (i.e. GFI and GISH) as dependent variables in econometric models 4.4 and 4.5.

$$GFI_{it} = \alpha_0 + \alpha_1 TFPG_{it-1} + \alpha_2 INF_{it} + \alpha_3 GOVSH_{it} + \alpha_4 GP_{it} + \alpha_5 GTO_{it} + U_{it} \quad 4.4$$

Where: i=1….N and t=1….T

$$GISH_{it} = \alpha_0 + \alpha_1 TFPG_{it-1} + \alpha_2 INF_{it} + \alpha_3 GOVSH_{it} + \alpha_4 GP_{it} + \alpha_5 GTO_{it} + U_{it} \quad 4.5$$

Where: i=1….N and t=1….T

After determining the effects of TFP growth on future real per capita output growth and on future investment using pooled cross-section time-series regression models the study will also employ fixed-effects panel data model for the same purpose. Fixed-effects panel data models provide country-specific estimates of constant term. Employing these models is useful given the fact that pooled cross-section time-series models ignore the space and time dimensions. According to Hsiao (1986), panel data models are characterized by high useable degrees of freedom with very low chances of collinearity simple cross-sectional or time series models. In cross-sectional models it is assumed that the aggregate production function is uniform across all the countries included in the sample. Cross-sectional analysis may suffer from omitted variable bias if some of the explanatory variables correlate with the country's specific effects. Contrary to this, panel data models are characterized by the variability of slope coefficients athwart cross-sections and these models possibly avoid the omitted variable bias.

The fixed-effects panel data model takes the following form:

$$GRGDP_{it} = \alpha_{0i} + \alpha_1 TFPG_{it-1} + \alpha_2 INF_{it} + \alpha_3 GOVSH_{it} + \alpha_4 GP_{it} + \alpha_5 GTO_{it} + U_{it} \quad 4.6$$

$$GRGDP_{it} = \alpha_{0i} + \alpha_1 TFPG_{it-1} + \alpha_2 GFI_{it-1} + \alpha_3 INF_{it} + \alpha_4 GOVSH_{it} + \alpha_5 GP_{it} + \alpha_6 GTO_{it} + U_{it} \quad 4.7$$

$$GRGDP_{it} = \alpha_{0i} + \alpha_1 TFPG_{it-1} + \alpha_2 GISH_{it-1} + \alpha_3 INF_{it} + \alpha_4 GOVSH_{it} + \alpha_5 GP_{it} + \alpha_6 GTO_{it} + U_{it} \quad 4.8$$

$$GFI_{it} = \alpha_{0i} + \alpha_1 TFPG_{it-1} + \alpha_2 INF_{it} + \alpha_3 GOVSH_{it} + \alpha_4 GP_{it} + \alpha_5 GTO_{it} + U_{it} \quad 4.9$$

$$GISH_{it} = \alpha_{0i} + \alpha_1 TFPG_{it-1} + \alpha_2 INF_{it} + \alpha_3 GOVSH_{it} + \alpha_4 GP_{it} + \alpha_5 GTO_{it} + U_{it} \quad 4.10$$

Where: i represents variations across cross-sections (i.e. from 1 to N) and t represents variation across time periods (i.e. from 1 to T) and α_{0i} represents the constant term and it gives the fixed effects for i^{th} country. Because in fixed-effects models fixed effects across all the cross-sections are captured using the dummy variables, the above specified models are also referred as least-square dummy variable models.

4.3 Convergence Test

Two types of convergence tests are applied in neoclassical growth models: conditional convergence and unconditional or absolute convergence. Conditional convergence refers to the situation that each country converges to its own steady-state level of real GDP per capita. Absolute convergence refers to the situation that all countries converge to the same steady-state level of real GDP per capita.

Two types of convergence are used to test for conditional or unconditional convergence: σ-type convergence and β-type convergence. The test of σ-type convergence investigates whether the dispersion of real Y is reducing over time or not. If it is reducing then I conclude that RGDP is converging to the steady-state level. Whereas the β-type convergence investigates whether the growth rates of countries are negatively correlated with the level of RGDP. For absolute β-type convergence test I use GRGDP as the dependent variable and the initial value of RGDP as the independent variable in the regression model. For the conditional β-type convergence

test I use GRGDP as dependent variable and initial value of RGDP and other control variables as independent variables.

This study uses the β-type test and investigates both (conditional and unconditional) convergences of RGDP. The regression models specified as 4.1 to 4.3 incorporate the conditional β-type convergence test. A negative sign of β_2 in 4.1 to 4.3 exhibits that each country included in the sample converges to its own steady-state level of real GDP per capita. However, our regression model to test the absolute β-type convergence takes the following form:

$$GRGDP_{it} = \beta_0 + \beta_1 LRGDP_{it-1} + U_t \qquad 4.16$$

Where: i=1….N and t=1….T

In the model specified above a negative sign of β_1 exhibits that all countries included in the sample converge to the same steady-state level of real GDP per capita.

In addition to the convergence test for real GDP per capita, I also test for the convergence of TFP. Our regression model to test for absolute β-type convergence of TFP is specified as follows:

$$TFPG_{it} = \beta_0 + \beta_1 LTFP_{it-1} + U_t \qquad 4.17$$

Where: i=1….N and t=1….T

Whereas, to test the conditional β-type convergence of TFPG our model takes the following form

$$TFPG_{it} = \beta_0 + \beta_1 LTFP_{it-1} + \sum_{j=1}^{M} \lambda_j X_{jit} + U_{it} \qquad 4.18$$

Where: i=1….N and t=1….T

$LTFP_{it-1}$ is the first lag of the log of TFP of the country i for time period t. X_{jit} is the set of M control variables (INF, GP, GTO, and GOVSH for country i in time period t) whereas U_{it} is the error term.

Miller and Upadhyay (2000, p. 10) explain that:

> The tests for convergence of total factor productivity provide some new insight as to the spread, adoption, and convergence of technical advances. Our test also may shed some light on the argument about whether technology is a public or a private good. That is, if technology is a public good that can speedily transit international boundaries, then we should find convergence of total factor productivity.

So, I test for convergence of TFP to investigate whether technology is a public good or a private good across nations for the sample of developing countries.

Chapter 5

Trends of Total Factor Productivity Growth[22]

This chapter presents the trends of TFP growth estimated through three different approaches: growth accounting approach, index number approach and econometric approach. The first section of this chapter shows the estimates of share of capital in output (S_k) in the case of each country. The second section shows and discusses the trends of TFP growth measured through the growth accounting approach (TFPG). The third section of this chapter presents the trends of TFP growth measured through the index number approach (TFPGI). Finally, the last section shows the estimates of TFP growth measured through the econometric approach.

5.1 Share of Capital in Output

This section estimates the share of capital in output in the case of each county included in the sample. For this purpose this study used equation 3.7, which uses growth rate of output per worker as the dependent variable and growth rate of capital per worker as the independent variable. Constant $\left(\frac{\dot{A}}{A}\right)$ shows average growth rate of TFP during the sample period in the case of each country. Table 5.1 demonstrates the results of estimation of share of capital in output. The first column of this table contains the names of countries included in the sample. The second column shows the region in which each country falls. The third column contains the value of constant in the case of each county according to equation 3.7, which is in fact average growth rate of TFP growth. The fourth column presents the values of share of capital per worker

[22] See Appendix 1 for the list of symbols and abbreviations used in the study.

in output per worker in the case of each country. The fifth column shows the value of R^2. The last column of the table shows the values of F statistic for each country.

Table: 5.1 Estimation of Share of Capital in Output

Dependent Variable: Growth rate of output per worker $\left(\frac{\dot{y}}{y}\right)$					
Country	Region / Variable	$\left(\frac{\dot{A}}{A}\right)$	$\left(\frac{\dot{k}}{k}\right)$	R^2	F-Stat
Hungary	Central and East Europe	–0.06	0.40*	0.92	3433.28*
Romania	Central and East Europe	2.00*	0.32*	0.88	132.65*
Turkey	Central and East Europe	–0.79	0.51*	0.98	1341.55*
Algeria	Africa	–0.41	0.43***	0.12	2.42***
Egypt	Africa	1.51*	0.46*	0.78	67.22*
Morocco	Africa	0.14	0.68*	0.81	79.56*
South Africa	Africa	–1.21	0.23*	0.52	19.74*
Argentina	Latin America	2.05*	0.53*	0.61	27.92*
Brazil	Latin America	–0.23	0.51*	0.71	46.94*
Chile	Latin America	0.07	0.37*	0.99	2022.02*
Colombia	Latin America	–0.40	0.45*	0.84	103.20*
Mexico	Latin America	–0.09	0.56*	0.85	381.83*
Bangladesh	South Asia	0.22	0.36**	0.17	4.64**
India	South Asia	1.67*	0.63*	0.79	71.72*
Pakistan	South Asia	0.72	0.47*	0.21	7.18**
Sri Lanka	South Asia	2.49*	0.59*	0.79	71.62*
Hong Kong	East Asia	1.17	0.50*	0.44	15.84*
Korea	East Asia	2.56*	0.25*	0.63	30.25*
Malaysia	East Asia	1.06	0.20**	0.31	7.98**
Thailand	East Asia	0.80	0.20**	0.27	6.72**
Austria	EU-15	0.77	0.53*	0.98	768.39*
Belgium	EU-15	0.06	0.51*	0.84	93.57*
Denmark	EU-15	–0.14	0.37*	0.10	1.82
Finland	EU-15	0.92	0.45*	0.69	43.84*
France	EU-15	–0.23	0.56*	0.30	9.18*
Germany	EU-15	0.93	0.53*	0.02	0.27
Greece	EU-15	–0.03	0.51*	0.60	29.43*
Ireland	EU-15	1.22**	0.36**	0.21	4.91**
Italy	EU-15	–0.22	0.41*	0.90	176.89*
Luxembourg	EU-15	0.10	0.27*	0.96	432.24*
Netherlands	EU-15	0.44	0.34*	0.25	6.09**
Portugal	EU-15	–0.81	0.32*	0.99	33629.76*
Spain	EU-15	–0.41	0.32*	0.92	217.08*
Sweden	EU-15	0.48	0.31*	0.74	53.58*
United Kingdom	EU-15	0.65	0.33*	0.65	36.59*

Note: * indicates statistical significance at 1%, ** at 5% and *** at 10%

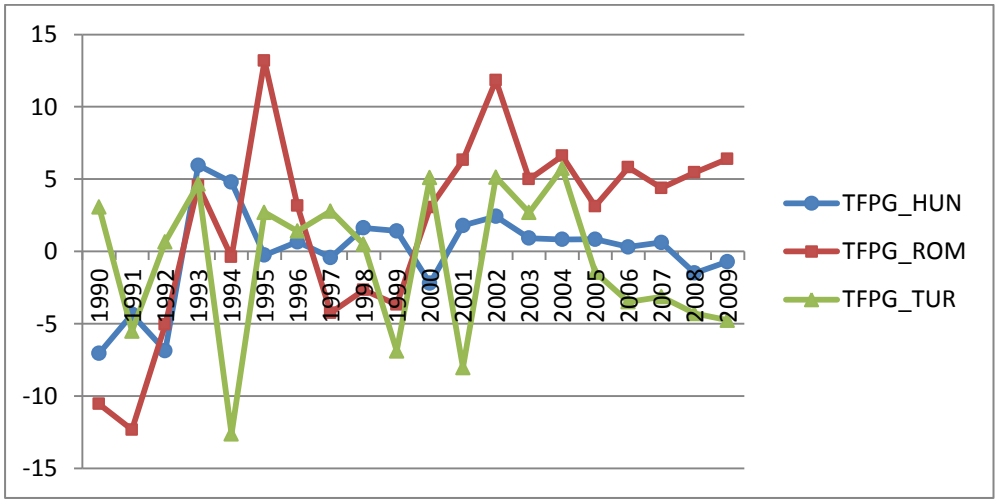
According to the results presented in Table 5.1, the share of capital per worker in output per worker (S_k) in the case of each country is significant either at one percent level of significance or at five percent significance level except Algeria where it is

significant at ten percent significance level. The magnitude of the share of capital in output in the case of various countries varies from 0.20 (in the case of Malaysia and Thailand) to 0.68 (in the case of Morocco). It is important to note that these shares of capital per worker have been estimated under the assumption of constant returns to scale considering labor and capital as factors of production.

5.2 Trends of TFPG

This section represents the trends of TFP growth measured through the growth accounting approach (TFPG) using equation 3.8. In order to obtain the time series of TFPG two time series (i.e. growth rate of output per worker and growth rate of capital per worker) have been used along with the estimates of share of capital per worker in output per worker given in Table 5.1 in the case of each country. For the purpose of representing the trends of TFPG, line graphs and tables have been used. Besides presenting the trends of TFPG in the case of each country, this section also compares these trends on a country level and regional level.

Figure: 5.1 Trends of TFPG in Central and East Europe



HUN = Hungary, ROM = Romania, TUR = Turkey.

Figure 5.1 shows the line graphs of TFPG over the sample period in the case of Central and East European countries included in the sample: Hungary, Romania and Turkey. Among these three countries Hungary reaped relatively stable growth of TFP during the sample period except in the early 1990s where TFPG remained a little volatile as it increased by almost thirteen percent from –7.04 percent to +5.95 percent in just one year from 1992 to 1993. The reason for this volatility of TFPG during the early 1990s may be the transition of the Hungarian economy from a planned economy to a market economy during this period[23].

Unlike Hungary, Romania and Turkey faced highly volatile growth rates of TFP. The range of growth rates of TFPG in Romania is greater than that of Turkey because it varies from –12.32 percent to more than +11.82 percent whereas in the case of Turkey it varies from –12.62 percent to +5.74 percent. However, since 2000 Romania has sustained a stable and appreciable positive growth rate (almost five percent) of TFP. The reason for high volatility of TFP growth in Romania during the sample period before 2000 may be the transition of its economy from a planned economy to a market economy. After the 1996 elections in Romania a new political system emerged; as a result, economic reforms were implemented which led to the private sector attracting local and foreign investment flows to support the Romanian economy[24].

At the start of the sample period Turkey experienced very volatile trends of growth rate of TFP similar to Romania. After 2004 Turkey sustained a stable growth rate of TFP, however, it remained negative during this period unlike that of Romania. During the 1990s the Turkish economy faced problems of unsustainable public debt, unstable growth rates of GDP, high and fickle INFs, structural issues and earthquake disasters (Banking Regulation and Supervision Agency, 2010). These issues could explain the

[23] See Erlich and Revesz (1995) for details.
[24] See Scrieciu and Winker (2002) for details.

volatile growth rates of TFP until 2004. Global economic competition negatively affected the private sector of the Turkish economy (Ministry of Industry and Trade, Republic of Turkey, 2010); this might explain the negative rates of TFP growth in Turkey at the end of the sample period.

Figure: 5.2 Trends of TFPG in Africa

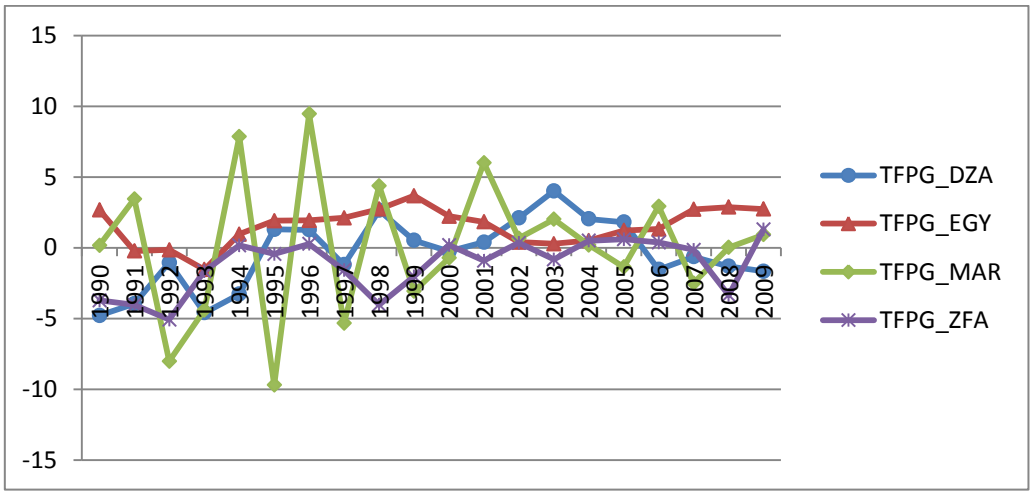


Figure 5.2 depicts the trends of TFP growth measured through the growth accounting approach in the case of four African countries: South Africa, Morocco, Egypt and Algeria, for the sample period. The graph shows that TFPG in Morocco remained highly volatile during the sample period especially until 2002. It is worth noting that it remained as low as –9.70 in 1995 and as high as 9.45 in 1996. Further, the average level of TFPG in Morocco remained at 0.14 percent with a high standard deviation (SD) of 4.90 producing a very high coefficient of variation (CV) which is 35. After 2002 the volatility of TFPG in Morocco decreased yet it was not stable. Frequent SD changes in world oil prices, environmental conditions, foreign remittances, capital flows and political situations may have caused the Moroccan economy to be volatile (Sekkat, 2004).

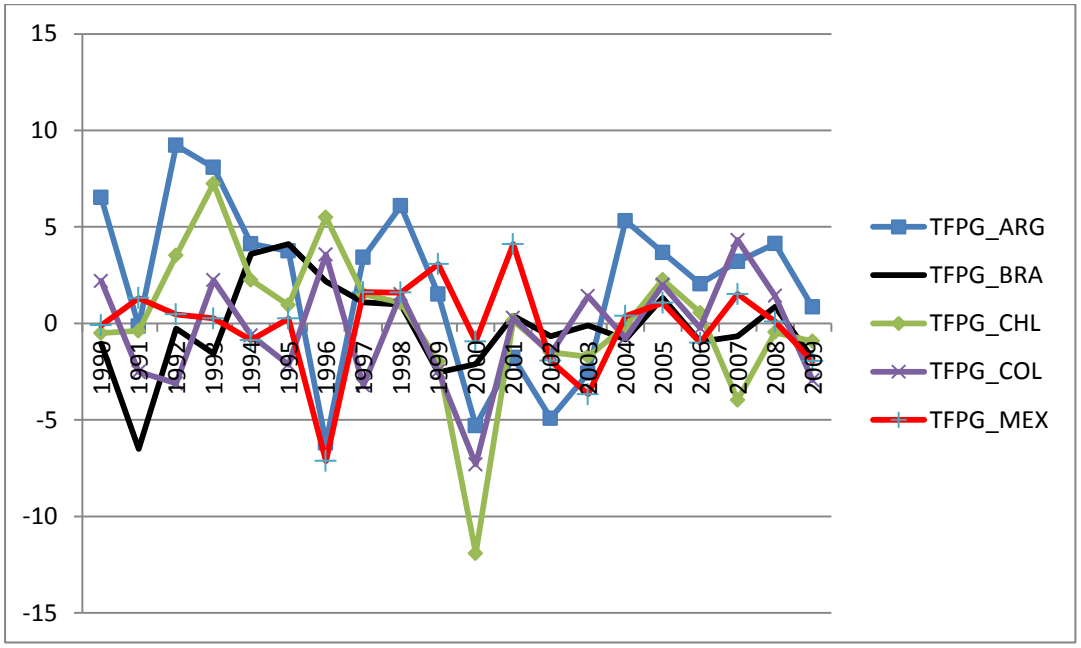
Trends of TFPG in South Africa and Algeria also showed volatility because they fluctuated between positive and negative growth rates. However, the average TFPG in these countries remained negative: –1.21 in South Africa and –0.41 in Algeria with SDs of 1.90 and 2.47 respectively. The IMF (2007) suggested that a lengthy period of transition to a market economy, weak institutional frameworks, petite private sector, disturbing investment ambiance, labor market bends, and large migrations of skilled laborers to abroad may have caused poor productivity growth in Algeria. The weak levels of TFP growth in South Africa may be ascribed to a low saving rate, lackluster foreign direct investment, labor market stringency, weak skill levels of labor force, and tight public policies as reported by Pillay (2001).

In the case of Egypt, fluctuations in TFP growth have not been random but have followed a cyclical trend. TFPG in Egypt remained positive throughout the sample period with an exception of three years (i.e. from 1991 to 1993) where it remained negative. The average growth rate of TFP in Egypt remained at 1.51 percent during the sample period included in the study with a SD of 1.31 giving a relatively small value of CV of 0.87. Ahmed (2006) reported a negative growth rate of TFP during the 1980s which continued until the early 1990s. However, Din and Morsi (2003) ascribed the positive growth rate of TFP during the 1990s to the implementation of the Economic Reform and Structural Adjustment Program in 1991. The present study also found the same trends of TFP growth during the period which remained remarkable especially from 1997 to 2001.

Figure 5.3 presents the trends of TFP growth in the case of the five Latin American countries included in the sample: Argentina, Brazil, Chile, Colombia, and Mexico. All the countries included in the region observed similar trends of TFP growth without exception; the trends were very volatile throughout the sample period. Average

growth rates of TFP, SDs and coefficients of variation in this region were: mean= 2.05, SD = 4.32, CV = 2.14; mean = –0.23, SD = 2.30, CV = –10.08; mean = 0.07, SD = 3.83, CV = 51.43; mean = –0.40, SD = 2.82, CV = –7.13; and mean = –0.09, SD = 2.42, CV = –26.13 for Argentina, Brazil, Chile, Colombia and Mexico respectively. These facts show that TFP growth in LA has been very volatile especially in the case of Chile and Mexico.

Figure: 5.3 Trends of TFPG in Latin America



Although the trends of TFP growth in this region have followed random fluctuations, the intensity of the volatility reduced after 2001and overall TFPG in this region during the mentioned period varied around zero percent with an average growth rate of 0.03 percent and SD of 2.29 as compared to average growth rate of 0.45 percent and SD of 3.86 from 1991 to 2001. Researchers ascribe the poor conditions of TFP growth in Latin American countries to policy mistakes. They think that trade restrictions in this region, political instability, industrialization targeted at import substitution and sectoral subsidies for attracting investment are responsible for the low level of TFP growth in LA (see for example Cole et al., 2005 and Hopenhayn and

Neumeyer, 2004). Hopenhayn and Neumeyer (2004) reported slightly negative growth rate of TFP in LA during the 1960s, 1970s and 1980s. The present study found a positive average growth rate of TFP in LA that reveals an improvement in TFP growth during the sample period under study.

Figure: 5.4 Trends of TFPG in South Asia

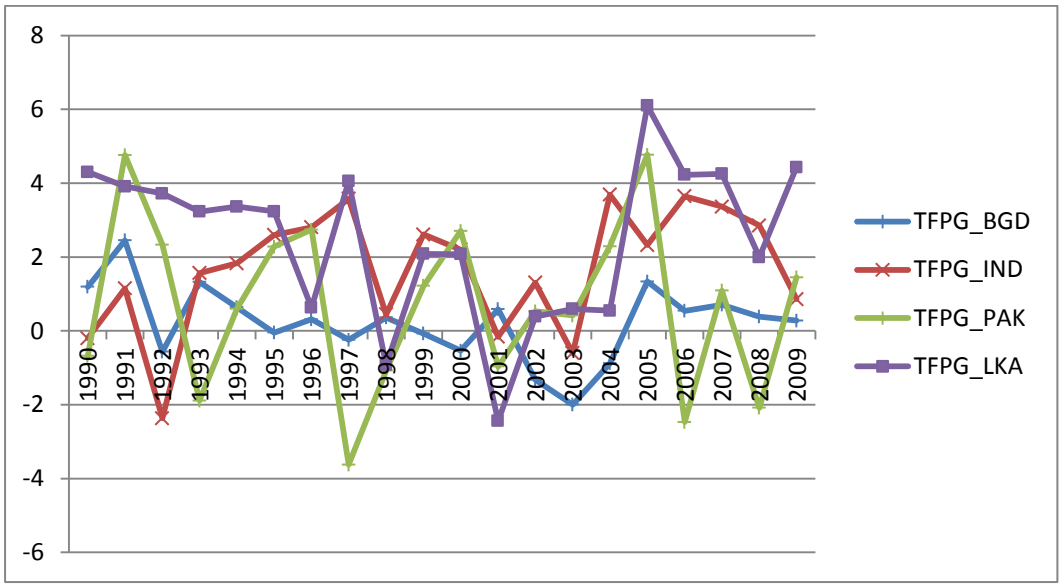


Figure 5.4 presents the trends of TFP growth in the case of four South Asian countries included in the study: Bangladesh, India, Pakistan, and Sri Lanka. The figure reveals that trends of TFP in the case of Bangladesh and Pakistan have been more volatile than in the case of India and Sri Lanka. Average growth rates of TFP in these four countries remained at 0.22 percent, 1.67 percent, 0.72 percent and 2.49 percent with SDs of 1.00, 1.63, 2.31 and 2.13 respectively for Bangladesh, India, Pakistan and Sri Lanka. These facts reflect that this region has reaped a positive growth rate of TFP during the sample period. However, growth rates of TFP in India and Sri Lanka were more remarkable than those in Bangladesh and Pakistan.

In particular, Sri Lanka realized the highest average growth rate of TFP during the sample period not only in the South Asian region but among countries of all regions included in this study. The IMF (2007) suggested that Sri Lanka benefitted from strong institutional indicators which are generally considered sources of TFP growth. The United Nations (2006) reported that Sri Lanka is blessed with a high quality labor force both in the terms of literacy rate and quality of education as compared to other South Asian nations. These are some possible reasons for the appreciable average growth rate of TFP in Sri Lanka. Low average growth rates of TFP and high values of SD in the case of Bangladesh and Pakistan represent the high volatility of TFP in these countries as compared to the other two countries. Average annual growth rate of TFP in this region during the sample period remained at 1.28 percent. Although this average annual growth rate of TFP seems good, it is less than the average annual growth rate of GDP in these four countries which has been 5.27 percent during the sample period. Since these countries are developing where the labor participation rate is very low compared to that in developed countries, so this appreciable economic growth rate in these countries may be the result of factor accumulation especially increases in labor force (World Bank, 2007). However, this growth rate is also linked with improvements in the overall policy climate in SA which included growing global integration, stabilization of economies and deregulation (Ahmed, 2006).

Figure: 5.5 Trends of TFPG in East Asia

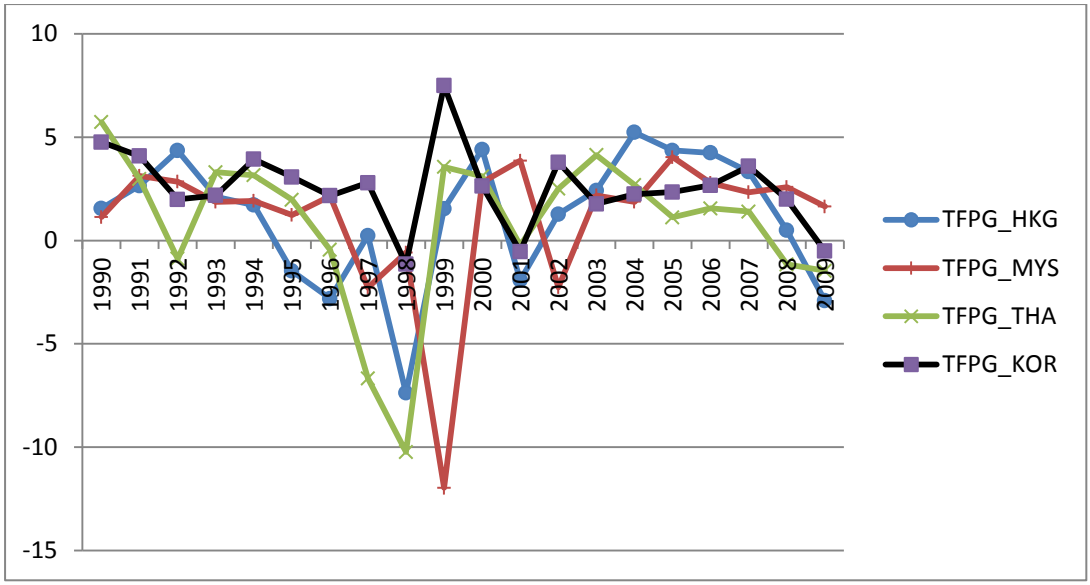


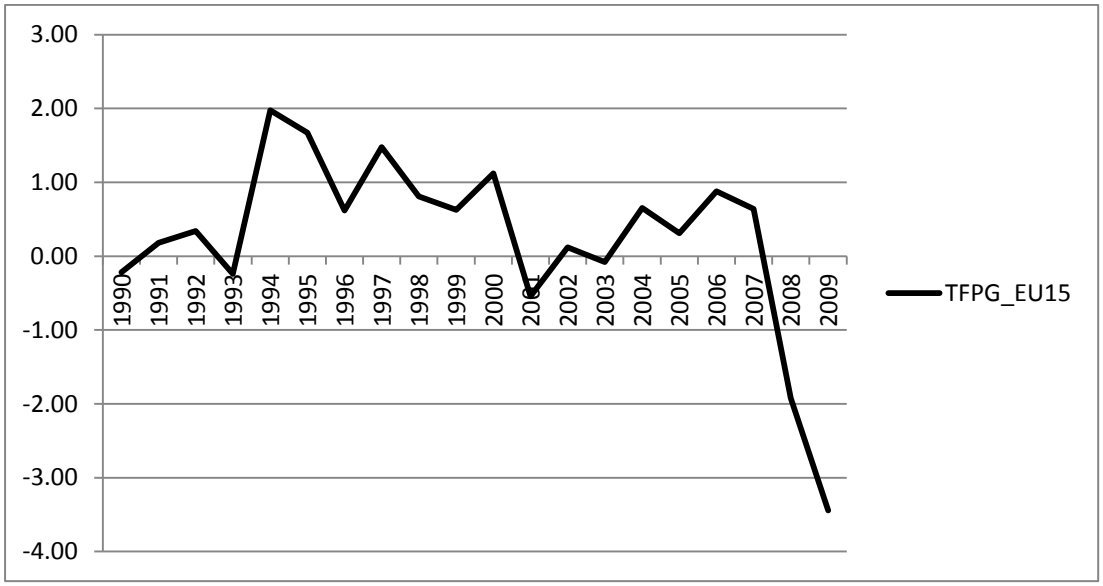
Figure 5.5 reflects the trends of TFP growth in the case of four East Asian countries: Hong Kong, Malaysia, Thailand, and Korea. The figure shows that the overall TFP in this region has been growing with a stable and positive growth rate until recently. However, in 1998 the growth rate of TFP in EA was observed to be highly negative and sharp recoveries in growth rate of TFP in the region were observed in 2000. In the case of Hong Kong, Korea, Malaysia and Thailand, the present study found average growth rates of TFP to be 1.17 percent, 2.56 percent, 1.06 percent and 0.80 percent with SDs of 3.16, 1.93, 3.51 and 3.74 respectively. In 1997 to 1998 this region faced a severe financial crisis in the terms of currency and banking. GDP in this region contracted remarkably in 1998 as compared to historical growth rates and other regions of Asia which were hardly affected by this crisis (Barro, 2001). This sharp variation in growth rate of TFP during 1997 to 2000 may be attributed to the financial crisis of EA during the period mentioned above.

After 2006 the average TFP of the four selected countries shrunk at a decreasing rate and in 2009 its growth rate turned into negative. The reason for this trend may pertain to the global financial crisis in the late 2000s. East Asian countries have the potential to be highly affected by any global crisis due to the facts indicated by Plummer

(2009). He observed that almost all East Asian countries have promoted greater outward economic integration with the global economy and reduced trade restrictions. In this situation it is not surprising to observe that the growth rate of TFP at the end of the mentioned period turned into negative.

Figure 5.6 exhibits the average trends of TFP growth for 15 countries included in EU-15 during the sample period. The figure shows that the growth rate of TFP in EU-15 countries was appreciable during the mid-1990s. In contrast to this, the EU-15 experienced a sharp decline in TFP growth after 2007. Similar to East Asian countries, this decline may be attributed to the global financial crisis during these years.

Figure: 5.6 Trends of TFPG in EU-15



Dhameja (2010) claimed that the financial crisis which started in mid-2007 was global in its nature as it affected almost every country of the world. The effects of this crisis had been observed in almost the whole world by the end of 2008. This crisis impacted the world economy by reducing production, causing disorders in world markets, financial losses and financial bubbles, and producing currency crises (Terazi and Senel, 2011). Crafts (2003) pointed out that until 1995 European economies grew fast

and their real GDP per man hour surpassed that of the USA. Further, he observed that investments in information and communication technologies in Europe during the 1990s got a momentum which could be the source of better levels of TFP growth in the region.

Table 5.2 contains the time series data of TFPG in the case of the 15 countries included in EU-15. This table shows that 2008 and 2009 were two vicious years for European economies during which TFPG in these economies declined sharply. In 2009 all of the EU-15 member economies faced negative TFP growth, whereas in 2008 only two member economies of EU-15 (i.e. Austria and The Netherlands) realized positive growth of TFP. This sharp decline in TFP growth may have been realized in these economies due to global financial crises which originated in 2007 and affected almost all of the economies of the world. Average growth rates of TFP during 2008 and 2009 were –1.92 and –3.45 respectively. Besides these two years, during 1990, 1993, 2001 and 2003 the EU-15 faced negative average growth of TFP. However, the intensity of decline in TFP growth in these years was not as high as in 2008 and 2009.

Among the 15 member countries of EU-15 six economies realized overall negative growth rates of TFP during the sample period: Denmark (mean = –0.14 percent), France (mean = –0.23%), Greece (mean = –0.03%), Italy (mean = –0.22%), Portugal (mean = –0.81%) and Spain (mean = –0.41%). All of the other countries included in EU-15 experienced positive average growth rates of TFP during the sample period. However, among the countries included in the region under discussion, Ireland realized the highest average growth rate of TFP (mean = 1.22%) during the sample period.

Table 5.2 Countrywide Trends of TFPG in EU-15

Years	EU15	AUT	BEL	DNK	FIN	IRL	ITA	LUX	FRA	GER	GRC	NLD	PRT	ESP	SWE	GBR
1990	–0.22	1.40	–0.40	0.12	–0.17	3.52	0.11	–2.60	–2.45	2.96	–2.26	0.88	–1.55	–0.69	–1.09	–1.07
1991	0.18	0.37	0.84	0.35	–2.80	0.98	–0.68	2.76	–0.51	2.12	2.41	0.24	–2.03	–0.92	–0.99	0.59
1992	0.34	–0.05	0.60	0.49	0.34	3.35	0.44	–0.96	–0.14	1.35	–2.56	–0.56	0.96	0.22	0.22	1.43
1993	–0.24	–0.04	–0.31	–0.76	2.63	0.95	0.33	0.57	–0.77	–0.14	–4.38	0.33	–2.42	–0.95	–0.81	2.16
1994	1.98	1.93	1.96	4.41	3.78	3.16	2.99	0.61	1.05	2.15	0.41	2.19	0.50	0.96	2.16	1.37
1995	1.67	4.20	–1.26	0.85	2.23	4.21	2.11	–1.66	0.87	1.97	0.19	0.87	0.69	2.18	1.52	6.08
1996	0.62	0.16	0.74	0.74	1.81	2.79	–0.76	–0.11	–0.90	1.57	0.21	0.34	2.11	–0.60	0.44	0.72
1997	1.48	–0.02	1.32	–0.53	2.86	6.18	0.93	2.19	0.65	1.73	0.86	0.91	2.93	–0.02	2.14	0.02
1998	0.81	1.58	–1.17	–1.67	3.27	1.74	–1.04	1.27	1.18	0.08	1.98	0.68	2.36	–0.53	1.76	0.68
1999	0.63	1.09	0.93	–0.59	0.98	2.53	–0.47	1.84	0.21	0.85	0.77	0.63	–0.47	–0.34	1.09	0.35
2000	1.12	1.41	2.26	0.77	3.23	2.07	1.44	2.91	1.54	2.43	1.56	1.39	–5.80	–0.67	1.15	1.13
2001	–0.54	–1.42	–2.79	–1.71	0.52	0.49	–0.26	–1.94	–0.54	0.82	1.45	–0.21	–1.08	–0.75	–0.68	–0.01
2002	0.12	0.63	0.20	–0.87	0.12	2.06	–1.61	1.51	0.79	0.07	–0.84	–1.18	–1.59	–0.65	2.66	0.49
2003	–0.08	–0.57	–0.06	0	0.97	–0.06	–1.95	–0.58	0.03	–0.09	1.91	–0.33	–3.38	–0.24	2.03	1.15
2004	0.65	1.13	2.59	1.72	2.38	–0.36	0.17	0.80	–0.48	0.39	–1.35	1.61	–1.80	–0.78	2.70	1.08
2005	0.31	1.41	–1.13	1.41	0.78	–0.39	–0.60	1.21	–0.10	1.52	–0.48	1.32	–0.77	–0.85	1.47	–0.16
2006	0.88	2.24	0.55	0.48	2.14	–0.35	0.04	0.55	1.18	2.57	–0.36	1.48	–0.26	–0.32	1.92	1.34
2007	0.64	2.18	0.81	–1.02	2.40	0.47	–0.28	1.09	–1.03	0.71	2.05	1.57	0.17	–0.11	–0.36	0.94
2008	–1.92	0.28	–1.77	–3.54	–1.91	–4.99	–1.80	–3.86	–2.09	–0.78	–1.25	0.30	–1.82	–1.62	–3.13	–0.84
2009	–3.45	–2.59	–2.74	–3.47	–7.14	–3.88	–3.53	–3.64	–3.08	–3.65	–0.98	–3.55	–2.88	–1.57	–4.57	–4.39

A negative average growth rate of TFP, as seen in the case of Denmark, is referred to as the productivity paradox. This paradox indicates that the reasons for weak (negative) productivity growth in the Danish economy are not known. This raises serious queries about why productivity growth in the Danish economy is weak (negative) despite having a good economic structure, for example a supple labor market where laborers are educated and skilled, and a stable macroeconomic environment (OECD, 2009).

The IMF (2011) reported that over the last decade France faced certain deteriorations in public finance. Further, the cost of hiring labor grew rapidly in France as compared to its neighboring country Germany. Miotti and Sachwald (2004) declared that the French economy was characterized by weak labor productivity, declining investments low efficiency of capital and high inflation. These could be the reasons for the overall negative TFP growth in France during the sample period.

Quatraro (2009) opined that the economy of Italy observed many dynamic structural peculiarities. He noted that Italy performed relatively poorly in adopting innovative techniques as compared to other advanced countries. Due to this, the manufacturing sector of Italy could not follow a growth path like other advanced countries. Salinas-Jimenez et al. (2006) noted that investment to raise TFP growth in European countries remained slow due to problems with macroeconomic adjustments. De la Fuente (2003) reported that each European country has its own macroeconomic structure in which some of the countries face labor market stringencies and investment rates. Due to these differences member countries of EU-15 could have faced different rates of average growth rate of TFP.

According to EEAG (2006), Greece attempted to accumulate physical capital and labor inputs rather than attempting to accumulate information, communicative and

human capital. This could have led to weak levels of TFP in Greece during the period under study.

Mas and Quesada (2005) reported that in the case of Spain, performance of the information and communication technologies producing-sector has been weak and the ratio of investments in this sector to the total investment has been very small. In this case the negative average rate of TFP is not a matter of surprise. Further, Dovis and Milgram-Baleix (2009) observed that due to European tariff structure the TFP in Spain declined.

Amador and Coimbra (2007) observed that the economy of Portugal experienced growth of TFP where capital labor ratios are high. They noticed that only the manufacturing industry and the information and communication industry took advantage of growing TFP. Contrarily, services and construction sector could not realize the growth of TFP due to the lower capital labor ratio in these sectors. Further, they opined that certain sectors of the Portuguese economy not only received a lower quantity of investment but a lower quality of investment as well.

Koedijk et al. (1996) observed that the product and labor markets of Ireland work freely and supply and demand forces interact with each other without facing any kind of government regulations. Barry (1999) observed that the cost of general utility services, for example telephone calls, postal fee and energy, used by industry in Ireland remained low as compared to that in other European countries. Coe and Helpman (1995) reported that Belgium and Ireland have realized a rapid inflow of foreign capital in research and development sectors. These findings may explain the reasons for Ireland having a higher TFP growth rate than the other EU-15 member countries.

Table 5.3 Descriptive Statistics of TFPG

SR. No.	Country	Region	Mean (TFPG)	SD (TFPG)	CV (TFPG)
1	Hungary	Central and East Europe	–0.06	3.23	–53.83
2	Romania	Central and East Europe	2.00	6.66	3.33
3	Turkey	Central and East Europe	–0.79	5.11	–6.47
4	Algeria	Africa	–0.41	2.47	–6.02
5	Egypt	Africa	1.51	1.31	0.87
6	Morocco	Africa	0.14	4.90	35
7	South Africa	Africa	–1.21	1.90	–1.57
8	Argentina	Latin America	2.05	4.38	2.14
9	Brazil	Latin America	–0.23	2.30	–10
10	Chile	Latin America	0.07	3.83	54.71
11	Colombia	Latin America	–0.40	2.82	–7.05
12	Mexico	Latin America	–0.09	2.42	–26.89
13	Bangladesh	South Asia	0.22	1.00	4.54
14	India	South Asia	1.67	1.63	0.98
15	Pakistan	South Asia	0.72	2.31	3.21
16	Sri Lanka	South Asia	2.49	2.13	0.86
17	Hong Kong	East Asia	1.17	3.16	2.70
18	Korea	East Asia	2.56	1.93	0.75
19	Malaysia	East Asia	1.06	3.51	3.31
20	Thailand	East Asia	0.80	3.74	4.68
21	Austria	EU-15	0.77	1.45	1.88
22	Belgium	EU-15	0.06	1.52	25.33
23	Denmark	EU-15	–0.14	1.77	–12.64
24	Finland	EU-15	0.92	2.55	2.77
25	France	EU-15	–0.23	1.26	–5.48
26	Germany	EU-15	0.93	1.50	1.61
27	Greece	EU-15	–0.03	1.78	–59.3
28	Ireland	EU-15	1.22	2.60	2.13
29	Italy	EU-15	–0.22	1.46	–6.64
30	Luxembourg	EU-15	0.10	1.99	19.9
31	Netherlands	EU-15	0.44	1.25	2.84
32	Portugal	EU-15	–0.81	2.10	–2.59
33	Spain	EU-15	–0.41	0.84	–2.05
34	Sweden	EU-15	0.48	1.94	4.04
35	United Kingdom	EU-15	0.65	1.87	2.88

Table 5.3 contains the descriptive statistics of TFP growth in the case of each country included in the study. The second column contains the name of the country and the

third column shows the region in which each country is located. The fourth column shows mean values of TFPG measured using the growth accounting approach in the case of each country during the sample period. The fifth column reflects SDs of TFPG in the case of each country during the period under study. The last column shows coefficients of variation for each country included in the study.

Mean values given in Table 5.3 show that in four of the six regions some of the countries experienced a negative average growth rate of TFPG during the sample period: Hungary (mean = –0.06) and Turkey (mean = –0.79) in CEE; Algeria (mean = –0.41) and South Africa (mean = –1.21) in Africa; Brazil (mean = –0.23), Colombia (mean = –0.40) and Mexico (mean = –0.09) in Latin America; Denmark (mean = –0.14), France (mean = –0.23), Greece (mean = –0.03), Italy (mean = –0.22), Portugal (mean = –0.81) and Spain (mean = –0.41) in EU-15. During the sample period covered in this study South Africa experienced the lowest average growth rate among all the countries included in the study, whereas Korea realized the highest average growth rate of TFP. SDs of TFPG show that the growth rate of TFP in Romania (SD = 6.66), Turkey (SD = 5.11), Morocco (SD = 4.90), Argentina (SD = 4.38), Chile (SD = 3.83), Hong Kong (SD = 3.16), Malaysia (SD = 3.51) and Thailand (SD = 3.74) has been very volatile as compared to that in other countries.[25] The possible reasons for realized (either low or high) average growth rates of TFP and their volatility in various countries might be explained by the situation discussed above.

[25] Since the growth rate of TFP in the case of certain countries varied around zero, which causes high values of CV, values of SD have been used to observe variation.

Figure: 5.7 Regional Trends of TFPG

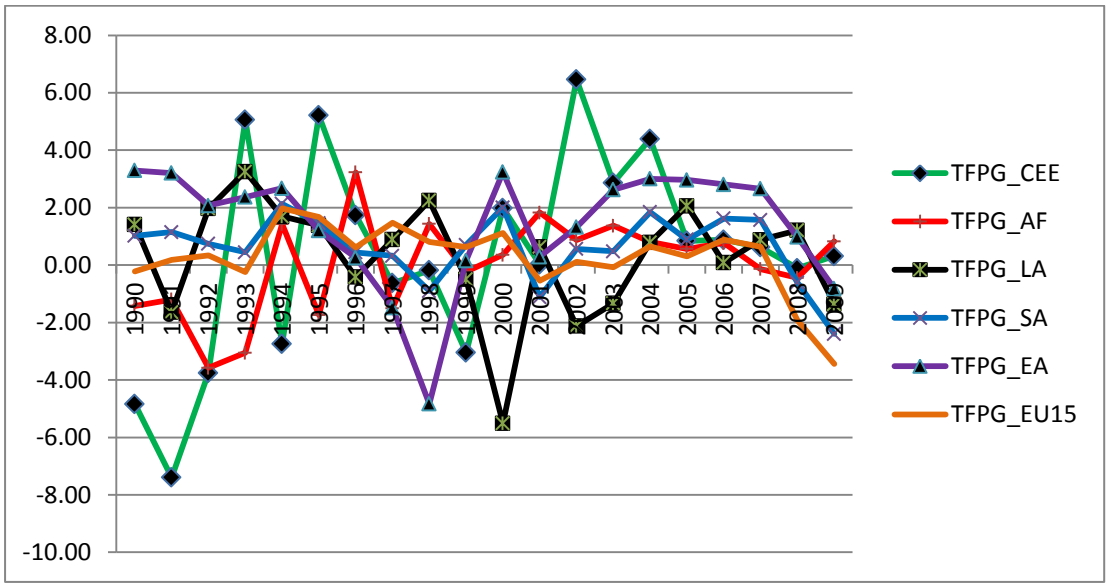


Table 5.4 Descriptive Statistics of Regional TFPG

Region	CEE	Africa	L. America	S. Asia	E. Asia	EU15	Overall
Mean	0.38	0.01	0.28	1.28	1.40	0.25	0.49
SD	3.53	1.69	1.98	1.08	2.05	1.22	2.10
CV	9.19	195.21	7.03	0.85	1.46	4.89	4.27

Figure 5.7 displays the trends of average growth rates of regional TFP over the sample period. Table 5.4 presents descriptive statistics of growth rates of regional TFP during the sample period of study. The statistics show that the East Asian region (mean = 1.40) realized the highest growth of TFP among all regions, whereas Africa (mean = 0.01) experienced the lowest growth rate of TFP during the time period under study. The Central and East European region (SD = 3.53) faced the highest volatility in TFP growth and the South Asian region (SD = 1.08) faced the least volatility in TFP growth rate during the years included in the study. However, the

overall growth rate of TFP in countries included in the study during these years has been volatile (mean = 0.49, SD = 2.10)

Figure: 5.8 Overall Trends of TFPG

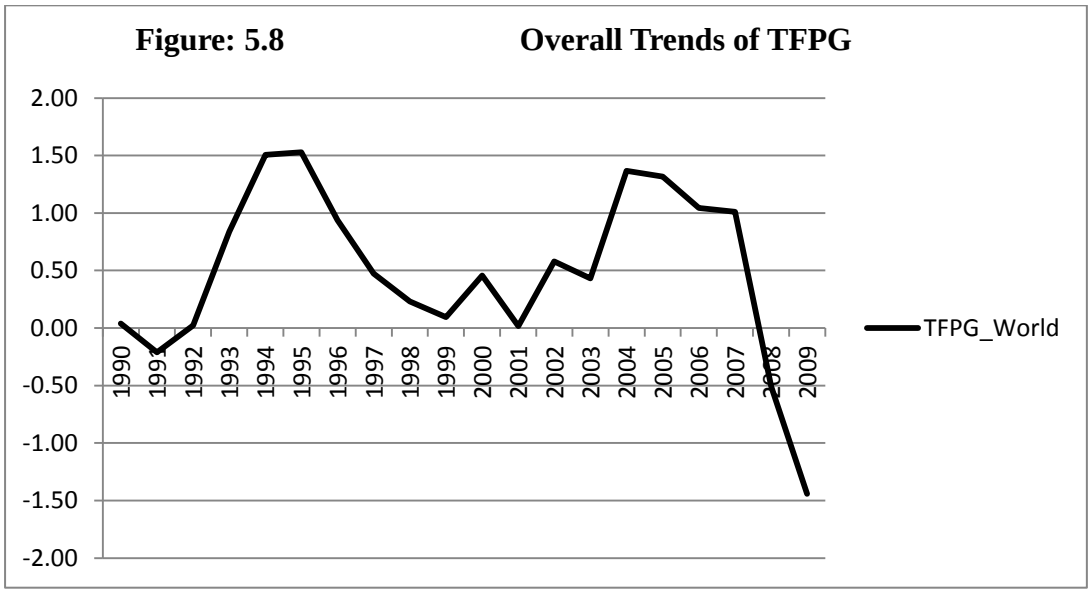


Figure 5.8 portrays the trends of overall annual average growth rate of TFP during the sample period in the case of the 35 countries covered in the sample. The line graph in Figure 5.8 shows that the sample countries included in the study realized highest average growth rates of TFP during 1994 and 1995. Conversely, the average growth rate of TFP was lowest during 2008 and 2009. Further, the graph reveals that the average growth rate of TFP in the sample countries follows cyclical fluctuations.

5.3 Trends of TFPGI

This section presents the trends of TFP growth which have been computed using the index number approach (TFPGI). For this purpose equation 3.24 given in Chapter 3 has been used. Similar to Section 5.2 this section uses line graphs and tables in order to exhibit the trends of TFP growth in the case of various countries and regions.

Figure: 5.9 Trends of TFPGI in Central and East Europe

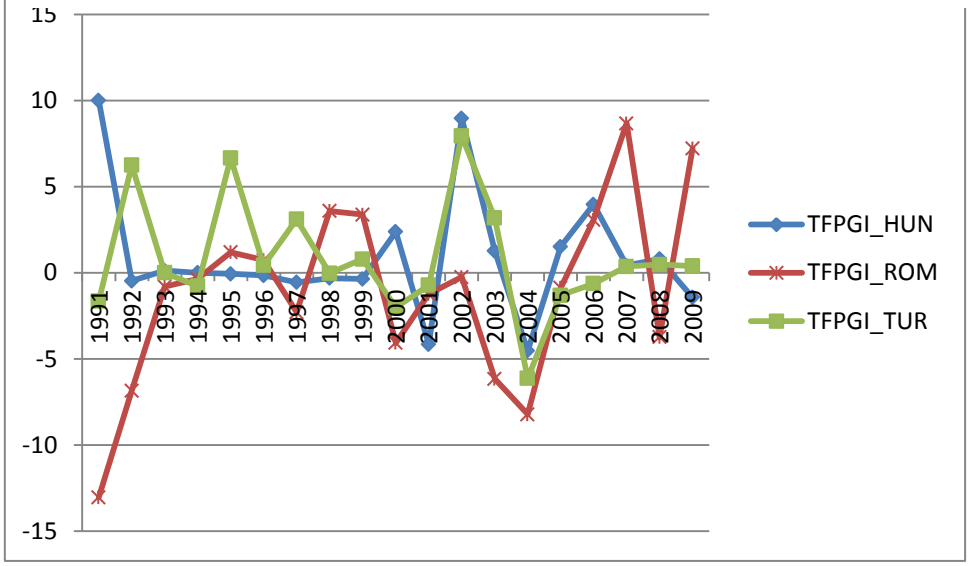


Figure 5.9 displays the trends of TFP growth measured with the help of the index number approach for the three countries selected from Central and East European region: Hungary, Romania and Turkey. This figure shows that TFPGI in the case of all the three countries during the sample period has been volatile over the period of time. However, on the basis of CV, in this region (except for Romania) the intensity of volatility of TFPG measured through the index number approach is less than that measured through the growth accounting approach. The growth accounting approach returned a positive average growth rate of TFP in the case of Romania and negative average growth rate for the other two countries. Contrarily, the index number approach produced a series of TFP growth which reflects a negative average growth rate of TFP in the case of Romania (mean = –1.05) and positive average growth rate for Hungary (mean = 0.92) and Turkey (mean = 0.86). However, the regional average growth rate of TFP calculated with index number approach remained positive (mean = 0.24, SD = 2.44) with a little higher volatility (CV = 10.02) as compared to TFPG using growth accounting approach (CV = 9.19).

Figure: 5.10 Trends of TFPGI in Africa

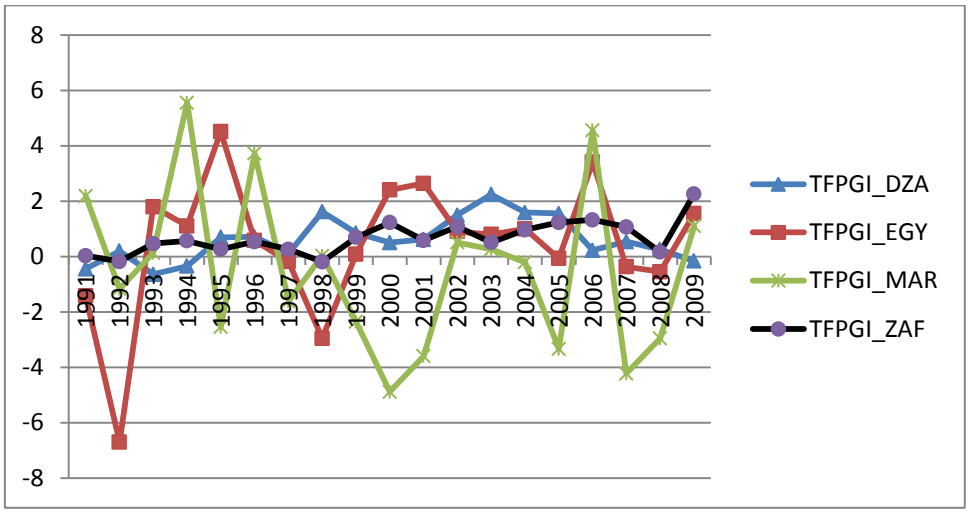


Figure 5.10 presents the trends of TFP growth obtained through the index number approach in the case of four African countries: Algeria, Egypt, Morocco and South Africa. The figure shows that the growth rate of TFP in the case of South Africa has been relatively consistent with a positive average (mean = 0.68, SD = 0.60) as compared to other countries of the region. The growth accounting approach gave a series of TFP growth rates which reflected a negative average growth rate in the case of South Africa (mean = –1.21, SD = 1.90). Similar is the case with Algeria where TFPG was negative (mean = –0.41, SD = 2.47) and TFPGI is positive (mean = 0.61, SD = 0.79). In the case of both these countries TFPGI (CV = 0.89 for South Africa and CV = 1.30 for Algeria) presents less volatile trends as compared to TFPG (CV = –1.57 for South Africa and CV = –6.02 for Algeria).

The case of Morocco is converse to that of South Africa and Algeria. In the case of this country TFPG was positive (mean = 0.14, SD = 4.90), whereas TFPG is negative (mean = –0.46, SD = 2.96). However, the intensity of volatility of TFP growth obtained through the index number approach was less (CV = –6.38) than that obtained through the growth accounting approach (CV = 35).

The growth accounting approach and index number approach both produced a series of TFP growths which gave positive average growth rates in the case of Egypt. However, the average of TFPG (mean = 1.51, SD = 1.31) is much greater than the average of TFPGI (mean = 0.45, SD = 2.43). Further, it has been found that the growth accounting approach produced a relatively stable growth rate of TFP (CV = 0.87) in comparison to the index number approach (CV = 5.43).

On the basis of regional comparisons this study found that the index number approach captured higher levels of TFP growth (mean = 0.32, SD = 1.02) than the growth accounting approach (mean = 0.01, SD = 1.69). Although both averages are positive the average of TFPG is near to zero. Moreover, the index number approach gave less volatile trends of TFP growth (CV = 3.21) than the growth accounting approach which produced highly volatile trends of TFP (CV = 195.21).

Figure: 5.11 Trends of TFPGI in Latin America

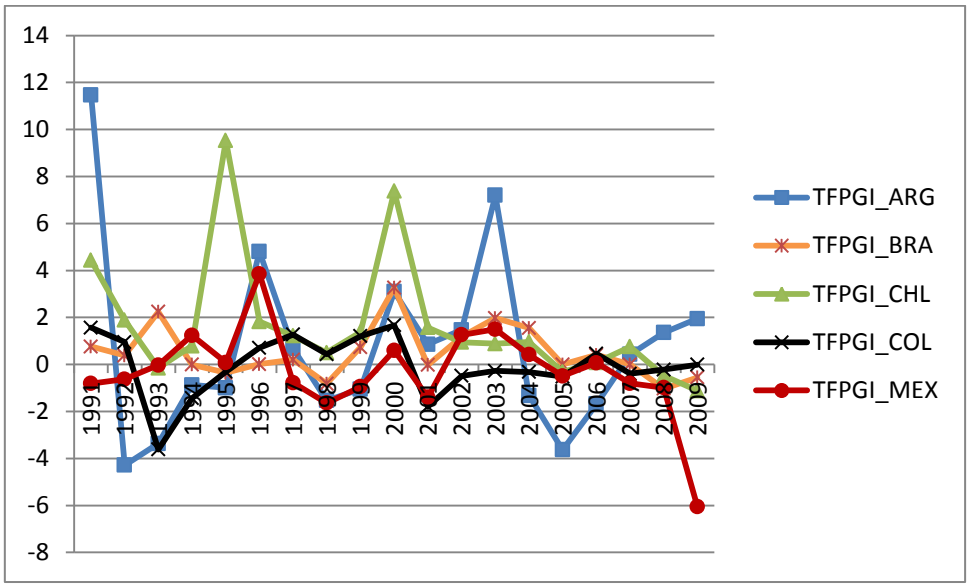


Figure 5.11 displays the trends of TFP growth obtained with the help of the index number approach for five Latin American countries: Argentina, Brazil, Chile,

Colombia and Mexico. The figure shows that the growth rate of TFP has been volatile in these countries during the sample period.

In the case of this region the growth accounting approach and index number approach both measured the growth rates of TFP and both showed similar signs of average growth rates for all the countries except for Brazil. In the case of Brazil the growth accounting approach computed growth rates of TFP which returned a negative average (mean = –0.23, SD = 2.30), whereas using the index number approach the present study calculated the growth rates of TFP which gave a positive average (mean = 0.52, SD = 1.10).

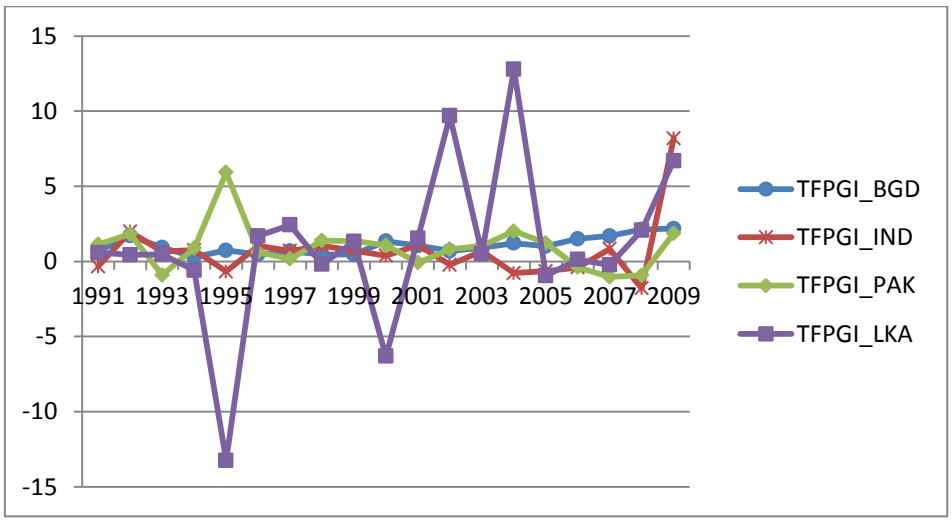
It is also interesting to discuss that in the case of Argentina the average of TFPG (mean = 2.05, SD = 4.38) is higher than the average of TFPGI (mean = 0.77, SD = 3.85). The CV of TFPG (CV = 2.14) remained lower than that of TFPGI (CV = 5.02) in the case of Argentina. The case of Chile is opposite to that of Argentina. In the case of Chile the average of TFPG (mean = 0.07, SD = 3.83) was found to be lower than that of TFPGI (mean = 1.69, SD = 2.68). On the basis of CV I observe that TFPGI (CV = 1.59) has been less volatile than TFPG (CV = 54.71) in the case of Chile.

The study finds that average trends of TFPGI in the case of Colombia (mean = –0.06, SD = 1.28) and Mexico (mean = –0.29, SD = 1.190) are almost similar to that of TFPG (mean = –0.40, SD = 2.82 for Colombia; mean = –0.09, SD = 2.42 for Mexico) with a little difference of magnitude but without any difference of sign of the magnitude. Considering the CVs, TFPGI (CV = –22.20) has been found to be more volatile than TFPG (CV = –7.05) in the case of the Colombian economy. The opposite is the case with the Mexican economy where TFPG (CV = –26.89) has been observed to be more volatile than TFPGI (CV = –6.50).

Regional comparisons of TFP growth, given in Tables 5.4 and 5.7, show that the index number approach captures higher growth rates (mean = 0.53, SD = 1.39) than the growth accounting approach (mean = 0.28, SD = 1.98) in the case of LA. However, both measures confirm that the average growth rate of TFP in this region has been positive during the sample period. Moreover, growth rates of TFP obtained through the index number approach (CV = 2.65) are less volatile than those obtained through the growth accounting approach (CV = 7.03).

Figure 5.12 portrays the trends of TFP growth computed employing the index number approach for the four South Asian countries: Bangladesh, India, Pakistan and Sri Lanka, over the sample period. In this case regional average growth rate of TFP (mean = 0.92, SD = 1.49) has been less volatile as compared to the former three regions: CEE, Africa and LA. However, in Sri Lanka the TFP growth rate was found to be highly volatile (mean = 0.99, SD = 5.36, CV = 5.41) during the sample period. In the case of the growth accounting approach Sri Lanka observed the least volatile growth rate of TFP (mean = 2.49, SD = 2.13, CV = 0.86) among all countries selected from the South Asian region, whereas the index number approach produced the most volatile growth rate of TFP for Sri Lanka.

Figure: 5.12 Trends of TFPGI in South Asia

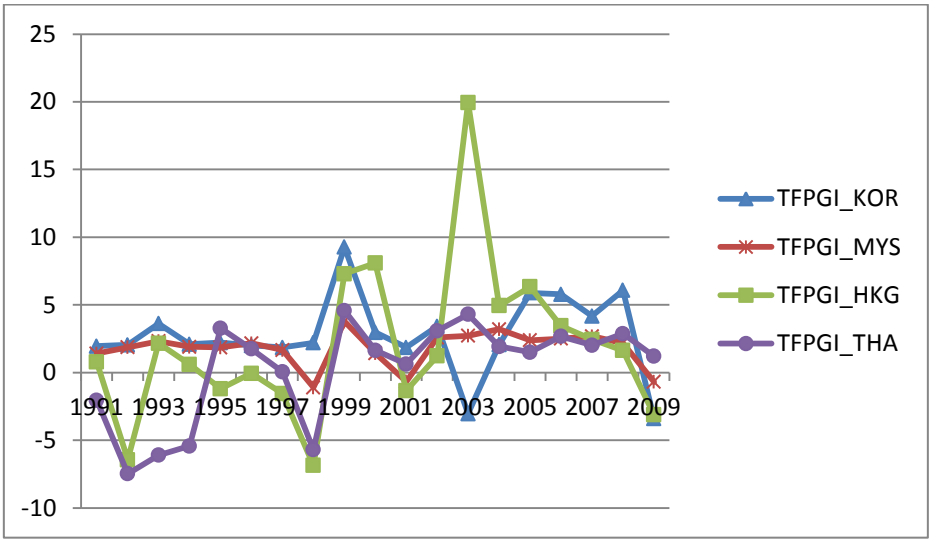


Another interesting finding in the case of the South Asian region is the trends of TFP in the case of Bangladesh measured through the growth accounting approach and index number approach. The growth rate of TFP with the index number approach (mean = 1.06, SD = 0.56, CV = 0.53) in Bangladesh remained higher and more stable than the growth rate of TFP with the growth accounting approach (mean = 0.22, SD = 1.00, CV = 4.54). Further, the growth rate of TFP with the index number approach has been increasing over time in the case of Bangladesh, yet this increasing trend has been very small. Moreover, among all four countries of the region the growth rate of TFP in Bangladesh remained the most volatile when measured using the growth accounting approach and the least volatile when measured using the index number approach.

Both the approaches, growth accounting and index number, returned positive average growth rates of TFP for each country in this region. However, the growth accounting approach produced higher levels of regional TFP growth with less volatility (mean = 1.28, SD = 1.08, CV = 0.85) than the index number approach which produced lower levels of regional TFP growth with higher volatility (mean = 0.92, SD = 1.49, CV = 1.62). The common finding of the index number approach and growth accounting approach is that the regional average growth rate of TFP in SA is the second largest among all the regions included in the study.

Figure 5.13 exposes trends of TFP growth obtained using the index number approach in the case of four East Asian countries: Korea, Malaysia, Hong Kong, and Thailand, over a period of 19 years ranging from 1991 to 2009. It is interesting to note that both approaches, growth accounting and index number, produced positive average growth rates of TFP in the case of each country selected in the sample from the East Asian region.

Figure: 5.13 Trends of TFPGI in East Asia



In the case of Thailand the index number approach captured lower levels of TFP growth (mean = 0.26, SD = 3.73, CV = 4.57) than that measured through the growth accounting approach (mean = 0.80, SD = 3.74, CV = 4.68). Nonetheless, the volatility of growth rate of TFP with the growth accounting approach was found to be a little more volatile than that with the index number approach. Conversely, in the case of the other three countries of this region the index number approach produced higher levels of TFP growth (mean = 2.02, SD = 5.94, CV = 2.94 for Hong Kong; mean = 2.79, SD = 2.91, CV = 1.04 for Korea; mean = 1.80, SD = 1.30, CV = 0.72 for Malaysia) than those measured through the growth accounting approach (mean = 1.17, SD = 3.16, CV = 2.70 for Hong Kong; mean = 2.56, SD = 1.93, CV = 0.75 for Korea; mean = 1.06, SD = 3.51, CV = 3.31 for Malaysia).

The average growth rate of TFP in the case of Korea remained highest among all the countries included in the sample from the East Asian region according to both approaches: index number and growth accounting. Similarly, average growth rates of TFP according to both approaches remained lowest in the case of Thailand.

The index number approach generated less volatile growth rates of TFP in the case of Malaysia and Thailand than did the growth accounting approach. Conversely, the growth accounting approach produced relatively less variant growth rates of TFP in the case of Hong Kong and Korea than the index number approach. Another important finding is that the East Asian region realized a higher average growth rate of TFP (mean = 1.40 with growth accounting approach; mean = 1.72 with index number approach) according to both approaches among all regions included in the sample. However, the index number approach captured higher levels of TFP growth than the growth accounting approach.

Figure: 5.14 Trends of TFPGI in EU-15

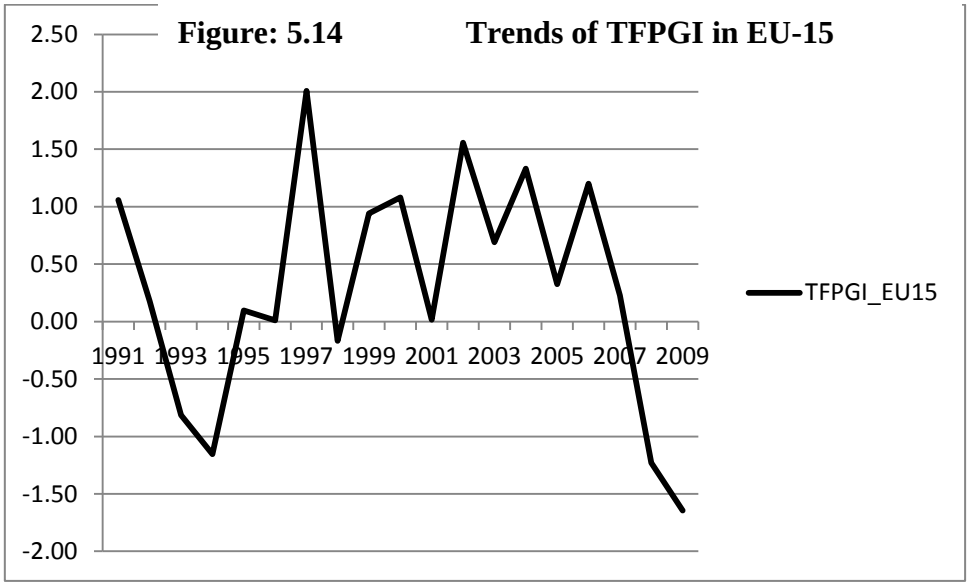


Figure 5.14 demonstrates average trends of TFP growth obtained through the index number approach for the group of E-15 countries during the sample period from 1991 to 2009. This figure shows that during 1993 and 1994 and then during 2007 to 2009 the European region experienced noteworthy negative growth rates of TFP. The negative growth rate of TFP during 2007 to 2009 may be attributed to global financial crises during these years as discussed in the previous section. This is similar to the finding I observed about the TFP growth rate obtained through the growth accounting approach for EU-15 countries during these years. However, the overall average

growth rate of TFP measured with the index number approach in EU-15 remained positive (mean = 0.30, SD = 1.00, CV = 3.34). The graph shows that annual averages of TFP growth in EU-15 measured with the index number approach follow two kinds of fluctuation: cyclical and random.

Table 5.5 presents the trends of TFP growth obtained using the index number approach in the case of each of the EU-15 countries over the period of study. This table shows that EU-15 experienced periods of negative average growth rate of TFP in 1992, 1993, 1997, 2007 and 2008. In all other years EU-15 realized positive average growth rates of TFP. Overall, EU-15 reaped a positive average growth rate during the sample period (mean = 0.30, SD = 1.00, CV = 3.34). However, according to findings this average is second lowest among all regions included in the study. As far as volatility of TFP growth is concerned, EU-15 experienced the second highest volatile trends of TFP growth during the sample period.[26]

The table shows that each of the countries included in EU-15 experienced negative growth rates of TFP several times during the sample period. However, The Netherlands realized a positive growth rate of TFP during the entire sample period except in 2009. However, Denmark experienced a negative growth rate of TFP 12 times during the sample period. This shows that the index number approach also confirms the productivity paradox in the case of the Danish economy. According to the findings of TFP growth with the index number approach, among the 15 countries included in EU-15 the highest average TFP growth (mean = 1.79, SD = 2.04, CV = 1.14) during the sample period was enjoyed by Luxembourg. By contrast, Finland faced the highest negative average growth rate of TFP (mean = –1.23, SD = 3.67, CV

[26] Central and East European region experienced the lowest growth rate of TFP which was characterized by the highest volatility.

Table 5.5
Trends of TFPGI in EU-15

Years	EU15	AUT	BEL	DNK	FIN	IRL	ITA	LUX	FRA	GER	GRC	NLD	PRT	ESP	SWE	GBR
1990	1.06	1.40	–0.40	0.12	–0.17	3.52	0.11	–2.60	–2.45	2.96	–2.26	0.88	–1.55	–0.69	–1.09	–1.07
1991	0.18	–0.25	0.41	4.29	0.66	0.57	0.54	1.71	–0.22	0.23	0.36	0.99	1.26	1.41	4.69	–0.76
1992	–0.82	–0.09	2.02	1.51	–2.61	–6.19	–0.26	0.81	2.75	4.02	0.20	0.82	0.07	2.27	–0.96	–1.70
1993	–1.16	0.55	–0.83	–0.82	–6.46	1.61	–2.81	3.20	2.92	5.18	0.20	1.29	–12.79	0.93	–0.96	–3.42
1994	0.10	0.33	2.33	–1.16	–8.83	1.69	–6.00	1.49	1.05	–3.72	1.70	1.67	1.20	2.49	–8.45	–3.10
1995	0.01	1.63	1.53	–0.49	0.67	2.80	–2.14	–0.70	1.97	5.69	0.86	1.60	–9.38	1.30	1.50	–5.39
1996	2.01	–0.93	1.37	–0.76	–5.03	0.73	–1.42	0.45	0.30	2.00	–0.34	0.66	1.21	0.57	–2.18	3.53
1997	–0.17	3.99	3.06	0.24	–3.56	2.30	5.25	2.59	6.73	2.87	–0.34	0.55	0.57	1.91	–1.46	5.42
1998	0.94	–6.76	–0.42	3.15	0.16	0.65	0.55	2.84	1.89	0.82	–0.42	0.70	1.30	1.31	–5.94	–2.32
1999	1.08	3.09	0.74	1.03	0.41	1.34	–0.22	1.59	–1.13	1.50	–1.81	1.04	1.39	0.69	3.34	1.12
2000	0.02	6.55	1.49	–4.20	2.88	1.69	7.80	1.80	–0.88	–8.81	–0.51	1.05	1.29	0.77	1.23	4.03
2001	1.56	–0.22	0.31	–0.72	0.31	1.52	0.04	8.02	–1.22	3.65	–0.85	0.96	0.68	–9.34	0.42	–3.31
2002	0.69	1.73	1.09	1.51	2.27	1.92	–0.57	0.73	0.74	6.15	–0.17	0.48	0.77	0.38	4.64	1.66
2003	1.33	0.54	2.94	–1.61	–5.49	1.02	–0.27	4.59	0.36	–3.71	0.31	2.79	0.89	0.40	4.87	2.70
2004	0.33	–3.72	0.59	1.36	–6.07	0.55	0.69	0.98	1.19	1.26	0.81	4.98	7.62	0.41	6.86	2.44
2005	1.20	1.05	–0.83	–6.74	1.43	0.18	–5.99	1.47	–0.36	0.41	8.12	3.47	0.71	0.48	0.44	1.03
2006	0.23	1.70	0.81	–0.18	1.99	0.55	2.09	1.49	0.24	1.55	1.72	1.60	1.89	0.51	1.38	0.69
2007	–1.23	1.27	0.37	–5.68	2.46	1.35	1.86	2.53	–0.63	–0.15	–8.52	1.06	3.27	0.68	0.34	3.21
2008	–1.64	0.28	–1.29	–0.08	–1.71	–3.55	–0.46	–0.91	–2.47	–4.60	0.61	0.07	–1.45	0.34	–2.07	–1.18
2009	1.06	–1.77	–4.92	–7.49	3.18	0.04	3.00	–0.61	–0.21	–6.47	2.14	–2.39	1.61	–0.42	–5.79	–4.56

= –2.99) during the period of study. It is also important to note that each of the EU-15 member countries enjoyed a positive average TFP growth during the sample period except Denmark and Finland when TFP growth is measured through the index

Table 5.6 Descriptive Statistics TFPGI

SR. No.	Country	Region	Mean (TFPG)	SD (TFPG)	CV
1	Hungary	Central and East Europe	0.92	3.58	3.90
2	Romania	Central and East Europe	–1.05	5.29	–5.03
3	Turkey	Central and East Europe	0.86	3.34	3.87
4	Algeria	Africa	0.61	0.79	1.30
5	Egypt	Africa	0.45	2.43	5.43
6	Morocco	Africa	–0.46	2.96	–6.38
7	South Africa	Africa	0.68	0.60	0.89
8	Argentina	Latin America	0.77	3.85	5.02
9	Brazil	Latin America	0.52	1.10	2.10
10	Chile	Latin America	1.69	2.68	1.59
11	Colombia	Latin America	–0.06	1.28	–22.20
12	Mexico	Latin America	–0.29	1.90	–6.50
13	Bangladesh	South Asia	1.06	0.56	0.53
14	India	South Asia	0.69	2.02	2.92
15	Pakistan	South Asia	0.94	1.54	1.63
16	Sri Lanka	South Asia	0.99	5.36	5.41
17	Hong Kong	East Asia	2.02	5.94	2.94
18	Korea	East Asia	2.79	2.91	1.04
19	Malaysia	East Asia	1.80	1.30	0.72
20	Thailand	East Asia	0.26	3.73	14.57
21	Austria	EU-15	0.47	2.79	5.91
22	Belgium	EU-15	0.57	1.80	3.18
23	Denmark	EU-15	–0.89	3.15	–3.55
24	Finland	EU-15	–1.23	3.67	–2.99
25	France	EU-15	0.68	2.02	2.95
26	Germany	EU-15	0.41	4.16	10.07
27	Greece	EU-15	0.21	2.93	13.70
28	Ireland	EU-15	0.57	2.09	3.69
29	Italy	EU-15	0.09	3.28	36.92
30	Luxembourg	EU-15	1.79	2.04	1.14
31	Netherlands	EU-15	1.23	1.46	1.19
32	Portugal	EU-15	0.11	4.35	39.43
33	Spain	EU-15	0.37	2.46	6.59
34	Sweden	EU-15	0.10	3.98	39.59
35	United Kingdom	EU-15	0.005	3.16	638.28

number approach. However, average TFP growth with the index number approach in the case of the United Kingdom during the sample period was closer to zero with the highest volatility (mean = 0.005, SD = 3.16, CV = 638.28).

Table 5.6 contains the descriptive statistics of TFP growth measured through the index number approach. This table shows that some of the countries faced a negative mean growth rate of TFP in four of the selected regions in this study: Romania (mean = –1.05) in Central and East European region, Morocco (mean = –0.46) in African region, Colombia (mean = –0.06) and Mexico (mean = –0.29) in Latin American region, Denmark (mean = –0.89) and Finland (mean = –1.23) in EU-15 region. However, the index number approach also confirms the findings of the growth accounting approach of TFP growth that each of the countries included in the South Asian region and East Asian region realized a positive average growth rate of TFP during the sample period. The index number approach of TFP measurement also confirms another finding of the growth accounting approach that among all the 35 countries included in the study Korea reaped the highest average growth rate of TFP (mean = 2.79). However, this approach found that Finland faced the highest negative growth rate of TFP (mean = –1.23) among all the 35 countries covered in the present study during the sample period.

Table 5.7 Descriptive Statistics of Regional TFPGI

Region	CEE	Africa	L. America	S. Asia	E. Asia	EU-15	Overall
Mean	0.24	0.32	0.53	0.92	1.72	0.30	0.67
SD	2.44	1.02	1.39	1.49	2.54	1.00	1.80
CV	10.02	3.21	2.65	1.62	1.48	3.34	2.68

Figure: 5.15 Regional Trends of TFPGI

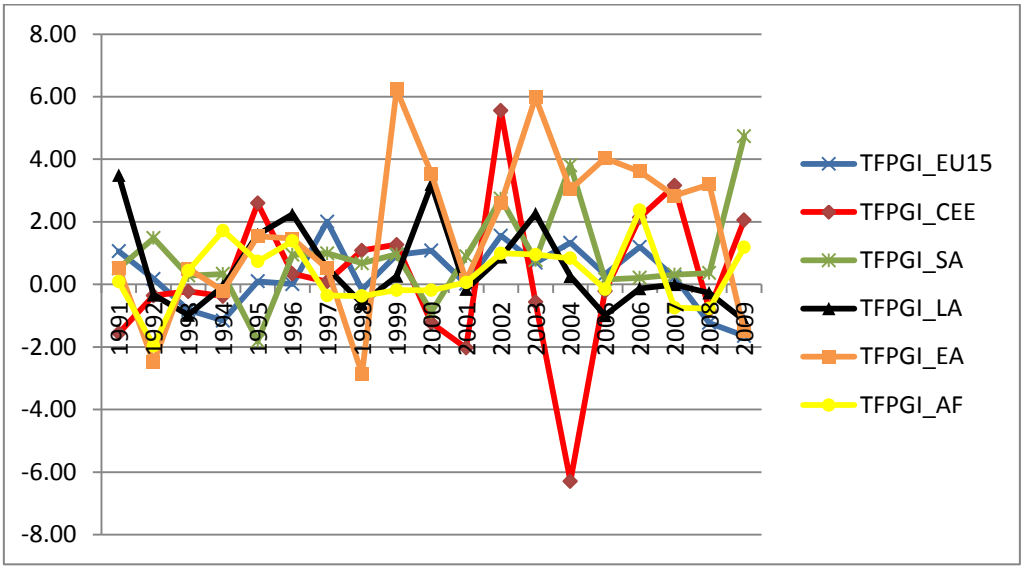


Figure 5.15 demonstrates the regional trends of TFP growth obtained through the index number approach over the period under study. Table 5.7 contains descriptive statistics of regional growth rates of TFP. These findings show that regional TFP growth rates measured with the index number approach have been volatile during the period of study. These estimates reveal that the East Asian region enjoyed the highest average growth rate of TFP with least volatility (mean = 1.72, SD = 2.54, CV = 1.48) followed by the South Asian region (mean = 0.92, SD = 1.49, CV = 1.62). Conversely, Central and East European region faced the least growth rates of TFP with highest volatility among all the regions included in the study (mean = 0.24, SD = 2.44, CV = 10.02) followed by EU-15 (mean = 0.30, SD = 1.00, CV = 3.34). It is also worth noting that by using the index number approach the volatility of overall TFP growth rates in the case of all the 35 countries included in the study has been reduced (mean = 0.67, SD = 1.80, CV = 2.68) as compared to that measured through the growth accounting approach (mean = 0.49, SD = 2.10, CV = 4.27). At this stage the present

study concludes that the index number approach presents less volatile trends of TFP growth as compared to the growth accounting approach.

Figure: 5.16 Overall Trends of TFPGI

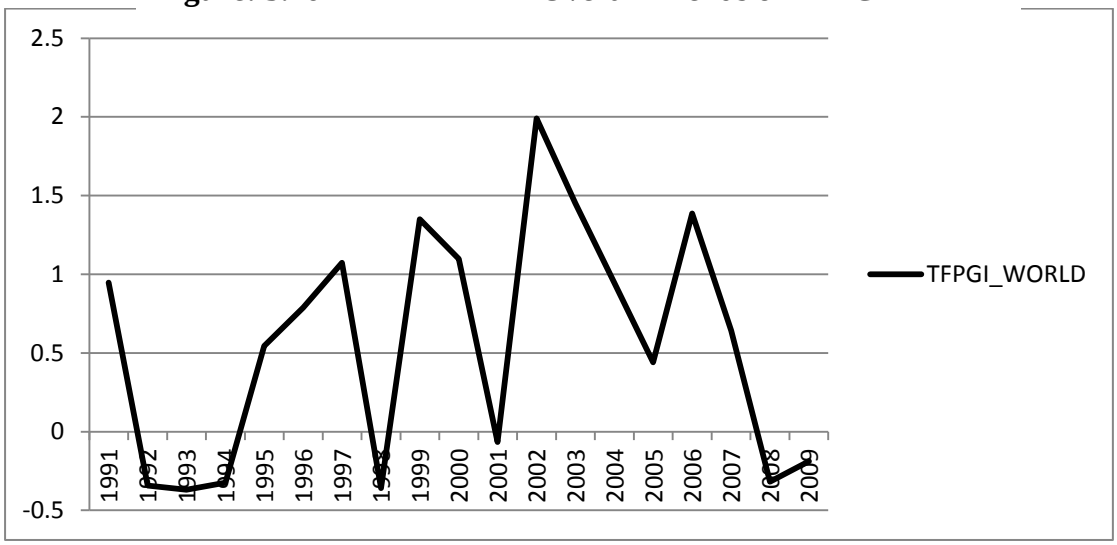


Figure 5.16 displays the annual average growth rates of TFP measured with the index number approach for all the 35 countries analyzed in this study. This figure shows that during the early 1990s world economies faced noticeable negative growth rates of TFP. It is of interest to mention here that during the early 1990s most of the world economies were affected by a global recession which has been reported by many researchers (see for example Entin, 1991; Thompson, 1992; Liscio, 1991). Similarly, at the end of the period covered in the present study negative growth rates of TFP may be attributed to well-known global financial crises.

5.4 Trends of TFPGE

This section presents the results of estimates of CD-PF employing an Ordinary Least Square approach according to equation 3.30 in the case of each economy selected in

the study. Table 5.8 contains these results where each of the variables except time has been used in logarithmic form. The coefficient of time in this table represents TC.

Table: 5.8
Estimation of Role of Technical Efficiency, Labor and Capital in Output

	Dependent Variable: lnQt						
Country	Variable / Region	C	Time	lnKt	lnLt	R^2	F-Stat
Hungary	Central and East Europe	–0.09	0.053	1.74**	–0.16	0.95	3954.38*
Romania	Central and East Europe	1.08*	0.021**	1.77***	–0.08	0.91	342.74*
Turkey	Central and East Europe	0.79	–0.032**	1.50**	0.19**	0.99	1872.65*
Algeria	Africa	0.08	–0.014	0.65**	0.50**	0.25	65.76*
Egypt	Africa	1.034*	0.051*	–0.19	1.46**	0.81	93.78*
Morocco	Africa	–0.05	0.003	–0.48	0.76**	0.83	187.76*
South Africa	Africa	–0.95**	–0.013***	0.77*	0.55	0.64	68.76*
Argentina	Latin America	1.19*	0.024**	–0.68**	0.51	0.68	98.98*
Brazil	Latin America	0.45**	–0.009	1.54**	–0.23	0.77	76.65*
Chile	Latin America	0.21	0.008	0.56***	0.74*	0.99	894.60*
Colombia	Latin America	0.13	–0.019***	0.44**	0.64**	0.85	623.89*
Mexico	Latin America	0.22	–0.007	0.49*	0.53**	0.87	872.33*
Bangladesh	South Asia	1.43*	0.043**	0.49**	0.57**	0.49	43.76*
India	South Asia	1.17*	0.022**	0.53*	0.51**	0.91	456.37*
Pakistan	South Asia	1.09*	0.017**	0.53**	64**	0.48	43.61*
Sri Lanka	South Asia	1.54*	0.023**	0.61*	0.54***	0.87	234.32*
Hong Kong	East Asia	1.43*	0.041**	0.71*	0.51**	0.82	234.34*
Korea	East Asia	2.12*	0.023**	0.41***	0.72*	0.78	334.34*
Malaysia	East Asia	1.12**	0.019**	–0.19	1.49*	0.55	65.34*
Thailand	East Asia	1.27*	0.020**	0.54***	0.49	0.36	56.43*
Austria	EU-15	0.92**	0.018**	0.61**	0.48**	0.99	433.34*
Belgium	EU-15	0.42***	0.003	0.46**	0.68***	0.91	176.76*
Denmark	EU-15	0.31	–0.004	0.61**	0.51	0.27	9.34*
Finland	EU-15	1.07**	0.029***	0.72***	0.33	0.71	142.67*
France	EU-15	0.87	–0.024	1.41**	–0.28***	0.37	213.43*
Germany	EU-15	1.24**	0.031**	1.38**	–0.023	0.47	143.46*
Greece	EU-15	–0.12	–0.004	0.62*	0.41**	0.62	653.342*
Ireland	EU-15	2.09*	0.031*	0.53**	0.51*	0.45	43.34*
Italy	EU-15	0.87**	–0.029**	1.52*	–0.19	0.93	343.34*
Luxembourg	EU-15	0.31	0.007	0.61***	0.47**	0.97	765.76*
Netherlands	EU-15	0.65**	0.018***	0.57***	0.59**	0.62	23.34*
Portugal	EU-15	0.65***	–0.025**	0.71*	0.31	0.99	7645.87*
Spain	EU-15	–0.07	–0.011	0.61**	0.46***	0.94	234.23*
Sweden	EU-15	0.64	0.016	0.79***	.36**	0.75	154.21*
United Kingdom	EU-15	0.45***	0.023***	0.81**	–0.14**	0.71	452.43*

Note: * indicates statistical significance at 1%, ** at 5%, and *** at 10%

Table 5.8 uses logarithm of output as the dependent variable, and time, logarithm of labor force and logarithm of capital as independent variables. The econometric

approach does not seem appropriate to measure the growth rate of TFP as coefficients of logarithms of labor and capital appear with negative signs in the case of some countries, which are difficult to justify. This is the same problem reported by Felipe and McCombie (2003) as they argue that when TFP growth is measured using a linear time trend with the log-level form of production function some of the capital elasticities may take negative values. The present study noticed the same problem in the case of Argentina where capital elasticity is negative and significant. In the case of Egypt, Morocco and Malaysia capital elasticities are also negative yet insignificant. Furthermore, according to these results, Turkey, South Africa, Colombia, Italy, and Portugal realized negative significant TC over time. TC in the case of Algeria, Brazil, Mexico, Denmark, France, Greece, and Spain also remained negative yet insignificant. In the case of all other economies TC remained positive and significant except in the case of Hungary, Morocco, Chile, Belgium, Luxembourg and Sweden where it was positive yet insignificant.

After getting the estimates of TC, I used equation 3.31 in order to obtain time series of TFPG in the case of each country selected in the sample. The rest of this section represents the trends of TFPG obtained through elasticities econometric approach (TFPGE) using line graphs and tables as were shown in Sections 5.2 and 5.3.

Figure: 5.17 Trends of TFPGE in Central and East Europe

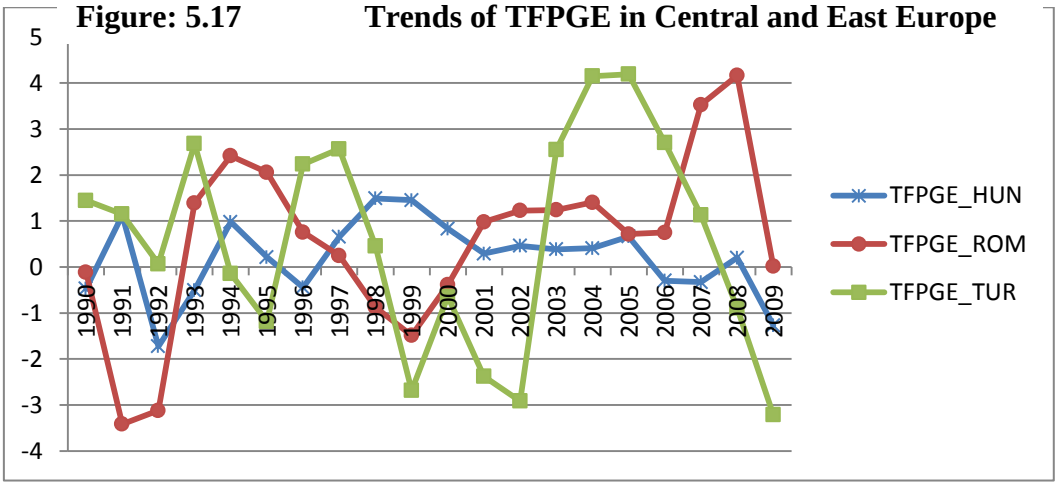


Figure 5.17 displays the trends of TFP growth measured with the help of the econometric approach for the three countries selected from the Central and East European region: Hungary, Romania and Turkey. This figure shows that TFPGE in the case of all the three countries during the sample period has not been as volatile as TFPG and TFPGI. However, on the basis of CV, in the case of Turkey TFPGE has been observed to be slightly more volatile than TFPGI during the sample period. Moreover, unlike the prior two approaches, the econometric approach produced a positive average TFP growth rate in the case of each of the three countries of CEE: Hungary (mean = 0.21, SD = 0.84), Romania (mean = 0.57, SD = 1.88) and Turkey (mean = 0.56, SD = 2.30).

Figure: 5.18 Trends of TFPGE in Africa

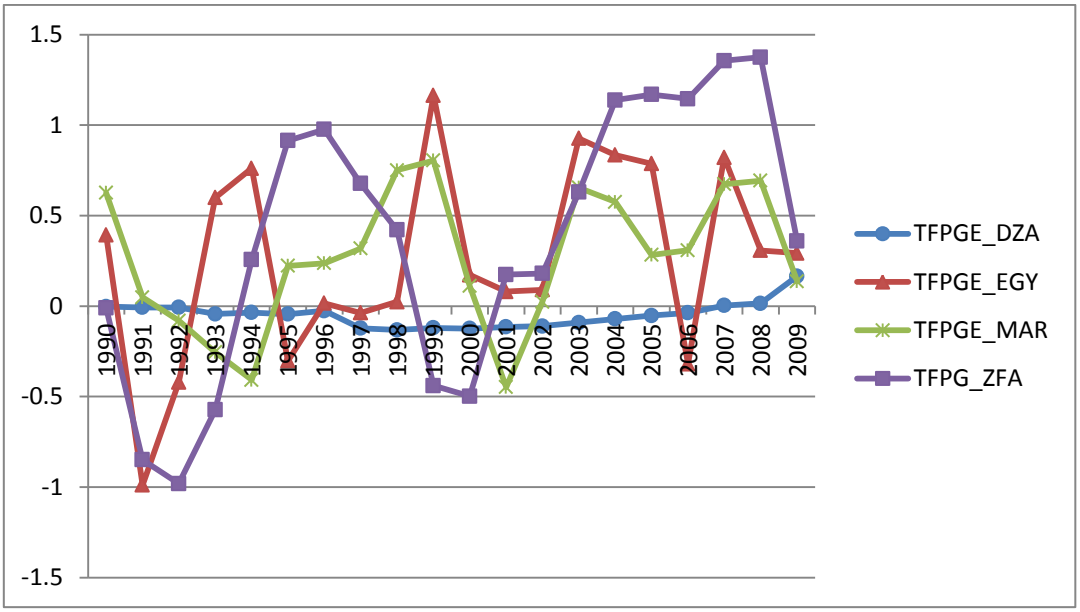
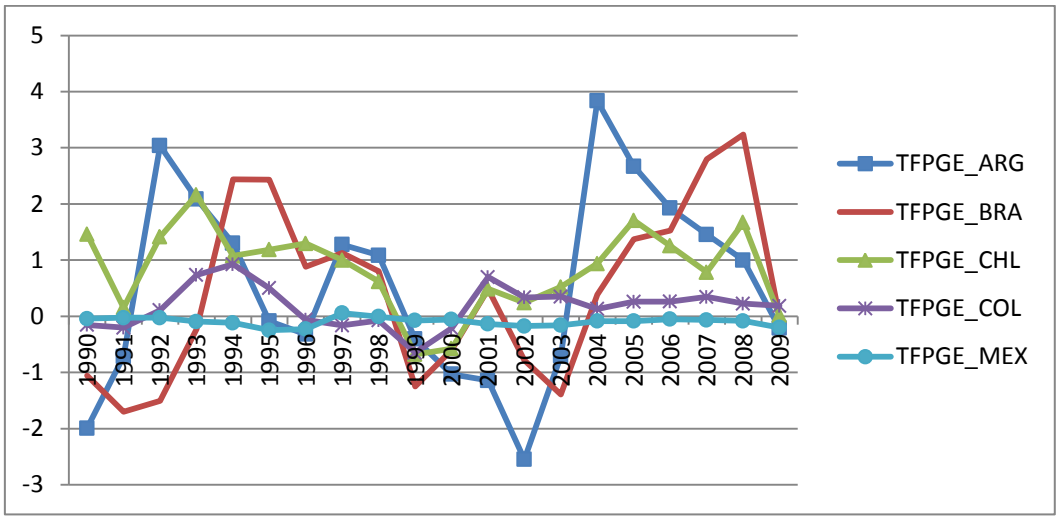


Figure 5.18 portrays the trends in TFPGE in the case of the four African countries: Algeria, Egypt, Morocco and South Africa. This figure reflects that in the African region TFPGE remained very volatile during the sample period. However, average TFPG in the case of Algeria is negative coupled with a low SD value (mean = –0.05, SD = 0.07) but high value of CV (CV = –1.45). The other three countries enjoyed a positive average of TFPGE. Another interesting finding is related to South Africa as

she faced cyclical trends of TFPGE. In this region South Africa reaped the highest average of TFPGE (mean = 0.37) followed by Egypt (mean = 0.26) and Morocco (mean = 0.26). Furthermore, among all the three countries of this region which realized positive average of TFPGE Morocco realized it with the least volatility (CV =1.45) as compared to South Africa (CV = 2.00) and Egypt (CV = 2.07).

Figure: 5.19 Trends of TFPGE in Latin America



Trends of TFPGE in the case of the five Latin American countries (Argentina, Brazil, Chile, Colombia and Mexico) have been displayed in Figure 5.19. This figure shows that the late 1990s and early 2000s were eras of low volatility of TFPGE in the selected Latin American countries, whereas at both ends of the sample period this region observed relatively high volatility of TFPGE. Moreover, at both ends of the sample period the region observed a higher average of TFPGE than in the late 1990s and early 2000s. In the case of Mexico the TFPGE fluctuated between a narrower range than in the other countries of the region; its average TFPGE during the sample period remained negative (mean = –0.09). Argentina observed a larger fluctuation in TFPGE during the sample period than other countries of the region. Moreover, Argentina observed sharp increases in TFPGE during the early 1990s and early 2000s. However, she could not sustain these improvements in TFPGE in either of the above

mentioned two periods and observed gradual declines afterward. Overall, the econometric approach produced a less volatile series of TFPGE than the growth accounting and index number approaches.

Figure: 5.20 Trends of TFPGE in South Asia

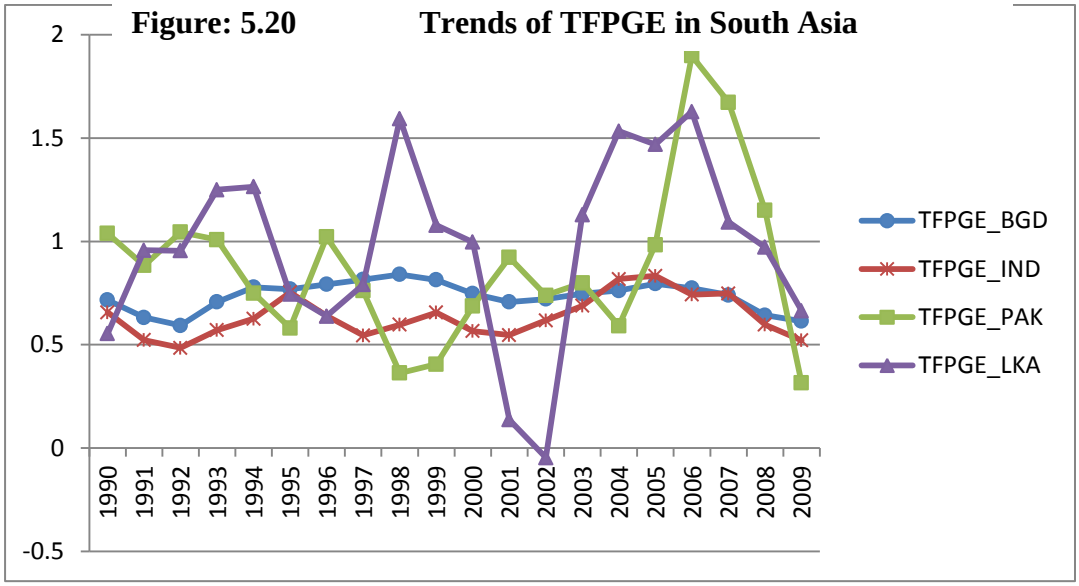


Figure 5.20 depicts the trends of TFPGE for the selected four South Asian countries: Bangladesh, India, Pakistan and Sri Lanka. In the case of Bangladesh the TFPGE remained between 0.58 and 0.85 with less volatility than other countries (mean = 0.74, SD = 0.07). However, India also reaped a much less volatile TFPGE with a positive average value (mean = 0.64, SD = 0.10). In the case of Pakistan (mean = 0.88, SD = 0.39) and Sri Lanka (mean = 0.97, SD = 0.45), TFPGE has been observed to be more volatile than in Bangladesh and India. It is interesting to note that in this region all the four selected countries enjoyed a positive average level of TFPGE. Moreover, the econometric approach produced more consistent trends of TFP growth than the growth accounting approach and index number approach.

Trends of TFPGE for the four selected East Asian countries (Hong Kong, Korea, Malaysia and Thailand) have been portrayed in Figure 5.21. The figure shows that during the first decade of the sample period TFPGE remained less consistent than in

the second decade. Among all the countries Malaysia observed the highest average TFPGE (mean = 1.19, SD = 0.20) with less volatility than other countries. It is also worth noting that the average TFPGE in the case of Malaysia is higher than all the other countries selected in this study from any region. Following Malaysia, Hong Kong also observed a higher average TFPGE (mean = 1.03, SD = 0.66) than all other countries selected in this study. The econometric approach generated a relatively more consistent time series of TFP growth than the other two approaches (i.e. growth accounting approach and index number approach).

Figure: 5.21 Trends of TFPGE in East Asia

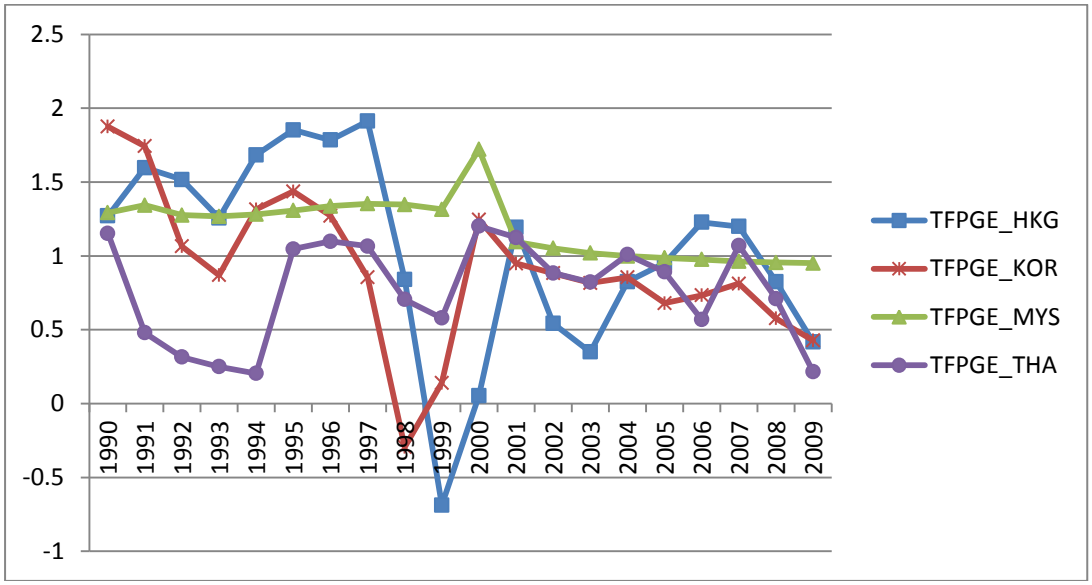


Figure 5.22 shows the trends of TFPGE in the case of EU-15 countries during the sample period. The graph has been developed using the annual averages of TFPGE in EU-15 for all the years included in the sample period. It reflects that TFPGE remained negative during 1992, 1993, 1994 and 2009. All other years observed positive TFPGE in EU-15. In 1999 the EU-15 realized 0.91% TFPGE, which is the highest value for this region during the sample period. Furthermore, similar to the growth accounting approach, TFPGE generated through the econometric approach follows cyclical fluctuation.

Figure: 5.22 Trends of TFPGE in EU-15

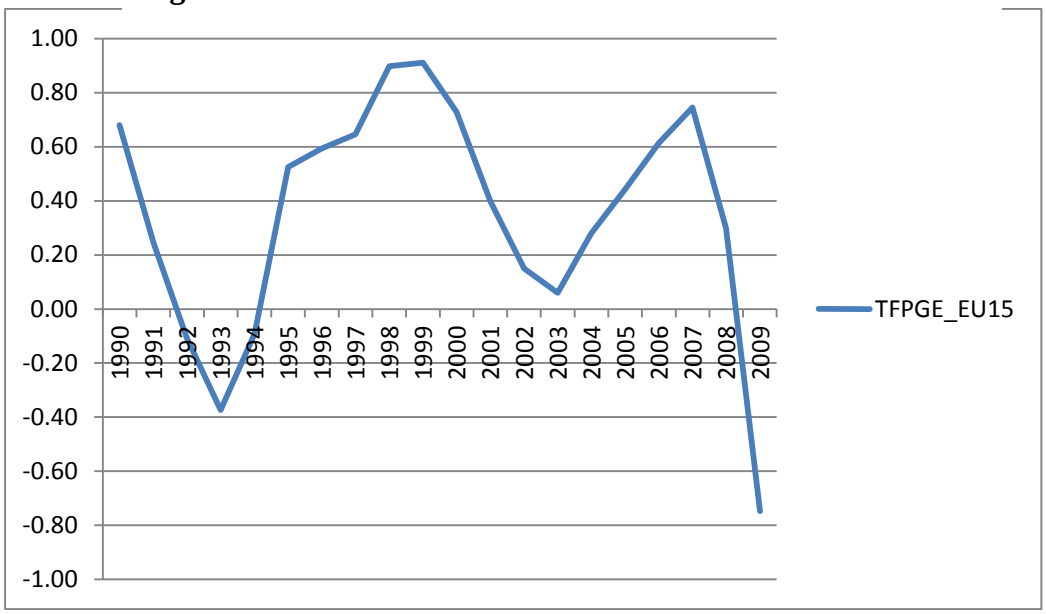


Table 5.9 contains time series of TFPGE in the case of each member country of EU-15. This table shows that all the member countries of EU-15, except Luxembourg and Sweden, faced negative TFPGE in the last year of the sample period (i.e. 1999) which might pertain to the global financial crisis of the late 2000s. However, during 2007 when this crisis started to emerge, TFPGE in all the member countries of EU-15 remained positive. This shows that TFPGE did not respond to the global financial crisis impulsively rather it started responding to it after a period of time; this is indicated by the findings that four countries of this region (Denmark, Greece, Ireland and Italy) observed negative TFPGE during 2008 and all of the countries of this region, except Luxembourg and Sweden, faced negative TFPGE during 2009. Moreover, in Sweden, TFPGE during 2009 remained at only 0.03 percent. None of the member countries of EU-15 enjoyed positive TFPGE throughout the sample period. However, the average level of TFPGE in the case of each of these countries during the sample period remained positive.

Table 5.10 contains the values of mean, SD and CV of TFPGE in the case of each country selected in the sample. This table reflects that two countries, Algeria and

Table 5.9
Trends of TFPGE in EU-15

Years	EU-15	AUT	BEL	DNK	FIN	FRA	GER	GRC	IRL	ITA	LUX	NLD	PRT	ESP	SWE	GBR
1990	0.68	0.41	0.84	0.04	0.45	1.33	1.83	0.25	0.46	1.05	0.65	0.63	0.88	0.97	0.04	0.39
1991	0.25	0.42	0.27	–0.35	–1.39	0.40	1.58	0.24	0.15	0.65	1.04	0.44	0.86	0.44	0.02	–1.09
1992	–0.11	0.33	–0.04	–0.25	–2.07	–0.30	1.19	0.07	–0.07	–0.05	0.20	0.35	0.40	–0.09	–0.36	–0.96
1993	–0.37	0.06	–0.01	–0.38	–1.73	–0.99	0.02	–0.13	0.03	–1.62	0.13	0.15	–0.12	–0.53	–0.37	–0.10
1994	–0.09	0.28	0.02	0.05	–0.88	–0.56	0.03	–0.11	0.20	–1.40	0.72	0.27	–0.16	–0.24	–0.11	0.50
1995	0.52	0.20	0.20	1.73	0.96	0.40	0.49	0.07	0.44	0.96	–0.28	0.53	0.65	0.53	0.18	0.82
1996	0.59	0.10	0.19	1.38	1.37	0.27	–0.06	0.33	0.54	1.05	0.37	0.87	0.91	0.58	0.07	0.93
1997	0.65	0.14	0.32	1.33	1.09	0.12	0.08	0.34	0.53	0.39	0.69	1.13	1.52	0.47	–0.24	1.77
1998	0.90	0.10	0.40	1.39	1.36	0.95	0.62	0.44	0.56	0.65	0.72	0.97	1.86	0.89	–0.07	2.64
1999	0.91	0.16	0.39	0.68	1.03	1.91	1.04	0.49	0.51	0.96	1.28	0.99	1.27	1.17	0.13	1.67
2000	0.73	0.18	0.36	0.55	0.70	1.82	0.87	0.42	0.38	1.28	0.86	0.73	0.78	1.03	0.37	0.60
2001	0.40	0.15	0.08	0.48	0.63	1.03	–0.07	0.25	0.18	1.09	0.17	0.30	0.40	0.51	0.17	0.58
2002	0.15	0.00	0.00	–0.10	–0.02	–0.01	–1.08	0.34	0.15	0.74	0.80	0.04	–0.12	0.68	0.12	0.70
2003	0.06	0.10	–0.12	–0.03	–0.06	0.01	–0.84	0.49	0.22	0.22	0.41	–0.20	–0.71	0.76	0.11	0.52
2004	0.28	0.12	0.42	0.39	0.45	0.66	–0.14	0.28	0.33	0.07	0.64	–0.05	–0.52	0.81	0.05	0.70
2005	0.44	0.15	0.67	0.66	0.58	0.92	0.10	–0.13	0.51	0.38	0.52	0.18	0.01	0.85	0.46	0.81
2006	0.61	0.15	0.37	1.59	0.52	0.99	1.11	0.32	0.38	0.56	0.51	0.66	–0.10	0.94	0.24	0.98
2007	0.74	0.22	0.43	1.06	0.86	1.23	1.53	0.53	0.21	0.61	0.91	0.83	0.11	0.74	0.30	1.58
2008	0.30	0.17	0.34	–0.23	0.65	0.74	0.77	–0.03	–0.06	–0.29	0.89	0.68	0.15	0.19	0.21	0.29
2009	–0.75	–0.11	–0.22	–1.36	–0.97	–1.10	–1.16	–0.45	–0.53	–1.96	0.31	–0.14	–0.73	–0.90	0.03	–1.92

Table 5.10 Descriptive Statistics TFPGE

SR. No.	Country	Region	Mean (TFPGE)	SD (TFPGE)	CV
1	Hungary	Central and East Europe	0.21	0.84	4.07
2	Romania	Central and East Europe	0.57	1.88	3.28
3	Turkey	Central and East Europe	0.56	2.30	4.07
4	Algeria	Africa	–0.05	0.07	–1.45
5	Egypt	Africa	0.26	0.54	2.07
6	Morocco	Africa	0.26	0.38	1.45
7	South Africa	Africa	0.37	0.74	2.00
8	Argentina	Latin America	0.53	1.71	3.24
9	Brazil	Latin America	0.45	1.52	3.40
10	Chile	Latin America	0.84	0.75	0.89
11	Colombia	Latin America	0.18	0.38	2.11
12	Mexico	Latin America	–0.09	0.08	–0.82
13	Bangladesh	South Asia	0.74	0.07	0.09
14	India	South Asia	0.64	0.10	0.16
15	Pakistan	South Asia	0.88	0.39	0.44
16	Sri Lanka	South Asia	0.97	0.45	0.46
17	Hong Kong	East Asia	1.03	0.66	0.64
18	Korea	East Asia	0.91	0.50	0.55
19	Malaysia	East Asia	1.19	0.20	0.17
20	Thailand	East Asia	0.77	0.34	0.44
21	Austria	EU-15	0.17	0.13	0.76
22	Belgium	EU-15	0.25	0.26	1.07
23	Denmark	EU-15	0.43	0.81	1.87
24	Finland	EU-15	0.18	1.03	5.83
25	France	EU-15	0.49	0.83	1.70
26	Germany	EU-15	0.40	0.86	2.17
27	Greece	EU-15	0.20	0.26	1.31
28	Ireland	EU-15	0.26	0.27	1.06
29	Italy	EU-15	0.27	0.93	3.48
30	Luxembourg	EU-15	0.58	0.36	0.63
31	Netherlands	EU-15	0.47	0.39	0.84
32	Portugal	EU-15	0.37	0.72	1.95
33	Spain	EU-15	0.49	0.55	1.12
34	Sweden	EU-15	0.07	0.22	3.21
35	United Kingdom	EU-15	0.57	1.03	1.81

Mexico, obtained a negative mean value of TFPGE during the sample period. Nonetheless, all other countries achieved a positive mean value of TFPGE. Among all countries Malaysia had the advantage of the highest TFPGE with a period's mean value of 1.19. By contrast, Mexico faced the lowest TFPGE with a period's mean value of –

0.09. The values of CV represent that TFPGE remained most volatile in the case of Finland (CV = 5.83) followed by Hungary (CV = 4.07) and Turkey (CV = 4.07). Conversely, Bangladesh was fortunate enough to harvest most consistent trends of TFPGE (CV = 0.09) followed by India (CV = 0.16) and Malaysia (CV = 0.17). For a better understanding of regional trends of TFPGE during the sample period, the regional trends have been plotted in Figure 5.23.

Figure: 5.23 Regional Trends of TFPGE

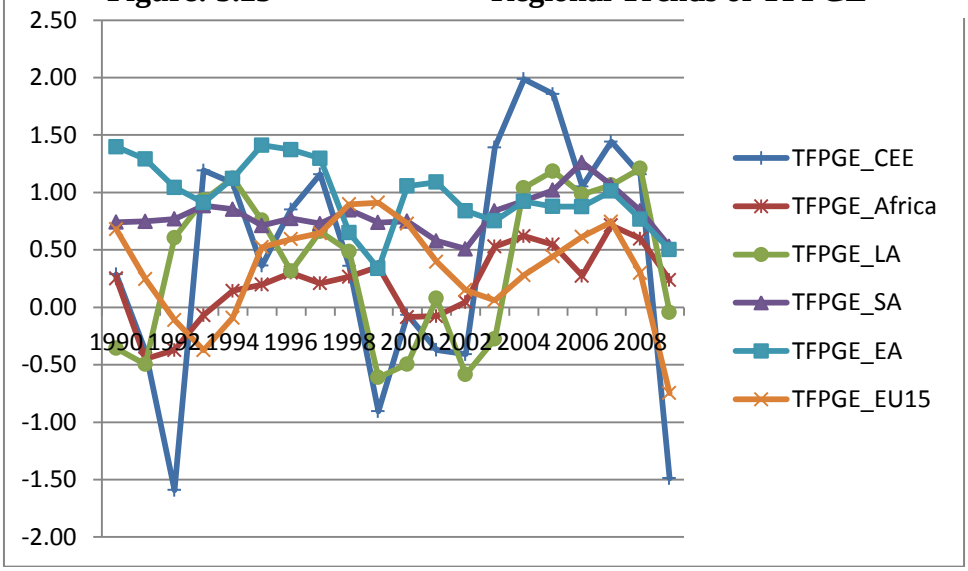


Figure 5.23 shows the regional trends of TFPGE during the sample period and Table 5.11 contains the values of mean, SD and CV in the case of all the regions selected in this study during the sample period. Figure 5.23 shows that during the mid-1990s and mid-2000s all of the selected regions achieved positive TFPGE. Both regions of Asia (i.e. EA and South Asia) reaped a positive regional TFPGE throughout the sample period. But, the period's mean value in the case of EA (mean = 0.98, SD = 0.29) remained higher than in the case of SA (mean = 0.81, SD = 0.18) and all other regions. However, in the case of SA the TFPGE (CV = 0.22) remained more consistent than in EA (CV = 0.30) and all other regions. Among all other regions the African region observed the lowest mean value of TFPGE (mean = 0.21, SD = 0.31) during the sample period. Moreover, among all

regions Central and East European region faced the most volatile trends of TFPGE (CV = 2.34) during the sample period. Finally, the overall mean value of TFPGE in the case of all the countries selected in this study during the sample period remained positive (mean = 0.53, SD = 0.34).

Table 5.11 Descriptive Statistics of Regional TFPGE

Region	CEE	Africa	L. America	S. Asia	E. Asia	EU-15	Overall
Mean	0.45	0.21	0.38	0.81	0.98	0.34	0.53
SD	1.05	0.31	0.67	0.18	0.29	0.43	0.34
CV	2.34	1.48	1.76	0.22	0.30	1.26	0.65

Figure: 5.24 Overall Trends of TFPGE

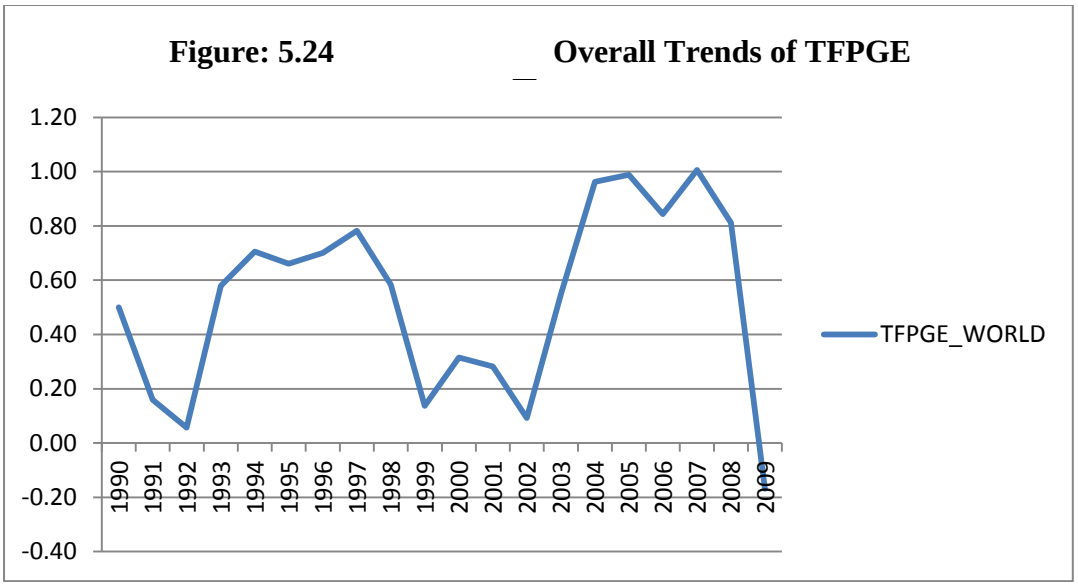


Figure 5.24 reveals the trends of annual averages of TFPGE of all the selected 35 countries during the sample period. The graph represents that the average TFPGE in the case of the selected group of 35 countries remained positive throughout the sample period except in the last year of the sample period (i.e. 2009). The periods of the mid-1990s and mid-2000s observed relatively high annual averages of TFPGE for the selected countries, whereas other periods observed low levels of TFPGE. Moreover, the trends of annual average TFPGE for the selected group of countries has been found to be cyclical.

Chapter 6

Empirical Findings[27]

This chapter has been divided into five sections. Section 1 of this chapter tests whether the time series used in this study are stationary. Section 2 analyses the ability of TFP growth to predict the economic growth. It also examines the possibility of conditional convergence of economic growth. Section 3 tests the effects of TFP growth on future investment. Section 4 discusses the possibility of convergence of economic growth. Last, but not least, Section 5 investigates the possibility of absolute and conditional convergence of TFP growth.

6.1 Unit Root Tests

Because all the time series used in this study are growth rates they are expected to be integrated of order zero (i.e. I(0)). However, for the purpose of confirmation, this section employs various unit root tests in order to examine if all the time series are stationary. For this purpose LLC; Im, Pesaran and Shin (2003); and Fisher-type tests using ADF and PP tests have been employed. In the LLC test of unit roots it is assumed that all of the cross-sections face a common unit root process. Contrary to LLC, the Im, Pesaran, and Shin, and the Fisher-ADF and PP tests assume individual unit root processes across cross-sections included in the sample. All of the unit root tests employed in this study assume the unit root in null hypothesis. Therefore, rejection of the null hypothesis shows that the series is stationary. Results of unit root tests have been presented in Table 6.1 in Appendix 6. Six of the nine time series (GRGDP, TFPG, TFPGI, GFI, INF, and GP) have been found to be I(0) at less than five percent level of significance according to all the four tests employed in this study. GISH has been found to be integrated of order zero at

[27] See Appendix 1 for the list of symbols and abbreviations used in the study. The results discussed in this chapter have been given in Appendix 6 in the form of tables.

less than five percent significance level according to Im, Pesaran and Shin W-stat, ADF-Fisher, Chi-square and PP-Fisher Chi-square tests. GTO and GOVSH have been found to be stationary at less than five percent level of significance according to LLC, and PP-Fisher Chi-square tests. These results reveal that the time series used in this study are stationary and can be used for further analysis.

6.2 TFP Growth and Future Economic Growth

This section determines the effects of TFP growth on future economic growth. For this purpose TFP growth has been computed through the three most widely used approaches: growth accounting approach (TFPG), index number approach (TFPGI) and econometric approach (TFPGE). Trends of TFP growth obtained through each of these approaches have been given in Chapter 5. In order to capture the true effect of TFP growth on economic growth this study uses a commonly reported set of control variables; INF, GP, GFI, GISH, GTO and GOVSH [28]. GRGDP has been used as the proxy of economic growth. Time series of TFP growth rate have been lagged by one period in order to determine the effect of TFP on future economic growth.

6.2.1 TFPG and Future Economic Growth in Full Sample

This section aims to discuss the effects of TFP growth obtained through TFPG on future economic growth. Besides the above, the possibility of conditional convergence of economic growth is also discussed in this section. In order to determine the effects of TFPG on future output growth one period lagged time series of TFP growth (TFPG(-1)) has been used as an independent variable. Further, INF, GP, first lag of GFI(-1), first lag of GISH(-1), GTO and GOVSH have been used as control variables. The growth rates of fixed investment and GISH have been used as the measures of investment. The effect of

[28] For details see Limam and Miller (2004) and Khan (2006).

TFPG on future GRGDP has been determined without including any measure of investment in the first model, including GFI(-1) In the second model and GISH(-1) in the third model. These three models have been estimated using pooled regression models and fixed effects models separately. The results of the above stated six models have been presented in Table 6.2 given in Appendix 6 in the case of the FS of 35 countries.

The results given in Table 6.2 reveal that TFPG significantly predicts future economic growth according to all the six models employed for the purpose of analysis. However, in pooled regression models TFPG(-1) is significant at less than ten percent level of significance in the first model when none of the investment measures has been used as independent variable and in the third model where GISH(-1) has been used as a control variable along with other control variables. Further, TFPG(-1) is significant at less than five percent level of significance In the second model of pooled regressions in which GFI(-1) has been included as a control variable along with other control variables. In the first model of pooled regressions the magnitude of coefficient of TFPG(-1) is 0.10 which indicates that a one percent growth of TFP raises the economic growth rate by 0.10 percent. The values of coefficients of TFPG(-1) in the second and third models of pooled regressions are 0.08 and 0.11 respectively which can be interpreted similarly as I did in the case of the first model.

The first model of pooled regressions expresses that INF, GTO and GOVSH are not significant predictors of GRGDP. Nevertheless, the effect of GP ($\beta = 0.81$) on GRGDP is significant at less than one percent significance level. It shows that a one percent increase in population growth leads to an increase of 0.81 percent in growth rate of RGDP. The magnitude of the coefficient of LRGDP(-1) ($\beta = -0.32$) is significant at less than one percent level of significance which shows that the growth rate of RGDP of each country is converging to its own steady-state level of economic growth. The value of adjusted R^2

is 0.18 which shows that independent variables jointly explain 18% of variations of GRGDP. Other necessary statistics have been given at the bottom of the table in each model.

The second model of pooled regressions includes GFI(-1) as an independent variable in addition to other variables included in the first model. According to the results of this model, TFPG(-1) ($\beta = 0.08$, sig.<0.05), GFI(-1) ($\beta = 0.25$, sig.<0.01), GP ($\beta = 0.57$, sig.<0.01), GTO ($\beta = 0.003$, sig.<0.05), GOVSH ($\beta = 0.03$, sig.<0.05) and LRGDP(-1) ($\beta = 0.13$, sig.<0.01) significantly determine the economic growth rate of the countries included in the sample. Although the effects of GTO and GOVSH on GRGDP are significant and positive, they are negligible with respect to the magnitude of the coefficients. However, GFI affects the future output growth significantly and positively. Inclusion of this variable in the pooled regression raises the value of adjusted R^2 to 0.60 which shows that independent variables jointly explain 60% of variations of GRGDP as compared to just 18% in the first model. Given the negative significant value of the coefficient of LRGDP in this model it is concluded that conditional convergence of economic growth rate exists in the countries selected in the sample. Conditional convergence shows that each country is converging to its own steady-state level of economic growth.

The third model of pooled regressions includes GISH(-1) instead of GFI(-1) which was added in the second model of pooled regressions. With respect to significance and direction, the effects of all independent variables have been found to be similar as in the second model except the effect of GTO which is insignificant in this model. However, the effect of GISH(-1) ($\beta = 0.001$, sig.<0.01) on GRGDP is lower as compared to the effect of GFI(-1) ($\beta = 0.25$, sig.<0.01) on GRGDP in the second model. This model also reconfirms the existence of conditional convergence of economic growth in the countries

selected for the purpose of analysis. The value of adjusted R^2 in this model is 0.19 which is barely higher than in the first model. The values of adjusted R^2 in the second and third models represent that GFI performs better than GISH as a predictor of future GRGDP on empirical grounds.

The last three columns of Table 6.2 given in Appendix 6 contain the results of three fixed effects panel models. Similar to pooled regression models, TFPG(-1) has been used as an independent variable in each of these three models. Further, the first model of fixed effects panel regressions does not include any measure of investment. The second model includes GFI(-1) as a control variable along with other four control variables. The third model includes GISH(-1) as a control variable instead of GFI(-1). According to these results the effect of TFPG on future economic growth is positive and statistically significant at less than one percent level of significance. The magnitude of coefficient of TFPG(-1) in each of the three fixed effects models is greater than its magnitude in each of the three pooled regression models respectively. This shows that TFPG performs better in fixed effects panel models than in pooled regressions on empirical grounds. However, the effects of INF and GP on GRGDP in fixed effects models are insignificant. GTO and GOVSH significantly and positively affect economic growth rate. Nonetheless, the effect of GOVSH on GRGDP is greater than that of GTO in each of the three models. As far as inclusion of a measure of investment is concerned, I found that GFI(-1) ($\beta = 0.26$, sig.<0.01) performs better than GISH(-1) ($\beta = 0.002$, sig.<0.05) on an empirical basis. These results are consistent with those which were found with the help of pooled regression models. This can be supported with the value of adjusted R^2 which is 0.64 when I included GFI(-1) as a control variable in the fixed effects model. Other necessary statistics have been given at the bottom of each model. Fixed effects for each of the three

fixed effects models employed in Table 6.2 have been presented in the form of table below Table 6.2.

From the above discussion I conclude that TFPG is a good predictor of future output growth. However, as a predictor it performs in fixed effects models better than in pooled regressions models. Further, GFI(-1) performs better than GISH(-1) as a measure of investment in each model on an empirical basis. Inflation does not significantly predict economic growth. According to pooled regressions there is strong evidence that GP significantly and positively affects economic growth rate, whereas no evidence has been found in fixed effects panel models that GP significantly predicts economic growth rate. GTO and GOVSH are positive and significant predictors of economic growth rate according to fixed effects panel model, whereas in the case of pooled regressions there is also some evidence that GTO and GOVSH are significant and positive predictors of economic growth. Last, but not least, results revealed that each country's economic growth rate is converging to its own steady-state level of economic growth which represents the existence of conditional convergence.

6.2.2 TFPGI and Future Economic Growth in Full Sample

Similar to the previous subsection, this subsection determines the effects of TFP growth and a set of control variables on economic growth in the case of a panel of all the 35 countries included in this study. The only difference between the previous subsection and this subsection is that the present subsection uses data on TFP growth obtained using the index number (TFPGI) approach rather than using the growth accounting approach. Results of the findings have been given in Table 6.3 in Appendix 6. With the difference of time series of TFP growth in the case of all the countries the same six models have been employed in this subsection as were employed in the previous subsection.

The results given in Table 6.3 reveal that one period lagged time series of TFP growth obtained through the index number approach (TFPGI(-1)) does not significantly predict future economic growth according to pooled regression models. However, in first of the three fixed effects panel regression models the impact of TFPG(-1) ($\beta = 0.09$, sig.<0.05) on future economic growth is positive and significant at less than five percent. It is important to note that in the first fixed effects panel regression model none of the measures of investment were included in the model as independent variables. In the case of the second fixed effects panel regression model where GFI(-1) has been added into the model as independent variable, the effect of TFPGI(-1) ($\beta = 0.–03$, sig.>0.10) on future economic growth does not remain significant. In the third of the three fixed effects panel regression models the effect of TFPGI(-1) ($\beta = 0.08$, sig.<0.10) on future economic growth is positive and significant at less than ten percent significance level. In this model GISH(-1) has been included as an independent variable. Comparing these results with those obtained in the previous subsection this study concludes that TFP growth obtained through the growth accounting approach empirically performs better than TFP growth obtained through the index number approach in predicting future economic growth in the case of the FS.

GFI(-1) positively and significantly predicts the future economic growth of the countries included in the FS. The magnitudes of the coefficients of GFI(-1) and significance levels in the pooled regression model ($\beta = 0.25$, sig.<0.01) and the fixed effects panel regression model ($\beta = 0.26$, sig.<0.01) are almost the same in both models (i.e. pooled regression model and fixed effects panel regression model).

Another measure of investment used in this study is GISH(-1). The results given in Table 6.3 reveal that the effect of GISH(-1) on future economic growth is positive and significant on economic growth both in the pooled regression model and fixed effects

panel regression model. However, the magnitude of the coefficients of GISH(-1) (β = 0.001, sig.<0.05 in pooled regression model and β = 0.002, sig.<0.10 respectively) is quite low in comparison to the coefficient of GFI(-1). Similar to Section 6.2.1, on the basis of these findings this study concludes that GFI performs better than GISH as the proxy of investment to be used in growth studies.

The results reflect that the INF does not significantly predict economic growth rate. These findings are similar to those discussed in the previous subsection. None of the employed six models show a significant effect of INF on economic growth of the panel of 35 countries included in this study.

The effect of GP on economic growth rate is positive and significant at less than one percent significance level according to the three pooled regression models. However, INF does not significantly predict the economic growth of the panel of 35 countries according to the three panel regression models. These findings are also consistent with those discussed in the previous subsection.

The effect of GTO on the economic growth rate is positive and significant according to all the economic growth models employed in Table 6.3 except the third pooled regression model where GISH has been used as a control variable. However, the results demonstrate that the magnitude of the significant coefficients of GTO is relatively low and varies from 0.004 to 0.007. These findings are almost consistent with those given in the previous subsection. This situation shows that although GTO positively and significantly predicts the economic growth of the panel of 35 countries its effect is weak.

Further, the GOVSH does not significantly predict economic growth of the countries included in the FS according to the results of all the three pooled regression models. Nonetheless, it predicts economic growth rate of the said panel of countries positively and significantly according to the results of all the three fixed effects panel regression models.

The magnitude of the coefficients of GOVSH in fixed effects panel regression models varies from 0.21 to 0.32 at less than five percent significance level in each case.

Last, but not least, the coefficients of LRGDP(-1) in all the three pooled regression models are negative and significant at less than one percent significance level. The magnitude of the coefficients of LRGDP(-1) varies from –0.34 to –0.15. The negative significant values of the coefficients of LRGDP(-1) reinforce the idea of the existence of conditional convergence in the case of the panel of 35 countries included in the FS.

The values of necessary statistics have been given at the bottom of each model presented in Table 6.3. The calculated values of F statistic are significant at less than one percent significance level in each case. It is important to note that the values of adjusted R^2 given in Table 6.2 are greater than their respective values given in Table 6.3 in the case of four models and equal to their respective values in the case of two models. On the basis of the values of adjusted R^2 the findings of this study reinforce the conclusion that TFP growth obtained through at the bottom of growth accounting approach empirically performs better than TFP growth obtained through at the bottom of index number approach in predicting future economic growth of the panel of 35 countries included in this study. Fixed effects have also been shown at the bottom of Table 6.3 in the case of each country for all the three fixed effects panel regression models.

6.2.3 TFPGE and Future Economic Growth in Full Sample

Similar to the previous two subsections, this subsection determines the effects of TFP growth and a set of control variables on economic growth in the case of a panel of all the 35 countries included in this study. This subsection uses the data on TFP growth obtained through the econometric approach (TFPGE) rather than using the growth accounting approach or index number approach. Table 6.4 given in Appendix 6 contains the results

of the findings. With the difference of TFPGE the table presents the results of the same six models as covered by the previous two tables.

The results given in Table 6.4 reveal that one period lagged time series of TFP growth obtained through econometric approach (TFPGE(-1)) does not significantly predict future economic growth according to two of the three pooled regression models. However, in the second pooled regression model, which includes GFI as an explanatory variable along with other variables, the effect of TFPGE ($\beta = 0.20$, sig.<0.05) is positive and significant on future output growth. In the case of fixed effects panel regression models, TFPGE affects future economic growth significantly and positively in each model. The coefficient of TFPGE(-1) remained 0.44, 0.27 and 0.42 for the first, second and third models respectively. All of these coefficients are significant at less than five percent significance level. Comparing these results with those obtained in previous two subsections this study concludes that TFPGE empirically performs better than TFPGI. However, the comparison of empirical performance of TFPGE with that of TFPG requires a detailed discussion. On the basis of values of adjusted R^2 both approaches perform equivalently as these values are exactly the same in the case of TFPG and TFPGE in pooled regression models. However, in the case of fixed-effects panel data models values of adjusted R^2 with the use of TFPG are greater than the values of adjusted R^2 with the use of TFPGE in the first and third models. In the case of the second fixed-effects panel data model the value of adjusted R^2 is same in both cases (i.e. with the use of TFPG and TFPGE). In general, the findings support the use of the growth accounting approach rather than econometric approach or index number approach as this approach produces the time series of TFPG which empirically performs better than the series produced through the other approaches.

Table 6.4 reveals that GFI positively and significantly predicts the future economic growth of the countries included in the FS. Magnitudes of the coefficients of GFI(-1) and

significance levels in pooled regression model ($\beta = 0.25$, sig.<0.01) and in fixed effects panel regression model ($\beta = 0.26$, sig.<0.01) are almost same in both models (i.e. pooled regression model and fixed effects panel regression model). It is also important to note that the coefficients of GFI(-1) remained robust to the changes in measurement approach of TFP growth.

The second measure of investment used in this study is GISH. Table 6.4 reveals that the effect of GISH on future economic growth is positive and significant in the pooled regression model, whereas it is insignificant in fixed effects panel regression model. However, the magnitude of the coefficients of GISH(-1) ($\beta = 0.001$, sig.<0.05 in pooled regression model and $\beta = 0.0018$, sig.>0.10 respectively) is quite low in comparison to the magnitude of corresponding coefficients of GFI(-1). Similar to the previous two subsections, on the basis of these findings this study concludes that GFI performs better than GISH as the proxy of investment to be used in growth studies.

The results reflect that the INF does not significantly predict economic growth rate. These findings are similar to those discussed in the previous two subsections. None of the employed six models show a significant effect of INF on economic growth of the panel of 35 countries included in this study.

The effect of GP on economic growth rate is positive and significant at less than one percent significance level according to all the three pooled regression models. Nonetheless, it does not significantly predict the economic growth of the panel of 35 countries according to all the panel regression models. These findings are also consistent with those discussed in previous sections.

The effect of GTO on economic growth rate is positive and significant according to the second pooled regression model of Table 6.4 where GFI has been used as a control

variable. In the case of all other five panel regression models the effect of GTO on economic growth of the panel of 35 countries is not significant.

Further, the GOVSH does not significantly predict the economic growth of the countries included in the FS according to the results of the first two pooled regression models. Nonetheless, it predicts the economic growth rate of the panel of 35 countries positively and significantly according to the third model of pooled regressions and all of the three models of fixed effects panel regressions.

Last, but not least, the coefficients of LRGDP(-1) in all the three pooled regression models are negative and significant. The magnitude of the coefficients of LRGDP(-1) varies from –0.08 to –0.46. The negative significant values of the coefficients of LRGDP(-1) reinforce the idea of existence of conditional convergence in the case of the panel of 35 countries included in the FS.

The values of necessary statistics have been given at the bottom of each model presented in Table 6.4. The calculated values of F statistic are significant at less than one percent significance level in each case. Fixed effects have also been shown at the bottom of Table 6.4 in the case of each country for all the three fixed effects panel regression models.

6.2.4 TFPG and Future Economic Growth in CEE

This subsection discusses the effects of TFPG measured through the growth accounting approach on future economic growth in the case of CEE. Table 6.5 contains the results of pooled regression models and fixed effects panel regression models. Each type of model has been employed three times: first, without using any proxy measure of investment; second, using GFI(-1) as proxy measure of investment; and third, using GISH(-1) as the proxy measure of investment.

The results show that TFPG significantly and positively predicts future economic growth of CEE according to the first and third pooled and fixed effects regression models. In the

second pooled regression model and in the second fixed effects panel regression model the effect of TFPG on future economic growth of CEE is not significant. To sum up, TFPG is a significant predictor of future economic growth in four of the six employed panel regression models.

Table 6.5 reveals that GFI positively and significantly predicts the future economic growth of CEE both in pooled regression model and fixed effects panel regression model. The magnitude of the coefficient of GFI(-1) ($\beta = 0.32$, sig.<0.01) remained the same in both models.

According to the results given in Table 6.5, the effect of GISH on future economic growth is positive and significant both in the pooled regression model and the fixed effects panel regression model. Moreover, the magnitude of the coefficient of GISH(-1) ($\beta = 0.98$, sig.<0.01 in pooled regression model and $\beta = 0.93$, sig.<0.01 in fixed effects panel regression model) is quite large in comparison to the magnitude of corresponding coefficients of GFI. This shows that in the case of CEE GISH empirically performs better than GFI as a proxy measure of investment.

The results given in Table 6.5 indicate that the effect of inflation on economic growth of CEE is negative and significant according to all the six employed pooled regression models and fixed effects panel regression models. The magnitude of the coefficients of inflation varied from –0.05 to –0.02. The effect of GP on economic growth is not significant in the case of CEE. Furthermore, GTO positively affects the economic growth of CEE according to the third model of pooled regressions and third model of fixed effects panel regressions. But, the effect of GTO on economic growth in the other four models is not significant. Moreover, the GOVSH significantly affects economic growth of CEE only in one of the six panel regression models, which is the third model of fixed effects panel regressions ($\beta = 0.57$, sig.<0.10).

Finally, the coefficients of LRGDP(-1) in the three pooled regression models given in Table 6.5 ($\beta = -0.08$, sig.<0.05 in model 1; $\beta = -0.17$, sig.<0.10 in model 2; $\beta = -0.46$, sig.<0.10 in model 3) are significant. The negative significant values of the coefficients of LRGDP(-1) suggest that the conditional convergence of economic growth in the case of CEE exists. Necessary statistics and fixed effects have been given at the bottom of Table 6.5.

6.2.5 TFPGI and Future Economic Growth in CEE

In this subsection the effects of TFP growth, obtained the through index number approach, on future economic growth in the case of CEE are discussed. All the discussion in this subsection corresponds to the results given in Table 6.6 in Appendix 6.

According to the results TFPGI does not significantly predict the future economic growth of CEE in any of the six employed models of pooled regressions and fixed effects panel regressions. On this account, it can be concluded that TFP growth obtained through the growth accounting approach empirically performs better than that obtained through the index number approach.

Similar to the results discussed in the previous subsection, both proxy measures of investment (i.e. GFI(-1) and GISH(-1)) positively and significantly affect the future economic growth of CEE countries selected in this study. However, the coefficients of GISH(-1) in both pooled regression models and fixed effects panel regression models emerged with greater values than the corresponding coefficients of GFI(-1). This reconfirms the idea that in the case of CEE GISH empirically performs better than GFI.

The results indicate that the effect of inflation on economic growth in CEE is negative and significant according to all the six employed pooled regression models and fixed effects panel regression models. The magnitude of the coefficients of inflation varied from –0.05 to –0.02. The effect of GP on economic growth is not significant in the case of

CEE. Furthermore, GTO positively affects economic growth of CEE according to the third model of pooled regressions and third model of fixed effects panel regressions. But, the effect of GTO on economic growth in the other four models remained insignificant. Moreover, the GOVSH does not significantly affect the economic growth of CEE in any of the six employed regression models.

Lastly, the coefficient of LRGDP(-1) in the second of the three pooled regression models given in Table 6.6 ($\beta = -0.18$, sig.<0.05) is significant. This negative significant value of the coefficient of LRGDP(-1) suggests that the conditional convergence of economic growth in the case of CEE exists. However, the evidence of conditional convergence of economic growth is insignificant in the other two pooled regression models. Necessary statistics and fixed effects have been given at the bottom of Table 6.6.

6.2.6 TFPGE and Future Economic Growth in CEE

Table 6.7 given in Appendix 6 contains the results of three pooled regression models and three fixed effects panel regression models in the case of CEE. In these models data on TFP obtained through the econometric approach (TFPGE) have been used. In this subsection all the discussion corresponds to the results given in Table 6.7.

The results of the three pooled regression models reflect that the effect of TFPGE on future economic growth of CEE is not significant. Contrary to pooled regression models the fixed effects panel regression models present some evidence of a significant effect of TFPGE on future economic growth of CEE. Two of the three fixed effects panel regression models show that TFPGE positively and significantly predicts the future economic growth of this region. However, the second model of panel regressions does not present any evidence of a significant effect of TFPGE on the future economic growth of the region. Results of fixed effects panel regressions resemble those given in Table 5.5 where the effect of TFPG has been tested on future economic growth of CEE. This shows

that the growth accounting approach and the econometric approach have generated time series of TFP growth that perform similarly in predicting the future economic growth of CEE. However, TFPG performs better than TFPGE in pooled regression models. From this discussion it can be concluded that the time series of TFP growth obtained through the growth accounting approach empirically performs better than that obtained through the econometric approach. Moreover, as discussed in the previous subsection, the growth accounting approach performs better than the index number approach in the case of CEE. This conclusion resembles that drawn in the case of the FS data: the growth accounting approach is better than the other two approaches.

The effects of two proxy measures of investment (GFI(-1) and GISH(-1)) on future economic growth in this subsection remained significant as it had done in the previous two subsections. The results reveal that both measures of investment affect the economic growth of CEE positively and significantly. However, the magnitude of the slope coefficients of GISH(-1) remained higher than magnitude of corresponding coefficients of GFI(-1). This helps in concluding that GIF empirically performs better than GISH in predicting economic growth of CEE. This conclusion is the same as was drawn in the previous two subsections in the case of CEE. However, this conclusion is in contrast to that drawn in the FS study, which revealed that GFI empirically performs better than GISH in predicting economic growth.

The results of the effects of inflation on economic growth of CEE tell a similar story to that discussed in the previous two subsections. According to the results of all the six panel regression models the impact of inflation on economic growth of CEE is significant and negative. It suggests that inflation should be targeted in CEE in order to accelerate economic growth.

GP does not affect the economic growth of CEE in any of the employed six panel data models. Besides that, GTO and GOVSH do not affect the economic growth of CEE according to all the pooled regression models. Nevertheless, both variables positively and significantly affect the economic growth of CEE according to the third model of fixed effects panel regressions. But, the first two models of fixed effects regressions do not present a different story to that of the pooled regression models.

The coefficient of LRGDP(-1) is negative and significant which suggests that conditional convergence of economic growth exists in the case of CEE. These results are in accordance with expectations and economic theory. Necessary statistics and fixed effects for the three countries included in sub-sample CEE have been given at the bottom of Table 6.7.

6.2.7 TFPG and Future Economic Growth in Africa

Table 6.8 given in Appendix 6 contains the results of three pooled regression models and three fixed effects panel regression models in the case of a panel of four countries selected from the African region: Algeria, Egypt, Morocco and South Africa. In these models data on TFP obtained through the growth accounting approach (TFPG) have been used. All the discussion in this subsection corresponds to the results given in Table 6.8.

According to the results given in Table 6.8, TFPG significantly and positively affects the future economic growth of Africa in all the three fixed effects panel regressions and in the second of the three pooled regressions. In the case of the African region the two measures of investment provide quite interesting results. In the case of pooled regression GFI does not significantly predict future economic growth ($\beta = 0.07$, sig.>0.10), whereas it does predict future economic growth significantly in the case of fixed effects panel regression ($\beta = 0.12$, sig.<0.05). Conversely, GISH significantly and positively determines the future economic growth of Africa in pooled regression ($\beta = 0.09$, sig.<0.01) but it does not

affect the future economic growth of Africa in the case of fixed effects panel regression ($\beta = 0.03$, sig.>0.10).

The results show that the effect of inflation on the economic growth of Africa is negative and significant in the case of all the six panel regressions: three pooled regressions and three fixed effects panel regression. These results resemble those found in the case of CEE. It suggests that the countries included in the panel of Africa should also target inflation in order to accelerate economic growth.

GP does not affect the economic growth of Africa in five of the employed six panel regression models. But, according to the second model of fixed effects panel regressions the effect of GP on the economic growth of Africa is negative and significant at less than 10 percent. Moreover, the effect of GTO on economic growth of this region is positive and significant according to all the three pooled regression models and two fixed effects panel regression models. The only exception is the second fixed effects panel regression model where the effect of GTO on economic growth is not significant. The effect of GOVSH on economic growth is not significant according to all the three pooled regression models. But, this effect is positive and significant in the case of all the three fixed effects panel regression models. From these results, it can be concluded that the governments of the African region should enhance their share in GDP to reap reasonable growth rates of GDP. Moreover, these governments should adopt such policies that may enhance the trade openness of the countries. Lastly, evidence of conditional convergence in the case of the panel of African countries is also found. The coefficient of LRGDP(-1) is negative and significant which suggests that conditional convergence of economic growth exists in the case of African countries. These results are in accordance with economic theory. Necessary statistics and fixed effects for the four countries included in the sub-sample Africa have been given at the bottom of Table 6.8.

6.2.8 TFPGI and Future Economic Growth in Africa

Table 6.9 given in Appendix 6 contains the results of three pooled regression models and three fixed effects panel regression models in the case of a panel of four countries selected from the African region: Algeria, Egypt, Morocco and South Africa. In these models data on the first lag of TFP obtained through the index number approach (TFPGI(-1)) have been used. All the discussion in this subsection corresponds to the results given in Table 6.9.

The results of panel regression models given in Table 6.9 reveal that TFPGI significantly and positively affects the future economic growth of Africa according to all the three fixed effects panel regressions but it does not determine the future economic growth of Africa according to any of the three pooled regression models. The effects of the two measures of investment (i.e. GFI and GISH) on the future economic growth of Africa were the same as those in Table 6.8. According to these results in the case of pooled regression GFI(-1) does not significantly predict future economic growth ($\beta = 0.12$, sig.>0.10), whereas it does predict future economic growth significantly in the case of fixed effects panel regression ($\beta = 0.13$, sig.<0.05). Conversely, GISH(-1) significantly and positively determines the future economic growth of Africa in pooled regression ($\beta = 0.14$, sig.<0.01) but it does not affect the future economic growth of Africa in the case of fixed effects panel regression ($\beta = 0.04$, sig.>0.10).

The results show that the effect of inflation on the economic growth of Africa is significantly negative in the case of the second and third pooled regression models. But, its effect on the economic growth of Africa according to the first pooled regression model and all of the three fixed effects panel regression models is not significant. GP does not affect the economic growth of Africa in five of the employed six panel regression models. But, according to the third model of pooled regressions the effect of GP on the economic

growth of Africa is negative and significant at less than 10 percent. Moreover, the effect of GTO on economic growth of the countries included in the African panel is positive and significant according to the first and third pooled regression models. However, the effect of GTO on economic growth is not significant according to all of the three fixed effects panel regressions and second pooled regression model. The effect of GOVSH on economic growth is not significant according to all the three pooled regression models and third fixed effects panel regression model. But, this effect is positive and significant in the case of the first and second fixed effects panel regression models. Evidence of conditional convergence in the case of the panel of African countries is also found in the case of the third pooled regression model. The coefficient of LRGDP(-1) is negative and significant in the said model, which suggests that conditional convergence of economic growth exists in the case of African countries. However, the first two models of pooled regressions do not provide significant evidence of the existence of conditional convergence in the case of these countries. Necessary statistics and fixed effects for the four countries included in the sub-sample Africa have been given at the bottom of Table 6.9. On the basis of the values of adjusted R^2 it can be concluded that each of the models given in Table 6.8 present a better explanation of variations of economic growth than its corresponding model given in Table 6.9. This comparison reinforces the conclusion that the use of TFPG obtained through the growth accounting approach in empirical studies is better than that obtained through the index number approach.

6.2.9 TFPGE and Future Economic Growth in Africa

Table 6.10 given in Appendix 6 represents the results of three models of pooled regressions and three models of fixed effects panel regressions in the case of the panel of four African countries: Algeria, Egypt, Morocco and South Africa. In these models the

data on TFP generated through the econometric approach (TFPGE) have been used. This subsection presents the discussion according to the results given in Table 6.10.

According to the results given in Table 6.10, the impact of TFPGE on the future economic growth of Africa is significantly positive according to all the three fixed effects panel regressions. But, in the case of pooled regression models the impact of TFPGE on the future economic growth of Africa is not significant. These results are similar to those found using TFPGI. But, the magnitudes of the slope coefficients of TFPGE are greater than those of TFPGI in corresponding models. This shows that TFGPE empirically performs better than TFPGI but not better than TFPG.

The effects of the two measures of investment (GFI and GISH) on the future economic growth of Africa remained the same as found in the previous two subsections. GFI(-1) does not significantly predict future economic growth of Africa ($\beta = 0.07$, sig.>0.10) in the case of pooled regression, whereas its effect on future economic growth is significantly positive in the case of fixed effects panel regression ($\beta = 0.12$, sig.<0.05). However, GISH significantly and positively determines future economic growth of Africa in pooled regression ($\beta = 0.09$, sig.<0.01) but it does not affect future economic growth in the case of fixed effects panel regression ($\beta = 0.03$, sig.>0.10).

The results show that the effect of inflation on the economic growth of Africa is negative and significant in the case of all the six panel regressions: three pooled regressions and three fixed effects panel regression. These results are similar to those discussed in Subsection 6.2.7. These results reinforce the suggestion that the countries included in the panel of Africa should target inflation in order to enhance economic growth.

GP does not affect the economic growth of Africa in five of the employed six panel regression models. But, according to the second model of fixed effects panel regressions the effect of GP on the economic growth of Africa is negative and significant at less than

5 percent. Moreover, the effect of GTO on the economic growth of this region is positive and significant according to all the three pooled regression models and two fixed effects panel regression models. The only exception is the second fixed effects panel regression model where the effect of GTO on economic growth is not significant. The effect of GOVSH on economic growth is not significant according to all the three pooled regression models. But, this effect is positive and significant in the case of all the three fixed effects panel regression models. From these results it can be concluded that the governments of the African region should enhance their share in GDP to reap reasonable growth rates of GDP. Moreover, these governments should adopt such policies which may enhance the trade openness of the countries. Lastly, evidence of conditional convergence in the case of the panel of African countries is also found. The coefficient of LRGDP(-1) is negative and significant which suggests that conditional convergence of economic growth exists in the case of African countries. These results are in accordance with economic theory. Necessary statistics and fixed effects for the four countries included in the sub-sample Africa have been given at the bottom of Table 6.10.

6.2.10 TFPG and Future Economic Growth in Latin America

In Table 6.11 through to Table 6.13 the effects of TFP growth on future economic growth are discussed in the case of a panel of Latin American countries. Table 6.11 contains the results of pooled regression models and fixed effects panel regression models using the data on TFP growth obtained through the growth accounting approach (TFPG). The sequence of the models presented in Table 6.11 is similar to those presented in Tables 6.2 to 6.10.

The results of pooled regressions given in Table 6.11 indicate that the effect of TFPG on future economic growth of the selected panel of Latin American countries is positive and significant at less than one percent significance level in the second model. But, it does not

affect future economic growth significantly according to first and third models of pooled regression. In the case of fixed effects panel regressions TFPG is a significant predictor of future economic growth of the region according to the second and third models. However, there is no significant effect of TFPG on future economic growth of the region according to the first model of fixed effects panel regressions.

The table shows that the effects of both one period lag measures of investment (GFI(-1) and GISH(-1)) are positive and significant in both kinds of regression: pooled regressions and fixed effects panel regressions. Nevertheless, the magnitudes of the coefficients of both investment measures in fixed effects panel regressions are slightly greater than respective magnitudes of the coefficients in pooled regression models. This shows the importance of investment in the case of Latin American countries. Moreover, in LA inflation does not significantly determine economic growth in any of the regression models. GP positively and significantly affects the economic growth of this region according to the second model of pooled regressions and first model of fixed effects panel regressions. GTO positively and significantly determines the economic growth of the region according to all of the three pooled regression models and second model of fixed effects panel regression. It does not affect the economic growth of the region according to first and third models of fixed effects panel regressions. The effects of GOVSH on the economic growth of the region are similar. GOVSH significantly and positively determines the economic growth of LA in all of the three pooled regressions. In the case of fixed effects panel regressions the effect of GOVSH on economic growth of the said region is significantly positive according to the second model but insignificant according to first and third models.

The table shows that the coefficient of LRGDP(-1) is significantly negative according to the second and third models of pooled regressions. This shows that conditional

convergence of economic growth exists in the case of LA. However, the evidence of conditional convergence of economic growth is not significant according to the first model of pooled regressions. Necessary statistics and fixed effects have been given at the bottom of Table 6.11.

6.2.11 TFPGI and Future Economic Growth in Latin America

Table 6.12 contains the results of pooled regression models and fixed effects panel regression models using the data on TFP growth obtained through the index number approach (TFPGI). All the discussion in the present subsection corresponds to Table 6.12. This table presents the results of six panel data regression models similar to the previous table.

The results of panel data regression models given in Table 6.12 demonstrate that the effect of TFPGI on future economic growth of the selected panel of Latin American countries is not significant in any of the six panel data regression models. According to the discussion given in the previous subsection TFPG significantly determines the future economic growth of the region according to three of the six panel data regression models. From this it can be concluded that TFPG empirically performs better than TFPGI in the case of panel of Latin American countries. This conclusion is similar to that drawn in the case of the FS of 35 countries and in the case of the previous two sub-samples: CEE and Africa.

The effects of two measures of investment (GFI and GISH) on future economic growth of LA are similar to that discussed in previous subsection without any noticeable differences of magnitudes of coefficients. The effect of inflation on economic growth remained insignificant according to the results presented in Table 6.12. The GP significantly and positively determines economic growth of the region according to the second model of pooled regressions and second model of fixed-effects panel data regressions. However, it

does not determine economic growth according to the other four models. The effects of GTO on the economic growth of Latin American countries are significantly positive according to the second and third models of pooled regressions and second model of fixed effects panel regression. But, it does not significantly determine the economic growth of LA according to the remaining three regression models. The impacts of GOVSH on economic growth of the region are significantly positive according to the second and third models of pooled regressions and third model of fixed effects panel regression. Evidence of the existence of conditional convergence of economic growth has been found. The slope coefficients of LRGDP(-1) are negatively significant in the case of all the three pooled regression models. Necessary statistics and fixed effects have been shown at the end of Table 6.12.

6.2.12 TFPGE and Future Economic Growth in Latin America

Table 6.13 contains the results of pooled regression models and fixed effects panel regression models using the data on TFP growth obtained through the econometric approach (TFPGE). All the discussion in the present subsection corresponds to Table 6.13. The results of panel data regression models given in Table 6.13 demonstrate that the effect of TFPGE on future economic growth of the panel of Latin American countries is not significant in any of the three pooled regression models and first fixed effects panel regression model. However, it determines the future economic growth of the region positively and significantly according to the second and third models of fixed-effects panel data regressions. According to the findings discussed in the previous two subsections and in the present subsection it can be concluded that in the case of Latin American countries TFPGE empirically performs better than TFPGI but not better than TFPG. This conclusion is similar to that drawn in the case of samples discussed previously.

The effects of both measures of investment (i.e. GFI and GISH) on future economic growth of the region are similar to those discussed in the previous two subsections. However, the magnitudes of the coefficients of both measures of investment in both models are slightly greater than the respective magnitudes given in Tables 6.11 and 6.12. As in Tables 6.11 and 6.12, the effect of inflation on economic growth of LA remained insignificant according to the results presented in Table 6.13. The GP significantly and positively determines economic growth of the region according to the second model of pooled regressions. However, it does not determine the economic growth of the region according to any other model. The effects of GTO on the economic growth of Latin American countries are significantly positive according to the second model of pooled regressions and second model of fixed effects panel regressions. But, it does not significantly determine the economic growth of these countries according to the remaining four regression models. The impacts of GOVSH on the economic growth of the region are significantly positive according to the second and third models of pooled regressions and the same two models of fixed effects panel regressions. The above discussion shows that the governments of Latin American countries should enhance their share in GDP, devise such policies that may enhance fixed total investment and share of investment in GDP in order to realize rapid economic growth. Moreover, policies to enhance trade openness may also help in raising the economic growth of the countries. The slope coefficients of LRGDP(-1) are negatively significant in the case of the second and third pooled regression models. It reconfirms the idea of existence of conditional convergence of economic growth in the said region. Necessary statistics and fixed effects have been shown at the end of Table 6.13.

6.2.13 TFPG and Future Economic Growth in East Asia

Table 6.14 contains the results of pooled regression models and fixed effects panel regression models using the data on TFP growth obtained through the growth accounting approach (TFPG) in the case of four countries of East Asia: Hong Kong, Korea, Malaysia and Thailand. All the discussion in the present subsection corresponds to Table 6.14.

The results of panel data regression models given in Table 6.14 demonstrate that the effect of TFPG on the future economic growth of East Asian countries is positively significant in the first and third models of each of the pooled and fixed effects regressions. However, it does not determine the future economic growth of the region significantly according to the second model of each of the pooled and fixed effects panel regressions.

Among the two measures of investment the impact of one period lag GFI is positively significant on future economic growth in both the pooled and fixed effects regression models at less than five percent. However, the effect of GISH on the future economic growth of the region is positively significant in the pooled regression models but not in fixed effects panel regression models. According to the results given in Table 6.14, inflation does not affect the economic growth of the selected East Asian countries significantly according to all of the employed six regression models. There is weak evidence that GP positively and significantly predicts the economic growth of the region as the coefficient of GP ($\beta = 1.35$, sig.<0.10) is significant at less than ten percent in the third pooled regression model. But, in all of the other five models the effect of GP on economic growth is insignificant. There is also some evidence that trade openness positively and significantly determines the economic growth of the selected countries of this region. The effect of trade openness on economic growth is significant at less than five percent significance level in the case of the first two models of pooled regressions. The impact of GOVSH on economic growth is positively significant in the case of all of

the three pooled regressions and the first two fixed effects panel regressions. However, the evidence of conditional convergence of economic growth has been found only in the second model of pooled regressions.

6.2.14 TFPGI and Future Economic Growth in East Asia

Table 6.15 contains the results of pooled regression models and fixed effects panel regression models using the data on TFP growth obtained through the index number approach (TFPGI) in the case of a panel of four East Asian countries. All the discussion in the present subsection corresponds to Table 6.15.

The results of panel data regression models given in Table 6.15 reveal that the effect of TFPGI on future economic growth of East Asian countries is not significant in the case of any of the employed six panel data models. This shows that TFPGI does not perform empirically as efficiently as TFPG.

The impacts of the two measures of investment (GFI and GISH) on the future economic growth of the region are positively significant both in pooled and fixed effects panel regression models. However, the slope coefficients of GFI(-1) in both models are slightly greater than those of GISH(-1) in the respective models. According to the results given in Table 6.15, inflation does not affect the economic growth of the selected East Asian countries significantly according to all of the employed six regression models. This finding is similar to that discussed in the previous subsection. There is no evidence that GP significantly predicts the economic growth of the region. There is some evidence that trade openness positively and significantly determines the economic growth of the selected countries of this region. The effect of trade openness on economic growth is significant at less than five percent significance level in the case of the first two models of pooled regressions. These are also similar findings discussed in the previous subsection. The impact of GOVSH on economic growth is positive and significant in the case of all

of the three fixed effects panel regressions and the first two pooled regressions. Moreover, evidence of conditional convergence of economic growth has been found only in the second model of pooled regressions. These findings also resemble those discussed in the previous subsection.

6.2.15 TFPGE and Future Economic Growth in East Asia

Table 6.16 demonstrates the results of pooled regression models and fixed effects panel regression models using the data on TFP growth obtained through the econometric approach (TFPGE) in the case of a panel of four East Asian countries. All the discussion in the present subsection corresponds to Table 6.16.

The results of panel data regression models given in Table 6.16 demonstrate that the effect of TFPGE on the future economic growth of East Asian countries is positive and significant in first and third models of each of the pooled and fixed effects regressions. However, it does not predict the future economic growth of the region significantly according to the second model of each of the pooled and fixed effects panel regressions.

Both measures of investment (GFI and GISH) significantly and positively determine the future economic growth of the region both in pooled and fixed effects panel regression models. However, the estimated values of slope coefficients of GFI(-1) in both models are slightly greater than those of GISH(-1) in the respective models. Insignificance of the effects of inflation on economic growth in the case of EA remains intact as in the previous two subsections. Evidence of the significant effects of GP on economic growth of the region has not been found in the case of five of the six employed models. However, the slope coefficient of GP is significant at less than ten percent in the case of the third model of pooled regressions. There is some evidence that trade openness positively and significantly determines the economic growth of the selected countries of this region. The effect of trade openness on economic growth is significant at less than five percent

significance level in the case of the first two models of pooled regressions. These findings are also similar to the findings discussed in the previous two subsections. The impact of GOVSH on economic growth is positive and significant in the case of all of the three pooled regressions and first two fixed effects panel regressions. Moreover, the evidence of conditional convergence of economic growth has been found only in the second model of pooled regressions. These findings also resemble those discussed in the previous two subsections. The findings discussed in the case of East Asian countries suggest that the policy makers of the selected countries of EA should enhance their government's share of GDP, try to boost investment and trade openness in order to raise the economic growth of their countries.

6.2.16 TFPG and Future Economic Growth in South Asia

This subsection discusses the role of TFP growth obtained through the growth accounting approach (TFPG) and other explanatory variables of economic growth for the panel of four South Asian countries: Bangladesh, India, Pakistan and Sri Lanka. The discussion given in this subsection is in accordance with the results of pooled regression models and fixed effects panel regression models given in Table 6.17.

According to the results of the first pooled regression model and first and third fixed effects panel regression models TFPG is a positive and significant predictor of future economic growth of the panel of four selected South Asian countries. But, in the other three models the role of TFPG in determining future economic growth of the said region has not been found to be significant during the sample period.

In the case of this region the role of GFI in determining the future economic growth of the region has been found to be significant positive both in pooled regression models (β = 0.19, sig.<0.01) and fixed effects panel regression models (β = 0.17, sig.<0.01) at less than one percent. However, the effect of the second measure of investment (i.e. GISH) on

future economic growth is significant and positive in pooled regression models ($\beta = 0.001$, sig.<0.01), but insignificant in fixed effects panel regression models. In the panel of these countries the effect of inflation on economic growth has been found to be negative and significant in the case of the first and third models of pooled regressions and third model of fixed effects panel regressions. According to the remaining three models the effect of inflation on economic growth has not been found to be significant. Moreover, the effects of GP and GOVSH on economic growth have not been found to be significant in any model. However, GTO plays a significant positive role in determining economic growth of the region according to all of the three fixed effects panel regression models and third model of pooled regressions. Evidence of conditional convergence of GDP growth has also been found in two of the three pooled regression models. Necessary statistics and fixed effects have been given at the bottom of Table 6.17.

6.2.17 TFPGI and Future Economic Growth in South Asia

The discussion given in this subsection covers the effects of TFP growth measured through the index number approach (TFPGI) and other explanatory variables included in this study on economic growth of the countries included in the panel of SA. All the discussion given in this subsection explains the results of pooled regressions and fixed effects panel regressions given in Table 6.18.

According to the results TFPGI positively and significantly determines the future economic growth of the four countries included in this panel at less than 10 percent significance level ($\beta = 0.14$, sig.<0.10) according to the third model of pooled regressions. But, the other two models of pooled regressions and all of the three models of fixed effects panel regressions indicate that TFPGI is not a significant predictor of future economic growth of the region.

According to the results given in Table 6.18 the effects of both measures of investment (i.e. GFI and GISH) on future economic growth have been found to be very similar to those discussed in the previous subsection. The effects of inflation and GOVSH on the economic growth of the countries included in the South Asian panel have not been found significant in any of the six employed regression models. The GP negatively and significantly determines the economic growth of the region according to the third model of pooled regressions at less than ten percent significance level. But, all of the other five models represent that GP does not significantly predict the economic growth of the region. Similarly, the effects of GTO on the economic growth of the region have not been found to be significant in all of the three models of pooled regressions. Nevertheless, it positively and significantly determines the economic growth of the region according to the results of the first and third models of fixed effects panel regressions. In addition, evidence of conditional convergence has also been found to be significant in the case of the first and third models of pooled regressions. Necessary statistics and fixed effects have been given at the bottom of Table 6.18.

6.2.18 TFPGE and Future Economic Growth in South Asia

Table 6.19 demonstrates the results of pooled regression models and fixed effects panel regression models using the data on TFP growth obtained through the econometric approach (TFPGE) in the case of the panel of four South Asian countries. All the discussion in the present subsection corresponds to Table 6.19.

The results of panel data regression models given in Table 6.19 demonstrate that the effect of TFPGE on the future economic growth of South Asian countries is positive and significant in the first and third models of fixed effects panel regressions. However, it does not predict the future economic growth of the region significantly according to all of

the three models of pooled regressions and second model of fixed effects panel regressions.

The impacts of both measures of investment (i.e. GFI and GISH) on the future economic growth of the region are the same as those discussed in the previous two subsections. The evidence of the significant effects of GP on economic growth of the region has not been found in the case of five of the six employed models. But, the slope coefficient of GP ($\beta = -0.26$, sig.<0.10) is negative and significant at less than ten percent in the case of the third model of pooled regressions. The effects of inflation on economic growth of the region have been found to be significant and negative according to the first and third models of pooled regressions. But, other models reflect that inflation does not affect the economic growth of this region significantly. Moreover, the GTO positively and significantly determines the economic growth rate of this region according to the results of all of the three models of fixed effects panel regressions and third model of pooled regressions. Furthermore, the GOVSH has not been found to be a significant predictor of economic growth of the South Asian region in any of the six employed regression models. Last, the coefficient of lagged values of LRGDP has been found negative and significant in the case of the second and third models of pooled regressions. This indicates that the GDP growth of these countries converges to each country's own steady-state growth rate. Necessary statistics and fixed effects have been given at the end of Table 6.19.

The results discussed in the present subsection and previous two subsections indicate that growth accounting is a better approach of measurement of growth rate of TFP than either the econometric approach or index number approach on empirical grounds. This suggests that empirical studies should use the growth accounting approach in order to measure TFP growth in the South Asian region. In addition, trade openness should be encouraged in order to raise the economic growth of the region, whereas the GP and inflation should

be controlled. Unlike the results found in the case of Africa, LA, and EA, the government's share of GDP does not significantly predict the economic growth rate of the South Asian region. It is also important to note that fixed effects panel regression models empirically perform better than pooled regression models on account of the values of adjusted R^2.

6.2.19 TFPG and Future Economic Growth in EU-15

This subsection discusses the role of TFP growth, obtained through the growth accounting approach (TFPG), and other explanatory variables in the economic growth of the panel of EU-15 countries. The discussion given in this subsection is in accordance with the results of pooled regression models and fixed effects panel regression models given in Table 6.20.

The results given in the said table reveal that TFPG is a positive and significant determinant of future economic growth of EU-15 countries according to all of the three models of fixed effects panel regressions and first and third models of pooled regressions. The second model of pooled regressions does not show TFPG as a significant determinant of future output growth of these countries.

Both of the measures of investment (GFI and GISH) are positive and significant determinants of future economic growth of EU-15 according to both types of models (i.e. pooled regression models and fixed effects panel models). The coefficient of GFI(-1) is almost robust in both types of regression models ($\beta = 0.27$, sig.<0.01 in pooled regression model and $\beta = 0.28$, sig.<0.01 in fixed effects panel regression model). Nonetheless, the coefficient of GISH(-1) is very low in pooled regression models ($\beta = 0.04$, sig.<0.01) as compared to that in fixed effects panel regression models ($\beta = 0.29$, sig.<0.01).

The role of inflation in determining the economic growth of the region is insignificant according to all of the employed models of pooled regressions and fixed effects panel

regressions. The effect of GP on economic growth of the region is positive and significant ($\beta = 0.46$, sig.<0.05) according to the second model of pooled regressions but insignificant according to all other employed models of pooled regressions and fixed effects panel regressions. The GTO positively and significantly determines the economic growth of the region in fixed effects panel regression models but it does not predict the economic growth in pooled regression models. The GOVSH positively and significantly determines the economic growth rate of EU-15 countries in the first two models of fixed effects panel regressions. However, in all other four models of pooled regressions and fixed effects panel regressions it does not significantly determine the economic growth of these countries. The evidence of conditional convergence of economic growth has been found to be significant in all of the three models of pooled regressions. The bottom of Table 6.20 contains necessary statistics.

6.2.20 TFPGI and Future Economic Growth in EU-15

The discussion given in this subsection covers the effects of TFP growth measured through the index number approach (TFPGI) and other explanatory variables included in this study on the economic growth of the countries included in the panel of EU-15. All the discussion given in this subsection explains the results of pooled regressions and fixed effects panel regressions given in Table 6.21.

According to the results TFPGI does not significantly determine the future economic growth of the countries included EU-15 panel according to all of the six models of pooled regressions and fixed effects panel regressions. The effects of other variables on the economic growth of the countries included in EU-15 panel given in Table 6.21 are similar to those discussed in the previous subsection.

6.2.21 TFPGE and Future Economic Growth in EU-15

Table 6.22 demonstrates the results of pooled regression models and fixed effects panel regression models using the data on TFP growth obtained through the econometric approach (TFPGE) in the case of the panel of EU-15 countries. The results of pooled regressions and fixed effects panel regressions given in Table 6.22 are similar to those given in Table 6.20 and discussed in Subsection 6.2.19. In order to avoid redundancy these results have not been discussed here. However, the similarity of the results obtained in Tables 6.20 and 6.22 indicates that the growth accounting approach and econometric approach empirically perform equally. The choice of pooled regressions and fixed effects regressions is arbitrary in the case of this region on the basis of values of adjusted R^2. However, growth rates of trade openness and government's share of GDP positively and significantly determine the economic growth of the region according to fixed effects panel regressions. These results suggest that the governments of EU-15 member countries should enhance trade openness and their shares in GDP in order to reap rapid economic growth rates.

6.3 TFP Growth and Future Investment Growth

This section discusses the effects of TFP growth on future investment growth. For this purpose TFP growth has been computed through three widely discussed approaches: growth accounting approach (TFPG), index number approach (TFPGI) and econometric approach (TFPGE). Trends of TFP growth obtained through each of these approaches have been given in Chapter 5. In order to capture the true effect of TFP growth on future investment growth this study uses a commonly reported set of control variables: INF, GP, GTO and GOVSH. Time series of TFP growth rate have been lagged by one period in order to determine the effect of TFP growth on future investment growth. Time series of investment growth has been proxied by two measures: GFI and GISH. Both of these

proxy variables have been used as dependent variables one by one both in pooled regressions and fixed effects panel regressions.

6.3.1 TFP Growth and Future Investment Growth in Full Sample

This subsection discusses the effects of TFP growth on future investment growth in the case of FS. The effects of other commonly reported explanatory variables on investment growth have also been discussed. Investment growth has been used as a dependent variable using two proxies (GFI and GISH) both in pooled regression models and fixed effects panel regression models. These results have been given in Table 6.23 through to Table 6.25. In Table 6.23 one period lagged TFPG has been used as an independent variable along with other explanatory variables, whereas in Tables 6.24 and 6.25 TFPGI and TFPGE have been used as independent variables respectively.

The results given in Table 6.23 indicate that TFPG significantly determines the future investment growth of the panel of countries included in this study. Its effects are positive and significant on both measures of investment. However, the magnitude of the coefficients in the case of GFI as dependent variable is higher than the corresponding coefficients in the case of GISH as dependent variable. Inflation does not significantly determine the investment growth of the said panel of countries. GP significantly and positively determines both proxies of investment growth in pooled regression models. But, its effects on investment growth are not significant in fixed effects panel regression models. The impact of trade openness is positive and significant on GISH in fixed effects panel regression models but insignificant in all other three models of Table 6.23. The GOVSH negatively and significantly determines GFI in fixed effects panel regression models, and it determines GISH both in pooled regression models and fixed effects panel regression models. The negative impact of GOVSH on investment growth supports the classical economists' notion of crowding out effects of fiscal policy. This finding shows

that fiscal policy should be implemented with caution so the positive growth rate of investment can be sustained.

With a little variation, results similar to those discussed above have been found in Table 6.24 where TFPGI has been used instead of TFPG but all other things are the same. Table 6.24 shows that the effect of trade openness on GISH is positive and significant both in pooled regression models and fixed effects panel models. However, its effect on GFI is positive and significant in fixed effects panel regression models but insignificant in pooled regression models. All other effects are similar to those discussed above in the light of results given in Table 6.23.

The results given in Table 6.25 where TFPGE has been used as the proxy of TFP growth are similar to those found in the previous two tables. The effects of TFPGE on future GFI and future GISH are positive and significant both in pooled regression models and fixed effects panel regression models. This shows that TFP growth is a significant predictor of future investment growth regardless of the approach of its measurement. This raises the importance of implementation of the policies which could enhance the growth rate of TFP in order to attract future investments in the countries. Moreover, negative significant effect of GOVSH on investment growth remains intact in Table 6.25 as well. This necessitates precautionary measures before implementing fiscal policy so that rapid investment growth can be realized.

6.3.2 TFP Growth and Future Investment Growth in CEE

In the present subsection the effects of TFP growth on future investment growth in the case of the panel of countries selected from CEE have been discussed. Table 6.26 through to Table 6.28 given in Appendix 6 present the effects of TFPG, TFPGI and TFPGE on future investment growth in CEE respectively.

Tables 6.26 and 6.27 reflect that the TFPG and TFPGI are the positive and significant predictors of future GFI in CEE. But, these two measures of TFP growth do not significantly affect future GISH in the said region. The effects of TFPGE on future GFI and future GISH are positive and significant both in the case of pooled regression models and fixed effects panel regression models as shown in Table 6.28. This signals that in the case of CEE the econometric approach gives such time series of TFP growth that empirically perform better than those obtained through the growth accounting approach and index number approach.

The results of pooled regression models and fixed effects panel regression models given in Tables 6.26 to 6.28 reveal that GP and GTO positively and significantly predict GFI and GISH in all of the 12 models. This shows the importance of these variables in CEE. Contrary to the above variables, GOVSH negatively and significantly affects the GFI and GISH in all of the 12 models given in Tables 6.26 through to 6.28. This finding once again supports the classical economists' notion of crowding out effects of fiscal policy.

6.3.3 TFP Growth and Future Investment Growth in Africa

The effects of TFP growth, measured through all the three approaches used in this study, on both proxies of future investment growth (GFI and GISH) in the panel of African countries selected in this study have been interpreted in this subsection. The discussion made in this subsection corresponds to Tables 6.29 through to 6.31 given in Appendix 6.

Tables 6.29 and 6.31 indicate that TFPG and TFPGE positively and significantly determine future GFI both in pooled regression models and fixed effects panel regression models. The effect of these variables on future GISH is positive and significant in pooled regression models but insignificant in fixed effects panel regression models. The effect of TFPGI on future GFI is significant in fixed effects panel regression and on GISH in pooled regression model. Similar to FS, the pooled and panel regression models indicate

that INF does not affect any proxy measure of investment significantly in the case of Africa. The effects of GP on future investment growth have been found to be negative and significant in two models of pooled regressions and in three models of fixed effects panel regressions. In other models the effects of GP on investment growth are not significant. GTO positively and significantly determines both measures of investment in both types of employed models with one exception in Table 6.30 where GTO does not significantly affect GISH. The effects of growth rate of government's consumption share of GDP on GFI have not been found significant in any model. Nonetheless, its effects on GISH are negative and significant in the pooled regression model of Table 6.31 and both models of Table 6.30.

The results discussed above indicate that African economies should raise trade openness and control GP in order to gain sustainable growth rates of investment. Moreover, precautionary measures should also be adopted during the course of fiscal policy. Last, but not least, these economies should adopt policies that may raise the level of TFP which will be useful in determining future investment growth in these economies.

6.3.4 TFP Growth and Future Investment Growth in Latin America

The effects of three measures of TFP growth (TFPG, TFPGI and TFPGE) on both proxies of future investment growth (GFI and GISH) in the panel of Latin American countries selected in this study have been discussed in this subsection. The discussion made in this subsection corresponds to Tables 6.32 through to 6.34 given in Appendix 6.

The results given in Tables 6.32 and 6.34 reveal that TFPG and TFPGE do not affect future GFI and future GISH significantly in the case of the selected panel of Latin American countries. Similar results have been found both in pooled regression models and fixed effects panel regression models. TFPGI also does not affect future GISH significantly in both types of employed regression models. However, the effect of TFPGI

on future GFI is positive and significant according to pooled regression models but insignificant in fixed effects panel regression models. This shows that TFP growth has not played a significant role in determining future investment in selected Latin American countries during the sample period. The reason for this may be the economic, financial and structural constraints and poor investment climate in Latin American countries. The World Bank (2009) reported a list of top constraints of investment climate in Latin American countries including tax rates, corruption, macroeconomic instability, education, labor regulations, access to finance, practices of informal competitors, and electricity. Despite having a positive growth rate of TFP, the above mentioned constraints could be the main reasons for low investment growth in Latin American countries. The insignificant effects of TFP growth on investment growth may be attributed to the same reasons which did not allow investment growth to respond to TFP growth.

Table 6.33 shows that inflation determines GISH in LA significantly and positively. However, it does not affect GFI in the case of these countries. In Tables 6.32 and 6.34 the effects of inflation both on GFI and GISH have been found to be insignificant. The effect of GP on GFI has been found to be negative and significant in fixed effects panel regression models in Tables 6.32 and 6.33. In the case of the pooled regression models of Tables 6.32 and 6.33, and in both models (pooled regression and fixed effects panel regression models) of Table 6.34 the effect of GP on GFI is insignificant. Moreover, its effects on GISH remained insignificant in all models of the said three tables. The effects of GTO on GFI and GISH have been found to be positive and significant in eight of the 12 regression models given in Tables 6.32 through to 6.34. In the case of Latin American countries the effects of GOVSH on GFI and GISH remained negative and significant in 10 of 12 employed models of said three tables. This shows that the classical economists'

notion of crowding out effects of government's expenses is relevant in Latin American countries as well.

6.3.5 TFP Growth and Future Investment Growth in East Asia

This subsection discusses the effects of TFP growth on future investment growth in the case of the panel of countries selected from EA. The flow of the discussion is similar to that in previous subsections. Tables 6.35 through to 6.37 given in Appendix 6 present the effects of TFPG, TFPGI and TFPGE on future investment growth in EA respectively.

Table 6.35 shows that the effects of TFPG on future investment growth in EA are positive and significant. These effects are positive and significant both on future GFI and future GISH in both types of models: pooled regression models and fixed effects panel regression models. According to the results given in Table 6.36 TFPGI does not significantly determine future GFI and future GISH both in pooled regression models and fixed effects panel regression models. The third proxy of TFP growth (i.e. TFPGE) positively and significantly determines future GFI both in pooled regression models and in fixed effects but it does not significantly determine future GISH as shown in Table 6.37. This shows that the growth accounting approach generates a time series of TFP growth that empirically performs better than those generated through the index number approach and econometric approach.

The results of pooled regression models and fixed effects panel regression models given in Tables 6.35 through to 6.37 reveal that INF does not significantly predict GFI and GISH in any of the 12 models. The GP positively and significantly determines GISH (in five of the six models) and GFI (in three of the six models). The effect of GTO on GISH is positive and significant in all of the six models employed in the said tables. But, it does not significantly affect GFI in any of the employed six models. The effects of GOVSH on GISH have been found negative and significant in all of the six pooled regression models

and fixed effects panel regression models given in Tables 6.35 through to 6.37. This reconfirms the idea of crowding out effects of fiscal policy discussed in the case of FS. The effects of GOVSH on GFI have been found negative and significant in Table 6.36 which partially supports the classical economists' notion of crowding out effects of fiscal policy. This situation reinforces the recommendation of implementing a precautionary fiscal policy. Necessary statistics and fixed effects have been given at the bottom of Tables 6.35 through to 6.37.

6.3.6 TFP Growth and Future Investment Growth in South Asia

The present subsection interprets the effects of TFP growth on future investment growth in the case of the panel of countries of SA. Tables 6.38 through to 6.40 given in Appendix 6 present the effects of TFPG, TFPGI and TFPGE on GFI and GISH using pooled regression models and fixed effects panel regression models.

The results, given in above mentioned tables, show that TFPG determines future GFI positively and significantly both in pooled regression models and fixed effects panel regression models. However, it does not affect future GISH significantly according to both of the employed models. However, the effects of TFPGI on future GFI and future GISH have been found positive and significant both in pooled regression models and fixed effects panel regression models in the case of selected panel of South Asian countries. Conversely, TFPGE does not affect future GFI and future GISH significantly in any of the employed models. This shows that TFP growth obtained through the index number approach empirically fits better than the other two approaches in determining future investment growth of panel of South Asian countries.

Discussion given in previous subsections shows that the effects of inflation on investment growth in the case of the FS of countries selected in this study and in other regional panels of countries remained either insignificant or positive and significant. But, in the

case of the panel of South Asian countries the effects of INF on GFI have been found to be negative and significant in five of the six employed models. Moreover, its effect on GISH is also negative and significant in the pooled regression model of Table 6.40, whereas in the case of the other models the effects of inflation on GISH remained insignificant. Nonetheless, the negative effects of inflation on investment growth in SA require the serious attention of policy makers in order to restrict inflation up to a threshold point so that the negative effects of inflation could be avoided in these countries. It is also worth mentioning here that the effects of inflation on the economic growth of South Asian countries were also found to be negative and significant in the case of some models. These results invite policy makers to revisit the situation and revise their policies. The effect of GP on GISH is negative and significant in the pooled regression model of Table 6.39. But, its effects on GISH in the other five models and on GFI in all of the employed models of pooled regressions and fixed effects panel regressions remained insignificant. The effects of GTO have been observed to be positive and significant in four of the six models on GFI and in two of the six models on GISH. The effects of GOVSH on GISH are negative and significant in five of the six employed models of pooled and fixed effects panel regressions. However, the negative effect of GOVSH on GFI has been found to be significant in only one of the six employed models. Like previous subsections, this subsection also confirms the existence of crowding out effects of GOVSH.

6.3.7 TFP Growth and Future Investment Growth in EU-15

This subsection discusses the effects of TFP growth on future growth rates of GFI and GISH in the case of the panel of EU-15 countries. The results of the effects of TFPG, TFPGI and TFPGE on GFI and GISH using pooled regression models and fixed effects panel regression models have been presented in Tables 6.41 to 6.43 given in Appendix 6.

Table 6.41 shows that TFPG determines future GFI positively and significantly both in pooled regression models and fixed effects panel regression models. Moreover, its effect on future GISH in fixed effects panel regression models is also significant but insignificant in pooled regression models. The effects of TFPGI and TFPGE on future GFI in pooled regression models have been found to be significant but insignificant in fixed effects panel regression models. GISH, however, does not receive significant effects of TFPGI and TFPGE both in pooled regression models and fixed effects panel regression models.

The effects of INF on GFI and GISH have been found positive and significant in five of the six pooled regression models given in Tables 6.41 to 6.43. But, the effects of inflation on GFI and GISH remained insignificant in all of the six fixed effects panel regression models. The effects of GP on GISH given in the said tables are positive and significant both in pooled regression models and fixed effects panel regression models. Moreover, the effect of GP on GFI is also positive and significant in the fixed effects panel regression model given in Table 6.41, but insignificant in all other five models of pooled regressions and fixed effects panel regressions. GTO positively and significantly determines GFI in all of the three models of fixed effects panel regressions and in one model of pooled regressions. It also positively and significantly predicts GISH in the fixed effects panel regression model of Table 6.42. In the case of the other five models the effects of trade openness on GISH have been found to be insignificant. The effects of GOVSH on GFI and GISH are negative and significant in 11 of the 12 employed models of pooled regressions and fixed effects panel regressions as depicted in the Tables 6.41 to 6.43. This strongly supports the existence of crowding out effects of expansionary fiscal policy implemented through governments' expenditures.

6.4 Convergence of Economic Growth

The debate about income convergence to its steady-state level started with a seminal paper by Solow (1957). This debate has not yet been resolved. Neoclassical economists believe in absolute convergence that suggests that poor economies of the world are growing faster than rich economies. This tendency will equalize the per capita income levels across all the economies of the world. According to the classical school of thought the reason for rapid economic growth in poor economies is the availability of unutilized resources and TFP. Contrary to this point, proponents of new endogenous growth theory, for example Arrow (1962), Sidrauski (1967), Romer (1986), Lucas (1988) and Rebelo (1991) support the idea that the economic growth of a country depends on its internal system, investments in human capital and technology. This theory implies that the world economies may not converge to the same steady-state level. Rather, each economy may converge to its own steady-state level of economic growth due to its internal economic systems and structures. This notion is called conditional convergence. This section discusses the results of absolute convergence and conditional convergence of economic growth in the FS of selected countries and regional panels of countries. The findings of conditional convergence have been partially discussed in Section 6.2 according to the results given in Tables 6.2 to 6.22 in Appendix 6. The results of absolute convergence have been given in Tables 6.44 through to 6.50 in Appendix 6.

The results of absolute convergence tests of economic growth given in Tables 6.44 through to 6.50 show evidence of highly significant convergence ($\beta = -0.0005$, sig.<0.01) across the countries in the case of FS but no evidence of absolute convergence across the countries included in sub-samples of countries selected on a regional basis. The evidence of absolute convergence of economic growth in the case of FS implies that poor economies are growing faster than rich economies. More specifically, all the selected

economies included in FS are converging to a common steady-state level. The negative sign of the coefficient of LRGDP(-1) ($\beta = -0.0005$, sig.<0.01) postulates that the effect of initial level of real per capita income of a country is negative on its current economic growth. In particular, the countries having low levels of initial real per capita income are realizing higher levels of economic growth. This finding seems to be consistent with the neoclassical growth models that recommend a common steady state of economic growth across the world economies. The evidence of conditional convergence is present in the case of FS of countries and all of the sub-samples as shown in Tables 6.2 through to 6.22. The coefficients of LRGDP(-1) in 48 models out of 63 models of pooled regressions given in above mentioned tables are negative and significant. These negative and significant coefficients suggest the existence of convergence to steady-state economic growth conditional on control variables. Conditional convergence indicates that each country's economic growth is converging to its own steady-state growth path rather than converging towards a common steady-state growth path. In the case of FS the existence of both types of convergence (absolute and conditional) shows that the countries selected in the FS are not only converging to their own steady-state economic growth path but to a common growth path as well. It is important to note that conditional convergence exists in the case of FS and all the sub-samples as well. The existence of absolute income convergence implies the existence of conditional convergence as well but the opposite of this is not necessary. The existence of conditional convergence in the case of sub-samples of countries on a regional basis supports the notion of new endogenous growth theory. The results discussed above imply that with larger income gaps among countries absolute convergence exists. This might relate to the availability of unutilized resources due to which poor countries are growing faster than rich countries. But, the absence of absolute convergence and presence of conditional convergence among regional panels suggests

that the income convergence of each country depends on a set of control variables. In the present study, TFP growth, INF, GP, trade openness, GOVSH, and investment have been used in regression models employed in Table 6.2 through to Table 6.22. These findings show that when the initial income gaps are not large among the countries (as is the situation among the regional panels of countries) the convergence of income is conditional to the growth rates of TFP, population, trade openness, government's share of GDP, investment and INF. In conclusion, the findings of this study support the notion of absolute income convergence implied in neoclassical growth theory if the initial income gaps among countries are large. Conversely, this study supports the notion of conditional convergence implied in the new endogenous growth theory if the initial income gaps among countries are not large.

6.5 Convergence of Total Factor Productivity Growth

The objective of this section is to discuss the results of absolute and conditional convergence of TFP growth to its steady-state growth path. It is important to mention that only index number approach-based TFP growth has been used in order to test the two types of β convergences (i.e. absolute and conditional). The reason for doing so is the power of the index number approach to provide levels of TFP rather than just providing TFP growth rates unlike the other two approaches. As has been discussed in Chapter four under the heading of convergence test both β type convergence tests (absolute and conditional) use TFP growth rate as a dependent variable and log of initial level of TFP as an independent variable. It implies that to test the convergence of a time series, growth rates and initial levels of that series are required. Among the three approaches of TFP measurement that have been employed in this study only the index number approach provides levels of TFP. After getting the levels of TFP its growth rates can easily be calculated. The results of absolute convergence tests of TFP growth for FS and six sub-

samples have been given in Tables 6.51 through to 6.57, whereas the results of conditional convergence have been shown in Table 6.58 in Appendix 6.

The results of absolute convergence tests given in Tables 6.51 through to 6.57 do not provide any significant evidence of absolute convergence of TFP growth in the case of FS and four sub-samples: CEE, Africa, LA, and SA. However, the evidence of absolute convergence of TFP growth has been found to be significant in the cases of EA and EU-15 countries where the coefficients of LTFP(-1) are negative and significant. It shows that the TFP growth rate is faster in the countries with low levels of initial TFP than those with high levels of initial TFP. The existence of absolute convergence of TFP growth across EU-15 countries and East Asian countries postulates that technology is a public good and it crosses international boundaries swiftly as suggested by Miller and Upadhyay (2000). Conversely, the absence of absolute convergence of TFP growth in the case of FS and the sub-samples of African, Latin American, Central and East European and South Asian regions indicates that technology is a private good for these panels of countries and it cannot readily cross international borders. It suggests that each country should allocate a fraction of resources to research and development in technology. Moreover, the evidence of conditional convergence of TFP growth in the case of FS and each of the six sub-samples has been found to be significant as shown in Table 6.58. This finding indicates that TFP growth converges to each country's own steady-state growth path. In particular, conditional convergence tests show that TFP growth in the countries selected in this study converges to a steady-state growth that is conditional on GP, INF, GTO and GOVSH. This suggests that the countries selected in this study should focus on the above

mentioned variables particularly on trade openness and government's share of GDP in order to accelerate TFP growth[29].

[29] The coefficient of GTO is significant in the case of each sample used in Table 6.58, whereas the coefficient of growth rate of government's share of GDP is also significant in each case except CEE and EA.

Chapter 7

Conclusions and Policy Implications

This concluding chapter presents a summary of the findings and highlights key theoretical and practical implications of the study. This chapter has been divided in three sections. Section 7.1 presents the summary of the findings of this study. The implications of the study have been given in Section 7.2. Last, but not least, Section 7.3 recommends some key research areas for future studies that have not been incorporated in the present study.

7.1 Summary of the Findings

Long-run economic growth is one of the major areas of research in the field of economics. The world has been observing wide gaps in economic growth rates among the various nations and regions. Some researchers ascribe high economic growth rates to factor accumulations. Conversely, others view these high economic growth rates in the context of TFP. TFP is the part of economic growth unexplained by the accumulation of factors of production. Researchers have been studying various issues of TFP very zealously since Solow (1957). One of the main determinants of TFP growth is technical progress. This study is based on the notion that if TFP growth reasonably captures the effects of technical progress then it should significantly predict future economic growth. According to neoclassical economists, technical progress pushes the aggregate production function upward and MPk increases. In order to realize increased MPk investors adopt new techniques of production through new investments[30]. Koeva (2000) reported that investment is a long-term process that takes 13 to 86 months for completion. Based on this finding, if TFP growth truly captures the effects of technical progress then it will significantly predict not only future investment growth but future economic growth as

[30] This statement is true only under the assumption of constant relative factor price.

well. The literature on TFP studies extensively reports on three approaches to measure TFP growth: growth accounting approach, index number approach and econometric approach. This study has measured and presented the trends of TFP growth for a panel of 35 countries selected from different regions of the world using all the above mentioned three approaches. In addition to the above, the present study has also tested the power of TFP growth to predict future investment growth and future economic growth. In this study TFP growth series used in investment and economic growth models have been obtained through each of the three above mentioned approaches, and the predictive powers of TFP growth obtained through the different approaches have been compared on the basis of empirical findings. Last, but not least, this study has also tested the β type absolute and conditional convergence of the economic growth and TFP growth. Apart from all the above mentioned tests in the case of the FS of the selected 35 countries, a sensitivity analysis using different sub-samples of regional panels of countries has also been performed[31].

The empirical findings of this study show that during the sample period the average TFP growth rate in the selected countries remained positive according to all the three methods of TFP measurement. But, the trends of TFP growth during the sample period remained volatile (mean = 0.49, SD = 2.10, CV = 4.27 with growth accounting approach; mean = 0.67, SD = 1.80, CV = 2.68 with index number approach; and mean = 0.53, SD = 0.34, CV =0.65 with econometric approach). During certain years the countries included in this study also observed negative TFP growth that is the indicator of technical regress. Among the three methods of measuring TFP growth the econometric approach produced less volatile trends of TFP growth. Among the six regional panels used in this study the East Asian region followed by the South Asian region observed higher TFP growth rates than

[31] The sub-samples used in this study include three Central and East European countries, four African countries, five Latin American countries, four East Asian countries, four South Asian countries and 15 EU-15 countries. The list of countries with respective regions has been given in Appendix 4.1.

other regions during the sample period. This reveals that Asian economies (both East Asian and South Asian) have observed higher TFP growth rates than Latin American, Central and East European, African and EU-15 economies. In addition to the above, the trends of TFP growth in Asian economies remained less volatile than in other regions. Growth accounting and econometric methods produced the least average growth rate of TFP for the African region (mean = 0.01). However, the index number method produced least average of TFP growth for Central and East European economies. It is also important to mention that the trends of TFP growth during the sample period for the selected economies remained cyclical particularly according to growth accounting and econometric methods. However, the index number method signaled random variations in the trends of TFP growth along with cyclical fluctuations.

The results of pooled regression models and fixed effects panel regression models revealed that TFP growth obtained through the growth accounting method (TFPG) is a good predictor of future economic growth of the countries selected in this study. The effect of TFPG on future economic growth remained positive and significant in 12 of 21 models of pooled regressions and in 17 of 21 models of fixed effects panel regressions. This suggests that although TFPG is a good predictor of future economic growth, it performs better in fixed effects panel regressions than in pooled regressions. The same models of pooled regressions and fixed effects panel regressions employed using the data on TFP growth obtained through the econometric approach (TFPGE) revealed that in pooled regression models TFPGE is not a good predictor of future economic growth as its effect remained insignificant in 16 of 21 models. However, in fixed effects panel regression models TFPGE performs similar to TFPG. The effect of TFPGE on future economic growth remained positive and significant in 17 of 21 models. This reinforces the idea that fixed effects panel regression models capture better effects of TFP growth on

future economic growth. TFP growth obtained through the index number method (TFPGI) has not been found to be a good predictor of future economic growth. Its effect on future economic growth was found to be positive and significant just in one model of pooled regressions and in five models of fixed effects panel regressions. From the above discussion it is concluded that the growth accounting method provides the series of TFP growth that is characterized with more predictive power than the other two methods.

This study used two proxies as the measures of investment growth: GFI and GISH. One period lagged values of each measure have been used as independent variables in pooled regression and fixed effects panel regression models given in Tables 6.2 through to 6.22. The effects of GFI on future economic growth remained positive and significant in 18 of 21 pooled regression models and in all of the fixed effects panel regression models. The mean value of the significant coefficients of GFI(-1) remained at 0.26 and 0.29 in pooled regression models and fixed effects panel regression models simultaneously. The other measure of investment growth (i.e. GISH) positively and significantly determined future economic growth in all of the pooled regression models and 12 of 21 fixed effects panel regression models. The mean value of the significant coefficients of GISH(-1) in pooled regression models remained at 0.20, whereas it remained at 0.37 in fixed effects panel regressions. From this discussion it is concluded that, in comparison to GISH, the effects of GFI on future economic growth remained almost robust to the changes in types of employed regression models.

The effects of inflation on economic growth have not been found to be significant both in pooled regression and fixed effects panel regression models in the case of FS of the selected countries and sub-samples of Latin American, East Asian and EU-15 countries. However, the effects of inflation on economic growth remained negative and significant in the case of Central and East European and African countries. Some evidence of the

negative effects of inflation on economic growth in the case of South Asian countries has also been found where the coefficient of inflation remained negative and significant in four of nine pooled regression models and in one of nine fixed effects panel regression models. From the negative and significant effects of INF on economic growth particularly in CEE and Africa it can be concluded that the overall INF during the sample period remained higher than the threshold point. Thus, necessary measures to control the INF in these regions should be taken.

The GP has somewhat startling effects on the economic growth rate of the selected countries. According to the results of fixed effects panel regression models GP does not significantly affect the economic growth of FS of selected countries and the sub-samples of CEE, EA, SA and EU-15. However, these models present some evidence of negative effects of GP on economic growth rate in the case of Africa, whereas positive effects in the case of LA. The results of pooled regression models also support the above mentioned two effects of GP on economic growth rate (i.e. negative in the case of Africa and positive in the case of LA). According to the results of pooled regression models GP positively and significantly affects the economic growth in the case of FS. Moreover, some evidence of positive effects of GP on economic growth in the case of EA and EU-15 and its negative effects on economic growth in the case of SA has also been found from pooled regression models. This shows that the effects of GP on economic growth are asymmetrical.

There is fair evidence of the positive effects of GTO on economic growth rate in the case of FS and all of the sub-samples. The coefficient of GTO remained positive and significant in four of nine pooled regression models and in six of nine fixed effects panel regression models in the case of FS. The results of pooled regression models reported that out of nine employed models for each sub-sample the effects of GP on the economic

growth rate remained positive and significant in two, eight, six, six, and two models in the case of CEE, Africa, LA, EA and SA respectively. However, these models did not provide any evidence of the significant effects of GP on the economic growth rate of EU-15. In the case of nine employed models of the fixed effects panel regressions for each sub-sample the coefficient of GTO remained positive and significant in three, four, three, eight, and nine models for CEE, Africa, LA, SA and EU-15 respectively. But, according to the results of fixed effects panel regressions in the case of EA the effect of trade openness on economic growth rate remained insignificant.

The results of fixed effects panel regression models exhibited the positive and significant effects of the GOVSH on the economic growth rate in nine, two, eight, four, four, and seven models in the case of FS and regional sub-samples of CEE, Africa, LA, EA, and EU-15 respectively. Similarly, the results of pooled regression models presented positive and significant effects of government's share of GDP on the economic growth rate of FS of countries and sub-samples of LA, EA and EU-15 in three, seven, six, and one model respectively. The effects of this variable on the economic growth rate of CEE, Africa and SA remained insignificant according to the pooled regression models. It is interesting to note that the effects of GOVSH on the economic growth rate of SA remained insignificant according to both types of the employed models.

The effects of TFP growth on future investment growth have been estimated using GFI and GISH as the proxies of investment growth. According to the results of pooled regression models and fixed effects models the effects of TFPG on future GFI remained positive and significant in the case of FS of selected countries and each of the sub-samples except LA. The effects of TFPG on future GISH remained positive and significant in the case of FS and sub-sample of East Asian countries according to both the models of pooled regressions and fixed effects panel regressions. Moreover, TFPG

positively and significantly determined the future GISH in the case of Africa in pooled regression models and in the case of EU-15 in fixed effects panel regression models. In other cases the effects of TFPG on future GISH remained insignificant.

The results exhibited the positive and significant effects of TFPGI on future GFI and GISH in the cases of FS and sub-sample of South Asian countries according to both types of employed models. The effects of TFPGI on future GFI remained positive and significant in the case of the sub-sample of CEE in both the employed models. Moreover, the results indicated that TFPGI positively and significantly determines future GFI of LA and EU-15 in pooled regression models and of Africa in fixed effects panel regression models. Last, the effects of TFPGI on future GISH of Africa remained positive and significant in pooled regression models. But, in other cases the effects of TFPGI remained insignificant.

The effects of TFPGE on future GFI and GISH in the cases of FS and sub-sample of Central and East European countries according to both the types of employed models remained positive and significant. The effects of TFPGE on future GFI remained positive and significant in the case of Africa in both the employed models and on future GISH in pooled regression models. Moreover, TFPGE positively and significantly determined future GFI of East Asian countries in both types of employed models. Last, the results of pooled regression models showed positive and significant effects of TFPGE on future GFI of EU-15. In all other cases the effects of TFPGE on future GFI and GISH remained insignificant. From the above discussion it can be construed that TFP growth obtained through TFPG generates more significant effects on future investment growth than those obtained through TFPGI or through TFPGE. A similar conclusion was drawn in the case of economic growth models: TFPG is a good predictor of future economic growth of the selected countries. The results of pooled regression models and fixed effects panel

regression models using investment growth as a dependent variable have also supported the notion that TFPG is a better predictor of future investment growth than TFPGI and TFPGE. Moreover, it has also been observed that future GFI captures more effects of TFP growth than GISH. This finding suggests that GFI is a better proxy of investment growth than GISH in the case of the selected countries.

The effects of INF on investment growth have not been found to be significant in the case of FS and sub-samples of Africa and EA. Some evidence of negative and significant effects of INF on investment growth has been found in the case of SA. The coefficient of INF remained negative and significant in five out of the 12 employed models of pooled and fixed effects panel regressions. The results of pooled regressions indicated that the effects of INF on investment growth are positive and significant in EU-15. However, these effects in fixed effects panel regressions remained insignificant. Weak evidence of positive and significant effects of INF on investment growth has also been found in the case of CEE and LA. The coefficient of INF remained positive and significant only in two of the employed 12 models for each of the above mentioned two regions.

The effects of GP on GFI and GISH remained positive and significant in all of the employed pooled regression models in the case of FS. But, these effects in all of the employed fixed effects panel regression models remained insignificant. In the case of CEE GP positively and significantly determined GFI and GISH in all of the employed models of pooled and fixed effects panel regression models. In EU-15 countries the effects of GP remained positive and significant on GISH in all of the employed models of pooled and fixed effects panel regressions and on GFI in one of the three fixed effects panel regression models. However, the effects of GP on GFI in pooled regression models remained insignificant in EU-15. The effect of GP on investment growth remained positive and significant in seven of 12 models of pooled and fixed effects panel

regressions in the case of EA. Conversely, the effects of GP on investment growth rate of Africa remained negative and significant in five of 12 models of pooled and fixed effects panel regressions. Moreover, weak evidence of negative and significant effects of GP on GFI in LA and on GISH in SA has also been found.

Out of 12 employed models of pooled and fixed effects panel regressions for each sample the effects of growth of trade openness on investment growth remained positive and significant in five, 12, nine, nine, six, six and five models in the case of FS and sub-samples of CEE, Africa, LA, EA, SA and EU-15 respectively. In the remaining models the effects of GTO have been found to be insignificant. Comparing the effects of above discussed control variables (INF, GP and GTO) it can be concluded that GTO is a better predictor of investment growth than the other two variables.

The effects of GOVSH on investment growth remained negative and significant in 60 out of 84 employed models of pooled and fixed effects panel regressions in the case of FS and the six sub-samples. However, the effects of GOVSH on GFI remained negative and significant in 22 out of 42 employed models of pooled and fixed effects panel regressions. But, the effects of GOVSH on GISH remained negative and significant in 38 out of 42 employed models. More specifically, GISH captures the negative effects of GOVSH more significantly than GFI. The negative and significant effects of GOVSH on investment growth support the notion of classical economists about crowding out effects of fiscal policy.

The results of this study exhibited significant evidence of absolute convergence of economic growth in the case of FS of the countries but not in the case of sub-samples. However, the existence of conditional convergence of economic growth has been found to be significant in the cases of FS and all of the sub-samples.

The study could not find the existence of absolute convergence of TFP growth in the case of FS and four sub-samples: CEE, Africa, LA, and SA. However, in the case of EU-15 and EA evidence of absolute convergence of TFP growth has been found to be significant. Moreover, the results show that significant conditional convergence of TFP growth exists in the case of FS and each of the sub-samples.

7.2 Implications of the Study

The objective of this section is to discuss the important implications of the study for academicians and practitioners as given below.

In the literature of economics there are three common methods to measure TFP growth: growth accounting, index number and econometric. Each method is characterized by certain advantages and disadvantages. The present study is one of the first to measure TFP growth for a large panel of countries selected from different regions of the world using all the three methods. The study has measured the trends of TFP growth using all the three methods and compared those trends with respect to central tendencies and dispersions.

The findings of this study suggested that the econometric method produces more consistent trends of TFP growth than the other two methods: growth accounting and index number. However, the index number approach captures higher levels of TFP growth than either the growth accounting method or the econometric method. But, in growth models TFP growth obtained through the growth accounting method emerged as the more significant predictor of future investment and economic growth rates than that obtained through the index number or econometric approach. Thus, this study recommends that for investment and economic growth models TFP growth should be obtained through the growth accounting method.

The study has found that the average growth rate of TFP in each of the selected countries during the sample period remained positive. However, in certain periods countries faced negative TFP growth which indicates a technological regress. In particular, a sharp technological regress was observed during the last three years of the study starting from 2007 to 2009. During these years the world economies faced a global financial crisis and this could be the reason for the said technological regress. Ranciere et al. (2005) and Cerra and Saxena (2008) relate macroeconomic volatility with financial development. Macroeconomic volatility remained high due to the global financial crises during said period and this could have caused the volatile trends of TFP growth obtained through all the three methods. Therefore, policy makers should develop such financial systems which could avoid any crises in order to achieve sustainable productivity growth.

The East Asian region realized higher average growth rates of TFP than the other five regions included in the study according to all of the three employed method of TFP growth. The South Asian region followed the East Asian region in capturing higher average growth rates of TFP. Moreover, in these countries trends of TFP growth remained less volatile than in other regions. In contrast to Asian regions, Africa captured the least average growth rates of TFP. This observation indicates that productivity differentials among different economic regions do exist, and these play an important role in determining the future economic growth of the countries as found in the investment and economic growth models of the present study. This finding invites policy makers to adopt policies that may accelerate the growth rates of TFP in order to achieve sustainable high investment and economic growth rates in the future.

The trends of TFP growth during the sample period of the study remained cyclical. The presence of cyclical movements in these trends suggests that researchers should use some variants of structural time series models in order to forecast future trends of TFP growth.

Moreover, TFP growth should not be linked only with structural variables, for example labor productivity, education and investment, rather, it should also be linked with cyclical variables, for example terms of trade and real exchange rate devaluation.

According to the findings of this study, there is absolute convergence of economic growth among the countries included in FS. But, in the case of the sub-samples of countries selected on a regional basis no evidence of absolute convergence of economic growth has been found. Nonetheless, conditional convergence of economic growth in the case of FS and each of the sub-samples exists significantly. In the case of FS income gaps among countries are large. Some of the countries are economically developed and others are developing. Large income gaps among the countries suggest that the availability of unutilized resources is different among countries; the availability of unutilized resources could be the initial driving force of economic growth and the reason why low income countries are growing fast and catching up with high income countries. This finding is consistent with the notion implied in new classical growth theory. The existence of conditional convergence among the regional panels of countries suggests that when the income gaps among the countries are not large the convergence of economic growth is conditional to the internal structure of the economies. In particular, among regional panels of countries the steady-state growth path of each economy is different than others due to differences of technological growth, investment growth, GP, trade openness growth, INFs and growth rates of government's share of GDP. This supports the notion implied in new endogenous growth theory

The study investigated the absolute and conditional convergence of TFP growth for the FS of countries and each of the regional sub-samples. The results indicated that the absolute convergence of TFP growth does not exist in FS and sub-samples of CEE, Africa, LA and SA. The absence of absolute convergence in the samples mentioned

above postulates that technology is a private good that does not readily cross international borders[32]. Moreover, the conditional convergence of TFP growth in the case of FS and all of the sub-samples has been found to be significant. This finding reinforces the idea that technology is a private good so each country should allocate reasonable funds for research and development in order to grow technologically rather than looking toward other countries for adoption of technology. However, in the case of the regional samples of EU-15 and EA, TFP growth is converging to a common steady state in each region. This shows that the countries located in these regions share technology with each other for which reason TFP growth is converging to a common steady-state growth path. This is what is implied in the suggestion of Miller and Upadhyay (2000).

The study has found that GTO positively and significantly determines the investment growth and economic growth of the countries included in the study. This finding remained robust to the choice of countries in different samples on a regional basis. This finding suggests that the countries included in this study should enhance international economic integration in order to grow fast. Trade restrictions should be minimized and flow of trade should be smoothed.

This study found very significant negative effects of GOVSH on investment growth particularly on GISH. These highly significant negative effects indicate that classical economists' notion of crowding out effects of fiscal policy is relevant in the countries selected in this study. It should be noticed that the effects of GOVSH and investment growth on economic growth remained positive. This suggests that for long-term economic growth both the variables (GOVSH and investment growth) are important. But, the negative effects of GOVSH on investment growth suggest that policy makers should

[32] For details about this concept see Miller and Upadhyay (2000).

implement precautionary expansionary fiscal policies so the crowding out of investment may be minimized.

Although the study did not find any significant effects of INF on economic growth in FS, the effects of inflation on economic growth remained negative and significant in the case of Central and East European and African countries. Some evidence of the negative and significant effects of inflation on economic growth and investment growth in the case of South Asian countries has also been found. From the negative and significant effects of INF on economic growth particularly in CEE and Africa it can be concluded that the overall INF during the sample period remained higher than the threshold point. Thus, necessary measures to control the INF in these regions should be taken. Inflation-targeting monetary policy may be a good choice for these countries. But, before adopting such a policy, researchers should investigate the appropriateness of this policy in detail.

The findings of this study suggest that in growth models, as a proxy of investment, GFI performs better than GISH. Moreover, in comparison to GISH the effects of GFI on future economic growth remained almost robust to the changes in types of employed regression models. This indicates that researchers should use GFI as the proxy of investment growth rather than GISH.

Last, but not least, the study found that the effects of GP on investment growth and economic growth are region specific. In Africa and SA some evidence of the negative effects of GP on investment growth and economic growth has been found to be significant. This indicates that policy makers should spread awareness among the public in order to control the GP so that higher investment and economic growth rates could be realized. Some evidence of the positive effects of GP on investment growth rate in EU-15 has been found to be significant. This implies that EU-15 countries should soften their immigration policies in order to realize more favorable effects of GP.

7.3 Recommendations for Future Research

The present study has several implications as discussed in the above section. Nevertheless, further studies are needed to address the following issues that were identified during the course of this study.

This study investigated and compared the powers of TFP growth in predicting future investment and economic growth rates. For this purpose, I obtained the time series of TFP growth through three commonly used different methods: growth accounting method, index number method and econometric method. In all these measures the time series of capital is required in order to calculate TFP growth. Unfortunately, the data on capital stock is not available in the case of many countries. In order to develop the time series of capital stock the present study used perpetual inventory method using four percent annual depreciation rate. It would be useful in future studies if the actual capital depreciation rate could be estimated for the selected countries.

This study compared the commonly used three methods of measuring TFP growth using macroeconomic data for the selected countries. The results suggested that the time series of TFP growth provided by the growth accounting method performed best in predicting future investment and economic growth rates. However, it is recommended that future studies investigate the relative predictive powers of the three methods using microeconomic firm-level data.

The overall results of this study suggested that TFP growth is a significant predictor of future investment and economic growth rates. Thus, policy makers should devise policies that may enhance the growth rates of TFP. However, for future research studies it is suggested that the effects of TFP growth on future economic development be tested rather than on economic growth. In particular, the future research should calculate the environmental cost of TFP growth.

The present study found that the average growth rate of TFP in each of the selected countries during the sample period remained positive according to all of the employed three methods of measuring TFP growth. However, in certain periods countries faced negative TFP growth rates that indicated technological regress. In particular, a sharp technological regress was observed during the last three years of the study starting from 2007 to 2009. During these years the world economies faced a global financial crisis that could be the reason for the said technological regress. However, future studies should explicitly determine the effects of financial development on TFP growth.

In the neoclassical growth model it is implied that technological progress pushes the aggregate production function upward and the economy moves to a new steady state. At the initial level of per worker capital (k) output per worker (y) increases, which reflects the higher level of MPk at each level of k. If TFPG is a good measure of TC then it must affect the MPk as well. In future studies the determination of the effects of TFP growth on MPk may be a valuable addition to the growth literature.

The present study used data on different variables for the period 1990 through to 2009 for a sample of 35 countries selected from different regions of the world. In future research studies both the number of countries and the sample period may be increased to test whether the results remain robust to the changes in cross-sections and time periods.

The present study has determined the absolute and conditional convergences of TFP growth. According to Miller and Upadhyay (2000), the existence of absolute convergence in TFP growth indicates that technology is a public good that readily crosses international borders. However, it would be appropriate if future studies could determine the absolute convergence of pure technical growth rather than TFP growth. More specifically, TFP should be decomposed into technological growth and scale effects and the first

component should be used to determine the possibility of absolute convergence in technological growth.

The present study suggested that if there are large income gaps among countries the notion of absolute convergence, implied in neoclassical growth theory, is relevant. However, if the income gaps are not large among the countries selected in a panel then the notion of conditional convergence, implied in endogenous growth theory, is more relevant. However, in order to test the endogenous growth theory more concretely human capital development and investment in research and development should be used as control variables along with other control variables.

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Appendices

Appendix 1

List of Symbols and Abbreviations used in the study

Sr. No.	Symbol and Abbreviations	Stand for
1	CEE	Central and East Europe
2	EA	East Asia
3	EU-15	Sub-sample of members of the European Union on May 01, 2004
4	FS	Full sample
5	GFCF	Gross fixed capital formation
6	GFI	Growth rate of total fixed investment
7	GFI(-1)	One period lag of GFI
8	GISH	Growth rate of investment share of GDP
9	GISH(-1)	One period lag of GISH
10	Gk	Growth rate of capital stock per worker
11	GOVSH	Growth rate of government's share of GDP
12	GP	Population growth rate
13	GRGDP	Growth rate of real GDP per capita
14	Gy	Growth rate of GDP per worker
15	IFS	International Financial Statistics
16	INF	Inflation rate
17	K	Capital stock per worker
18	LA	Sub-sample of Latin American countries
19	LGRGDP(-1)	One period lagged natural log of RGDP
20	MPk	Marginal productivity of capital per worker
21	PWT	Penn World Tables
22	RGDP	Real GDP per capita
23	SA	South Asia
24	S_K	Capital share of output
25	S_L	Labor share of output
26	TFP	Total factor productivity
27	TFPG	Total factor productivity growth (Growth accounting method)
28	TFPGE	Total factor productivity growth (Econometric method)
29	TFPGI	Total factor productivity growth (Index Number method)
30	TFPG(-1)	First lag of TFPG
31	WDI	World Development Indicators
32	Y	GDP per worker
33	δ	Depreciation rate of capital

Appendix 3.1

Derivation of Factor Elasticity

Assume $y = \frac{Y}{L}$

Differentiating y with respect to time

$$\dot{y} = \frac{L\dot{Y} - Y\dot{L}}{L^2}$$

Dividing both sides of above equation by y

$$\frac{\dot{y}}{y} = \frac{L\dot{Y} - Y\dot{L}}{L^2}\frac{L}{Y}$$

$$\frac{\dot{y}}{y} = \frac{L\dot{Y} - Y\dot{L}}{LY}$$

$$\frac{\dot{y}}{y} = \frac{L\dot{Y}}{LY} - \frac{Y\dot{L}}{LY}$$

$$\frac{\dot{y}}{y} = \frac{\dot{Y}}{Y} - \frac{\dot{L}}{L}$$

Assume $k = \frac{K}{L}$

Differentiating k with respect to time

$$\dot{k} = \frac{L\dot{K} - K\dot{L}}{L^2}$$

Dividing both sides of aboveequation by k

$$\frac{\dot{k}}{k} = \frac{L\dot{K} - K\dot{L}}{L^2}\frac{L}{K}$$

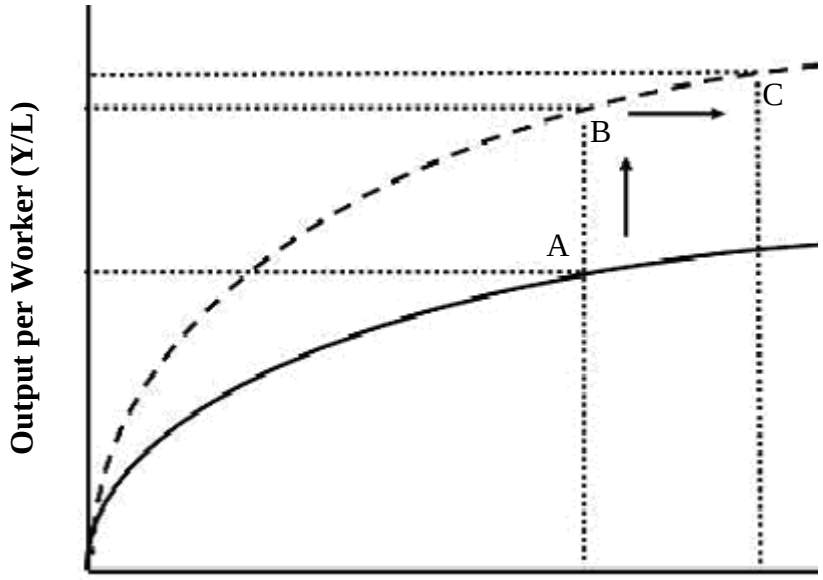
$$\frac{\dot{k}}{k} = \frac{L\dot{K} - K\dot{L}}{LK}$$

$$\frac{\dot{k}}{k} = \frac{L\dot{K}}{LK} - \frac{K\dot{L}}{LK}$$

$$\frac{\dot{k}}{k} = \frac{\dot{K}}{K} - \frac{\dot{L}}{L}$$

Appendix 3.2

TFP Growth



A technical progress shifts the steady-state level of output per worker to C from the initial steady-state level of output per worker A in the above diagram. The movement from point A to point B is the pure effect of technical change, whereas the movement from point B to C is due to capital deepening.

Appendix 4.1

List of countries included in the study

SR. No.	Country	Iso-Code	Region
1	Hungary	HUN	Central and East Europe
2	Romania	ROM	Central and East Europe
3	Turkey	TUR	Central and East Europe
4	Algeria	DZA	Africa
5	Egypt	EGY	Africa
6	Morocco	MAR	Africa
7	South Africa	ZFA	Africa
8	Argentina	ARG	Latin America
9	Brazil	BRA	Latin America
10	Chile	CHL	Latin America
11	Colombia	COL	Latin America
12	Mexico	MEX	Latin America
13	Bangladesh	BGD	South Asia
14	India	IND	South Asia
15	Pakistan	PAK	South Asia
16	Sri Lanka	LKA	South Asia
17	Hong Kong	HKG	East Asia
18	Korea	KOR	East Asia
19	Malaysia	MYS	East Asia
20	Thailand	THA	East Asia
21	Austria	AUT	EU-15
22	Belgium	BEL	EU-15
23	Denmark	DNK	EU-15
24	Finland	FIN	EU-15
25	France	FRA	EU-15
26	Germany	GER	EU-15
27	Greece	GRE	EU-15
28	Ireland	IRL	EU-15
29	Italy	ITA	EU-15
30	Luxembourg	LUX	EU-15
31	Netherlands	NLD	EU-15
32	Portugal	PRT	EU-15
33	Spain	ESP	EU-15
34	Sweden	SWE	EU-15
35	United Kingdom	GBR	EU-15

Appendix 6[33]

Table: 6.1 Unit Root Tests

Null Hypothesis: Unit Root

Series	Method	Statistic	Cross-Sections	Obs
GRGDP	Levin, Lin & Chu t	–2.27*	35	648
	Im, Pesaran and Shin W-stat	–5.44*	35	648
	ADF-Fisher Chi-square	148.59*	35	648
	PP-Fisher Chi-square	170.05*	35	665
TFPG	Levin, Lin & Chu t	–10.00*	35	637
	Im, Pesaran and Shin W-stat	–10.64*	35	637
	ADF-Fisher Chi-square	261.42*	35	637
	PP-Fisher Chi-square	286.74*	35	665
TFPGI	Levin, Lin & Chu t	–12.61*	35	614
	Im, Pesaran and Shin W-stat	–12.41*	35	614
	ADF-Fisher Chi-square	279.74*	35	614
	PP-Fisher Chi-square	435.80*	35	630
TFPGE	Levin, Lin & Chu t	–6.82*	35	616
	Im, Pesaran and Shin W-stat	–9.25*	35	616
	ADF-Fisher Chi-square	220.28	35	616
	PP-Fisher Chi-square	115.58	35	665
GFI	Levin, Lin & Chu t	–1.67**	35	619
	Im, Pesaran and Shin W-stat	–8.01*	35	619
	ADF-Fisher Chi-square	216.62*	35	619
	PP-Fisher Chi-square	208.79*	35	665
GISH	Levin, Lin & Chu t	0.84	35	622
	Im, Pesaran and Shin W-stat	–3.32*	35	622
	ADF-Fisher Chi-square	129.68*	35	622
	PP-Fisher Chi-square	138.29*	35	665
INF	Levin, Lin & Chu t	–167.43*	35	643
	Im, Pesaran and Shin W-stat	–46.12*	35	643
	ADF-Fisher Chi-square	450.86*	35	643
	PP-Fisher Chi-square	495.52*	35	665
GP	Levin, Lin & Chu t	–3.06**	35	615
	Im, Pesaran and Shin W-stat	–5.65*	35	615
	ADF-Fisher Chi-square	191.32*	35	615
	PP-Fisher Chi-square	152.53*	35	615
GTO	Levin, Lin & Chu t	–3.90*	35	651
	Im, Pesaran and Shin W-stat	0.48	35	651
	ADF-Fisher Chi-square	64.92	35	651
	PP-Fisher Chi-square	158.20**	35	625
GOVSH	Levin, Lin & Chu t	–1.78*	35	631
	Im, Pesaran and Shin W-stat	–1.22	35	631
	ADF-Fisher Chi-square	94.50	35	631
	PP-Fisher Chi-square	184.07**	35	635

[33] * indicates statistical significance at 1%, ** at 5% and *** at 10%.

Table: 6.2 TFPG and Future Economic Growth in Full Sample[34]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	1.21* (0.43)	1.05 (0.30)	1.86* (0.50)	7.05* (1.57)	4.58* (1.04)	7.26* (1.58)
TFPG(-1)	0.10*** (0.05)	0.08** (0.04)	0.11*** (0.05)	0.26* (0.04)	0.10* (0.03)	0.26* (0.05)
GFI(-1)		0.25* (0.009)			0.26* (0.01)	
GISH(-1)			0.001* (0.0003)			0.002** (0.001)
INF	0.001 (0.001)	–0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	–0.001 (0.001)	0.001 (0.001)
GP	0.81* (0.17)	0.57* (0.12)	0.73* (0.17)	0.13 (0.31)	–0.06 (0.20)	0.14 (0.31)
GTO	0.001 (0.002)	0.003** (0.001)	0.001 (0.002)	0.007* (0.002)	0.007*** (0.004)	0.007** (0.003)
GOVSH	–0.01 (0.02)	0.03** (0.01)	0.07*** (0.04)	0.43* (0.13)	0.25* (0.09)	0.47* (0.14)
LRGDP(-1)	–0.32* (0.05)	–0.13* (0.03)	–0.30* (0.05)			
Adj. R^2	0.18	0.60	0.19	0.17	0.64	0.19
D.W. Stat	1.94	1.98	1.92	1.68	2.05	1.68
F-Stat	26.20	145.52	23.63	4.57	30.89	4.53
Prob (F-Stat)	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	665	665	665	665	665	665
No. of countries	35	35	35	35	35	35

Fixed Effects

Model 1	HUN=0.73	ROM=5.36	TUR=–1.49	DZA=2.95	EGY=1.63	MAR=–2.77	ZFA=–2.84
	ARG=–1.77	BRA=1.39	CHL=–1.67	COL=–1.10	MEX=–7.02	BGD=–3.42	IND=6.19
	PAK=2.94	LKA=9.28	HKG=–6.58	KOR=–0.27	MYS=–2.13	THA=–0.95	AUT=–0.46
	BEL=0.40	DNK=0.31	FIN=0.28	FRA=0.85	GER=0.61	GRE=0.85	IRL=–0.52
	ITA=–0.98	LUX=–1.38	NLD=3.44	PRT=–2.99	ESP=0.37	SWE=1.08	GBR=–0.34
Model 2	HUN=0.41	ROM=4.32	TUR=–1.41	DZA=2.27	EGY=1.71	MAR=–2.43	ZFA=–2.76
	ARG=–1.74	BRA=1.17	CHL=–1.48	COL=–1.20	MEX=–6.36	BGD=–2.98	IND=5.67
	PAK=2.92	LKA=8.39	HKG=–5.40	KOR=–0.07	MYS=–1.35	THA=–0.53	AUT=–0.38
	BEL=0.34	DNK=0.13	FIN=0.29	FRA=0.60	GER=0.45	GRE=0.55	IRL=–0.14
	ITA=–1.04	LUX=–0.97	NLD=3.09	PRT=–2.81	ESP=0.22	SWE=0.91	GBR=–0.38
Model 3	HUN=0.81	ROM=5.46	TUR=–1.46	DZA=3.02	EGY=1.69	MAR=–2.76	ZFA=–2.81
	ARG=–1.74	BRA=1.44	CHL=–1.65	COL=–1.06	MEX=–7.03	BGD=–3.42	IND=6.24
	PAK=2.99	LKA=7.61	HKG=–6.57	KOR=–0.24	MYS=–2.11	THA=–0.91	AUT=–0.39
	BEL=0.49	DNK=0.39	FIN=0.36	FRA=0.93	GER=0.69	GRE=–0.90	IRL=–0.47
	ITA=0.93	LUX=–1.33	NLD=3.54	PRT=–2.97	ESP=0.41	SWE=1.15	GBR=–0.29

[34] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.3 TFPGI and Future Economic Growth in Full Sample[35]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	0.85*** (0.44)	0.68** (0.31)	1.27** (0.51)	6.23* (1.70)	4.03* (1.12)	6.43* (1.71)
TFPGI(-1)	0.05 (0.04)	–0.02 (0.03)	0.05 (0.04)	0.09** (0.04)	–0.03 (0.03)	0.08*** (0.04)
GFI(-1)		0.25* (0.009)			0.26* (0.01)	
GISH(-1)			0.001** (0.0005)			0.002*** (0.001)
INF	–0.001 (0.001)	–0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	–0.001 (0.001)	0.001 (0.001)
GP	0.86* (0.19)	0.67* (0.13)	0.79* (0.19)	–0.13 (0.41)	0.009 (0.27)	–0.12 (0.41)
GTO	0.004** (0.002)	0.004** (0.001)	0.001 (0.001)	0.006* (0.002)	0.007*** (0.004)	0.007** (0.003)
GOVSH	0.03 (0.03)	0.001 (0.02)	0.01 (0.03)	0.29** (0.14)	0.21** (0.10)	0.32** (0.15)
LRGDP(-1)	–0.34* (0.04)	–0.15* (0.03)	–0.33* (0.04)			
Adj. R^2	0.18	0.59	0.18	0.17	0.62	0.17
D.W. Stat	1.95	1.94	1.94	1.64	1.91	1.63
F-Stat	22.69	129.84	19.88	4.44	26.82	4.15
Prob (F-Stat)	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	630	630	630	630	630	630
No. of countries	35	35	35	35	35	35

Fixed Effects

Model 1	HUN=0.87	ROM=5.86	TUR=–1.61	DZA=3.05	EGY=2.19	MAR=–2.79	ZFA=–3.11
	ARG=–1.89	BRA=0.99	CHL=–1.96	COL=–1.10	MEX=–7.10	BGD=–3.27	IND=6.62
	PAK=2.97	LKA=5.50	HKG=–3.85	KOR=–0.32	MYS=–1.47	THA=–0.79	AUT=–0.58
	BEL=0.24	DNK=0.09	FIN=0.73	FRA=0.34	GER=0.17	GRE=0.36	IRL=0.27
	ITA=–1.48	LUX=–1.22	NLD=3.26	PRT=–1.58	ESP=–0.04	SWE=1.01	GBR=–0.38
Model 2	HUN=0.54	ROM=4.19	TUR=–1.45	DZA=2.20	EGY=2.14	MAR=–2.25	ZFA=–2.88
	ARG=–2.03	BRA=0.36	CHL=–1.60	COL=–1.33	MEX=–6.11	BGD=–2.72	IND=5.63
	PAK=2.66	LKA=8.02	HKG=–3.86	KOR=–0.19	MYS=–0.10	THA=–0.00	AUT=–0.47
	BEL=0.37	DNK=–0.11	FIN=0.58	FRA=–0.04	GER=–0.16	GRE=–0.06	IRL=0.91
	ITA=–1.58	LUX=–0.28	NLD=2.82	PRT=–3.18	ESP=–0.21	SWE=0.76	GBR=–0.58
Model 3	HUN=0.94	ROM=5.95	TUR=–1.59	DZA=3.10	EGY=2.24	MAR=–2.78	ZFA=–3.09
	ARG=–1.87	BRA=1.03	CHL=–1.94	COL=–1.07	MEX=–7.12	BGD=–3.27	IND=6.67
	PAK=3.02	LKA=8.20	HKG=–5.85	KOR=–0.29	MYS=–1.46	THA=–0.77	AUT=–0.53
	BEL=0.31	DNK=0.15	FIN=0.79	FRA=0.41	GER=0.24	GRE=0.40	IRL=0.30
	ITA=–1.44	LUX=–1.18	NLD=3.34	PRT=–3.56	ESP=0.00	SWE=1.07	GBR=–0.34

[35] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.4 TFPGE and Future Economic Growth in Full Sample[36]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	1.06** (0.42)	0.95* (0.30)	1.68** (0.49)	7.31* (1.61)	4.51* (1.05)	7.51* (1.61)
TFPGE(-1)	–0.12 (0.17)	0.20** (0.10)	–0.13 (0.17)	0.44* (0.16)	0.27** (0.11)	0.42** (0.16)
GFI(-1)		0.25* (0.009)			0.27* (0.01)	
GISH(-1)			0.001** (0.0003)			0.0018 (0.001)
INF	0.001 (0.001)	–0.001 (0.001)	0.0003 (0.001)	0.001 (0.001)	–0.001 (0.001)	0.001 (0.001)
GP	0.75* (0.17)	0.52* (0.12)	0.66* (0.18)	0.10 (0.31)	–0.12 (0.20)	0.02 (0.31)
GTO	0.001 (0.001)	0.003** (0.001)	0.001 (0.002)	–0.002 (0.007)	–0.002 (0.004)	–0.002 (0.007)
GOVSH	–0.004 (0.02)	–0.02 (0.02)	0.06*** (0.03)	0.46** (0.14)	0.25* (0.09)	0.50* (0.14)
LRGDP(-1)	–0.39* (0.04)	–0.14* (0.03)	–0.37* (0.05)			
Adj. R^2	0.28	0.64	0.29	0.35	0.62	0.41
D.W. Stat	1.94	1.90	1.92	1.64	1.91	1.71
F-Stat	45.68	245.05	56.11	76.82	238.66	83.78
Prob (F-Stat)	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	665	665	665	665	665	665
No. of countries	35	35	35	35	35	35

Fixed Effects

Model 1	HUN=–0.60	ROM=4.28	TUR=–1.35	DZA=1.64	EGY=1.31	MAR=–1.28	ZFA=–2.74
	ARG=–0.61	BRA=–0.43	CHL=–0.23	COL=–1.01	MEX=–3.20	BGD=–0.67	IND=4.63
	PAK=1.50	LKA=9.16	HKG=–1.72	KOR=–0.04	MYS=0.58	THA=–0.10	AUT=–0.58
	BEL=–0.35	DNK= –0.94	FIN=–0.62	FRA=–0.92	GER=–0.78	GRE=–0.40	IRL=0.83
	ITA=–2.21	LUX=0.00	NLD=2.20	PRT=–2.78	ESP=–0.84	SWE=0.01	GBR=–1.34
Model 2	HUN=–0.94	ROM=1.03	TUR=–0.62	DZA=–0.82	EGY=1.18	MAR=–0.80	ZFA=–2.42
	ARG=–1.01	BRA=0.11	CHL=–0.16	COL=–1.53	MEX=–2.08	BGD=–0.38	IND=2.84
	PAK=1.71	LKA=5.05	HKG=–0.07	KOR=–0.51	MYS=1.46	THA=–1.12	AUT=–0.30
	BEL=–0.15	DNK=0.88	FIN=–0.14	FRA=–0.67	GER=–0.48	GRE=–0.42	IRL=1.39
	ITA=–1.38	LUX=0.39	NLD=1.24	PRT=–1.60	ESP=–0.39	SWE=0.05	GBR=–0.81
Model 3	HUN=–0.33	ROM=4.93	TUR=–1.35	DZA=1.90	EGY=1.45	MAR=–1.33	ZFA=–2.73
	ARG=–0.60	BRA=–0.26	CHL=–0.22	COL=–0.97	MEX=–3.31	BGD=–0.74	IND=4.87
	PAK=1.67	LKA=4.59	HKG=–1.70	KOR=–0.01	MYS=0.57	THA=–0.05	AUT=–0.75
	BEL=–0.06	DNK=0.71	FIN=–0.40	FRA=–0.68	GER=–0.51	GRE=–0.26	IRL=0.89
	ITA=–2.08	LUX=0.13	NLD=2.61	PRT=–2.78	ESP=–0.74	SWE=0.24	GBR=–1.20

[36] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.5 TFPG and Future Economic Growth in CEE[37]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	–0.20 (3.76)	1.42 (2.24)	–8.31* (3.71)	0.95 (5.01)	3.78 (2.98)	–4.45 (4.53)
TFPG(-1)	0.18** (0.09)	0.04 (0.08)	0.56* (0.20)	0.23*** (0.12)	0.13 (0.08)	0.20*** (0.11)
GFI(-1)		0.32* (0.03)			0.32* (0.03)	
GISH(-1)			0.98* (0.22)			0.93* (0.22)
INF	–0.04* (0.01)	–0.02*** (0.01)	–0.05* (0.01)	–0.04*** (0.02)	–0.02*** (0.01)	–0.05* (0.02)
GP	2.57 (1.67)	0.72 (1.01)	1.55 (1.45)	0.18 (4.48)	–1.44 (2.66)	5.39 (4.08)
GTO	0.003 (0.02)	0.003 (0.01)	0.04*** (0.02)	0.01 (0.02)	0.01 (0.01)	0.06** (0.03)
GOVSH	0.18 (0.17)	0.03 (0.1)	0.25 (0.18)	0.13 (0.31)	0.17 (0.18)	0.57*** (0.29)
LRGDP(-1)	–0.08** (0.04)	–0.17*** (0.08)	–0.46*** (0.23)			
Adj. R^2	0.16	0.70	0.39	0.15	0.70	0.36
D.W. Stat	1.65	2.01	1.55	1.64	2.03	1.60
F-Stat	2.79	19.90	6.03	2.42	17.56	5.00
Prob (F-Stat)	0.02	0.00	0.00	0.03	0.00	0.00
No. of obs.	57	57	57	57	57	57
No. of countries	3	3	3	3	3	3

Fixed Effects

Model 1	HUN=–2.05	ROM=–0.97	TUR=3.02
Model 2	HUN=–2.41	ROM=0.07	TUR=2.34
Model 3	HUN=2.52	ROM=6.41	TUR=–8.93

[37] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.6 TFPGI and Future Economic Growth in CEE[38]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	0.35 (3.57)	2.96 (2.18)	–6.70*** (3.67)	–0.81 (4.80)	4.99*** (2.99)	–6.60 (4.25)
TFPGI(-1)	0.13 (0.15)	–0.001 (0.09)	0.18 (0.14)	0.13 (0.16)	0.005 (0.10)	0.17 (0.13)
GFI(-1)		0.31* (0.034)			0.32* (0.03)	
GISH(-1)			0.75* (0.20)			0.92* (0.20)
INF	–0.029*** (0.017)	–0.02** (0.01)	–0.04** (0.02)	–0.04** (0.02)	–0.03* (0.01)	–0.05* (0.02)
GP	1.89 (1.48)	0.36 (0.92)	0.62 (1.35)	1.62 (4.49)	0.29 (2.77)	6.31 (3.93)
GTO	0.008 (0.022)	0.012 (0.013)	0.05** (0.023)	0.001 (0.02)	0.003 (0.02)	0.07* (0.02)
GOVSH	0.21 (0.16)	0.06 (0.10)	0.08 (0.16)	0.33 (0.30)	0.20 (0.19)	0.35 (0.29)
LRGDP(-1)	–0.20 (0.13)	–0.18** (0.08)	0.03 (0.13)			
Adj. R^2	0.10	0.67	0.30	0.14	0.64	0.32
D.W. Stat	1.76	2.00	1.37	1.41	1.77	1.34
F-Stat	1.96	16.18	4.15	1.32	12.59	4.10
Prob (F-Stat)	0.09	0.00	0.00	0.26	0.00	0.00
No. of obs.	54	54	54	54	54	665
No. of countries	03	03	03	03	03	35

Fixed Effects

Model 1	HUN=–0.42	ROM=–1.35	TUR=1.77
Model 2	HUN=–1.03	ROM=1.47	TUR=–0.43
Model 3	HUN=3.60	ROM=5.65	TUR=–9.25

[38] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.7 TFPGE and Future Economic Growth in CEE[39]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	–1.22 (0.74)	–1.45 (1.06)	–2.56 (1.42)	–1.41 (0.90)	–0.89 (0.55)	–1.60 (1.15)
TFPGE(-1)	0.08 (0.06)	0.09 (0.06)	0.11 (0.07)	0.24** (0.11)	0.16 (0.09)	0.18** (0.08)
GFI(-1)		0.33* (0.032)			0.28* (0.07)	
GISH(-1)			0.68* (0.22)			0.74* (0.19)
INF	–0.03** (0.014)	–0.02** (0.01)	–0.04** (0.02)	–0.06* (0.02)	–0.05* (0.02)	–0.06* (0.02)
GP	0.68 (0.44)	0.32 (0.22)	0.58 (0.36)	0.83 (0.62)	0.31 (0.25)	0.54 (0.35)
GTO	–0.006 (0.02)	–0.01 (0.01)	–0.04 (0.03)	0.07 (0.04)	0.06 (0.04)	0.07* (0.03)
GOVSH	0.16 (0.12)	0.08 (0.10)	0.09 (0.14)	0.40 (0.25)	0.31 (0.18)	0.48** (0.22)
LRGDP(-1)	–0.10** (0.04)	–0.14** (0.06)	–0.16** (0.07)			
Adj. R^2	0.14	0.62	0.28	0.14	0.64	0.32
D.W. Stat	1.72	1.99	1.66	1.41	1.77	1.34
F-Stat	2.21	24.21	5.23	1.32	12.59	4.10
Prob (F-Stat)	0.06	0.00	0.00	0.26	0.00	0.00
No. of obs.	54	54	54	54	54	665
No. of countries	03	03	03	03	03	35

Fixed Effects

Model 1	HUN=–1.53	ROM=–0.85	TUR=2.38
Model 2	HUN=–1.43	ROM=2.05	TUR=–0.62
Model 3	HUN=1.36	ROM=3.45	TUR=–4.81

[39] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.8 TFPG and Future Economic Growth in Africa[40]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	–0.36 (2.29)	0.76 (2.44)	–0.34 (2.17)	12.86* (6.40)	14.32** (6.23)	13.18** (6.47)
TFPG(-1)	0.34 (0.21)	0.49** (0.21)	0.28 (0.18)	0.38* (0.11)	0.44* (0.11)	0.37* (0.11)
GFI(-1)		0.07 (0.05)			0.12** (0.05)	
GISH(-1)			0.09* (0.03)			0.03 (0.07)
INF	–0.11** (0.05)	–0.11** (0.05)	–0.13** (0.04)	–0.15* (0.05)	–0.14* (0.04)	–0.15* (0.04)
GP	–0.25 (0.60)	–0.39 (0.61)	–0.60 (0.58)	–0.74 (0.54)	–1.03*** (0.54)	–0.76 (0.55)
GTO	0.10** (0.04)	0.08** (0.04)	0.16* (0.04)	0.08** (0.04)	0.04 (0.04)	0.07** (0.03)
GOVSH	0.03 (0.38)	0.04 (0.13)	0.11 (0.13)	1.43* (0.64)	1.37** (0.62)	1.49** (0.66)
LRGDP(-1)	–0.18** (0.08)	–0.22* (0.08)	–0.30* (0.06)			
Adj. R^2	0.21	0.65	0.42	0.32	0.36	0.31
D.W. Stat	1.99	1.98	2.03	2.03	2.13	2.04
F-Stat	4.14	145.52	6.28	5.40	8.77	6.89
Prob (F-Stat)	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	76	76	76	76	76	76
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	DZA=6.75	EGY=3.04	MAR=–5.26	ZFA=–4.53
Model 2	DZA=6.33	EGY=3.28	MAR=–4.91	ZFA=–4.70
Model 3	DZA=6.85	EGY=3.70	MAR=–5.83	ZFA=–4.72

[40] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.9 TFPGI and Future Economic Growth in Africa[41]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	–0.89 (2.59)	0.43 (2.65)	1.18 (2.43)	12.92*** (7.48)	14.77** (7.32)	12.62*** (7.01)
TFPGI(-1)	0.05 (0.38)	0.04 (0.22)	0.04 (0.28)	0.36** (0.17)	0.41** (0.18)	0.32** (0.14)
GFI(-1)		0.12 (0.08)			0.13** (0.06)	
GISH(-1)			0.14* (0.03)			0.04 (0.08)
INF	–0.09 (0.06)	–0.094*** (0.05)	–0.12** (0.05)	–0.07 (0.05)	–0.06 (0.05)	–0.07 (0.05)
GP	0.32 (0.89)	0.43 (0.88)	–1.57** (0.91)	–1.56 (1.04)	–1.55 (1.01)	–1.71 (1.10)
GTO	0.09** (0.04)	0.05 (0.05)	0.17* (0.04)	0. 07 (0.04)	0. 01 (0.04)	0. 07 (0.05)
GOVSH	0.01 (0.13)	0.02 (0.13)	0.06 (0.12)	1.19*** (0.70)	1.19*** (0.68)	1.09 (0.74)
LRGDP(-1)	–0.13 (0.13)	–0.13 (0.13)	–0.30** (0.13)			
Adj. R^2	0.18	0.22	0.29	0.26	0.30	0.25
D.W. Stat	1.84	1.88	1.94	2.37	2.45	2.38
F-Stat	2.17	2.52	4.19	3.38	3.70	2.98
Prob (F-Stat)	0.06	0.02	0.00	0.002	0.00	0.005
No. of obs.	72	72	72	72	72	72
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	DZA=5.64	EGY=2.89	MAR=–4.70	ZFA=–3.83
Model 2	DZA=5.69	EGY=2.94	MAR=–4.61	ZFA=–4.02
Model 3	DZA=5.37	EGY=2.21	MAR=–3.99	ZFA=–3.59

[41] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.10 TFPGE and Future Economic Growth in Africa[42]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	–0.17 (1.18)	0.43 (1.01)	–0.54 (1.67)	5.87* (2.32)	6.32* (2.14)	7.18* (2.22)
TFPGE(-1)	0.36 (0.13)	0.51 (0.28)	0.34 (0.24)	0.54* (0.23)	0.44* (0.18)	0.39* (0.14)
GFI(-1)		0.09 (0.07)			0.16* (0.06)	
GISH(-1)			0.11* (0.04)			0.04 (0.07)
INF	–0.14* (0.04)	–0.13** (0.06)	–0.13** (0.05)	–0.17* (0.06)	–0.15* (0.05)	–0.13* (0.03)
GP	–0.21 (0.51)	–0.42 (0.46)	–0.48 (0.44)	–0.68 (0.43)	–0.98** (0.48)	–0.85 (0.49)
GTO	0.12** (0.05)	0.07** (0.03)	0.14* (0.04)	0.12** (0.05)	0.06 (0.04)	0.13** (0.06)
GOVSH	0.11 (0.35)	0.14 (0.21)	0.17 (0.19)	0.43** (0.21)	0.37** (0.18)	0.49** (0.22)
LRGDP(-1)	–0.13** (0.06)	–0.18** (0.09)	–0.27** (0.12)			
Adj. R^2	0.19	0.62	0.39	0.30	0.35	0.28
D.W. Stat	1.97	1.96	2.04	2.05	2.09	2.05
F-Stat	4.04	138.43	6.06	4.87	7.43	5.87
Prob (F-Stat)	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	76	76	76	76	76	76
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	DZA=4.57	EGY=2.65	MAR=–3.65	ZFA=–3.57
Model 2	DZA=4.65	EGY=5.65	MAR=–5.54	ZFA=–4.76
Model 3	DZA=5.42	EGY=4.34	MAR=–4.06	ZFA=–5.70

[42] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.11

TFPG and Future Economic Growth in Latin America[43]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	2.50 (3.91)	–5.62* (1.94)	–7.62** (3.50)	13.50*** (7.11)	–11.83* (3.92)	–1.78 (5.94)
TFPG(-1)	0.06 (0.12)	0.15* (0.05)	0.16 (0.10)	0.10 (0.12)	0.13** (0.05)	0.16*** (0.08)
GFI(-1)		0.24* (0.009)			0.25* (0.01)	
GISH(-1)			0.20* (0.03)			0.25* (0.03)
INF	0.001 (0.001)	0.0001 (0.0001)	–0.0003 (0.001)	0.001 (0.001)	–0.0004 (0.0006)	–0.0003 (0.001)
GP	0.07 (1.31)	2.38* (0.64)	0.51 (1.06)	1.82** (0.81)	3.68* (0.74)	1.20 (1.12)
GTO	0.06** (0.03)	0.05* (0.02)	0.08** (0.03)	–0.07 (0.07)	0.06** (0.03)	–0.008 (0.05)
GOVSH	0.27** (0.13)	0.31** (0.12)	0.87* (0.25)	1.27 (0.85)	1.06** (0.40)	0.43 (0.62)
LRGDP(-1)	0.12 (0.11)	–0.10*** (0.05)	–0.26* (0.09)			
Adj. R^2	0.19	0.78	0.42	0.15	0.80	0.51
D.W. Stat	1.70	1.56	1.64	1.57	1.61	1.85
F-Stat	3.42	48.09	8.98	2.24	38.72	10.98
Prob (F-Stat)	0.00	0.00	0.00	0.04	0.00	0.00
No. of obs.	95	95	95	95	95	95
No. of countries	5	5	5	5	5	5

Fixed Effects

Model 1	ARG=–0.08	BRA=2.25	CHL=1.85	COL=0.12	MEX=–4.14
Model 2	ARG=1.36	BRA=–2.70	CHL=1.18	COL=–1.47	MEX=1.63
Model 3	ARG=1.39	BRA=–1.12	CHL=3.40	COL=0.02	MEX=–3.69

[43] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.12

TFPGI and Future Economic Growth in Latin America[44]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	–5.03 (3.87)	–5.13 (3.80)	–8.88** (3.39)	13.22 (9.61)	-19.37* (4.65)	–11.65 (7.29)
TFPGI(-1)	0.24 (0.15)	0.21 (0.21)	0.18 (0.13)	0.27 (0.18)	0.05 (0.04)	0.11 (0.12)
GFI(-1)		0.23* (0.01)			0.26* (0.01)	
GISH(-1)			0.20* (0.02)			0.27* (0.03)
INF	0.0009 (0.000)	0.0008 (0.002)	–0.0006 (0.002)	0.001 (0.001)	–0.0009 (0.0006)	–0.0009 (0.001)
GP	1.38 (0.81)	1.93* (0.64)	0.19 (1.02)	0.66 (1.59)	4.24* (0.73)	1.96 (1.13)
GTO	0.08 (1.39)	0.05** (0.02)	0.09* (0.03)	–0.04 (0.07)	0.11* (0.03)	0.06 (0.05)
GOVSH	0.24 (0.16)	0.29** (0.13)	1.01** (0.25)	1.56 (1.04)	1.85 (0.50)	1.44*** (0.80)
LRGDP(-1)	–0.34** (0.16)	–0.17** (0.05)	–0.31* (0.08)			
Adj. R^2	0.12	0.78	0.45	0.02	0.81	0.52
D.W. Stat	2.05	1.64	1.75	1.38	1.60	1.74
F-Stat	2.99	48.25	11.38	1.23	38.00	10.50
Prob (F-Stat)	0.01	0.00	0.00	0.29	0.00	0.00
No. of obs.	90	90	90	90	90	90
No. of countries	5	5	5	5	5	5

Fixed Effects

Model 1	ARG=0.65	BRA=0.28	CHL=2.15	COL=0.76	MEX=–3.86
Model 2	ARG=0.32	BRA=0.70	CHL=1.74	COL=0.76	MEX=–3.52
Model 3	ARG=0.62	BRA=0.65	CHL=1.99	COL=0.84	MEX=–4.11

[44] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.13

TFPGE and Future Economic Growth in Latin America[45]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	1.41 (1.65)	–2.43** (1.22)	–3.28** (1.46)	7.87** (3.36)	–5.66** (2.34)	–2.89 (3.43)
TFPGE(-1)	0.23 (0.16)	0.17 (0.11)	0.19 (0.13)	0.16 (0.14)	0.09** (0.04)	0.11*** (0.06)
GFI(-1)		0.38* (0.06)			0.32* (0.05)	
GISH(-1)			0.26* (0.04)			0.28* (0.05)
INF	0.001 (0.001)	0.0001 (0.0001)	–0.0003 (0.001)	0.001 (0.001)	–0.0003 (0.0006)	–0.0004 (0.001)
GP	0.08 (0.94)	1.26* (0.66)	0.48 (0.98)	0.43 (0.73)	0.67 (0.45)	0.88 01.76)
GTO	0.006 (0.04)	0.06** (0.03)	0.07 (0.04)	–0.07 (0.06)	0.08** (0.04)	–0.02 (0.04)
GOVSH	0.06 (0.18)	0.28** (0.11)	0.59** (0.27)	0.72 (0.58)	0.96** (0.40)	1.22** (0.58)
LRGDP(-1)	0.12 (0.11)	–0.10*** (0.05)	–0.26* (0.09)			
Adj. R^2	0.05	0.73	0.49	0.02	0.78	0.47
D.W. Stat	1.74	1.62	1.73	1.62	1.72	1.81
F-Stat	1.81	52.54	9.34	1.24	31.19	12.51
Prob (F-Stat)	0.17	0.00	0.00	0.28	0.00	0.00
No. of obs.	95	95	95	95	95	95
No. of countries	5	5	5	5	5	5

Fixed Effects

Model 1	ARG=–0.19	BRA=1.46	CHL=3.20	COL=0.57	MEX=–5.04
Model 2	ARG=0.25	BRA=–3.59	CHL=3.23	COL=–2.52	MEX=2.63
Model 3	ARG=0.39	BRA=–0.23	CHL=4.40	COL=0.13	MEX=–4.69

[45] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.14

TFPG and Future Economic Growth in East Asia[46]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	9.87** (4.43)	13.25* (4.46)	–2.39 (12.67)	24.74* (8.58)	18.13* (4.96)	8.29 (13.36)
TFPG(-1)	0.38*** (0.20)	0.15 (0.11)	0.38** (0.19)	0.35** (0.15)	0.003 (0.09)	0.27*** (0.15)
GFI(-1)		0.32* (0.02)			0.30* (0.03)	
GISH(-1)			0.22** (0.09)			0.16 (0.10)
INF	–0.13 (0.16)	–0.03 (0.09)	–0.06 (0.15)	–0.14 (0.14)	–0.09 (0.08)	–0.10 (0.14)
GP	0.76 (0.70)	0.16 (0.40)	1.35*** (0.73)	1.46 (1.19)	–0.39 (0.70)	0.94 (1.22)
GTO	0.031** (0.013)	0.02** (0.008)	0.001 (0.01)	–0.01 (0.01)	–0.01 (0.01)	–0.006 (0.02)
GOVSH	2.00** (0.90)	1.12** (0.52)	0.28 (1.15)	3.73* (1.13)	2.21* (0.66)	2.12 (1.51)
LRGDP(-1)	–0.04 (0.16)	–0.21** (0.09)	–0.17 (0.17)			
Adj. R^2	0.12	0.72	0.17	0.17	0.73	0.19
D.W. Stat	1.99	1.55	1.84	1.99	1.99	1.93
F-Stat	2.67	28.17	3.19	2.92	23.03	2.93
Prob (F-Stat)	0.02	0.00	0.005	0.007	0.00	0.005
No. of obs.	76	76	76	76	76	76
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	HKG=–6.84	KOR=5.17	MYS=–2.32	THA=3.99
Model 2	HKG=–3.90	KOR=1.89	MYS=–0.02	THA=2.03
Model 3	HKG=–5.54	KOR=3.37	MYS=–0.63	THA=2.80

[46] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.15

TFPGI and Future Economic Growth in East Asia[47]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	21.98** (9.08)	14.10* (5.11)	–5.95 (14.91)	27.84** (11.27)	18.83* (6.43)	3.14 (15.75)
TFPGI(-1)	0.15 (0.14)	0.06 (0.08)	0.20 (0.14)	0.19 (0.15)	0.02 (0.08)	0.17 (0.14)
GFI(-1)		0.32* (0.03)			0.30* (0.03)	
GISH(-1)			0.24** (0.10)			0.22** (0.10)
INF	–0.15 (0.18)	–0.04 (0.09)	–0.12 (0.17)	–0.14 (0.16)	–0.10 (0.09)	–0.11 (0.16)
GP	0.32 (0.88)	0.13 (0.49)	1.38 (0.97)	1.14 (1.90)	–0.40 (1.08)	0.78 (1.85)
GTO	0.03** (0.015)	0.02** (0.009)	0.002 (0.02)	–0.013 (0.02)	–0.01 (0.01)	0.01 (0.03)
GOVSH	2.25** (1.05)	1.23** (0.59)	0.005 (1.41)	4.12* (1.22)	2.28* (0.76)	1.80 (1.62)
LRGDP(-1)	0.008 (0.14)	–0.17** (0.08)	–0.05 (0.15)			
Adj. R^2	0.10	0.71	0.14	0.11	0.72	0.16
D.W. Stat	1.81	1.73	1.65	1.67	2.01	1.71
F-Stat	1.77	25.52	2.39	2.13	20.82	2.54
Prob (F-Stat)	0.11	0.00	0.03	0.045	0.00	0.015
No. of obs.	72	72	72	72	72	72
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	HKG=–7.32	KOR=5.28	MYS=–2.24	THA=4.28
Model 2	HKG=–3.82	KOR=1.72	MYS=0.022	THA=2.07
Model 3	HKG=–6.12	KOR=3.39	MYS=–0.27	THA=3.00

[47] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.16

TFPGE and Future Economic Growth in East Asia[48]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	12.56** (5.33)	09.38* (4.67)	–3.18 (8.29)	16.82* (5.14)	9.16* (3.63)	11.63 (12.82)
TFPGE(-1)	0.19*** (0.10)	0.14 (0.12)	0.22*** (0.12)	0.19** (0.08)	0.12 (0.09)	0.21*** (0.12)
GFI(-1)		0.21* (0.03)			0.28* (0.03)	
GISH(-1)			0.19** (0.08)			0.18 (0.12)
INF	–0.12 (0.11)	–0.05 (0.07)	–0.09 (0.13)	–0.17 (0.11)	–0.06 (0.05)	–0.13 (0.11)
GP	0.59 (0.64)	0.27 (0.38)	0.86 (0.66)	0.98 (1.11)	–0.21 (0.52)	0.78 (0.84)
GTO	0.04* (0.012)	0.04* (0.009)	–0.002 (0.02)	0.02 (0.03)	0.03 (0.02)	–0.03 (0.02)
GOVSH	1.76** (0.80)	0.91** (0.41)	0.23 (0.25)	1.47** (0.62)	1.12** (0.48)	0.95 (0.67)
LRGDP(-1)	–0.06 (0.12)	–0.27** (0.11)	–0.16 (0.18)			
Adj. R^2	0.11	0.74	0.16	0.19	0.76	0.23
D.W. Stat	1.93	1.75	1.87	1.78	1.95	1.94
F-Stat	2.88	31.24	4.26	2.86	21.11	3.71
Prob (F-Stat)	0.01	0.00	0.00	0.01	0.00	0.01
No. of obs.	76	76	76	76	76	76
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	HKG=–3.50	KOR=1.65	MYS=–3.18	THA=5.03
Model 2	HKG=–2.47	KOR=2.27	MYS=–1.14	THA=1.34
Model 3	HKG=–3.72	KOR=2.18	MYS=–1.42	THA=2.96

[48] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.17

TFPG and Future Economic Growth in South Asia[49]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	4.68* (1.30)	3.84* (1.05)	3.23** (1.45)	–0.26 (2.56)	0.72 (2.09)	–0.25 (2.62)
TFPG(-1)	0.18** (0.08)	0.08 (0.11)	0.17 (0.14)	0.19** (0.08)	0.05 (0.09)	0.17** (0.08)
GFI(-1)		0.19* (0.03)			0.17* (0.03)	
GISH(-1)			0.001* (0.0005)			0.00001 (0.0007)
INF	–0.10*** (0.06)	–0.02 (0.05)	–0.11*** (0.06)	–0.08 (0.06)	–0.01 (0.05)	–0.13** (0.06)
GP	–0.05 (0.35)	–0.009 (0.28)	0.16 (0.34)	0.05 (0.34)	–0.02 (0.28)	0.05 (0.35)
GTO	0.02 (0.02)	0.003 (0.01)	0.06*** (0.03)	0.09* (0.03)	0.07** (0.003)	0.09* (0.03)
GOVSH	0.03 (0.05)	0.009 (0.04)	0.05 (0.06)	0.14 (0.16)	0.07 (0.13)	0.14 (0.17)
LRGDP(-1)	0.17 (0.13)	–0.04* (0.01)	–0.12** (0.06)			
Adj. R^2	0.19	0.41	0.54	0.23	0.46	0.49
D.W. Stat	1.92	1.86	1.89	1.95	2.12	1.95
F-Stat	6.22	8.57	21.63	7.86	8.03	17.38
Prob (F-Stat)	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	76	76	76	76	76	76
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	BGD=2.02	IND=1.84	LKA=–4.49	PAK=0.64
Model 2	BGD=0.91	IND=1.32	LKA=–2.69	PAK=0.45
Model 3	BGD=2.02	IND=1.84	LKA=–4.50	PAK=0.64

[49] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.18

TFPGI and Future Economic Growth in South Asia[50]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	6.55* (1.83)	5.18* (1.53)	5.20* (1.89)	1.66 (3.15)	2.36 (2.60)	1.51 (3.19)
TFPGI(-1)	0.12 (0.08)	0.01 (0.06)	0.14*** (0.07)	0.12 (0.07)	0.02 (0.06)	0.13 (0.07)
GFI(-1)		0.18* (0.03)			0.16* (0.02)	
GISH(-1)			0.001** (0.0005)			–0.0003 (0.0007)
INF	–0.05 (0.06)	0.004 (0.05)	–0.05 (0.06)	–0.03 (0.06)	0.01 (0.05)	–0.03 (0.06)
GP	–0.94 (0.64)	–0.57 (0.53)	–1.19*** (0.63)	–0.52 (0.68)	–0.46 (0.56)	–0.54 (0.69)
GTO	–0.02 (0.02)	–0.02 (0.02)	0.02 (0.03)	0.065*** (0.033)	0.04 (0.03)	0.07*** (0.033)
GOVSH	0.009 (0.05)	0.008 (0.04)	0.09 (0.06)	0.14 (0.16)	0.05 (0.10)	0.17 (0.17)
LRGDP(-1)	–0.29* (0.11)	0.10 (0.10)	–0.22** (0.11)			
Adj. R^2	0.11	0.40	0.16	0.22	0.47	0.21
D.W. Stat	1.95	1.88	1.95	1.74	2.02	1.75
F-Stat	2.47	7.63	2.93	3.54	7.99	3.13
Prob (F-Stat)	0.03	0.00	0.01	0.001	0.00	0.03
No. of obs.	72	72	72	72	72	72
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	BGD=1.75	IND=1.98	LKA=–4.06	PAK=0.33
Model 2	BGD=0.64	IND=1.38	LKA=–2.34	PAK=0.33
Model 3	BGD=1.78	IND=1.76	LKA=–3.70	PAK=0.16

[50] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.19

TFPGE and Future Economic Growth in South Asia[51]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	2.08* (0.64)	2.96* (0.71)	3.11** (1.31)	–0.26 (2.56)	0.72 (2.09)	–0.25 (2.62)
TFPGE(-1)	0.17 (0.14)	0.11 (0.14)	0.09 (0.11)	0.22** (0.09)	0.07 (0.08)	0.19** (0.09)
GFI(-1)		0.23* (0.04)			0.21* (0.04)	
GISH(-1)			0.002* (0.0004)			0.00004 (0.0009)
INF	–0.11*** (0.06)	–0.03 (0.08)	–0.13*** (0.07)	–0.09 (0.07)	–0.02 (0.04)	–0.04 (0.06)
GP	–0.17 (0.13)	–0.22 (0.17)	–0.26*** (0.14)	0.12 (0.26)	–0.09 (0.16)	0.11 (0.12)
GTO	0.04 (0.04)	0.005 (0.01)	0.09** (0.04)	0.16* (0.05)	0.14** (0.06)	0.12* (0.03)
GOVSH	0.04 (0.07)	0.01 (0.03)	0.07 (0.09)	0.11 (0.18)	0.15 (0.17)	0.18 (0.12)
LRGDP(-1)	0.14 (0.08)	–0.05** (0.02)	–0.12* (0.04)			
Adj. R^2	0.16	0.37	0.64	0.28	0.46	0.31
D.W. Stat	1.87	1.86	1.89	1.96	1.84	1.82
F-Stat	2.22	6.16	27.68	4.63	11.18	4.27
Prob (F-Stat)	0.05	0.00	0.00	0.00	0.00	0.00
No. of obs.	76	76	76	76	76	76
No. of countries	4	4	4	4	4	4

Fixed Effects

Model 1	BGD=1.13	IND=2.17	LKA=–4.02	PAK=0.72
Model 2	BGD=0.73	IND=2.27	LKA=–3.52	PAK=0.52
Model 3	BGD=0.92	IND=2.15	LKA=–4.20	PAK=1.13

[51] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.20

TFPG and Future Economic Growth in EU-15[52]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	1.21*** (0.68)	1.15** (0.48)	0.45 (0.76)	20.21*** (3.03)	5.89* (2.06)	11.81* (2.80)
TFPG(-1)	0.31* (0.10)	0.08 (0.06)	0.34* (0.10)	0.65* (0.08)	0.16* (0.06)	0.41* (0.08)
GFI(-1)		0.27* (0.01)			0.28* (0.01)	
GISH(-1)			0.04* (0.01)			0.29* (0.03)
INF	0.04 (0.05)	–0.006 (0.04)	–0.01 (0.06)	0.02 (0.06)	–0.01 (0.04)	0.02 (0.06)
GP	0.30 (0.31)	0.46** (0.21)	0.05 (0.32)	0.63 (0.42)	0.07 (0.27)	–0.21 (0.38)
GTO	0.0005 (0.003)	0.0002 (0.001)	0.001 (0.002)	0.03* (0.008)	0.02* (0.005)	0.03* (0.007)
GOVSH	0.09 (0.06)	0.04 (0.04)	0.04 (0.06)	1.65* (0.26)	0.31*** (0.18)	1.10 (0.24)
LRGDP(-1)	–0.55* (0.08)	–0.25* (0.06)	–0.49* (0.08)			
Adj. R^2	0.37	0.73	0.39	0.36	0.74	0.51
D.W. Stat	1.62	1.84	1.61	1.67	1.85	1.73
F-Stat	29.04	114.40	27.64	9.40	41.59	15.87
Prob (F-Stat)	0.00	0.000	0.000	0.00	0.000	0.00
No. of obs.	285	285	285	285	285	285
No. of countries	15	15	15	15	15	15

Fixed Effects

Model 1	AUT=–1.46	BEL=3.36	DNK=0.77	FIN=–0.36	FRA=0.30
	GER=0.96	GRE=–0.81	IRL=–2.39	ITA=–2.85	LUX=1.62
	NLD=10.25	PRT=–6.48	ESP=–2.04	SWE=2.20	GBR=–3.08
Model 2	AUT=–0.19	BEL=0.93	DNK=–0.53	FIN=–0.23	FRA=–0.74
	GER=–0.46	GRE=–0.55	IRL=1.67	ITA=–1.49	LUX=2.64
	NLD=2.08	PRT=–1.67	ESP=–0.58	SWE=0.21	GBR=–1.07
Model 3	AUT=2.81	BEL=6.41	DNK=3.72	FIN=3.40	FRA=3.35
	GER=3.95	GRE=–3.84	IRL=–2.25	ITA=–5.99	LUX=1.40
	NLD=5.67	PRT=–9.43	ESP=–5.31	SWE=–0.31	GBR=–3.58

[52] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.21

TFPGI and Future Economic Growth in EU-15[53]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	0.87 (0.76)	1.10** (0.50)	0.23 (0.70)	23.64* (3.51)	5.94* (2.24)	12.04* (3.13)
TFPGI(-1)	0.022 (0.04)	–0.01 (0.03)	0.01 (0.04)	0.01 (0.05)	–0.01 (0.03)	0.03 (0.04)
GFI(-1)		0.27* (0.01)			0.30* (0.02)	
GISH(-1)			0.036* (0.013)			0.35* (0.03)
INF	0.003 (0.06)	–0.04 (0.04)	–0.046 (0.06)	0.0002 (0.08)	–0.03 (0.05)	0.05 (0.07)
GP	0.13 (0.31)	0.45** (0.20)	–0.13 (0.32)	0.12 (0.49)	–0.02 (0.29)	–0.78 (0.42)
GTO	0.002 (0.003)	–0.0002 (0.001)	0.0009 (0.002)	0.04* (0.009)	0.02** (0.006)	0.04* (0.008)
GOVSH	0.04 (0.06)	0.035 (0.04)	0.001 (0.06)	1.87* (0.31)	0.30 (0.19)	1.11* (0.27)
LRGDP(-1)	–0.72* (0.07)	–0.29* (0.05)	–0.69* (0.06)			
Adj. R^2	0.35	0.72	0.37	0.22	0.72	0.35
D.W. Stat	1.82	1.92	1.83	1.75	1.94	1.82
F-Stat	25.92	101.51	23.79	4.89	36.08	25.92
Prob (F-Stat)	0.00	0.00	0.00	0.00	0.00	0.00
No. of obs.	270	270	270	270	270	270
No. of countries	15	15	15	15	15	15

Fixed Effects

Model 1	AUT=–1.41	BEL=3.80	DNK=0.57	FIN=0.37	FRA=–0.11
	GER=1.27	GRE=–1.71	IRL=–1.34	ITA=–3.86	LUX=2.62
	NLD=11.87	PRT=–8.53	ESP=2.90	SWE=2.63	GBR=–3.28
Model 2	AUT=–0.06	BEL=0.79	DNK=–0.70	FIN=–0.004	FRA=–0.83
	GER=–0.50	GRE=–0.60	IRL=1.99	ITA=–1.57	LUX=2.69
	NLD=2.07	PRT=–1.90	ESP=–0.63	SWE=0.23	GBR=–0.97
Model 3	AUT=3.68	BEL=7.14	DNK=4.09	FIN=4.42	FRA=3.68
	GER=4.65	GRE=–5.00	IRL=–1.35	ITA=–7.16	LUX=1.98
	NLD=5.65	PRT=–11.22	ESP=–6.35	SWE=–0.48	GBR=–3.72

[53] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.22

TFPGE and Future Economic Growth in EU-15[54]

Dependent Variable: growth rate of real GDP per capita (GRGDP)						
Independent Variables	Pooled Regression			Fixed-effects Panel Regression		
	1	2	3	1	2	3
Constant	1.05 (0.71)	1.21** (0.52)	0.58 (0.65)	11.74* (2.74)	7.6* (2.42)	6.50** (2.92)
TFPGE(-1)	0.28** (0.11)	0.11 (0.08)	0.29* (0.09)	0.54* (0.13)	0.13** (0.06)	0.32* (0.09)
GFI(-1)		0.19* (0.02)			0.21* (0.02)	
GISH(-1)			0.05** (0.02)			0.23* (0.03)
INF	0.05 (0.04)	–0.003 (0.04)	–0.04 (0.05)	0.03 (0.03)	–0.02 (0.03)	0.03 (0.04)
GP	0.19 (0.21)	0.35** (0.17)	0.07 (0.13)	0.32 (0.22)	0.12 (0.17)	–0.17 (0.18)
GTO	0.008 (0.009)	0.003 (0.002)	0.003 (0.003)	0.04* (0.006)	0.03* (0.005)	0.03* (0.005)
GOVSH	0.18*** (0.10)	0.06 (0.09)	0.08 (0.07)	0.84* (0.19)	0.46** (0.17)	0.53** (0.21)
LRGDP(-1)	–0.41* (0.06)	–0.33* (0.07)	–0.56* (0.09)			
Adj. R^2	0.41	0.69	0.40	0.35	0.71	0.48
D.W. Stat	1.73	1.86	1.69	1.68	1.87	1.79
F-Stat	35.65	189.65	37.69	8.89	65.59	25.54
Prob (F-Stat)	0.00	0.000	0.000	0.00	0.000	0.00
No. of obs.	285	285	285	285	285	285
No. of countries	15	15	15	15	15	15

Fixed Effects

Model 1	AUT=1.17	BEL=0.58	DNK=0.18	FIN=1.06	FRA=0.44
	GER=0.44	GRE=–1.74	IRL=1.87	ITA=–0.85	LUX=0.50
	NLD=–0.33	PRT=–1.54	ESP=–0.71	SWE=–0.57	GBR=–0.49
Model 2	AUT=3.01	BEL=2.23	DNK=1.71	FIN=2.73	FRA=1.93
	GER=–0.24	GRE=–3.55	IRL=1.76	ITA=–1.64	LUX=1.86
	NLD=–1.14	PRT=–3.78	ESP=–2.34	SWE=–1.18	GBR=–1.37
Model 3	AUT=3.21	BEL=3.72	DNK=1.77	FIN=2.48	FRA=1.16
	GER=1.50	GRE=–2.69	IRL=2.60	ITA=–4.60	LUX=3.72
	NLD=–0.79	PRT=–4.71	ESP=–3.54	SWE=–1.50	GBR=–2.34

[54] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.23

TFPG and Future Investment in Full Sample[55]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	Model 1	**Model 2**	**Model 1**	**Model 2**
	GFI	**GISH**	**GFI**	**GISH**
Constant	2.40*** (1.22)	1.86* (0.50)	9.39** (4.51)	2.76* (0.25)
TFPG(-1)	0.64* (0.13)	0.11*** (0.05)	0.64* (0.14)	0.03* (0.007)
INF	0.002 (0.002)	0.001 (0.001)	0.004 (0.003)	0.001 (0.001)
GP	1.83* (0.48)	0.73* (0.17)	0.76 (0.88)	0.14 (0.31)
GTO	–0.006 (0.005)	0.001 (0.002)	–0.001 (0.02)	0.007** (0.003)
GOVSH	0.002 (0.08)	–0.07*** (0.04)	–0.69** (0.30)	–0.47* (0.14)
Adj. R^2	0.17	0.21	0.18	0.32
D.W. Stat	1.85	1.92	1.86	1.68
F-Stat	7.95	9.63	8.02	18.53
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	665	665	665	665
No. of countries	35	35	35	35

Fixed Effects

Model 1											
HUN	ROM	TUR	DZA	EGY	MAR	ZFA	ARG	BRA	CHL	COL	MEX
1.27	10.89	−1.16	9.98	0.56	−1.11	0.46	1.05	−1.16	0.90	2.95	−3.57
BGD	IND	PAK	LKA	HKG	KOR	MYS	THA	AUT	BEL	DNK	FIN
0.13	6.64	0.38	1.89	−5.36	−3.02	−1.81	−4.17	−2.64	−0.51	0.234	−2.42
FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT	ESP	SWE	GBR	
−0.35	−1.54	0.203	−2.09	−2.81	−0.36	3.621	−3.63	−0.84	−0.6	−2.01	
Model 2											
HUN	ROM	TUR	DZA	EGY	MAR	ZFA	ARG	BRA	CHL	COL	MEX
0.00	8.66	−0.60	7.43	1.89	0.95	1.02	2.15	−1.41	2.09	4.47	−1.74
BGD	IND	PAK	LKA	HKG	KOR	MYS	THA	AUT	BEL	DNK	FIN
2.24	6.50	−0.54	−0.78	−3.71	−2.67	−1.43	−3.50	−3.02	−1.58	−0.15	−0.84
FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT	ESP	SWE	GBR	
−1.73	−2.76	−0.31	−0.01	−3.21	−0.95	0.323	−3.16	−1.36	−1.11	−1.15	

[55] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.24

TFPGI and Future Investment in Full Sample[56]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	Model 1	**Model 2**	**Model 1**	**Model 2**
	GFI	**GISH**	**GFI**	**GISH**
Constant	2.43* (0.61)	1.75* (0.43)	7.05* (1.57)	7.26* (1.58)
TFPGI(-1)	0.10*** (0.05)	0.14** (0.05)	0.26* (0.04)	0.26* (0.05)
INF	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
GP	0.81* (0.17)	0.61* (0.14)	0.13 (0.31)	0.14 (0.31)
GTO	0.001 (0.002)	0.004** (0.002)	0.007* (0.002)	0.007** (0.003)
GOVSH	–0.01 (0.02)	–0.07*** (0.04)	–0.43* (0.13)	–0.47* (0.14)
Adj. R^2	0.18	0.19	0.17	0.19
D.W. Stat	1.94	1.92	1.68	1.68
F-Stat	26.20	23.63	4.57	4.53
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	630	630	630	630
No. of countries	35	35	35	35

Fixed Effects

Model 1											
HUN	ROM	TUR	DZA	EGY	MAR	ZFA	ARG	BRA	CHL	COL	MEX
0.73	5.36	−1.49	2.95	1.63	−2.77	−2.84	−1.77	1.39	−1.67	−1.10	−7.02
BGD	IND	PAK	LKA	HKG	KOR	MYS	THA	AUT	BEL	DNK	FIN
−3.42	6.19	2.94	9.28	−6.58	−0.27	−2.13	−0.95	−0.46	0.40	0.31	0.28
FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT	ESP	SWE	GBR	
0.85	0.61	0.85	−0.52	−0.98	−1.38	3.44	−2.99	0.37	1.08	−0.34	
Model 2											
HUN	ROM	TUR	DZA	EGY	MAR	ZFA	ARG	BRA	CHL	COL	MEX
1.341	13.16	−2.43	10.23	1.207	−1.77	−1.03	1.522	−1.45	−0.13	2.29	−4.29
BGD	IND	PAK	LKA	HKG	KOR	MYS	THA	AUT	BEL	DNK	FIN
−0.91	7.669	0.356	4.501	−5.89	−2.21	−2.47	−4.46	−2.24	−0.4	0.027	−1.65
FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT	ESP	SWE	GBR	
−0.61	−0.89	0.03	−1.72	−3.14	−0.87	4.44	−4.76	−1.51	0.04	−1.98	

[56] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.25

TFPGE and Future Investment in Full Sample[57]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	Model 1	**Model 2**	**Model 1**	**Model 2**
	GFI	**GISH**	**GFI**	**GISH**
Constant	2.15*** (1.24)	11.76* (3.65)	10.46** (4.60)	–0.43 (0.51)
TFPGE(-1)	0.62* (0.19)	0.46* (0.17)	0.63*** (0.34)	0.94** (0.39)
INF	0.001 (0.003)	0.15 (0.12)	0.003 (0.003)	0.001 (0.03)
GP	1.74* (0.49)	0.12* (0.009)	0.50 (0.90)	0.51 (0.44)
GTO	–0.004 (0.005)	0.64* (0.23)	0.002 (0.02)	0.26 (0.23)
GOVSH	0.04 (0.08)	–0.66* (0.03)	–0.79*** (0.40)	–0.67** (0.32)
Adj. R^2	0.15	0.38	0.11	0.95
D.W. Stat	1.85	1.62	1.59	1.85
F-Stat	7.95	81.38	2.43	332.48
Prob (F-Stat)	0.00	0.00	0.04	0.00
No. of obs.	665	665	665	665
No. of countries	35	35	35	35

Fixed Effects

Model 1											
HUN	ROM	TUR	DZA	EGY	MAR	ZFA	ARG	BRA	CHL	COL	MEX
1.27	12.17	–2.71	9.22	0.46	–1.75	–1.18	1.46	–2.04	–0.26	1.96	–4.20
BGD	IND	PAK	LKA	HKG	KOR	MYS	THA	AUT	BEL	DNK	FIN
–1.08	6.72	–0.79	15.39	–6.15	–2.08	–3.31	–4.57	–2.35	–0.75	–0.23	–1.83
FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT	ESP	SWE	GBR	
–0.94	–1.12	0.067	–2.11	–3.1	–1.49	3.593	–4.45	–1.69	–0.18	–1.96	
Model 2											
HUN	ROM	TUR	DZA	EGY	MAR	ZFA	ARG	BRA	CHL	COL	MEX
0.768	11.67	–2.5	9.578	0.814	–1.69	–1.1	1.427	–1.92	–0.2	2.12	–4.09
BGD	IND	PAK	LKA	HKG	KOR	MYS	THA	AUT	BEL	DNK	FIN
–0.85	7.041	–0.13	15.53	–5.7	–2.3	–2.41	–4.52	–2.66	–0.98	–0.52	–2.18
FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT	ESP	SWE	GBR	
–1.2	–1.53	–0.31	–1.82	–3.46	-1	3.521	–4.8	–1.8	–0.5	–2.31	

[57] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.26

TFPG and Future Investment in Central and East Europe[58]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	11.65* (3.75)	7.79* (2.35)	9.73* (2.98)	5.82** (2.78)
TFPG(-1)	0.42* (0.12)	0.007 (0.08)	0.36** (0.10)	0.04 (0.07)
INF	0.001 (0.002)	0.008 (0.01)	0.001 (0.002)	0.02*** (0.01)
GP	1.23** (0.57)	2.65* (0.95)	1.17** (0.48)	5.61** (2.49)
GTO	0.06* (0.01)	0.07* (0.01)	0.06* (0.01)	0.08* (0.01)
GOVSH	–0.51* (0.16)	–0.47* (0.10)	–0.44** (0.18)	–0.76* (0.17)
Adj. R^2	0.68	0.39	0.57	0.57
D.W. Stat	1.94	1.77	1.78	1.88
F-Stat	36.20	8.09	24.57	9.37
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	57	57	57	57
No. of countries	3	3	3	3

Fixed Effects

Country	HUN	ROM	TUR
Model 1	–4.92	–7.96	12.88
Model 2	1.11	–3.28	2.16

[58] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.27

TFPGI and Future Investment in Central and East Europe[59]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	5.65** (2.21)	9.07* (2.42)	4.87** (2.35)	6.30** (2.89)
TFPGI(-1)	0.29** (0.13)	–0.06 (0.10)	0.23** (0.11)	–0.04 (0.10)
INF	0.002 (0.002)	0.003 (0.01)	0.003 (0.002)	0.01 (0.01)
GP	1.86** (0.86)	2.43** (0.96)	1.42** (0.65)	5.12*** (2.71)
GTO	0.09* (0.03)	0.06* (0.02)	0.08** (0.03)	0.07* (0.02)
GOVSH	–0.52* (0.15)	–0.43* (0.11)	–0.51* (0.14)	–0.75* (0.18)
Adj. R^2	0.68	0.35	0.57	0.46
D.W. Stat	1.91	1.74	1.78	1.81
F-Stat	67.20	6.73	54.57	7.43
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	54	54	54	54
No. of countries	3	3	3	3

Fixed Effects

Country	HUN	ROM	TUR
Model 1	–4.39	–7.64	12.03
Model 2	1.90	–8.74	6.84

[59] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.28

TFPGE and Future Investment in Central and East Europe[60]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	4.45** (2.10)	7.68* (2.25)	6.86** (3.18)	5.24*** (2.66)
TFPGE(-1)	0.39** (0.19)	0.52** (0.25)	0.43** (0.20)	0.49** (0.22)
INF	0.002 (0.002)	0.01 (0.01)	0.003 (0.002)	0.02** (0.009)
GP	2.12** (0.93)	2.36** (0.91)	1.89** (0.91)	5.18** (2.39)
GTO	0.07* (0.02)	0.06* (0.01)	0.08* (0.02)	0.08* (0.01)
GOVSH	–0.55* (0.11)	–0.44* (0.10)	–0.41* (0.13)	–0.76* (0.16)
Adj. R^2	0.58	0.44	0.57	0.55
D.W. Stat	1.83	1.72	1.87	1.81
F-Stat	56.13	9.71	44.57	10.86
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	57	57	57	57
No. of countries	3	3	3	3

Fixed Effects

Country	HUN	ROM	TUR
Model 1	–4.39	–7.64	12.03
Model 2	–4.38	–7.80	12.18

[60] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.29

TFPG and Future Investment in Africa[61]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	–14.54* (4.62)	–1.29 (8.03)	–11.93 (14.45)	–8.98 (10.67)
TFPG(-1)	0.64** (0.25)	1.12** (0.42)	0.49*** (0.26)	0.09 (0.18)
INF	–0.01 (0.09)	–0.15 (0.17)	–0.06 (0.10)	–0.03 (0.08)
GP	1.65 (1.21)	–3.30 (2.10)	–2.34*** (1.23)	0.44 (0.90)
GTO	0.31* (0.07)	0.57* (0.14)	0.33* (0.08)	0.27* (0.06)
GOVSH	0.05 (0.26)	–0.59 (0.46)	–0.49 (1.46)	–1.75 (1.07)
Adj. R^2	0.21	0.22	0.24	0.86
D.W. Stat	1.70	1.71	1.89	1.68
F-Stat	5.10	5.14	4.02	60.54
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	76	76	76	76
No. of countries	04	04	04	04

Fixed Effects

Country	DZA	EGY	MAR	ZFA
Model 1	–3.26	–18.94	–16.46	5.74
Model 2	3.35	–1.95	–2.89	1.49

[61] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.30

TFPGI and Future Investment in Africa[62]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	16.69** (8.24)	1.86* (0.50)	–14.33 (15.32)	–7.58 (10.80)
TFPGI(-1)	0.45 (0.58)	0.11*** (0.05)	1.22* (0.35)	–0.15 (0.25)
INF	–0.04 (0.18)	0.001 (0.001)	–0.05 (0.12)	–0.01 (0.08)
GP	–13.44* (2.86)	–0.73* (0.17)	–0.09 (2.14)	–3.84** (1.51)
GTO	0.46* (0.12)	0.001 (0.002)	0.35* (0.09)	0.026* (0.06)
GOVSH	–0.17 (0.42)	–0.07*** (0.04)	0.07 (1.45)	–2.37** (1.02)
Adj. R^2	0.37	0.19	0.29	0.89
D.W. Stat	1.78	1.92	1.63	1.80
F-Stat	9.41	23.63	4.56	71.80
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	72	72	72	72
No. of countries	4	4	4	4

Fixed Effects

Country	DZA	EGY	MAR	ZFA
Model 1	–0.38	–0.36	–0.76	1.51
Model 2	–6.94	–17.16	17.95	6.15

[62] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.31

TFPGE and Future Investment in Africa[63]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	–16.33* (4.57)	2.71 (8.28)	–12.86 (14.56)	–9.76 (10.58)
TFPGE(-1)	2.86*** (1.51)	4.30*** (2.25)	2.78*** (1.57)	0.53 (1.15)
INF	–0.03 (0.09)	–0.07 (0.17)	0.08 (0.10)	–0.02 (0.07)
GP	1.97 (1.21)	–3.62 (2.19)	–2.46*** (1.25)	0.59 (0.92)
GTO	0.31* (0.08)	0.55* (0.14)	0.32* (0.09)	0.26* (0.07)
GOVSH	–0.21 (0.27)	–0.89*** (0.49)	–0.34 (1.47)	1.77 (1.08)
Adj. R^2	0.23	0.17	0.24	0.19
D.W. Stat	1.62	1.60	1.70	1.78
F-Stat	5.55	4.06	3.92	4.53
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	76	76	76	76
No. of countries	4	4	4	4

Fixed Effects

Country	DZA	EGY	MAR	ZFA
Model 1	–3.68	–19.23	16.93	5.98
Model 2	3.43	–1.51	–2.56	0.64

[63] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.32

TFPG and Future Investment in Latin America[64]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	28.90** (14.46)	49.49* (11.37)	101.43* (29.04)	59.98* (22.76)
TFPG(-1)	–0.12 (0.44)	–0.44 (0.35)	–0.12 (0.45)	–0.22 (0.35)
INF	0.003 (0.004)	0.006 (0.003)	0.006 (0.005)	0.006 (0.003)
GP	–6.94 (4.74)	–1.49 (3.73)	–13.59** (5.70)	–3.60 (4.47)
GTO	0.31** (0.14)	0.34* (0.11)	0.54* (0.24)	0.24 (0.19)
GOVSH	–1.39** (0.58)	–2.68* (0.57)	–2.32** (1.05)	–2.69** (1.29)
Adj. R^2	0.15	0.27	0.19	0.33
D.W. Stat	1.65	1.65	1.53	1.80
F-Stat	2.73	8.00	2.60	6.04
Prob (F-Stat)	0.02	0.00	0.02	0.00
No. of obs.	95	95	95	95
No. of countries	5	5	5	5

Fixed Effects

Country	ARG	BRA	CHL	COL	MEX
Model 1	–5.80	19.85	2.69	6.35	–23.09
Model 2	–5.97	13.30	–6.11	0.37	–1.76

[64] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.33

TFPGI and Future Investment in Latin America[65]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	24.13 (15.10)	50.00* (11.77)	127.67* (33.77)	93.33* (25.80)
TFPGI(-1)	1.07*** (0.63)	0.37 (0.49)	0.89 (0.63)	0.62 (0.48)
INF	0.002 (0.004)	0.006*** (0.003)	0.008 (0.005)	0.007** (0.003)
GP	–5.67 (4.84)	0.03 (3.77)	–14.00** (5.61)	–4.86 (4.29)
GTO	0.10 (0.15)	0.36* (0.11)	0.59** (0.26)	0.36*** (0.20)
GOVSH	1.14 (1.05)	–5.02* (0.82)	–13.38* (3.68)	–11.28* (2.81)
Adj. R^2	0.05	0.30	0.22	0.40
D.W. Stat	1.59	1.63	1.71	1.77
F-Stat	1.04	8.48	2.35	7.60
Prob (F-Stat)	0.34	0.00	0.04	0.00
No. of obs.	90	90	90	90
No. of countries	5	5	5	5

Fixed Effects

Country	ARG	BRA	CHL	COL	MEX
Model 1	–8.85	33.19	–1.78	11.10	–33.65
Model 2	–9.36	26.64	–9.17	4.91	–13.02

[65] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.34

TFPGE and Future Investment in Latin America[66]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	29.93** (14.84)	45.35* (11.69)	102.23* (29.14)	58.32** (22.73)
TFPGE(-1)	0.50 (1.39)	1.33 (1.09)	0.31 (1.39)	–1.17 (1.09)
INF	0.004 (0.005)	0.006 (0.004)	0.007 (0.005)	0.005 (0.004)
GP	–7.22 (4.77)	–1.13 (3.75)	–14.04 (5.72)	–3.19 (4.47)
GTO	0.13 (0.14)	0.29** (0.11)	0.55** (0.24)	0.20 (0.189)
GOVSH	–1.47 (1.02)	–4.33* (0.80)	–9.31* (3.04)	–6.69* (2.37)
Adj. R^2	0.03	0.27	0.05	0.33
D.W. Stat	1.57	1.62	1.65	1.76
F-Stat	0.74	7.97	1.60	6.18
Prob (F-Stat)	0.59	0.00	0.12	0.00
No. of obs.	95	95	95	95
No. of countries	5	5	5	5

Fixed Effects

Country	ARG	BRA	CHL	COL	MEX
Model 1	–5.86	14.48	–6.41	0.34	–2.55
Model 2	–6.16	19.62	2.77	6.54	22.78

[66] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.35

TFPG and Future Investment in East Asia[67]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	24.88 (20.21)	09.72* (1.33)	21.74 (23.16)	22.06* (5.54)
TFPG(-1)	1.17* (0.40)	0.51** (0.20)	1.15* (0.41)	0.52* (0.18)
INF	–0.10 (0.40)	–0.09 (0.20)	–0.16 (0.403)	–0.21 (0.17)
GP	2.32 (1.81)	2.27** (0.93)	6.09*** (3.22)	3.22** (1.42)
GTO	–0.05 (0.035)	0.15* (0. 02)	0.0007 (0.05)	0.10* (0.02)
GOVSH	–3.21 (2.35)	–3.63* (1.19)	–4.99 (3.07)	–3.29* (1.01)
Adj. R^2	0.12	0.52	0.12	0.64
D.W. Stat	1.84	1.75	1.81	1.67
F-Stat	3.04	17.46	2.25	17.99
Prob (F-Stat)	0.01	0.00	0.03	0.00
No. of obs.	76	76	76	76
No. of countries	4	4	4	4

Fixed Effects

Country	HKG	KOR	MYS	THA
Model 1	–9.66	10.79	–7.57	6.43
Model 2	–8.02	11.14	–10.43	7.32

[67] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.36

TFPGI and Future Investment in East Asia[68]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	37.67 (23.22)	124.52* (10.85)	29.88 (30.93)	110.08* (13.40)
TFPGI(-1)	0.58 (0.37)	–0.003 (0.17)	0.58 (0.42)	0.09 (0.18)
INF	0.02 (0.43)	0.08 (0.20)	–0.11 (0.45)	–0.10 (0.19)
GP	0.47* (2.34)	4.47* (1.09)	5.12 (5.23)	1.59 (2.26)
GTO	–0.06 (0.03)	0.16* (0.02)	–0.004 (0.07)	0.12* (0.032)
GOVSH	–4.58*** (2.72)	–3.30** (1.27)	–3.07** (1.49)	–2.74** (1.27)
Adj. R^2	0.12	0.55	0.07	0.61
D.W. Stat	1.74	1.65	1.62	1.65
F-Stat	1.30	18.59	1.07	14.93
Prob (F-Stat)	0.27	0.00	0.40	0.00
No. of obs.	72	72	72	72
No. of countries	4	4	4	4

Fixed Effects

Country	HKG	KOR	MYS	THA
Model 1	–5.36	8.43	–8.78	5.71
Model 2	–11.61	11.80	–7.52	7.33

[68] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.37

TFPGE and Future Investment in East Asia[69]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	31.77 (21.42)	112.01* (10.85)	23.33 (24.28)	102.15* (10.82)
TFPGE(-1)	2.93** (1.31)	–1.00 (1.68)	2.80** (1.38)	–0.72 (1.51)
INF	0.23 (0.44)	0.02 (0.22)	0.19 (0.45)	–0.09 (0.19)
GP	2.02 (1.93)	2.50** (0.01)	2.29*** (1.20)	3.15** (1.52)
GTO	–0.04 (0.03)	0.15* (0.01)	0.01 (0.05)	0.09* (0.024)
GOVSH	–3.52 (2.47)	–3.72** (1.35)	–4.99 (3.22)	–3.01** (1.43)
Adj. R^2	0.13	0.48	0.13	0.60
D.W. Stat	1.62	1.65	1.61	1.63
F-Stat	2.50	15.10	2.32	15.18
Prob (F-Stat)	0.04	0.00	0.04	0.00
No. of obs.	76	76	76	76
No. of countries	4	4	4	4

Fixed Effects

Country	HKG	KOR	MYS	THA
Model 1	–11.06	13.38	–7.97	5.65
Model 2	–8.98	12.44	–10.65	7.19

[69] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.38

TFPG and Future Investment in South Asia[70]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	7.87** (3.58)	–1.62* (0.26)	–5.83 (8.90)	–6.56 (4.44)
TFPG(-1)	0.92** (0.39)	–0.04 (0.03)	0.72*** (0.39)	–0.21 (0.19)
INF	–0.47** (0.19)	0.001 (0.001)	–0.42** (0.21)	0.016 (0.010)
GP	–0.27 (1.12)	–0.10 (0.08)	0.17 (1.21)	–0.12 (0.60)
GTO	0.09** (0.04)	0.04* (0.005)	0.20** (0.10)	0.06** (0.03)
GOVSH	–0.16 (0.17)	–0.08* (0.01)	0.45 (0.57)	–0.87* (0.28)
Adj. R^2	0.20	0.87	0.17	0.94
D.W. Stat	1.66	1.61	1.73	1.65
F-Stat	3.44	108.04	2.80	155.88
Prob (F-Stat)	0.01	0.00	0.01	0.00
No. of obs.	76	76	76	76
No. of countries	4	4	4	4

Fixed Effects

Country	BGD	IND	LKA	PAK
Model 1	6.52	3.08	1.10	–10.70
Model 2	1.47	–5.93	–4.32	8.77

[70] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.39

TFPGI and Future Investment in South Asia[71]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	13.53** (5.83)	2.58 (2.68)	7.05* (1.57)	–4.31 (11.08)
TFPGI(-1)	0.54** (0.26)	0.48* (0.12)	0.26* (0.04)	0.57** (0.27)
INF	–0.35 (0.21)	0.08 (0.09)	0.001 (0.001)	–0.26 (0.22)
GP	–2.45 (2.15)	–2.10** (0.91)	0.13 (0.31)	–0.42 (2.40)
GTO	0.001 (0.08)	–0.03 (0.04)	0.007* (0.002)	0.14 (0.11)
GOVSH	–0.02 (0.17)	–0.15** (0.07)	–0.43* (0.13)	0.58 (0.58)
Adj. R^2	0.16	0.89	0.17	0.17
D.W. Stat	1.73	1.67	1.68	1.79
F-Stat	2.56	28368.85	4.57	2.56
Prob (F-Stat)	0.03	0.00	0.00	0.02
No. of obs.	72	72	72	72
No. of countries	4	4	4	4

Fixed Effects

Country	BGD	IND	LKA	PAK
Model 1	6.86	3.70	0.01	–10.56
Model 2	8.06	–0.84	1.95	–9.17

[71] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.40

TFPGE and Future Investment in South Asia[72]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	8.27** (3.90)	–4.28 (21.77)	–8.74 (9.32)	–1.29* (0.40)
TFPGE(-1)	0.43 (2.45)	1.52 (1.10)	–0.09 (2.88)	–0.70 (1.12)
INF	–0.48** (0.20)	–0.36*** (0.19)	–0.42** (0.21)	–0.71 (0.93)
GP	–0.49 (1.17)	–0.43 (0.53)	0.12 (1.24)	0.23 (0.53)
GTO	0.08 (0.08)	–0.11 (0.45)	0.21** (0.10)	0.23 (0.45)
GOVSH	–0.05 (0.17)	–0.67* (0.21)	0.72 (0.65)	–1.05* (0.29)
Adj. R^2	0.13	0.39	0.21	0.39
D.W. Stat	1.70	2.11	1.84	1.92
F-Stat	2.14	241.04	2.28	185.29
Prob (F-Stat)	0.06	0.00	0.03	0.00
No. of obs.	76	76	76	76
No. of countries	4	4	4	4

Fixed Effects

Country	BGD	IND	LKA	PAK
Model 1	8.40	3.62	1.50	–13.52
Model 2	9.70	0.26	3.00	–12.96

[72] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.41

TFPG and Future Investment in EU-15[73]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	3.36*** (1.76)	10.47* (1.62)	10.92* (1.22)	8.63* (1.07)
TFPG(-1)	1.73* (0.23)	0.06 (0.36)	1.72* (0.24)	0.80* (0.14)
INF	0.27*** (0.15)	1.22 (0.26)	–0.02 (0.18)	–0.15 (0.10)
GP	0.47 (0.91)	6.77* (1.44)	2.00*** (1.17)	2.87* (0.71)
GTO	0.008 (0.007)	0.007 (0.012)	0.05** (0.002)	0.013 (0.014)
GOVSH	–0.37** (0.17)	–1.42*** (0.26)	–4.77* (0.74)	–1.88* (0.44)
Adj. R^2	0.20	0.29	0.28	0.90
D.W. Stat	1.90	1.72	1.71	1.66
F-Stat	13.91	24.48	6.81	149.57
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	285	285	285	285
No. of countries	15	15	15	15

Fixed Effects

Model 1											
AUT	BEL	DNK	FIN	FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT
–4.51	8.66	4.65	–0.45	3.75	5.09	–0.92	–9.45	–4.87	–3.63	9.08	–7.13
ESP	SWE	GBR									
–5.19	7.05	–2.12									
Model 2											
AUT	BEL	DNK	FIN	FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT
–14.58	–10.35	–10.03	–12.82	–10.36	–10.20	10.33	–0.51	10.68	0.77	15.61	10.04
ESP	SWE	GBR									
11.15	8.53	1.73									

[73] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.42

TFPGI and Future Investment in EU-15[74]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	3.68 (2.36)	19.26* (3.38)	10.23* (1.62)	12.96* (2.53)
TFPGI(-1)	0.23*** (0.12)	0.24 (0.20)	0.07 (0.14)	–0.05 (0.08)
INF	0.37*** (0.20)	1.45* (0.29)	0.11 (0.23)	–0.14 (0.13)
GP	–0.20 (1.00)	7.51* (1.44)	0.50 (1.35)	2.57* (0.78)
GTO	0.008 (0.008)	–0.002 (0.002)	0.08* (0.003)	0.02* (0.002)
GOVSH	–0.30 (0.19)	–1.30* (0.27)	–5.34* (0.85)	–2.17* (0.49)
Adj. R^2	0.17	0.31	0.18	0.49
D.W. Stat	1.81	1.85	1.91	1.85
F-Stat	2.39	25.59	2.96	128.32
Prob (F-Stat)	0.03	0.00	0.00	0.00
No. of obs.	270	270	270	270
No. of countries	15	15	15	15

Fixed Effects

Model 1											
AUT	BEL	DNK	FIN	FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT
–4.60	10.23	4.32	1.28	2.47	6.02	–3.75	–11.35	–7.77	–0.26	13.35	–2.54
ESP	SWE	GBR									
–7.72	8.19	–7.86									
Model 2											
AUT	BEL	DNK	FIN	FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT
–14.47	–9.48	–10.00	–11.52	–10.76	–9.61	9.37	0.04	9.38	1.82	17.65	7.65
ESP	SWE	GBR									
9.79	8.88	1.26									

[74] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.43

TFPGE and Future Investment in EU-15[75]

Independent Variables	Dependent Variables in Pooled Regression		Dependent Variables in Fixed-effects Panel Regression	
	GFI	**GISH**	**GFI**	**GISH**
Constant	3.03 (2.28)	20.32* (3.35)	10.62* (1.52)	13.01* (1.59)
TFPGE(-1)	2.04* (0.67)	0.35 (0.99)	0.47 (0.72)	0.13 (0.42)
INF	0.23** (0.11)	1.22* (0.26)	0.03 (0.19)	–0.12 (0.11)
GP	–0.41 (0.98)	6.71* (1.44)	0.79 (1.28)	2.33* (0.75)
GTO	0.02** (0.01)	–0.007 (0.012)	0.07* (0.02)	0.004 (0.01)
GOVSH	–0.32*** (0.18)	–1.41* (0.27)	–1.58* (0.19)	–2.30* (0.50)
Adj. R^2	0.25	0.29	0.24	0.69
D.W. Stat	1.86	1.67	1.91	1.69
F-Stat	4.06	24.50	3.52	133.24
Prob (F-Stat)	0.00	0.00	0.00	0.00
No. of obs.	285	285	285	285
No. of countries	15	15	15	15

Fixed Effects

Model 1											
AUT	BEL	DNK	FIN	FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT
–4.29	10.02	4.21	1.04	2.97	6.87	–3.06	–3.24	–7.15	–1.92	4.75	–2.90
ESP	SWE	GBR									
–7.83	8.68	–8.16									
Model 2											
AUT	BEL	DNK	FIN	FRA	GER	GRE	IRL	ITA	LUX	NLD	PRT
–14.51	–9.67	–10.19	–12.11	–10.67	–9.29	9.31	–0.09	9.60	1.47	18.48	7.22
ESP	SWE	GBR									
9.88	9.33	1.23									

[75] * indicates statistical significance at 1%, ** at 5% and *** at 10% and values in parenthesis are standard errors.

Table: 6.44

Absolute Convergence Test of GRGDP in Full Sample

Dependent Variable: GRGDP					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LRGDP(-1)	–0.0005*	0.00003	0.06	665	35

Note: * indicates statistical significance at 1%

Table: 6.45

Absolute Convergence Test of GRGDP in Central and East Europe

Dependent Variable: GRGDP					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LRGDP(-1)	–0.0001	0.0002	0.01	57	3

Note: * indicates statistical significance at 1%

Table: 6.46

Absolute Convergence Test of GRGDP in Latin America

Dependent Variable: GRGDP					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LGRGDP(-1)	–0.0003	0.0002	0.02	95	5

Note: * indicates statistical significance at 1%

Table: 6.47

Absolute Convergence Test of GRGDP in Africa

Dependent Variable: GRGDP					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LRGDP(-1)	–0.0004	0.0003	0.02	76	4

Note: * indicates statistical significance at 1%

Table: 6.48

Absolute Convergence Test of GRGDP in East Asia

Dependent Variable: GRGDP					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LRGDP(-1)	–0.00009	0.00007	0.04	76	4

Note: * indicates statistical significance at 1%

Table: 6.49

Absolute Convergence Test of GRGDP in South Asia

Dependent Variable: GRGDP					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LRGDP(-1)	–0.0002	0.0003	0.005	76	4

Note: * indicates statistical significance at 1%

Table: 6.50

Absolute Convergence Test of GRGDP in EU-15

Dependent Variable: GRGDP					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LRGDP(-1)	–0.000003	0.00002	0.001	285	15

Note: * indicates statistical significance at 1%

Table: 6.51

Absolute Convergence Test of TFPGI in Full Sample

Dependent Variable: TFPGI					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LTFPI(-1)	–0.013	0.008	0.01	630	35

Note: * indicates statistical significance at 1%

Table: 6.52

Absolute Convergence Test of TFPGI in Central and East Europe

Dependent Variable: TFPGI					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LTFPI(-1)	–0.07	0.12	0.001	54	3

Note: * indicates statistical significance at 1%

Table: 6.53

Absolute Convergence Test of TFPGI in Latin America

Dependent Variable: TFPGI					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LTFPI(-1)	–0.09	0.10	0.001	90	5

Note: * indicates statistical significance at 1%

Table: 6.54

Absolute Convergence Test of TFPGI in Africa

Dependent Variable: TFPGI					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LTFPI(-1)	–0.008	0.12	0.005	72	4

Note: * indicates statistical significance at 1%

Table: 6.55

Absolute Convergence Test of TFPGI in East Asia

Dependent Variable: TFPGI					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LTFPI(-1)	–0.023**	0.011	0.04	72	4

Note: * indicates statistical significance at 1%

Table: 6.56

Absolute Convergence Test of TFPGI in South Asia

Dependent Variable: TFPGI					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LTFPI(-1)	–0.04	0.13	–0.001	72	4

Note: * indicates statistical significance at 1%

Table: 6.57

Absolute Convergence Test of TFPGI in EU-15

Dependent Variable: TFPGI					
Independent Variable	Coefficient	Standard Error	Adj. R^2	No. of Obs.	No. of Countries
LTFPI(-1)	–0.015**	0.007	0.006	270	35

Note: * indicates statistical significance at 1%

Table: 6.58

Conditional Convergence Test of TFPGI

Independent Variables	Dependent Variable: TFPG						
	Samples						
	Full	CEE	Latin America	Africa	East Asia	South Asia	EU-15
Constant	–0.30	–0.42	–1.83	1.54	–1.40	–1.97	–0.39
LTFPI(-1)	–0.10**	–0.07***	–0.09**	–0.03***	–0.17*	–0.16**	–0.09**
INF	0.0001	–0.01	0.0002	–0.02	–0.44*	–0.0001	0.02
GP	0.30**	0.97	–0.09	–0.18	0.31**	1.67	0.21
GTO	0.005*	0.01***	0.03**	0.03***	0.004***	0.07*	0.006**
GOVSH	0.08**	0.006	0.20***	0.15***	0.56	0.06**	0.005**
Adj. R^2	0.21	0.11	0.18	0.16	0.24	0.21	0.19
D.W.-Stat	1.95	2.00	1.70	1.93	1.99	1.88	1.98
F-Stat	4.58	2.68	3.60	3.52	4.46	3.75	3.44
Prob.(F)	0.000	0.02	0.00	0.00	0.00	0.00	0.002
No. of Obs.	630	54	90	72	72	72	270
No. of Countries	35	3	5	4	4	4	15

Note: Figures in the parentheses are standard errors and * indicates statistical significance at 1%, ** at 5% and *** at 10%