Multi-Factor Productivity in Developing Countries: Exploring the Role of Institutions, Macroeconomic and Global Factors

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Exploring the Role of Institutions, Macroeconomic and Global Factors

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Declaration of Authorship

I, **Tauqir Ahmed** S/O **Shabbir Hussain**, Registration No. 141-SE/PhD/F14, student of PhD Economics at the School of Economics, IIIE, IIUI, do hereby solemnly declare that the thesis entitled "**Multi-Factor Productivity in Developing Countries: Exploring the Role of Institutions, Macroeconomic and Global Factors**", submitted by me in partial fulfillment for the award of Ph.D degree in Economics, is my original work, except where otherwise acknowledged in the text.. I have carried it individually under the supervision and guidance of my supervisor. I further declare that this work has not been submitted to any institution for the award of a certificate, diploma or degree. It is done in partial fulfillment for the Doctor of Philosophy in Economics of the International Islamic University Islamabad.

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The views in this publication are exclusively of the author. The author does not accept any responsibility for the validity of the evidence presented or costs resulting from its use by third parties.

Dedication

This dissertation is dedicated to my beloved father

SUB (R) Shabbir Hussain (Late)

Who had given me invaluable educational opportunities, guidance and support,

Whose affection, love, encouragement and prays of day and night made me able to succeed and to get honor to complete this work

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List of Abbreviations and Acronyms

APF	Aggregate Production Function
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CES	Constant Elasticity of Substitution
DEA	Data Envelopment Analysis
DGP	Data Generating Process
DOLS	Dynamic Ordinary Least Square
DPDM	Dynamic Panel Data Models
EC	Efficiency Change
ECI	Economic Complexity Index
ECM	Error Correction Model
EGM	Endogenous Growth Models
ER	Exchange Rate
FA	Factor Accumulation
FDH	Free Disposal Hull
FDI	Foreign Direct Investment
FE	Fixed Effects
FSU	Former Soviet Union
GAA	Growth Accounting Approach
GEP	Global Economic Prospects
GII	Global Innovation Index
GMM	Generalized Method of Moments
HC	Human Capital
HMI	Hicks-Moorsteen Approach
HPDD	Historical Public Debt Database
ICRG	International Country Risk Guide
ICT	Information and Communications Technology

IMF	International Monetary Fund
IQ	Institutional Quality
IVGLS	Instrumental Variable-Generalized Least Squares
LIML	Limited Information Maximum Likelihood
LSDV	Least Squares with Dummy Variables
LSDV- WG	Least Squares with Dummy Variables within Group
LSE	London School of Economics
MFP	Multi-Factor Productivity
MFPG	MFP Growth
MFPG_H	Human capital Adjusted MFP Growth
MIT	Massachusetts Institute of Technology
MLM	Maximum-Likelihood Method
MPI	Malmquist productivity index
NGM	Neoclassical Growth Model
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Square
PCA	Principal Component Analysis
PWT	Penn World Table
R&D	Research and Development
REN	Renewable Energy
RE	Random Effects
SAR	Spatial Autoregressive
SDM	Spatial Durbin Model
SFA	Stochastic Frontier Analysis
SFM	Stochastic Frontier Model
SMF	Stochastic Meta Frontier
SSM	State Space Model
SUR	Seemingly Unrelated Regression

SURE	Seemingly Unrelated Regression Equations
3SLS	Three-stage Least Squares
2SLS	Two-stage least squares
TC	Technological Change
TE	Technical Efficiency
TED	Total Economy Database
TFP	Total Factor Productivity
UNIDO	United Nations Industrial Development Organization
VAR	Vector autoregressive
WDI	World Development Indicators
WPD	World Productivity Database

ABSTRACT

This study attempts to measure multi-factor productivity growth (MFPG) and examines how institutions, macroeconomic and global factors affect MFPG of developing countries? Measuring MFP precisely is crucial to understand the cross-countries' growth differences. We review the existing methodologies on MFP measurement and then use the most suitable method for the measurement of MFPG and human capital adjusted MFPG (MFPG_H) of each country in our sample, using growth regression methodology. To the best of our knowledge, the MFPG series, particularly, the estimates of MFPG_H are not available in the existing empirical literature for developing and emerging economies.

We examine the effects of institutional as well as macroeconomic factors on MFPG and MFPG_H by employing the standard panel data estimation techniques. The empirical analysis is based on an unbalanced panel data set consisting of 49 selected developing countries for the period 1980-2016. The sample selection as well as time length is mainly based on the availability of data for our core variables. We find that the effect of government size, inflation, debt to DGP ratio, and financial depth is negative and statistically significant in all regressions; the results are robust to model specifications and estimation techniques. As expected, the impact of investment and institutional quality on MFPG and MFPG_H is positive and significant in all regressions. Moreover, we find the positive significant impact of openness, merchandise trade, and foreign direct investment on MFPG in some regressions, however, this result is not robust. The regression results based on five-year averages confirm that human capital, investment, government size, inflation, debt to GDP ratio, CO2 emissions, remittances, and institutional quality matter for MFPG. In general, the regression results of both the static and dynamic panel data modes show that the investment, size of the government, inflation, public debt, financial development, and quality of institutions have a significant impact on MFPG.

Most of the existing empirical literature overlooks the channels and conditions through which macroeconomic and institutional factors may affect the MFPG. By identifying the channels and conditions through which institutional and macroeconomic factors affect MFPG and MFPG_H, we may provide better guidelines and policy recommendations for macroeconomic and institutional reforms. To investigate the indirect and conditional effects, we use the Seemingly Unrelated Regression (SUR) method for unbalanced panel data as recommended by Biorn (2004). However, we make use of the Moderated Mediation approach of Preacher et al. (2007) and Muller et al. (2005) for the construction of our econometric models. In the analysis of channels and conditions, the results of the SUR method show that investment has a positive significant impact on MFPG and MFPG_H, and public debt conditions mitigate the positive effect of investment on productivity growth. Therefore, a reduction in public debt is necessary for developing nations to provide breathing space to raise investment and hence achieve a higher level of productivity growth. Moreover, trade openness has a negative significant impact on MFPG and MFPG_H, and institutional quality moderates the negative effect of openness on productivity growth. The moderating role of IQ in the relationship between openness and MFPG is positive and significant and IQ conditions lesson the negative effect of openness on MFPG. The positive association between trade openness and MFPG is strengthened as we improve the level of institutional quality in developing countries; there exists a threshold level in the relationship between trade openness and productivity growth. So, the developing nations need to improve their absorptive capacity and institutional framework to harvest the full benefit of trade openness. Furthermore, the indirect effects of trade openness on productivity growth via innovation are positive and significant. Nevertheless, the moderating role of innovation in the relationship between trade openness and MFPG is positive and significant up to a certain minimum threshold level. The policy implications call for reinvigorating and strengthening the undermined growth prospects and institutional framework for achieving sustainable economic growth, development and human well-being.

Chapter 1

INTRODUCTION

1.1 Context and Background of the Study

The importance of productivity growth in promoting the economic well-being and living standards of the people is well recognized in the existing literature. Ever since the seminal work of Smith (1776), analyzing the drivers of output per capita and productivity growth has been at the forefront of the theoretical and empirical growth literature. There is a legion of empirical evidence that acknowledges the convincing role of productivity in output growth differences and patterns of economic growth across countries (Prescott, 1998; Restuccia and Rogerson, 2013). Productivity is used to measure the economic performance of a country. It is usually described as "real output per unit of all inputs" or "portion of the change in aggregate output (value-added) not explained by the conventional inputs (labor and capital) used in the production process." In other words, it is in some ways a measure of our ignorance (Syverson, 2011).

Labor productivity (output produced per hour of work) is also used to measure the economic performance of a country. However, it is a partial measure that does not permit to include the effect of substitution between capital and labor (Kim et al., 2009). The basic ideas behind productivity and economic growth can be linked to Smith (1776). He argues that the division of labor through the specialization of tasks increases the productivity of labor. An increase in the productivity of labor permits business entities to produce greater output for the same level of input, and thus achieve higher growth.

The importance of multi-factor productivity (hereafter, MFP)[1] is well documented in growth literature. Theoretically, economic growth based on MFP constitutes one of the prime insights of modern-day growth theories developed by Romer (1990), Grossman and Helpman (1991), and Aghion and Howitt (1998). Productivity is used to measure fluctuations in the economic and business cycles, as well as growth differences across countries over time. The discussion on productivity growth generally starts with neoclassical growth model (hereafter, NGM) of Solow (1956), together with the endogenous savings extension of Cass (1965) and Koopmans (1965). Solow (1956) argues that MFP is an exogenous and time-driven phenomenon, while Romer (1986) and Lucas (1988) argue that MFP is endogenous and depends on the stock of knowledge or human capital (hereafter, HC)[2]. Islam et al. (2014) emphasize the significance of both quantity and quality of HC.

Taking to the past, supporters of second-generation endogenous growth models (henceforth, EGM) including Romer (1990), as well as Grossman and Helpman (1991), claim that besides HC, research and development (hereafter, R&D) expenditure also affects MFP growth. Aghion and Howitt (1992) suggest a Schumpeterian model where innovation drives technological progress. Schumpeterian growth theory is based on the notion of creative destruction through which new creations and innovations replace older technologies. Grossman and Helpman (1994) add trade openness (henceforth, OPEN) to the model and argue that the countries with more OPEN are likely to have higher MFP

[1] Also known as "total factor productivity" (TFP). The terms "TFP", "MFP," and "productivity" are used interchangeably throughout this study. productivity indicates that how efficiently inputs are converted into outputs (Hultén et al., 2007).

[2] Lucas (1988) defines HC as "skills embodied in individuals that are used either for producing output or accumulate knowledge through education".

growth than the closed or less open economies. Islam (2008) advocate that a reduction in government expenditure is necessary to achieve higher TFP. Benhabib and Spiegel (2000) proclaim that financial development drives productivity growth while Woo (2009) emphasis the rapid growth of foreign direct investment (hereafter FDI) to achieve higher MFP growth. Whereas, Miller and Upadhyay (2000) endorse a tradeoff between inflation and MFP. Among others, Hall and Jones (1999), and Rodrik (2008) recognize that MFP depends upon the quality of institutions. However, Funke and Strulik (2000) endorse a general model that accommodates both the standard NGM and the modern endogenous growth theory.

A considerable amount of literature recognizes MFP as a prime mover of economic growth and argues that growth differences across economies are mainly explained by differences in productivity growth and capital accumulation (Kawai, 1994; Klenow and Rodriguez-Clare, 1997; Prescott, 1998). For instance, the neoclassical production function (from which the Solow residual is calculated) provides the theoretical framework for TFP in the growth process. In the neoclassical growth framework, economic growth is based on two aspects: factor accumulation[3] and MFP growth. In the NGM, TFP is exogenously determined, hence it is just like manna from heaven (determined outside the model). The dynamics of macroeconomic variables are mainly come about due to the change in the autocorrelation structure of the exogenous processes, particularly MFP shocks. Achieving sustained economic growth with a higher level of productivity has now become one of the challenging tasks for governments and policymakers. The MFP growth

[3]Factor accumulation in the Solow (1956) NGM can explain around 50 percent variation in the growth rate. The remaining unexplained part known as Solow residual is attributed to the growth in exogenous technical progress or TFP. For detail of the neoclassical model, see Barro and Sala-i-Martin (1995)

differences reflect variations in output produced by different countries for a given amount of inputs.

From the mid-twentieth century to the present day, researchers have endeavored to examine the patterns and drivers of output and productivity growth across the globe. In a pioneer work, Tinbergen (1942) provides a baseline for empirical work on TFP growth. The author estimates the growth rate of technological progress, using data from the UK, France, Germany, and the USA for the period 1870-1914. Productivity enhancement through technological advancement and improvement in HC performs a decisive role in uplifting the living standards of the people. Krugman (1997) defines the role of productivity in fostering the wellbeing of nations as *"Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise output per worker."* Similarly, Adler et al. (2017) said *"As the key source of progress in living standards over the long term, persistently sluggish TFP growth is an obvious source of concern…."*. MFP has important policy implications because MFP growth is not only used to quantify the effect of technological change (hereafter, TC) but also used to answer one of the fundamental macroeconomic questions, such as *"Why do some countries grow, and others stagnate?"*.

1.2 Measurement of Productivity Growth

By recognizing the fundamental role of productivity in economic growth, a considerable amount of research is dedicated to finding the best measurement of aggregate productivity (Nadiri, 1970; Lipsey & Carlaw, 2004; Fuentes & Morales, 2011; Del Gatto et al., 2011; Kumbhakar & Sun, 2012).

Measuring MFP precisely is crucial for better policy formulation. Easterly and Levine (2001) suggest that *"Economists should devote more effort toward modeling and quantifying TFP"*.

Measurement errors pertaining to the MFP frontier may lead to a wrong conclusion about the speed of convergence. Similarly, flaws in MFP estimates may depict vagueness and uncertainty to the role of various institutions and government policies for the evolution of MFP. Measurement error occurs because output and employment are directly observable and quantifiable, while capital stock is fundamentally unobservable[4] which involves growth accounting issues and several debatable assumptions[5]. Indeed, the calculation of MFP in the best possible way is one of the challenging tasks in international macroeconomics because technological improvements are influenced by some other factors; such as macroeconomic environment, social infrastructure, and unobserved common shocks. Felipe and McCombie (2020) state that *"Empirical calculations of TFP may be likened as the quest for the Holy Grail"*.

We need to place further attention on the calculation of economy-wide MFP growth for four main reasons. First, The TFP growth rates have been estimated largely for advanced countries by using growth accounting or index number methods frequently. There is hardly any empirical study that estimates the TFP growth of developing countries, using the growth regression method. Secondly, as pointed out by Felipe (1999), the TFP estimates are biased towards functional form and techniques or approaches being used.

[4] Solow (1956) argues that the appropriate measurement should be of *"capital in use, not capital in place"* Applying an appropriate depreciation rate is difficult if not impossible.

[5] For detail, see Robinson (1953); capital controversy between Cambridge University and the Massachusetts Institute of Technology (MIT).

The differences in the estimates of TFP produced by various studies even for the same sample, using the similar data and time are obvious. So, the empirical literature still lacks consensus on any specific measure. The third reason lies in the fact that the growth accounting approach (hereafter, GAA) is not able to tackle the problem of parameter heterogeneity as well as the possible endogeneity of factor inputs. Over the past couple of decades, there has been an intense debate on these issues (see Durlauf, et al., 2001 and Eicher and Leukert, 2009). Four, both the theoretical and empirical studies have shown their serious concerns on the assumptions on which most of the measurement methods are premised.

By going through the empirical literature on productivity measurement[6] presented in the literature review chapter, we can infer that there is no empirical study that measures the MFP growth of developing economies, employing an econometric method that incorporates both the homogeneity and heterogeneity assumptions. We contribute to the sphere of literature by measuring MFP growth through econometric method, which tackles the endogeneity bias caused by reverse causality and feedback effects. At the country level, we have incorporated the assumption of heterogeneity into MFP measurement along with controlling the possible endogeneity of the factor inputs. Further, the HC adjusted measure of productivity growth (hereafter, MFPG_H) has seldom been used in the existing studies. Hanushek and Kimko (2000) address the measurement issues of labor quality and scrutinize the growth effects of labor force quality.

[6] The Conference Board Total Economy Database (TED) provides Tornqvist index-based annual estimates of TFP growth for 123 countries in the world. we find high correlation between our estimates of productivity growth (that is MFP growth, and HC adjusted MFP growth) and estimates provided by TED. See Figure 4.2 scatterplot matrix for their interrelationships and behaviours.

The study concludes that labor-force quality differences are important to drive the growth differences among countries. Similarly, Islam et al. (2014) recommend the use of quality of schooling (quality-adjusted HC) in modeling economic growth as well as in the measurement of TFP. The authors conclude that the quality-adjusted HC has not been used in the existing empirical literature as an input in the measurement of TFP. Therefore, we serve to bridge the literature gap by incorporating the growth of labor quality as an input to measure HC adjusted estimates of MFP growth. To our knowledge, the HC adjusted estimates of MFP growth for developing economies are not available in the existing literature. Moreover, we critically review the existing available methodologies of TFP measurement and attempt to suggest the best possible methods of TFP measurement, particularly for macro-level studies.

1.3 Macroeconomic and Institutional Drivers of MFP Growth

The past few decades have witnessed a growth slowdown in many countries around the globe. The prospects of economic growth are also not promising. The Global Economic Prospects (GEP) report published by the World Bank in January 2019 forecasts a substantial slowdown in global economic growth and documents that a rapid drop in GDP growth of the United States and China could have severe consequences for the global economy. Growth slowdown is often associated with weaker capital accumulation, lower productivity growth[7], a decrease in the rate of technological progress embedded in investment, lower R&D expenditure, and the increasing role of government in the economy (Griliches, 1979, 1980; Fischer, 1988; and Guellec & de la Potterie, 2004).

[7]The decline in productivity growth implies that a country is achieving the lower level of output over time for a given level of inputs that is capital and labor.

Since the beginning of the 21st century, the lower MFP growth in mature and emerging economies instigates a debate among researchers and policymakers on the causes and consequences of the productivity slowdown.

Over the last few decades, a growing body of theoretical and empirical literature attempts to explore the determinants of MFP at firm, plant, industry, and sectoral level (Gehringer et al., 2016; Syverson 2011; Bartelsman and Doms, 2000; and Nelson, 1981). However, surprisingly there is a limited empirical evidence on the drivers of MFP across countries at the aggregate level (Egert, 2016). The empirical literature is even more limited in the case of developing economies (Herzer, 2017). The focus of the literature is on developed countries and OECD; ignoring the low- and middle-income countries. To the best of our knowledge, no in-depth empirical study has been carried out so far to examine the effects of institutional as well as macroeconomic factors on MFP growth for the sample of developing countries. In general, empirical studies have performed partial analyses by focusing on the specific determinant of MFP. Moreover, the existing empirical literature even on developed countries either solely focuses on macroeconomic drivers or discusses the institutional factors concerning MFP. Therefore, the analysis of both factors (macroeconomic and institutions) simultaneously may open a new avenue of research related to MFP. Following Islam (1995) and Baltabaev (2014), we employ the standard panel estimation methodology to investigate the macroeconomic as well as institutional determinants of MFP in the selected developing countries. Whether the macroeconomic and institutional determinants of MFP have a significant effect on MFP growth is one of the important questions for practice and policy purposes.

1.4 Determinants of MFP: Exploring the Channels and Conditions

In the new paradigm of research, the researchers and policymakers have shown their attention towards the conditional and indirect effects, commonly known as moderated mediation effects. Most of the existing empirical literature overlooks the channels and conditions through which macroeconomic and institutional factors may affect MFP growth. We could not find any empirical study on aggregate productivity growth in which macroeconomic and institutional indicators are used as both the mediator and moderator. The most important novelty of this study is the analysis of various channels and conditions through which macroeconomic and institutional factors may affect MFP growth in developing countries.

To explore the mediating and moderating roles of macroeconomic and institutional variables, we consider different mediators (channels) and moderators (conditions) such as investment, institutional quality (hereafter, IQ), innovation capacity, public debt, and OPEN. In the analysis of channels and conditions, this study attempts to determine whether investment mitigates the expected negative effects of public indebtedness on MFP growth. Similarly, it attempts to investigate whether public debt mitigates the expected positive effects of INV on MFP growth of developing economies. In the same line of analysis, it attempts to investigate the impacts of HC on MFP growth through the channel of IQ and the effects of IQ on MFP growth via OPEN and vice versa.

To explore the channels and conditions, we construct our econometric models following the mediation approach of Muller et al. (2005) and Preacher et al. (2007). This study employs three-stage least squares (hereafter, 3SLS) method technique and seemingly unrelated regression (hereafter, SUR) method for unbalanced panel data as recommended by Biorn (2004).

1.5 Objectives of the Study

From the earlier discussion, we can conclude that there is a literature gap. Therefore, based on the literature gaps, the objectives of the present study are outlined as under:

1) To provide an overview of MFP measurement approaches and to examine the major strengths and weaknesses of commonly used methods of productivity measurement.
2) To measure MFP growth as well as HC adjusted MFP growth for a sample of developing countries by employing the most suitable method of productivity measurement.
3) To investigate the macroeconomic and institutional drivers of productivity growth.
4) To explore the channels and conditions through which macroeconomic and institutional indicators may affect productivity growth. More precisely, to analyze the mediating and moderating roles of macroeconomic and institutional variables.
5) To examine the mediating and moderating roles of macroeconomic and institutional variables towards HC adjusted MFP growth.

1.6 Research Questions

Based on the above-mentioned objectives of the study, the following research questions and hypotheses have been sketched.

1) What are the major strengths and weaknesses of commonly used methods of productivity measurement?

2) How to measure the aggregate MFP growth of developing countries more precisely dealing with reverse causality and feedback effects?

3) What determines the MFP growth and HC adjusted MFP growth in the selected developing countries?

4) Whether there exist indirect and conditional effects of macroeconomic and institutional indicators towards MFP growth and HC adjusted MFP growth in the selected developing countries?

5) Are these effects remain the same across two different measures of aggregate productivity growth (that is, MFP growth and HC adjusted MFP growth)?

1.7 Significance and Contributions of the Study.

Measuring and understanding the productivity growth patterns and determinants is of great importance for both academicians and policymakers in assessing output growth differences across economies. The importance of macroeconomic stability and better IQ for productivity and economic growth increases in a situation where policymakers face cumulative external debt along with huge unproductive government expenditures.

Besides the uneven macroeconomic conditions, most of the developing countries are facing an institutional vacuum that leads to parasitic and illegitimate activities. Both the uneven macroeconomic situation and deficient institutional setting affect the economic development and productivity of the developing economies. But the interrogation that how would macroeconomic and institutional factors affect the MFP growth, and through which channels have not yet been fully answered in both theoretical and empirical studies.

The policy makers need to get suitable answers to this question as well as the other queries related to the issue under consideration. A rather new research approach that has not been fully explored in the empirical literature is the channels and conditions through which IQ and macroeconomic factors may affect MFP growth. So, by identifying the different channels and conditions through which IQ and macroeconomic factors affect MFP growth, we may provide better guidelines and policy recommendations for institutional reforms in developing countries.

This study reviews the existing methodologies on MFP measurement and then uses the suitable method(s) for the measurement of MFP growth and HC adjusted MFP growth, using a sample of developing countries. The HC adjusted measure of productivity growth has seldom been used in the growth literature. The empirical literature endorses the use of quality-adjusted HC or labor force quality along with its quantity as an input in the measurement of TFP. Therefore, we serve to bridge the literature gap by incorporating the growth of labor quality as an input to measure HC adjusted MFP growth. To the best of our knowledge, the HC adjusted estimates of MFP growth for developing economies are not available.

1.8 Layout of the Thesis

Chapter 2 provides a literature review. This chapter is divided into three broad sub-sections. The first sub-section presents the literature regarding the measurement of MFP whereas the second sub-section illustrates an overview of the literature on the determinants of MFP. In the third sub-section, we summarize the existing literature on measurement and determinants of productivity. In chapter 3 of the study, we present an overview of the methods commonly used for the measurement of MFP. This section provides the readers with an up-to-date survey of the methods and approaches usually used for the measurement of productivity.

Chapter 4 portrays the theoretical framework, models, methodology, data, and theoretical underpinning of variables being used for the analysis. It also depicts the nature and sources of data used for empirical examination. The sample and time selection are mainly based on the availability of data on core variables. In chapter 5, we examine the effects of institutional as well as macroeconomic factors on both MFP growth and HC adjusted MFP growth for 49 developing countries. it highlights the empirical results and findings obtained through static and dynamic panel data models. In chapter 6, we move a step forward and explore the indirect and conditional effects of macroeconomic and institutional factors on both MFP growth as well as on HC adjusted MFP growth. The estimation results are obtained by employing the SUR method for unbalanced panel data as suggested by Biorn (2004). Finally, chapter 7 contains the conclusion and policy implication with a summary of directions for future research.

Chapter 2

LITERATURE REVIEW

In this chapter, we review the most prominent studies related to the measurement and determinants of MFP. This section is divided into three broad sub-sections. The first sub-section presents the literature regarding the measurement of MFP whereas the second section describes the literature on the determinants of MFP. The second sub-section is further divided into macroeconomic determinants of MFP and Institutional determinants of MFP. The third sub-section provides summary and conclusion of the literature concerning to the measurement and determinants of MFP.

2.1 Literature on Productivity Measurement

In the existing empirical literature, several tec[illegible] both the micro and macro-level studies to obtain an improved and more accu[illegible] e of MFP (Van Biesebroeck, 2007). However, we do not find any consensus among the researchers on a specific measure as the best measure of productivi[illegible] still struggling to choose a method of productivity measurement that best fits with the[illegible]. Nevertheless, we retain our focus on macro-level literature keeping in view the nature of our study.

The methods used in macroeconomic studies are concerned with aggregate productivity; that is comparison of productivity across different countries, states, regions, and industries or investigating the patterns of productivity for a single economy and its different sectors such as manufacturing, agriculture, and services. The focus of these methods is to ascertain the role and importance of MFP in economic growth dynamics, especially cross-country dissimilarities in terms of per capita GDP. The literature on the measurement of aggregate productivity generally begins with the growth accounting framework, one of the pioneer deterministic approaches being used to estimate the MFP at aggregate as well as at sectoral levels.

The methods used in microeconomic studies are concerned with individual productivity; that is comparison of productivity across different firms and plants. From the last few decades, attention has been shifted from the aggregate measurement of productivity towards its measurement at the firm or plant level. This change is mainly due to the availability of micro data, improvement in computing packages, and data analysis techniques. Besides their growing use and importance, the results of micro studies may not be generalized easily (Del Gatto, 2011; and Van Beveren, 2012).

In the existing literature, considerable advancement has been made on productivity estimation at both the micro and macro levels. However, to develop a compelling link between micro and macro levels has yet to be forged. This challenge is more daunting since the industries are consist of heterogeneous firms operated under imperfect competition and imperfect mobility of capital and labor inputs across industries. The link between the individual and aggregate MFP measures can be established through 'bottom-up' and 'top-down' approaches developed by Jorgenson (1966) and Jorgenson et al. (2005) in the total business sector. To construct the aggregate estimates of MFP growth, the bottom-up approach considers the individual entities and production units (establishments or firms) as a basic frame of reference whereas the top-down approach of sectoral productivity measurement starts from a different standpoint and takes aggregate TFP residual as a fundamental point of reference. The estimates of both approaches differ as the bottom-up approach relaxes one of the main assumptions of the top-down approach that the output and input prices are equalized across industries (Greene et al., 2016).

The KLEMS database constructed by the Bureau of Labor Statistics (henceforth, BLS) and the Bureau of Economic Analysis (henceforth, BEA) provides the industry-level data on output, inputs, and productivity for more than forty countries of the world. The growth accounting framework set by Jorgenson et al. (1987) in a more general input-output framework has been used as a baseline methodology to construct this database. The KLEMS data sets are based on inputs of capital (K), labor (L), energy (E), materials (M), and services (S) for individual industries. It provides the input side of the production account. Jorgenson persuades statistical agencies and academicians around the world to calculate and extend the KLEMS measures. In this regard, Van Ark and Jager (2017) analyze the sectoral productivity in Europe by using the most recent European Union (EU) KLEMS database. By employing the same database over the period 1970-2007, Oulton (2016) examines sectoral MFP growth across 18 countries and concludes that the negative MFP growth in business services is very implausible and the mystery of TFP is likely to remain there if measurement error persists. The findings give rise to an important question: does the prevailing productivity slowdown across the developed and developing nations is due to the mismeasurement of MFP?

Syverson (2107) claims that the TFP slowdown is not due to cyclical phenomena but due to the mismeasurement hypothesis. The author argues that true TFP growth has not slowed since 2004, but recent gains have not been reflected in productivity statistics. The use of information and communication technology (hereafter, ICT) or web-related products is not considered in the calculation of GDP because of its low or zero price. Darby (1984) argues that the productivity slowdown in the U.S. is simply the result of 'statistical myopia'. Fernald (2015) states that cyclical factors are not important to drive TFP growth. In the same line of analysis, Diewert and Fox (2019) assert that the traditional measures of TFP including KLEMS measures do not take into consideration the accumulation of cash holdings and money balances of the corporate firms and industries.

Since the seminal work of Gabor and Pearce (1958), the inclusion of money as a factor of production in the estimation of production functions has long been debated. In this context, Nguyen (1986) said that *"money plays a role, not as an input, but as a factor whose growth rate contributes to productivity growth".* Taking a step beyond, Diewert (2000) and Schreyer (2014) are of the views that it is important to consider all relevant assets, including land inventories and other non-financial assets in the measurement of MFP growth. Hamilton et al. (2019) attempt to improve the estimates of TFP by including natural resources as an input. The authors conclude that the estimates of TFP increase when natural resources being added as an input with the traditional two-factors (labor and fixed capital). Further, these new estimates are comparatively less volatile over time in most of the countries.

By using a set of statistical tools, Pancrazi and Vukotic (2011) examine macroeconomic dynamics at different sets of frequencies and conclude that the volatility dynamics of macroeconomic variables change with variations in frequencies. The redistribution of the variance towards lower frequencies implies an increase in the persistence of macroeconomic variables which mainly depends upon the persistence of MFP. The persistent shocks to MFP growth rates endogenously drive long term capital formation and speed of convergence. Therefore, precise identification of the statistical properties of the stochastic process for MFP and its measurement methods is a key step to drive economic models and linking them to the data. For instance, asymptotic statistical properties of Data Envelopment Analysis (henceforth, DEA) make it more desirable than the parametric approach (Kneip et al., 1998). The parametric approach is based on the statistical properties of the error terms. The properties of the closed skew-normal distribution are very useful for SFA and econometric methods of MFP measurement (Mahadevan, 2003).

Broadly there are three strands of literature concerning the measurement of MFP. The first strand employs the GAA to measure MFP. The second strand of literature uses index number methods along with frontier techniques (parametric or non-parametric). The third strand employs the growth regressions or econometric methods to estimate MFP across countries and regions. We endeavor to review these strands as under:

The evolving literature on MFP measurement can be classified according to the different criteria such as deterministic vs stochastic, frontier vs non-frontier, parametric vs non-parametric, conventional vs modern methods, etc. However, for the sake of better understanding and fruitful discussion, we divide the existing methods into four broad categories that are: conventional methods, index number methods, frontier techniques, and growth regressions.

2.1.1 Literature on Solow's Residual Approach

The conventional method to measure MFP is the GAA. The growth GAA (residual method) of TFP measurement is based on the seminal work of Solow (1956 and 1957). It relates the measured inputs to measured output through a production function. It decomposes the observed economic growth into explained (contribution of factor inputs) and unexplained (contribution of TC known as the Solow residual) parts. In this framework, Stigler (1947) was one of the pioneer attempt followed by Sollow (1956), Abramovitz (1956), Kendrick (1956, 1961), Denison (1972, 1974), Hulten (1992), Griliches (1996), Collins and Bosworth (1996), Hall and Jones (1999), Caselli (2005), Antonelli and Quatraro (2010), and many others. These studies show that economic growth associated with the growth of factors of production (explained part) is dominated by the unexplained part (contribution of TC).

For example, factor accumulation in the Solow (1956) NGM[8] explains less than 50 % variation in the growth rate. The remaining unexplained part known as Solow residual is attributed to the growth in exogenous technical progress or TFP. In the NGM, exogenously determined technological progress is just like manna from heaven. The empirical analysis shows that about 50% to 90% share of aggregate growth remains unexplained due to the unknown factors other than the conventional inputs (labor and capital) or factor accumulation (FA). These unknown factors are either attributed to the impact of technical progress or "measure of our ignorance" (Syverson, 2011; Abramovitz, 1956).

TFP has been considered as an engine of economic growth (Grossman and Helpman, 1991; Aghion and Howitt, 1998). One of the earliest studies by Abramovitz (1956) uses USA data for the period 1869-78 to 1944-53 and concludes that 90 % growth in output is linked with the growth of TFP while only 10 % of per person output growth in the USA is related with the growth of conventional inputs. Similarly, Solow (1957) employs data from 1900 to 1949 on the United States and finds that 88 % of output growth is associated with the growth of TFP (unexplained part or residual) while only 12 % of per person output growth in the United States is linked with the growth of factor inputs. Further, Kendrick

[8] For detail of the neoclassical model, see Barro and Sala-i-Martin (1995)

(1961), Maddison (1995), Young (1995), Jones and Manuelli (1997), Jorgenson and Stiroh (2000), Oliner and Sichel (2000), Caselli (2005) and Baier et al. (2006) reduce this unexplained part or residual, however, it remains far from zero. In contrast, by using the sample of East Asian countries, Young (1995) claims that GDP growth is mostly explained by inputs accumulation rather than TFP growth.

In the same line of analysis, one of the recent attempts by Hofman and Valderrama (2020) provides a growth accounting assessment of the long-run performance of Latin American countries from a comparative perspective by widening the time frame of analysis to 1820–2016. The authors pointed out that during 1913- 1980 most of the countries have grown faster with the exceptions of Argentina, Uruguay, and Chile. During the said period, economic growth was factor-intensive and overall efficiency growth as measured by TFP was low or even negative. In the period after 1980, TFP growth became negative, almost for all the sample countries. Overall, we can conclude that researchers have tried to reduce the Solow residual by incorporating the different factors in the models.

2.1.2 Literature on Index Number Approach

The index number method is an extension of the growth accounting framework. As mentioned above that the researchers usually use the index number method as a check on measurement problems of growth accounting framework, as it does not require an aggregate production function (henceforth, APF). For example, the Malmquist Productivity index (henceforth, MPI) introduced by Caves et al. (1982b) makes use of distance functions to measure productivity change. It can be defined using input or output orientated distance functions. It compares ratios of outputs with inputs (that is, TFP) across units. It assumes that all the units being used can be compared, which may be firms, industries, or countries. This assumption may not be satisfied in the real world.

The commonly used productivity measurement indexes are the Laspeyres (1871), Divisia (1973), Paasche (1874), Fisher (1922) Tornqvist (1936), and Malmquist (1953) productivity, etc. The Tornqvist[9] has been the most popular TFP index. This approach is also known as the Hicks-Moorsteen Index (henceforth, HMI) Approach (that is, productivity index is the ratio of output and input index numbers). The MPI is the same as the HMI if the technology exhibits global constant returns to scale and inverse homotheticity. The merits and limitations of the index number are almost identical to the GAA. Index number methods have been extensively used for measuring the efficiency and productivity of different firms, institutions as well as sectors of the economy. However, these methods do not provide sources of productivity growth. Therefore, at the aggregate level their use remains limited (See, Caves et al., 1982a, 1982b; Del Gatto, 2011). Maudos et al. (1999) examine the TFP evolution in OECD countries by using the Malmquist indices of productivity. They break down the productivity gains into technical change and efficiency.

2.1.3 Literature Regarding Frontier Methods

Besides the growth accounting framework and methods of index number, we can also measure[10] the MFP growth by frontier techniques (parametric[11] or non-parametric[12]). Frontier models[13] have been used in both macro and micro studies. Frontier

[9] Also known as translog index, see Jorgenson and Nishimizu (1978)
[10]For detail overview and survey of productivity measurement methodologies see Nadiri (1970), Diewert (1992), Felipe (1999), Carlaw and Lipsey (2003), Del Gatto (2011), Van Beveren (2012), Ilyas & Riaz (2016) and Ahmed & Bhatti (2020).
[11]Commonly used parametric frontier technique is SFA. See, Fried et al. (2008) for an overview of SFA.
[12] Non-parametric technique is DEA.
[13]For detail description of frontier models, see Daraio and Simar (2007); Schmidt (2008).

models divide the productivity growth into two main sources; (a) technological change (TC), which by assumption pushes the production frontier upward, and (b) technical efficiency (TE) change, which improves the production by improving the capacity of productive units' given the level of technology and inputs. Most of the empirical research within the frontier approach adopts either DEA or Stochastic Frontier Analysis (henceforth, SFA) as parametric and non-parametric estimation techniques respectively.

These methods have been applied as a check on the measurement problem of the growth accounting framework. Farrell (1957) introduces DEA. Later, Deprins et al. (1984) propose the Free Disposal Hull (henceforth, FDH) method. This method is comparatively less popular although it is a flexible model concerning DEA. Fuentes and Morales (2011) propose the use of a State Space Model (henceforth, SSM) to estimate the level of TFP, its long-term growth rate, and other relevant parameters such as the capital-output elasticity.

An alternative way of estimating MFP and efficiency analysis is based on stochastic frontier models (henceforth, SFM) given by Aigner et al. (1977) and Meeusen and Broeck (1977). The SFM decomposes productivity changes into two parts: the change in TE (movements towards the frontier) and technical progress (the shift of the frontier over time) by assuming the existence of technical inefficiency (a discrepancy between observed and potential output). Kumbhakar et al. (2000) propose the SFA to the decomposition of TFP in a panel framework. However, Kumbhakar and Tsionas (2005) introduce Bayesian SFA to estimate the model. One of the recent attempts by Makiela and Ouattara (2018) adopt both the SFA and Bayesian SFA to derive estimates of TFP. Schmidt and Sickles (1984) endorse the use of conventional panel data techniques in the SFA context. In this connection, Kumbhakar and Lovell (2003) provide a survey of panel data production frontier models.

Among others, Fare et al. (1994), Koop et al. (1999), and Kruger (2003) have employed frontier techniques to calculate the TFP growth in cross-country analyses. Fare et al. (1994) analyze the productivity growth in 17 OECD countries over the period 1979-1988 by employing MPI. These are decomposed into two component measures that are: TC and efficiency change (hereafter, EC). They conclude that the TFP growth is of the US and Japan is higher in the sample, all of which is due to TC and almost half due to EC respectively. Kumbhakar and Wang (2005) employ SFA to decompose the Malmquist index for 82 countries. Similarly, Alvarez (2007) decompose regional productivity growth for Spanish regions. The study contributes to the productivity literature by combining the fixed effects (henceforth, FE) and SFA, enabling the researchers to start a discussion on whether to use average or frontier functions to estimate regional TFP.

Arazmuradov et al. (2014) employ a time-varying SFA on 15 Former Soviet Union (henceforth, FSU) economies for the period of 1995–2008 to explore the effects of FDI, import of machinery, and HC on TFP. The results show that FDI and HC improve TE and hence real GDP growth of FSU republics. By using a similar methodology, Aguiar et al. (2017) estimate TFP growth and technical inefficiency for a panel of 40 OECD and emerging economies for 2001–11. The findings of the study show that growth rates in the emerging economies are four times higher than in OECD countries. Huang et al. (2014) employ a two-step SFA[14] (meta-frontier production function) to estimate TE. in the first step, parameters of the stochastic meta frontier (SMF) regression are estimated through the

[14] This approach was introduced by Hayami (1969).

conventional maximum likelihood method (MLM). In the second step, the group-specific technology gap ratio is estimated based on the SFA. This approach opposes O'Donnell et al. (2008) in the second step, where they apply mathematical programming techniques. The advantage of SFA[15] over DEA is that it values the possible impact of noise (a symmetric term) on the positioning and shape of the frontier.

2.1.4 Literature on Growth Regressions and Econometric Models

To overcome the shortcoming of the growth accounting and frontier techniques, growth regressions and econometric methods have been proposed. These methods are extensions of the earlier methods of Solow residual. In growth regressions, a structural equation is identified to estimate the MFP level from aggregate data (Mankiw et al., 1992; Islam, 1995; Hall and Jones, 1999; Caselli, 2005).

One of the recent attempts by Duygun et al. (2017) focuses on the econometric estimation of TFP growth. The study employs the model averaging methodology on the World Productivity Database (henceforth, WPD) developed by the United Nations Industrial Development Organization (henceforth, UNIDO) to compute the TFP estimates. To implement the model averaging methodology weights are assigned to each set of model estimates.

The econometric methods used to measure MFP growth have their merits and limitations. Firstly, the prior ordering of the selected countries is not required. Secondly, it is less sensitive to the inclusion/ exclusion of countries. Thirdly, we do not need data on physical capital stock, which may have the problems of measurement error due to the

[15] See, Forsund et al. (1980); Kopp (1981); Atkinson and Cornwell (1994) and Murillo-Zamorano (2004) for a comprehensive overview of frontier techniques.

different profile of depreciation rate and initial level of capital stock. Kiviet (1995) wrote two decades before is still true to some extent. He said, *"Yet, no technique is available that has shown uniform superiority in finite samples over a wide range of relevant situations as far as the true parameter values and the further properties of the data generating process (DGP) are concerned".* The limitation of econometric methods of MFP estimation is that it ignores the contribution of EC to productivity change. Secondly, based on specified functional form, the condition of homogeneity across countries is imposed which may not hold.

One of the important features of econometric methods is the use of panel estimators and dynamic panel data models (henceforth, DPDM) in growth regressions, particularly at macro-level studies. Mankiw et al. (1992) and Islam (1995) have been considered the pioneer attempts. They explore how the results change when a model-based approach is applied instead of growth accounting methodologies. Islam (1995) uses the Least Squares with Dummy Variables (LSDV) estimator based on the FE assumption along with LSDV-within-group (WG) to estimate the cross-country TFP. He focuses on the role of various unobservable factors such as institutions, resource endowments, and climate in TFP differences.

Considerable advancement in TFP measurement has taken place since the seminal work of Jorgenson and Griliches (1967). Surprisingly, the TFP measurement methods and estimators developed overtimes are silent about market power, scale economies, and the demand side of the market (Cusolito & Maloney, 2018). To find out the best measure of MFP, Bournakis and Mallick (2018) consider five methodologies of MFP measurement namely superlative index numbers, generalized method of moments (henceforth GMM), Olley and Pakes (1996), Levisohn and Petrin (2003), and Ackerberg et al. (2015). The findings of the study show that Ackerberg et al. (2015) algorithm is the cutting-edge estimation technique with the most plausible results, while system GMM is the second-best estimator. Ackerberg et al. (2015) criticize the Levisohn and Petrin (2003) method regarding a possible collinearity problem, which arises in the first stage of the estimation.

In principle, MFP estimates can be obtained for each level of economic activity, that is, firm, plant, industry, and aggregate level. The aggregate productivity depends upon the productivity of constituent firms and industries. Another strand of literature, for example, Bandyopadhyay et al. (2019) finds that HC misallocation adversely affects the TFP, output, and welfare. One of the recent attempts by Caggese (2019) provides new empirical evidence on the nexus between financial frictions and TFP growth by using a very rich dataset of Italian manufacturing firms from 1989-2000. The findings of the study suggest that technology adoption and innovation activities by young firms is a key driver of productivity growth. Moreover, there exists a negative relationship between financial frictions and TFP growth.

To examine the nexus among firing costs, distribution of establishments, and aggregate TFP, Da-Rocha et al. (2019) develop a dynamic general-equilibrium framework with heterogeneous production units. The authors conclude that there exists a negative relationship between firing costs and aggregate TFP. Buera (2011) finds that the observed cross-country differences in aggregate TFP (that is, output per worker) are mainly driven by financial frictions.

2.2 Drivers of MFP: A Thematic Review of Literature

Since the start of the twentieth century, substantial variations in MFP growth patterns have been observed across the globe mainly due to the differences in the adoption and diffusion of ICT. Van Ark et al. (2008) illustrate that the slower evolution of ICT is one of the important factors behind the European productivity slowdown. Another explanation put forward by Syverson (2017) regarding slowdown is the "mismeasurement hypothesis". The author argues that true productivity growth has slowed much lower than the measured or reported one. However, we can infer from the existing literature that mismeasurement alone is unlikely to account for the productivity paradox or puzzle as a productivity mismeasurement issue exists before the start of its slowing down the process. Some economists place the blame on the financial crises and the Great Recession (Miao and Wang, 2012).

During the 1970s, most of the mature and advanced countries have witnessed productivity growth slowdown including Germany, France, Netherlands, Italy, Australia, Finland, Canada, and Sweden. Since the mid-1990s, the European countries have experienced a significant slowdown in productivity growth (Cette et al., 2016). In contrast, MFP growth in the United States has accelerated considerably during the said period, as a result of a larger investment in ICT. The long-run dynamics of productivity growth and hence a change in productivity leadership over time reverses the sequence of economic convergence and divergence among countries (Fischer, 1988; Bergeaud et al., 2015).

After the global financial crisis of 2008, the accelerated productivity slump in developed and emerging economies has baffled the policymakers and economists, leading to reinstates a debate on drivers of productivity growth. Notably, Bergeaud et al. (2015) examine the TFP trends and patterns for 13 advanced countries over the period 1890-2012. The authors observe that revolutions, wars, crises, shocks, and policy changes lead to productivity dynamics and trends. Syverson (2017) concludes his paper with the remarks that "Whether productivity slowdown will end anytime soon remains an open question". it follows that the behavior of MFP in advanced countries has undergone deviations historically which motivate the subsequent review of the literature.

The neoclassical APF is at the heart of the economic growth theory, developed by Solow (1956). The NGM, together with the endogenous savings extension of Cass (1965) and Koopmans (1965) consider technological progress as exogenous. Becker (1964) is one of the pioneers who considers the role of technology and new scientific knowledge in productivity growth. In the late 1980s, a new stance of thinking emerges that give rise to the inception of EGM. These models consider technological progress as endogenous. In the first generation of endogenous growth models (Romer, 1986; 1990 and Lucas, 1988), MFP growth is positively related to the technological advancement and the levels of R&D. The second-generation endogenous growth models of Aghion and Howitt (1998) and Dinopoulos and Thompson (2000) recommend that the ratio of researchers in employment or R&D expenditures as % of GDP should be used in growth models rather than their absolute values (Ulku, 2007).

Despite having various measurement concerns laid down in the previous section, the TFP slowdown has now become the fundamental features of the world economy. Nevertheless, there is not much unanimity on the factors which drive the aggregate MFP. In this section, we review the most prominent studies related to the determinants of

MFP. As already noted in the introduction that at aggregate level, the economic growth and productivity literature attempt to relate the Solow residual (usually represented by A) to certain drivers such as HC, R&D activities, openness, FDI, ICT, international R&D spillovers, innovation, and financial development. One of the pioneering attempts by Nelson and Phelps (1966) finds that HC is important to determine the disparity between the technology frontier and TFP.

Some prominent studies such as Romer (1986) modeled A as a function of the stock of R&D; Lucas (1988) as a function of the stock of HC; Grossman and Helpman (1994) as a function of international knowledge spillovers; Coe and Helpman (1995) as a function of trade spillovers; Edwards (1998) as a function of OPEN; Aghion and Howitt (1998) as a function of innovation; Benhabib and Spiegel (2000) as a function of financial development; Dar and AmirKhalkhali (2002) as a function of government expenditure; Woo (2009) as a function of FDI; Deliktas and Bacilar (2005) as a function of natural resources; Acemoglu et al. (2003, 2005) as a function of institutions; Egert (2016) as a function of regulation and institutions. We review the existing literature on the drivers of MFP by classifying it into two broad categories: macroeconomic determinants of MFP and institutional determinants of MFP.

2.2.1 Macroeconomic Determinants of MFP

The abundant theoretical and empirical literature explores the determinants of MFP at firm, plant, industry, and sectoral level (Gehringer et al., 2016; Bartelsman and Doms, 2000; and Nelson, 1981). However, there is limited empirical evidence on the drivers of MFP across countries at the aggregate level (Egert, 2016). The empirical studies regarding the macroeconomic determinants of MFP are scarce in the case of developing countries. More focus has been given to the advanced countries particularly, OECD countries.

As pointed out earlier, a recent surge of research on economic growth has convincingly shown the worth of MFP growth for achieving a higher level of real income per capita. It recognizes MFP as an engine of economic growth and argues that growth differences across economies are mainly explained by MFP differences. So, to figure out the growth of nations, we must review and develop a better understanding of the macroeconomic factors that shape MFP growth. The selected studies in this domain are summarized in Table 2.1

Table 2.1: Selected Studies on the Macroeconomic Determinants of Multi-Factor Productivity (MFP)

Author (s) Year	Sample / Type of study/ Coverage	Motivation / Research Objectives	Key Macroeconomic Variables	Methodology/ Estimation Method	Key Findings / Results
Gordon and Sayed (2020)	United States and Ten Western European nations over the period of 1977 to 2015.	Explore the impact of ICT on labor productivity and TFP growth	ICT investment, dummy variables	weighted least squares (WLS) FE model	The results indicate that the ICT intensive industries of US have played a significant role in stimulating its labor productivity TFP growth till 2005. In contract, the investment in ICT inversely effect the productivity of EU-10 countries for longer period. After 2005, the impact of ICT turns out to be negative for US as well.
Kijek and Kijek (2020)	European regions between 2009 and 2014	study the nonlinear link among HC, R&D and TFP and complementarity between HC and R&D	expenditure on R&D as % of gross fixed capital formation, human resources in science and technology, unemployment rate, population density, tertiary educational attainment	Spatial panel data models	The empirical results show that the impact of HC and R&D on TFP is nonlinear. Both the variables turn out to be strategic complements. The relationship between TFP of European regions and its neighboring regions is positive significant.
Asongu (2020)	25 Sub-Saharan Africa (SSA) countries over the period of 1980-2014	Examine the link between financial access and four main dynamics of TFP (that are: TFP, real TFP, and real welfare TFP)	FDI, population growth, private domestic credit, government size, education	System GMM	The findings show that the improvement in financial access via credit channel has a positive significant impact on real welfare TFP. However, the effect of financial access on other dynamics of TFP is insignificant for the sample of SSA countries.

Adnan et al. (2020)	Time series annual data for the period 1970–2018	To explore the macroeconomic determinants of TFP Pakistan	FDI, OPEN, and HC	ARDL bound testing methodology	FDI and HC are the main drivers of TFP, and there exists a long-run relationship among FDI, HC and TFP in Pakistan.
Rath et al. (2019)	Panel data of 36 developed and developing countries for the period of 1981-2013	Examine the impact of fossil fuel (FF) and renewable energy (REN) consumption on TFP growth.	FF, energy consumption (EC), REN, HC, OPEN and FDI	Dynamic ordinary least square (DOLS), Panel Granger causality test	The FF energy consumption adversely affects the TFP growth while the impact of REN consumption on MFP growth is positive and significant. Further, long-run relationship exists between EC and MFP growth.
Li and Tanna (2019)	Cross countries data of 51 low and lower-middle-income countries over the period 1984-2010	Empirically investigate the effect of inward FDI on TFP growth	FDI, HC, inflation, civil conflict, financial development, external debt, OPEN and institutional index,	System GMM	The direct impact of FDI on TFP growth is positive and significant. However, the indirect effect of FDI on TFP growth becomes strong and positive when interaction of FDI with HC and IQ are incorporated.
Habib et al. (2019)	Panel of 16 countries for period of 2007–2015	Analyze the impact of intellectual property rights (IPR), R&D, and HC on TFP	HC, IPR, R&D expenditure, FDI, OPEN	FE model	The results indicate that HC, IPR, and R&D have a significant and positive impact on TFP in sample countries.
Afzal and Ahmad (2018).	Panel of nine Asian emerging economies for the period of 1996 - 2015.	Empirically scrutinizes the potential determinants of TFP growth	Index of ICT, FDI, HC, R&D expenditure, Domestic Credit by the Financial sector (% of GDP), gross domestic investment (% of GDP), Liquid liabilities (% of GDP), index of Governance, Index of Financial Deepening	FE model	The results show that Governance, ICT and gross domestic investment yield positive and statistically significant impact on TFP growth of selected Asian countries.

Kim and Park (2018)	Cross countries panel data for the period of 1975-2014	Examine the importance and determinants of TFP growth in middle income countries (MIC)	Domestic credit to GDP ratio, FDI, financial development, ICT, Average schooling year, openness, R&D stock, R&D investment, patent applications per million persons (resident), population growth	OLS estimations, FE regressions	TFP growth plays a significant role in escaping from middle income trap. The result shows that HC, smaller population, weak currency, R&D growth and innovation activities are significant sources of TFP growth
Ahmed and Kialashki (2017)	11 Asia Pacific countries over the period 1970-2012	Scrutinize the factors determining the productivity development and explore the Effects of FDI spillover on TFP growth of the most growing countries in the Asia Pacific region	FDI, HC, telecommunications investment	Extensive growth theory (output productivity model)	The regression result shows that FDI inflows have positive significant impact on economic growth of all selected economies except for developed nations (Japan and South Korea). Moreover, the study finds that the impact of FDI spillover is positive with insignificant contribution to the TFP growth.
Saad (2017)	Time series data on Lebanon economy over the period 1980-2014.	Investigate the determinants of economic growth and TFP in Lebanon	OPEN, claims on private sector (CPS), FDI, and official development assistance (ODA).	Autoregressive Distributed Lag (ARDL) modeling approach	OPEN and CPS show a positive significant effect on TFP. Nevertheless, FDI and Aid flows are found to be insignificant.
Lopez-Rodriguez and Martinez-Lopez (2017).	sample of 26 EU countries for the period 2004–2008	Explain dynamics of TFP and examine the impact of different types of innovation activities (R&D and non-R&D innovation spending) on TFP growth	R&D, Non-R&D, HC	Build augmented macro-theoretical growth model, OLS	The impact of R&D on TFP growth is found to be twice as big as that of non-R&D

Roy (2016)	89 countries for the period of 1980 to 2000	Examine the net effect of FDI on TFP growth keeping into consideration the initial distance of a country from the technology frontier. Further, explore the nonlinearity associated with FDI.	Net FDI inflow as a % of GDP, FDI as a % of gross domestic investment, HC, Real GDP per capita	OLS estimations, threshold estimation technique	The findings of the study show that the initial distance from the technology frontier is an important driver of the FDI effects on TFP growth. It is found that if a country is below a threshold initial distance, then there is a negative outcome of FDI, although the net effect may be positive.
Dabla-Norris et al. (2016)	100 countries for the period 1970–2010	To explore the short and medium-term effects of structural and institutional reforms on productivity evolvement over the time.	Banking system reforms, privatization, Trade (tariff and current account restrictions), FDI liberalization, legal system and property rights, business and labor market regulations	distance-to frontier framework	The payoffs and dividends of productivity vary across reforms and over time as per development stage of a country. The lower income countries can get more benefits from reforms.
Tientao et al. (2016)	107 countries for the period 2000-2011.	The study derives a model of TFP growth by decomposing TFP into quality and variety components and explore the impact of technological spillovers on TFP growth	R&D expenditure, OPEN, FDI, HC	Spatial Durbin model (SDM)	The findings show that technological spillovers have substantial effects on TFP growth.
Salotti and Trecroci (2016)	Developing and OECD countries for a longer time spane (that is 1870-2009)	examine the impact of fiscal policy on productivity growth and private investment.	gross government debt/GDP ratio, deficit/ GDP ratio, government expenditure, INV, OPEN, oil prices, financial	System GMM, FE model	The study finds the adverse impact of large fiscal imbalances and high public debt (85-90% of GDP) on productivity growth and investment.

			development, capital stock		
Gehringer et al. (2016)	17 European Union (EU) countries and 13 sectors over the period 1995–2007	investigate the determinants of TFP and examine the evolution of TFP across countries and sectors over the period and	FDI inflow as a % of GDP, ICT, OPEN, HC	The augmented mean group (AMG) estimator, dynamic ordinary least-squares (DOLS) estimator	The HC and ICT are the main drivers of TFP.
Puskarova and Piribauer (2016)	European sub-national regions for the period of 2000 to 2010.	Quantify the spillover effects of knowledge and HCl stocks on TFP	Population (aged 25-64) share with minimum secondary education	Spatial Durbin panel model and maximum likelihood approach	The overall findings suggest that both knowledge and HC spillovers exhibit significant effexcts on the TFP in the European sub-national regions.
Venturini (2015)	OECD, United States and 15 EU countries over the period 1980–2003	To examine the role of investments in ICT and R&D in long-run productivity performance of selected countries	ICT capital and non-ICT equipment. R&D expenditure, HC	Dynamic OLS, FE regression	The result shows that both ICT and R&D investment influence TFP over the long run.
Naz et al. (2015)	Panel of 94 countries over the period 1964-2003.	Investigate the impact of OPEN on TFP growth	OPEN, population growth, size of a country	FE regression	OPEN has a positive significant impact on TFP growth for all the four groups of countries. However, the magnitude of the impact is stronger for middle-income than low- and high-income group of countries
Everaert et al. (2015)	Panel of OECD countries over the period 1970–2012.	Analyze the direct and indirect effects of fiscal policy on TFP	Total government expenditures and personal taxes as % of GDP	common correlated effects pooled (CCEP) estimator	The results ascertain the crucial role of fiscal policy in driving TFP. Budget deficits harm TFP as direct channel while unobserved worldwide level of technology plays a mediating role in the relationship between fiscal policy and TFP.

Rath and Parida (2014)	Panel of 05 Asian countries for the period 1980 to 2011.	Study the impact of openness and HC on TFP	labor force, investment, GDP, HC, exports, and imports	dynamic ordinary least squares (DOLS), panel cointegration	the impact of openness and HC on TFP is positive and significant for a sample of five South Asian countries. However, the impact of HC on TFP is relatively weaker than the impact of openness.
Arazmuradov et al. (2014)	15 former Soviet Union ((FSU) economies for the period of 1995–2008	To explore the effects of FDI, import of machinery, and HC on TFP.	FDI, import of machinery, HC	Time-varying stochastic production frontier model	The results show that FDI and HC improve TE and hence real GDP growth of FSU republics.
Amann and Virmani (2014)	34 OECD countries over the period of 1990-2010	Analyze the impact of outward and inward FDI on TFP via technology spillovers	outward and inward FDI flows, number of patent applications filed by residents, R&D intensity, average years of total schooling (age 25+)	Cointegration tests, FE regression	The findings of the study show that inward FDI from OECD to developing countries benefit more and has a positive and significant impact on the TFP growth.
Baltabaev (2014)	49 countries over the period of 1974–2008	Examine the impact of FDI on TFP and test whether the larger distance to the technology leader can enhance the positive effect of FDI on TFP.	FDI, HC, OPEN, inflation, R&D, Population growth, technology frontier distance	Two-Step System GMM, FE and RE models	The result shows a positive significant effect of FDI on TFP growth. The larger distance to the technology leader enhances the positive effect of FDI on TFP.
Afonso and Jalles (2013)	155 (developed and developing) countries for the period 1970–2008.	Assess the links between economic growth, productivity and public debt	debt-to-GDP ratio, budget deficit, population growth, secondary school enrolment, private investment, OPEN, different proxies of financial development	growth equations, growth accounting techniques, PCA, Pooled OLS, Within FE, Panel IV-GLS estimation and Two-Step Robust System GMM	They find a negative effect of the debt ratio for the full sample. However, for the OECD, the relationship between debt maturity and TFP growth is positive.

				(SYS-GMM), threshold regression model by Hansen (1996), Pesaran's Common Correlated Effects Pooled Estimator (CCEP).	
Ang and Madsen (2013)	Sample of six Asian miracle economies over the period of 1955- 2006.	Examine the importance of the domestic R&D stock and foreign knowledge spillovers on TFP	International Knowledge Spillovers, R&D Expenditure, Patent Statistics, Imports, Exports, Bilateral Trade Flows, FDI, Financial development, OPEN	Panel cointegration tests	The results showed that TFP, domestic R&D stock, and international knowledge spillovers are cointegrated. Hence, the growth rates of both domestic and international knowledge stock are important determinants of TFP growth.
Bianco and Niang (2012)	24 OECD countries over the period 1971-2004	Examine the role of R&D spillovers in generating productivity gains	R&D capital stock, HC	Common factor framework developed by Bai and Ng (2006)	The cross-country spillovers concerning to R&D and HC contribute significantly to TFP of OECD countries.
Park (2012)	12 Asian economies for 1970–2007, projection of TFP growth for the period of 2010–2030.	investigates the important factors influencing the TFP growth in the Asian economies to understand the TFP growth dynamics.	initial life expectancy, initial population. ratio of gross expenditure on R&D and HC, R&D capital stock, Initial per capita GDP relative to the United States	growth accounting method, regression-based approach,	The results indicate that major determinants of productivity in these countries is the convergence. effect, HC, and R&D.
Herzer (2011)	33 countries for the period 1980 to 2005	Test the long-run nexus between TFP and outward FDI	outward FDI stocks, TFP	Dynamic ordinary least squares (DOLS) estimator and common	Outward FDI has positive significant long-run effect on TFP in developing countries.

				correlated effects (CCE) mean group estimator suggested by Pesaran (2006)	
Bravo-Ortega and Marin (2011)	65 countries for the period of 1965 - 2005	Use different R&D indicators to examine the relationship between R&D and TFP	R&D expenditure as % of GDP, R&D per capita, FDI, term of trade, inflation, Private credit to domestic sector,	System GMM	The findings indicate that the impact of R&D on TFP is positive and significant.
Berument et al. (2011)	Time series data on Turkish economy from 1987Q1-2007Q3	Analyze the relationship between different indicators of macroeconomic stability and TFP growth	Consumer price index (CPI), ratio of M2 to GDP, OPEN	Multivariate GARCH, Exponential Generalized ARCH (EGARCH)	The results suggest that price volatility increases TFP growth while OPEN, macroeconomic uncertainty and volatilities reduce TFP growth.
Bekaert et al. (2011)	96 countries over the period 1980–2006	examine different channels through which financial openness and IQ may affect productivity.	Capital account openness, Official equity market liberalization, Equity market openness, Financial openness, Macro-economic environment, country credit rating	Pooled OLS estimate, SUR	The findings indicate that the financially developed countries with higher quality of institutions experience larger TFP growth
Madsen et al. (2010)	32 developing and 23 OECD countries for 1970–2004.	Examine the role of R&D in promoting TFP growth	R&D spending, educational attainment, FDI as a proportion of GDP, OPEN, and inflation	System GMM	The finding shows that the developing countries need to invest in R&D to get the benefit of the technology that is devised by the developed countries. In developing countries, the growth effects of R&D arise mainly via imitation.
Kose et al. (2009)	Sample of 67 developed and	Analyze the relationship between	Capital account OPEN (de jure),	FE model, System GMM	The capital account OPEN (de jure) is associated with higher TFP growth

	developing countries	financial OPEN and TFP growth.	OPEN (% GDP), Population growth, Credit to private sector (% GDP), FDI (% GDP), IQ, equity liabilities (% GDP)		while financial integration (de facto) does not drive TFP growth.
Aghion et al. (2009)	83 countries over the years 1960–2000	Analyze the impact of volatility of real exchange rate (ER) on TFP via financial development.	Degree of ER flexibility, terms-of-trade volatility private credit to GDP from banks and the financial institutions inflation, OPEN, Education (secondary enrollment), government consumption expenditure % of GDP,	GMM dynamic panel data estimator, Seemingly Unrelated Regression Equations (SURE)	Result shows that financial development plays an important role in mitigating the negative effects of ER volatility on productivity growth. The study finds that the interaction of exchange flexibility with financial development is significant suggesting that this variable condition the impact of ER flexibility on TFP growth.
Kose et al. (2009)	Annual data over the period 1966–2005 for 67 countries	Examine the relationship between financial openness and TFP growth	gross stocks of external liabilities as % of GDP, OPEN, financial sector development, terms of trade, FDI, debt liabilities, population growth, private sector credit (% of GDP)	FE panel regressions	The findings suggest that FDI and portfolio equity liabilities boost TFP growth while external debt adversly effects TFP growth.
Loko and Diouf (2009)	62 developed, emerging, and developing countries	explore the macroeconomic drivers of TFP growth	Inflation, government size, OPEN, FDI, labour quality	GMM, PCA	The results confirm the key role of OPEN as well as HC in increasing productivity growth.

	over the period 1970–2005				
Islam (2008)	Explores the determinants of productivity	Provide cross country analysis of TFP derivers.	HC, Physical capital, government size, OPEN, public investment institutional variables	OLS, Instrumental Variable (IV) approach	The author classifies the drivers of productivity into four main categories that is economic factors, institutional factors, social base and physical base. The study commends that HC is one of the important determinants of productivity. further, reduction of government expenditure and undertaking measures that improve the IQ and reduce the black-market premium is necessary to achieve higher productivity.
Bonfiglioli (2008)	70 countries over the period 1975–99	examine the impact of financial integration on TFP growth	The ratio of total credit to the private sector over GDP, government expenditure as a ratio of GDP, OPEN, inflation	Dynamic panel regressions System GMM	The findings of the study confirm that financial integration has a positive effect on TFP growth
Madsen (2007)	Data of OECD countries over the period 1870-2004	Tests the contribution of diffusion of knowledge towards TFP convergence through the channel of trade.	World stock of knowledge, equally weighted imports of knowledge, and foreign patent stock	Dynamic Least Squares (DOLS) estimator	The findings of the study show that knowledge spillovers (imports of knowledge) are significantly contributing towards TFP convergence across the OECD countries.
Khan (2006)	Time series annual data from 1960 to 2003	To analyze the macroeconomic drivers of TFP in Pakistan	Inflation, OPEN, FDI, Government expenditure on education, government budget surplus or deficit (% of GDP), population growth, Domestic	Ordinary Least Square (OLS) method	The results confirm that stability of economy, FDI, and financial depth drive TFP. Interestingly, human capital measured by educational expenditure is insignificant.

			credit to GDP ratio, Domestic Investment, employment		
Kogel (2005)	70 countries of the world for 1965–1990	Explore the effect of demographic age structure on TFP.	Youth and elderly dependency ratio, OPEN, labor force, savings, GDP price index	pooled time series and cross-section regressions.	The findings show that youth dependency ratio has a negative effect on TFP.
Maudos et al. (2003)	OECD countries for 1965–90	Analyses the HC affects of productivity gains.	GDP, HC stock, aggregated labor input, total capital stock	SFA, DEA, Malmquist indices of productivity	The results show that HC induces TC and hence lead towards TFP gains.
Guellec and de la Potterie (2002)	16 OECD countries over the period of 1980-1998.	Test the long-run nexus between R&D and TFP growth	Business, foreign and public R&D capital stock,	ECM, and 3SLS Procedures	All three sources of R&D are important for TFP growth. The findings suggest that to take advantage of foreign technology a country needs to improve domestic R&D intensity.
Miller and Upadhyay (2000)	83 developed and developing countries for the period 1960 -1989	study the effects of OPEN, HC, and trade orientation on TFP	Physical capital HC, term of trade, inflation, OPEN	FE method	The results show positive significant impact of OPEN and HC on productivity growth.
Edwards (1998)	93 countries (advanced and developing) over the period of 1960–90	Whether more open economies experience faster TFP growth?	GDP per capita, HC, different proxies of OPEN, indexes of trade policy	Weighted and Instrumental Weighted Least Squares	The results show that the more open countries experienced faster TFP growth
Coe and Helpman (1995)	pooled time series cross section data for Israel and OECD countries over the time 1971-1990.	The impact of domestic and foreign R&D on TFP	Domestic R&D capital stocks, foreign R&D capital stocks, R&D expenditure	Panel cointegratio n	The results show that both domestic as well as foreign R&D spillovers matter for TFP. Moreover, in case of OPEN the effect of foreign R&D on domestic productivity may become more evident.

2.2.1.1 Literature on Human Capital and MFP

The path-breaking contribution of Romer (1986) shifts the attention of policymakers and researchers again towards the macroeconomic dynamics. Romer (1986, 1989) highlights the role of HC in the process of productivity and growth. This is sometimes referred to as "the resurgence of growth theory". The resurgence of growth theory during the 1980s with an expansion of the new neo-classical EGM (Romer, 1986; Lucas, 1988) has highlighted new avenues of research and introduced several discussions such as failure of cross-country convergence and international patterns of migration and wage differentials. Romer's (1986) model is based on Frankel (1962) and Arrow's (1962) "learning by doing" concept which implies that HC is a byproduct of market work and mechanization; an increase in the capital stock leads towards an increase in the stock of knowledge through learning by doing. Lucas (1993) asserts that learning by doing process shows that the rate of learning in the production process declines to zero overtime.

The contribution of HC[16] to productivity growth has been discussed and recognized in many empirical studies such as Nelson and Phelps (1966), Becker et al. (1990), Mankiw, et al. (1992), Barro (1993), Tallman and Wang (1994), Benhabib and Spiegel (1994), Temple (1999), Miller and Upadhyay (2000), Barro and Lee (2001), Baier et al. (2006),

[16]It refers to higher education, skills and training, technical know-how etc. inculcated in the person of an individual. it has spill-over effects on the process of growth. Lucas (1988) defines HC as "skills embodied in individuals that either are used for producing output or accumulate knowledge through education". In general, secondary school enrolment (Mankiw et. al., 1992), returns to education (Psacharopoulos, 1994) average years of schooling (Benhabib and Spiegel, 1994; Bosworth et. al., 1995; Zhang and Zhuang, 2011; De la Fuente and Doménech, 2001), weighted average of the population listed in primary, secondary and tertiary education (Murthy and Chien, 1997), gross enrollment rate at secondary education (Qadri and Waheed, 2014) have been used as a proxy for HC. In this context, Index of HC is widely accepted and extensively used database. It covers both developed and developing countries over a long period.

and Acemoglu (2012). One of the pioneering attempts by Nelson and Phelps (1966) finds that HC is important to determine the disparity between the technology frontier and TFP.

In the same line of analysis Vandenbussche et al. (2006) analyze OECD economies for the period 1960–2000 and advocate that only skilled HC rather than total HC amplifies TFP differences across countries. Moreover, the study asserts that the skilled HC has a sound growth augmenting effect in those economies that are nearer to the technological frontier. Similarly, Puskarova and Piribauer (2016) quantify the knowledge spillover[17] effects and HC stocks on TFP in European sub-national regions by employing a spatial Durbin panel model and maximum likelihood approach for the period of 2000 to 2010. The overall findings suggest that both knowledge and HC spillovers exhibit significant impacts on the TFP in the European sub-national regions.

It is well established that the skills and knowledge embodied in an individual (that is HC) plays an important role in TFP growth. Several macro levels studies such as Benhabib and Spiegel (1994), Maudos et al. (1999), Mahmood and Talat (2008), and Coe et al. (2009) find a significant and positive impact of HC on TFP. In contrast, there are some cross-section and panel data evidence which show either insignificant or significant and negative impact of HC on output growth and TFP growth (among others see Knight et al., 1993; Benhabib and Spiegel, 1994; Hamilton and Monteagudo, 1998; Pritchett, 2001; and Freire-Seren, 2001). Krueger and Lindahl (2001) pointed out that measurement error in data on educational attainment, particularly for developing countries may lead towards biased or inconclusive conclusions.

[17]Fischer et al. (2009) define "knowledge spillovers as the benefits of knowledge to firms, industries or regions not responsible for the original investment in the creation of this knowledge". Glaeser et al. (1992) suggest that knowledge spillovers might occur between industries in different cities rather than within industries.

Mankiw, et al. (1992) show that if HC is explicitly incorporated in the analysis, the neo-classical model is then capable to explain the cross-country differences in TFP growth but another supporter of endogenous growth theory Romer (1995), strongly contradicts Mankiw, et al. (1992) findings. Similarly, Islam (1995) refute the direct impact of HC (average years of schooling) on output growth in two of the three samples by using panel regressions. Similarly, several studies illustrate the either insignificant or significant negative impact of HC on MFP growth (for example, see Becker et al., 1990; Mankiw, et al., 1992; Tallman and Wang, 1994; Miller and Upadhyay, 2000; Baier et al., 2006; and Acemoglu, 2012).

2.2.1.2 Literature on R&D, ICT, and MFP

Under the Schumpeterian perspective,[18] both innovation activities (technological spillovers) and imitation are important for MFP growth. Schumpeter (1934)[19] argues that innovation plays a crucial role in economic and social changes. The investments in R&D lead to innovation activities and hence long-run economic growth. Among others, the major attempts to assess the effects of technological spillovers on TFP are Grossman and Helpman (1994), Coe and Helpman (1995) Engelbrecht (1997), Frantzen (2000), Engelbrecht (2002), Barrio-Castroa et al. (2002), Mendi (2007), Coe et al. (2009), Hasan and Tucci (2010), and Bianco and Niang (2012). Innovation (technological spillovers) in new growth theories is considered as a by-product (externality) of other economic activities

[18]Also, known as "innovation-based EGM or innovation-led growth models." For detailed information, see Geroski (1989), Grossman and Helpman (1991), Aghion and Howitt (1992, 1998), King & Levine (1993) and Ha & Howitt (2007).

[19] Schumpeter (1934) divides innovation into five different categories, these are: new types, new methods of production, new sources of supply, the exploitation of new markets, and new ways to organize business.

(investments in physical and HC). Some studies emphasize the complementary role of R&D, HC, ICT, and innovation such as Redding (1996), Cameron et al. (2005), Cardona et al. (2013), and Chou et al. (2014). Since the seminal work of Schultz (1953) and Griliches (1958), a bulk of literature investigates the effects of R&D expenditure on TFP. Theoretically, R&D expenditures upsurges TFP via different channels such as technological spillovers, foreign R&D activities, and technology embodied imports and exports (Coe and Helpman, 1995). Bravo-Ortega and Marin (2011) examine the relationship between R&D and productivity using several R&D indicators. The result shows that the per capita R&D expenditures are strongly exogenous to TFP and a 10% increase in R&D per capita generates an average increase of about 1.6% in the long-run TFP. The findings are consistent with Lederman and Maloney (2003).

There are number of studies that endorse a positive significant effect of ICT on TFP (Jorgenson, 2000; Timmer and Ark, 2005; Dimelis and Papaioannou, 2010). One of the pioneer attempts by Smith (1776) argues that economic growth not only depends on capital accumulation but also on technology. Further Schumpeter (1939) emphasizes on the role of innovation and ICT for productivity growth. Solow (1957) describes the productivity paradox as *"you can see computer everywhere except in productivity statistics"*. Venturini (2015) examines the role of investments in ICT and R&D in the long-run productivity performance of OECD countries. The result shows that both ICT and R&D investment influence TFP over the long run. Acemoglu and Zilibotti (2001) argue that a large fraction of the observed differences in TFP and output per worker is due to the technology-skill mismatch. Contrarily, Atella and Quintieri (2001) pointed out that the relationship between R&D expenditure and TFP is far from being established. The link between R&D and TFP depends upon how the TFP or Solow residual is measured. Further, in the case of an adjusted measure of TFP, the contribution of R&D expenditure towards TFP growth may be different.

2.2.1.3 Literature on R&D Spillovers and MFP

One of the earlier empirical studies by Coe and Helpman (1995) use sample of OECD countries and Israel over the time 1971-1990 to examine the spillover effects of R&D on MFP. By employing panel cointegration, they conclude that R&D spillovers (domestic and foreign) matter for TFP. Moreover, the findings suggest that in the case of OPEN and free trade, the effect of foreign R&D on domestic productivity may become more evident. Generally, in large open economies, productivity depends upon domestic R&D spillovers rather than international R&D spillovers. For example, Frantzen (2002) reports a significant impact of domestic R&D in large countries. The study finds that inter-sectoral R&D spillovers instead of intra-sectoral R&D spillovers are the main driving force of productivity growth.

Similarly, Bianco and Niang (2012) attempt to extend the analysis of Coe et al. (2009) by using the panel data for 24 OECD countries over the period 1971-2004. TFP is used as a dependent variable while R&D capital stock[20] and HC are used as principal exogenous variables. As per Coe et al. (2009), HC is proxied by average years of schooling from Barro and Lee (2001). The study uses a common factor framework developed by Bai and Ng (2006) to capture the effects of global interdependence implied by international spillover and diffusion mechanisms involved. The results suggest that there are considerable cross-

[20]Correspond to R&D capital stocks in the business sector.

country spillovers (mainly resulting from knowledge diffusion and R&D) which are significantly contributing to the TFP growth. Madsen (2007) uses the data of OECD countries for the period 1870-2004 to test the diffusion of knowledge through the channel of trade. The findings of the study show that knowledge spillovers (imports of knowledge) are significantly contributing towards TFP convergence across the OECD countries. El-hadj and Brada (2009) show that capital accumulation and structural change contribute towards convergence in the new European Union (EU) member countries.

Maryam and Jehan (2018) investigate the determinants of TFP convergence across developing countries for the period 1960-2015 and conclude that although OPEN supports productivity growth and convergence, FDI has a dominant role. Following Madsen (2007), one of the recent attempts by Lee (2020) explores the role of R&D investment and technology spillovers on productivity growth via intermediate input trade channel using country-industry-level data for 25 advanced and emerging economies. The author concludes that those countries and industries where technology converges to the frontier are more likely to get the productivity payoffs of technology spillovers via input trade channels. However, the role of domestic capacity in smoothing technology spillovers needs to be recognized.

2.2.1.4 Literature on Fiscal Policy and MFP

Over the last few decades, a bulk of empirical literature examines the relationships between fiscal policy and productivity growth. According to Islam (2008), a reduction in government expenditure is necessary to achieve higher productivity. Peden and Bradley (1989) conclude a negative link between government size and productivity.

They argue that an increase in the scale of government erodes both productivity and its growth. Modigliani (1961) followed by Diamond (1965) is considered as one of the pioneer theoretical contributions on the subject, advocates that expansion in the public debt always leads to a reduction in economic growth. For a sample of 19 OECD countries, Dar and Amirkhalkhali (2002) postulate that TFP growth is lower in countries with a higher debt-to-GDP ratio. Afonso and Jalles (2013) assess the links between economic growth, productivity, and public debt by using a panel of 155 countries for the period 1970–2008. By employing the growth equations and growth accounting techniques they find a negative effect of the debt ratio for the full sample. However, for the OECD, the relationship between average debt maturity and TFP growth is positive. Using a sample of 20 OECD countries for the period 1970-2009, Salotti and Trecroci (2016) empirically examine the impact of fiscal policy on productivity growth and private investment. They find the adverse impact of large fiscal imbalances and high public debt (85-90% of GDP) on productivity growth and investment

Everaert et al. (2015) examine the direct and indirect effects of fiscal policy on TFP in a sample of 15 OECD countries over the period 1970–2012. The study implements a nonlinear version of the common correlated effects pooled (CCEP) estimator of Pesaran (2006). The regression results ratify the previous findings by Fischer (1993) that budget deficits reduce the TFP. Moreover, the findings show that the productive expenditures by the government boost the TFP; the statutory corporate tax rate and free trade are effective fiscal policy tools for stimulating the absorptive capacity of a country and increasing the country's access to global technology. One of the indirect channels through which fiscal policy influences TFP is the absorptive capacity of a country.

Many studies examine the relationship between government spending and economic growth (for example, Ram, 1986; Glomm and Ravikumar, 1997; Folster and Henrekson, 2001). However, there is limited empirical evidence on the issue of whether high government size affects the productivity growth of an economy. One of the earlier studies by Aschauer (1989) considers the relationship between aggregate productivity and government-spending and concludes that government spending on infrastructure development is necessary to boost economic growth and productivity.

2.2.1.5 Literature on Monetary Policy, Global Factors, and MFP

The empirical relationship between inflation and MFP growth has been extensively examined by the economists in the last few decades (see Fischer, 1993; Smyth, 1995; Freeman and Yerger, 1998; Miller and Upadhyay, 2000; Kiley, 2003; Christopoulos and Tsionas, 2005; Bitros & Panas, 2006; Narayan and Smyth, 2009; and Li and Tanna, 2019). Generally, the empirical results are contradictory. For example, using SUR methodology on time series data, Smyth (1995) finds a strong inverse relationship between inflation and MFP growth in the case of the United States. In a response to Smyth (1995), Freeman and Yerger (1998) advocate the minor or negligible impact of inflation on MFP growth by employing the Granger causality' tests on the same data.

The 'Tobin effect' given by Tobin (1965) is a mechanism through which inflation may influence capital accumulation and MFP growth positively through enhancing the incentive to invest; as the opportunity cost of holding money increases. However, the likeliness of holding such an effect is limited as argued by Sidrauski (1967) that money is super-neutral[21] in the long run and Stockman (1981) that it acts as a complementary factor to capital. The proponents of the "neutrality of money" assert that if we hold the cash for capital formation, then a permanent increase in the rate of monetary growth and hence inflation may reduce the potential benefits of investment due to the depreciation of capital over time.

Generally, MFP growth and GDP growth per capita show a similar pattern; significantly negative during the crisis and global shocks, and significantly positive after the crisis and shocks (Bruno and Easterly, 1998). The unobserved global shocks and common factors such as technological innovation, global oil price shocks, and financial booms and busts may affect the output growth as well as MFP growth of different regions and countries differently (Eberhardt & Teal, 2011). These stocks not only affect the output and MFP growth directly but also affect the input and output in the production process through investment related decisions.

2.2.1.6 Literature on Financial Development and MFP

During the last few decades, a great deal of attention has been devoted towards the growth effects of financial development (among others, see Levine, 1997; Benhabib and Spiegel, 2000; Beck et al., 2000 and Bhatti et al., 2013). The basic idea of financial development and productivity nexus is based on Schumpeter (1934). King and Levine (1993) reemphasize the Schumpeterian view that financial development stimulates output growth through increasing the rate of capital accumulation and its efficiency. Financial markets boost productivity via well-organized and efficient capital reallocation in growth-oriented

[21] Money is "super-neutral" when growth rate of money supply has nothing to do with real variables such as real GDP and the investment.

industries. Benhabib and Spiegel (2000) scrutinize the impact of financial development on TFP growth and investment by using different proxies of financial development. They find that indicators of financial development are correlated with both TFP growth and investment. However, the indicators that are correlated with TFP growth differ from those that encourage investment. The results of Benhabib and Spiegel (2000) are in line with the findings of King and Levine (1993).

In a cross-country growth regression framework Beck et al. (2000) show that financial development positively and significantly affects TFP growth. Similarly, Bonfiglioli (2008) examines the impact of overall financial integration on TFP growth and concludes that it has a positive impact on TFPe growth. In the new paradigm of research Aghion et al. (2009) analyze the impact of real exchange rate volatility on productivity growth via financial development channel and conclude that financial development mitigates the negative effects of exchange rate volatility on TFP growth.

2.2.1.7 Literature on Foreign Direct Investment and MFP

There are three main theories that support the nexuses between cross-border investment and MFP. First, modernization theories, which are based and motivated by the neoclassical and endogenous growth theories. There are not much cross-country empirical evidences regarding the impact of FDI on MFP growth (hereafter, MFPG). However, there is abundant empirical research on the FDI-growth nexus[22]. The theoretical literature on the FDI-growth nexus identifies a contrasting view. According to the neoclassical model of economic growth, FDI affects economic growth in the short run but not in the long run.

[22] See De Mello (1999) and Almfraji & Almsafir (2014) for a comprehensive review of literature concerning the FDI-growth nexus.

The endogenous growth model focuses on the indirect and conditional effects of FDI on economic growth by arguing that the effects of FDI on growth are conditional upon the existence of some other factors.

According to modernization theories, the technology transfer and spillover via FDI are very important to promote capital accumulation, TFP, and economic growth in developing economies. Second, the classical or dependency theory is driven by the features of Marxism. It considers economic globalization and OPEN as the main source for capital movements and FDI across the world. Globalization does bring the use of ICT through which developing countries may achieve better long-run economic performance and higher levels of MFP growth. Third, the middle path theory which accommodates both the modernization and classical theories. The middle path theory recommends that the technology transfer and OPEN policies must be aligned with government regulations to tackle the adverse effects of complete OPEN and capital accounts (Gorg et al., 2005).

In the existing empirical literature, there are mixed evidences regarding the impact of FDI on MFP growth. For example, Zhu and Jeon (2007) employ panel data of OECD countries and find a positive significant impact of FDI stock on the productivity of sample countries. Similarly, Woo (2009) depicts a significant positive impact of FDI on TFP growth in the case of developing countries. Similarly, Baltabaev (2014) finds a significant positive effect of FDI on TFP growth. Recently, Herzer (2017) finds a positive long-run effect of FDI on TFP in Bolivia. Contrary to these findings, Wang and Wong (2009) advocate a negative effect of FDI on TFP. The study suggests that as the level of HC increases, the negative effects of FDI on TFP becomes smaller in absolute term.

2.2.1.8 Literature on Openness to Trade and MFP

The new growth theories (See, Romer, 1986; Lucas, 1988 and Grossman and Helpman,1991) support the proposition that OPEN positively affects economic growth. They contend that more open economies have more chances and ability to absorb technological advances and innovation generated by the technologically advanced countries. By using the Sample of 93 advanced and developing countries for 1960–90, Edwards (1998) tests the hypothesis whether more open economies experience faster TFP growth. The regression results show that the more open countries experienced faster productivity growth. Similarly, Miller and Upadhyay (2000) find a positive significant impact of OPEN on productivity growth. Alcala and Ciccone (2004) find that OPEN has significant and statistically robust positive effect on productivity growth. Egert (2016) argues that greater OPEN amplifies the positive effect of R&D spending on MFP growth.

On the other side of the debate, the empirical literature casts doubt on the growth effects of OPEN. There are several studies that suggest that OPEN may have no impact or even negative impact on growth, particularly in low-income countries. For instance, Kim (2011) reports positive significant effects of OPEN on growth for the developed countries while negative effects for the developing countries. Moreover, the empirical literature on the subject claims a non-linear link between OPEN and growth. For example, Foster (2006) indicates that there exists a threshold level in the relationship between OPEN and growth. The relationship between two variables depends upon the country's initial levels of per capita income. Similarly, Kim and Lin (2009) argue that there exists an income threshold below which the growth effects of OPEN become either negative or insignificant.

2.2.1.9 Literature on Physical Infrastructure and MFP

There is consensus among the researchers and policymakers that the investment in public capital, particularly, improving the physical infrastructure (for example, roads, telecommunication, and electricity) is vital to expand the productive capacity of the existing resources. A well-constructed highway reduces the total cost of the producers Aschauer (1989), Munnell (1992), Easterly and Rebelo (1993) and Rodrik (2005) find the positive significant impact of infrastructures such as streets, highway, airports, and other public capital expenditures on economic development and productivity. Rodrik (2005) reveals that TFP growth in India is mainly due to a substantial investment in physical infrastructure. However, Holtz-Eakin and Schwartz (1995) find a negative coefficient for public capital and infrastructure investment which indicates the negative impact of public investment on productivity.

2.2.2 Institutional Determinants of MFP

The discussion on institutions as one of the main driver of productivity and economic growth has been evolving in the mainstream economic literature over the last three decades (see among others North, 1990; Wolf et al.,1955; Hall and Jones, 1999; Rodrik, 2000; Rodrik et al., 2004; Acemoglu et al., 2003, 2005; Glaeser et al., 2004; Dias and Tebaldi, 2012; Dreher et al., 2014; Nawaz, 2015) However, to explore the different channels and links through which the IQ may impact MFP growth is one of the challenging tasks and a probe of an ongoing debate among researchers (Egert, 2016). An empirical investigation is much needed to scrutinize the different channels and conditions through which IQ affect TFP especially for a sample of developing economies.

Hall and Jones (1999), one of the pioneer empirical attempts on the subject examine the impact of institutions and government policies (social infrastructure) on productivity measured by output per worker. By employing the instrumental variables approach developed by Wright (1928) on the dataset of 79 countries, the study concludes that the IQ and government policies (social infrastructure) are important determinants of productivity differences and long-run economic performance across countries. However, variation in output per worker across countries is partially explained by the investment in physical and HC. Similarly, Rodrik (1999) advocates that institutions not only determine the economic performance of a country but also predict its sustainability. North (1990) declares that institutions improve the incentive structure that leads to enhance the productivity of factor inputs. Keefer, and Knack (1997) report that IQ raises the country's ability to catch up. Thus, better institutions would support to attain the convergence between developing and developed countries. Fadiran and Akanbi (2017) find a significant role of market-based institutions in determining the TFP in Sub-Saharan African countries.

Rigobon and Rodrik (2005) use panel data of 86 countries to gauge the interrelationships among income levels, economic and political institutions and OPEN. The regression results show the positive significant effects of economic and political institutions on output growth while the coefficient of OPEN is statistically insignificant. Grigorian and Martinez (2000) check the nexus between institutions and industrial growth in 27 Asian and Latin American countries. The findings of the study indicate that improvement in the legal and regulatory framework affects industrial growth via TFP and investment.

In the same line of analysis, Dreher et al. (2014) examine the link between output, productivity, and institutions, by taking in to account the role of the shadow economy. They used panel data for 76 countries over the period 1980–2000 to estimate the FE and RE models. The results ratify the positive relationship among IQ, output, and TFP, while the existence of a negative relationship between IQ and shadow economy; implies that better IQ reduces the proportion of the shadow economy. The results are consistent to Schneider (2010). Coe et al. (2009) extend the previous research of Coe and Helpman (1995) by including the role of institutions. The findings are consistent with the previous outcomes. Also, the results suggest that institutional differences across nations significantly determine TFP. A higher level of IQ is complementary to the higher levels of TFP together with domestic and foreign R&D spillovers.

Egert (2016) uses the sample of 34 OECD countries to scrutinize the impact of regulations and the quality of institutions on country level MFP. The findings of the study show that better IQ, friendly business environment, greater OPEN strengthen the positive effect of R&D expenditures on MFP. The result shows that greater innovation intensity enhances MFP. The finding can be further corroborated by Hall and Jones (1999) and Olson et al. (2000). They demonstrate a positive significant relationship between IQ and TFP growth. Hall and Jones (1999) measure the IQ by the "social infrastructure" index[23]. A recent attempt by Akhremenko et al. (2019) considers BRICS as an empirical example to examine the interdependence among TFP, economic welfare, and political institutions. The study employs DEA (nonparametric methods) to estimate TFP levels for selected

[23]The index is mainly consisting of law and order, protection of property rights by the government, corruption, bureaucratic quality, and risk of expropriation.

countries. The findings suggest that per capita GDP and TFP levels are mainly determined by the quality of institutions.

Bjornskov and Meon (2015) investigate the impact of social trust on TFP by employing a panel dataset for the period 1950–2000. By using FE and RE models the study reported a significant positive effect of social trust on TFP growth. Moreover, the impact of social trust on TFP growth runs through the channel of economic institutions, instead of political institution. This finding can be linked with the findings of Uslaner (2002) who advocates that social trust matters to institutions.

Jalles and Tavares (2015) consider the effect of trade, scale, and social capital on TFP by using a panel dataset of 59 countries over the period 1970–2007. To capture the scale effect (size of the economy) the study uses different indicators including real GDP, capital stock, population, and labor force. To assess the effect of social capital, different sets of social capital-related variables including trust, civil liberties, civic cooperation, religious, linguistic, and ethnic fractionalization have been used. The results show that the effect of trade and social capital is significant, whereas the scale effect is insignificant. Both higher trade intensity and higher levels of social capital raise the TFP growth rate.

To find the evidence of global or regional TFP convergence Tebaldi (2016) uses a sample of 63 countries for 1960 to 2011. The study employs Phillips and Sul (2007) methods to test the cross-countries convergence. Additionally, the study employs a system GMM estimator to analyze the factors driving TFP growth. The convergence test shows evidence of strong TFP cross-countries convergence by recognizing the role of initial conditions. The results indicate that economies with a lower value of TFP at the beginning remain below as compare to those economies which have a better start. The results of the system GMM imply that institutions and OPEN are crucial factors that determine the TFP growth. The summary of selected empirical studies that examine the impact of regulations and institutions on aggregate productivity is given in Table 2.2.

Table 2.2: Selected Studies on the Institutional Determinants of Multi-Factor Productivity (MFP)

Author (s) Year	Sample / Type of study/ Coverage	Motivation / Research Objectives	Key Institutional Variables	Methodology/ Estimation Method	Key Findings / Results
Papaioan (2017)	23 OECD countries for the period 1975–2007.	Explore the impact of regulation on TFP growth	Different types of regulation, Technology gap	Panel cointegration	In short run, the impact of regulation on TFP growth is not significant in all cases. The long run influence of regulation on TFP growth is negative. However, the adverse effects of regulations are more severe in countries with lower technology gaps.
Egert (2016)	34 OECD countries	scrutinize the impact of regulations and the quality of institutions on country level MFP.	market regulation, institutional quality	Dynamic OLS (DOLS) estimator	The findings of the study show that better IQ, friendly business environment, greater OPEN amplify the positive effect of R&D spending on MFP. The result shows that greater innovation intensity enhances MFP.
Tebaldi (2016)	63 countries over the period of 1960 to 2011	To find the evidence of global or regional TFP convergence and to analyze the factors driving TFP growth.	The Political Constraints Index, Independent Judiciary Corruption, Law and Order, Bureaucracy Quality, Index of Democratization	Phillips and Sul (2007) methods to test the cross countries convergence, System GMM,	The convergence test shows evidence of strong TFP cross countries convergence. The results of system GMM imply that institutions and OPEN are crucial factors which determine the TFP growth.
Ng and Ng (2016)	32 OECD countries and United States between 2000-2001	Analyses the factors that account for TFP differences between	HC, ICT investment, R&D, IQ, number of researchers	Difference GMM,	The results show that IQ, investment in M&E, ICT investment, and economic globalization are important factors

		OECD countries and United States.			that explain the difference in TFP among countries.
Krammer (2015).	47 countries over the period 1990 to 2009	To explore the both direct and indirect effects of IQ on the productivity of developed and transition economies and to examine the effect of R&D spillovers on productivity via IQ.	Governance indicators, trade and FDI spillovers, domestic R&D	Panel cointegration tests, FE model	The results of my empirical analysis confirm that the effects of institutions on productivity differ across developed and less developed countries. In most of the cases, IQ has positive significant impact on productivity. Moreover, IQ moderates the effects of foreign technological spillovers (FDI and trade) on productivity. However, these indirect effects vary across institutional elements and countries.
Bjornskov and Meon (2015)	panel dataset for the period of 1950–2000	investigate the impact of social trust on TFP	Social trust	FE and RE models	The study reports a significant positive effect of social trust on TFP growth. Moreover, the impact of social trust on TFP growth runs through the channel of economic institutions, instead of political institution.
Jalles and Tavares (2015)	59 countries over the period of 1970–2007	consider the effect of trade, scale and social capital on TFP	different set of social capital-related variables including Trust, civil liberties, civic cooperation, religious, linguistic and ethnic fractionalization	least-squares dummy variable (LSDV) estimator, Instrumental Variable-Generalized Least Squares (IVGLS) approach System GMM,	The positive effect of social capital is more significant in rich countries, suggesting that good institutions may be complementary to social capital.

Dreher et al. (2014)	76 countries over the period of 1980–2000	examine the link between output, productivity, and institutions, by taking in to account the role of the shadow economy.	Rule of law	OLS and instrumental variables estimates, FE and RE models.	The results ratify the positive relationship among IQ, output and TFP, while the existence of inverse relationship between IQ and shadow economy; implies that better institutions reduce the size of the shadow economy.
Farhadi et al. (2014)	99 countries for the period of 1970–2010	Examine the role of high-quality economic institutions and economic freedom in promoting productivity growth in resource-rich economies.	resource rents GDP ratio, index of economic freedom, investment as % of GDP, OPEN, urbanization	System GMM	The results show that the economic freedom improves the productivity growth in resource-rich economies via its impact on rent-seeking. Further, the producer-friendly institutions stimulate competition and efficient utilization of resources by controlling rent-seeking and unproductive activities (lobbying, corruption, and black markets etc.); leading to higher productivity growth.
Chanda and Dalgaard (2008)	40 countries over the period of 1980–1985	investigate the factors that drive variation in relative efficiency across countries and examine the impact of institutions, geography and trade on the productivity of through the channel of dual economy channel.	Institutions, OPEN, and geography	ordinary least squares (OLS), two-stage least squares (2SLS), Limited Information Maximum Likelihood (LIML) estimation	The international variation in aggregate TFP is mainly driven by the variation in relative efficiency across sectors. The property rights, financial development and geographical advantage are important to enhance efficiency and TFP level.
Hall and Jones (1999)	79 countries for the period of 1970-1995	Examine the impact of government policies (social infrastructure) and	log output per worker, investment in physical and HC, Institutional	OLS, instrumental variables estimation, bootstrap method.	The productivity differences across countries are mainly determined by the IQ and government policies (social infrastructure). However,

		institutions on productivity (that is output per worker)	indicators such OPEN measures, educational attainment, government anti-diversion policies (GADP) policy index variable		variation in output per worker across countries is partially explained by physical and HC.

2.3 Summary and Conclusion

The focus of this chapter is to provide an extensive review of the literature on the measurement and determinants of MFP. This literature begins with a growth accounting framework, one of the pioneer deterministic approaches being used to estimate the MFP at aggregate as well as at sectoral levels. As a check on measurement problems of the growth accounting framework, the index number method is also applied by the researchers to measure MFP, since it does not require an APF. An alternative way of estimating MFP and efficiency analysis is based on frontier methods. To overcome the shortcoming of the growth accounting and frontier techniques, growth regressions and econometric methods have been proposed. These methods are extensions of the earlier methods of Solow residual. In growth regressions, a structural equation is identified to estimate the MFP level from aggregate data

By going through the empirical literature, we conclude that there is hardly any empirical study that employs the econometric method for the measurement of MFP growth. Mostly, the existing empirical literature on measurement ignores the endogeneity bias caused by reverse causality and feedback effects. Further, the HC adjusted measure of productivity growth has seldom been used in the growth literature. To the best of our knowledge, the HC adjusted estimates of MFP growth for developing economies is not available. Moreover, a critical review of the existing available methodologies of TFP measurement is needed to provide the researchers with a platform to develop more suitable measurement method(s).

Similarly, no in-depth empirical study has been carried out so far to examine the effects of institutional as well as macroeconomic factors on MFP growth for the sample of developing countries. The existing literature on developed economies either solely focuses on macroeconomic drivers or discusses the institutional factors concerning MFP. Therefore, the analysis of both factors (macroeconomic and institutions) simultaneously may open a new avenue of research related to MFP. Most of the existing empirical literature overlooks the channels and conditions through which macroeconomic and institutional factors may affect MFP growth. We could not find any empirical study on aggregate productivity growth in which macroeconomic and institutional indicators are used as both the mediator and moderator.

Chapter 3

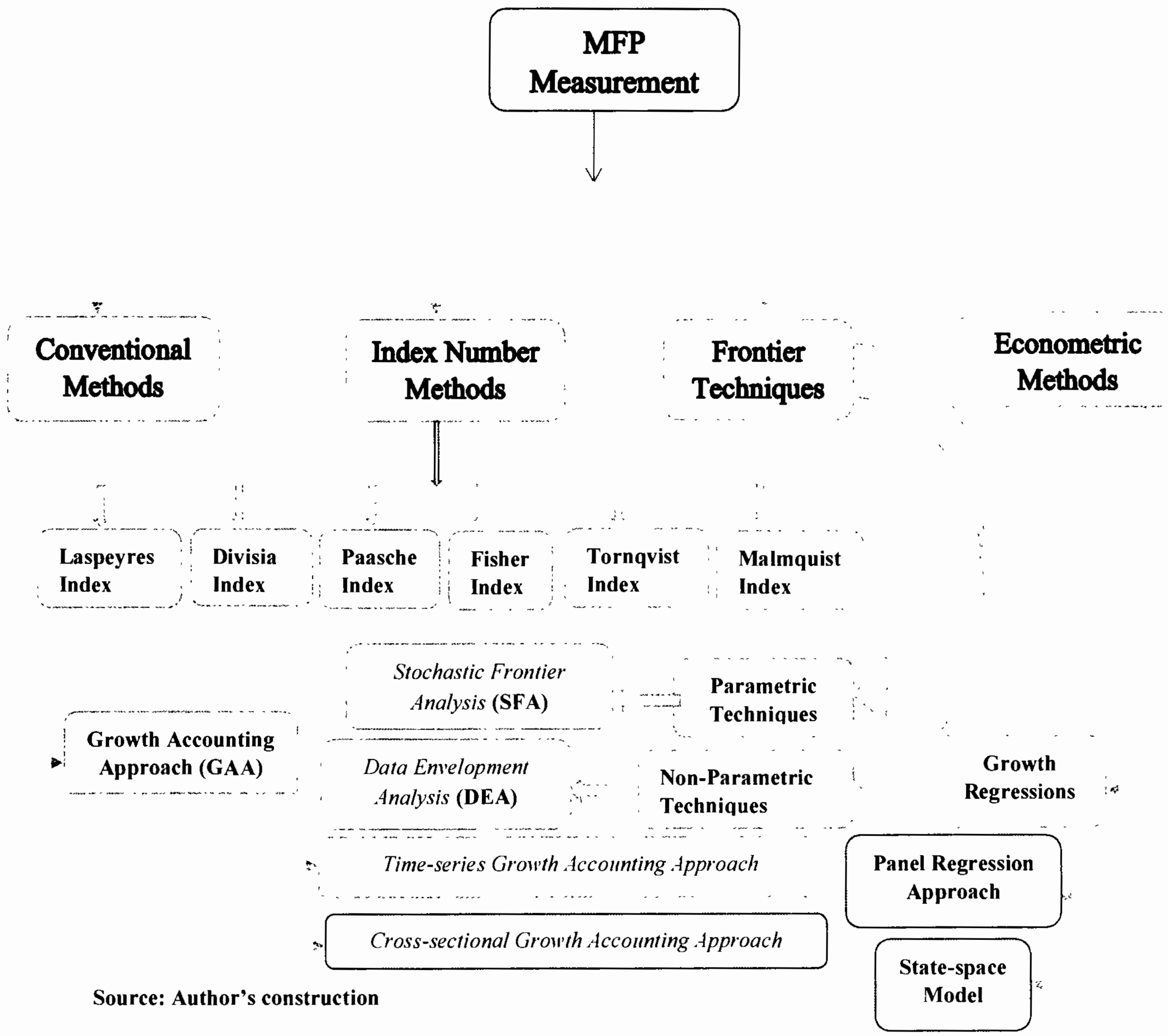
MEASURING MULTI-FACTOR PRODUCTIVITY: AN OVERVIEW

Broadly, there are three strands of literature concerning the measurement of MFP. The conventional method is the GAA. The second strand of literature uses index number methods along with frontier techniques. The third strand employs the growth regressions or econometric methods to estimate MFP across countries and regions. A flow chart of these methods is given in Figure 3.1.

3.1 Conventional Methods

The conventional method to measure MFP is the GAA. It decomposes the observed economic growth into two components: first, the contribution of factor inputs; and second, the contribution of TC known as the Solow residual. In this framework, Stigler (1947) was one of the pioneer attempts, followed by Sollow (1956), Abramovitz (1956), Kendrick (1961), Hall and Jones (1999), Oliner and Sichel (2000), Jorgenson and Stiroh (2000) and many others. These studies show that economic growth associated with the growth of factors of production is dominated by the unexplained part of the contribution of TC. In the NGM, exogenously determined technological progress is just like manna from heaven. The empirical analysis shows that about a 50% to 90% share of aggregate growth remains unexplained due to unknown factors other than the conventional inputs of labor and capital. These unknown factors are either attributed to the impact of technical progress or a "measure of our ignorance" (Syverson, 2011; Abramovitz, 1956).

Figure 3.1: Methodologies for MFP Measurements



Source: Author's construction

TFP has been considered as an engine of economic growth (Grossman and Helpman, 1991; Aghion and Howitt, 1998). One of the earliest studies by Abramovitz (1956) uses US data from 1869-78 to 1944-53 and concludes that 90 % of output growth is linked with the growth of TFP, while only 10 % of output growth per person is related to the growth of factors of production. Similarly, Solow (1957) uses the time series data of the US economy from 1900 to 1949 and finds that 88 % of output growth is associated with the growth of TFP, while only 12 % of output growth per person is linked with the growth of factor inputs. Further, Kendrick (1961), Klenow and Rodriguez-Clare (1997), Oliner and Sichel (2000), Jorgenson and Stiroh (2000), and Baier et al. (2006) attempt to minimize this unexplained part or residual through modeling and empirical testing, but still it remains far from zero. Contrarily, using the sample of East Asian countries, Young (1995) claims that GDP growth is mostly explained by input accumulation rather than TFP growth.

The production function in a general form can be expressed as

$$y = f(x_1, x_2, x_3 \dots \dots \dots, x_n)$$

where y is output and x_i's are inputs with i = 1, …, n. In the existing literature, several functional forms of the production function have been proposed for example Cobb Douglas, constant elasticity of substitution (CES), translog, generalized Leontief and normalized quadratic, etc. The Cobb–Douglas function supported by the standard neoclassical production function has been widely used in the applied economic literature, which is expressed in its simple form as:

$$Y = F(K, L) \qquad (3.1)$$

where Y is output. K and L denote capital stock and labor respectively.

The GAA of TFP measurement is based on the seminal work of Solow (1956 and 1957). As said earlier, this approach relates the measured inputs to measured output through a production function of the form:

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

where Y is output, K is capital input, L is labor input, and t represents time. If we differentiate equation (3.2) with respect to time, and divide it by Y, then we have:

$$\frac{\frac{dY}{dt}}{Y} = \frac{\left(\frac{\partial F}{\partial K}\right)K}{Y} \times \frac{\frac{dK}{dt}}{K} + \frac{\left(\frac{\partial F}{\partial L}\right)L}{Y} \times \frac{\frac{dL}{dt}}{L} + \frac{\frac{\partial F}{\partial t}}{Y} \quad (3.3)$$

In equation (3.3), the terms $\frac{\left(\frac{\partial F}{\partial K}\right)}{Y}$ *and* $\frac{\left(\frac{\partial F}{\partial L}\right)}{Y}$ represent the factor shares of capital and labor respectively, while the term $\frac{\frac{\partial F}{\partial t}}{Y}$ denotes the proportional rate of shift of the production function (TC or MFP). If we assume a "Cobb-Douglas APF", then

$$Y = AK^{\propto}L^{1-\alpha} \quad (3.4)$$

where, Y is output, K is capital stock, and L is labor force, α demonstrates the elasticities of production functions, $0 < \alpha < 1$, and A represents the Solow Residual which is equal to:

$$TFP = A = Y/K^{\propto}L^{1-\alpha} \quad (3.5)$$

The endogenous growth theories[24] consider "A" as TFP or "measure of our ignorance" (Syverson, 2011). Although the residual method has been developed several decades ago, it has still been applied consistently by the academician to estimate productivity. Occasionally, some improvements have been made in the traditional estimates of the Solow Residual. For example, instead of using growth rates of TFP, the researchers use TFP levels (Benhabib and Spiegel, 1994; Hall and Jones, 1999). According to Islam (1999), the time-series GAA has two different forms; the absolute and the relative. The former requires the time-series data of individual countries for a long period to obtain the TFP growth rates rather than TFP levels.

[24] For detail see Barro and Sala-i-Martin (1995) and Aghion and Howitt (1998).

Contrary to the absolute, the relative form initiated by Jorgenson and Nishimizu (1978) that not only provides the TFP growth rates but also relative TFP levels by converting the data of different countries to a common benchmark currency. Senhadji (2000) theoretically explores the source of cross-country differences in TFP levels and conjectures in favor of TFP level estimation.

The GAA is suggested for comparison of relative TFP levels across countries by Hall and Jones (1996). This approach also has its strengths and weaknesses. The main advantage is that it allows factor share parameters to vary across countries and therefore does not require econometric estimation of parameters. Secondly, it does not impose a specific form on the APF. The limitations are, first, that it depends on the assumption [illegible] an even rate of return across countries to compute the country's specific value for the factor share parameter. Most of the empirical studies including Fischer (1993) have used 0.40 as a share of capital in output, which implies that the share of labor in output is 0.60. For example, Crafts (1999) and Bernanke and Gurkaynak (2001) take 0.30 as a share [illegible] capital in output, which implies that the share of labor in output is 0.70. Second, prior [illegible]ring of selected countries is required, and inclusion or exclusion of countries [illegible] to biased TFP indices. Third, it requires data on physical capital stock which may contain measurement errors due to differences in depreciation rates and initial levels of capital stocks. Barro (1999) proposes a dual approach for the estimation of MFP by the GAA. Instead of computing MFP from the growth rates of factor quantities, this approach computes the Solow Residual or MFP from the growth rate of factor prices. According to the dual approach, output equalizes total factor income, given that production function is linearly homogenous.

The rationale behind the wider use of the GAA in the existing empirical literature is; firstly, it can be applied in case of scarce data or missing observations. Secondly, it is simple in its application. Thirdly, it gives TFP growth estimates for each period; enabling the policymakers to monitor the productivity growth of the economies, industries, and firms regularly. Likewise, this approach also has a few limitations. For example, the required assumption of a stable production function may be violated in most cases. Similarly, the assumption of linear homogeneity of production function and constant return to scale may not be satisfied. Lucas (1988) and Romer (1986, 1990) argue that the production function may exhibit increasing returns to scale. Hence, it may not apply to the less developed and developing economies. Moreover, this approach assumes that technological progress is Hicks neutral, that is it increases the efficiency of both capital and labor at the same time. Technological progress may increase the efficiency and productivity of different factors of production inconsistently.

To overcome the shortcoming and to circumvent the limitations of the GAA, the frontier techniques and econometric methods have been proposed. These methods have been applied as a check on problems in the measurement of the growth accounting framework. Deprins et al. (1984) propose the Free Disposal Hull (FDH) method, which is relatively less popular, though more flexible, than the DEA introduced by Farrell (1957). Fuentes and Morales (2011) propose the use of a SSM to estimate the level of TFP, its long-term growth rate, and other relevant parameters, such as the capital-output elasticity.

3.2 Index Number Methods

The index number method is an extension of the growth accounting framework and it does not require an APF. For example, the MPI introduced by Caves et al. (1982) makes use of distance functions to measure productivity change. It can be defined using input or output orientated distance functions. It compares ratios of outputs with inputs (that is TFP) across units. It assumes that all the units being used (firms, industries, or countries) can be compared. However, this assumption may not be satisfied in the real world. We can write the TFP index in standard forms as:

$$MFP = A = X/L^{\alpha}K^{\beta} \tag{3.6}$$

where, equation (3.6) is a geometric index. A is the MFP index, X is the output index, L and K are factor inputs, while α and β are their respective weights.

To construct an index that measures the contribution of combined inputs, the growth rates of the factor inputs should be weighted appropriately. The main problem is the selection of appropriate weights for factor inputs and output. Two commonly used approaches for the selection of an appropriate index number for MFP measurement are the "axiomatic approach" and "economic approach". The former compares the properties of various index numbers with desirable properties and the one having the maximum number of desirable properties is selected for the estimation of MFP. The latter links index numbers to a production form such as the Cobb-Douglas production function, CES production function, and Translog production function, etc.

The commonly used productivity measurement indexes are the Laspeyres (1871), Divisia (1973), Paasche (1874), Fisher (1922), Tornqvist (1936), and Malmquist (1953) productivity, etc. The Tornqvist has been the most popular TFP index.

This approach is also known as the HMI Approach. It defines productivity index simply as the ratio of output and input index numbers. The MPI is the same as the HMI if the technology exhibits global constant returns to scale (henceforth, CRS) and inverse homotheticity. The merits and limitations of index number methods are almost identical to the GAA.

Index number methods have been extensively used for measuring the efficiency and productivity of different firms, institutions as well as various sectors of the economy. However, these methods do not provide sources of productivity growth. Therefore, at the aggregate level their use remains limited (Caves et al., 1982 Del Gatto, 2011). For example, Maudos et al. (1999) examine the TFP evolution in OECD countries by using the Malmquist indices of productivity and break down the productivity gains into TC and efficiency.

3.3 Frontier Techniques

Besides the growth accounting framework and methods of the index number, we can also measure[25] the MFP growth by frontier techniques. Frontier models[26] have been used in both macro and micro studies. Frontier models divide the productivity growth into two main sources; first, TC, which by assumption pushes the production frontier upward; and second, TE change, which improves the production by improving the capacity of productive units, given the level of technology and inputs. Most of the empirical research

[25] For detailed overview and survey of productivity measurement methodologies, see Nadiri (1970), Felipe (1999), Del Gatto (2011), and Van Beveren (2012).

[26] For detailed description of frontier models, see Schmidt (2008).

within the frontier approach adopts either SFA or DEA as parametric and non-parametric estimation techniques respectively.

The parametric methods rely on strong assumptions of the functional form and in most of the cases, the parametric studies use a translog functional form without any prior testing. So, many researchers based on simultaneity bias and endogeneity problems have shown their serious concerns regarding the validity of findings being drawn through these approaches (see Polemis & Stengos, 2015 and Tran & Tsionas, 2010). To overcome the weaknesses of the parametric techniques, Olley and Pakes (1996) initiate a semi-parametric approach and developed a semi-parametric estimator followed by Levisohn and Petrin (2003) and Ackerberg et al. (2015). However, the Cobb-Douglas specification is the prerequisite for this approach, which is quite restrictive in empirical research. Recognizing the elusive nature of various MFP measurement approaches, Van Biesebroeck (2007) and Bournakis and Mallick (2018) provide a deliberate discussion on the robustness of different parametric, non-parametric, and semi-parametric MFP estimation techniques keeping in view the endogeneity issue and differences in production technology.

Taking a step forward on productivity measurement, Tsionas and Polemis (2019) propose a new approach to the estimation of TFP growth, based on a nonparametric specification along with a novel Bayesian nonparametric local likelihood approach. The authors apply Bayesian techniques around Markov Chain Monte Carlo (MCMC) approach and conclude that parametric methods lead to biased estimation of TFP growth while the proposed nonparametric method performs well in terms of sensitivity analyses and diagnostic testing. These methods are now getting popularity among researchers due to developments in digital technology and posterior simulators.

An alternative way of estimating MFP and efficiency analysis is based on SFM given by Aigner et al. (1977). Greene (2010) extends the analysis and provides SFM with sample selection. Based on the Heckman (1979) framework, the study develops a full information "true" sample selection model for the stochastic frontier specification to measure the overall health system performance across 191 countries. It appears that the existing SFM are more inclined towards the issues of endogeneity as compare to standard cost function and average production models. The traditional approach to deal with the endogeneity problem is to employ the FE or least squares dummy variables estimation techniques.

One of the earliest attempts by Guan et al. (2009) follows a two-step estimation methodology to handle the issues of endogeneity in SFM. In the first step, the authors use the GMM method to estimate the frontier parameters consistently. In the second step, the residuals obtained from the first stage are used as a dependent variable to get efficiency estimates, applying standard SFA.

Kumbhakar et al. (2000) propose the SFA to the decomposition of TFP in a panel framework. In this connection, Kumbhakar and Lovell (2003) provide a survey of panel data production frontier models. In contrast to the earlier proposed solutions of endogeneity, Karakaplan and Kutlu (2017) identify some alternative ways through which the endogeneity problem could be attacked. For example, using the instruments from the standard literature or employing a control function approach (introduced by Olley and Pakes), particularly in the case of estimating a translog model that involves cross products of endogenous variables. Danquah et al. (2014) combine Bayesian model averaging techniques with a non-parametric approach of MFP growth to address TFP measurement issues and the importance of country-level time-invariant unobserved heterogeneity in TFP growth. The findings of the study suggest that the cross-country TFP growth differences exhibit a lucid pattern, and country-specific unobserved heterogeneity is an important driver of TFP growth.

MFP growth differences have the power to portray cross-country differences. Among others, Fare et al. (1994), Koop et al. (1999), and Kruger (2003) have employed frontier techniques to calculate the TFP growth in cross-country analyses. Fare et al. (1994) examine the MFP growth in 17 OECD countries by employing MPI that is decomposed into two component measures: TC and EC. They conclude that the productivity growth of the US and Japan is higher in the sample; all due to TC in the US, while about half due to EC in Japan. Kumbhakar and Wang (2005) employ SFA to decompose the Malmquist index for 82 countries. Similarly, Alvarez (2007) decomposes regional productivity growth for Spanish regions. The study contributes to the productivity literature by combining FE and SFA, enabling the researchers to start a discussion on whether to use average or frontier functions to estimate regional TFP.

Arazmuradov et al. (2014) employ a time-varying SFA on 15 FSU economies for 1995–2008 to explore the impacts of FDI, import of machinery, and HC on TFP. Their results show that FDI and HC improve TE and hence real GDP growth of FSU republics. By using a similar methodology, Aguiar et al. (2017) estimate TFP growth and technical inefficiency for a panel of 40 OECD and emerging economies throughout 2001–11. The findings of the study show that growth rates in the emerging economies are four times higher than in OECD countries.

In the same line of analysis, Huang et al. (2014) employ a two-step SFA (meta-frontier production function) to estimate TE. In the first step, parameters of the stochastic meta frontier (SMF) regression are estimated through the conventional maximum likelihood method. In the second step, the group-specific technology gap ratio is estimated based on the SFA. This approach opposes O'Donnell et al. (2008) in the second step, where they apply a mathematical programming technique. The advantage of SFA over DEA is that it values the possible impact of noise (a symmetric term) on the positioning and shape of the frontier. Glass et al. (2016) develop a heteroscedastic version of the spatial autoregressive (SAR) stochastic frontier for panel data; whose specification allows efficiency to vary over time and across the cross-sections. Similarly, Greene et al. (2016) provide a discussion on the methods of introducing heterogeneity into the parameters of the SFM via FE and RE specifications.

3.4 Growth Regressions or Econometric Methods

The growth regressions or econometric methods are commonly used parametric methods to estimate MFP across countries and regions. These methods are extensions of the earlier methods of the Solow residual. In growth regressions, a structural equation is identified to estimate the MFP level from aggregate data (Mankiw et al., 1992; Islam, 1995; Hall and Jones, 1999). So, the econometric methods use a model-based approach instead of estimating the residual from a calibration exercise. In this method, residual in the regression is interpreted as MFP growth. Usually, the econometric approach starts from a Cobb-Douglas production function with a constant return to scale (CRS).

$$Y_t = A_t \, K_t^{\tau} \, L_t^{1-\tau} \tag{3.7}$$

where, Y is output at time t, K is the capital input at time t, L is the labor input at time t, A_t represents the shift in production function due to TC, τ and 1- τ characterize the share of capital and labor in the production function respectively. A_t implies that technology grows at a constant exponential rate of λ. It can be defined as:

$$A_t = A_o\, e^{\lambda t} \tag{3.8}$$

By substituting (3.8) into (3.7), we get

$$Y_t = A_o e^{\lambda t}\, K_t^{\tau}\, L_t^{1-\tau} \tag{3.9}$$

Taking logarithms of both sides, we obtain the following

$$ln\, Y_t = lnA_o + \lambda t + \tau lnK_t \ + (1-\tau)lnL_t + \varepsilon_t \tag{3.10}$$

Using a time-series data for Y, K, and L, we can estimate the output elasticities and technology coefficient λ and hence the contribution of TC to output growth. However, the technology coefficient is not embodied in factor inputs, exogenous, and Hicks-neutral[27] just like manna from heaven. A smaller λ may indicate misspecification of the production function while larger λ could be due to significant effects of resource allocation and economies of scale.

For estimation purpose, the equation (3.10) can be transformed as:

$$ln\, Y_t = \tau_o + \tau_1\, t + \tau_2\, lnK_t \ + \tau_3\, lnL_t + \varepsilon_t \tag{3.11}$$

We can measure the MFP growth as:

$$MFPG_t = \tau_1 \ + (\tau_2 \ + \tau_3 \ - 1)(\tau_2\, \dot{K}_t + \tau_3\, \dot{L}_t) \tag{3.12}$$

[27] The Hicks-neutral technological change implies that technology increases the efficiency of both capital and labor inputs proportionately; while, Harrod-neutral and Solow-neutral technological changes are labor-augmenting and capital-augmenting respectively.

In equation (12), τ_1 is a time trend, τ_2 *and* τ_3 represent the output elasticity for capital and labor respectively while $\dot{K_t}$ and $\dot{L_t}$ express the annual growth rates of capital and labor force respectively.

One of the recent attempts by Duygun et al. (2017) focuses on the econometric estimation of TFP growth. The study employs the model averaging methodology on the WPD developed by the UNIDO to compute TFP estimates. To implement the model averaging methodology, weights are assigned to each set of model estimates. The econometric methods used to measure MFP growth have their own merits and limitations. Firstly, the prior sequencing and ordering of the selected countries is not required. Secondly, it is less sensitive to the sample selection and inclusion or exclusion of countries. Thirdly, we do not need data on physical capital stock, which may have the problems of measurement error due to the different profile of depreciation rate and initial level of capital stock. Kiviet (1995) might be right in saying *"Yet, no technique is available that has shown uniform superiority in finite samples over a wide range of relevant situations as far as the true parameter values and the further properties of the data generating process (DGP) are concerned"*. The limitation of econometric methods of MFP estimation is that it ignores the contribution of EC to productivity change. Secondly, based on specified functional form, the condition of homogeneity across countries is imposed which may not hold.

One of the important features of econometric methods is the use of panel estimators and DPDM in growth regressions, particularly in macro-level studies. Mankiw et al. (1992) and Islam (1995) have been considered as classic articles. They explore how the results change when a model-based approach is applied instead of growth accounting methodologies. Islam (1995) uses the LSDV estimator based on the FE assumption along with LSDV-WG to estimate the cross-country TFP. He focuses on the role of various unobservable factors such as institutions, resource endowments, and climate in TFP differences.

3.5 Summary and Conclusion

This chapter provides an overview of the productivity measurement methods and approaches. We identify three strands of the literature to measure MFP: the first is growth accounting, which decomposes observed economic growth into the contribution of factor inputs and TC, called the Solow Residual; the second is index number methods, accompanied by frontier techniques; the third is growth regressions and econometric methods used to estimate productivity across countries and regions. We keep our focus on assessing the major strengths and weaknesses of commonly used methods for MFP measurement.

Chapter 4

DATA AND METHODOLOGY

This chapter describes data, nature and sources of data, and theoretical underpinning of variables being used for the analysis. The sample and time selection are mainly based on the availability of data on core variables. This chapter also depicts the theoretical framework, models, and methodology being applied for empirical examination.

4.1 Building the Dataset for Estimation

After estimating the MFPG and MFPG_H from equations 4.10 and 4.11, we examine the determinants of MFPG, using standard panel data methodology. The study is based on an unbalanced panel data for 49 developing countries over the period 1980-2016. The sample selection is based on data availability. The countries with poor data collection are excluded from the sample to elude the potential measurement error. A list of sample countries is given in Appendix A1. The data is taken from several sources including World Bank's World Development Indicators (WDI), Penn World Table (PWT), The Conference Board, Total Economy Database (TED), International Country Risk Guide (ICRG) Researchers dataset Published by the Political Risk Services (PRS) Group and the Historical Public Debt Database (HPDD) By International Monetary Fund (IMF).

The dependent variables are multi-factor productivity growth (MFPG) and HC adjusted MFP growth (MFPG_H) which are measured by econometric methods[28]; an extension of

[28] See Ahmed and Bhatti (2020) or Chapter 3 of this study for a thorough description of econometric methods.

the growth accounting framework. We carry out the panel data regression analysis using both the annual as well five years averages data. We exploit a relatively wider set of mediating, moderating, explanatory, and controls variables than those used in previous empirical studies. These variables are investment (INV), government size (GSIZE), Inflation (INF), debt to GDP ratio (DGDP). domestic credit to the private sector (PRIV), human capital (HC) index, Economic Complexity Index (ECI), trade openness (OPEN) or trade volume index, index of information and communications technology (ICT), institutional quality (IQ) index, carbon dioxide (CO2) emissions used as a proxy for environmental degradation, population growth (POPG), age dependency ratio (ADR), % of the working-age population (ADR) and foreign direct investment (FDI).

The INV is measured by the gross fixed capital formation as a % of GDP. Capital accumulation leads to capital-deepening which raises labor productivity as well as productivity growth by technological advancement and spillovers. Investment, one of the key determinants of economic growth, is critical for the adoption of new technologies and hence productivity growth. GSIZE is measured by the general government final consumption as a % of GDP. INF is measured by the consumer price index. DGDP is the debt-to-GDP ratio. PRIV is the domestic credit to the private sector as a % of GDP which indicates the financial depth of a country. One may argue that it is not a good indicator to judge the financial depth of the country, but it has the edge of being available consistently across our sample countries over a requisite period. Further, it has been widely used in the existing empirical literature as an indicator of financial depth. We use credit to the private sector as a % of GDP and ratio of total liquid liabilities (M2) to GDP as indicators of financial development[29] and monetary policy. The data on these variables have been taken from WDI, 2018 database published by the World Bank, PWT 9, and the HPDD by IMF.

IQ is the index of institutional quality.The IQ index (on a scale of 0 to 100) is based on the twelve indicators of ICRG[30] researchers dataset published by the PRS Group, on which principal component analysis (henceforth, PCA)[31] is applied to construct the IQ index. The higher scale or values of the IQ index indicates better performing institutions while the lower range of index exhibits the poor performance of institutions. Tables A1 and A2, Appendix provides a thorough description of how we constructed the index of IQ. The scree plot is given in Figures C1, Appendix C. These plots display the factor eigenvalues in descending order which represent the variance explained by each factor. The elbows in the scree plots show the points at which the inclusion of additional factors does not support in explaining the variance of the data set significantly. HC is the human capital index based on years of schooling and returns to education. OPEN is the openness or trade volume index measured by the total trade (% of GDP) or export plus import (% of GDP). FDI is the foreign direct investment, net inflows as a % of GDP. ICT is information and communications technology.

We have applied the PCA on three indicators, namely; mobile cellular subscriptions (per 100 people), fixed telephone subscriptions (per 100 people), and fixed broadband subscriptions (per 100 people) to construct the index of ICT (on a scale of 1 to 100). As

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[29] Different indicators of financial development measurement have been used in the existing empirical literature. For example, domestic credit to credit to private sector (Beck et al., 2000 and Levine et al., 2000; Khan & Senhadji, 2003; Kose et al., 2009; Bekaert et al., 2011; and Arizala et al., 2013), liquid liabilities (King & Levine, 1993) and ratio of total bank deposits liabilities to GDP (Christopoulos & Tsionas, 2004).

[30] ICRG data has been used by various empirical studies on institutions-growth nexus such as Knack and Keefer (1995), Mauro (1995), Hall and Jones (1999), Assane and Grammy (2003), and Kar et al. (2019).

[31] PCA is a useful statistical technique that detects patterns in the data and then keeping into consideration these patterns reduces the dimensionality of the dataset without losing much information (See among others, Francois and Manchin, 2013; Slesman et al., 2015).

mentioned in the case IQ index, the lower values of the ICT index show the non-availability of advanced infrastructure, and vise vera. The Appendix C provides a thorough description of how we construct the ICT index. The scree plot is given in Figure C1. These plots display the factor eigenvalues in descending order which represent the variance explained by each factor. The elbows in the scree plots show the points at which the inclusion of additional factors does not support in explaining the variance of the data set significantly.

Innovation is usually measured by R&D expenditures. The countries with higher level of R&D spending are more likely to have a greater number of innovation than the countries having less R&D expenditures (see Stern et al., 2000 and Bilbao-Osorio & Rodriguez-Pose, 2004). However, in the latest empirical research, the economic complexity index (hereafter, ECI) is also used as a proxy of innovation (See Kataryniuk & Martínez-Martin, 2018; Sweet & Eterovic, 2019). ECI[32] is the economic complexity index developed by Hidalgo and Hausmann (2009), used as a proxy of innovation, keeping in view its high correlation with R&D expenditures. However, the lack of mandatory reporting for R&D expenditures in most developing countries precludes reliable and systematic data collection. Therefore, following Kataryniuk and Martínez-Martín (2018) and Sweet and Eterovic (2019), we use the ECI to gauge the innovative capacity of a country. It is based on diversity and ubiquity. The former shows the amount of productive or embedded knowledge that a country holds to produce distinct and more complex products. The latter represents the number of countries that can produce and export distinct or highly technical products, for example, Chemical products and appliances based on the use of X-rays or

[32] See Hidalgo and Hausmann (2009), Kataryniuk and Martínez-Martín (2018) and Sweet and Eterovic (2019) for an extended view.

radiation (Hausmann et al., 2014). Therefore, a country could increase its ECI scores by producing and exporting sophisticated and highly technical products.

Global Innovation Index (GII) report 2020 shows the trends and innovation performance of more than 130 economies around the world. Figure C3 given in the Appendix C shows the top three innovation economies by region. CO2 is the carbon dioxide emissions used as an indicator of environmental degradation. POPG is population growth. ADR is the age dependency ratio, % of the working-age population. MTRADE is the merchandise trade (% of GDP). GDPG is the growth rate of GDP while RPCGDP is the per capita real GDP.

Table 4.1: Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
MFPG	1,618	-0.0003	4.121	-32.389	19.756
MFPG_H	1,764	-5.38e-10	3.890	-35.856	16.080
GDPG	1,813	3.682	4.511	-32.900	23.800
INV	1,640	2.997	0.371	0.693	3.818
GSIZE	1,642	2.534	0.397	0.716	3.912
INF	1,755	3.764	0.662	-0.050	10.196
DGDP	1,617	3.919	0.674	-0.029	6.120
PRIV	1,660	3.112	0.874	-1.618	5.076
IQ	1,610	4.112	0.268	2.560	4.557
HC	1,715	0.626	0.271	0.029	1.155
OPEN	1,691	3.965	0.686	-1.787	5.395
FDI	1,559	0.204	1.613	-10.571	3.733
ICT	1,759	14.180	2.550	8.501	21.152
ECI	1,779	0.876	0.3162	-1.567	1.428
CO2	1,715	10.204	1.847	6.481	16.147
POPG	1,666	1.971	1.019	-1.586	5.639
ADR	1,813	4.264	0.258	3.572	4.727
MTRADE	1,736	3.776	0.544	1.591	5.258
RPCGDP	1,766	7.520	1.044	4.880	9.592
TAXR	1,013	2.640	0.439	-0.249	4.044

Source: *Author's calculation*

Following Alcala and Ciccone (2004), all variables are taken in natural logarithm form except for those which are in growth rates. The logarithm form has been used extensively in the empirical work because the slope coefficients are invariant to rescaling. It narrows the range of the variables considerably and makes estimates less sensitive to extreme or outlying observations. Further, it mitigates and overcomes the problem of heteroscedasticity (Wooldridge, 2006). The summary statistics and correlation matrix for the variables used in the estimation exercises are given in Tables 4.1 and 4.2 respectively.

With few exceptions such as economic complexity index, age dependency ratio and carbon dioxide (CO2) emissions the above-mentioned explanatory variables have been used frequently in growth literature (See, Levine and Renelt, 1992; Chang et al., 2009; Afonso and Jalles, 2013; and Li and Tanna, 2019). The definitions and construction of variables along with their data sources are given in the Appendix B.

4.1.1 Preliminary Data Analysis and Stylized facts

Before embarking on the estimation of productivity growth effects of institutions and macroeconomic factors, it is crucial to present some properties of our data through descriptive statistics and correlation matrix. Additionally, we make use of scatter plots and bar charts for our preliminary data analysis and stylized facts of productivity growth in developing countries and regions. A scatterplot is primarily used to judge, whether there exists any linear or nonlinear dependence between two variables; however, sometimes it is not easy to judge the accurate dependence between two variables. Figures 4.1 through 4.5 show the scatter plots and bar charts respectively. In the scatter plots the scales of variables are logarithmic except those who are in growth rates, whereas in bar charts the mean values of variables have been used.

Table 4.1 shows the descriptive statistics of the selected variables used in the analysis across different specifications. Data on MFPG and MFPG_H indicate significant variations and disparities in the entire sample of 49 developing countries. On average, most of the countries in the sample are with negative MFPG and MFPG_H. Our estimates of MFPG are predominantly consistent with one of the recent attempts by Heshmati and Rashidghalam (2020). They estimate TFP growth parametrically and conclude that productivity growth remains negative across all countries over the period 1996–2013. The maximum and minimum values of MFPG are 19.756 and -32.389 respectively. In the case of MFPG_H, we find the same type of disparity pattern. Similarly, the maximum and minimum values of GDP growth (GDPG) are 23.800 and -32.900. These statistics show that there are profound similarities among MFPG, MFPG_H, and GDPG series. The debt to GDP ratio reaches a maximum of 6.120 and a minimum of -0.029. Similarly, PRIV ranges from a maximum of 5.076 to a minimum of -1.618. The standard deviation for MFPG is greater than MFPG_H which implies that MFP growth fluctuates more compared to the HC adjusted MFPG. We notice that both series of MFPG are exhibiting a high variation of productivity growth across the developing countries (with a standard deviation greater than the mean). The ICT and FDI like MFPG, show a considerable amount of variation in the dataset. Nevertheless, FDI comparatively demonstrates high variation across the sample (with a standard deviation greater than the mean). The mean value of ICT is 14.180 but ranges from 8.501 to 21.152 with a standard deviation of 2.550. FDI ranges from a maximum of 3.733 to a minimum of -10.571 with a standard deviation of 1.613.

Table 4.2 depicts a first but crude approximation of the direction and extent of the relationship between productivity growth and its macroeconomic and institutional determinants. The correlation matrix shows that the variables including government size, inflation, debt to GDP ratio, domestic credit to the private sector, carbon dioxide emissions, population growth, and age dependency ratio are negatively correlated with MFPG. However, as expected, investment, IQ, HC , OPEN, ICT, and FDI have a positive relationship with MFPG. Not surprisingly, OPEN is highly correlated with merchandise trade (% of GDP); therefore, we have used these two variables alternatively in the regression analysis. Similarly, the age dependency ratio is positively correlated with population growth; whereas, it is negatively correlated with HC and economic complexity index, used as a proxy for innovation. Prima facie, it is evident that decreasing the age dependency ratio is one of the requirements to promote HC as well as innovation and hence attaining a higher level of MFPG in developing countries

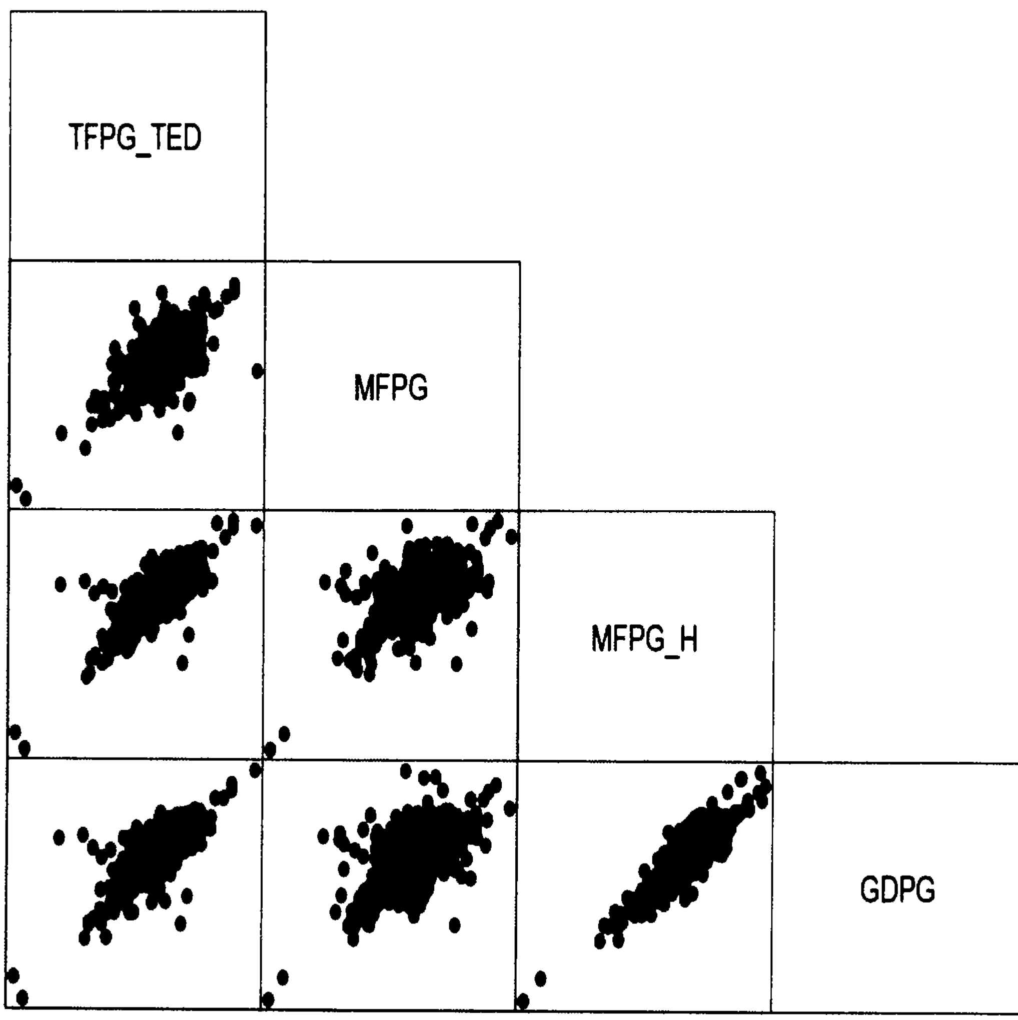
Table 4.2: Correlation matrix

	MFPG	MFPG_H	INV	GSIZE	INF	DGDP	PRIV	IQ	HC	OPEN	FDI	ICT	ECI	CO2	POPG	ADR	MTRADE
MFPG	1.000																
MFPG_H	0.723	1.000															
INV	0.090	0.069	1.000														
GSIZE	-0.033	-0.010	0.105	1.000													
INF	-0.141	-0.149	-0.102	-0.042	1.000												
DGDP	-0.065	-0.105	-0.299	0.001	0.088	1.000											
PRIV	-0.049	-0.060	0.425	0.278	-0.053	-0.210	1.000										
IQ	0.095	0.076	0.338	0.320	-0.209	-0.159	0.378	1.000									
HC	0.063	0.065	0.288	0.113	-0.014	-0.199	0.349	0.323	1.000								
OPEN	0.060	0.061	0.194	0.254	-0.119	0.013	0.247	0.333	0.331	1.000							
FDI	0.151	0.155	0.176	0.163	-0.094	-0.098	0.087	0.387	0.385	0.428	1.000						
ICT	0.022	0.041	0.408	0.077	-0.059	-0.394	0.436	0.284	0.442	-0.035	0.285	1.000					
ECI	-0.007	-0.039	0.214	0.097	0.011	-0.082	0.474	0.240	0.518	0.110	0.120	0.341	1.000				
CO2	-0.004	-0.014	0.373	0.141	-0.031	-0.355	0.505	0.243	0.261	-0.152	0.013	0.629	0.443	1.000			
POPG	-0.060	-0.039	-0.254	-0.063	0.022	0.177	-0.252	-0.306	-0.648	-0.140	-0.300	-0.359	-0.458	-0.361	1.000		
ADR	-0.058	-0.019	-0.401	-0.116	0.046	0.292	-0.456	-0.359	-0.698	-0.192	-0.345	-0.568	-0.567	-0.594	0.792	1.000	
MTRADE	0.065	0.0677	0.212	0.228	-0.134	-0.080	0.286	0.334	0.359	0.953	0.415	0.045	0.133	-0.062	-0.177	-0.258	1.000

Source: *Author's calculation*

Figure 4.1: Cross-Country Interrelationship among Different Estimates of Productivity Growth and Economic Growth

The scatterplot matrix given in Figure 4.1 provides a visual image of different estimates of productivity growth. it depicts the cross-country interrelations among TFPG estimates; provided by the Conference Board TED and our estimates of productivity growth namely; MFPG, and HC adjusted MFPG (henceforth, MFPG_H). Further, it shows their relationship with economic growth (henceforth, GDPG).



Source: *Author's calculation*

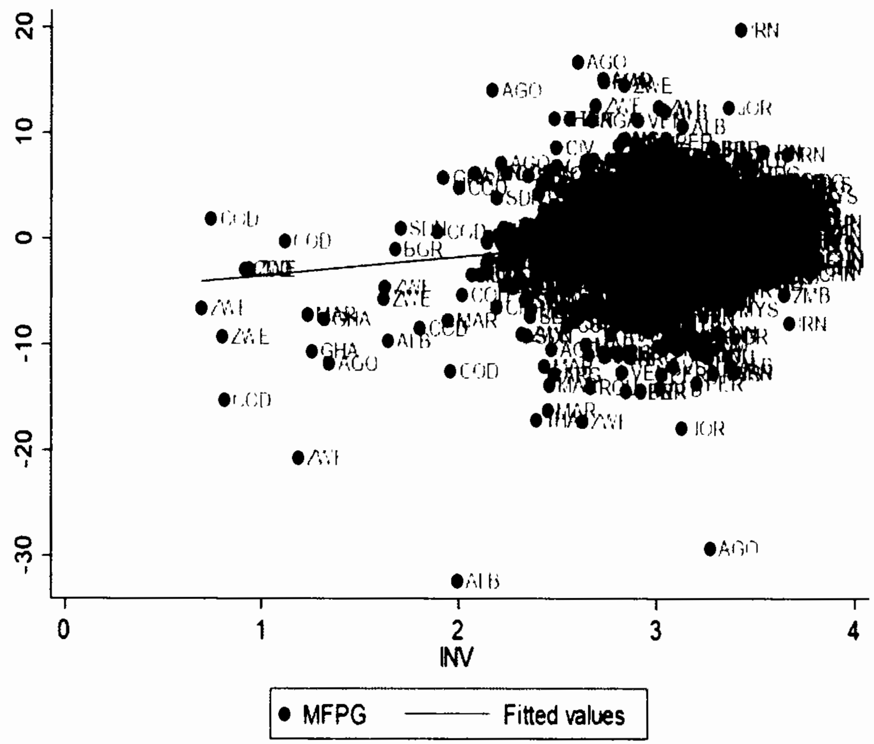
It is obvious from the pictorial relationship that there exists a strong positive correlation among TFPG, MFPG, MFPG_H, and GDPG and there are pronounced similarities among these series. There is consensus among researchers that higher productivity leads to higher economic growth; the relationship between productivity and economic growth is well addressed in the growth literature (see Klenow & Rodriguez-Clare, 1997; Edwards, 1998; Prescott, 1998; and Islam et al., 2006).

Figure 4.2 shows the scatter plots of INV and IQ against MFPG for a sample of 49 developing countries over the last three and a half decades. It indicates the positive correlation between INV and MFPG as well as IQ and MFPG. Expectedly, there is a scatter of heights with evidence of a positive relationship being two variables as shown using a smooth curve. The figure shows that on average developing countries with a higher level of INV and IQ tend to enjoy faster MFPG over the period 1980-2016.

Figure 4.3 shows the scatter plots of debt to GDP ratio (DGDP) and inflation (INF) against multifactor productivity growth (MFPG) for the sample of 49 developing countries over the last three and a half decades. It indicates the negative correlation between DGDP and MFPG as well as INF and MFPG. The figure shows that on average developing countries with a higher level of public debt and inflation rate tend to experience lower MFPG over the 1980-2016 period.

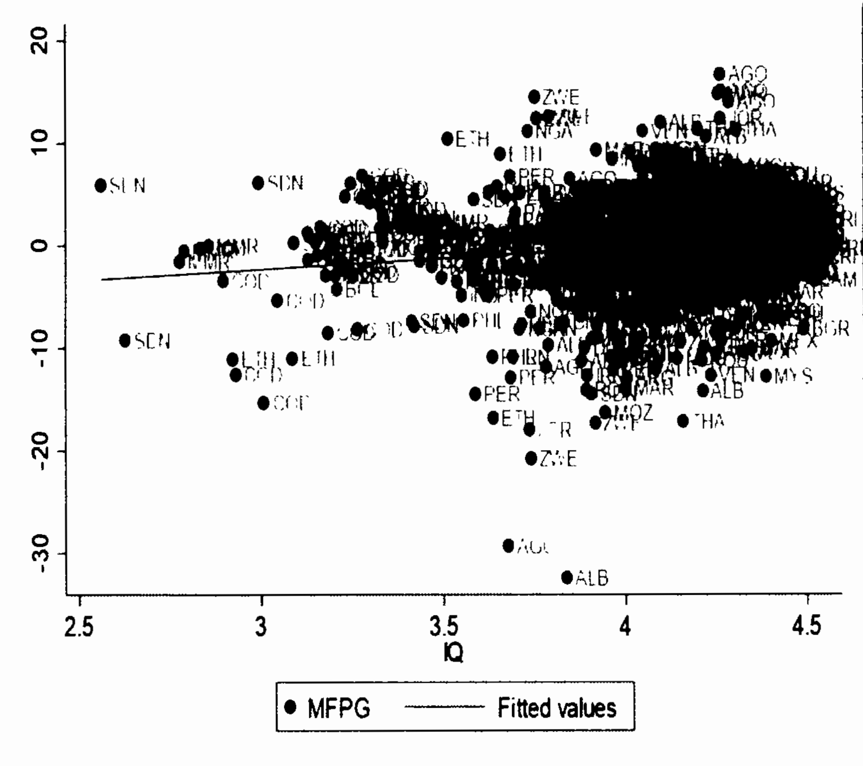
Figure 4.2: Scatter Plots of Investment (INV) and Institutional Quality (IQ) against Multifactor Productivity Growth

(a) Investment (INV) and Multifactor Productivity Growth



Source: *Author's construction*

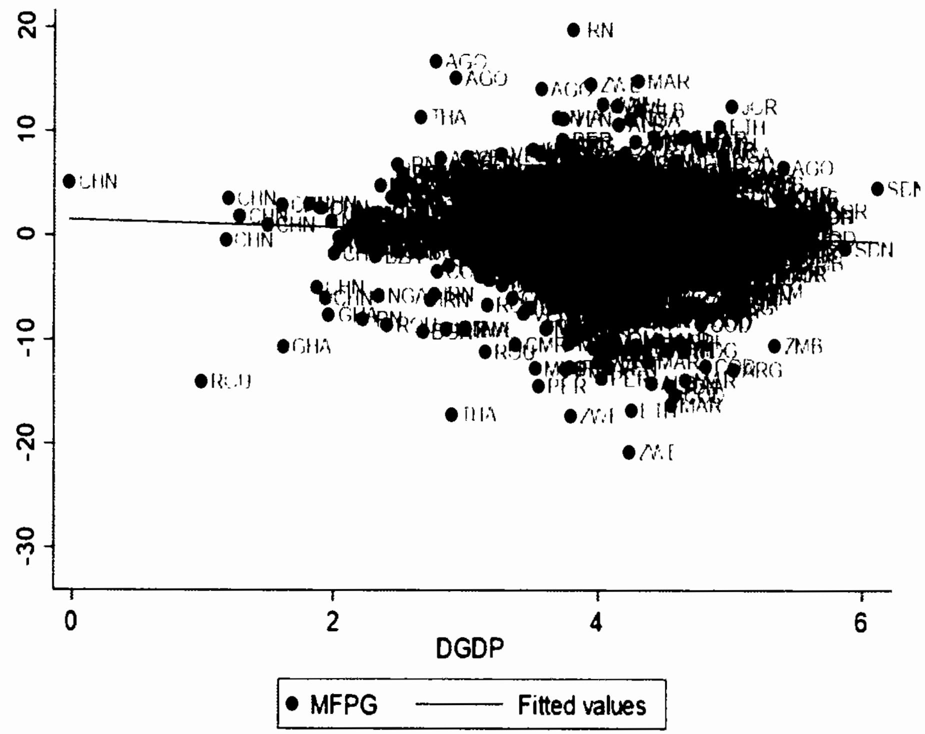
(b) Institutional Quality (IQ) and Multifactor Productivity Growth



Source: *Author's construction*

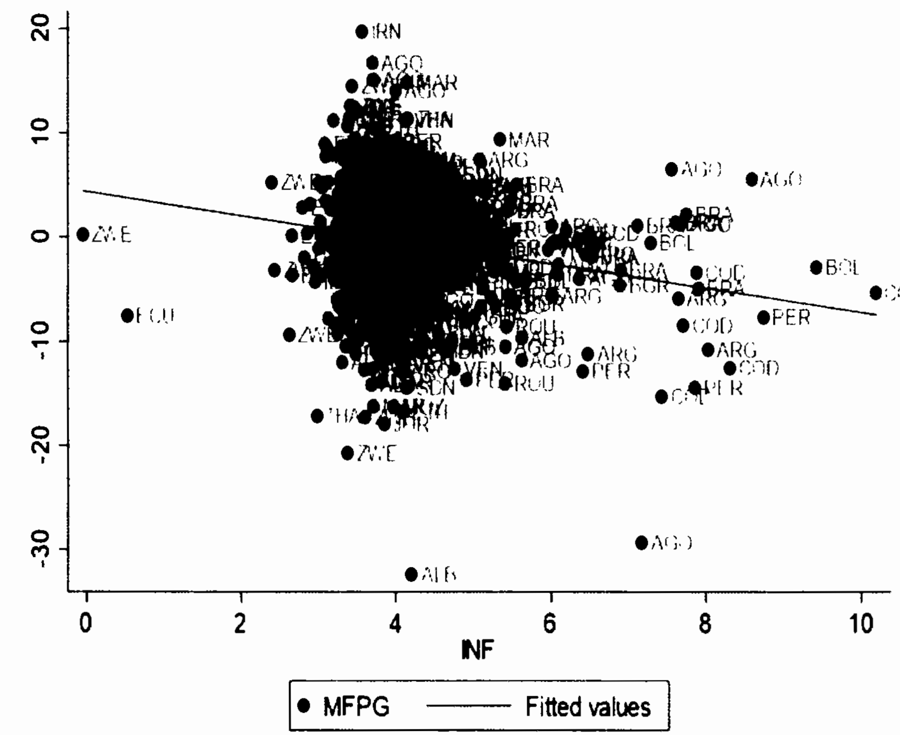
Figure 4.3: Scatter Plots of Public Debt (DGDP) and Inflation (INF) against Multifactor Productivity Growth

(a) Debt to GDP Ratio (DGDP) and Multifactor Productivity Growth (MFPG)



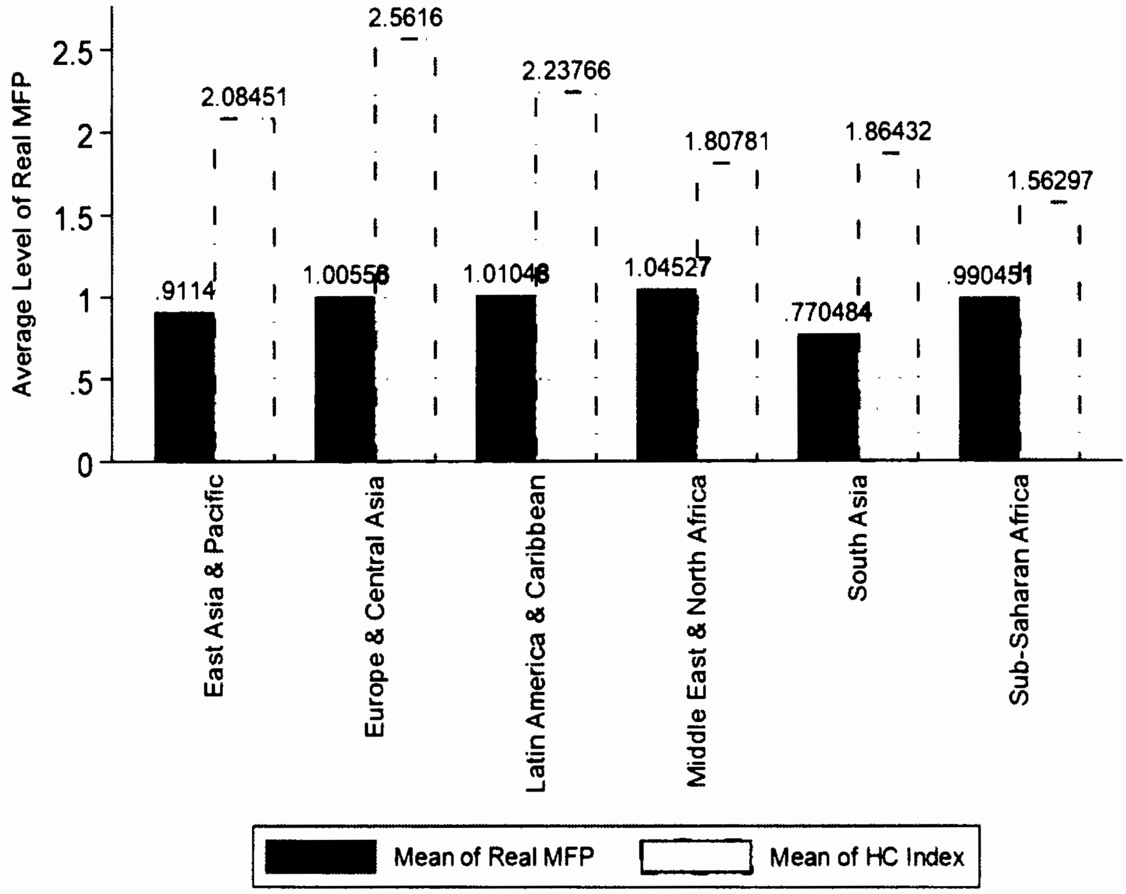
Source: *Author's* construction

(b) Inflation (INF) and Multifactor Productivity Growth (MFPG)



Source: *Author's* construction

Figure 4.4: Human Capital and Average Level of Real MFP in the Developing Regions, 1980-2016



Source: *Author's construction*

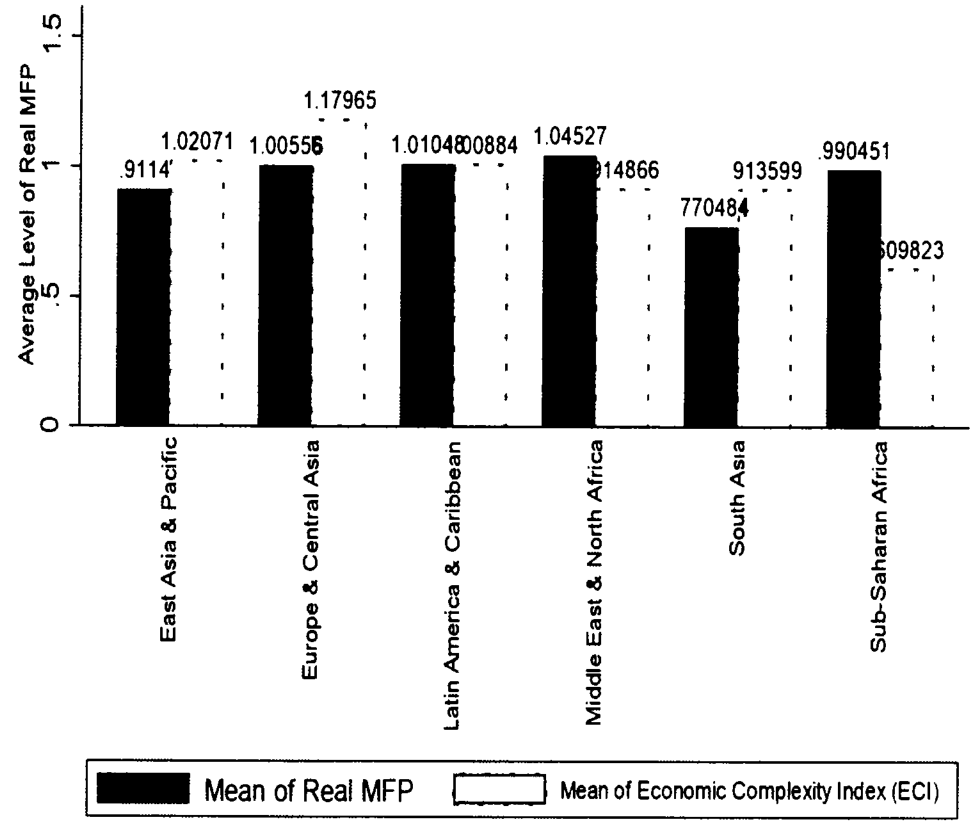
Figure 4.4 shows the evolution of average levels of HC and the real MFP in developing countries by regions over the period 1980-2016. It is evident that the effects of education on the average level of real MFP vary across regions. On average, the developing countries in the region of Europe and Central Asia have the highest level of HC which is contributing toward its real MFP, although the average level of real MFP in other two (that are Latin America & Caribbean and Middle East and North Africa) regions is relatively higher to some extent. Of the seven regions, two regions narrow the gap with the Europe & Central

Asia with respect to MFP. The other two regions, namely, South Asia, and East Asia & Pacific fall behind, although having better level of HC compare to the developing nations in the region of Middle East & North Africa.

We conclude that the low mean of real MFP in South Asia, and East Asia and Pacific indicates that the HC measured by years of schooling and return to education is not considerably contributing towards enhancing the real MFP in these regions. Most interestingly, Sub-Saharan Africa with the least HC has a higher average level of real MFP than South Asia, and East Asia and Pacific regions. The fundamental question that arises from the above discussion is that why the contributions of HC towards MFP are rather limited in South Asia, and East Asia and Pacific regions. One possible answer to this question is that the developing countries in these regions are not equipping their labor force with skills, which allows them to adopt new technologies. The high skilled workers have much more innovative capacity as compared to low-skilled workers. Therefore, the regions with a larger proportion of high skilled workers in their labor market composition have a greater probability to achieve a higher level of MFP (Sweet and Eterovic, 2019). While discussing the Asian productivity growth patterns, Chang and Luh (1999) conclude that the investment in HC and enough learning capacity is a prerequisite to get benefit from the innovative knowledge transferred through FDI.

Figure 4.5 shows the association between the average innovation[33] activities and the average level of real MFP in developing regions over the period 1980-2016. In general, the high-income countries are more knowledge-intensive, produce high technology and novel products which are capital intensive such as communications equipment, medical imaging, etc. On the other hand, labor-intensive products such as sports equipment, toys, garments are mainly produced by low-income countries.

Figure 4.5: Innovation and Average Level of Real MFP in the Developing Regions, 1980-2016



Source: *Author's* construction

It is clear from Figure 4.5 that the Europe and Central Asia is more innovative with a higher mean value of ECI since it includes only the upper-middle-income countries

[33]The economic complexity index (ECI) has been used as a proxy for innovation capacity of a country. ECI is a measure of the relative knowledge intensity of an economy. it ranks the countries according to the knowledge intensity (complexity and diversification) of their export baskets. For detailed information see https://ourworldindata.org/how-and-why-econ-complexity and http://atlas.cid.harvard.edu/rankings

rather than lower-middle and low income. It is worth noting that as the HC in Figure 4.4, the innovation is also not contributing much towards enhancing the real MFP in the South Asian region. Again, the question is how to justify this incompatibility between average innovation activities and the mean level of real MFP, particularly in South Asia. It is not a question that can be answered fully, at least based on the evidence we have at present. However, a possible answer may be that the South Asian countries, on average do not have complementarity between innovation activities (knowledge intensity) and absorption of knowledge.

In addition, as perceived in Figure 4.4, a higher-level domestic capacity for knowledge absorption is required to get the full benefits of innovation and technologies. Borensztein et al. (1998) argue that developing countries could get benefits from the technologies innovated by developed countries if they have a minimum threshold stock of human capital; their workers can understand and work with the new technology. Similarly, Tientao et al. (2016) present a theoretical model of TFP growth and define the technological threshold as the geometric means of knowledge levels in all countries. They conclude that the host countries must have a certain level of absorption capacity to master the technology and adapt it to local conditions. Further, Engelbrecht (2002) confirms a positive role for HC in the absorption of international knowledge spillovers. Therefore, the South Asian countries need to enhance their knowledge absorption capacity by equipping their labor force with skills which require quality academic institutions along with vocational training institutions. Instead of competing in the race of producing graduates in humanities and arts, the government of developing regions must devise more scientific education.

4.1.2 Annual Data Versus Period Averages

It has been argued that the use of annual data to estimate growth equations, when there exists too much short-term volatility for each country, may lead towards disguising the influence of short-term fluctuations and business cycle effects. This issue could be mitigated by focusing on long-run effects, instead of business cycle fluctuations and by averaging the data over multi-years (3-,5-,8- and 10-year averages). However, Temple (1999) recommends the use of long lags of independent variables in cross-country growth regressions to prevent the influence of business cycle effects. He emphasizes the use of annual data in the case of panels with the arguments that five- or ten-year averages resulted in data with little time-series variation. Temple (1999) notes, that the issue of using data over multi-years instead of annually is not completely settled in the existing empirical literature.

Consequently, some researchers have opted to use annual data (Senhadji, 2000; Mendi, 2007; and Papaioannou, 2017) while other employ multi -year averages, predominantly 5-year averages (Engelbrecht, 2002; Loko and Diouf, 2009; and Salotti and Trecroci, 2016) with the argument that it mitigates business cycle effects. Further, it is well established in the existing empirical literature that the use of 5-year averages mitigates the risk of possible endogeneity (Zalduendo and Batista, 2004).

Considering the concerns raised over the use of multi-year averages as well as on annual data, we have performed our empirical analysis, using both annual and five-yearly data. The data over five years is used to check the robustness of our results. Further, it helps us to avoid any biased estimates and capture the business cycle movements. We have transformed the annual data series into non-overlapping intervals of five-years during the 1980–2016 period—that is, seven observations (1981–1985, 1986–1990, 1991–1995, 1996–2000, 2000–2005, 2006–2010, and 2011–2016) for each variable and country. To undertake panel estimations based on 5-year averages, we modify the estimating equations by including the initial level of MFP to test the hypothesis that whether initial conditions matter.

4.2 Theoretical Framework

The economic theory of production accompanied by the NGM provides the theoretical and analytical framework for our analysis. The production function which is the cornerstone of the theory of production postulates a clear-cut link between a vector of factors of production (that is, inputs) and a vector of maximum producible output. Nishimizu and Page (1982) illustrate the theoretical framework for empirical research on MFP. In growth literature, MFP is recognized as an important driver of economic growth. The neoclassical APF[34] (from which the Solow residual is calculated) provides the theoretical framework for TFP in the growth process. In the neoclassical growth framework, economic growth is based on two aspects: factor accumulation (FA) and TFP growth. In the NGM, TFP is exogenously determined, (determined outside the model). However, the EGM pioneered by Romer (1986) and Lucas (1988) discard the conventional thoughts that technological advancement is exogenous. Romer (1986, 1990) emphasize the role of HC in the process of productivity and growth.

The path-breaking work of Romer (1986) shifts the attention of the researchers towards the macroeconomic dynamics. The resurgence of growth theory in mid 1980s with an expansion of the new neo-classical EGM (Romer, 1986; Lucas, 1988, 1993) has initiated new avenues of research and revisit the basic questions that

[34] The underlying basic APF can be written as Y=F (L, K), with Y being the real aggregated output; L, labor force or employment; K, capital (physical and human).

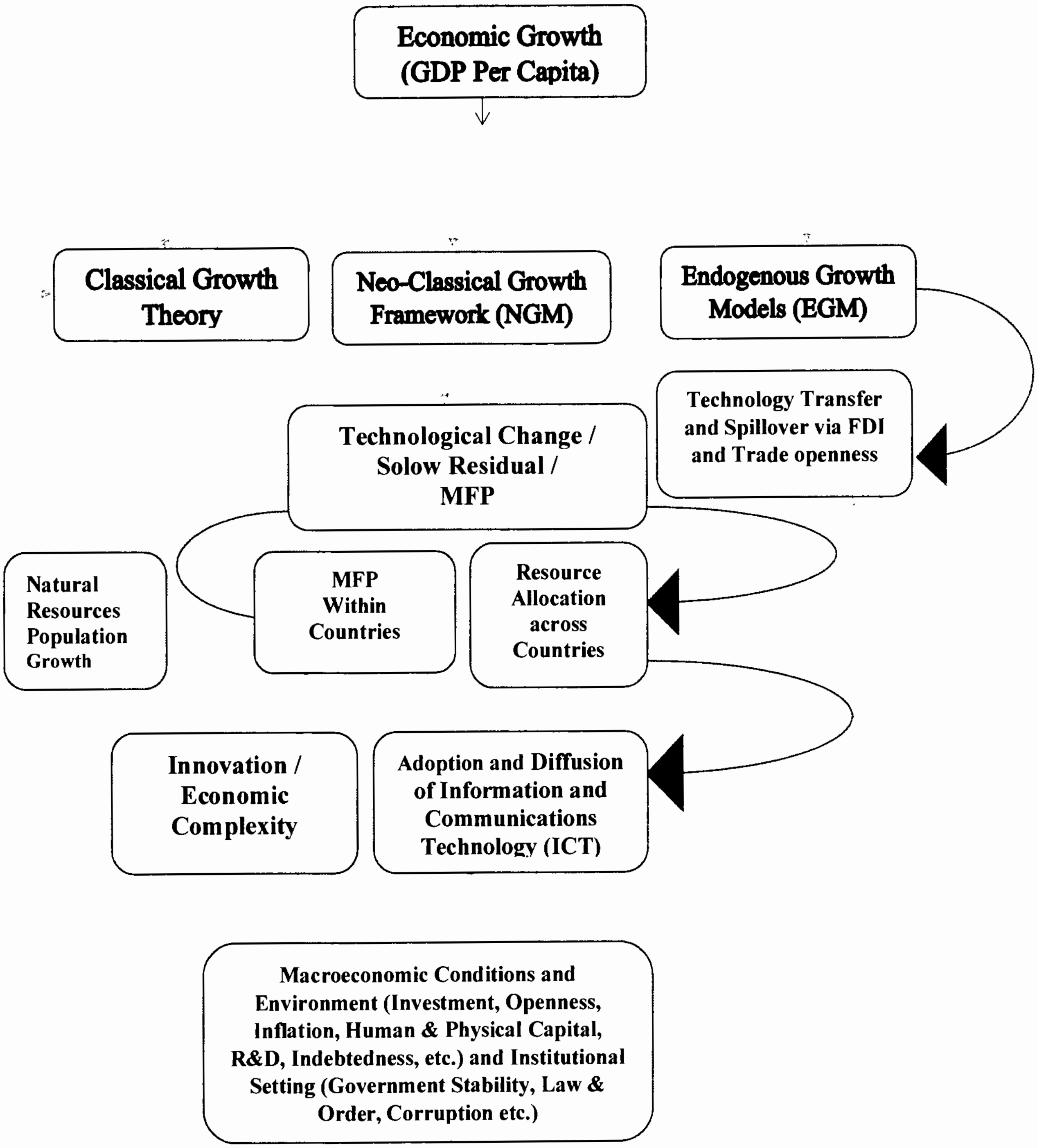
"why some countries are richer than others?". "Why do some countries grow, and others stagnate?". "What factors explain the bulk of cross-country growth differences?".

Mankiw et al. (1992) conclude that in the long run all countries have an equal chance of development as the same level of technology may be accessible to all countries. However, the exogenous differences in saving and HC may bring some countries to the top, while leaving the others at the bottom. They show that if HC is explicitly incorporated in the analysis, the neo-classical model is then capable to explain the cross-country differences in TFP growth. It is well established that the skills and knowledge embodied in an individual (HC) plays an important role in TFP growth. Mankiw et al. (1992) find that 78% of the income differences across the globe could be explained by differences in HC and saving rates.

One of the pioneering attempts by Nelson and Phelps (1966) finds that HC is important to determine the disparity between the technology frontier and TFP. Several macro levels studies such as Benhabib and Spiegel (1994), Maudos et al. (1999), Mahmood and Talat (2008), and Coe et al. (2009) find a significant and positive impact of HC on TFP. In contrast, there are some cross-sectional and panel data evidences which show either insignificant or significant and negative influence of HC on output growth and TFP growth (see Knight et al., 1993; Benhabib and Spiegel, 1994; Pritchett, 2001; and Hamilton and Monteagudo, 1998). Innovation (technological spillovers) in new growth theories is considered as a by-product (externality) of other economic activities (investments in physical and HC). Some studies emphasize the complementary role of R&D and HC such as Redding (1996), Berman et al. (1998), and Cameron et al. (2005). We have developed a theoretical and conceptual framework (See Figure 4.6) that allows us to understand the theoretical mechanisms by which institutions and macroeconomic factors are linked to MFP and economic growth.

During the 1980s and afterward, a debate came to the surface under the title of convergence. One of the pioneer empirical attempts on the convergence hypothesis is by Baumol (1986). Among others, Baumol (1986), De Long (1988), Grier and Tullock (1989), Barro (1991), Li and Papell (1999), Kumar and Russell (2002), Cameron et al. (2005), Henderson and Russell (2005), Bah and Brada (2009) and Tebaldi (2016) empirically examine the convergence and catching up phenomenon by employing different econometric methods and frontier approaches.

Figure 4.6: Theoretical and Conceptual Framework for MFP



Source: Author's own compilation

The general conclusion that emerges from the findings of these studies is that the evidence of absolute convergence exists for developed countries, mainly OECD only. If the sample of developing countries or both developed and developing is used, then the evidence of absolute convergence is rejected in most of the cases. Generally, the evidence of conditional convergence is drawn even in the latter case. One of the prominent attempts by Islam (2003) provides an overview of different concepts of convergence including TFP convergence[35] to advance the understanding of economic growth literature. By synthesizing the convergence literature, the author concludes that although the convergence debate might not have resolved the economic growth issues entirely, it has provided enough food for thought to growth economists.

The innovation-based EGM allow for both convergence and divergence. Under the Schumpeterian perspective, both innovation activities (technological spillovers) and imitation are important for MFP growth. Schumpeter (1934) argues that innovation plays a crucial role in economic and social changes. The investments in R&D lead to innovation activities and hence long-run economic growth. Among others, the major attempts to assess the effects of technological spillovers on TFP are Grossman and Helpman (1994), Coe and Helpman (1995), Engelbrecht (1997), Frantzen (2000), Engelbrecht (2002), Del Barrio-Castro et al. (2002), Mendi (2007), Coe et al. (2009) Hasan and Tucci (2010), and Bianco and Niang, (2012).

In the last decade of the 20th century, EGM recognize the role of social infrastructure (institutions, government regulations, and policies) in cross countries productivity and growth differences (see Hall and Jones, 1999; Acemoglu et al., 2003, 2005; Rodrik, 2008; Coe et al., 2009; Egert, 2016). Now the discussion on institutions as one of the

[35] According to Islam (2003), TFP convergence is the outcome of technological catch-up. The basic idea behind TFP convergence is that whether countries have come closer in terms of TFP or vice versa.

main drivers of productivity and economic growth has been evolving in the mainstream economic literature. For example, a recent attempt by Egert (2016) uses the sample of 34 OECD to analyze the impacts of regulations and the IQ on country level MFP. The findings of the study show that better IQ, friendly business environment, greater OPEN amplify the positive effect of R&D spending on MFP.

4.3 Estimation Methodologies

We have three sub-sections of our estimation methodologies. The first section is dedicated to the measurement of our dependent variables that is MFP growth and HC adjusted MFP growth. We employ the econometric approach to measure MFPG, and HC adjusted MFPG. In the second section, we employ the standard static (FE and RE) and dynamic (difference GMM and system GMM) panel data methods for the analysis of macroeconomic as well as institutional drivers of MFP growth and HC adjusted MFP growth in the selected developing countries. The developing countries differ in several observable (productivity growth, real per capita GDP, and investment, etc.) and unobservable country-specific characteristics which could raise the problems of endogeneity and reverse causation while estimating the panel. The presence of endogeneity and simultaneity make the OLS, FE and RE estimators biased and inconsistent. To avoid the problem of endogeneity, we use the GMM.

The third section presents an estimation methodology to explore whether there exist indirect and conditional effects of macroeconomic and institutional indicators towards MFP growth? To investigate the indirect and conditional effects, we follow the two steps strategy. Firstly, we check whether to apply the FE or the RE models. We employ the Hausman test to assess whether FE is an accurate choice. If yes, then we demean[36] the data; to remove the FE and use either the Three-stage Least Square (3SLS) estimation technique or SUR method for our system of two equations. Secondly, if Hausman test suggests the RE then we apply the SUR method for unbalanced panel data as recommended by Biorn (2004) on original data. However, we make use of the Moderated Mediation approach of Muller et al. (2005) and Preacher et al. (2007) for the construction of our econometric models.

The RE model has the advantage of making use of both the cross-country and the time-series variations included in the sample. By contrast, FE estimates would be very imprecise because they only capture the time-series variation within the sample. However, it is not a matter of debate whether we apply the FE or RE model; because as Mundlak (1978) points out, the selection between FE and RE is "arbitrary and unnecessary". He argues that when the model is properly specified, the RE estimator is identical to the FE estimator. This argument is further supported by him when he says, "there is only one estimator". Thus, keeping into consideration the arguments of Mundlak (1978), we apply the SUR method in both the FE and RE settings (that is, on demeaned as well as original data).

Some researchers provide the methods to analyze the mediation and moderation separately (For instance, Frazier et al., 2004; and Rose et al., 2004). However, in the latest research, methods have been suggested by the researchers to estimate the mediation and moderation effects simultaneously (see, Muller et al., 2005; Preacher et al., 2007, Edwards and Lambert, 2007; and MacKinnon, 2008). So, we explore the

[36] In general, demeaning of each variable (that is, compute the mean of each variable for each case, subtract the mean from the original variable) is done to remove the FE and to estimate FE models. To do so, we have applied "center" command in STATA written by Ben Jann in 2004, with subsequent revisions.

mediating and moderating effects of both macroeconomic and institutional factors simultaneously.

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4.3.1 Econometric Methodology for the Measurement of MFP growth and Human Capital Adjusted MFP growth

Since we attempt to analyze the determinants of MFP in the selected developing countries, we first need to measure MFP in the best possible way. Chapter 3 of this study presents an overview of the commonly used methods of MFP measurement. As pointed out in chapter 3, the growth regressions or econometric methods are commonly used parametric methods to estimate MFP across countries and regions. These methods are extensions of the earlier methods of the Solow Residual. In growth regressions, a structural equation is identified to estimate the MFP level from aggregate data (Mankiw et al., 1992; Islam, 1995; Hall and Jones, 1999; and Miller and Upadhyay, 2000). So, the econometric methods use a model-based approach instead of estimating the residual from a calibration exercise. In this method, residual in the regression is interpreted as MFP growth. Usually, the econometric approach starts from a Cobb-Douglas production function.

$$Y_t = A_t\, K_t^{\alpha}\, L_t^{\beta}, \qquad 0 < \alpha < 1 \text{ and } 0 < \beta < 1 \qquad (4.1)$$

By incorporating stock of human capital in production function, we get

$$Y_t = A_t\, K_t^{\alpha}\, L_t^{\beta}\, H_t^{\delta}, \quad 0 < \alpha < 1,\ 0 < \delta < 1 \text{ and } \quad 0 < \beta < 1 \qquad (4.2)$$

where Y is aggregate output at time t, K is the capital input at time t, L is the labor input at time t, H is HC input at time t A_t represents the shift in production function due to TC, α, β and δ characterize the share of capital, labor, and HC in the production function respectively. A_t implies that technology grows at a constant exponential rate of λ. It can be defined as:

$$A_t = A_o\, e^{\lambda t} \tag{4.3}$$

By substituting (4.3) into (4.1) and (4.2), we get

$$Y_t = A_o e^{\lambda t}\, K_t^{\alpha}\, L_t^{\beta} \tag{4.4}$$

$$Y_t = A_o e^{\lambda t}\, K_t^{\alpha}\, L_t^{\beta}\, H_t^{\delta} \tag{4.5}$$

Taking logarithms of both sides, we obtain the following

$$\ln Y_t = \ln A_o + \lambda t + \alpha \ln K_t \; + \beta \ln L_t + \varepsilon_t \tag{4.6}$$

$$\ln Y_t = \ln A_o + \lambda t + \alpha \ln K_t \; + \beta \ln L_t + \delta \ln H_t + \varepsilon_t \tag{4.7}$$

Using a time-series data for Y, K, L, and H, we can estimate the output elasticities and technology coefficient λ and hence the contribution of TC to output growth. However, the technology coefficient is not embodied in factor inputs, exogenous, and Hicks-neutral[37]. A smaller λ may indicate misspecification of the production function while larger λ could be due to significant effects of resource allocation and economies of scale.

For estimation purpose, the equations (4.6) and (4.7) can be transformed as:

$$\ln Y_t = \alpha_o + \alpha_1\, t + \alpha_2\, \ln K_t \; + \beta_3 \ln L_t + \varepsilon_t \tag{4.8}$$

$$\ln Y_t = \alpha_o + \alpha_1\, t + \alpha_2\, \ln K_t \; + \beta_3 \ln L_t + \delta_4 \ln L_t + \varepsilon_t \tag{4.9}$$

We can measure the MFP growth (MFPG) and HC adjusted MFP growth (MFPG_H) as:

$$MFPG_t = \alpha_1 + (\alpha_2 + \beta_3 \; - 1)(\alpha_2\, \dot{K}_t + \beta_3 \dot{L}_t) \tag{4.10}$$

$$MFPG\_H_t = \alpha_1 + (\alpha_2 + \beta_3 \; + \delta_4 \; - 1)\big(\alpha_2\, \dot{K}_t + \beta_3 \dot{L}_t + \delta_4 \dot{H}_t\big) \tag{4.11}$$

In equations (4.10) and (4.11), α_1 is a time trend, α_2, β_3 and δ_4 represent the output elasticity for capital and labor and HC respectively while $\dot{K}_t$, $\dot{L}_t$, and $\dot{H}_t$ express the

[37] The Hicks-neutral technological change implies that technology increases the efficiency of both capital and labor inputs proportionately; while, Harrod-neutral and Solow-neutral technological changes are labor-augmenting and capital-augmenting respectively.

annual growth rates of real capital stock, the labor force (growth of labor quantity), and HC (growth of labor quality) respectively. The data on the growth of labor quantity and quality has been taken from The Conference Board TED while data on the growth rate of aggregate output (growth of GDP) and real capital stock has been obtained from the WDI and PWT version 9.0. To measure the MFP growth (MFPG), the employment growth has been used as a proxy for labor input (DLL). For the calculation of HC adjusted MFP growth (MFPG_H), labor input has been disaggregated into quantity and quality and the growth of labor quality (LQLT) along with its quantity (LQNT) have been used. Jorgenson and Griliches (1967) demonstrate that the Solow residual is overestimated if factor inputs are not disaggregated to account for quality change. The $\Delta \ln (K_t)$ is used to calculate the growth rate of real capital stock (DLK).

One of the important contributions of our work is that we have measured the MFPG[38] of each country of our sample, using the latest approach that is growth regression methodology. The estimates of MFPG and MFPG_H are given in the Appendix B (Table B2). The MFP growth series are not available in the WDI, TED, PWT 9.0, and other databases for all the sample countries (see Dieppe et al., 2020). Moreover, we have taken a conservative approach by calculating our own MFPG series rather than using the one provided by TED and PWT due to methodological differences. For instance, TED provides Tornqvist index-based annual estimates of TFP growth for 123 countries in the world. Similarly, PWT uses the production function approach to measure TFP, which incorporates variations in factor shares to some extent. One of the latest attempts in this area by Felipe and McCombie (2020) asserts that the production function approach to calculate TFP is a flawed and futile exercise since the series of

[38] MFPG and MFPG_H are calculated as the residual fraction of the growth of gross domestic product (GDPG) that cannot be accounted for by the growth of accumulated factors of production (labor and capital).

GDP, labor, and capital stock used in an accounting identity are definitionally related to each other. However, the general understanding of the existing growth literature is that the production-function based models are meaningful constructions since they have a sound theoretical basis. Further, they are useful as their assumptions and predictions can be tested by using the actual data. So, many of the growth theorists believe that performing a growth accounting exercise[39] is a valuable step in looking at the data and still a useful item in the cliometrician's toolkit. (Barro, 1999; Crafts and Woltjer, 2020).

The mainstream literature on growth accounting assumes an even rate of return across countries to compute the country's specific value for the factor share parameter[40]. However, the recent empirical literature argues that the income shares of labor in developing countries are not corresponding to the developed countries. In developing countries, capital is relatively scarce, and hence its return is high while labor is comparatively cheaper, leading to its less share. Nevertheless, the labor share in income around the world is declining over time and there is an upward trend in the capital share (Izyumov and Vahaly, 2015; Bridgman, 2018). As pointed out earlier in chapter 1 of this study that the production function or GAA is not capable to deal with the problem of parameter heterogeneity and possible endogeneity of factor inputs. Over the past couple of decades, there has been an intense debate on these issues (see Temple, 1999; Durlauf, et al., 2001 and Eicher and Leukert, 2009).

It is important to note that when we measure the contribution of input growth to output growth through growth equation or econometric methodology, the later may have a reverse causal effect on the former by stimulating investments in physical capital

[39] Crafts and Woltjer (2020) provide a comprehensive overview and survey of growth-accounting studies and estimates in economic history for now-advanced countries. Similarly, Hofman and Valderrama (2020) provide a growth accounting assessment of long-run performance of Latin American countries from a comparative perspective by widening the time frame of analysis to 1820–2016.

[40] that is, a constant labor share of 2/3; the capital share is calculated as one minus this labor share for all developed and developing countries

and augmenting the HC in respect of improved educational and health facilities (see for example Bils and Klenow 2000). The reverse causality generates a correlation between input growth and error term that makes estimated coefficients of ordinary least squares (OLS) inconsistent. So, the reverse causality and feedback effects from output to input growth may be one of the reasons for the endogeneity problem which most of the existing literature overlook while estimating the productivity growth. To handle the issue of endogeneity, we use one-period lag of inputs growth in the calculation of both the MFPG and HC adjusted MFP growth.

The econometric methods used to measure MFP growth have their own merits and limitations. Firstly, the prior ordering of the selected countries is not required. Secondly, it is less sensitive to the inclusion or exclusion of countries. Thirdly, we do not need data on physical capital stock, which may have the problems of measurement error due to the different profile of depreciation rate and initial level of capital stock. The limitation of econometric methods of MFP estimation is that it ignores the contribution of EC to productivity change. Secondly, based on specified functional form, the condition of homogeneity across countries is imposed which may not hold.

4.3.2 Econometric Models and Estimation Methodology for the Determinants of MFP Growth

Over the last four decades, the empirical literature attempt to explore the potential determinants of MFPG. Many efforts have been put into the choice of a suitable econometric model and on the selection of key variables to be included in growth regressions. Economic theory does not provide full guidance regarding the selection of the proper econometric model (that is which explanatory variables should be included in the model). Sala-i-Martin (1997) states that "*...economic growth theory is not explicit about what variables matter for growth...*".

We consider a more parsimonious parameterization of the panel model. It is less likely to have omitted variable bias in our model since based on the existing empirical literature; we are considering most of the explanatory variables in our general model which could determine the aggregate productivity growth. We follow the general to specific modeling approach[41] based on the theory of reduction, to select a baseline and parsimonious specifications (Hendry, 1995). We add the control variables one by one in the baseline model to check the robustness of regression results as well as their probable effects on MFPG. we confirm the robustness of our results over alternative specifications and different estimation methods.

To assess the impact of institutions and macroeconomic indicators on MFPG, we follow Hall and Jones (1999), and regress it on the IQ and different macroeconomic indicators, using panel data of developing countries. Following Nawaz (2015), the study constructs the index of IQ by employing PCA on ICRG indicators. Similarly, The PCA has been used to construct the index of ICT or advanced infrastructure (INFRA). To examine the determinants of both types of MFPG, we employ standard panel data methodology on the sample of 49 developing countries. The endogeneity problem made the FE and RE estimators biased and inconsistent. To avoid the problem of endogeneity, we use the GMM.

[41] Also known as London School of Economics (LSE) approach, abbreviated as *Gets*. Following "LSE" approach we start with a general statistical model (that is, congruent model) and reduce it in complexity by eliminating statistically insignificant variables. Further, we check the validity of the reductions at every stage to ensure congruence of the finally selected model.

4.3.2.1 Static Panel Data Models

The models for determinants of MFPG and MFPG_H using static modeling can be specified as under:

$$\text{MFPG}_{it} = \propto_i + \sum_{p=1}^{P} \beta_i X_{it}^{p} + \sum_{q=1}^{Q} \beta_q Y_{it}^{q} + \sum_{r=1}^{R} \beta_r Z_{it}^{r} + e_{it}$$

... (4.12)

$$\text{MFPG\_H}_{it} = \propto_i + \sum_{p=1}^{P} \beta_i X_{it}^{p} + \sum_{q=1}^{Q} \beta_q Y_{it}^{q} + \sum_{r=1}^{R} \beta_r Z_{it}^{r} + e_{it}$$

... (4.13)

Where $e_{it} = v_i + u_{it}$ denotes disturbance term with unobserved country-specific effects, v and u are idiosyncratic error with $v_i \sim$ IIN (0, σ_v^2) and $u_i \sim$ IIN (0, σ_v^2). The MFPG (ΔlogMFP) and MFPG_H (ΔlogMFP_H) represent multifactor productivity growth and HC adjusted multifactor productivity growth of country *i =1... N,* and *t=i ..... T.* ∝ is the constant term. The X, Y, and Z are vectors of macroeconomic, institutional, and control variables respectively. The subscript *i* and *t* shows the country and time period respectively. For robustness, we add control variables one by one in the model. The static panel data models are estimated with FE and RE estimators. We perform a battery of robustness and diagnostic tests. In all estimations, we use robust standard errors, commonly known as heteroskedasticity - and autocorrelation - consistent (HAC) standard errors (SEs) to control the possible serial correlation and heteroskedasticity. The estimation results of static panel data models are shown in Tables 5.1 through 5.4.

4.3.2.2 Dynamic Panel Data Models (DPDM)

The traditional FE and RE methods of estimation assume that the current observations of an explanatory variable are fully independent of the past value of the dependent variables. These methods may raise the biasness arises from unobserved heterogeneity. As said earlier that the endogeneity problem made the FE and RE estimators biased and inconsistent. To avoid the problem of endogeneity, the use of Instrumental Variables (IV) methods or the GMM[42] has now become common in empirical research. This may be because for a finite number of periods, and a large cross-sectional dimension, these methods particularly system GMM produce consistent parameter estimates (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998; Judson and Owen, 1999). Moreover, these methods employ a relatively smaller set of statistical assumptions and provide asymptotically efficient inference. It is important to note that the precision and consistency[43] of GMM estimation largely depends upon the validity of instruments or instrumentation of endogenous variables. An important condition for a valid instrument is that it must be highly correlated with the endogenous variable but orthogonal to the error term. it is very difficult to find exogenous instruments (outside the model) that fulfill this condition, therefore, we use lagged values of dependent variables as instruments.

We estimate the DPDM using the Arellano-Bond difference and the Blundell-Bond system GMM estimator. it is consistent in the presence of both country-specific effects and endogenous regressors (Arellano and Bover, 1995; Blundell and Bond, 1998). We estimate the MFP growth equations by system GMM, which jointly estimates the equations in first differences and levels. To estimate the equations in the first difference, it uses lagged levels of the dependent and independent variables as instruments while to estimate the equations in levels, it utilizes the first differences of the regressors as

[42] See Windmeijer (2008) and Roodman (2009a) for comprehensive discussion on GMM methodology.
[43] The validity of instruments is used as a check for the consistency of GMM estimator. The Sargan test of over-identifying restrictions tests the overall validity of the instruments by analyzing the moment conditions. The Hansen's J statistics whose null is "over identification conditions are satisfied and instruments are exogenous" is used for the validation of instruments.

instruments. The GMM estimators include some refinements to limit the number of instruments[44]. As a simple rule of thumb, the GMM estimators suffer from "overfitting bias" as the number of instruments becomes equal or greater than the number of countries. It does affect the consistency but not the efficiency of parameter estimates.

The system GMM[45] estimator is categorized into; GMM one step and two steps. However, the use of the former is preferred over the latter because it is more efficient asymptotically. One of the limitations of two-step system GMM is that the asymptotic standard errors yield a downward bias. So, it is preferable to use the Windmeijer (2005) corrected standard errors when the two-step GMM estimator is applied. Further, one-step system GMM is a better choice when the observations are less than the time period while two-step system GMM is a worthwhile choice when we have a model with a larger number of countries and a smaller time span. Overall, these estimators provide us efficient estimates by controlling the problems of omitted variable biases, measurement error, and endogeneity.

To check the validity of our retained instruments and to confirm the appropriateness of our model specification, we conduct two tests. Firstly, we apply the Hansen J test[46] of over-identifying restrictions and secondly, we perform the second order correlation

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[44] See Bowsher (2002) and Roodman (2009 a, b). Roodman (2009a) said that "...researchers *should report the number of instruments and reviewers should question regressions where it is not reported.*" The instrument count is based on the number of "collapsed" instruments, using the xtabond2 specification from Roodman (2009a). Roodman (2009b) discusses the risks of using too many instruments and limiting them severely in a systematic manner. According to the Roodman (2009b) the use of many lags may resultant into instrument proliferation, specifically when endogenous explanatory variables are highly persistent. For the system GMM estimation (the default in xtabond2), he suggests some guidelines and principles for reducing the set of instruments, that are follow in this study. We may specify the instruments as applying to the level equations, the differenced equations, or both. By employing the lag limits options, we may specify the lags limit to be used in constructing the GMM instruments. For example, the lag (2 6) option is used to restrict the maximum lag to 6 periods.

[45] System GMM is more efficient for large (N) and small (T). In our sample, we have N=49 and T=37 that is, N > T; Hence, using System GMM in this case is a better choice.

[46] Alternatively, we have also applied the Sargan test for over-identifying restrictions. However, we have reported the Hansen's J statistics in the regression results of GMM because, it is more robust in the presence of autocorrelation and heteroskedasticity (Li and Tanna, 2019).

that is AR (2)[47] test to examines whether the stochastic term is serially correlated? In both cases, failure to reject the null hypothesis gives support to our model specification, but if we encounter a strong rejection of the null hypothesis of the former (that is, p-value =1.00 or ≥ 0.9), then the validity of the estimates is doubtful. Roodman (2009a) proclaims that the ideal range for the p-value of Hansen test is 0.1 to 0.25.

For estimation purpose, we proceed as under:

$$\text{MFPG}_{it} = \propto_i + \delta\ \text{MFPG}_{i,t-1} + \sum_{p=1}^{P} \beta_i X_{it}^{p} + \sum_{q=1}^{Q} \beta_q Y_{it}^{q} + \sum_{r=1}^{R} \beta_r Z_{it}^{r} + e_{it} \qquad \ldots(4.14)$$

$$\text{MFPG\_H}_{it} = \propto_i + \delta\ \text{MFPG\_H}_{i,t-1} + \sum_{p=1}^{P} \beta_i X_{it}^{p} + \sum_{q=1}^{Q} \beta_q Y_{it}^{q} + \sum_{r=1}^{R} \beta_r Z_{it}^{r} + e_{it} \qquad \ldots(4.15)$$

Where $e_{it} = v_i + u_{it}$ denotes disturbance term with unobserved country-specific effects, v and u are idiosyncratic error with $v_i \sim$ IIN (0, σ_v^2) and $u_i \sim$ IIN (0, σ_v^2). The MFPG (ΔlogMFP) and MFPG_H (ΔlogMFP_H) represent multifactor productivity growth and HC adjusted multifactor productivity growth of country i =*1*... *N*, and *t=i,..,T*. $\propto$ is the constant term. The convergence effect is denoted by δ, as lagged multi-factor productivity growth, $MFPG_{i,t-1}$ or (initial MFPG[48] in some cases $MFPG_{i,t0}$) is expected to have a negative impact on the productivity growth rate. The X, Y, and Z are vectors of macroeconomic, institutional and control variables respectively. The subscript i and t shows the country and time period respectively. For robustness, we add control variables one by one in the model. To remove the unobserved country-

[47] The null hypothesis of AR (2) is that "the error term does not have serial correlations in both difference-level and difference regressions". We could allow for the rejection of no first-order autocorrelation, AR (1). The most important criterion, which is consistent with the assumption of the GMM estimation procedure is that, there should be no second-order autocorrelation AR (2) of the residuals.
[48] Initial level of MFP is the MFPG at the beginning of each five-year period from 1980-2016 and represents a country's initial conditions.

specific effects, the equations (4.14) and (4.15) can be written in the first difference form.

$$\mathrm{MFPG}_{it} = \alpha_i + \delta\, \Delta \mathrm{MFPG}_{i,t-1} + \sum_{p=1}^{P} \beta_i\, \Delta X_{it}^{p} + \sum_{q=1}^{Q} \beta_q\, \Delta Y_{it}^{q} + \sum_{r=1}^{R} \beta_r\, \Delta Z_{it}^{r} + e_{it} \quad \text{.... (4.16)}$$

$$\mathrm{MFPG\_H}_{it} = \alpha_i + \delta\, \Delta \mathrm{MFPG\_H}_{i,t-1} + \sum_{p=1}^{P} \beta_i \Delta X_{it}^{p} + \sum_{q=1}^{Q} \beta_q\, \Delta Y_{it}^{q} + \sum_{r=1}^{R} \beta_r\, \Delta Z_{it}^{r} + e_{it} \quad \text{.... (4.17)}$$

This study uses the GMM one-step and two-step methods to obtain the estimates. The error terms are assumed to be independent and homoscedastic across country and time in the former, while later relaxes the assumption of homoscedasticity (estimate the variance-covariance matrix of residuals consistently), using residuals of the first step. Two-step GMM[49] procedure is asymptotically more efficient; however, in case of a small sample size, its estimate may be biased downward, hence GMM one step is more suitable in such cases. The DPDM are estimated with dynamic GMM methodology. The estimation results of DPDM are given in Tables 5.5 through 5.8.

4.3.3 Econometric Models and Estimation Technique for the Direct, Indirect and Conditional Effects

As discussed earlier that the econometric methods for the estimation of a system of equations for unbalanced panel data are relatively scarce in the existing empirical literature. Biorn (2004) develops a procedure for the estimation of one-way SUR [50] system with random effects (henceforth, RE). Monte Carlo demonstrate

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[49] Following Windmeijer (2005), the standard errors of our two step System GMM are subject to finite sample correction of the asymptotic variance.

[50] The essential feature which distinguish the SUR model from the linear-regression model is that in the former there exists the contemporaneous correlation in the error terms associated with the equations whereas in the latter disturbances are assumed to be independent.

that SUR methods are better than the standard single equation FE and RE estimators. To investigate the indirect and conditional effects, we follow the two steps strategy. Firstly, we check whether to apply the FE or the RE models. We employ the Hausman test to assess whether FE is an accurate choice? If yes, then we use the Three-stage Least Square (3SLS) or SUR estimation technique with one-way FE, for our system of two equations on demeaned data. Secondly, If Hausman test suggests the RE then we apply the SUR method with one-way RE, as recommended by Biorn (2004) on original data; without demeaning the data. However, we make use of the Moderated Mediation approach of Preacher et al. (2007) and Muller et al. (2005) for the construction of our econometric models.

SUR method is designed to estimate systems of regression equations that are linked by contemporaneously correlated disturbances. At first glance, the equations appeared to be unrelated structurally, but statistically, they are related through the correlation in the error terms. The intercept term in RE and FE models is considered as random and fixed respectively. Contrary to the individual equations, the system of equations introduces additional information to draw the statistical inferences about the model parameters. Like 3SLS, SUR provides more efficient estimates in large samples, since it considers the contemporaneous correlation of the error terms across equations. One of the important advantages of the SUR method is that it mitigates and controls the biasness arises from unobserved heterogeneity. Further, it is more likely to achieve efficiency in the estimates by applying the SUR method (Biorn, 2004; Baltagi, 2005).

SUR method has more than one regression equations; having owned explained variable and potentially different set of explanatory variables. So, it is the generalization of a linear regression model. It is called seemingly unrelated since each equation can be estimated separately. The estimates of SUR and OLS become almost identical in a case where error terms of both are uncorrelated and when each equation contains the same explanatory variables on the right-hand side. As pointed out earlier that SUR is designed to estimate the system of equations having a different set of regressors and contemporaneous correlation of error terms across equations.

To explore the mediating and moderating roles of macroeconomic and institutional variables, we take in to account different mediators (channels) and moderators (conditions) such as INV, IQ, innovation capacity, ICT, public debt, and OPEN, In the analysis of channels and conditions, we attempt to determine whether investment mitigates the expected negative effects of public indebtedness on MFP growth. Similarly, we attempt to investigate whether public debt mitigates the expected positive effects of INV on MFP growth of developing economies. In the same line of analysis, we attempt to investigate the effects of HC on MFP growth through the channel of IQ and the effects of IQ on MFP growth via OPEN and vice versa. To have a clear conceptualization, path diagrams and schematic models have been constructed (See Figure 4.6 through Figure 4.12).

In this respect, it is worth mentioning here that to examine the direct, indirect, and conditional effects of both macroeconomic and institutional variables on HC adjusted (MFPG_H), we replace our dependent variable (MFPG) with (MFPG_H). In order to avoid lengthy and tedious repetition in the text, we have given the schematic and econometric models for MFPG only. The same procedure could be adopted for our second dependent variable (that is, MFPG_H). However, the regression results are reported separately for both dependent variables to draw several interesting conclusions and policy implications for developing countries.

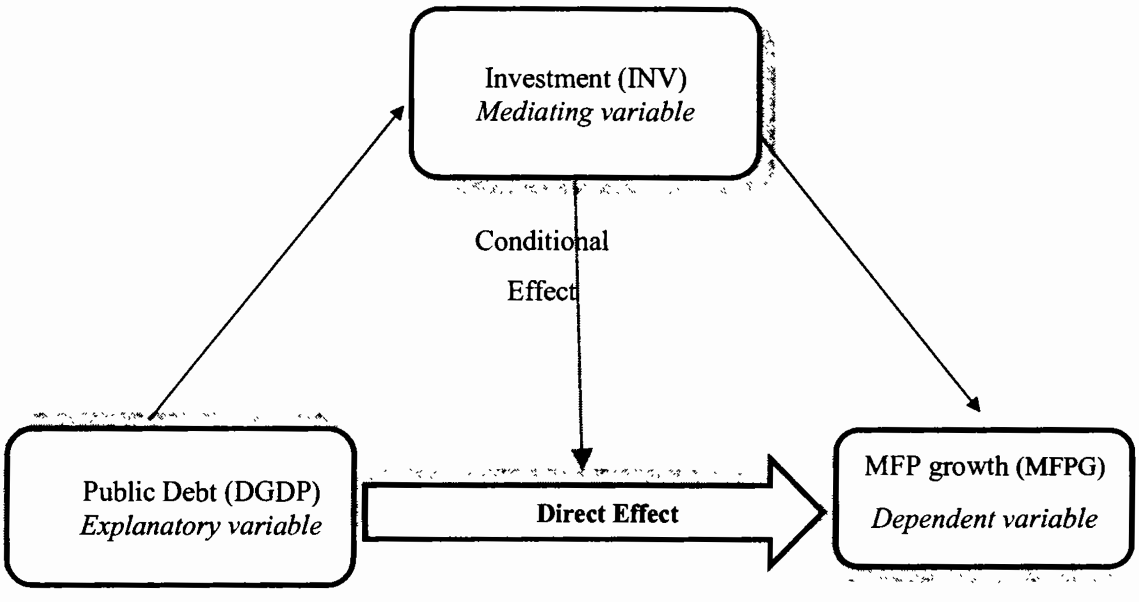
4.3.3.1 Direct, Indirect and Conditional Effects of Public Debt on MFPG

From the last few decades, research scholars have devoted much effort to examine the direct impact of public debt on productivity and economic growth. Theoretical literature suggests an inverse relationship between the public debt-to-GDP ratio and the steady-state growth rate of per capita GDP (Saint-Paul, 1992; and Aizenman et al., 2007). Nevertheless, there are four strands in empirical literature concerning the link between public debt and growth. The first strand which supports the theoretical literature finds a negative relationship between debt and growth (See, Cohen, 1993; Rockerbie, 1994; Dar and Amirkhalkhali, 2002; and Reinhart and Rogoff, 2010). The second school advocates a positive link between debt and growth. The third strand merges the overmentioned strands and proclaims that there is a non-linear relationship between debt and growth (Grossman, 1988; Nguyen et al., 2003; Poirson et al., 2004; Kumar and Woo, 2010; Checherita-Westphal and Rother, 2012; Eberhardt & Presbitero, 2015; and Egert, 2015). The fourth strand of literature does not find any significant and robust connection between debt and growth (Schclarek, 2004; and Panizza & Presbitero, 2014).

Contrarily, in a cross-country analysis, Reinhart and Rogoff (2010) reveal that countries with higher levels of debt to GDP ratio (90 % and above) experience significantly lower GDP growth compare to the less indebted countries. Similarly, for a sample of 19 OECD countries, Dar and Amirkhalkhali (2002) postulate that TFP growth is lower in countries with a higher debt-to-GDP ratio. Nevertheless, in the existing empirical literature, the mechanism or channel through which DGDP effect the MFP growth has not been examined, particularly, for developing countries, using sophisticated econometric modeling.

Indeed, in a new paradigm of research, an important view of research scholars is that the effect of public debt on productivity growth is indirect or conditional. At the macro level, the effect of debt on MFPG depends upon countries' economic and institutional settings. Therefore, it is worthwhile to examine the mediating and moderating role of one of the important macroeconomic indicators that is, investment in public debt and MFPG nexus for a sample of emerging economies.

Figure 4.7: The Mediating and Moderating Effects of Investment in the Relationship between Public Debt and MFPG



Source: Authors' own research

The schematic model depicts that investment (INV) measured by the gross fixed capital formation acts as a mediating as well as moderating variable between public debt (DGDP) and MFP growth. Moderation effects can be capture through the interactions of INV and PD which is also termed as conditional effects. When public debt increases then the government needs to increase either tax rate or borrowing. Government borrowing leads to discouraging the private investment (capital formation) due to an increase in the discount rate (opportunity cost of borrowing the money) and ultimately result in lower productivity (Afonso & Jalles, 2013).

To examine the direct, conditional, and indirect effects of PD on MFPG by the channel of INV the econometrics models can be specified as under:

$$INV_{it} = \alpha_1 + \alpha_2 DGDP_{it} + \alpha_3 Z_{1it} + \mu_{it} \quad (4.18)$$

$$MFPG_{it} = \delta_1 + \delta_2 PDDGDP_{it} + \delta_3 INV_{it} + \delta_4 (DGDP^{*}INV)_{it} + \delta'_5 Z_{2it} + \varepsilon_{it} \quad (4.19)$$

Whereas, MFPG is the multifactor productivity growth, public debt is measured by Central Government Debt (% GDP) or debt to GDP ratio (DGDP), INV is gross fixed capital formation, private sector (% of GDP), Z is the vector of control variables. α_1 and δ_1 are the intercept of the regressions. u and ε are stochastic error terms.

Indirect Effect

The indirect effect of DGDP on MFPG by the channel of INV is calculated from the regressions (4.18), (4.19) as follows: We differentiate partially equation (4.18) with respect to DGDP and get α_2, secondly, we differentiate partially equation (4.19) for INV and get $(\delta_3 + \delta_4 DGDP)$. Then, to get equation 4.21 we multiply both terms, which $\alpha_2(\delta_3 + \delta_4 DGDP)$ represents the indirect effect of DGDP on MFPG. The signs of the above cited indirect effects depend upon the signs and magnitudes of α_2, δ_3 and δ_4.

$$\frac{\partial MFPG}{\partial DGDP} = \frac{\partial INV}{\partial DGDP} * \frac{\partial MFPG}{\partial INV} \quad (4.20)$$

$$\frac{\partial MFPG}{\partial DGDP} = \alpha_2(\delta_3 + \delta_4 DGDP) \rightarrow \quad \text{(Indirect Effect)} \quad (4.21)$$

Conditional Effect

Moreover, to calculate the conditional effects we take the derivative of equation (4.19) with respect to DGDP and we get $\delta_2 + \delta_4 INV$.

$$\frac{\partial MFPG}{\partial DGDP} = \delta_2 + \delta_4 INV \qquad (4.22)$$

Our conditional hypotheses concentrate around the coefficients of δ_2 and δ_4. There exist the following four possibilities:

- If $\delta_2>0$ and$\delta_4>0$ then public debt (DGDP) has a positive impact on MFP and investment conditions intensify the unexpected positive impact of DGDP.
- If$\delta_2>0$ and$\delta_4<0$, then public debt (DGDP) has a positive impact on MFPG, and investment conditions mitigate the positive impact of DGDP (private sector investment lessens the unexpected positive impacts of DGDP).
- If$\delta_2<0$ and$\delta_4>0$, public debt (DGDP) has a negative impact on MFPG, and investment conditions mitigate the expected negative effect of DGDP.
- If $\delta_2<0$ and$\delta_4<0$, public debt (DGDP) has a negative impact on MFPG, and investment conditions aggravate the expected negative effect of DGDP.

4.3.3.2 Direct, Indirect and conditional Effects of Human Capital on MFPG

After the advent of endogenous growth theory and establishment of the human development index by Mahbubul Haq and Amartya Sen, the nexus between HC and per capita GDP has been much debated theoretically and tested empirically. The significant positive impact of HC on economic and productivity growth has been recognized by voluminous literature such as Nelson and Phelps (1966), Benhabib and Spiegel (1994), Maudos et al. (1999), Mahmood and Talat (2008), and Coe et al. (2009).

Theoretically, HC is positively related to economic growth as individuals having a higher level of education and cognitive skills are comparatively more productive and innovative (See, Becker, 1962; Romer, 1990; Benhabib and Spiegel, 1994; Barro, 2001; Sianesi and Reenen, 2003; Hanushek and Woessmann, 2008 and Hanushek, 2013).

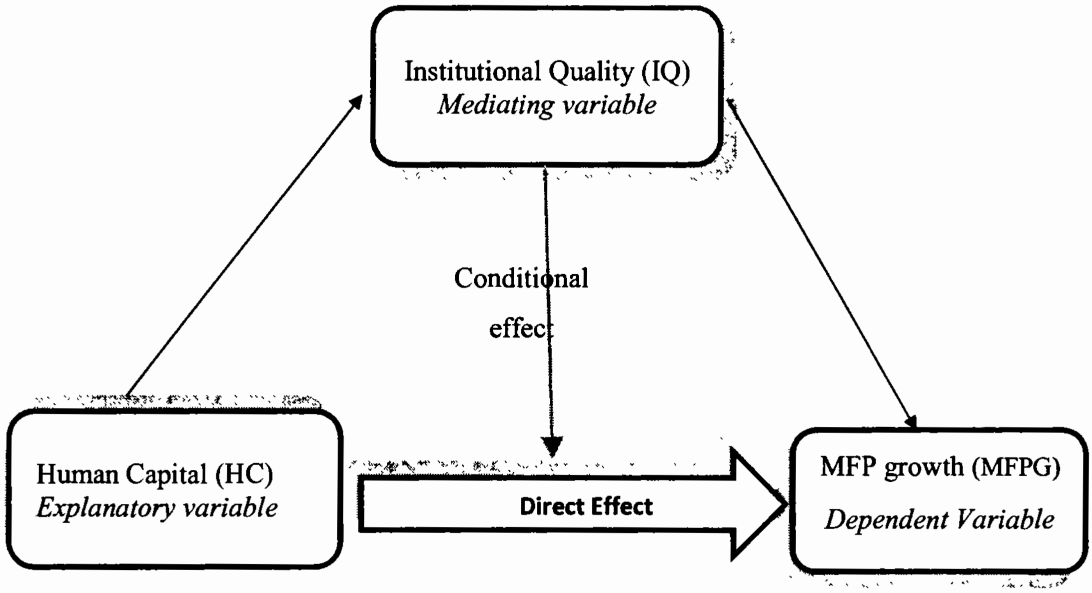
However, in the existing empirical studies, this relationship does not hold due to several reasons; for example, following the model specification which is not based on economic theory. The definite impact of HC on economic and productivity growth is still controversial empirically; showing a clear paradox that deserves much attention (Pritchett, 2001). One of the prominent attempts by Islam (1995) refute the direct impact of HC (average years of schooling) on output growth in two of the three samples by using panel regressions. In the same line of analysis, several studies illustrate the either insignificant or significant negative impact of HC on MFP growth (for example, see Becker et al., 1990; Mankiw, et al., 1992; Tallman and Wang, 1994; Miller and Upadhyay, 2000; Baier et al., 2006; and Acemoglu, 2012).

The above discussion gives rise to an important question of whether HC matters for MFP growth or not? Answering this question requires to identify the channels and conditions through which HC affects aggregate productivity. The recent research on the subject proclaims that one of the important factors behind these empirical irregularities is neglecting the channels and conditions through which HC can affect economic growth. Sunde and Vischer (2015) explore the factors behind the weak and inconclusive empirical effect of HC on economic growth in cross-country studies. They conclude that the effect of HC is likely to be underestimated and biased if our empirical specification does not incorporate the important channels through which HC affects growth. Further, they also assert that several existing empirical studies have used either wrong model specification or irrelevant estimation technique(s) in their empirical and econometric analysis. In the analysis of indirect and conditional effects, interaction terms of variables have been used to capture these effects. A potent approach to capture the indirect and conditional effects is the moderated mediation approach which has commonly been used in social science, business, health, psychological, and educational research.

One of the recent attempts by Uddin et al., (2020) explore the moderating effect of institutions and human development on the economic growth of developing countries and conclude that institutions and human development have a significant negative interactive effect on economic growth. Similarly, Zhu and Li (2017) examine the moderating role of economic complexity on the contribution of HC to economic growth by including the interaction terms of complexity and different levels of HC in their econometric model. They conclude a positive interaction effect, suggesting that economic complexity reinforces the effect of HC on growth.

Thus, getting leads from the evolving domain of research, we examine the important channels and conditions in our empirical analysis and explore the indirect and conditional effects of HC on MFPG by applying the most suitable estimation technique. We analyze the mediating and moderating effects of IQ in the relationship between HC and MFPG, which has not yet been adequately examined empirically. To derive a better utility from its stock of human capital, a country must possess a well-functioning and quality institutions (Benhabib and Spiegel, 1994). The results and findings of our study are going to supplement and enrich the existing literature by bridging this research gap.

Figure 4.8: The Mediating and Moderating Effects of Institutional Quality in the Relationship between Human Capital and MFPG



Source: Authors' own research

The schematic model portrays that IQ act as mediating as well as moderating variables between HC and MFP growth. Moderation effects can be capture through the interactions of IQ and HC which is also termed conditional effects. The impact of HC on MFP growth runs through the channel of IQ. In those countries where IQ is good, an increase in HC may lead to productivity and economic growth. However, HC may affect productivity and economic growth adversely in case of bad IQ (Hall et al., 2010).

To examine the direct, conditional, and indirect effects of HC on MFP by the channels of IQ the econometric models can be specified as under:

$$IQ_{it} = \alpha_1 + \alpha_2 HC_{it} + \alpha_3 Z_{1it} + \mu_{it} \quad (4.23)$$

$$MFPG_{it} = \delta_1 + \delta_2 HC_{it} + \delta_3 IQ_{it} + \delta_4 (HC^{*}IQ)_{it} + \delta'_5 Z_{2it} + \varepsilon_{it} \quad (4.24)$$

Whereas, MFPG is the multifactor productivity growth, HC is measured by the human capital index based on years of schooling and returns to education, IQ is the index of institutional quality, Z is the vector of control variables. α_1 and δ_1 are the intercept of the regressions. u and ε are stochastic error terms.

Indirect Effect

The indirect effect of HC on MFP growth by the channel of IQ is calculated from the regressions (4.23), (4.24) as follows:

$$\frac{\partial \text{MFPG}}{\partial \text{HC}} = \frac{\partial IQ}{\partial \text{HC}} * \frac{\partial \text{MFPG}}{\partial \text{IQ}} \quad (4.25)$$

$$\frac{\partial \text{MFPG}}{\partial \text{HC}} = \alpha_2(\delta_3 + \delta_4 \text{HC}) \rightarrow \text{ (Indirect Effect)} \quad (4.26)$$

The signs of the above cited indirect effects depend upon the signs and magnitudes of α_2, δ_3 and δ_4.

Conditional Effect

$$\frac{\partial \text{MFPG}}{\partial \text{HC}} = \delta_2 + \delta_4 \text{IQ} \quad (4.27)$$

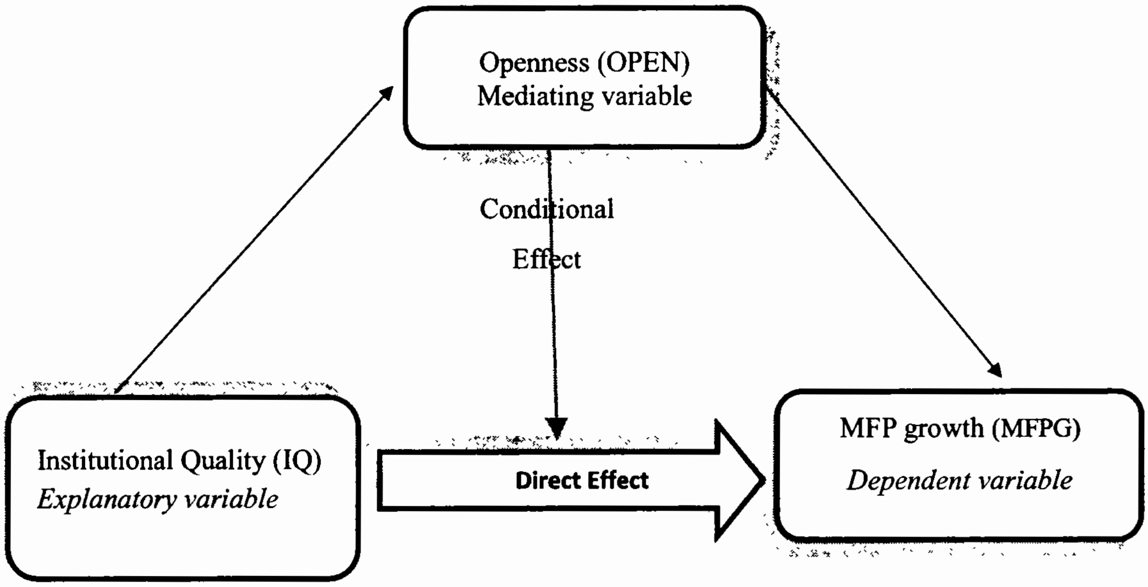
Equation 4.27 represents conditional effects. Our conditional hypotheses concentrate around the coefficients of δ_2 and δ_4.

4.3.3.3 Direct, Indirect and Conditional Effects of Institutional Quality on MFPG

It is well documented in the existing theoretical and empirical literature that institutional development is crucial to attaining a higher level of productivity and economic growth (North and Thomas, 1973; Hall and Jones, 1999; Rodrik, 2008; and Egert, 2016). The high-quality institutions and good governance drive trade flows and vice versa. The IQ matters for comparative advantage as it influences factor accumulation and technological innovation. Nunn and Trefler (2014) provide a review of the theoretical and empirical literature on the nexus between trade and institutions. Dollar and Kraay (2003) assert that countries with better institutions tend to trade more and hence grow faster. They argue that both trade and institutions are important to understand the cross-country growth differences because both move together and have a significant joint effect on growth in the very long run. However, OPEN alone has a larger effect on growth in the short run. In theoretical models of endogenous growth, Grossman and Helpman (1991) consider imports of capital equipment as one of the important channels for technology transfer. Similarly, Coe and Helpman (1995) conclude that the openness of the economy is crucial to achieving a higher level of domestic TFP.

Following Dollar and Kraay (2003), in a new frontier of research, scholars have shown more concern regarding the indirect and conditional effects of IQ on growth. Acemoglu et al. (2014) assert that the interaction between key macroeconomic variables and institutions is yet to be settled; since the existing empirical literature is agnostic and skeptical about the channels through which IQ affect growth and development. To bridge this gap, we examine the mediating and moderating effects of OPEN in the relationship between IQ and MFPG, that has not been addressed properly in the existing empirical literature.

Figure 4.9: The Mediating and Moderating Effects of Openness in the Relationship between Institutional Quality and MFPG



Source: Authors' own research

The schematic model portrays that OPEN act as mediating as well as moderating variables between IQ and MFP growth. Moderation effects can be capture through the interactions of OPEN and IQ which is also termed conditional effects. The openness of international trade across countries occurs to lead towards technology diffusion through FDI. Countries with good IQ can attract more FDI & international trade, resultantly could achieve a higher level of productivity and economic growth (Benassy-Quere et al., 2007; Keller, 2004). So, OPEN act as mediating as well as moderating variables between IQ and MFP.

To examine the direct, conditional, and indirect effects of IQ on MFP by the channel of OPEN the econometric models can be specified as under:

$$OPEN_{it} = \alpha_1 + \alpha_2 IQ_{it} + \alpha_3 Z_{1it} + \mu_{it} \tag{4.28}$$

$$MFPG_{it} = \beta_1 + \beta_2 IQ_{it} + \beta_3 OPEN_{it} + \beta_4 (IQ^{*}OPEN)_{it} + \beta'_5 Z_{2_{it}} + \varepsilon_{it} \tag{4.29}$$

Whereas, MFPG is the multifactor productivity growth, IQ is measured by an index of institutional quality, OPEN is measured by the total trade (% of GDP), Z is the vector of control variables. α_0 and $\gamma_0$are the intercept of the regressions. u and ε are stochastic error terms.

Indirect effect

The indirect effect of IQ on MFPG by the openness (Open) is calculated from the regressions (4.28), (4.29) as follows:

$$\frac{\partial MFPG}{\partial IQ} = \frac{\partial OPEN}{\partial IQ} * \frac{\partial MFPG}{\partial OPEN} \quad (4.30)$$

$$\frac{\partial MFPG}{\partial IQ} = \alpha_2(\beta_3 + \beta_4 IQ) \rightarrow \quad \text{(Indirect Effect)} \quad (4.31)$$

The signs of the above cited indirect effects depend upon the signs and magnitudes of α_2, β_3 and β_4.

Conditional Effect

$$\frac{\partial MFPG}{\partial IQ} = \beta_2 + \beta_4 OPEN \quad (4.32)$$

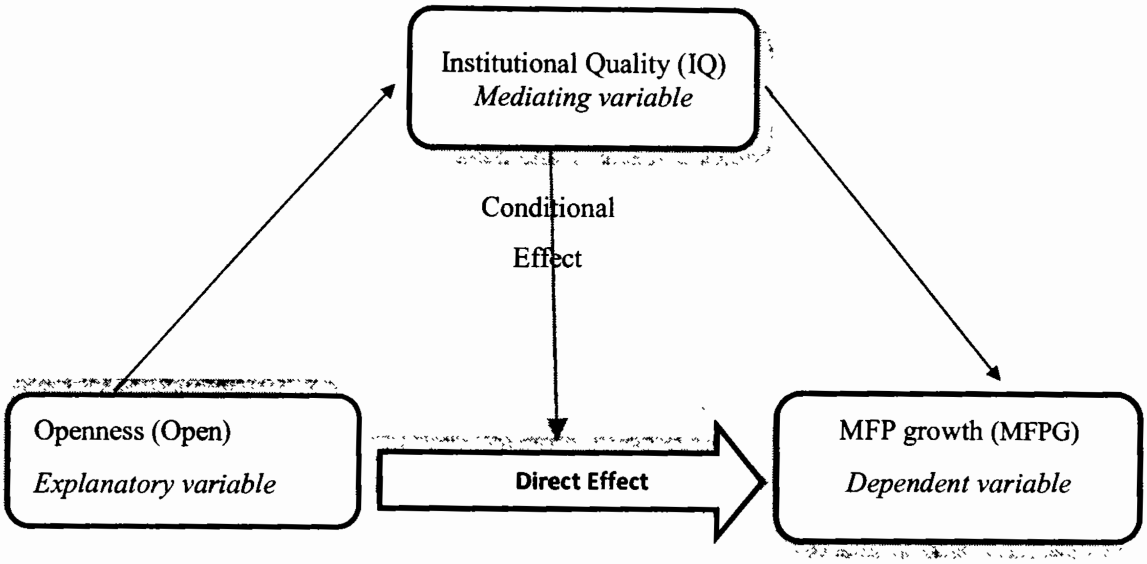
Equation (4.32) represents the conditional effects. Our conditional hypotheses concentrate around the coefficients of β_2 and β_4.

4.3.3.4 Direct, Indirect and Conditional Effects of Openness on MFPG

There is a widespread consensus on the growth effects of OPEN and IQ. Theoretically, OPEN improves the efficiency of allocation of resources (towards the most efficient sectors) besides expanding the trade opportunities. it accelerates R&D activities through trade liberalization and technological spillovers. The expenditures on R&D and high-technology imports enhance domestic innovation, hence raising growth and productivity. The empirical evidence on productivity growth effects of OPEN remains rather mixed. Nevertheless, most of the empirical attempts find a positive significant impact of OPEN on growth. (See for example; Keefer and Knack, 1995; Edwards, 1998; Hall and Jones, 1999; Miller and Upadhyay, 2000; Rodrik, 2001; and Alcala and Ciccone, 2004).

Edwards (1998) argues that more open countries experienced faster productivity growth. Similarly, Miller and Upadhyay (2000) find a positive significant impact of OPEN on productivity growth. Contrarily, Rodriguez and Rodrik (2000) do not find a significant and robust impact of OPEN on growth. The EGM give a framework for a positive significant impact of trade openness on growth via institutional development (Rodrik et al., 2004). In general, countries with high-quality institutions and better governance can get more benefit from OPEN. Motivated by the literature on indirect effects of OPEN on growth and mainly by the study of Doyle and Martinez-Zarzoso (2011), we attempt to explore the mediating and moderating effects of IQ in the nexus between OPEN and MFPG.

Figure 4.10: The Mediating and Moderating Effects of Institutional Quality in the Relationship between Openness and MFPG



Source: Authors' own research

The schematic model portrays that OPEN act as mediating as well as moderating variables between IQ and MFP growth. Moderation effects can be capture through the interactions of OPEN and IQ which is also termed conditional effects. To examine the direct, conditional, and indirect effects of OPEN on MFP growth by the channel of IQ, the econometric models can be specified as under:

$$IQ_{it} = \alpha_1 + \alpha_2 OPEN_{it} + \alpha_3 Z_{1it} + \mu_{it} \qquad (4.33)$$

$$MFPG_{it} = \beta_1 + \beta_2 OPEN_{it} + \beta_3 IQ_{it} + \beta_4 (OPEN * IQ)_{it} + \beta'_5 Z_{2it} + \mathcal{E}_{it} \qquad (4.34)$$

Whereas, MFPG is the multifactor productivity growth, IQ is measured by an index of institutional quality, OPEN is measured by the total trade (% of GDP), Z is the vector of control variables. α_0 and $\gamma_0$are the intercept of the regressions. u and ε are stochastic error terms.

Indirect effect

The indirect effect of OPEN on MFPG by IQ is calculated from the regressions (4.33), (4.34) as follows:

$$\frac{\partial \text{MFPG}}{\partial \text{OPEN}} = \frac{\partial \text{IQ}}{\partial \text{OPEN}} * \frac{\partial \text{MFPG}}{\partial \text{IQ}} \quad (4.35)$$

$$\frac{\partial \text{MFPG}}{\partial \text{OPEN}} = \alpha_2(\beta_3 + \beta_4\text{OPEN}) \rightarrow \quad \text{(Indirect Effect)} \quad (4.36)$$

the signs and magnitudes of α_2, β_3 and β_4 is used to determine the signs of the above-mentioned indirect effects.

Conditional Effect

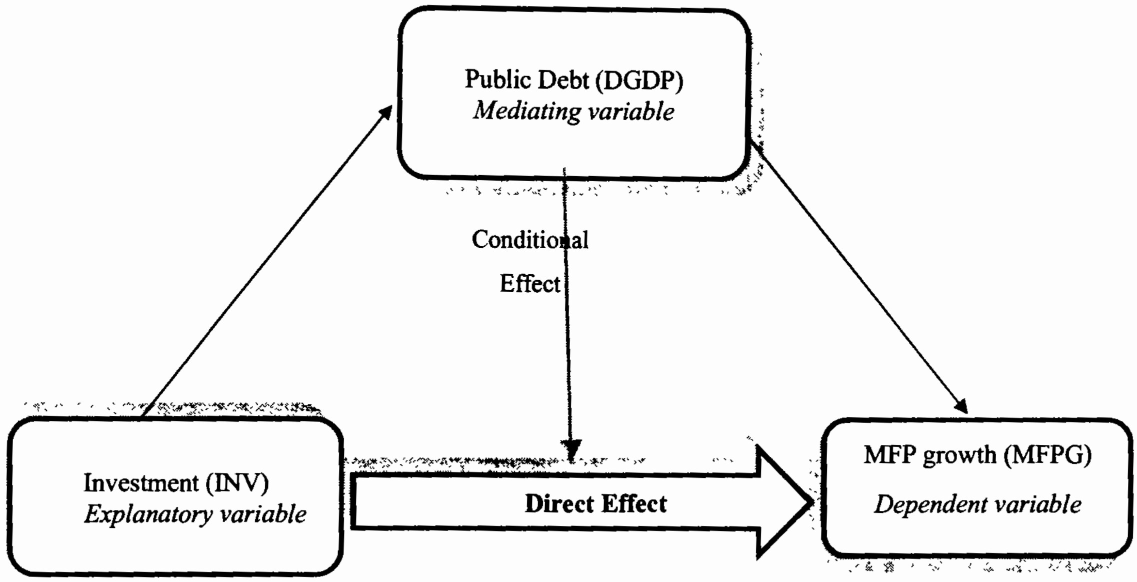
$$\frac{\partial \text{MFPG}}{\partial \text{Open}} = \beta_2 + \beta_4\text{IQ} \quad (4.37)$$

Equation (4.37) represents the conditional effects. Our conditional hypotheses concentrate around the coefficients of $\beta_2$andβ_4.

4.3.3.5 Direct, Indirect and Conditional Effects of Investment on MFP Growth

Most of the developing countries are facing the issue of high current account payment deficits, which lead to the accumulation of debt and debt servicing. In general, the governments in high indebted countries impose a higher tax rate to finance their expenditures. Consequently, investors turn down their investment decisions as their expectations regarding future returns mitigate. This decline in investment due to the accumulation of debt adversely affects productivity growth (Cohen, 1993; and Rockerbie, 1994). So, the public debt is one of the important channels through which the impact of INV on MFP growth can be examined. We could not find any empirical evidence on the mediating and moderating effects of DGDP on the relationship between INV and MFP growth. This study aims at filling the literature gap by providing the indirect and conditional effects of INV on MFP growth.

Figure 4.11: The Mediating and Moderating Effects of Public Debt in the Relationship between Investment and MFP growth



Source: Authors' own research

The schematic model depicts that public debt (DGDP) acts as mediating a well as moderating variable between investment (INV) and MFP growth. Moderation effects can be capture through the interactions of DGDP and INV which is also termed conditional effects. When DGDP increases then the government needs to increase either tax rate or borrowing. Government borrowing leads to discouraging private investment (capital formation) due to an increase in the discount rate (opportunity cost of borrowing the money), and ultimately result in lower productivity (Afonso & Jalles, 2013).

To examine the direct, conditional, and indirect effects of INV on MFP growth by the channel of DGDP the econometrics models can be specified as under:

$$DGDP_{it} = \alpha_1 + \alpha_2 INV_{it} + \alpha_3 Z_{1it} + \mu_{it} \quad (4.38)$$

$$MFPG_{it} = \delta_1 + \delta_2 INV_{it} + \delta_3 DGDP_{it} + \delta_4 (INV^{*}DGDP)_{it} + \delta'_5 Z_{2it} + \varepsilon_{it} \quad (4.39)$$

Whereas, MFPG is the multifactor productivity growth, public debt is measured by the Central Government Debt (% GDP) or debt to GDP ratio (DGDP), INV is gross fixed capital formation, private sector (% of GDP), Z is the vector of control variables. α_1 and δ_1 are the intercept of the regressions. u and ε are stochastic error terms.

Indirect Effect

The indirect effect of investment on MFPG by the channel of DGDP is calculated from the regressions (4.38), (4.39) as follows: We differentiate partially equation (4.38) with respect to INV and get α_2, secondly, we differentiate partially equation (4.39) for DGDP and get $(\delta_3 + \delta_4\text{INV})$. Then, to get equation 4.41 we multiply both terms, which $\alpha_2(\delta_3 + \delta_4\text{DGDP})$ represents the indirect effect of DGDP on MFPG. The signs of the above-cited indirect effects depend upon the signs and magnitudes of α_2, δ_3 and δ_4.

$$\frac{\partial \text{MFPG}}{\partial \text{INV}} = \frac{\partial \text{DGDP}}{\partial \text{INV}} * \frac{\partial \text{MFPG}}{\partial \text{DGDP}} \qquad (4.40)$$

$$\frac{\partial \text{MFPG}}{\partial \text{INV}} = \alpha_2(\delta_3 + \delta_4\text{INV}) \rightarrow \quad \text{(Indirect Effect)} \qquad (4.41)$$

Conditional Effect

Moreover, to calculate the conditional effects we take the derivative of equation (4.39) with respect to INV and we get $\delta_2 + \delta_4\text{DGDP}$.

$$\frac{\partial \text{MFP}}{\partial \text{DGDP}} = \delta_2 + \delta_4\text{DGDP} \qquad (4.42)$$

Our conditional hypotheses concentrate around the coefficients of $\delta_2$andδ_4. There exist the following four possibilities:

- If δ_2>0 andδ_4>0 then investment (INV) has a positive impact on MFPG and public debt conditions intensify the expected positive impact of PD.

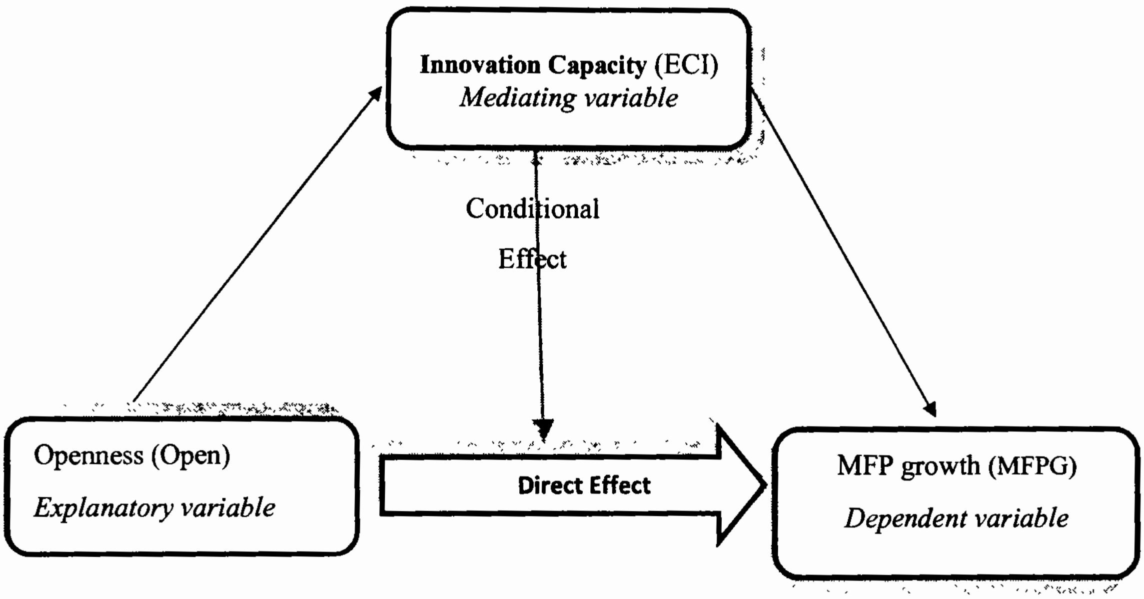
- Ifδ_2>0 andδ_4<0, then investment (INV) has a positive impact on MFPG and public debt conditions mitigate the positive impact of investment (public debt lessens the expected positive impacts of investment).
- Ifδ_2<0 andδ_4>0, public debt (DGDP) has a negative impact on MFPG, and investment conditions mitigate the expected negative effect of DGDP.
- If δ_2<0 andδ_4<0, investment (INV) has a negative impact on MFPG and public debt conditions aggravate the unexpected negative effect of investment.

4.3.3.6 Direct, Indirect and Conditional Effects of Openness on MFPG

There is a growing number of studies that explore the relationship between OPEN, innovation, and economic growth. Modern growth theories (See, among others, Romer, 1986; Lucas, 1988; Grossman and Helpman,1991; Edwards, 1998; Ulku, 2004; and Sweet and Eterovic, 2019) consider OPEN and innovation as an engine of economic growth due to their long-lasting effects on MFPG. The EGM contend that more open economies have more chances and ability to absorb technological advances and innovation generated by the technologically advanced countries. It is well established that countries that specialize in knowledge-intensive products achieve higher rates of MFP growth and favorable terms of trade.

One of the recent attempts by Belazreg and Mtar (2020) examines the interactions among OPEN, innovation, financial depth, and economic growth in 27 OECD countries, using a panel vector autoregressive model. They conclude a bidirectional relationship between OPEN and growth. Despite having a legion of literature on the issue, there is a lack of consensus among economists regarding the positive direct impact of OPEN on growth. Hence, to add more lucidity and insightfulness into the existing literature, it is desirable to explore the indirect and conditional effects of OPEN on MFPG.

Figure 4.12: The Mediating and Moderating Effects of Innovation Capacity in the Relationship between Openness and MFP growth



Source: Authors' own research

The schematic model portrays that innovation capacity proxied by the economic complexity index (ECI) act as mediating as well as moderating variables between OPEN and MFP growth. Moderation effects can be capture through the interactions of Open and ECI which is also termed as conditional effects.

To examine the direct, conditional, and indirect effects of OPEN on MFP growth via ECI, the econometric models can be specified as under:

$$ECI_{it} = \alpha_1 + \alpha_2 OPEN_{it} + \alpha_3 Z_{1it} + \mu_{it} \quad (4.43)$$

$$MFPG_{it} = \beta_1 + \beta_2 OPEN_{it} + \beta_3 ECI_{it} + \beta_4 (OPEN * ECI)_{it} + \beta'_5 Z_{2_{it}} + \varepsilon_{it} \quad (4.44)$$

Whereas, MFPG is the multifactor productivity growth, ECI is measured by the economic complexity index, OPEN is measured by the total trade (% of GDP), Z is the vector of control variables. α_0 and $\gamma_0$are the intercept of the regressions. u and ε are stochastic error terms.

Indirect effect

The indirect effect of openness on MFPG via ECI is calculated from the regressions (4.43), (4.44) as follows:

$$\frac{\partial MFPG}{\partial OPEN} = \frac{\partial ECI}{\partial OPEN} * \frac{\partial MFPG}{\partial ECI} \quad (4.45)$$

$$\frac{\partial MFPG}{\partial OPEN} = \alpha_2(\beta_3 + \beta_4 OPEN) \rightarrow \quad \text{(Indirect Effect)} \quad (4.46)$$

The signs of the above-cited indirect effects depend upon the signs and magnitudes of α_2, β_3 and β_4.

Conditional Effect

$$\frac{\partial MFPG}{\partial OPEN} = \beta_2 + \beta_4 ECI \quad (4.47)$$

Equation (4.47) indicates the conditional effects that is captured by the coefficients of $\beta_2$and β_4.

Chapter 5

RESULTS AND DISCUSSION-I

Macroeconomic and Institutional Drivers of MFP Growth: Static and Dynamic Analysis

5.1 Introduction

This chapter presents the regression analysis on the institutional and macroeconomic determinants of both MFP growth and HC adjusted MFP growth for the sample of 49 developing countries. it highlights the empirical results and findings obtained through static and DPDM. The empirical analysis is based on an unbalanced panel data set consisting of 49 developing countries for the period 1984-2016.

Tables 5.1 through 5.4 show the estimates of the static panel data models (FE and RE) for alternative specifications, using MFPG and MFPG_H as dependent variables respectively. In the same way, Tables 5.5 through 5.8 use lagged values of MFPG and MFPG_H as regressands and show the estimates of the DPDM (Difference and System GMM) for different specifications. In a broader context, the estimates of static and DPDM yield similar results. The lower panels of Tables 5.5 through 5.8 report the results of Arellano-Bond test for autocorrelation and the Hansen J test for over-identifying restrictions.

5.2 Regression Results from Static Analysis

Model 1 of Tables 5.1 through 5.4 portrays the estimates obtained from our baseline and parsimonious specifications, using FE and RE models. Model 2 onwards of Tables 5.1 to 5.4 shows the estimates obtained from adding additional regressors or control variables in static panel data models. The control variables are added one by one in the baseline models to check the robustness of regression results as well as their probable effects on MFPG. The robustness of results is also been checked by employing different specifications, estimation techniques as well as forms of datasets (that is, using annual and five-year averages of data). Tables D2 and D3, Appendix D report the results of the FE model, using five-year averages data. The regression results of the RE model are not reported in the Appendix, as the Hausman test suggests that the FE model is preferable to the RE model (See Table D1, Appendix D; we reject the null of Hausman test; chi2 = 24.74, p-value = 0.0002) which implies that FE model is more appropriate). A closer inspection of our estimates reveals that the results are consistent and robust across the different specifications, estimators, and datasets that have been applied.

In general, the estimation results show that investment, size of the government, inflation, debt to GDP ratio, financial depth, and institutional quality matter for MFPG. As expected, the coefficients on INV and IQ are positive and significant. The coefficients on GSIZE, INF, DGDP, and PRIV are negative and statistically significant in all regressions; the results are robust to model specifications and estimation techniques. Moreover, we find the positive significant impact of OPEN and FDI on MFPG in some regressions, however, this result is not robust. In sum, we are unable to draw a firm inference regarding the effects of OPEN and FDI on MFPG. A priori signs and the outcomes for the explanatory and control variables being used in the regression analysis are given in the Appendix D (Table D4).

Despite the anticipated significant direct impact of other prominent well-known macroeconomic variables including HC, ICT, ECI, POPG; we find either insignificant or inconclusive results. However, these results can be expected given the complexity of the MFPG process in developing economies. In chapter 6, we move a step forward and focus on the transmission mechanisms in contrast to the direct impact of these variables on productivity growth. It is expected that by identifying the different channels and conditions, we may able to get further insights and conclusions.

The investment and IQ have much stronger effects in the sense that their coefficients are larger than the coefficients of other significant variables, particularly inflation. Technically, it might not be considered as a unit problem, since all variables are expressed in logs. These results suggest that investment climate and institutions need to be improved as they may have an even more important role in improving productivity growth in developing countries. The economic growth literature gives investment and institutions the due weightage by considering them as competing determinants of the cross-countries' growth disparities (North, 1990; Hall and Jones, 1999; Rodrik et al., 2004; Acemoglu et al., 2003, 2005; and Nawaz, 2015). Our findings are consistent with the results of several prominent empirical studies including Olson et al. (2000) and Hall and Jones (1999).

The findings of static analysis indicate that inflation, government expenditures, and public debt hinder MFPG by creating disincentives and inefficiencies in resource allocation and management. The negative effect of INF on MFP growth is consistent with most of the existing empirical literature (see Fischer, 1993; Miller and Upadhyay, 2000; Kiley, 2003; Bitros & Panas, 2006; Narayan and Smyth, 2009; and Li and Tanna, 2019). The large fiscal imbalances could result in lower growth because of crowding-out effects on private investment and weaker capital accumulation, which would thereby reduce MFPG. Sometimes, higher government spending is financed by moving the resources from the productive sector of the economy to government, which undermines economic growth and productivity.

According to Islam (2008), a reduction in government expenditure is necessary to achieve higher productivity. Peden and Bradley (1989) conclude a negative link between government size and productivity. They argue that an increase in the scale of government erodes both productivity and its growth. In a cross-country analysis, Reinhart and Rogoff (2010) reveal that countries with higher levels of debt to GDP ratio (90 % and above) shall experience lower growth than less-indebted countries. Similarly, Salotti and Trecroci (2016) conclude that the large fiscal imbalances and high public debt adversely affect productivity growth and investment.

Our findings are consistent with the results of Cohen (1993), Rockerbie (1994), Aizenman et al. (2007), Reinhart and Rogoff (2010), and Salotti and Trecroci (2016). In general, the governments in high indebted countries impose a higher tax rate to finance their expenditures. Consequently, investors turn down their investment decisions as their expectations regarding future returns mitigate. This decline in investment due to the accumulation of debt adversely affects productivity growth.

We use credit to the private sector as a % of GDP and ratio of total liquid liabilities (M2) to GDP as indicators of financial development and monetary policy. The conventional wisdom is that the financial sector development contributes positively to productivity growth. Interestingly, our findings reveal that financial sector development does not improve MFPG. This is contrary to the existing empirical literature, as the financial depth is expected to have a positive and significant impact on TFP growth, as suggested by Beck et al. (2000) and Bonfiglioli (2008). In this vein, a possible explanation is that most of the people in developing nations are still lagging in the adoption of financial products and services. Similarly, inflation adversely affects productivity, since incomplete information and uncertainty about future prices reduce the volume of investment. During periods of the rising price level, the purchasing power of money held by economic agents decreases so investors tend to minimize the potential losses and utilize their savings to accumulate real assets rather than capital stock.

However, the theory of rational expectations states that agents make their expectations rationally and the changes in prices are already taken into consideration in their saving and investment decisions, so inflation has no effect on real economic activity.

The results of the FE model reported in Table 5.1 indicate that INV and IQ play an important role in determining MFPG in developing countries. We find, as expected, that the coefficients on INV and IQ are positive and remain significant at 1% and 5% levels across all estimates. The positive signs of the coefficients of INV illustrate that if investment increases by one % then the rate of growth of MFP increases on average by 0.02705 (that is, 2.705*0.01)[51] percentage points per year. Similarly, the positive signs of coefficients of IQ demonstrate that an improvement in the quality of institutions increases the MFPG by approximately 0.01-0.02 percentage points per year, depending upon the specification and addition of the control variable.

As noted earlier, the INV and IQ have much stronger effects in the sense that its coefficients are larger than the coefficients of other significant variables, particularly inflation. Technically, it might not be considered as a unit problem, since all variables are expressed in logs. These results suggest that investment climate and institutions need to be improved as they may have an even more important role in improving productivity growth in developing countries. Our findings are consistent with the results of several prominent empirical studies including Olson et al. (2000) and Hall and Jones (1999).

[51] The specification of our model is linear-log (that is, mirror image of the log-linear model). So, for the interpretation of the results, the coefficients are either divided by 100 or multiplied by 0.01. As our dependent variable is the MFP growth rate (that is, ΔlogMFP); therefore, we have a percentage point change interpretation. We follow this pattern throughout of the study. Wooldridge (2006) pointed out that the linear-log or level-log is preferred over the level-level model, as it captures the relationship between dependent and independent variables more closely. For further understanding of how to incorporate commonly used functional forms into regression analysis, see Wooldridge (2006).

Further, we find that the coefficients of GSIZE, INF, DGDP, and PRIV are negative and statistically significant. It appears that these factors hurt the developing country's productivity growth. The negative signs of the coefficients of GSIZE show that if government size increases by one % then the rate of MFPG declines on average by 0.025 percentage points. Similarly, the negative signs of coefficients of public debt and financial depth portray that a 1% increase in the DGDP and PRIV reduces the MFPG by almost 0.006 to 0.009 percentage points, depending on the model specification and addition of control variable. Theoretically, mild inflation rate is expected to have a positive impact on MFPG, however, hyperinflation may reduce it. As most of the developing and emerging economies are experiencing a two-digit inflation rate, hence, we may expect the negative impact of inflation on MFP growth.

Table 5.1: Regression Results of MFPG (Fixed Effect Model)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
INV	2.705*** (0.000)	2.712*** (0.000)	2.398*** (0.001)	2.698*** (0.000)	2.683*** (0.000)	2.698*** (0.000)	2.751*** (0.000)	2.722*** (0.000)	2.509*** (0.000)
GSIZE	-2.545*** (0.001)	-2.547*** (0.001)	-2.603*** (0.001)	-2.520*** (0.001)	-2.553*** (0.001)	-2.555*** (0.001)	-2.526*** (0.001)	-2.547*** (0.001)	-2.208*** (0.000)
INF	-0.000*** (0.004)	-0.000*** (0.004)	-0.000*** (0.004)	-0.000*** (0.006)	-0.000*** (0.004)	-0.000*** (0.005)	-0.000*** (0.005)	-0.000*** (0.004)	-0.001* (0.097)
DGDP	-0.784** (0.020)	-0.713* (0.056)	-0.792** (0.027)	-0.794** (0.023)	-0.751** (0.047)	-0.717* (0.061)	-0.734** (0.034)	-0.762** (0.028)	-0.586* (0.099)
PRIV	-0.831** (0.013)	-0.812** (0.016)	-0.928*** (0.006)	-0.836** (0.014)	-0.854** (0.011)	-0.828** (0.039)	-0.814** (0.014)	-0.859** (0.011)	-0.751** (0.027)
IQ	2.306*** (0.002)	2.173*** (0.003)	1.943*** (0.005)	2.331*** (0.002)	2.240*** (0.001)	2.169*** (0.005)	2.101*** (0.009)	2.213*** (0.003)	1.409** (0.035)
HC		0.477 (0.735)							
OPEN			1.067 (0.148)						
ECI				0.845 (0.489)					
ICT					0.025 (0.770)				
CO2						0.128 (0.802)			
POPG							-0.162 (0.683)		
ADR								-0.432 (0.657)	

Cont...

Table 5.1: Regression Results of MFPG (Fixed Effect Model)

FDI									0.145 (0.218)
Constant	-5.334 (0.165)	-5.461 (0.166)	-6.729 (0.118)	-6.179* (0.095)	-5.411 (0.167)	-6.332 (0.235)	-4.617 (0.300)	-3.174 (0.608)	-2.918 (0.424)
R Squared	0.085	0.083	0.089	0.085	0.085	0.083	0.084	0.086	0.082
Wald Stat. (P-Values)	12.68 (0.000)	11.16 (0.000)	10.45 (0.000)	11.04 (0.000)	10.93 (0.000)	11.30 (0.000)	12.39 (0.000)	10.89 (0.000)	6.71 (0.000)
Observations	1,282	1,245	1,282	1,271	1,282	1,245	1,245	1,282	1,202
Countries	47	47	47	47	47	47	47	47	47

Notes: The dependent variable is multi-factor productivity growth (MFPG). All explanatory variables are in log form except for those which are in growth rates that is, population growth. INV is the gross fixed capita formation (% of GDP). GSIZE is the general government final consumption expenditure (% of GDP). INF is inflation as measured by the Consumer Prices (annual %). DGDP is the debt-to-GDP ratio. PRIV is the domestic credit to the private sector (% of GDP). IQ is the index of institutional quality. HC is the human capital index based on years of schooling and returns to education. OPEN is the trade openness measured by the total trade (% of GDP). ECI is the Economic Complexity Index. ICT is information and communications technology. CO_2 is carbon dioxide emissions. POPG is population growth. ADR is the age dependency ratio, % of the working-age population. FDI is the foreign direct investment, net inflows (% of GDP). The p-values are given in brackets. ***, **, * indicate significance at 1%, 5%, and 10% respectively.

As per our results, the magnitudes of the inflation coefficients are much smaller. Nevertheless, these coefficients remain negative and significant at a 1% level across all estimates, indicating the undesirable consequences of macroeconomic price instability. This finding is in line with the finding of Freeman and Yerger (1998), who advocate the minor or negligible negative impact of inflation on TFP growth in the case of the United States. Undoubtfully, Smyth (1995) finds a strong inverse relationship between inflation and productivity growth in the case of the United States. The control variables are added one by one in the baseline model to check the robustness of regression results as well as their probable effects on MFPG. The estimated coefficients of HC, OPEN, ECI, ICT, CO2, and FDI are positive but not significant in most of the regressions. Similarly, the estimated coefficients of POPG and ADR are negative but not significant.

Table D2, Appendix D shows the regression results using 5-year non-overlapping data averages during the 1980–2016 period—that is, seven observations (1981–1985, 1986–1990, 1991–1995, 1996–2000, 2000–2005, 2006–2010, and 2011–2016) for each variable and country. The regression results based on 5-year averages confirm that human capital, investment, government size, inflation, debt to GDP ratio, CO2 emissions, remittances, and institutional quality matter for MFPG. The coefficients on HC, INV, REM, and IQ are positive and significant. The coefficients on GSIZE, INF, DGDP, and CO2 are negative and statistically significant in all regressions; the results are robust to model specifications. We see that the estimated coefficient of GSIZE is negative and statistically significant and the value of coefficient around 1.6 indicates that a one % increase in GSIZE tends to be associate with a 0.016 percentage point decrease in MFPG. However, the statistically significant positive coefficients of HC suggest a corresponding increase of 0.034 – 0.047 percentage point in MFPG of selected developing countries, depending on the model specification and control variables. Similarly, the statistically significant positive coefficients of IQ around 1.8 indicate a corresponding increase of 0.018 percentage point in MFPG over 5 years.

When we use 5-year averages instead of annual observations, we no longer find a statistically significant association between financial depth and MFPG. However, human capital, remittances, and CO2 emissions become significant which were insignificant in the case of annual data. The positive signs and magnitudes of the coefficients of HC confirm that on average a one % improvement in the HC brings forth about a three-four percentage points increase in the rate of MFPG. Likewise, the maximum acceleration in MFPG due to the flow of foreign remittances is 0.001 - 0.003 percentage points per year. The negative signs of the coefficients of CO2 show that if CO2 emissions increases by one % then the rate of MFPG decreases by an average of 0.013 - 0.016 percentage points. The signs and quantitative effects of other significant variables such as INV, GSIZE, DGDP, and IQ are approximately identical and robust.

Taken together, the result of the FE model shows that INV, GSIZE, INF, DGDP, PRIV, and IQ are the main drivers of MFPG in selected developing countries. The coefficients on INV and IQ are positive and significant. On the other hand, the coefficients of GSIZE, INF, DGDP, and PRIV are negative and statistically significant.

The regression results in Table 5.2 indicate that HC adjusted MFPG depends upon the INV, GSIZE, INF, OPEN, DGDP, PRIV, and IQ. As expected, the coefficients on INV, OPEN, and IQ are positive and significant. The coefficients on GSIZE, INF, DGDP, and PRIV are negative and significant. The positive effects of OPEN on MFPG is robust to the existing empirical literature. (see among others Edwards, 1998; Alcala and Ciccone, 2004 and Naz et al., 2015)

The Table D3 given in the Appendix D shows the regression results using 5-year non-overlapping data averages during the 1980–2016 period—that is, seven observations (1981–1985, 1986–1990, 1991–1995, 1996–2000, 2000–2005, 2006–2010, and 2011–2016) for each variable and country. The regression results in Table D3 demonstrate that FDI, GSIZE, INF, DGDP, CO2, and IQ matter for HC adjusted MFPG. it is important to observe that in the case of five averages of the data, the variables that is, INV, OPEN, and PRIV lose their statistical significance while FDI and CO2 emissions gain it. However, the sign and significance of other drivers of HC adjusted MFPG that is, GSIZE, INF, DGDP, and IQ remain robust in all regressions. By and large, the pattern of regression results obtained using annual observations and 5-year averages of the data are not changed considerably.

Table 5.2: Regression Results of MFPG_H (Fixed Effect Model)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
INV	1.570** (0.041)	1.592** (0.037)	1.576** (0.042)	1.452** (0.049)	1.445* (0.062)	1.361* (0.077)	1.562* (0.069)
GSIZE	-1.453** (0.017)	-1.458** (0.017)	-1.439** (0.018)	-1.478** (0.014)	-1.497** (0.018)	-1.520** (0.015)	-1.392*** (0.005)
INF	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001* (0.055)
OPEN	1.271* (0.054)	1.177* (0.067)	1.597** (0.017)	1.657** (0.047)	1.352* (0.064)	1.715** (0.024)	1.233** (0.039)
DGDP	-1.140*** (0.002)	-1.150*** (0.002)	-1.296*** (0.002)	-1.273*** (0.003)	-1.142*** (0.003)	-1.280*** (0.001)	-0.894** (0.018)
PRIV	-1.037*** (0.002)	-1.012*** (0.002)	-0.959*** (0.004)	-0.900** (0.019)	-1.013*** (0.003)	-0.992*** (0.003)	-0.894*** (0.005)
IQ	1.415*** (0.005)	1.443*** (0.005)	1.605*** (0.002)	1.773*** (0.002)	1.471*** (0.006)	1.696*** (0.002)	0.784 (0.123)
ECI		0.526 (0.629)					
ICT			-0.118 (0.124)				
CO2				-0.670 (0.224)			
POPG					0.110 (0.618)		
HC						-2.311** (0.045)	
FDI							0.072 (0.485)

Cont...

Table 5.2: Regression Results of MFPG_H (Fixed Effect Model)

CONSTANT	-4.011 (0.311)	-4.297 (0.300)	-4.061 (0.295)	0.472 (0.922)	-4.351 (0.309)	-4.178 (0.292)	-2.778 (0.471)
R Squared	0.091	0.089	0.094	0.092	0.089	0.092	0.084
Wald Stat. (P-Values)	10.40 (0.000)	9.61 (0.000)	8.87 (0.000)	9.21 (0.000)	9.28 (0.000)	9.21 (0.000)	6.29 (0.000)
Observations	1,290	1,278	1,290	1,247	1,247	1,247	1,210
Countries	47	47	47	47	47	47	47

Notes: As for Table 5.1. The dependent variable is multi-factor productivity growth, HC adjusted (MFPG_H).

The coefficients on FDI have positive signs in all the regressions. There is a dearth of empirical studies that find a positive significant impact of FDI on productivity growth (see among others Woo, 2009; Amann and Virmani, 2014; Baltabaev, 2014; and Li & Tanna, 2019). Therefore, this evidence is quite in line with the empirical studies that find a positive significant impact of FDI on productivity growth. The coefficients on CO2 emissions, used as an indicator of environmental degradation have negative signs in all specifications of Table D3. The empirical research on the relationship between MFPG and CO2 emissions is not conclusive. Most of the studies find a direct relationship between CO2 emissions and productivity growth. These studies consider it as a by-product of the production of goods. Their understanding is based on the concept that we cannot produce good output without producing bad output or polluting emissions (Amri, 2018).

In all regressions, the coefficients on the initial level of MFPG_H (intended to capture the existence of convergence) are consistently negative and significant at 5% level. Convergence implies a negative correlation between the initial level of MFP and its subsequent growth rate. This is exactly what our data reveal. So, based on these results, we can conclude that there exists evidence of convergence for this set of countries and periods. This in line with the theory; countries that had lower MFPG in 1980 tend to have higher productivity growth rates relative to countries with higher rates of MFPG in 1980 (De Long, 1988; Cameron et al., 2005). It suggests that countries possess their steady-state per capita real GDP to which they are converging. The steady state in each country is conditional upon the state of its economy. For instance, the Solow (1956) growth model considers saving and population growth rates as exogenous and suggest that these two variables are the derivers of steady-state per capita GDP.

The results from Table 5.3 show that the positive effects of INV, FDI, and IQ on MFPG remain stable across different control variables and alternative specifications. Similarly, the negative effects of financial depth, measured by the domestic credit to the private sector as a percentage of GDP and inflation, measured by the consumer prices (annual %) remain stable across different control variables and model specifications.

Model 1 shows the baseline specification. Model 2-9 augments the specification with different control variables, added one by one to check the robustness of the baseline specification. The empirical research regarding the effects of FDI on economic growth is growing rapidly over time. Surprisingly, there are limited cross country empirical studies on the role of FDI in aggregate productivity. Notably, Woo (2009) finds a positive significant effect of FDI and institutions on TFP growth in a large sample of countries. our results are in line with the findings of Woo (2009). Similarly, in the case of domestic investment, our results are consistent with the results of Afzal and Ahmad (2018). Further, our findings are consistent with the results of several prominent empirical studies including Olson et al. (2000), Hall and Jones (1999), Acemoglu et al. (2005), and Nawaz (2015). Our result that inflation harms aggregate productivity is in line with the findings of Fischer (1993), Smyth (1995), Miller and Upadhyay (2000), and Li and Tanna (2019). The result suggests the need to reduce the rate of inflation to achieve higher MFPG.

The regression results in Table 5.4 show that the coefficients on INV and IQ are positive and remain significant at 1% across all estimates. The positive signs and magnitudes of the coefficients of INV illustrate that if investment increases by one % then the MFPG_H raises almost by an equal percentage point per annum. Similarly, the coefficients on IQ remain positive and statistically significant at 1% level of significance in all models (1) through (9) and range from 1.50 to 1.96. The coefficients of financial depth, inflation, and debt to DGP ratio are negative and statistically significant in all regressions; the results are robust to model specifications. We add additional regressors and control variables one by one to check the robustness of our results.

Table 5.3: Regression Results of MFPG (Random Effect Model)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
INV	0.965** (0.033)	0.918** (0.041)	0.967** (0.033)	1.033** (0.023)	0.944** (0.037)	0.986** (0.033)	1.022** (0.032)	1.027** (0.028)	0.953* (0.054)
FDI	0.233** (0.016)	0.256*** (0.007)	0.238** (0.015)	0.237** (0.021)	0.226** (0.018)	0.238** (0.013)	0.238** (0.015)	0.234** (0.019)	0.229** (0.023)
PRIV	-0.598*** (0.002)	-0.550*** (0.006)	-0.595*** (0.002)	-0.590*** (0.002)	-0.569*** (0.007)	-0.585*** (0.003)	-0.598*** (0.002)	-0.593*** (0.002)	-0.607*** (0.001)
INF	-0.001* (0.063)	-0.001* (0.064)	-0.001* (0.064)	-0.001* (0.064)	-0.001* (0.064)	-0.001* (0.062)	-0.001* (0.064)	-0.001* (0.063)	-0.001* (0.063)
IQ	1.307* (0.067)	1.340* (0.054)	1.325* (0.070)	1.331* (0.083)	1.421** (0.044)	1.293* (0.072)	1.331* (0.063)	1.309* (0.081)	1.291* (0.069)
GSIZE		-0.452 (0.107)							
OPEN			-0.045 (0.797)						
HC				0.005 (0.991)					
ECI					-0.145 (0.687)				
ICT						-0.013 (0.779)			
CO2							0.010 (0.876)		
POPG								-0.023 (0.871)	
ADR									-0.093 (0.859)

Cont…

Table 5.3: **Regression Results of MFPG (Random Effect Model)**

CONSTANT	-6.082** (0.027)	-5.090* (0.055)	-5.994** (0.026)	-6.403** (0.029)	-6.444** (0.020)	-5.938** (0.033)	-6.444** (0.021)	-6.244* (0.052)	-5.559 (0.190)
R Squared	0.063	0.070	0.062	0.064	0.063	0.063	0.064	0.064	0.062
Wald Statistics **(P-Values)**	19.02 (0.001)	20.57 (0.002)	19.31 (0.004)	23.33 (0.000)	18.97 (0.004)	19.29 (0.004)	20.78 (0.002)	23.83 (0.000)	23.74 (0.000)
Observations	1,250	1,241	1,250	1,214	1,240	1,250	1,214	1,214	1,250
Countries	47	47	47	47	47	47	47	47	47

Notes: As for Table 5.1.

Table 5.4: Regression Results of MFPG_H (Random Effect Model)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PRIV	-0.621*** (0.000)	-0.592*** (0.000)	-0.638*** (0.000)	-0.657*** (0.000)	-0.570*** (0.000)	-0.651*** (0.000)	-0.551*** (0.001)	-0.611*** (0.000)	-0.578*** (0.000)
INF	-0.000*** (0.002)	-0.001*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.002)	-0.000*** (0.002)	-0.000*** (0.002)	-0.000*** (0.002)	-0.000*** (0.002)
DGDP	-0.666*** (0.000)	-0.729*** (0.001)	-0.763*** (0.000)	-0.651*** (0.002)	-0.676*** (0.000)	-0.627*** (0.002)	-0.724*** (0.001)	-0.673*** (0.001)	-0.694*** (0.001)
IQ	1.863*** (0.000)	1.584*** (0.000)	1.519*** (0.000)	1.509*** (0.003)	1.962*** (0.000)	1.825*** (0.001)	1.861*** (0.000)	1.855*** (0.001)	1.931*** (0.000)
GSIZE		-0.050 (0.853)							
OPEN			0.272 (0.163)						
INV				0.491 (0.308)					
ECI					-0.276 (0.558)				
ICT						0.032 (0.587)			
CO2							-0.065 (0.408)		
POPG								0.006 (0.966)	
ADR									0.372 (0.502)
CONSTANT	-2.837 (0.220)	-1.404 (0.479)	-2.088 (0.283)	-2.806 (0.172)	-3.122 (0.159)	-3.217 (0.175)	-2.144 (0.420)	-2.819 (0.252)	-4.715 (0.148)
R Squared	0.064	0.066	0.069	0.071	0.063	0.064	0.065	0.064	0.066

Cont…

Table 5.4: Regression Results of MFPG_H (Random Effect Model)

Wald Statistics (P-Values)	57.69 (0.000)	52.97 (0.000)	52.57 (0.000)	49.64 (0.000)	61.00 (0.000)	58.47 (0.000)	56.56 (0.000)	57.95 (0.000)	57.88 (0.000)
Observations	1,369	1,294	1,330	1,298	1,357	1,369	1,325	1,325	1,369
Countries	49	47	48	47	49	49	49	49	49

Notes: As for Table 5.1. The dependent variable is multi-factor productivity growth, HC adjusted (MFPG_H).

5.3 Regression Results from Dynamic Analysis

Tables 5.5 through 5.8 use MFPG and MFPG_H as regressands and show the estimates of the DPDM (Difference and System GMM) for different specifications. The results presented in Tables 5.5 through 5.8 exhibit slight variations from the earlier regression results; obtained from the static panel data model of FE and RE. These results do not show a considerable variation in terms of the significance of each determinant and its nature of the relationship with MFPG as well as MFPG_H. Although there are few dissimilarities, notwithstanding this, the dynamic model offers consistent and robust results to model specifications and estimation techniques. Mainly, we focus on the interpretation and explanation of those results that have differences and dissimilarities from what we obtained under the static panel models.

The signs of the coefficients do not indicate any variation; for instance, in both the static and DPDM, the INV and IQ have positive signs of the coefficients throughout the specifications. Similarly, the coefficients of GSIZE, INF, DGDP, and PRIV remain negative and significant. The supplementary information in difference and system GMM is the positive and significant relationship of the lag value of productivity growth to MFPG.

The regression results of MFPG with the difference GMM estimator are displayed in Table 5.5. The results of the baseline model show that IQ has a positive significant impact on MFPG in most of the specifications. In quantitative terms, it is estimated that a one % improvement in the quality of institutions raises the MFPG by around 0.06-0.08 percentage points.

Table 5.5: Regression Results of MFPG (Difference GMM)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MFPG (-1)	0.149*** (0.004)	0.155*** (0.002)	0.157*** (0.003)	0.134*** (0.007)	0.098* (0.071)	0.148*** (0.003)	0.153*** (0.002)
PRIV	-2.330** (0.048)	-1.950* (0.052)	-2.830** (0.015)	-2.495** (0.027)	-3.137** (0.033)	-2.289* (0.051)	-2.662** (0.032)
DGDP	-2.284** (0.036)	-1.823* (0.087)	-2.333** (0.026)	-2.390** (0.038)	-3.214* (0.060)	-1.365 (0.170)	-2.676** (0.031)
INF	-1.197** (0.047)	-1.173** (0.041)	-1.253** (0.039)	-1.339** (0.025)	-0.939 (0.153)	-1.250** (0.034)	-1.376** (0.019)
GSIZE	-6.883*** (0.001)	-6.770*** (0.001)	-6.274*** (0.001)	-7.515*** (0.000)	-6.147*** (0.002)	-6.948*** (0.000)	-6.823*** (0.001)
IQ	6.057 (0.102)	6.211* (0.063)	5.241* (0.093)	4.816 (0.151)	8.203* (0.054)	5.908* (0.100)	4.131 (0.242)
ADR	3.684 (0.299)	6.546 (0.171)	3.065 (0.397)	4.220 (0.256)	2.974 (0.477)	5.310 (0.325)	4.710 (0.301)
HC		4.356 (0.285)					
ECI			-4.569* (0.096)				
OPEN				1.450 (0.461)			
INV					5.029** (0.046)		
CO2						1.549 (0.415)	
POPG							-0.767 (0.410)

Cont…

Table 5.5: Regression Results of MFPG (Difference GMM)

Wald statistics (P-Value)	12.42 0.000	10.84 0.000	9.49 0.000	10.98 0.000	10.76 0.000	10.54 0.000	11.87 0.000
# of instruments	28	32	32	32	16	32	32
Hansen test (P-Value)	0.212	0.365	0.348	0.257	0.464	0.249	0.324
AR 1 test (P-Value)	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
AR 2 test (P-Value)	0.132	0.161	0.174	0.120	0.105	0.137	0.177
Observations	1,213	1,176	1,202	1,208	1,208	1,176	1,176
Countries	47	47	47	47	47	47	47

Notes: As for Table 5.1. MFPG (-1) is the first lag of MFPG. The Wald statistics p-value shows the test on the joint significance of the regressors. The Hansen test evaluates the validity of the instrument (tests for over-identifying restrictions). AR (1) and AR (2) are the Arellano-bond autocorrelation tests of first and second order (the null is no autocorrelation), respectively. All regressions satisfy the F-test for the joint significance of the coefficients and the AR (1) and AR (2) test for first and second order serial correlation.

On the other hand, the government size, inflation, debt to GDP ratio, and financial depth negatively affect the MFPG in developing economies. Model 5 of Table 5.5 shows that the effect of investment is positive and significant, which is as per our prior expectation. Contrarily, model 3 indicates that the estimated coefficient of ECI, used as an indicator of innovation is negative and significant which is not in line with most of the existing empirical literature and theoretical predictions. The effect of other control variables on MFPG is insignificant, albeit their coefficients have the expected signs.

The negative effects of ECI on MFPG might be due to the inability of developing nations to have complementarity between innovation activities (knowledge intensity) and absorption of knowledge. A high domestic capacity for knowledge absorption is required to get the full benefits of innovation and R&D (see Griffith et al., 2003). Hofman and Valderrama (2020) suggest that the educational level of the labor force is one of the important drivers of the competitiveness and absorption capacity of a country. Therefore, developing nations need to enhance their knowledge absorption capacity by equipping their labor force with skills that require quality academic institutions as well as a vocational training institution.

Similarly, the regression results of MFPG_H with the difference GMM estimator are reported in Table 5.6. In this case, the coefficients of IQ have positive signs, but they become insignificant in most of the specifications. However, the sign and significance of other variables such as the government size, inflation, debt to GDP ratio, investment, financial depth, and ECI remain intact and robust to different specification. The negative and significant signs of financial development, inflation, government size, and public debt at least at the 10% level in most of the specifications confirm their harmful effects on HC adjusted MFPG in developing nations.

Table 5.6: Regression Results Of MFPG_H (Difference GMM)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MFPG_H (-1)	0.149** (0.014)	0.154*** (0.010)	0.150** (0.015)	0.154** (0.011)	0.146** (0.021)	0.111* (0.058)	0.136** (0.029)	0.151** (0.014)
PRIV	-3.604*** (0.009)	-2.755** (0.016)	-4.024*** (0.007)	-1.527 (0.200)	-3.538*** (0.005)	-4.436*** (0.004)	-3.599*** (0.007)	-3.991*** (0.006)
DGDP	-4.424*** (0.000)	-3.669*** (0.001)	-3.881*** (0.001)	-4.217*** (0.000)	-4.366*** (0.000)	-5.164*** (0.001)	-3.528*** (0.000)	-4.685*** (0.000)
INF	-1.299* (0.066)	-1.106 (0.103)	-1.388* (0.056)	-1.370** (0.046)	-1.249* (0.082)	-1.074 (0.161)	-1.254* (0.081)	-1.271* (0.073)
GSIZE	-3.734* (0.057)	-3.090* (0.092)	-2.642 (0.150)	-2.979 (0.118)	-3.572* (0.078)	-3.416 (0.128)	-3.302 (0.103)	-3.307 (0.102)
IQ	4.167 (0.304)	6.336* (0.065)	4.577 (0.226)	3.987 (0.240)	3.808 (0.257)	6.205 (0.170)	5.127 (0.176)	4.123 (0.239)
ADR	2.301 (0.581)	4.424 (0.434)	1.688 (0.702)	0.071 (0.989)	2.574 (0.550)	2.547 (0.596)	3.702 (0.590)	2.085 (0.739)
HC		1.439 (0.800)						
ECI			-7.623** (0.030)					
ICT				-0.607 (0.114)				
OPEN					0.376 (0.866)			
INV						5.366*** (0.002)		

Cont…

Table 5.6: Regression Results Of MFPG_H (Difference GMM)

CO2							1.198 (0.623)	
POPG								-0.032 (0.978)
Wald statistics (P-Value)	11.66 0.000	10.21 0.000	8.63 0.000	9.38 0.000	12.20 0.000	13.17 0.000	9.17 0.000	10.97 0.000
# of instruments	28	32	32	32	36	18	32	32
Hansen test (P-Value)	0.299	0.310	0.382	0.197	0.361	0.084	0.344	0.322
AR 1 test (P-Value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR 2 test (P-Value)	0.305	0.330	0.262	0.335	0.306	0.181	0.280	0.326
Observations	1,223	1,180	1,211	1,223	1,218	1,218	1,180	1,180
Countries	47	47	47	47	47	47	47	47

Notes: As for Table 5.1 and Table 5.5. The Dependent Variable is Multi-Factor Productivity Growth, HC Adjusted (MFPG_H). MFPG_H (-1) is the first lag of MFPG_H.

The next step in our analysis is to employ the commonly used System GMM estimator. Tables 5.7 and 5.8 present one step and two-step system GMM regressions on annual data for MFPG and MFPG_H respectively. The regression results of system GMM estimator show that the lag values of MFPG and MFPG_H are positive significant in all specifications. Similarly, the impact of INV and IQ have a positive significant impact on MFPG and MFPG_H in most of the specifications.

Further, in case of one step GMM, we have the positive significant impact of OPEN on MFPG_H and in case of two step GMM, the MTRADE becomes positive and significant. However, as found in case of difference GMM, the effect of financial depth, government size, inflation, and public debt on MFPG and MFPG_H is negative significant in most of the specifications. We add additional regressors or control variables one by one to check the robustness of our results. In case of two step GMM, the DGDP being added in the regression is negative significant at 10% level of significance. We find negative significant relationship between DGDP and MFPG throughout the specifications. Therefore, our results are robust to model specifications and estimation techniques.

The lower panel of Tables 5.7 and 5.8 show the results of several conditions and diagnostic tests being applied such as nature of the autocorrelation in the disturbances and validity of the instruments. The estimates given in Tables 5.7 and 5.8 satisfy the requirements of both tests of the Arellano-Bond (that are, AR1 and AR2). The Hansen tests which is applied to check the validity of the instruments suggests that the lag-structure and instruments are valid for all models reported in Table 5.7 and 5.8.

Table 5.7: Regression Results of MFPG (System GMM)

	System GMM One Step									System GMM Two Step
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(1)
MFPG (-1)	0.168*** (0.003)	0.170*** (0.003)	0.158*** (0.002)	0.168*** (0.005)	0.161*** (0.004)	0.170*** (0.004)	0.157*** (0.008)	0.151*** (0.007)	0.164*** (0.006)	0.187*** (0.001)
PRIV	-2.829** (0.011)	-2.874*** (0.005)	-2.381** (0.023)	-0.934 (0.315)	-3.274*** (0.008)	-2.071** (0.049)	-2.081 (0.150)	-4.637*** (0.000)	-2.590** (0.011)	-3.929*** (0.000)
GSIZE	-5.637*** (0.006)	-5.281*** (0.009)	-5.620*** (0.007)	-5.832*** (0.002)	-5.302*** (0.007)	-6.444*** (0.001)	-6.913*** (0.004)	-7.072*** (0.002)	-5.931*** (0.002)	-5.711** (0.018)
INF	-1.494** (0.021)	-1.408** (0.024)	-1.640** (0.024)	-2.105*** (0.002)	-1.390** (0.026)	-1.799*** (0.002)	-1.860*** (0.004)	-0.888 (0.114)	-1.598*** (0.007)	-0.625 (0.328)
INV	3.250** (0.049)	3.020* (0.061)	4.139** (0.026)	4.239** (0.024)	2.915* (0.063)	3.475** (0.046)	3.930** (0.024)	1.990 (0.380)	3.616** (0.023)	
IQ	5.796** (0.023)	6.670*** (0.006)	6.512* (0.085)	2.928 (0.289)	5.984** (0.014)	4.876** (0.016)	5.023* (0.073)	7.607* (0.070)	5.048* (0.065)	5.529* (0.066)
ECI		-1.520 (0.120)								-1.135 (0.350)
FDI			-0.211 (0.345)							
OPEN					2.289 (0.212)					
ADR						2.153 (0.485)				
CO2							-0.533 (0.496)			
DGDP								-2.107 (0.107)		-1.539* (0.078)
POPG									-0.250 (0.735)	
CONSTANT	-4.767 (0.732)	-7.444 (0.570)	-11.287 (0.532)	7.366 (0.624)	-13.563 (0.387)	-9.974 (0.667)	4.144 (0.793)	6.840 (0.795)	-1.955 (0.898)	13.713 (0.420)
Wald statistics (P-Value)	14.92 0.000	13.44 0.000	16.64 0.000	10.14 0.000	13.15 0.000	11.01 0.000	10.87 0.000	11.74 0.000	12.66 0.000	7.86 0.000

Cont…

Table 5.7: Regression Results of MFPG (System GMM)

# of instruments	25	29	29	29	29	29	29	29	29	36
Hansen test (P-Value)	0.167	0.077	0.120	0.162	0.134	0.258	0.194	0.281	0.196	0.388
AR 1 test (P-Value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR 2 test (P-Value)	0.122	0.161	0.115	0.112	0.162	0.097	0.123	0.148	0.131	0.131
Observations	1,350	1,337	1,261	1,350	1,350	1,350	1,311	1,305	1,311	1,298
Countries	47	47	47	47	47	47	47	47	47	47

Notes: As for Table 5.1 and Table 5.5.

Table 5.8: Regression Results of MFPG_H (System GMM)

	System GMM One Step	System GMM Two Steps
MFPG_H (-1)	0.154*** (0.002)	0.145*** (0.008)
PRIV	-4.267*** (0.003)	-4.214*** (0.000)
GSIZE	-5.123*** (0.007)	-5.048** (0.022)
INF	-1.597** (0.015)	-0.940 (0.198)
OPEN	3.884*** (0.009)	
MTRADE		3.780** (0.031)
ECI	-0.083 (0.955)	
INV	1.081 (0.441)	
ADR	5.196 (0.208)	-0.993 (0.734)
DGDP	-2.505** (0.027)	-1.300* (0.066)
CO2	1.431 (0.230)	
IQ	5.627** (0.018)	4.877* (0.079)
CONSTANT	-22.917 (0.366)	4.609 (0.852)
Wald statistics (P-Value)	11.71 0.000	16.44 0.000
# of instruments	45	41
Hansen test (P-Value)	0.349	0.566
AR 2 test (P-Value)	0.283	0.418
Observations	1,208	1,318
Countries	46	47

Notes: As for Table 5.1 and Table 5.6. MTRADE is the Merchandise Trade (% Of GDP).

5.4 Summary and Conclusion

The regression results show that investment, size of the government, inflation, debt to GDP ratio, financial depth, and institutional quality matter for MFPG. The coefficients on INV and IQ are positive and significant. The coefficients on GSIZE, INF, DGDP, and PRIV are negative and statistically significant in all regressions; the results are robust to model specifications and estimation techniques. Moreover, we find the positive significant impact of OPEN and FDI on productivity growth in some regressions, however, this result is not robust. In sum, we are unable to draw a firm inference regarding the effects of OPEN and FDI on MFPG.

Chapter 6

RESULTS AND DISCUSSION-II

Macroeconomic and Institutional Determinants of MFP Growth: Exploring the Channels and Conditions

6.1 Introduction

In this chapter, we explain results for the direct, indirect, and conditional effects of both the institutions and macroeconomic indicators on MFP growth. The estimation results reported in Tables 6.1 through 6.11 are obtained by employing the SUR[52] method for unbalanced panel data as suggested by Biorn (2004). The regression results are based on unbalanced panel data of 49 developing countries over the period 1980-2017. However, for the construction of our econometric models, the Moderated Mediation approach of Muller et al. (2005) and Preacher et al. (2007) and have been used. The regression results presented in this chapter mainly provide the possible answers to our two research questions. First, whether there exist indirect and conditional effects of macroeconomic and institutional indicators towards productivity growth in developing countries? Second, do these effects remain identical across two different measures of aggregate productivity growth (that are, MFPG and MFPG_H).

Tables 6.1 through 6.11 show the results of SUR method in a default RE setting. Tables E1 through E11 given in Appendix E show the regression results of using 5-year non-overlapping data averages for the period 1980–2016—that is, seven observations (1981–1985, 1986–1990, 1991–1995, 1996–2000, 2000–2005, 2006–2010, and 2011–

[52] SUR is designed to estimate a system of linear equation (with potentially different set of explanatory variables). Like 3SLS, SUR provides more efficient estimates in large samples, since it considers the contemporaneous correlation of the error terms across equations.

2016) for each variable and country. Tables E12 through E22 given in Appendix E portray the results of SUR method in a FE setting (that is, on demeaned data).

To explore the mediating and moderating roles of macroeconomic and institutional variables, we employ the SUR method. we take in to account different mediators (channels) and moderators (conditions). Further, following the standard growth models of Barro (1991) and Barro and Sala-i-Martin (1995) the initial value is included to test the convergence[53] across countries over the period towards a common level of MFP growth. In all cases, the initial MFP remains negative and significant. This explains the convergence phenomenon supported by the previous literature (Barro and Sala-i-Martin 1995).

Generally, the Hausman test is used to assess whether FE or RE is a right choice. It is well documented that both FE and RE have their weaknesses and strengths. Moreover, it is not a matter of debate whether we apply the FE or RE model; because as Mundlak (1978) points out, the selection between FE and RE is "arbitrary and unnecessary". He argues that when the model is properly specified, the RE estimator is identical to the FE estimator. This argument is further supported by him when he says, "there is only one estimator".

Thus, keeping into consideration the arguments of Mundlak (1978) and to check the robustness of our results, we have applied the SUR method in both the FE and RE settings (that is, on demeaned as well as original data). So, the sensitivity of results is checked by an array of sensitivity analyses.

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[53] Lichtenberg (1994) reveals that "putting initial value of dependent variable, as a regressor is a necessary, but not a sufficient condition for convergence. He shows that it is a test of mean reversion and under some assumptions, the rate of convergence is independent of the degree of mean-reversion.

6.2 Results for Direct, Indirect, and Conditional Effects of Public Debt on MFPG: Role of Investment

The regression analysis is based on SUR method for unbalanced panel data as suggested by Biorn (2004). We employ this method on an unbalanced panel data set consisting of 49 developing countries throughout 1980-2016. Like 3SLS, SUR method for unbalanced panel data provides more efficient estimates in large samples, since it considers the contemporaneous correlation of the error terms across equations. It mitigates and controls the biasness arising from unobserved heterogeneity. Further, it is more likely to achieve efficiency in the estimates by applying the SUR method (Biorn, 2004; Baltagi, 2005).

The models (1) and (2) in Table 6.1 illustrates the results of our baseline model. The models (3) and (4) in Table 6.1 exhibits the results of the final model, obtained through estimating equations (4.18) and (4.19) simultaneously, using SUR method as suggested by Biorn (2004). Nevertheless, we demeaned the data and estimate the equations (4.18) and (4.19) simultaneously using SUR. The results of SUR (with FE) are presented in Table E1 given in Appendix E. The results of the baseline model are presented to check the robustness of our results to alternative specifications (that is, final model). We find that the results in our final model are robust and consistent with our benchmark specification. Our results are consistent with the existing empirical literature that has found a negative correlation between debt and MFPG.

Table 6:1 Direct, Indirect and Conditional Effects of Public Debt on MFPG

Dependent Variables INV, MFPG	(1) Baseline Model		(2) Final Model	
	(1) INV	(2) MFPG	(3) INV	(4) MFPG
DGDP	- 0.553*** (0.000)	-1.159*** (0.000)	-0.144*** (0.000)	-9.417*** (0.000)
INV		3.493*** (0.000)		9.728*** (0.000)
DGDP * INV				3.601*** (0.000)
HC				-33.213*** (0.000)
OPEN				7.785*** (0.000)
PRIV				-0.803 (0.277)
GSIZE				-18.054*** (0.000)
INF				-0.003 (0.815)
M2				-9.563*** (0.000)
ECI				0.234 (0.887)
ICT				0.777*** (0.000)
CO2PC				5.067*** (0.000)
ADR				-8.542*** (0.000)
IQ				13.288*** (0.000)
RIR			-0.008*** (0.000)	
RPCGDP			0.571*** (0.000)	
REM			-0.014*** (0.000)	

Indirect Effects of Public Debt on MFPG

	Indirect Effects	95% Confidence Interval	
Investment (Mediator or Channel Variable)	0.076 (0.488)	-0.139	0.292

Cont...

Table 6.1: Direct, Indirect and Conditional Effects of Public Debt on MFPG

Conditional Effects of Public Debt on MFPG

Investment (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of investment (25th percentile)		-6.773*** (0.000)	-8.283	-5.262
Average level of investment (50th percentile)		-7.435*** (0.000)	-9.153	-5.716
High level of investment (75th percentile)		-8.149*** (0.000)	-10.094	-6.204
Observations	1,419	1,419	861	861
Countries	49	49	49	49

Notes: In the first model, the dependent variable is the log of gross fixed capital formation (% of GDP) used as a proxy for investment (INV) while in the second model the dependent variable is multi-factor productivity growth (MFPG). All explanatory variables are in log form except for those which are in growth rates that is, population growth (POPG). DGDP is the debt-to-GDP ratio. DGDP*INV is the interaction of debt-to-GDP ratio and investment. HC is the human capital index based on years of schooling and returns to education. OPEN is the trade openness measured by total trade (% of GDP). PRIV is the domestic credit to private sector (% of GDP). GSIZE is the general government final consumption expenditure (% of GDP). INF is the Inflation as measured by the GDP deflator. M2 is the Broad money (% of GDP). ECI is the Economic Complexity Index. ICT is the information and communications technology. CO2PC is the carbon dioxide emissions (metric tons) per capita. ADR is the age dependency ratio, percentage of working-age population. IQ is the index of institutional quality. RIR is the real interest rate (%). RPCGDP is the real GDP per capita. REM is the personal remittances, received (% of GDP). All regressions include a constant or intercept term, but the results are not reported. The p-values are given in brackets. ***, **, * indicate significance at 1%, 5%, and 10% respectively.

Table 6.1 shows that the direct effects of DGDP on INV and MFPG are negative and significant at 1% level in both the baseline as well as in the final model. The negative sign of the coefficients of DGDP in the final model illustrate that if DGDP increases by one % then the INV and MFPG decrease on average by 0.00144 (that is, 0.144*0.01) and 0.09417 (that is, 9.417*0.01) percentage points per year respectively. Moreover, the regression results indicate that direct effects of HC, GSIZE, M2 and ADR on MFPG are negative and significant, whereas the direct impacts of OPEN, ICT, CO2PC and IQ on MFPG are positive significant at 1% level of significance.

The econometric models and empirical specifications (4.18 through 4.21) layout in chapter 4 allow the mediating and moderating variable INV to have indirect and conditional effects on MFPG. The indirect effects of DGDP on MFPG run via mediating variable as shown in Table 6.1 and Table E12, Appendix E. More specifically, INV acts as mediating as well as moderating[54] variable between DGDP and MFPG. The results of the final model in RE and FE setting (that is, with annual and demeaned annual data respectively) show that the variable of our interest (that is public debt) has a negative and significant relationship with both investment and MFPG in the baseline as well as the final model.

The direct effects of DGDP on MFPG are negative and significant for our sample countries at the 1% significance level (see Table E12). However, the indirect effect is found to be insignificant. We check the signs and significance of the coefficient of DGDP and the coefficient of the interaction term (that is, DGDP*INV or C_DGDP*INV) to interpret the conditional hypothesis. The final model results show that the coefficient of DGDP is negative while the coefficient of the interaction term is positive and significant at the 1% level in all cases (see Table 6.1; Tables E1 and E12, Appendix E). It exhibits that DGDP has a negative significant impact on MFPG and investment conditions at all levels mitigate the negative effect of DGDP on MFPG. So, the reduction in DGDP is necessary for developing nations to provide breathing space to raise INV and hence achieve a higher level of MFPG. The higher DGDP affects the MFPG of developing countries by worsening the macroeconomic environment and key policy variables including the INV. Our results support and validate the stance of "crowding out" and "debt overhang" hypotheses extensively discussed in the literature (Krugman, 1988; Cohen, 1993; Deshpande, 1997; Presbitero, 2012; Kharusi and Ada, 2018).

[54] The conditional effects of moderator at its different levels; low, average and high are measured through 25th, 50th and 75th percentile respectively.

Elbadawi et al. (1997) find that debt burden and obligations of debt service are important factors behind the low level of investment and growth in the developing countries. The negative effect of DGDP on MFPG arises either from "crowding out" or "debt overhang[55]" effects. The former relates to the diversion of resources from public investment to debt services. In general, the crowding-out effect intensifies with a rise in debt to GDP ratio rises. The latter reduces the incentives for governments in low-income countries to carry out some structural and fiscal reforms, since these reforms may deepen the pressures on governments to repay foreign creditors. Similarly, the uncertainty regarding government policies and actions to meet its debt servicing obligations lowers INV and MFPG (Koeda, 2008; Yared, 2019).

It is evident from the results shown in Table 6.1 that an increase in the real interest rate and foreign remittances (REM) reduce the INV while an increase in the real per capita GDP enhances the INV in developing economies. The negative link between REM and INV might be due to the reason that an increase in remittance income encourages the recipient households to reduce work effort and supply less labor. Moreover, remittances are mainly devoted to daily consumption needs and altruistic motives. Another possible channel through which REM lower INV is that the large remittances induce the exchange rate appreciation, which could dampen the investment as a result of a rise in the demand for imports and fall of net exports. An upward movement in the real interest rate raises the opportunity cost of holding money and the cost of borrowing which consequently decreases the level of investment. These findings are in line with a chunk of the empirical literature (see Jorgensen, 1963; Greene and Villanueva, 1991; Chami et al., 2005; Dzeha et al., 2017).

[55] it occurs when debt surpasses the repayment ability of a nation. Krugman (1988) defines it as a situation in which repayment ability falls below the contractual value of debt.

The adverse relationship between the interest rate and investment is fundamentally proposed by the real theory of interest rate - put forward by the well-known classical economists including Ricardo, Marshall, and Pigou. They consider interest rates as a real phenomenon and a reward for the use of capital (price for investment). According to the classical or real theory of interest rate, saving or supply of capital is an increasing function of the rate of interest; as households save their money to earn the interest rate. So, the interest rate is determined by the intersection of the supply of saving and downward sloping investment demand curves in the goods market. On the other hand, according to Keynes's theory of liquidity preference, the rate of interest is purely a monetary phenomenon, which is determined by the intersection of demand and supply of money in the money market. The neoclassical and neo-Keynesian theories of interest rate incorporate both real and monetary sectors to determine the interest rate with the help of demand for and supply of loanable funds and Hicks' IS-LM model respectively.

The empirical evidences on the relationship between the interest rate and investment are ambiguous. Taylor (1999) finds a weak link between real interest rates and investment. Greene and Villanueva (1990) find a negative relationship between the interest rate and investment using the panel data of 23 least developed countries (LDCs) throughout 1975 to 1985. Hyder and Ahmed (2004) observe that the interest rate hurts investment in the case of Pakistan. In contrast, Athukorala (1998) concludes that the interest rate has a positive significant effect on saving and investment in the case of the Indian economy.

Further, the estimation results of the final model show that most of the control variables are significant and carry the expected signs. The results confirm that the negative effects of human capital, government size, money supply, and age dependency ratio on MFPG are indeed relatively large in magnitude and statistically significant.

Similarly, the positive effects of IQ and OPEN on MFPG are also relatively large in magnitude and statistically significant. Further, as expected the impact of ICT on MFPG is positive and significant. Moreover, the initial value remains negative and significant in both the baseline as well as in the final model; estimated through the SUR method using five-year averages data (see Table E1 in Appendix E).

In the final model, all the control variables in the regression of INV are significant at the 1% level. The empirical results suggest a positive and statistically significant relationship between investment and real per capita GDP. On the other hand, we find that an increase in RIR and REM decrease the INV. The RPCGDP has been used extensively in the growth literature as an indicator of economic growth.

A robust positive association between RPCGDP and INV has been established in the vast empirical literature (see Kuznets and Murphy, 1966; Levine and Renelt, 1992; De Long and Summers, 1992; Mankiw et. al., 1992; Madsen, 2002; Bose and Haque, 2005; and Uneze, 2013). For instance, Uneze (2013) suggests that there exists bi-directional causality between economic growth and INV in Sub-Saharan African countries, disregarding whether INV is measured with the gross capital formation or by private fixed capital formation. Nevertheless, Bose and Haque (2005) find unidirectional causality, from economic growth to INV.

6.3 Results for Direct, Indirect, and Conditional Effects of Public Debt on MFPG_H: Role of Investment

The models (3) and (4) of Table 6.2 show that the direct effect of DGDP on INV and MFPG_H are negative and significant at 1% level of significance.This finding is consistent to the number of theoretical and empirical evidences such as Diamond (1965), Amirkhalkhali (2002) and Afonso and Jalles (2013). Contrary to the previous assertion presented in Table 6.1, now the direct impact of HC on MFPG_H are positive significant, while the direct impact of CO2PC on MFPG_H are negative significant. Moreover, we find the positive significant impacts of IQ on MFPG_H. The positive coefficient of IQ indicates that if IQ increases by one % then the MFPG_H increases on average by 0.05026 (that is, 5.026*0.01) percentage points.

The indirect effects of DGDP on MFPG_H run via mediating variable as shown in the Table 6.2 and E13, Appendix E. Unambiguously, INV acts as mediating as well as moderating variable between DGDP and MFPG. The results show that the variable of our interest in this case (that is, DGDP) has a negative and significant direct relationship with both investment and MFPG_H. Nevertheless, in the baseline model, the effect of DGDP on MFPG_H is insignificant with a positive sign.

Table 6.2: Direct, Indirect and Conditional Effects of Public Debt on MFPG_H

Dependent Variables INV, MFPG_H	(1) Baseline Model		(2) Final Model	
	(1) INV	(2) MFPG_H	(3) INV	(4) MFPG_H
DGDP	-0.483*** (0.000)	0.016 (0.692)	-0.077*** (0.000)	-5.272*** (0.000)
INV		-1.981*** (0.000)		-0.992 (0.486)
DGDP*INV				1.293*** (0.000)
HC				3.514** (0.038)
OPEN				0.154 (0.706)
PRIV				-1.982*** (0.000)
GSIZE				-1.228* (0.088)
INF				0.276 (0.563)
M2				-2.722*** (0.000)
CO2PC				-1.036** (0.013)
POPG				-0.482 (0.446)
IQ				5.026*** (0.000)
RIR			0.001 (0.156)	
RPCGDP			0.050*** (0.000)	
REM			0.030*** (0.000)	

Indirect Effects of Public Debt on MFPG_H

Investment (Mediator or Channel Variable)	Indirect Effects	95% Confidence Interval	
	0.076 (0.488)	-0.139	0.292

Conditional Effects of Public Debt on MFPG_H

Investment (Moderator Variable)	Conditional Effects	95% Confidence Interval	
Low level of investment (25th percentile)	-0.954*** (0.000)	-1.347	-0.560
Average level of investment (50th percentile)	-1.080*** (0.000)	-1.541	-0.620
High level of investment (75th percentile)	-1.218*** (0.000)	-1.752	-0.683

	(1)	(2)	(3)	(4)
Observations	1,464	1,464	870	870
Countries	49	49	49	49

Notes: As for Table 6.1.

Moreover, the indirect effect of DGDP on MFPG_H is insignificant while the conditional effects of DGDP on MFPG_H are negative and significant at the 1% significance level in both RE as well as FE setting (see Table 6.2 and Table A.613). Interestingly, when we average our data over five-year intervals (see Table E2 in Appendix E) to mitigate business cycle concerns and endogeneity issues, the initial level of MFP is strongly significant and has the expected negative sign. Moreover, the mediating effect of investment in the relationship between public debt and MFPG which was insignificant in the case of annual data now becomes negative significant. However, the moderating effect of INV turns out to be positive and significant at all level of investment. So, both the direct and indirect effects of public debt on MFPG are negative which confirms the harmful effects of public debt on the productivity growth of developing countries. It is worth mentioning that the adverse impact of public debt on MFPG_H could be lessened by promoting the investment.

In order to interpret the conditional effects, the signs and significance of the coefficient of DGDP and the coefficient of the interaction term (that is, DGDP*INV or C_DGDP*INV) need to be checked. The final model results show that the coefficient of DGDP is negative while the coefficient of the interaction term is positive and significant at the 1% level. It exhibits that DGDP has a negative significant impact on MFPG_H and investment conditions that mitigate the negative effect of DGDP on MFPG_H. So, the reduction in DGDP is necessary for developing nations to provide breathing space to raise INV and hence achieve a higher level of MFPG_H. Our results support and validate the stance of "crowding out" and "debt overhang" hypotheses extensively discussed in the literature (Krugman, 1988; Cohen, 1993; Deshpande, 1997; Presbitero, 2012; Kharusi and Ada, 2018). As said earlier that the negative effects of DGDP on MFPG arises either from "crowding out" or "debt overhang" effects. The former relates to the diversion of resources from public investment to debt services. In general, the crowding-out effect intensifies with a rise in debt to GDP ratio rises. The latter reduces the incentives for governments in low-income countries to carry out some structural and fiscal reforms, since these reforms may deepen the pressures on governments to repay foreign creditors. Similarly, the uncertainty regarding government policies and actions to meet its debt servicing obligations lowers INV and MFPG (Koeda, 2008; Yared, 2019).

6.4 Results for Direct, Indirect, and Conditional Effects of Human Capital on MFPG: Role of Institutions

Table 6.3 depicts the direct, indirect and conditional effects of HC on MFPG. the direct effects of HC on MFPG. We find contradictions regarding the direct effects of HC on MFPG. The model (2) of Table 6.3 shows the positive significant impact of HC on MFPG while in model (4) , the direct impact of HC on MFPG turns out to be negative significant as we add interaction of HC and IQ along with control variables. This finding is consistent to the existing empirical literature as Miller and Upadhyay (2000) also find mixed results of HC on TFP for different specifications and samples. As for as the impact of control variables is concerned, we find positive significant impact of OPEN, PRIV, ICT and CO2PC on MFPG. Moreover, model (4) of Table 6.3 indicates the negative significant effects of M2 and POPG on MFPG.The indirect effects of HC on MFPG via IQ in the default RE setting of SUR are shown in Table 6.3.

Table 6.3: Direct, Indirect and Conditional Effects of Human Capital on MFPG

Dependent Variables	(1) Baseline Model		(2) Final Model	
IQ, MFPG	(1) IQ	(2) MFPG	(3) IQ	(4) MFPG
HC	-2.531*** (0.000)	1.665*** (0.000)	0.345*** (0.000)	-19.903** (0.014)
IQ		1.277*** (0.000)		0.309 (0.773)
HC * IQ				4.200** (0.016)
INV				-0.696 (0.408)
OPEN				2.529*** (0.000)
PRIV				0.797** (0.050)
GOV				-1.029 (0.267)
M2				-4.243*** (0.000)
ECI				1.015 (0.329)
ICT				0.828*** (0.000)
CO2PC				0.891*** (0.000)
POPG				-0.802*** (0.000)
TAXR			0.157*** (0.000)	
Indirect Effects of Human Capital on MFPG				
Institutional Quality (IQ) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		0.107 (0.773)	-0.617	0.830
Conditional Effects of Human Capital on MFPG				
Institutional Quality (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Institutional Quality (25th percentile)		2.669** (0.014)	0.544	4.794
Average level of Institutional Quality (50th percentile)		4.128** (0.014)	0.841	7.416
High level of Institutional Quality (75th percentile)		5.413** (0.014)	1.082	9.744
Observations	1,483	1,483	855	855
Countries	49	49	49	49

Notes: As for Table 6.1. HC*IQ is the interaction of HC and institutional quality. TAXR is the tax revenue as a percentage of GDP.

The mediating effect of IQ in the relationship between HC and MFPG is found to be insignificant. However, we find a positive significant effect of IQ as a moderator in our sample countries irrespective of the level of institutional quality (that is low, average, and high). The magnitudes of the coefficients of the conditional variable (that is, IQ) rise with the increase in the quality of institutions. Our conditional hypotheses concentrate around the signs and significance of the coefficient of HC and the coefficient of the interaction term (that is, HC*IQ or C_HC*IQ). The final model results show that the coefficient of HC is negative and significant while the coefficient of the interaction term is positive and significant at the 5% level. It indicates that HC has a negative significant impact on MFPG, and IQ conditions mitigate the negative effect of HC on MFPG. Our empirical analysis reveals that investment in HC alone is not adequate to achieve a higher level of MFPG; to improve the quality of institutions is an imperative and prerequisite to get benefit from the investment in human capital.

It is important to mention that when we average our data over five-year intervals (see Table E3 in Appendix E) to mitigate business cycle concerns and endogeneity issues, the initial level of MFP is strongly significant and has the expected negative sign. Moreover, the mediating effect of IQ in the relationship between HC and MFPG which was insignificant in case of annual data, now become positive significant. Further, the moderating effect of IQ in the relationship between HC and MFPG remains intact and robust. Interestingly, in all cases, the magnitudes of the coefficients in respect of conditional effects of HC on MFPG rise with the increase in the quality of institutions (that is 25^{th}, 50^{th}, and 75^{th} percentile is used to represent the low, average, and high level of institutional quality respectively).

As mentioned in the methodology section that we demeaned the data to apply the SUR method in FE setting. The indirect and conditional effects of HC on MFPG in FE setting with annual demeaned data (see Table E14 in Appendix E) are positive and significant. The mediating effect of IQ in the relationship between HC and MFPG which was insignificant in the case of annual data becomes positive significant in the case of demeaned annual data. Further, the moderating effect of IQ in the relationship between HC and MFPG remains intact and robust in all cases. In the case of demeaned data (FE setting of SUR), the coefficient on the moderating variable does decrease slightly in comparison but remains positive and significant at all levels of IQ.

Moving towards the effects of other explanatory and control variables on MFPG; we find the significant role of investment, OPEN, government size, inflation, financial development, innovation, ICT, FDI, population growth, and CO2PC in determining the MFPG in developing nations. Our empirical findings are consistent with the theoretical model of Dias and Tebaldi (2012) which shows that better quality of institutions foster HC accumulation and change the productivity and development path by decreasing income inequality. The theoretical model together with empirical findings demonstrates the complementarity of HC and institutions for explaining the development path. Further, the empirical findings of Dias and Tebaldi (2012) suggest that the quality of institutions drives the amount of HC available in the economy.

6.5 Results for Direct, Indirect, and Conditional Effects of Institutional Quality on MFPG: Role of Openness

The direct impact of IQ on MFPG is positive significant in both the baseline as well as final model. The model (4) of Table 6.4 depicts the negative significant effects of HC, PRIV, GSIZE, DGDP and INF while positive significant effects of INV, ECI, POPG and CO2PC on MFPG. The indirect and conditional effects of IQ on MFPG run via OPEN which is being used as a mediating and moderating variable (see Table 6.4;

Tables E4, and E15, Appendix E). Tables 6.4 and E15, Appendix E portray the direct, indirect, and conditional effects of IQ on MFPG in random and FE setting of SUR.

The direct, indirect, and conditional effects of IQ on MFPG using five-year averages data are shown in Table E4. It is evident from the regression results that direct, indirect, and conditional effects of IQ on MFPG in RE and FE setting are positive and significant. So, the positive significant role of OPEN as a mediator as well as a moderator in the relationship between IQ and MFPG remain intact and robust in both cases; whether we apply SUR on equations (4.28) and (4.29) simultaneously in RE or FE setting.

We inspect the signs and significance of the coefficient of IQ and the coefficient of the interaction term (that is, IQ*OPEN or C_IQ*OPEN) to interpret the conditional hypothesis. The results show that the coefficients of IQ as well as interaction terms are positive and significant at the 1% level. It indicates that IQ has a positive significant impact on MFPG, and OPEN conditions strengthen the positive effect of IQ on MFPG. Our results are in concurrence with the empirical studies of Coe and Helpman (1995) and Dollar and Kraay (2003).

Table 6.4: Direct, Indirect and Conditional Effects of Institutional Quality on MFPG

Dependent Variables	(1) Baseline Model		(2) Final Model	
OPEN, MFPG	(1) **OPEN**	(2) **MFPG**	(3) **OPEN**	(4) **MFPG**
IQ	-1.562*** (0.000)	2.372*** (0.000)	0.505*** (0.000)	1.030*** (0.000)
OPEN		0.062*** (0.000)		1.381*** (0.000)
IQ * OPEN				0.250*** (0.000)
HC				-1.800*** (0.000)
PRIV				-0.781*** (0.000)
GSIZE				-3.153*** (0.000)
INV				0.437*** (0.000)
DGDP				-0.257*** (0.000)
INF				-0.526*** (0.000)
ECI				0.728*** (0.000)
POPG				0.081*** (0.000)
CO2PC				1.017*** (0.000)
FDI			0.093** (0.050)	
Indirect Effects of Institutional Quality on MFPG				
Openness (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		0.698*** (0.000)	0.497	0.899
Conditional Effects of Institutional Quality on MFPG				
Openness (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Openness (25th percentile)		2.598*** (0.000)	1.364	3.833
Average level of Openness (50th percentile)		2.792*** (0.000)	1.451	4.134
High level of Openness (75th percentile)		3.009*** (0.000)	1.547	4.471
Observations	1,467	1,467	1,158	1,158
Countries	49	49	49	49

Notes: As for Table 6.1. IQ* OPEN is the interaction of institutional quality and trade openness. FDI is the foreign direct investment, net inflows as a percentage of GDP.

Dollar and Kraay (2003) assert that countries with better institutions tend to trade more and hence grow faster. They argue that both trade and institutions are important to understand the cross-country growth differences because both move together and have a significant joint effect on growth in the very long run. However, OPEN alone has a larger effect on growth in the short run. Similarly, Coe and Helpman (1995) conclude that the OPEN is crucial to achieving a higher level of domestic TFP. The high-quality institutions and good governance drive trade flows and vice versa. The IQ matters for comparative advantage as it influences factor accumulation and technological innovation.

The initial level of MFP in the case of five-year averages data (see Table E5) is used to capture what we called the "catch up" effect or convergence phenomenon supported by the previous literature (Barro and Sala-i-Martin 1995). The initial value remains negative and significant at the 1% level in both the baseline as well as in the final model.

6.6 Results for Direct, Indirect, and Conditional Effects of Institutional Quality on MFPG_H: Role of Openness

Table 6.5 and Table E16 depict the direct, indirect, and conditional effects of IQ on MFPG_H in RE and FE setting of SUR respectively. The direct, indirect, and conditional effects of IQ on MFPG_H using five-year averages data are shown in Table E5. The direct and conditional effects of IQ on MFPG_H are positive and significant in all cases. However, the role of OPEN as a mediator is negative and significant in the case of the RE model, being applied on annual as well as five-year averages data. Whereas, the role of OPEN as moderator is positive and significant in all cases; whether we apply SUR in RE or FE setting.

The model (2) of Table 6.5 shows the positive significant relationship between IQ and MFPG_H. This relationship becomes insignificant when we add interaction of IQ and OPEN along with control variables in the model (4). Similarly, the relationship between OPEN and MFPG_H turns out to be negative significant from positive significant. Model (4) shows that all the control variables are significant with expected signs. For example, the coefficients of PRIV, GSIZE, DGDP, and INF are negative and the coefficients of INV, FDI, ECI, POPG and CO2PC are positive. These results are in line with the existing literature.

The conditional hypotheses concentrate around the signs and significance of the coefficient of IQ and the coefficient of the interaction term (that is, IQ*OPEN or C_IQ*OPEN). The results show that the coefficients of IQ as well as interaction terms are positive and significant at the 1% level. It indicates that IQ has a positive significant impact on MFPG, and OPEN conditions strengthen the positive effect of IQ on MFPG. Our results are in concurrence with the empirical studies of Coe and Helpman (1995) and Dollar and Kraay (2003). Dollar and Kraay (2003) assert that countries with better institutions tend to trade more and hence grow faster.

They argue that both trade and institutions are important to understand the cross-country growth differences because both move together and have a significant joint effect on growth in the very long run. However, OPEN alone has a larger effect on growth in the short run. Similarly, Coe and Helpman (1995) conclude that the OPEN of the economy is crucial to achieving a higher level of domestic TFP.

Table 6.5: Direct, Indirect and Conditional Effects of Institutional Quality on MFPG_H

Dependent Variables	(1) Baseline Model		(2) Final Model	
OPEN, MFPG_H	(1) **OPEN**	(2) **MFPG_H**	(3) **OPEN**	(4) **MFPG_H**
IQ	-2.316*** (0.000)	3.290*** (0.000)	0.794*** (0.000)	0.010 (0.884)
OPEN		0.051*** (0.001)		-0.366*** (0.000)
IQ*OPEN				0.447*** (0.000)
PRIV				-1.145*** (0.000)
GSIZE				-2.340*** (0.000)
INV				1.341*** (0.000)
DGDP				-0.566*** (0.000)
INF_CPI				-0.326*** (0.000)
FDI			0.086* (0.075)	0.047*** (0.000)
ECI				2.802*** (0.000)
POPG				0.547*** (0.000)
CO2PC				0.277*** (0.000)
Indirect Effects of Institutional Quality on MFPG_H				
Openness (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-0.291*** (0.000)	0.497	0.899
Conditional Effects of Institutional Quality on MFPG_H				
Openness (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Openness (25th percentile)		5.059*** (0.000)	4.052	6.067
Average level of Openness (50th percentile)		5.605*** (0.000)	4.480	7.729
High level of Openness (75th percentile)		6.215*** (0.000)	4.959	7.470
Observations	1,523	1,523	1,160	1,160
Countries	49	49	49	49

Notes: As for Table 6.1. IQ* OPEN is the interaction of institutional quality and trade openness. FDI is the foreign direct investment, net inflows as a percentage of GDP.

The high-quality institutions and good governance drive trade flows and vice versa. The IQ matters for comparative advantage as it influences factor accumulation and technological innovation. The initial level of MFP in the case of five-year averages data (see Table E4) is used to capture what we called the "catch up" effect or convergence phenomenon supported by the previous literature (Barro and Sala-i-Martin 1995). The initial value remains negative and significant at the 1% level in both the baseline as well as in the final model.

6.7 Results for Direct, Indirect, and Conditional Effects of Openness on MFPG: Role of Institutions

Model (2) of Table 6.6 indicates the negative significant direct impacts of OPEN and IQ on MFPG. These impacts become other way around in case of model (4). As expected, the direct impacts of PRIV, GSIZE, DGDP, and INF are negative significant while the direct effects of INV, ECI, CO2, and POPG on MFPG are positive significant. The regression results presented in Table 6.6 show the indirect effects of OPEN on MFPG via the quality of institutions in a RE setting of the SUR method. The results of our baseline model show that the variable of our interest in this case (that is, OPEN) has a negative and significant relationship with IQ while it has a positive and significant relationship with MFPG. However, this relationship becomes the other way around in the case of the final model where we have included the interaction of OPEN and IQ along with other control variables.

Table 6.6: Direct, Indirect and Conditional Effects of Openness on MFPG

Dependent Variables	(1) Baseline Model		(2) Final Model	
IQ, MFPG	(1) IQ	(2) MFPG	(3) IQ	(4) MFPG
OPEN	-3.233*** (0.000)	0.122*** (0.000)	0.170*** (0.000)	-1.485* (0.100)
IQ		3.824*** (0.000)		-1.239*** (0.008)
OPEN * IQ				0.604*** (0.001)
HC				-0.109 (0.916)
PRIV				-1.517*** (0.000)
GSIZE				-1.635*** (0.000)
INV				2.413*** (0.000)
DGDP				-0.864*** (0.000)
INF				-1.152*** (0.002)
ECI				2.511*** (0.004)
CO2				0.211* (0.096)
POPG				0.796*** (0.000)
FDI			0.031*** (0.000)	
Indirect Effects of Openness on MFPG				
Institutional Quality (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-0.211** (0.010)	-0.371	-0.051
Conditional Effects of Openness on MFPG				
Institutional Quality (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Institutional Quality (25th percentile)		1.340** (0.002)	0.497	2.183
Average level of Institutional Quality (50th percentile)		1.499** (0.002)	0.562	2.435
High level of Institutional Quality (75th percentile)		1.675** (0.002)	0.634	2.716
Observations	1,467	1,467	1,159	1,159
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN * IQ is the interaction of trade openness and institutional quality. FDI is the foreign direct investment, net inflows as percentage of GDP.

It is important to note that the relationship between FDI and IQ is positive and significant in the regression of IQ, where it is included as a control variable, following Dang (2013) and Demir (2016). FDI may affect the IQ of host countries via technology, skills, and management know-how spillovers. All the control variables in the regression of MFPG are significant except the human capital. The coefficients of PRIV, GSIZE, DGDP, and INF are negative and significant at the 1% level while the coefficients of INV, ECI, POPG, and CO2 are positive and significant. The conditional hypotheses concentrate on the signs and significance of the coefficient of OPEN and the coefficient of the interaction term (that is, OPEN * IQ). The final model results show that the coefficient of OPEN is negative and significant at the 10% while the coefficient of the interaction term is positive and significant at the 1% level. It exhibits that OPEN has a negative significant impact on MFPG and IQ conditions lessen the negative effect of OPEN on MFPG. So, developing nations need to improve the quality of their institutions for attenuating the negative effects of OPEN on MFPG.

The mediating and moderating effects of IQ in the relationship between OPEN and MFPG are presented in the lower panel of Table 6.6. The indirect effects of OPEN on MFPG are negative and significant for our sample countries at the 5% significance level. The conditional effects are positive and significant at all levels of IQ. The association between OPEN and MFPG is strengthened as we improve the level of IQ in developing countries.

As mentioned earlier that we demeaned the data to apply the SUR method in a FE setting. The indirect and conditional effects of OPEN on MFPG via quality of institutions in FE settings are presented in Table E17. In this case, both the indirect and conditional effects of OPEN on MFPG via the quality of institutions are positive and significant. As for as the moderating effects of IQ in the relationship between OPEN and MFPG are concerned; once again, the coefficient of openness (that is, C_OPEN) is negative and significant while the coefficient of the interaction term (C_OPEN*IQ) is positive and significant at the 1% level. It reveals that OPEN has a negative significant impact on MFPG and IQ conditions lessen the negative effect of OPEN on MFPG. So, developing nations need to improve the quality of their institutions to mitigate the negative effects of OPEN on MFPG. To capture the convergence phenomenon, we add the initial level of MFP in the case of five-year averages data (see Table E6). The initial value remains negative and significant at the 1% level in both the baseline as well as in the final model.

6.8 Results for Direct, Indirect, and Conditional Effects of Openness on MFPG_H: Role of Institutions

Table 6.7 and Table E18 show the direct, indirect, and conditional effects of OPEN on MFPG_H in RE and FE setting of SUR respectively. The direct relationship between OPEN and IQ remains positive significant in both the baseline and final model. Model (3) shows that all the control variables are significant, and signs of the coefficients are as per our expectations. Model (4) indicates that the direct impact of OPEN on MFPG_H is negative significant. We find the positive significant direct impact of INV, POPG and CO2, while the negative significant effects of DGDP, PRIV, INF, and M2 on MFPG_H.

Table 6.7: **Direct, Indirect and Conditional Effects of Openness on MFPG_H**

Dependent Variables	(1) Baseline Model		(2) Final Model	
IQ, MFPG_H	(1) **IQ**	(2) **MFPG_H**	(3) **IQ**	(4) **MFPG_H**
OPEN	0.078*** (0.000)	0.528*** (0.000)	0.096*** (0.000)	-6.257*** (0.000)
IQ		1.007*** (0.000)		-1.053*** (0.000)
OPEN*IQ				2.053*** (0.000)
DGDP				-0.664*** (0.000)
PRIV				-0.540*** (0.000)
INF				-0.576*** (0.000)
M2				-3.257*** (0.000)
INV				1.912*** (0.000)
POPG				1.286*** (0.000)
CO2				1.073*** (0.000)
GSIZE			0.070*** (0.000)	
ICT			0.005*** (0.000)	
GDPG			0.039*** (0.000)	
Indirect Effects of Openness on MFPG_H				
Institutional Quality (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-0.100*** (0.000)	-0.142	-0.060
Conditional Effects of Openness on MFPG_H				
Institutional Quality (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Institutional Quality (25th percentile)		2.860*** (0.000)	2.416	3.303
Average level of Institutional Quality (50th percentile)		3.162*** (0.000)	2.672	3.652
High level of Institutional Quality (75th percentile)		3.499*** (0.000)	2.957	4.041
Observations	1,526	1,526	1,269	1,269
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN * IQ is the interaction of trade openness and institutional quality. FDI is the foreign direct investment, net inflows as a percentage of GDP.

The direct, indirect, and conditional effects of OPEN on MFPG_H using five-year averages data are shown in Table E7. In the case of the RE setting of SUR, the results of our baseline model show that the variable of our interest in this case (that is, OPEN) has a positive and significant direct relationship with both IQ and MFPG_H. The relationship between OPEN and MFPG_H becomes negative and significant in the case of the final model where we have included the interaction of OPEN and IQ along with other control variables. In the case of FE setting of SUR, the results of our baseline model indicate that OPEN has a negative and significant direct relationship with both IQ and positive significance with MFPG_H. Nevertheless, these relationships become the other way around in the case of the final model.

It is important to state that in the case of FE setting the relationship between FDI and IQ is positive and significant in the regression of IQ, where it is included as a control variable, following Dang (2013) and Demir (2016). FDI may affect the IQ of host countries via technology, skills, and management know-how spillovers. Contrary to the previous case, now the direct relationship between HC and IQ has become positive and significant. This finding is consistent with most of the theoretical and empirical literature. Theoretically, higher quality of institutions fosters HC accumulation, reduce income inequality, and thereof change the development path of nations (Dias and Tebaldi, 2012). Further, all the control variables in the regression of MFPG_H are significant. The coefficients of PRIV, GSIZE, DGDP, and INF are negative and significant at the 1% level while the coefficients of INV, POPG, and MTRADE are positive and significant.

We check the signs and significance of the coefficient of OPEN and the coefficient of the interaction term (that is, OPEN*IQ or C_OPEN*IQ) to finalize the conditional effects. The final model results show that in all cases the coefficient of OPEN is negative and significant at the 1% while the coefficient of the interaction term is positive and significant at the 1% level. It exhibits that OPEN has a negative significant impact on MFPG and IQ conditions lessen the negative effect of OPEN on MFPG. So, developing nations need to improve the quality of their institutions for attenuating the negative effects of OPEN on MFPG_H.

In the case of FE setting, both the indirect and conditional effects of trade OPEN on MFPG_H via the quality of institutions are positive and significant. On the other hand, in the case of RE setting of SUR, the conditional effects of OPEN on MFPG_H via the quality of institutions are positive and significant, whereas the indirect effect is insignificant. It is important to note that when we convert the data into five years averages to capture the business cycle and transitional dynamics effects, the indirect effect of OPEN on MFPG_H, which was insignificant becomes significant. To capture the convergence phenomenon, we add the initial level of MFP in the case of five-year averages data (see Table E7). The initial value remains negative and significant at the 1% level in both the baseline as well as in the final model.

6.9 Results for Direct, Indirect, and Conditional Effects of Investment on MFPG: Role of Public Debt

The models (1) and (2) in Table 6.8 display the results of our baseline model, whereas models (3) and (4) in Table 6.8 illustrate the results of final model. Nevertheless, we demeaned the data and estimate the equations (4.38) and (4.39) simultaneously using SUR. The results of SUR (with FE) are presented in the Table E19 given in the Appendix E. The regression results illustrate that INV is positively related to MFPG while it has a negative significant direct relationship with DGDP.

The results of baseline model are presented to check the robustness of our results to alternative specification (that is, final model). We find that the results in our final model are robust and consistent with our benchmark specification. Our results are in line to the existing empirical literature that has found a positive significant relationship between investment and MFPG and negative significant relationship between investment and public debt. The econometric models and empirical specifications (4.38 through 4.42) lay out in chapter 4 allow mediating and moderating variable (DGDP) to have indirect and conditional effects on MFPG.

The indirect effects of investment (INV) on MFPG run via mediating variable (that is, DGDP) as shown in the Table 6.8, Table E8 and Table E19. The results of final model in RE and FE setting (that is, with annual and demeaned annual data respectively) show that the variable of our interest (that is, INV) has a positive and significant relationship with MFPG while negative and significant relationship with DGDP in both the baseline as well as final model.

Table 6.8: Direct, Indirect and Conditional Effects of Investment on MFPG

Dependent Variables	(1) Baseline Model		(2) Final Model	
DGDP, MFPG	(1) DGDP	(2) MFPG	(3) DGDP	(4) MFPG
INV	-0.470*** (0.000)	2.079*** (0.000)	-0.354*** (0.000)	2.350*** (0.000)
DGDP		-0.212*** (0.000)		-3.695*** (0.000)
INV * DGDP				0.924*** (0.000)
HC				-1.895*** (0.005)
OPEN				-7.395*** (0.000)
PRIV				1.883*** (0.000)
GSIZE				-3.954*** (0.000)
IQ				1.997*** (0.000)
M2				-7.870*** (0.000)
ICT				0.017 (0.715)
ECI				1.279*** (0.003)
CO2PC				3.468*** (0.000)
POPG				3.250*** (0.000)
MTRADE				13.684*** (0.000)
GDPG			-0.030*** (0.000)	
Indirect Effects of Investment on MFPG				
Public Debt (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		1.306*** (0.000)	1.024	1.588
Conditional Effects of Investment on MFPG				
Public Debt (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Public Debt (25th percentile)		-2.073*** (0.000)	-2.775	-1.371
Average level of Public Debt (50th percentile)		-2.490*** (0.000)	-3.306	-1.673
High level of Public Debt (75th percentile)		-2.939*** (0.000)	-3.879	-1.999
Observations	1,419	1,419	1,254	1,254
Countries	49	49	49	49

Notes: As for Table 6.1. INV* DGDP is the interaction of investment and debt-to-GDP ratio. MTRADE is the merchandise trade (% of GDP). GDPG is the GDP growth, used to measure economic growth.

In case of RE setting of SUR, the direct, indirect effects of INV on MFPG are positive and significant whereas the conditional effects are negative and significant for our sample countries at the 1% significance level (see Table 6.8). In case of FE setting of SUR, all the direct, indirect and conditional effects are positive and significant (see Table E19). The signs and significance of the coefficient of DGDP and the coefficient of interaction term (that is, INV* DGDP or C_ INV* DGDP) provide us the outcome of our conditional hypotheses. The final model results show that the coefficient of INV is positive while the coefficient of interaction term is negative and significant at the 1% level in all cases (see Table 6.8, Table E8 and Table E19). It exhibits that INV has a positive significant impact on MFPG and public debt conditions mitigate the positive effect of INV on MFPG. So, the reduction in DGDP is necessary for developing nations to provide breathing space to raise INV and hence achieve higher level of MFPG. The higher DGDP effects the MFPG of developing countries by worsening the macroeconomic environment and key policy variables including the gross fixed capital formation. Our results support and validate the stance of "crowding out" and "debt overhang" hypotheses extensively discussed in the literature (Krugman, 1988; Cohen, 1993; Deshpande, 1997; Presbitero, 2012; Kharusi and Ada, 2018).

Elbadawi et al. (1997) finds that debt burden and obligations of debt service are important factors behind the low level of investment and growth in the developing countries. The negative effects of DGDP on MFPG arises either from "crowding out" or "debt overhang[56]" effects. The former relates to the diversion of resources from public investment to debt services. In general, the crowding-out effect intensifies with a rise in debt to GDP ratio rises. The later reduces the incentives for governments in

[56] it occurs when debt surpasses the repayment ability of a nation. Krugman (1988) defines it as a situation in which repayment ability falls below the contractual value of debt.

low-income countries to carry out some structural and fiscal reforms, since these reforms may deepen the pressures on governments to repay foreign creditors. Similarly, the uncertainty regarding government policies and actions to meet its debt servicing obligations lowers INV and MFPG (Koeda, 2008; Yared, 2019).

It is evident from the results shown in Table 6.8, Table E8 and Table E19 that there exists an inverse relationship between economic growth and public debt. So, an increase in the DGDP hampers the economic growth of developing economies. Further, the estimation results of the final model show that almost all the control variables are significant and carry the expected signs. In case of the RE setting of SUR, the results confirm the direct negative impact of HC, OPEN, GSIZE, and M2 whereas the positive effect of IQ, PRIV, ECI, POPG, and MTRADE on MFPG. Further, the coefficient of ICT is positive but not significant in this case.

It is pertinent to mention that when we apply the SUR method in FE setting as suggested by Hausman test the direct impact of HC and OPEN on MFPG turn out to be positive and significant. However, POPG becomes insignificant and the impact of PRIV on MFPG changes from positive to negative. Most importantly, the sign and significance of other control variables such as IQ, GSIZE, M2, ECI and CO2PC remain intact and robust in both cases.

In case of five-year averages data, the direct impact of HC on MFPG is insignificant; however, the FDI turns out to be positive and significant and the coefficient of ICT which was though positive but not significant in case of annual observations now becomes significant. There are number of empirical studies that find similar results. For example, Miller and Upadhyay (2000) find that by improving the terms of trade and lowering the real value of the domestic currency OPEN benefits TFP. Moreover, the contribution of HC towards TFP is positive and significant but not in all specifications. Similarly, Rath and Parida (2014) find that the impact of HC and OPEN on TFP of South Asian countries is positive and significant. However, the impact of HC on TFP is relatively weaker than the impact of OPEN. In the same line of analysis, Soderbom and Teal (2003) analyze the impact of OPEN and HC on Productivity Growth of 93 countries using static and dynamic methods of panel data and conclude that OPEN causes TFPG, but HC does not play any significant role in productivity growth.

Following the economic growth literature, the initial value is included to test the convergence across countries over the period towards a common level of MFP growth. The initial value remains negative and significant in both the baseline as well as in the final model; estimated through SUR method using five-year averages data (see Table E8 in the Appendix E). This explains convergence phenomenon supported by the previous literature (Barro and Sala-i-Martin, 1995). Further, it indicates that there is tendency for poor developing economies to grow faster on average than their relatively rich counterparts.

6.10 Results for Direct, Indirect, and Conditional Effects of Investment on MFPG_H: Role of Public Debt

The Table 6.9 shows the results of SUR method in RE setting. As expected, there is a negative significant relationship between INV and DGDP. Surprisingly, we also find a negative significant relationship between INV and MFPG_H. However, it important to note that when we use five years averages of data to mitigate business cycle concerns and endogeneity issues (see Table E9), the direct relationship between INV and MFPG_H turns out to be positive significant. Similarly, in case of FE setting of SUR method (see Table E20) the direct impact of INV on MFPG_H is positive significant at

1%. Table E9 shows the indirect and conditional effects of investment (INV) on MFPG_H obtained through using five-year averages of data.

The results of FE show that INV has a positive and significant relationship with MFPG_H while negative and significant relationship with DGDP in both the baseline as well as final model. In case of RE setting of SUR, the indirect effects of INV on MFPG_H are positive and significant whereas the direct and conditional effects are negative and significant for our sample countries at the 1% significance level. In case of five-year averages, we find positive significant direct effect of INV on both DGDP and MFPG_H. However, the indirect and conditional effects in this case are negative and significant irrespective of the level of public debt.

It is evident from the results shown in Table 6.9, Table E9 and Table E20 that there exists an inverse relationship between GDP growth and public debt. So, an increase in the DGDP hampers the economic growth of developing economies. Further, the estimation results of the final model show that almost all the control variables are significant and carry the expected signs. In case of the RE setting of SUR, the results confirm that the DGDP, OPEN, GSIZE, M2 and INF have negative significant effect on MFPG_H whereas the IQ, PRIV, ECI, POPG, CO2PC and MTRADE have positive significant effect on MFPG_H in developing countries.

Table 6.9: Direct, Indirect and Conditional Effects of Investment on MFPG_H

Dependent Variables	(1) Baseline Model		(2) Final Model	
DGDP, MFPG_H	**(1) DGDP**	**(2) MFPG_H**	**(3) DGDP**	**(4) MFPG_H**
INV	-0.640*** (0.000)	-5.268*** (0.000)	-0.563*** (0.000)	-1.053*** (0.000)
DGDP		-1.184*** (0.000)		-3.862*** (0.000)
INV*DGDP		1.618*** (0.000)		1.109*** (0.000)
OPEN				-5.822*** (0.000)
PRIV				1.467*** (0.000)
GSIZE			0.616*** (0.000)	-0.543*** (0.000)
M2				-4.999*** (0.000)
ECI				1.638*** (0.000)
MTRADE				8.144*** (0.000)
INF				-0.000 (0.713)
CO2PC				0.563*** (0.000)
POPG				1.865*** (0.000)
IQ				3.065*** (0.000)
GDPG			-0.028** (0.027)	
Indirect Effects of Investment on MFPG_H				
		Indirect Effects	**95% Confidence Interval**	
Public Debt (Mediator or Channel Variable)		2.173*** (0.000)	1.236	3.111
Conditional Effects of Investment on Human MFPG_H				
Public Debt (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Public Debt (25th percentile)		-4.281*** (0.000)	-6.115	-2.446
Average level of Public Debt (50th percentile)		-5.076*** (0.000)	-7.253	-2.900
High level of Public Debt (75th percentile)		-5.934*** (0.000)	-8.479	-3.390
Observations	1,464	1,464	1,255	1,255
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN * IQ is the interaction of trade openness and institutional quality. FDI is the foreign direct investment, net inflows as a percentage of GDP.

It is important to mention that when we apply the SUR method in FE setting as suggested by Hausman test the direct impact of OPEN on MFPG turn out to be positive and significant and PRIV becomes negative and significant. Most importantly, the sign and significance of other control variables such as IQ, GSIZE, M2, ECI, POPG and CO2PC remain intact and robust in both cases. The coefficient on INF does decrease from -1.812 to -0.000 though remains negative but becomes insignificant in case of FE. However, in case of five-year averages, the direct impact of INF on MFPG_H is negative and significant at 1 % level with coefficient of -0.927. Similarly, the ICT turns out to be positive and significant. Moreover, we find that in this case both the PRIV and OPEN are inversely related to MFPG_H.

The empirical relationship between inflation and MFP growth has been extensively examined by the economists in the last few decades (see Fischer, 1993; Smyth, 1995; Freeman and Yerger, 1998; Miller and Upadhyay, 2000; Kiley, 2003; Christopoulos and Tsionas, 2005; Bitros & Panas, 2006; Narayan and Smyth, 2009; and Li and Tanna, 2019). In generally, the empirical results are contradictory. For example, Using SUR methodology on time series data, Smyth (1995) finds a strong inverse relationship between inflation and MFP growth in case of the United States. In a response to Smyth (1995), Freeman and Yerger (1998) advocate the minor or negligible impact of inflation on MFP growth by employing the Granger causality' tests on the same data. So, our results regarding the effect of INF on productivity growth are largely consistent with the existing empirical literature. As mentioned before that we find the positive and significant impact of ICT on MFPG_H. This finding corroborates the empirical studies of Jorgenson (2000) and Timmer and Ark (2005) that find the positive significant impact of ICT on TFP.

The initial value remains negative and significant at 1% level in both the baseline as well as in the final model; estimated through SUR method using five-year averages data (see Table E9 in the Appendix E). This explains convergence phenomenon supported by the previous literature (Barro and Sala-i-Martin 1995). Further, it indicates that there is tendency for poor developing economies to grow faster on average than their relatively rich counterparts.

6.11 Results for Direct, Indirect, and Conditional Effects of Openness on MFPG: Role of Innovation

Table 6.10 shows that the direct effect of OPEN on MFPG is positive significant in both the baseline as well as final model. However, the direct relationship between OPEN and ECI is negative significant in both cases. It may be because more open economies do not concentrate much on innovations. By getting the advantages of OPEN, the open economies easily get new technologies developed elsewhere through imitation. Table 6.10 shows the indirect effects of OPEN on MFPG via ECI in RE setting of SUR method. Similarly, Table E21 portrays the indirect effects of OPEN on MFPG via ECI in FE setting of SUR method. The results of our baseline model and final model in case of RE show that the variable of our interest (that is, OPEN) has a negative and significant relationship with innovation, measured by ECI. On the other hand, it has a positive and significant relationship with MFPG in baseline as well as in final model.

Table 6.10: Direct, Indirect and Conditional Effects of Openness on MFPG: Role of Innovation

Dependent Variables ECI, MFPG	(1) Baseline Model		(2) Final Model	
	(1) ECI	**(2) MFPG**	**(3) ECI**	**(4) MFPG**
OPEN	-0.274*** (0.000)	1.059*** (0.000)	-0.203*** (0.000)	0.637*** (0.000)
ECI		2.010*** (0.000)		-0.731*** (0.000)
OPEN * ECI				0.221*** (0.000)
HC			1.311*** (0.000)	-1.612*** (0.000)
GSIZE				-1.438*** (0.000)
INV				1.893*** (0.000)
DGDP				-0.814*** (0.000)
M2				-1.014*** (0.000)
INF				-0.887*** (0.000)
IQ				1.598*** (0.000)
ICT			0.025* (0.065)	0.049*** (0.000)
POPG				0.111*** (0.000)
Indirect Effects of Openness on MFPG				
		Indirect Effects	**95% Confidence Interval**	
ECI (Mediator or Channel Variable)		0.148*** (0.000)	0.072	0.225
Conditional Effects of Openness on MFPG				
ECI (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Innovation (25th percentile)		0.027*** (0.004)	0.009	0.045
Average level of Innovation (50th percentile)		-0.013** (0.024)	-0.023	-0.002
High level of Innovation (75th percentile)		-0.046*** (0.000)	-0.070	-0.023
Observations	1,540	1,540	1,267	1,267
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN*ECI is the interaction of trade openness and innovation capacity.

It is important to note that ECI is positively and significantly related to HC and ICT in the regression of ECI, where these variables are included as a control variable. Most importantly, all the control variables in regression of MFPG are significant. The coefficients of HC, GSIZE, DGDP, M2 and INF are negative and significant at the 1% level while the coefficients of INV, IQ, ICT and POPG are positive and significant at the 1% level.

The conditional hypothesis is based on the signs and significance of the coefficient of OPEN and the coefficient of interaction term (that is, OPEN * ECI). The final model results show that the coefficients of both the OPEN and the interaction term are positive and significant at the 1%. It exhibits that OPEN has a positive significant impact on MFPG and innovation conditions strengthen the positive effect of OPEN on MFPG. The mediating and moderating effects of ECI in the relationship between OPEN and MFPG are presented in the lower panel of the Table 6.10. The indirect effects of OPEN on MFPG are positive and significant for our sample countries at the 1% significance level.

It is important to note that the conditional effects are positive and significant at low level of ECI while negative and significant at average and high level of ECI. So, the moderating role of innovation in the relationship between OPEN and MFPG is positive and significant up to a certain minimum threshold level. This is primarily due to the fact that in general, the countries with low level of innovation capacity and latecomers may have more potential for MFPG; they have lower effective costs in devising new products as their growth is driven by imitation (Gerschenkron, 1962; Howitt, 2000; and Madsen et al., 2010). Further, imports of capital-intensive products, machinery and allied equipments may help the developing countries to enhance their innovative capacity and, hence, to accelerate MFPG. Nevertheless, technologically backwardness not necessarily implies higher growth potentials and capacities because the imitators are required to spend more time and energies to master the new technologies that are developed elsewhere. By solely relying on tacit knowledge, the imitators need to improve the absorptive capacity of their domestic labor force. The developing nations need to provide the adequate training to their factory workers, technicians, engineers, and managers so that they can easily adapt new technologies devised by the developed countries (Hobday, 2003; and Howitt, 2005). By adapting the new technologies, the countries lacking in new technologies and innovation may be able to obtain economies of scale via leapfrogging over the early stages of growth and development (Gerschenkron, 1962).

As indicated before that the indirect effects of OPEN on MFPG via innovation in FE setting are presented in the Table E21. In this case, indirect and effects of OPEN on MFPG via ECI are positive and significant. As for as the moderating effects of ECI in the relationship between OPEN and MFPG are concerned; the coefficient of openness in final model (that is, C_OPEN) is negative and significant while the coefficient of interaction term (C_OPEN*ECI) is positive and significant at the 1% level. It reveals that OPEN has a negative significant impact on MFPG and innovation conditions at low and average levels lessen the negative effect of OPEN on MFPG.

It is important to note that, at higher level of innovation capacity (that is 75th percentile) the negative effect of OPEN on MFPG tends to increase. It may be due to the fact that countries with higher innovation capacity do not need further OPEN to enhance their level of innovation, as they have achieved the required threshold level of OPEN. So, it is important for developing nations with low and average innovation capacity to move towards free trade. However, it is crucial for them to improve their absorptive capacity in order to harvest the full benefit of OPEN. To capture the convergence phenomenon, we add the initial level of MFP in case of five-year averages data (see Table E10). The initial value remains negative and significant at the 1% level in both the baseline as well as in the final model.

6.12 Results for Direct, Indirect, and Conditional Effects of Openness on MFPG_H: Role of Innovation

The indirect effects of OPEN on MFPG_H run via mediating variable as shown in the Table 6.11. Unambiguously, innovation measured by the economic complexity index acts as mediating variable between OPEN and MFPG. The results of RE and FE setting of SUR method are presented in Table 6.11 and Table E22 respectively. Table E11 shows the indirect effects of OPEN on MFPG_H obtained through using five-year averages of data.

The results of final model in all cases show that the variable of our interest in this case (that is, OPEN) has a negative and significant direct relationship with MFPG_H. However, the indirect effects of OPEN on MFPG_H are positive and significant at the 1% significance level in both cases whether we use SUR method in RE or FE setting (see Table 6.11 and Table A.622). However, the mediating effect of OPEN turn out to be negative significant in case of five-year averages data.

Table 6.11: Direct, Indirect and Conditional Effects of Openness on MFPG_H: Role of Innovation

Dependent Variables	(1) Baseline Model		(2) Final Model	
ECI, MFPG_H	(1) ECI	(2) MFPG_H	(3) ECI	(4) MFPG_H
OPEN	-0.073*** (0.000)	0.739*** (0.000)	-0.341*** (0.000)	-4.019*** (0.000)
ECI		-3.102*** (0.000)		-6.085*** (0.000)
OPEN*ECI				1.514*** (0.000)
GSIZE				-2.398*** (0.000)
INV				0.547*** (0.000)
MTRADE				5.635*** (0.000)
PRIV				-0.600*** (0.000)
INF				-0.001*** (0.000)
POPG				0.751*** (0.000)
IQ				0.951*** (0.000)
HC			0.936*** (0.000)	
Indirect Effects of Openness on MFPG_H				
ECI (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		2.078*** (0.000)	1.570	2.586
Conditional Effects of Openness on MFPG_H				
ECI (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	**ECI (Moderator Variable)**
Low level of Innovation (25th percentile)		0.680*** (0.000)	0.514	0.846
Average level of Innovation (50th percentile)		0.224*** (0.020)	0.170	0.279
High level of Innovation (75th percentile)		-0.163*** (0.000)	-0.206	-0.121
Observations	1,622	1,622	1,279	1,279
Countries	49	49	49	49

Notes: As for Table 5.9. OPEN*ECI is the interaction of trade openness and innovation.

Interestingly, when we average our data over five-year intervals (see Table E11 in the Appendix E) to mitigate business cycle concerns and endogeneity issues, the initial level of MFP is strongly significant and has the expected negative sign. Moreover, the moderating effect of ECI in the relationship between OPEN and MFPG_H are negative significant at low and average level of innovation whereas positive significant at higher level of innovation. It is worthwhile to mention here that when we use MFPG_H as dependent, the conditional effects of innovation become positive and significant at higher level of innovation capacity while negative and significant at lower innovation capacity. It is contrary to our previous case, where unadjusted MFPG has been used as dependent variable.

These findings further strengthen our assertion that improvement in the absorptive capacity of the developing countries is very crucial to get benefit from the new technologies devised by the developed nations. As absorption capacity (that is human capital) has been incorporated in the MFPG_H, therefore in this case we find the positive significant conditional effects of innovation at its higher level. In the case of unadjusted MFPG; the absorption capacity is not incorporated, so the negative significant conditional effects of innovation have been found at its higher level. So, we can say that there exists a threshold level in the relationship between OPEN and MFPG.

The conditional hypotheses concentrate around the signs and significance of the coefficient of OPEN and the coefficient of interaction term (that is, OPEN*ECI). The final model results of RE and FE setting of SUR method show that the coefficient of OPEN is negative while the coefficient of interaction term is positive and significant at the 1% level. It implies that OPEN has a negative significant impact on MFPG_H and innovation conditions mitigate the negative effect of OPEN on MFPG_H. Our results are consistent to the Grossman and Helpman (1991), Foster (2006) and Kim and Lin (2009).

Grossman and Helpman (1991) present a model where OPEN affects growth negatively. According to their model, free trade may sometimes shift labor from research into production. This "allocation effect" will slow down technical change and hence MFPG. Foster (2006) indicates that there exists a threshold level in the relationship between OPEN and growth. The relationship between two variables depends upon country's initial levels of per capita income and absorption capacity. Similarly, Kim and Lin (2009) argue that there exists an income threshold below which the growth effects of OPEN become either negative or insignificant.

6.13 Summary

We employ the Seemingly Unrelated Regression (SUR) method in both RE and FE setting, for our system of two equations to explore the mediating and moderating roles of macroeconomic and institutional variables towards MFPG and MFPG_H. The data over five years is used to check the robustness of results and to capture the business cycle movements. We include the initial value to test the convergence across countries over the period towards a common level of MFP growth. The results are robust to model specifications and estimation techniques.

Chapter 7

CONCLUSION AND RECOMMENDATIONS

This chapter has been divided into three sections. Section 7.1 presents the major findings of our empirical analysis for measurement and determinants of MFP growth in the selected developing countries. Section 7.2 is dedicated to the policy implications based on the findings of this study. Section 7.3 highlights the future area of research to motivate the researchers to dig out and analyze some other determinants and channels of MFP growth by exploiting different datasets and econometric methods.

7.1 Conclusion

Productivity growth is a driving force of economic development. The prolonged episode of lower productivity growth in mature and emerging economies instigates a debate among researchers on the causes and consequences of the productivity slowdown. Although the existing empirical literature spotlights the certain drivers of aggregate productivity growth but does not reveal an overall picture regarding its measurement and determinants. We provide new empirical evidence on the measurement and determinants of MFPG as well as MFPG_H.

Broadly, there are three strands of literature concerning measurement of MFP. The conventional method to measure MFP is the GAA which decomposes the observed economic growth into the contribution of factor inputs and contribution of TC known as the Solow residual. The second array of literature uses the index number methods accompanied by the frontier techniques to measure MFP. The third research stream employs growth regressions and econometric methods to estimate productivity across countries and regions. The econometric approach tackles the endogeneity bias caused by feedback effects and produces more precise and consistent estimates.

Hence, we employ the econometric approach to measure MFPG, and MFPG_H. At the country level, we have incorporated the assumption of heterogeneity into MFP measurement along with controlling the possible endogeneity of the factor inputs. Further, the HC adjusted measure of productivity growth has seldom been used in the growth literature. To handle the issue of endogeneity, we use one-period lag of inputs growth in the calculation of both the MFPG and MFPG_H.

To examine the determinants of both types of MFPG, we employ standard panel data methodology on the sample of 49 developing countries. The endogeneity problem made the FE and RE estimators biased and inconsistent. To avoid the problem of endogeneity, we use the GMM. The findings indicate that a high level of inflation, the huge size of government expenditures, credit expansion to the private sector, and public debt hinder productivity growth while a higher level of investment and better institutional quality tend to promote it. On average, developing countries with a higher level of public debt and inflation rate tend to experience lower MFPG over the period 1980-2016. The results are robust to model specifications and estimation techniques.

The regression results based on five-year averages confirm that human capital, investment, government size, inflation, debt to GDP ratio, CO2, remittances, and institutional quality do matter for MFPG. The coefficients on human capital, investment, remittances, and institutional quality are positive and significant. The coefficients on government size, inflation, debt to DGP ratio, and CO2 are negative and statistically significant in all regressions; the results are robust to model specifications.

In all regressions, the coefficients on the initial level of MFPG are consistently negative and significant. Convergence implies a negative correlation between the initial level of MFP and its subsequent growth rate. This is exactly what our data reveal. Thus, based on these results, we can conclude that there exists evidence of convergence. This in line with the theory; countries that had lower MFPG in 1980 tend to have higher productivity growth rates relative to countries with higher rates of MFPG in 1980. The concept of convergence is based on the notion that "*each country converges to its long-run equilibrium path and record a high growth rate when it's far from the path*". It suggests that countries possess their steady-state per capita real GDP to which they are converging. The steady-state in each country is conditional upon the state of its economy

In the new paradigm of research, the researchers and policymakers have shown their attention towards the conditional indirect effects, commonly known as moderated mediation effects. Most of the existing empirical literature overlooks the channels and conditions through which macroeconomic and institutional factors may affect MFP growth. We could not find any empirical study on aggregate productivity growth in which macroeconomic and institutional indicators are used as both the mediator and moderator. To explore the mediating and moderating roles of macroeconomic and institutional variables, we employ the Seemingly Unrelated Regression (SUR) method, for our system of two equations in each analysis of channel and condition. We take in to account different mediators (channels) and moderators (conditions) such as INV, IQ, ECI, ICT, DGDP, and OPEN.

In the analysis of channels and conditions, we determine whether investment mitigates the expected negative effects of public indebtedness on MFPG. Similarly, we investigate whether public debt mitigates the expected positive effects of INV on MFPG and MFPG_H of developing economies. In the same line of analysis, we examine the effects of HC on aggregate productivity growth through the channel of IQ and the effects of IQ on productivity growth via OPEN and vice versa. Further, we examine the indirect effects of OPEN on MFPG as well as on MFPG_H via innovation.

Moreover, we explore the conditional effects of OPEN on MFPG given the low, medium and high level of OPEN. From the regression analysis of channels and conditions, some interesting conclusions can be drawn.

The INV has a positive significant impact on MFPG, and public debt conditions mitigate the positive effect of investment on MFPG. The reduction in public debt is necessary for developing nations to provide breathing space to raise investment and hence achieve a higher level of MFPG. The higher DGDP affects the MFPG of developing countries by worsening the macroeconomic environment and key policy variables including the gross fixed capital formation. The negative link between REM and INV might be due to the reason that an increase in remittance income encourages the recipient households to reduce work effort and supply less labor. Moreover, remittances are mainly devoted to daily consumption needs and altruistic motives. Another possible channel through which REM lower INV is that the large remittances induce the exchange rate appreciation, which could dampen the investment as a result of a rise in the demand for imports and fall of net exports. A rise in the real interest rate raises the opportunity cost of holding money and the cost of borrowing which consequently decreases the level of investment.

Our empirical analysis reveals that investment in HC alone is not adequate to achieve a higher level of MFPG; to improve the quality of institutions is an imperative and prerequisite to get benefit from the investment in human capital. The results indicate that HC has a negative significant impact on MFPG, and IQ conditions mitigate the negative effect of HC on MFPG. The mediating effect of IQ in the relationship between HC and MFPG which was insignificant in the case of annual data becomes positive significant in the case of demeaned annual data. Further, the moderating effect of IQ in the relationship between HC and MFPG remains intact and robust in all cases.

In the case of demeaned data (FE setting of SUR), the coefficient on the moderating variable does decrease slightly in comparison but remains positive and significant at all levels of IQ. Moving towards the effects of other explanatory and control variables on MFPG; we find the significant role of investment, OPEN, government size, inflation, financial development, innovation, ICT, FDI, population growth, and CO2PC in determining the MFPG in developing nations.

Trade openness has a negative significant impact on MFPG, and IQ conditions lessen the negative effect of OPEN on MFPG. The conditional effects are positive and significant at all levels of IQ. The association between OPEN and MFPG is strengthened as we improve the level of IQ in developing countries. There exists a threshold level in the relationship between OPEN and MFPG. The mediating effects of ECI in the relationship between OPEN and MFPG are positive and significant in the case of FE setting of the SUR method. The conditional or moderating effects are positive and significant at a low level of ECI while negative and significant at an average and high level of ECI. So, we can say that the moderating role of innovation in the relationship between OPEN and MFPG is positive and significant up to a certain minimum threshold level. The countries with a low level of innovation capacity may have more potential for MFPG since they have lower effective costs in devising new products as their growth is driven by imitation. Nevertheless, technologically backwardness not necessarily implies higher growth potentials and capacities because the imitators are required to spend more time and energies to master the new technologies that are developed elsewhere. By solely relying on tacit knowledge, the imitators need to improve their absorptive capacity by providing adequate training to their factory workers, technicians, engineers, and managers so that they can easily adapt to new technologies devised by the developed countries.

When we use MFPG_H as a dependent, the conditional effects of innovation become positive and significant at a higher level of innovation capacity while negative and significant at lower innovation capacity. It is contrary to our previous case, where unadjusted MFPG has been used as a dependent variable. These findings further strengthen our assertion that improvement in the absorptive capacity of the developing countries is very crucial to get benefit from the new technologies devised by the developed nations. As absorption capacity (that is human capital) has been incorporated in the MFPG_H, therefore in this case we find the positive significant conditional effects of innovation at its higher level. In the case of unadjusted MFPG; the absorption capacity is not incorporated, so the negative significant conditional effects of innovation have been found at its higher level. Hence, we can say that there exists a threshold level in the relationship between OPEN and MFPG.

7.2 Policy Recommendations

Achieving sustained economic growth with a higher level of productivity has now become one of the challenging tasks for governments and policymakers. In general, in the last few decades, MFPG in developing economies has remained low or even negative in most of the countries. Since the beginning of the 21^{st} century, the lower MFPG in mature and emerging economies instigates a debate among economists and policymakers on the causes and consequences of the productivity slowdown. The fluctuations and trends in MFPG across developing countries suggest that it should be computed periodically and reported at least annually on aggregate as well as sectoral level along with other important macroeconomic indicators.

Based on the findings of our study, we recommend that investment climate and institutions need to be improved as they may have an even more important role in improving productivity growth in developing countries. The policy implications call for reinvigorating and strengthening the undermined economic growth prospects and institutional framework for achieving sustainable economic growth and development. Developing nations need to improve the quality of their institutions for attenuating the negative effects of OPEN and HC on MFPG. An improvement in the quality of labor and HC is vital to achieving a higher level of MFPG as it improves the absorption capacity. A higher-level domestic capacity for knowledge absorption is required to get the full benefits of innovation and new technologies devised by the developed countries. The high skilled workers have much more innovative capacity as compare to low-skilled workers. The developing countries, on average, do not have complementarity between innovation activities (knowledge intensity) and absorption of knowledge. The developing nations need to enhance their knowledge absorption capacity by equipping their labor force with skills that require quality academic institutions as well as a vocational training institution. Instead of competing in the race of producing graduates in humanities and arts, the government of developing regions must devise a more scientific education. Further, these countries must promote domestic saving and investment to achieve a higher level of MFPG and hence sustained economic growth. Furthermore, an important policy advice is to control the public debt, government size, and inflation rate as we find a negative impact of these variables on MFPG of selected developing countries.

7.3 Limitations and Directions for Future Research

Whilst we have attempted to made research contributions on the measurement and determinants of MFPG, fairly the availability of data on developing countries for a longer period is one of the main limitations to the analysis. The data on physical capital stock may contain measurement errors due to differences in depreciation rates and initial levels of capital stocks. Therefore, obtaining reliable, consecutive and better-quality data on the capital stock, employment, R&D spending, and some other macroeconomic variables has amplified the limitations of the study.

The existing literature can be extended in several directions. Firstly, future studies may apply more rigorous and authentic techniques to dig out the other important direct, indirect, and conditional factors affecting MFPG. By exploring these factors, the investigators could provide interesting policy implications for improving overall productivity in developing countries. Secondly, the unobserved global shocks and common factors, such as oil and financial crisis, may affect different regions and countries differently. Ignoring these factors may lead to inconsistent and biased estimates. These factors affect MFP both directly and indirectly, by affecting the demand for inputs in the production process through investment-related decisions. Further research in this direction may incorporate the heterogeneous and interactive effects of common shocks to further explore the drivers of aggregate productivity. Thirdly, MFP measurement bias arises from business cycles, capacity utilization, and scale effects that could be captured to refine the MFP estimates and understanding the mystery of productivity slowdown across the globe. Similarly, neglecting the nonfinancial assets including land inventories leads toward biased MFP estimates, hence future research may be carried out in this direction.

Another fruitful direction of research would be to examine the threshold effects of institutional and macroeconomic indicators that are not adequately scrutinized by using sophisticated econometric techniques. In the case of developing economies, we do not find any empirical evidence whatsoever on the threshold effects of fiscal imbalances on the productivity–economic growth relationship. Similarly, the threshold level of R&D spending and IQ for MFP growth is not yet fully explored. Therefore, future research may be carried out in this direction. These analyses could provide additional insights to policymakers and open new avenues of research.

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Appendices

Appendix A.

Table A1: Country List

Albania	Ethiopia	Peru
Algeria	Ghana	Philippines
Angola	Guatemala	Romania
Argentina	India	Senegal
Bangladesh	Indonesia	South Africa
Bolivia	Iran	Sri Lanka
Brazil	Jamaica	Sudan
Bulgaria	Jordan	Tanzania
Cameroon	Kenya	Thailand
China	Madagascar	Tunisia
Colombia	Malaysia	Turkey
Congo, Dem. Rep.	Mexico	Venezuela, RB
Costa Rica	Morocco	Vietnam
Côte d'Ivoire	Mozambique	Zambia
Dominican Republic	Myanmar	Zimbabwe
Ecuador	Nigeria	
Egypt	Pakistan	

Appendix B.

Table B1: Variables Description and Sources

Variable name	Acronym	Variable Description and Construction	Source
Multifactor productivity growth	MFPG	Multifactor productivity growth is a measure of long-term technological change. It measures output per unit of a set of combined factors of production. We employ the growth regressions and econometric methods to estimate MFPG	Authors' own calculation
Human capital adjusted multifactor productivity growth	MFPG_H	Human capital adjusted multifactor productivity growth take into consideration both the contribution of "brains" (education) and "brawn" (the size of the labor force). we have used the growth of labor quality and quantity as labor input respectively and growth regressions and econometric methods is used to estimate MFPG_H.	Authors' own calculation
Labor Input - Quantity	LQNT	Growth of Labor Quantity, log change (multiplied by 100)	The Conference Board, Total Economy Database
Labor Input - Quality	LQLT	Growth of Labor Quality, log change (multiplied by 100)	The Conference Board, Total Economy Database
Employment	DLL	Number of persons engaged (in millions). Employment include all persons aged 15 years and over, who during the reference week performed work, even just for one hour a week, or were not at work but had a job or business from which they were temporarily absent. The employment growth $\Delta \ln (L_t)$ has been used as a proxy for labor input.	Penn World Tables (PWT9)
Growth of Real Capital Stock	DLK	Capital stock at constant 2011 national prices (in mil. 2011US$). Reports capital stock levels in terms of the constant (2011) prices. The $\Delta \ln (K_t)$ is used to calculate the growth rate of real capital stock (DLK).	PWT9
Human Capital	HC	Human capital index based on years of schooling and returns to education.	PWT9
Population	POPG	Population growth (annual percentage)	World Development Indicators (WDI)
Economic Growth or GDP growth (annual percentage)	GDPG	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars.	WDI (2018)

Inflation, consumer prices (annual %)	INF	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.	WDI (2018)
Broad money (% of GDP)	M2	Broad money is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.	WDI (2018)
Gross fixed capital formation (% of GDP)	INV	Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchase; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.	WDI (2018)
Debt to GDP ratio	DGDP	The debt-to-GDP ratio is the ratio of a country's public debt to its gross domestic product (GDP). The debt-to-GDP ratio indicates its ability to pay back its debts	The Historical Public Debt Database (HPDD) By International Monetary Fund (IMF)
Openness measured by total trade (% of GDP)	OPEN	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	WDI (2018)
Foreign direct investment, net inflows (% of GDP)	FDI	Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 % or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments.	WDI (2018)
General government final consumption expenditure (% of GDP). It is used as a proxy to measure the government size.	GSIZE	General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security but excludes government military expenditures that are part of government capital formation.	WDI (2018)
Domestic credit to private sector (% of GDP)	PRIV	Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of nonequity	WDI (2018)

		securities, and trade credits and other accounts receivable, that establish a claim for repayment	
Personal remittances, received (% of GDP)	REM	Personal remittances comprise personal transfers and compensation of employees. Personal transfers consist of all current transfers in cash or in kind made or received by resident households to or from nonresident households. Compensation of employees refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by nonresident entities.	WDI (2018)
Merchandise trade (% of GDP	MTRADE	Merchandise trade as a share of GDP is the sum of merchandise exports and imports divided by the value of GDP, all in current U.S. dollars.	WDI (2018)
Age dependency ratio.	ADR	Age dependency ratio, young, is the ratio of younger dependents--people younger than 15--to the working-age population--those ages 15-64.	WDI (2018)
Tax revenue (% of GDP)	TAXR	Tax revenue refers to compulsory transfers to the central government for public purposes. Certain compulsory transfers such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue.	WDI (2018)
Real interest rate (%)	RIR	Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. The terms and conditions attached to lending rates differ by country, however, limiting their comparability.	WDI (2018)
CO2 emissions (kt)	CO2	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	WDI (2018)
CO2 emissions (metric tons per capita)	CO2PC	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	WDI (2018)
Mobile cellular subscriptions (per 100 people)	MOB_ Per 100	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology.	WDI (2018)
Fixed telephone subscriptions (per 100 people)	TELS_ Per 100	Fixed telephone subscriptions refer to the sum of active number of analogue fixed telephone lines, voice-over-IP (VoIP) subscriptions, fixed wireless local loop (WLL) subscriptions, ISDN voice-channel equivalents and fixed public payphones.	WDI (2018)

Fixed broadband subscriptions (per 100 people)	BBS_ Per 100	Fixed broadband subscriptions refer to fixed subscriptions to high-speed access to the public Internet.	WDI (2018)
Economic Complexity Index	ECI	The ECI is a measure of the relative knowledge intensity of an economy. it ranks the countries according to the knowledge intensity (complexity and diversification) of their export baskets. For detailed information see https://ourworldindata.org/how-and-why-econ-complexity and http://atlas.cid.harvard.edu/rankings	MIT Observatory of Economic Complexity (OEC) (2016) and the Harvard Atlas of Economic Complexity (2016)
Government stability	GOVS	This captures risk linked with the government's ability to stay in office and carry out its declared programs through government unity, legislative strength and public support. Ranges between 0 (very high risk) and 12 (very low risk).	International Country Risk Guide (ICRG), the PRS, USA.
Investment profile	INVP	This is an assessment of factors affecting the risk to investment including contract viability and expropriation, profit repatriation and payment delays. Ranges between 0 (very high risk) and 12 (very low risk)	ICRG the PRS, USA.
Corruption	COR	This is an assessment of corruption within the political system that causes distortion in the economic and financial system, reduces the efficiency of public as well as private sector by enabling the people to hold positions of power through patronage rather than ability and creates instability in political system. Ranges between 0 (very high risk) and 6 (very low risk)	ICRG the PRS, USA.
Military in politics	MP	This is an assessment of military participation in government that may be a symptom rather than a cause of underlying difficulties. Overall, lower risk ratings indicate more military participation in politics and a higher level of political risk.	ICRG the PRS, USA.
Law and order	LO	This is an assessment of the strength and impartiality of the legal system and the public observance of law. Ranges between0 (very high risk) and 6 (very low risk).	ICRG the PRS, USA.
Bureaucracy quality	BQ	This is an assessment of strengths and expertise of bureaucracy to govern independently and tend to be autonomous from political pressure. Ranges between 0 (very high risk) and 4 (very low risk)	ICRG the PRS, USA.
Democratic accountability	DA	This is an assessment of how responsive government is to its people, by if the less responsive it is, the more likely it is that the government will fall, peacefully in a society, Ranges between but possibly violently in a non-democratic one. Democratic 0 (very high risk) and 6 (very low risk	ICRG the PRS, USA.

Ethnic tension	ET	This is an assessment of the degree of tension within a country attributable to racial, nationality, or language divisions.	ICRG the PRS, USA.
Socioeconomic Conditions	SEC	A measure of the socioeconomic pressures at work in society that could constrain government action or fuel social dissatisfaction. The risk rating assigned is the sum of three subcomponents: Unemployment, Consumer Confidence, and Poverty.	ICRG the PRS, USA.
Internal Conflict	IC	A measure of political violence in the country and its actual or potential impact on governance. The risk rating assigned is the sum of three subcomponents: Civil War/Coup Threat, Terrorism/Political Violence, and Civil Disorder.	ICRG the PRS, USA.
External Conflict	EC	A measure of both the risk to the incumbent government from foreign action, ranging from non-violent external pressure (diplomatic pressures, withholding of aid, trade restrictions, territorial disputes, sanctions, etc.) to violent external pressure (cross-border conflicts to all-out war). The risk rating assigned is the sum of three subcomponents: War, Cross-Border Conflict, and Foreign Pressures.	ICRG the PRS, USA.
Religious Tensions	RT	A measure of religious tensions arising from the domination of society and/or governance by a single religious group -- or a desire to dominate -- in a way that replaces civil law by religious law, excludes other religions from the political/social processes, suppresses religious freedom or expressions of religious identity. The risks involved range from inexperienced people imposing inappropriate policies to civil dissent or civil war.	ICRG the PRS, USA.

Table B2: Estimates* of MFPG and MFPG_H for the Sample Countries

Albania

Year	MFPG	MFPG_H
1980	.	.
1981	1.2103	0.084247
1982	0.737649	0.241638
1983	-0.95597	0.387055
1984	-3.58525	0.089138
1985	-0.66364	-0.08047
1986	3.170321	-0.08201
1987	-2.87703	0.251012
1988	-3.52871	0.193523
1989	7.494608	-0.03146
1990	-12.0073	0.018265
1991	-32.3888	-35.8562
1992	-9.67293	-9.83107
1993	3.229365	2.433186
1994	4.755039	5.808388
1995	12.056	7.91924
1996	5.678546	5.678822
1997	-14.1643	-14.5241
1998	6.181207	5.893949
1999	10.65802	9.173395
2000	3.872025	3.606237
2001	5.416927	4.973386
2002	1.559581	1.126337
2003	3.089742	2.089236
2004	3.060504	2.034864
2005	3.014355	1.86053
2006	2.580435	2.201896
2007	2.982158	2.324618
2008	4.556197	3.857491
2009	0.691831	0.706216
2010	-0.42328	0.419947
2011	-0.46952	-0.78314
2012	-1.11086	-1.59519
2013	-1.09718	-1.33182
2014	-1.79541	-0.54424
2015	-0.04432	-0.28953
2016	.	1.57666

Algeria

Year	MFPG	MFPG_H
1980	.	.
1981	.	-0.30312
1982	2.805412	3.53161
1983	1.482677	2.416468
1984	1.994582	2.621575
1985	0.319617	2.44864
1986	-2.90327	-3.50016
1987	-3.80305	-2.68715
1988	-3.77875	-3.5777
1989	1.694286	1.718901
1990	-1.96336	-3.37127
1991	-3.82341	-2.95926
1992	-0.66336	-0.24548
1993	-4.36904	-3.94823
1994	-2.94401	-2.4928
1995	1.613845	1.857937
1996	1.333706	1.1212
1997	-1.34186	-1.24354
1998	2.697207	2.795203
1999	0.827487	0.891591
2000	1.72205	1.621402
2001	0.631608	0.594276
2002	2.679222	2.839518
2003	4.386305	4.231393
2004	2.820788	2.573626
2005	1.022349	1.10319
2006	-1.10494	-1.29844
2007	-0.64435	-0.92558
2008	0.576141	-0.17566
2009	-1.96678	-2.60664
2010	0.449277	-0.64908
2011	-0.17813	-1.35028
2012	0.904809	-0.05057
2013	-0.97189	-1.25055
2014	-0.07457	-0.45161
2015	0.569409	1.388417
2016	.	-0.66783

Angola

Year	MFPG	MFPG_H
1980	.	.
1981	.	-5.25182
1982	.	-8.26687
1983	.	-6.87124
1984	.	-2.82091
1985	.	-2.88597
1986	-2.24853	-12.6044
1987	1.464724	7.859671
1988	-0.33668	10.37775
1989	-6.05413	-1.52258
1990	-5.83948	0.268712
1991	-6.58016	-2.37102
1992	-11.8061	-10.2291
1993	-29.3148	-32.1916
1994	1.248752	-3.51114
1995	6.560705	9.520467
1996	5.572288	7.906445
1997	0.668654	1.8364
1998	-0.06417	0.050106
1999	-3.983	-2.81446
2000	-2.64565	-1.66665
2001	0.067001	0.161696
2002	-10.499	8.927769
2003	1.121041	-0.00967
2004	7.15682	6.063457
2005	14.02714	12.31023
2006	15.10463	14.55085
2007	16.72757	16.07966
2008	7.415455	8.347957
2009	-3.61648	-2.79157
2010	-0.45249	-2.19673
2011	0.869426	-1.19148
2012	1.163963	0.111518
2013	2.971296	1.834835
2014	1.301178	-0.2874
2015	.	-2.14506
2016	.	-4.5778

* The estimates of MFPG and MFPG_H could be used or reprinted with the permission of the author (tauqir.ahmed@iiu.edu.pk)

Argentina

Year	MFPG	MFPG_H
1980	.	.
1981	.	-0.98516
1982	-5.59395	-1.4186
1983	1.067338	0.561095
1984	-1.67458	-1.70932
1985	-11.215	-10.4245
1986	4.69912	3.165368
1987	-1.30589	-2.72119
1988	-5.67129	-3.78421
1989	-10.7818	-10.777
1990	-5.85641	-4.36198
1991	7.440394	4.52491
1992	7.385538	5.926414
1993	3.532099	6.786972
1994	5.991179	7.553241
1995	-2.97842	-2.97578
1996	7.77309	3.110027
1997	5.628864	7.714204
1998	0.469606	3.113689
1999	-6.37324	-1.40709
2000	-2.06732	-0.66896
2001	-6.61797	-3.63171
2002	-12.8695	-10.4231
2003	5.326946	5.292551
2004	2.642761	0.607871
2005	2.820545	0.662751
2006	4.40332	-1.34509
2007	6.818147	4.167628
2008	2.05112	1.411222
2009	-7.08425	-6.66608
2010	8.826691	7.18416
2011	4.179687	4.672467
2012	-1.73497	-0.20343
2013	1.620715	1.688337
2014	-3.41445	-1.91618
2015	2.561817	1.116863
2016	.	-3.8405

Bangladesh

Year	MFPG	MFPG_H
1980	.	.
1981	.	-1.18238
1982	-3.49417	-3.66106
1983	-0.48893	-0.23342
1984	0.770621	0.371266
1985	-0.57135	-1.88456
1986	-0.0156	-0.66594
1987	-1.46313	0.492451
1988	-1.85275	-2.45817
1989	-1.33151	-2.46635
1990	1.477669	0.56323
1991	-0.4342	-0.88188
1992	1.547625	-0.8567
1993	0.887883	-1.157
1994	-0.2022	0.130437
1995	0.775108	0.446485
1996	0.164048	0.591165
1997	-0.08364	0.672914
1998	0.534666	0.217883
1999	-0.26146	0.55174
2000	0.152788	0.684462
2001	0.017217	-0.12311
2002	-1.05955	-0.11994
2003	-0.37237	0.829431
2004	0.149531	1.10203
2005	0.981388	0.797838
2006	0.823115	1.332955
2007	1.223032	0.917722
2008	0.37647	0.419593
2009	-0.70197	0.35759
2010	-0.1904	0.966671
2011	0.736807	1.326776
2012	0.764532	-0.1132
2013	0.134215	-0.21214
2014	0.28798	-0.1186
2015	0.718533	1.479965
2016	.	1.881861

Bolivia

Year	MFPG	MFPG_H
1980	.	.
1981	.	-2.04644
1982	-5.81399	-7.60993
1983	-4.1804	-6.61306
1984	-0.54328	-2.06236
1985	-2.86464	-4.32531
1986	-4.23735	-0.95793
1987	1.149836	1.694536
1988	1.173209	1.037406
1989	3.171021	2.168527
1990	2.392736	0.927275
1991	2.238643	0.424525
1992	-1.64486	-2.28765
1993	0.900783	0.823086
1994	1.562328	1.278714
1995	1.328895	0.047951
1996	1.243328	1.288785
1997	1.310645	1.681331
1998	0.310815	2.012752
1999	-5.19023	-2.07315
2000	-1.51323	-0.4431
2001	-1.81073	-1.80471
2002	0.710982	-0.23082
2003	-0.12469	-0.06831
2004	1.993085	0.889047
2005	1.327757	-0.74665
2006	2.713894	2.125889
2007	1.628147	1.410933
2008	2.61825	1.78318
2009	-1.28454	-0.17203
2010	0.359497	1.23285
2011	0.476902	0.926836
2012	-0.54303	0.515647
2013	1.775895	3.086691
2014	0.055166	2.139932
2015	-0.69086	2.661985
2016	.	1.283582

Brazil

Year	MFPG	MFPG_H
1980	.	.
1981	.	-2.98299
1982	0.10019	-0.98024
1983	-4.89889	-5.9696
1984	3.271457	1.21223
1985	5.043733	3.277337
1986	4.321869	4.534462
1987	2.549856	1.996525
1988	-1.87434	-2.12607
1989	1.118352	-0.45525
1990	-4.93496	-5.80434
1991	-3.55886	-0.8827
1992	-3.17723	0.162986
1993	1.421868	4.096802
1994	2.196857	2.965874
1995	2.026861	2.880308
1996	0.103782	0.584938
1997	1.680414	-0.04778
1998	-2.10558	-2.10766
1999	-1.80353	-2.55951
2000	-0.50769	2.066254
2001	-2.41725	-3.15072
2002	-0.25592	-0.65689
2003	-3.35209	-1.97865
2004	1.492849	1.535658
2005	-1.47608	-0.86941
2006	-0.14703	0.377473
2007	2.34138	1.110374
2008	2.213089	1.711356
2009	-2.4088	-2.58772
2010	5.05137	3.936708
2011	1.38031	4.901561
2012	0.118741	2.728414
2013	1.29734	2.507755
2014	0.101096	-1.25394
2015	-4.91318	-3.38901
2016	.	-4.78453

Bulgaria

Year	MFPG	MFPG_H
1980	.	.
1981	.	0.868109
1982	-1.04338	1.339438
1983	0.444427	-3.37969
1984	0.78951	2.283096
1985	0.512333	-3.76584
1986	1.960002	1.9394
1987	3.637452	-0.88456
1988	8.576896	-1.63467
1989	-5.22647	-3.07306
1990	-9.61086	-11.9407
1991	-6.33752	-5.59198
1992	0.049178	-1.08758
1993	2.403877	2.760452
1994	0.429782	3.637302
1995	0.937437	3.703752
1996	-1.01223	-9.28731
1997	-4.61825	0.949555
1998	3.214236	6.886755
1999	-8.11011	-3.85284
2000	5.060521	3.818471
2001	2.92566	4.033717
2002	3.430444	0.547603
2003	1.968772	2.904778
2004	1.646842	3.081488
2005	2.539969	3.796881
2006	1.698822	2.049543
2007	2.205456	1.982191
2008	0.272295	1.090509
2009	-9.21171	-8.44732
2010	-1.58848	0.789429
2011	2.157575	1.32197
2012	-0.7836	-0.69469
2013	0.256062	0.434913
2014	-0.66	-0.46444
2015	1.085055	2.057168
2016	.	1.828139

Cameroon

Year	MFPG	MFPG_H
1980	.	.
1981	.	12.37102
1982	3.420666	3.898048
1983	2.225907	3.281071
1984	1.865673	3.907307
1985	1.850339	4.670428
1986	1.201556	2.870131
1987	-6.00745	-8.94194
1988	-10.4619	-8.14062
1989	-4.23692	-12.7693
1990	-8.24791	-4.86074
1991	-5.35994	-6.83923
1992	-3.93502	-5.92918
1993	-7.40239	-5.83837
1994	1.770424	-5.10952
1995	4.229803	0.618731
1996	5.021366	2.361065
1997	5.26154	2.023032
1998	4.289662	2.352483
1999	2.967174	1.279267
2000	2.692244	1.217493
2001	2.855707	1.478277
2002	0.390613	1.214193
2003	0.971937	1.612537
2004	1.64007	1.069516
2005	-0.51958	-0.06629
2006	0.731279	0.76425
2007	1.111177	0.971951
2008	-0.09376	-1.11779
2009	-1.09183	0.058697
2010	0.383902	0.73122
2011	0.45296	1.295751
2012	-0.39137	1.495797
2013	1.042521	2.117638
2014	1.248921	2.491329
2015	0.122586	2.289951
2016	.	1.171785

China

Year	MFPG	MFPG_H
1980	.	.
1981	.	-3.44076
1982	0.363174	-2.67486
1983	1.598247	0.140962
1984	5.131799	7.948488
1985	3.571839	10.97601
1986	-0.47099	1.670325
1987	1.868716	4.615507
1988	1.014095	10.70742
1989	-4.97155	0.879706
1990	-6.01078	-1.59668
1991	-1.73233	-4.75251
1992	2.959534	2.459229
1993	2.641348	2.034076
1994	3.046767	1.066979
1995	1.010867	-0.72012
1996	-0.22118	-1.56282
1997	-0.84367	-1.17159
1998	-2.32286	-3.01543
1999	-2.24795	-3.47108
2000	-1.87158	-2.43742
2001	-2.32337	-2.1955
2002	-1.22509	-1.57663
2003	-0.1182	-0.26973
2004	0.330038	-0.65644
2005	1.776047	0.445888
2006	3.073529	3.172548
2007	4.512338	4.580827
2008	-0.14296	-2.33761
2009	-0.49489	-0.69402
2010	1.655927	-0.4677
2011	0.377575	-1.53815
2012	-1.81603	-2.85176
2013	-2.06174	-2.82987
2014	-2.76035	-3.23795
2015	-3.29631	-3.5455
2016	.	-3.65385

Colombia

Year	MFPG	MFPG_H
1980	.	.
1981	.	-1.34875
1982	-3.44341	-2.72095
1983	-1.77458	-1.75295
1984	0.600674	0.402377
1985	0.071061	0.039772
1986	2.313651	2.617245
1987	1.450086	1.733009
1988	-0.37493	0.331476
1989	-0.60198	-0.36742
1990	1.787656	0.481569
1991	-1.20008	-0.95723
1992	0.247604	0.566144
1993	-0.6771	2.49395
1994	1.106008	0.929169
1995	1.188355	1.107623
1996	-2.26341	-1.81626
1997	0.44589	0.061591
1998	-2.84786	-2.81318
1999	-6.84511	-7.3311
2000	2.598838	0.282353
2001	-2.95874	-1.93356
2002	-0.38337	-0.53809
2003	0.614943	0.292817
2004	1.615856	1.767744
2005	0.834454	1.368722
2006	2.620971	2.761304
2007	2.952377	3.486896
2008	-0.65465	-0.4576
2009	-1.83649	-2.2561
2010	1.144334	0.720331
2011	2.89337	2.920769
2012	-0.18133	-0.30818
2013	0.965944	1.341442
2014	1.075524	0.598167
2015	-0.48454	-0.28735
2016	.	-1.41577

Congo, Dem. Rep.

Year	MFPG	MFPG_H
1980	.	.
1981	.	0.99406
1982	-4.42606	-1.84544
1983	-1.81252	0.095771
1984	1.293688	4.092549
1985	-2.38789	-0.81931
1986	3.074883	3.391646
1987	1.314301	1.459723
1988	-0.30252	-0.58051
1989	-2.7892	-1.837
1990	-8.10629	-3.55063
1991	-8.45912	-9.79792
1992	-12.5393	-12.0537
1993	-15.2926	-15.4649
1994	-5.33001	-7.30914
1995	0.604521	1.815904
1996	0.388438	-2.81295
1997	-2.88028	-8.91237
1998	1.853975	-4.70187
1999	-0.23789	-4.602
2000	-3.39399	-9.24176
2001	0.63212	-2.90191
2002	4.83788	2.217549
2003	6.228783	4.688792
2004	6.869693	5.752049
2005	6.123784	5.17972
2006	4.732531	4.378521
2007	4.828433	5.269759
2008	4.266909	5.211382
2009	0.675665	1.960783
2010	2.71959	5.922446
2011	1.710598	5.680816
2012	1.28559	5.848927
2013	5.556566	7.234408
2014	5.380341	8.094553
2015	3.579425	5.727247
2016	.	1.414768

Costa Rica

Year	MFPG	MFPG_H
1980	.	.
1981	.	-6.20516
1982	-10.1701	-10.7416
1983	-1.09544	-0.86326
1984	1.257336	3.650542
1985	-3.99232	-3.15084
1986	1.599527	1.431829
1987	2.815435	0.611997
1988	-0.6385	-0.82585
1989	1.072601	2.072147
1990	-1.41797	-0.34428
1991	-0.95862	-1.84055
1992	4.93416	5.207265
1993	1.931549	2.673784
1994	0.145747	0.409624
1995	0.087463	-0.66452
1996	-2.51311	-2.40073
1997	1.872803	1.555777
1998	2.561085	2.207743
1999	-0.26067	-0.25216
2000	0.057758	-0.4706
2001	-1.12378	-0.88208
2002	-0.56449	0.392129
2003	0.600039	0.623872
2004	0.209606	0.720012
2005	-0.21712	-0.08883
2006	3.11994	2.728427
2007	3.874454	4.153025
2008	0.299552	0.131573
2009	-4.7371	-4.41304
2010	2.778068	1.875081
2011	-0.27554	0.415959
2012	1.252148	1.377571
2013	-3.73247	-1.43952
2014	0.466945	0.364539
2015	0.760974	1.641172
2016	.	0.338941

Cote d'Ivoire

Year	MFPG	MFPG_H
1980	.	.
1981	.	-0.29389
1982	-1.97214	-3.87374
1983	-6.061	-7.22794
1984	-4.84212	-5.05283
1985	2.38398	3.97689
1986	1.144489	1.319978
1987	-2.463	-3.31457
1988	-0.97127	-3.2723
1989	0.844609	-1.8836
1990	-3.21791	-8.00827
1991	-2.06978	-0.46816
1992	-2.36589	-0.64545
1993	-2.28954	-0.96267
1994	-1.3127	-0.84842
1995	5.013925	4.451958
1996	5.599243	6.200458
1997	1.60379	3.705313
1998	2.784494	2.584306
1999	-0.53523	0.430359
2000	-4.1796	-4.23602
2001	-1.96693	-1.554
2002	-3.74251	-3.10982
2003	-3.43543	-3.05653
2004	-0.83494	-0.29996
2005	-0.34985	0.020582
2006	-0.55843	-0.0392
2007	-0.31832	0.091587
2008	0.448462	0.539217
2009	1.151294	1.066849
2010	-0.08593	-0.13178
2011	-6.50168	-6.66291
2012	8.614289	8.144336
2013	6.779371	6.612991
2014	6.671084	5.792648
2015	7.035152	5.618535
2016	.	4.386053

Dominican R.

Year	MFPG	MFPG_H
1980	.	.
1981	.	-0.28512
1982	-2.85158	-2.63004
1983	-0.06408	-0.09636
1984	-3.37468	-4.15953
1985	-6.80855	-6.95988
1986	-1.18602	-1.46122
1987	5.550875	2.690809
1988	-2.27181	-3.84577
1989	-0.14764	7.451454
1990	-9.93371	-9.42079
1991	-3.679	-3.61632
1992	5.731669	6.044145
1993	2.303949	2.596071
1994	-2.26156	-2.02922
1995	1.492681	0.920448
1996	2.544361	1.215507
1997	3.230366	3.985484
1998	2.838983	1.991386
1999	3.219593	1.399567
2000	1.252672	0.122374
2001	-2.72094	-1.96689
2002	0.689494	-2.33672
2003	-4.70052	-3.52187
2004	-3.90525	-0.34786
2005	4.551216	3.182111
2006	5.900464	2.696881
2007	4.391562	3.225769
2008	-1.28192	-0.6277
2009	-3.58452	-0.86286
2010	3.001099	2.294666
2011	-1.29725	-1.85597
2012	-1.69668	-3.95967
2013	-0.08045	2.122158
2014	2.587518	3.835404
2015	2.559643	2.218361
2016	.	1.991196

Ecuador

Year	MFPG	MFPG_H
1980	.	.
1981	.	0.958138
1982	-2.78632	-1.5339
1983	-3.65698	-4.86474
1984	-0.27755	1.376074
1985	1.176368	1.405146
1986	0.131467	0.031281
1987	-3.09713	-9.06127
1988	2.845955	7.516736
1989	-1.85316	-0.08973
1990	1.116282	0.533033
1991	1.775101	2.682836
1992	-0.64496	1.30828
1993	-0.85909	-0.55029
1994	1.41844	1.276264
1995	-0.77404	-0.50929
1996	-1.21819	-2.33514
1997	1.604553	1.43309
1998	0.342243	0.536614
1999	-7.5463	-7.77788
2000	-1.07538	-1.11312
2001	1.298781	0.869647
2002	0.9449	0.695204
2003	-0.61786	-1.6374
2004	5.095928	3.648861
2005	1.846545	3.085035
2006	1.16938	0.797231
2007	-1.15655	0.119938
2008	3.166898	2.15611
2009	-2.8945	-3.02551
2010	0.305099	0.239841
2011	4.554266	2.865844
2012	1.992707	2.2484
2013	1.229396	1.127247
2014	0.082611	1.93754
2015	-3.63891	-1.03223
2016	.	-5.31788

Egypt

Year	MFPG	MFPG_H
1980	.	.
1981	.	-2.70923
1982	2.183297	1.537109
1983	-0.79399	0.848624
1984	-0.48791	1.121732
1985	1.231668	1.71071
1986	-2.14645	-1.61427
1987	-1.84251	-1.37577
1988	1.237137	0.867767
1989	1.092531	-1.00634
1990	1.50725	-1.42138
1991	-3.00045	-0.76311
1992	0.445117	-0.82055
1993	-0.63468	-0.18156
1994	0.953831	0.025325
1995	1.035807	0.505705
1996	1.389536	1.047524
1997	1.669727	1.494503
1998	-0.21528	0.930886
1999	1.367516	0.214794
2000	0.838375	1.028985
2001	-0.96992	-0.43728
2002	-1.85843	-1.22917
2003	-1.07527	-1.69429
2004	0.279494	-0.86587
2005	0.366274	0.690208
2006	2.322859	1.398915
2007	2.155671	2.325849
2008	1.155226	2.361823
2009	-1.4242	-0.58195
2010	0.269875	1.726989
2011	-3.14338	-3.79379
2012	-2.08509	-1.20075
2013	-1.97264	-0.76698
2014	-0.68193	-0.14191
2015	0.830948	0.184111
2016	.	0.582638

Ethiopia

Year	MFPG	MFPG_H
1980	.	.
1981	.	-2.84652
1982	-3.07609	-2.81611
1983	4.054855	0.707145
1984	-8.36634	-6.41564
1985	-16.7831	-10.8406
1986	5.291392	4.0879
1987	8.937479	6.007
1988	-3.76404	-0.9909
1989	-4.1975	-1.12418
1990	-1.48688	-4.63365
1991	-10.938	-9.872
1992	-11.0106	-10.8622
1993	10.44794	0.475956
1994	1.224271	7.514881
1995	1.678306	2.685356
1996	8.720123	6.277401
1997	-1.51815	4.11905
1998	-7.05691	-2.5307
1999	1.771311	-2.13774
2000	2.183456	1.587194
2001	3.439916	1.056504
2002	-3.1088	0.918304
2003	-6.50064	-3.57266
2004	9.343452	1.313977
2005	6.001655	6.128567
2006	4.599754	4.728285
2007	5.198857	4.666555
2008	3.938237	3.687442
2009	0.704943	2.514297
2010	4.405013	2.971181
2011	2.257292	3.858736
2012	-2.42827	0.415591
2013	-1.70508	-0.9315
2014	-2.25788	-1.59884
2015	.	-1.45474
2016	.	-3.09341

Ghana

Year	MFPG	MFPG_H
1980	.	.
1981	.	-3.92313
1982	-10.6383	-10.1972
1983	-7.61675	-6.33514
1984	5.781067	4.980855
1985	0.874746	-0.87305
1986	1.026179	0.726811
1987	1.349179	1.586239
1988	1.727125	1.917381
1989	1.279416	1.848071
1990	-0.63984	0.149857
1991	1.526976	2.6227
1992	0.525857	2.629851
1993	1.147792	0.864856
1994	-0.3038	0.841768
1995	0.117061	1.060747
1996	0.621557	1.505367
1997	-0.09782	0.270053
1998	0.232698	-0.37817
1999	0.259695	-0.10667
2000	0.147291	-0.37613
2001	-1.12385	-0.89073
2002	-0.6824	-0.3097
2003	1.250451	1.173816
2004	0.897318	0.951914
2005	0.533763	0.583653
2006	0.983378	0.403135
2007	-1.50284	-1.66552
2008	2.975594	2.719529
2009	-2.82489	-2.8778
2010	2.454244	2.41402
2011	6.580098	5.242924
2012	-0.16651	-0.99759
2013	-1.38136	-0.23687
2014	-3.36951	-2.55392
2015	-1.94362	-1.33533
2016	.	-1.43656

Guatemala

Year	MFPG	MFPG_H
1980	.	.
1981	.	-1.97731
1982	-6.92077	-6.50768
1983	-5.53285	-4.05075
1984	-2.10449	-0.72402
1985	-3.10479	-2.54641
1986	-2.11179	-1.48501
1987	1.317144	1.953492
1988	1.017466	1.075036
1989	1.075967	1.152302
1990	-0.11222	0.003036
1991	1.055392	0.900855
1992	1.992606	2.096082
1993	0.737482	0.518523
1994	0.594612	0.262575
1995	1.808224	1.496438
1996	-0.31236	0.056236
1997	1.486982	1.332914
1998	1.435166	0.813377
1999	0.183031	0.094589
2000	-0.2207	-1.41124
2001	-0.92118	-0.75601
2002	0.724542	1.275685
2003	-0.7402	0.174712
2004	0.038241	-0.15955
2005	0.484616	1.194108
2006	2.142474	0.197282
2007	2.905453	0.558685
2008	0.266249	0.411249
2009	-2.33505	-2.1178
2010	0.22498	0.487169
2011	1.730776	1.745167
2012	0.096006	0.148956
2013	0.114633	-0.51835
2014	1.756711	2.792267
2015	1.22765	1.217796
2016	.	0.29559

India

Year	MFPG	MFPG_H
1980	.	.
1981	.	1.46369
1982	-1.75034	-1.88347
1983	1.583398	2.110839
1984	-1.6573	-0.16532
1985	-0.21093	-2.35793
1986	-0.69035	-1.83163
1987	-1.5708	-1.79718
1988	4.086658	4.092091
1989	0.337399	0.321221
1990	-0.18168	0.298592
1991	-4.8112	-3.69178
1992	0.089645	-0.06264
1993	-1.11368	-0.05693
1994	0.897996	0.940125
1995	1.621291	1.172838
1996	1.257343	1.540031
1997	-2.02718	-1.96418
1998	0.228999	-0.53077
1999	2.836447	-0.03702
2000	-2.30988	-0.77961
2001	-1.16306	-1.7307
2002	-1.83679	-1.1526
2003	2.035191	1.269176
2004	1.842653	0.880527
2005	2.692894	1.747379
2006	1.62187	1.721073
2007	1.861149	2.119076
2008	-4.17303	-0.00967
2009	0.555568	-1.46875
2010	2.470875	1.974961
2011	-1.16045	-0.24368
2012	-2.42377	-2.79204
2013	-0.99688	-0.82597
2014	0.748268	-0.35995
2015	1.30967	0.81177
2016	.	1.278431

Indonesia

Year	MFPG	MFPG_H
1980	.	.
1981	.	1.734111
1982	-1.58329	-8.64702
1983	-0.30986	-0.96538
1984	3.926542	1.777497
1985	-2.30185	-2.45996
1986	0.512964	0.853181
1987	-0.50196	0.008718
1988	0.552213	0.750101
1989	2.589805	3.786206
1990	3.284105	3.773303
1991	2.709483	3.810581
1992	3.309545	1.470696
1993	2.409185	2.743448
1994	3.812765	2.350798
1995	4.233568	3.055021
1996	5.439222	2.675129
1997	1.474584	0.753502
1998	-10.9271	-18.5306
1999	-3.28423	-4.08861
2000	-2.95666	0.078228
2001	-3.68961	-1.34042
2002	-2.59983	-0.96097
2003	-2.23257	-1.07032
2004	-2.07611	-0.61228
2005	-0.73047	0.566497
2006	-0.37083	0.193833
2007	0.071107	2.389672
2008	-0.90708	1.973643
2009	-1.37644	-0.73386
2010	0.253369	0.868263
2011	0.076252	1.799345
2012	0.550402	1.211512
2013	0.401808	0.795993
2014	-0.66235	0.284651
2015	0.903309	-0.21134
2016	.	-0.08316

Iran

Year	MFPG	MFPG_H
1980	.	.
1981	.	-5.30728
1982	19.75617	12.62447
1983	7.987684	9.511791
1984	-8.02242	-1.68894
1985	0.581013	2.045636
1986	-12.6535	-12.7248
1987	-4.39759	-2.07144
1988	-10.8242	-9.14135
1989	0.660203	0.628325
1990	8.4597	6.225361
1991	8.23773	5.025851
1992	-0.03247	3.104347
1993	-4.24554	-4.8129
1994	-5.55824	-3.55574
1995	-2.09092	-1.43563
1996	1.661425	3.620274
1997	-2.42443	-1.6313
1998	-2.02834	-0.49187
1999	-2.47893	-1.84039
2000	1.21436	-2.50676
2001	-1.46612	-1.88407
2002	4.147709	3.711895
2003	5.209685	1.882017
2004	0.542901	2.206128
2005	0.250469	-0.92308
2006	3.365312	-0.05966
2007	6.82383	3.579409
2008	-1.06025	-6.49403
2009	2.123322	4.81956
2010	4.931541	-0.96126
2011	2.135586	6.10828
2012	-8.94165	-6.75668
2013	-6.15569	-3.2868
2014	-0.06414	-1.82671
2015	-5.64424	-2.35343
2016	.	6.660806

Jamaica

Year	MFPG	MFPG_H
1980	.	.
1981	.	1.241395
1982	0.262719	-0.79966
1983	1.291408	1.639371
1984	-3.04021	-2.00529
1985	-5.2699	-7.09386
1986	1.081071	0.948641
1987	5.805501	5.150433
1988	2.139392	0.64055
1989	4.99018	4.356049
1990	2.327267	3.072959
1991	2.74614	-0.07285
1992	0.396821	1.716114
1993	7.38375	0.989494
1994	-0.3189	1.460693
1995	0.323501	1.212655
1996	-2.63159	-1.32154
1997	-2.19774	-1.96177
1998	-3.38224	-1.56973
1999	0.313568	-0.20531
2000	0.773588	1.090672
2001	0.386423	1.127416
2002	0.40808	-0.30273
2003	-0.60131	-0.28822
2004	-1.0682	-0.58869
2005	-0.62867	0.019914
2006	0.399313	0.928103
2007	-1.38471	-0.70455
2008	-3.41272	-2.94649
2009	-5.42631	-4.18914
2010	-0.92266	-0.78134
2011	2.001043	1.777727
2012	-1.5768	-1.35967
2013	-0.34622	-0.61282
2014	-0.31855	-0.38854
2015	-0.50304	-0.43335
2016	.	0.253381

Jordan

Year	MFPG	MFPG_H
1980	.	.
1981	.	3.039351
1982	5.104433	5.210902
1983	-1.48278	-0.96414
1984	4.253179	3.954725
1985	-0.95767	-0.76202
1986	1.950519	3.679478
1987	-1.9952	-1.99623
1988	-6.43497	-5.17717
1989	-17.9272	-14.9448
1990	-3.62773	-4.10603
1991	-1.93535	-2.6242
1992	12.41494	5.729853
1993	0.00727	0.411893
1994	0.432836	0.78377
1995	0.79043	0.552769
1996	-3.5987	-3.97305
1997	-1.06575	-0.75671
1998	-1.12489	-0.8116
1999	-0.22521	-0.605
2000	0.379933	0.512928
2001	1.692955	1.43496
2002	2.515879	2.230217
2003	0.517324	0.308087
2004	4.650698	4.201432
2005	3.477997	3.195993
2006	4.825991	4.761255
2007	3.676756	3.603815
2008	1.613796	1.563833
2009	1.315729	1.476285
2010	-2.54979	-2.36972
2011	-1.65252	-1.45658
2012	-1.3115	-1.05896
2013	-1.12704	-1.11587
2014	-0.97093	-0.22395
2015	-1.63347	-1.90642
2016	.	-1.79909

Kenya

Year	MFPG	MFPG_H
1980	.	.
1981	.	-1.41041
1982	-2.76278	1.841047
1983	-2.20524	-2.86322
1984	-1.18676	-1.09929
1985	1.053639	0.91362
1986	4.203824	4.046249
1987	2.610605	2.477797
1988	2.82458	2.395115
1989	1.106293	0.681065
1990	1.193429	1.369435
1991	-1.95797	-2.10078
1992	-4.00251	-4.22137
1993	-2.86552	-2.97477
1994	-0.06501	-0.09806
1995	2.127388	1.939887
1996	1.937056	2.354375
1997	-2.10434	-1.98724
1998	0.189162	0.052583
1999	-1.35345	-1.26049
2000	-2.83616	-3.04595
2001	-0.10532	0.349333
2002	-3.56035	-3.66502
2003	-1.0271	-1.1485
2004	1.119998	0.458618
2005	2.473189	2.455358
2006	1.93479	1.055472
2007	2.065185	1.496324
2008	-4.34917	-4.4269
2009	-1.16528	-1.11741
2010	3.2691	2.756483
2011	1.052478	0.861997
2012	-0.43409	-0.58898
2013	1.140569	1.241761
2014	0.748938	0.869089
2015	0.930828	0.762434
2016	.	1.630344

Madagascar

Year	MFPG	MFPG_H
1980	.	.
1981	.	-10.4985
1982	-3.41005	-3.89859
1983	-0.83405	-1.53807
1984	0.117118	-6.03224
1985	-0.34494	-0.10731
1986	0.329712	-1.63289
1987	-0.52814	-0.06286
1988	1.833969	-0.45735
1989	3.045147	2.278936
1990	2.022731	2.206064
1991	-6.82276	-7.71225
1992	-3.33707	-1.44196
1993	-0.8869	-0.13841
1994	-4.11507	-2.16404
1995	-0.50108	-0.58778
1996	-2.7299	-0.24588
1997	0.241598	1.420196
1998	0.331844	1.741568
1999	2.159358	2.768365
2000	2.102159	2.503596
2001	3.814536	4.274554
2002	-10.9448	-14.5242
2003	7.15324	7.058234
2004	4.273497	3.560706
2005	-0.19502	3.684871
2006	-0.04987	3.851302
2007	6.15584	5.104242
2008	5.422975	6.242541
2009	-3.49579	-4.49335
2010	-1.10519	-0.77192
2011	-4.7085	0.354757
2012	1.523424	1.795014
2013	0.800742	1.088049
2014	1.416893	1.949971
2015	1.264376	1.74858
2016	.	2.676061

Malaysia

Year	MFPG	MFPG_H
1980	.	.
1981	.	1.043628
1982	-1.3068	-0.92367
1983	1.2637	0.15245
1984	1.660353	1.561432
1985	-6.65129	-6.27626
1986	-4.28567	-3.56476
1987	-0.24646	0.163128
1988	3.608435	2.536375
1989	3.051388	3.396944
1990	2.753917	3.071959
1991	3.088585	2.915243
1992	3.323315	3.795054
1993	4.180174	2.929134
1994	2.919859	2.206333
1995	4.062012	4.4109
1996	5.154957	4.393208
1997	-0.47891	-1.24664
1998	-12.7451	-12.9273
1999	1.123651	1.608115
2000	3.081457	2.895487
2001	-5.81603	-5.9631
2002	0.291508	0.421529
2003	0.320525	-0.08082
2004	0.947075	0.944876
2005	0.227794	0.167512
2006	0.499975	0.08294
2007	3.787162	1.135706
2008	-2.39378	-0.23275
2009	-7.79875	-5.8378
2010	1.351699	1.631834
2011	-2.44942	-2.46466
2012	-0.44647	-0.23526
2013	-1.30134	-0.72927
2014	-0.05389	0.641108
2015	-0.72366	-0.73363
2016	.	-0.88899

Mexico

Year	MFPG	MFPG_H
1980	.	.
1981	1.441985	7.417268
1982	-4.42317	-1.96332
1983	-2.08105	-6.26911
1984	1.986885	1.171608
1985	-0.48096	0.254541
1986	-4.12212	-6.14192
1987	0.853979	-0.87426
1988	-0.90266	-1.42245
1989	1.729838	1.666192
1990	2.971131	2.491515
1991	1.834868	1.633627
1992	0.701897	0.797847
1993	-0.48012	-0.20519
1994	2.150646	2.59967
1995	-2.741	-8.46993
1996	-6.18367	4.221213
1997	0.489842	3.124076
1998	-9.27378	2.971184
1999	-7.10378	0.27458
2000	-2.11321	2.647011
2001	1.249578	-3.17779
2002	4.064151	-1.11514
2003	3.562981	-0.45504
2004	4.469699	2.609988
2005	4.242617	0.588234
2006	0.925682	1.67171
2007	-1.07242	0.926102
2008	3.392145	-0.69734
2009	-10.3333	-7.15783
2010	4.009343	2.167291
2011	4.886275	0.844261
2012	-3.88917	1.472084
2013	6.538325	-1.85215
2014	2.138713	-0.3867
2015	.	-0.32632
2016	.	-1.03552

Morocco

Year	MFPG	MFPG_H
1980	.	.
1981	.	-5.38082
1982	-12.0731	2.202336
1983	-16.2464	-0.44303
1984	-13.8773	-1.13127
1985	-7.16974	2.479429
1986	-7.7282	5.696344
1987	9.356004	-2.72231
1988	-2.32368	2.455077
1989	1.71726	1.631964
1990	-4.16433	-0.34205
1991	-1.08529	2.209088
1992	-10.0141	-4.51262
1993	-1.7736	-9.86137
1994	-3.0631	5.036046
1995	-4.47827	-5.23664
1996	14.8493	2.513288
1997	5.489671	-0.18005
1998	1.902318	0.241073
1999	2.178716	-0.58091
2000	-4.53711	-3.56866
2001	6.098741	2.123529
2002	3.159173	0.966989
2003	0.424441	1.99897
2004	3.45916	2.474399
2005	4.19337	-0.25837
2006	4.630035	2.237442
2007	5.069157	1.399755
2008	3.828382	-0.12883
2009	7.35289	1.07948
2010	5.45395	1.806327
2011	2.312194	0.764492
2012	3.709424	-0.37714
2013	2.353522	-0.33815
2014	1.42944	-1.54089
2015	-0.43282	0.336013
2016	.	-3.04894

Mozambique

Year	MFPG	MFPG_H
1980	.	.
1981	.	-3.06414
1982	2.614126	-3.34689
1983	1.153495	-8.02352
1984	2.561458	-2.67926
1985	0.472324	-9.55221
1986	-2.55093	1.565894
1987	-5.70498	3.304612
1988	-16.268	4.941978
1989	-3.41097	2.538974
1990	-1.2685	0.079421
1991	-3.65288	4.085467
1992	2.125765	-10.3995
1993	-2.90503	-2.27895
1994	-3.40586	-2.24521
1995	-3.49354	-6.97933
1996	-2.97541	14.99163
1997	-2.85208	6.349714
1998	-1.74686	4.61693
1999	2.715764	0.705673
2000	5.807591	-5.51162
2001	2.41497	3.499327
2002	4.25917	2.918813
2003	5.787807	-1.29688
2004	6.27615	0.682694
2005	6.972176	3.075154
2006	6.441344	4.100511
2007	5.364093	2.524807
2008	3.699402	3.933898
2009	2.692164	-0.22393
2010	1.850768	0.460544
2011	-2.52495	0.895173
2012	-1.10337	1.149369
2013	-2.41447	-2.06836
2014	-4.39942	-2.76317
2015	-2.53129	-0.32011
2016	.	-5.66756

Myanmar

Year	MFPG	MFPG_H
1980	.	.
1981	.	0.040392
1982	-2.77754	-0.57004
1983	-4.6036	-1.53591
1984	-1.95122	-0.58314
1985	-1.80077	-1.58845
1986	2.364668	-5.2799
1987	1.49832	-8.17418
1988	-0.9217	-15.9323
1989	0.0095	0.957986
1990	-0.50842	0.096755
1991	-1.52845	0.512101
1992	3.97213	5.442707
1993	-3.68702	1.503359
1994	-0.61414	2.574451
1995	1.147139	1.449202
1996	0.247068	0.167239
1997	1.330849	-1.20686
1998	0.580875	-0.95295
1999	0.424211	3.829289
2000	1.177288	5.983328
2001	-1.80633	4.283447
2002	1.354346	5.248998
2003	0.741847	7.340548
2004	8.27925	6.059921
2005	-1.79108	5.808325
2006	2.424709	4.578445
2007	1.777764	3.245336
2008	-2.47506	-5.07015
2009	-4.86272	-2.85946
2010	0.685061	-3.55009
2011	-0.45056	-3.89852
2012	-0.60558	-3.21821
2013	0.534057	-1.03061
2014	1.411705	-0.91805
2015	0.423408	-0.97694
2016	.	-1.77611

Nigeria

Year	MFPG	MFPG_H
1980	.	.
1981	.	-11.1004
1982	-8.93564	-3.03287
1983	-2.76782	-10.1698
1984	-8.07999	-8.2686
1985	11.19515	4.117822
1986	-3.5036	-3.45063
1987	-6.42032	-5.73256
1988	2.687838	5.052266
1989	0.40651	1.661402
1990	-7.26925	0.467151
1991	7.782491	-4.17415
1992	-7.17072	-1.32289
1993	-0.36574	-1.4393
1994	0.480291	-2.13741
1995	-3.36687	-1.30198
1996	2.413079	-0.18566
1997	1.058569	-1.39412
1998	4.126395	-1.78239
1999	2.04567	-4.07079
2000	-3.50335	0.264636
2001	9.44989	2.758774
2002	-2.42846	9.953931
2003	5.238814	5.592893
2004	-2.72641	8.648732
2005	4.730672	2.470443
2006	-0.21742	1.206543
2007	-0.42467	2.501375
2008	1.354597	2.955939
2009	0.979463	3.932482
2010	1.988962	7.57426
2011	-0.00453	1.520089
2012	-5.77953	1.125628
2013	-1.46109	2.026504
2014	4.813919	1.461835
2015	3.673091	-1.45372
2016	.	-4.27538

Pakistan

Year	MFPG	MFPG_H
1980	.	.
1981	.	2.931839
1982	1.860376	2.660226
1983	2.105008	1.87714
1984	0.405913	-0.76617
1985	2.956942	3.697889
1986	0.817599	1.500144
1987	1.578485	1.111468
1988	3.246502	1.48789
1989	0.190025	0.183236
1990	-0.15236	-0.25766
1991	0.394381	1.474512
1992	2.504977	0.079583
1993	-2.82477	-1.9578
1994	-0.8977	-0.46512
1995	0.295747	0.185576
1996	-0.01509	-1.81028
1997	-3.69272	-2.72534
1998	-1.78034	-1.76326
1999	-0.71044	-0.90216
2000	-0.31205	-1.68096
2001	-2.9442	-1.94956
2002	-1.4372	-0.52397
2003	0.392808	1.467508
2004	2.78101	2.737373
2005	3.312209	1.770065
2006	1.592605	0.451989
2007	0.535426	-1.79067
2008	-3.03384	-2.00417
2009	-1.77203	-1.97387
2010	-2.89873	-2.62552
2011	-1.80349	-1.80449
2012	-0.90284	-0.694
2013	-0.16691	-0.0341
2014	0.115502	0.167477
2015	0.259202	0.798067
2016	.	1.147095

Peru

Year	MFPG	MFPG_H
1980	.	.
1981	.	1.665521
1982	-3.85001	-3.1946
1983	-13.6997	-17.6879
1984	-0.02295	2.508611
1985	-1.04124	-0.12353
1986	6.798333	7.535347
1987	4.778059	5.087744
1988	-12.841	-11.6439
1989	-14.4345	-15.031
1990	-7.64763	-7.42471
1991	-0.65119	0.477118
1992	-4.78394	-3.86296
1993	3.369149	2.399743
1994	9.191298	8.3467
1995	3.492142	3.392417
1996	-1.16602	-1.27288
1997	3.046059	2.715807
1998	-3.31262	-3.89604
1999	-2.16388	-1.64939
2000	-0.31648	-0.14846
2001	-3.04751	-3.21512
2002	3.039713	3.20608
2003	1.467287	1.61102
2004	2.196029	2.214073
2005	3.492805	3.553584
2006	4.728117	4.588628
2007	5.163744	5.000409
2008	6.098481	5.397791
2009	-1.97227	-2.60538
2010	5.321706	4.996633
2011	3.172187	2.867969
2012	2.934929	2.173842
2013	2.901649	2.038642
2014	-0.86512	-0.89965
2015	0.624363	-0.03555
2016	.	0.913394

Philippines

Year	MFPG	MFPG_H
1980	.	.
1981	.	2.323567
1982	3.952856	4.100811
1983	1.834769	1.415231
1984	-7.26014	-7.28883
1985	-10.8112	-10.1084
1986	-2.14003	-0.63469
1987	-1.29394	1.047128
1988	1.33383	2.932774
1989	1.753602	2.115555
1990	-0.53443	1.095462
1991	-3.49034	-2.88076
1992	-3.95759	-3.2306
1993	-1.89829	-1.19868
1994	0.733038	0.341064
1995	1.28677	1.23441
1996	2.398206	2.032976
1997	2.419466	2.713771
1998	-3.09322	-4.07444
1999	-1.49287	-1.65299
2000	0.189272	0.597559
2001	-1.08436	-1.51291
2002	-0.20843	-1.04877
2003	0.733285	0.395254
2004	2.829957	2.091237
2005	0.596061	0.311447
2006	1.074489	0.460536
2007	2.429778	0.463351
2008	0.155202	2.758141
2009	-2.91871	-1.6894
2010	3.282945	1.350445
2011	0.167425	-1.29199
2012	2.811611	0.494684
2013	3.270201	0.90859
2014	3.516195	0.578721
2015	3.414589	-0.3523
2016	.	5.20203

Romania

Year	MFPG	MFPG_H
1980	.	.
1981	-4.27771	-4.06343
1982	-2.18195	-1.94151
1983	-2.35126	-1.68207
1984	2.255782	3.617659
1985	-1.76622	-0.53059
1986	0.034282	1.590301
1987	-3.09331	-2.06271
1988	-0.98651	0.117521
1989	-4.38997	-2.15446
1990	-8.15945	-8.3463
1991	-14.0599	-15.4232
1992	-8.57491	-8.50592
1993	0.760358	-0.85875
1994	2.781917	4.576478
1995	6.474994	7.665436
1996	1.714142	4.100095
1997	-6.64718	-3.93336
1998	-2.74222	-0.7827
1999	-2.0362	-0.90666
2000	1.311638	2.939121
2001	4.513217	6.155938
2002	3.813533	4.929567
2003	1.254763	0.118427
2004	6.929345	5.707107
2005	2.263021	2.420298
2006	5.944152	4.811485
2007	4.842048	4.513412
2008	4.811237	2.545395
2009	-11.1666	-13.6263
2010	-3.05585	-2.67874
2011	-0.50149	0.829871
2012	-1.12042	0.624291
2013	0.734101	-0.85792
2014	1.756349	2.777905
2015	.	3.76742
2016	.	4.546856

Senegal

Year	MFPG	MFPG_H
1980	.	.
1981	.	-4.08539
1982	5.776345	10.94178
1983	-7.16266	-0.94659
1984	1.261319	-7.78883
1985	1.049676	0.539317
1986	0.914328	1.514215
1987	3.826555	0.530978
1988	-2.7538	1.322199
1989	1.512897	-5.22398
1990	-3.22187	0.913353
1991	-0.09563	-0.9144
1992	-1.22945	-2.29717
1993	-2.20766	-1.56697
1994	-3.61827	-2.71109
1995	1.749396	2.386982
1996	-1.2723	-1.15573
1997	-0.63893	0.311538
1998	2.430434	2.799287
1999	2.843295	2.800809
2000	-0.67688	0.058244
2001	0.743421	1.247168
2002	-3.40694	-3.18605
2003	2.88746	2.66943
2004	2.112462	1.886838
2005	1.838843	1.305167
2006	-1.69758	-1.83006
2007	0.884609	0.745021
2008	-0.10283	-0.49059
2009	-2.13992	-1.72389
2010	0.085824	0.027475
2011	-1.97209	-2.3314
2012	0.350327	0.394244
2013	-0.40231	-0.55849
2014	0.092256	-0.05565
2015	2.239678	2.192843
2016	.	2.279398

South Africa

Year	MFPG	MFPG_H
1980	.	.
1981	.	2.588119
1982	-2.0284	-2.69937
1983	-3.69633	-4.01849
1984	3.056682	2.871259
1985	-3.34561	-3.27613
1986	-2.32549	-1.90446
1987	-0.64959	-0.08592
1988	1.863311	2.662121
1989	0.247824	0.542027
1990	-2.407	-2.49835
1991	-3.179	-2.60015
1992	-4.40151	-3.77437
1993	-1.42325	-0.84821
1994	0.569645	1.069362
1995	0.592742	0.892736
1996	1.940366	1.965026
1997	0.329898	0.256971
1998	-1.79526	-1.86234
1999	0.028686	0.094522
2000	1.647464	0.967834
2001	0.230835	-0.16294
2002	0.521515	-0.2141
2003	0.985028	2.105726
2004	1.715509	0.779236
2005	3.033574	3.009497
2006	3.971378	4.080047
2007	4.051119	3.140128
2008	1.058707	1.223558
2009	-2.94196	-2.43737
2010	0.634343	0.513645
2011	0.845892	0.264099
2012	0.647978	1.089589
2013	0.733859	-0.43106
2014	0.069885	-0.19785
2015	-0.58285	-1.22133
2016	.	-1.88308

Sri Lanka

Year	MFPG	MFPG_H
1980	.	.
1981	.	0.286755
1982	-1.71638	-0.91714
1983	-0.55924	-0.48604
1984	-0.0095	-0.47899
1985	0.505413	-1.2436
1986	-0.0579	-1.14883
1987	-2.46227	-2.83675
1988	-2.21901	-2.23448
1989	-1.99526	-2.03646
1990	2.259306	1.674501
1991	-0.29253	4.622253
1992	-0.47194	-8.15977
1993	1.947128	1.297804
1994	0.935098	3.256751
1995	0.496378	0.38796
1996	-0.96274	5.953083
1997	1.738708	5.465929
1998	-0.26903	-7.31644
1999	-0.36276	-1.18493
2000	0.930913	3.016671
2001	-6.25451	-6.11116
2002	-0.80953	-1.56852
2003	1.714313	0.677478
2004	0.624781	-0.73767
2005	1.132689	2.067715
2006	2.500795	1.990182
2007	1.242089	1.305512
2008	0.156526	-0.28212
2009	-1.78759	-0.99845
2010	2.607437	1.657516
2011	3.039025	4.007734
2012	3.427865	3.926573
2013	-2.86457	-1.56081
2014	-0.9636	-0.81002
2015	-1.2001	-0.56336
2016	.	-0.91889

Sudan

Year	MFPG	MFPG_H
1980	.	.
1981	.	-0.54986
1982	6.060234	7.972264
1983	-3.24534	-1.76173
1984	-7.79303	-8.55855
1985	-7.35223	-8.45266
1986	2.764984	1.671809
1987	0.790193	-0.28325
1988	0.29655	-0.84045
1989	6.188884	5.231471
1990	-9.18529	-10.3574
1991	5.945429	4.752951
1992	4.559294	3.523946
1993	1.945713	1.031662
1994	-1.25864	-2.33342
1995	0.964787	1.704351
1996	1.47755	1.943612
1997	3.874327	4.93424
1998	-1.27487	-0.7556
1999	-5.82127	-3.82407
2000	1.087114	1.925469
2001	2.028844	2.519021
2002	1.330229	2.141232
2003	1.043783	2.232432
2004	-3.02532	-1.69429
2005	0.224743	1.644087
2006	2.64415	4.112176
2007	5.422735	6.385895
2008	2.420567	3.123304
2009	0.484929	-0.98737
2010	-1.12572	-0.83948
2011	-5.81562	-5.41074
2012	-14.4381	-16.2355
2013	5.705091	5.39861
2014	1.568854	0.603718
2015	1.506419	0.999094
2016	.	-0.96694

Tanzania

Year	MFPG	MFPG_H
1980	-3.53266	.
1981	-4.44206	-5.36456
1982	-1.5514	-2.18167
1983	-2.98305	-3.58446
1984	0.694972	-0.36838
1985	-1.70348	-2.6319
1986	0.461981	1.04246
1987	1.715173	2.076026
1988	0.810171	0.76332
1989	0.223482	-0.1314
1990	-0.3456	0.332298
1991	-1.62694	-1.74587
1992	-4.98779	-3.48792
1993	-4.20646	-2.54485
1994	-3.1225	-1.9325
1995	-0.82582	0.106437
1996	0.096887	1.691241
1997	-1.46151	1.766879
1998	-1.46815	1.558054
1999	0.853395	1.118098
2000	0.546199	0.422162
2001	1.817174	2.156842
2002	2.687664	2.609144
2003	2.133847	2.077477
2004	2.406631	2.464684
2005	2.456504	1.339331
2006	-1.33201	-0.89262
2007	2.28942	2.185907
2008	-0.3589	-0.48372
2009	-0.67086	-1.01595
2010	0.286245	0.15003
2011	1.733519	1.730589
2012	-1.02843	-1.62563
2013	1.73947	-0.01642
2014	1.551352	0.194868
2015	.	1.245918
2016	.	0.97609

Thailand

Year	MFPG	MFPG_H
1980	.	.
1981	.	-0.96772
1982	-8.76356	-0.1381
1983	-3.56251	2.392975
1984	0.231277	-2.9307
1985	3.981226	-1.66959
1986	-1.29202	0.712576
1987	-1.40785	3.462313
1988	5.093645	6.786728
1989	2.28884	4.307561
1990	-2.80134	3.036954
1991	-1.95825	2.933592
1992	-9.01185	2.463295
1993	-17.1432	1.307421
1994	11.36148	2.432607
1995	3.86477	1.431447
1996	5.945383	-0.86467
1997	11.29928	-8.1955
1998	-4.82655	-12.8331
1999	-1.56459	1.343753
2000	-2.79656	1.201637
2001	-3.5908	-1.02431
2002	-2.81255	2.645047
2003	3.18693	2.351699
2004	0.114186	2.009128
2005	-0.85139	-0.79021
2006	1.599738	0.749094
2007	-0.28271	0.531265
2008	-0.27151	-3.47089
2009	1.144175	-5.64985
2010	1.669431	2.873485
2011	2.256215	-3.78699
2012	2.283591	2.312873
2013	1.445448	-1.71055
2014	3.180229	-3.18689
2015	1.991431	0.74165
2016	.	-0.80806

Tunisia

Year	MFPG	MFPG_H
1980	.	.
1981	.	2.014555
1982	-3.18602	-3.64889
1983	1.951582	1.460947
1984	2.62229	2.414952
1985	2.493027	1.61473
1986	-5.02811	-5.1566
1987	2.576731	2.681829
1988	-4.42393	-3.86875
1989	-2.84737	-0.29885
1990	3.554862	3.810252
1991	-0.31613	0.381845
1992	3.549692	3.926467
1993	-1.74893	-1.23982
1994	-0.7411	-0.12566
1995	-1.61263	-0.99524
1996	3.072672	1.86408
1997	1.389877	2.112379
1998	0.903094	1.558501
1999	2.069618	0.970186
2000	0.864377	-0.59084
2001	0.085745	0.751903
2002	-2.2919	-2.38811
2003	0.969881	1.351484
2004	2.368262	1.426939
2005	-0.19638	1.210764
2006	1.364136	1.291672
2007	2.99077	1.907196
2008	0.580682	0.319826
2009	-0.55644	-0.87699
2010	-0.07419	-1.30514
2011	-5.52028	-5.74674
2012	0.205606	1.186776
2013	-1.08599	-1.55098
2014	-1.1538	-1.63498
2015	-2.8297	-2.03765
2016	.	-2.79204

Turkey

Year	MFPG	MFPG_H
1980	.	.
1981	.	-1.96037
1982	-0.77825	0.656479
1983	0.335679	-0.43646
1984	1.369189	1.031628
1985	-1.06386	2.89536
1986	3.310249	1.731671
1987	5.80962	5.055479
1988	-1.52815	1.055389
1989	-3.6421	-2.97426
1990	4.246758	2.066189
1991	-2.57888	-2.79256
1992	-0.71729	0.036458
1993	4.41623	2.279778
1994	-1.40788	-4.15362
1995	-1.81816	-1.83871
1996	1.916804	1.116708
1997	2.962461	1.103
1998	0.684515	1.274871
1999	-8.40565	-9.10745
2000	0.618325	-0.97676
2001	-8.05961	-8.75903
2002	-0.63565	0.448129
2003	-0.10363	0.546493
2004	5.395874	5.672714
2005	4.576758	5.905988
2006	3.42785	2.442934
2007	2.155032	1.383661
2008	-2.39952	-1.30635
2009	-9.913	-9.22171
2010	2.531965	3.991559
2011	2.31156	2.346029
2012	-3.56205	-2.61145
2013	1.894196	2.826312
2014	-1.34938	0.867476
2015	.	1.570831
2016	.	-2.16642

Venezuela, RB

Year	MFPG	MFPG_H
1980	.	.
1981	.	-1.48046
1982	0.86317	-1.87159
1983	-1.95457	-3.96469
1984	0.293949	-0.09506
1985	-3.37545	-0.02872
1986	1.539925	3.674154
1987	-1.63165	2.364422
1988	0.893371	4.230636
1989	-12.6438	-9.9324
1990	1.296781	3.529913
1991	3.260882	7.363398
1992	2.519755	5.12605
1993	-0.48648	0.820893
1994	-4.27038	-3.344
1995	1.168509	1.500078
1996	-3.01926	-2.32885
1997	2.654486	-0.30571
1998	-1.63465	-5.79486
1999	-7.48325	0.520152
2000	2.307084	1.896968
2001	-1.14855	3.985925
2002	-12.0896	-11.676
2003	-11.1339	-7.32313
2004	11.18131	15.43558
2005	2.926058	6.848602
2006	5.468162	4.332279
2007	7.815475	5.333352
2008	7.506404	7.725854
2009	-1.52599	-1.3133
2010	-0.77089	-0.51348
2011	3.507487	1.367205
2012	4.603275	3.889464
2013	3.362333	-0.00012
2014	.	-3.73254
2015	.	-6.76274
2016	.	-19.4773

Vietnam

Year	MFPG	MFPG_H
1980	.	.
1981	.	-1.89104
1982	.	2.389395
1983	.	0.135157
1984	.	3.245957
1985	-1.11335	0.525453
1986	-0.43434	-1.45057
1987	-1.19505	-1.67347
1988	-0.50956	0.043549
1989	1.750846	-1.26019
1990	-0.51585	-1.09785
1991	0.530591	-0.32954
1992	2.957407	2.189666
1993	1.810434	1.138135
1994	2.046039	1.48478
1995	2.371186	1.926615
1996	2.138574	1.715253
1997	0.681983	0.490833
1998	-1.97691	-1.9288
1999	-2.20015	-2.0737
2000	-0.04161	-0.35053
2001	-1.18045	-0.17034
2002	-0.79921	-0.95596
2003	0.055224	0.354699
2004	0.577354	0.982608
2005	0.679647	0.326868
2006	-0.0612	0.067525
2007	0.464594	0.537882
2008	-1.32819	-1.16545
2009	-1.25472	-0.56477
2010	-0.78791	0.330519
2011	-0.3998	-1.21657
2012	-1.17787	-0.70526
2013	-0.77394	-1.07533
2014	-0.31378	-0.08032
2015	.	-0.52055
2016	.	0.625353

Zambia

Year	MFPG	MFPG_H
1980	.	.
1981	.	3.596707
1982	-4.64192	-5.83934
1983	-4.28988	-4.50671
1984	-2.67339	-2.08567
1985	-0.06621	-0.03274
1986	-0.51961	-1.49638
1987	1.274557	0.440145
1988	5.190551	4.143671
1989	-2.21806	-0.49157
1990	-1.63489	7.907189
1991	-1.29424	-2.75782
1992	-3.27117	1.072931
1993	4.984801	-0.93311
1994	-10.5236	-16.245
1995	0.647888	1.220702
1996	3.60082	3.931421
1997	2.133635	1.277245
1998	-2.6234	-3.1162
1999	1.448433	1.109612
2000	0.942552	-0.07389
2001	1.440592	0.778751
2002	-0.20996	-0.48147
2003	1.938817	1.487311
2004	1.766283	0.841333
2005	2.550213	1.863691
2006	3.679714	2.70289
2007	4.030756	3.205708
2008	2.737127	2.305863
2009	3.644122	3.331879
2010	4.385492	4.641478
2011	-0.27058	0.434481
2012	0.430119	1.758902
2013	-3.21311	-0.21092
2014	-4.06249	-1.19235
2015	-5.314	-2.95569
2016	.	-5.63309

Zimbabwe

Year	MFPG	MFPG_H
1980	.	.
1981	.	3.596707
1982	1.482543	-5.83934
1983	0.372236	-4.50671
1984	-3.15457	-2.08567
1985	5.284407	-0.03274
1986	0.472538	-1.49638
1987	-0.52042	0.440145
1988	5.940708	4.143671
1989	4.116135	-0.49157
1990	5.77483	7.907189
1991	4.827868	-2.75782
1992	-9.34979	1.072931
1993	-0.14072	-0.93311
1994	7.915292	-16.245
1995	-0.13949	1.220702
1996	8.992852	3.931421
1997	0.228794	1.277245
1998	0.238136	-3.1162
1999	-2.86429	1.109612
2000	-5.44606	-0.07389
2001	1.715427	0.778751
2002	-9.00031	-0.48147
2003	-17.2822	1.487311
2004	-4.59835	0.841333
2005	-6.52931	1.863691
2006	-9.25555	2.70289
2007	-5.68069	3.205708
2008	-20.7326	2.305863
2009	5.23764	3.331879
2010	12.43637	4.641478
2011	14.51678	0.434481
2012	12.59843	1.758902
2013	1.25977	-0.21092
2014	0.748668	-1.19235
2015	0.534879	-2.95569
2016	.	-5.63309

Appendix C.

Construction of the Index of Institutional Quality (IQ)

We proxy institutional quality (IQ) with twelve different measures computed using PCA. These components are government stability (GOVS), investment profile (INVP), corruption (COR), military in politics (MP), law and order (LO), bureaucracy quality (BQ), democratic accountability (DA), ethnic tension (ET), socioeconomic conditions (SEC), internal conflict (IC), external conflict (EC) and religious tensions (RT). In order to construct a composite index of IQ, we have applied the PCA. It has been widely used in various disciplines, particularly in the social science research as a dimension- reducing tool.

The main objective of applying PCA is to reduce the dimensionality of the dataset that contains many correlated regressors together with retaining much of the possible variation and variability. PCA is a useful statistical technique that detects patterns in the data and then keeping into consideration these patterns reduce the dimensionality of the dataset. As the main motive is to reduce our set of variables, so it is desirable to have a criterion for selecting the optimal number of components to be used. The widely used criterion (that is, Kaiser criterion, known as Latent Root Criterion) is to choose those components whose eigenvalues are greater than one (Kaiser, 1960; Slesman et al., 2015).

Table C1: PCA Results for the Construction of Index of the IQ

No. of Observations		No. of Comp.		Traces	
1610		12		12	
Number of Comp.	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative Value**	**Cumulative Prop**
1	4.23096	2.78719	0.3526	4.23096	0.3526
2	1.44377	.199906	0.1203	5.67473	0.4729
3	1.24387	.177557	0.1037	6.9186	0.5765
4	1.06631	.282478	0.0889	7.98491	0.6654
5	.783831	.0933074	0.0653	8.76741	0.7307
6	.690523	.0588198	0.0575	9.459264	0.7883
7	.631703	.0788291	0.0526	10.09097	0.8409
8	.552874	.127535	0.0461	10.64384	0.8870
9	.42534	.0608078	0.0354	11.06918	0.9224
10	.364532	.0771322	0.0304	11.43371	0.9528
11	.2874	.00850682	0.0239	11.72111	0.9768
12	.278893	.	0.0232	12.00001	1.0000

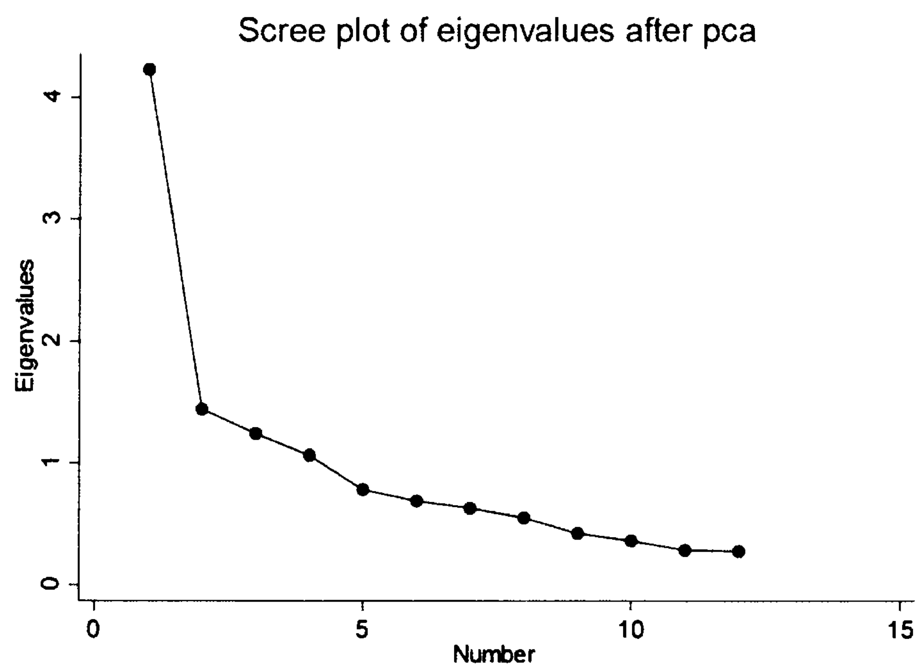
Table C2: PCA Results for the Construction of (IQ) - Principal Components (Eigenvectors/Loadings)

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10	PC 11	PC 12
GOVS	0.2314	-0.4905	0.3329	0.2040	-0.0060	-0.1453	0.4132	0.2575	-0.0434	-0.0763	0.4465	-0.2969
INVP	0.2838	-0.1736	0.4917	-0.2873	0.1489	0.0474	0.3205	-0.2581	-0.0544	-0.0727	-0.4727	0.3735
COR	0.2372	0.4264	-0.1570	0.2424	-0.3421	0.3216	0.4509	0.3199	-0.2965	-0.1647	-0.1920	-0.1920
MP	0.3532	0.2494	-0.0756	-0.1986	-0.1830	-0.2621	-0.0559	-0.3253	0.1947	-0.6631	0.2805	0.2805
LO	0.3018	-0.1564	-0.0502	0.4984	-0.3626	0.1547	-0.0712	-0.3182	0.3788	0.3018	0.1017	0.3562
BQ	0.2702	0.3647	0.3071	0.1158	0.1912	-0.2909	-0.1958	0.5320	0.4580	0.0988	-0.1499	0.0416
DA	0.5476	0.1949	0.1514	-0.5514	0.2803	-0.3839	0.0188	-0.0573	-0.0162	-0.1405	0.2402	-0.1670
ET	0.3312	-0.1310	-0.2387	0.1522	0.0473	-0.5413	-0.2390	0.0752	-0.5860	0.0869	-0.0579	0.2841
SEC	0.2445	0.3569	0.1931	0.2655	0.5725	0.2966	-0.0975	-0.3225	-0.2601	0.1012	0.2810	-0.1376
IC	0.3890	-0.2349	-0.1817	0.0575	-0.0104	0.0901	-0.2013	-0.1162	0.0725	-0.0054	-0.5018	-0.6617
EC	0.2850	-0.3002	-0.1468	-0.2628	0.1303	0.5443	-0.3533	0.3887	0.0036	-0.2104	0.1777	0.2702
RT	0.2008	0.0032	-0.5903	-0.2139	0.4060	-0.1013	0.4913	-0.0103	0.2828	0.2433	0.0738	0.0656

Notes: GOVS is government stability, INVP is investment profile, COR is corruption MP is military in politics, LO is law and order, BQ is bureaucracy quality, DA is democratic accountability, ET is ethnic tension, SEC is socioeconomic conditions, IC is internal conflict, EC is external conflict, and RT is religious tensions.

Figure C1: Scree Plot of Eigenvalues

This figure shows the eigenvalues on the vertical axis and the number of factors on the horizontal axis. It shows the scree plots for the sample of selected developing countries for 1984–2016 period. The elbow in the scree plot shows the points at which the inclusion of additional factors does not support in explaining the variance of the data set significantly. It can be seen in Figure C1 that four factors have a large then one or equal to one eigenvalue and explain a relatively large part of the variance contained in all indicators. The other factors have a lower eigenvalue and explain a relatively lesser part of the variance contained in all indicators. However, the scree plot technique involves somehow subjectivity if clear elbow does not appear in the curve.



Source: Author's Own Construction

When we apply PCA it is required to determine the number of components or factors to retain. The scree test, a graphical strategy suggested by Cattell (1966) is widely used for this purpose. It plots the eigenvalues against the number of components or factors and check the shape of the resultant curve to detect the point at which the curve changes drastically or having an elbow in it. This point on the curve indicates the maximum number of components to retain.

Construction of the Index of Information and communications technology (ICT) or ICT infrastructure (INFRA)

The PCA, which is a form of factor analysis has been used to estimates linear combinations of the three underlying variables of ICT or ICT infrastructure namely Mobile cellular subscriptions (per 100 people), Fixed telephone subscriptions (per 100 people) and Fixed broadband subscriptions (per 100 people).

Table C3: PCA Results for the Construction of Index of ICT

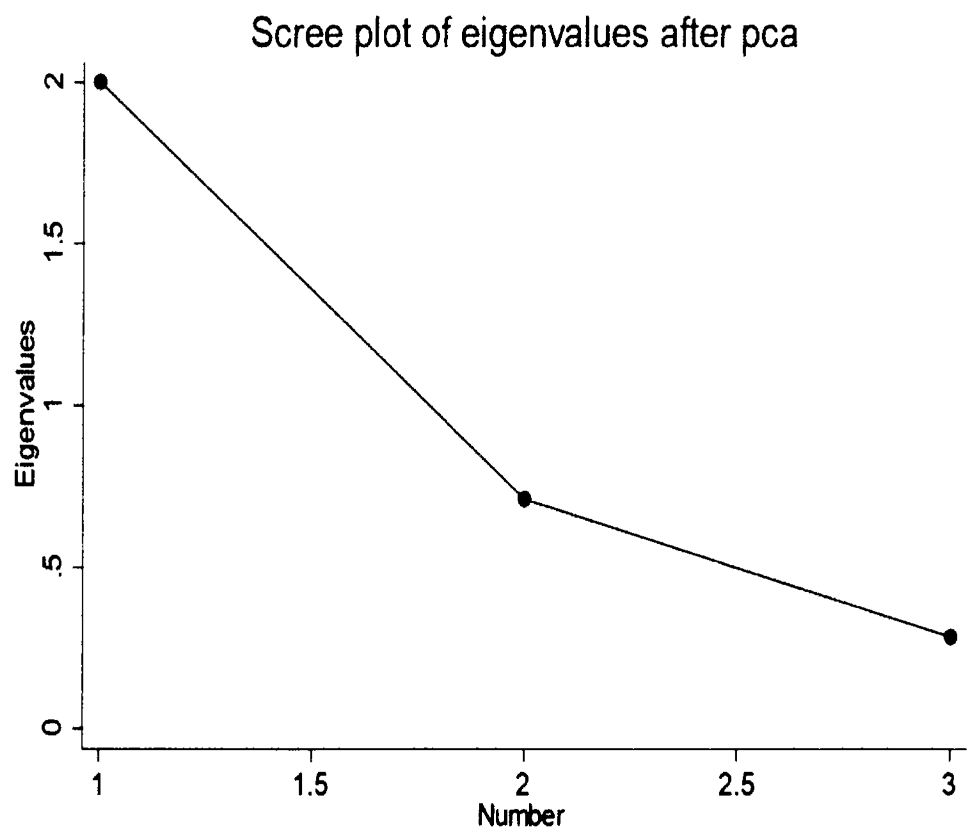
No. of Observations		No. of Comp.		Traces	
634		3		3	
Number of Comp.	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative Value**	**Cumulative Prop**
1	2.00151	1.28906	0.6672	2.00151	0.6672
2	.712454	.426417	0.2375	2.713964	0.9047
3	.286037	.	0.0953	3	1.0000

Table C4: PCA Results for the Construction of Index of ICT Principal Components (Eigenvectors/Loadings)

Variable	PC 1	PC 2	PC 3
MOB	0.5599	-0.6427	0.5229
TELS	0.5207	0.7638	0.3813
BBS	0.6445	-0.0588	-0.7624
Notes: MOB is Mobile cellular subscriptions (per 100 people), TELS is Fixed telephone subscriptions (per 100 people) and BBS is Fixed broadband subscriptions (per 100 people).			

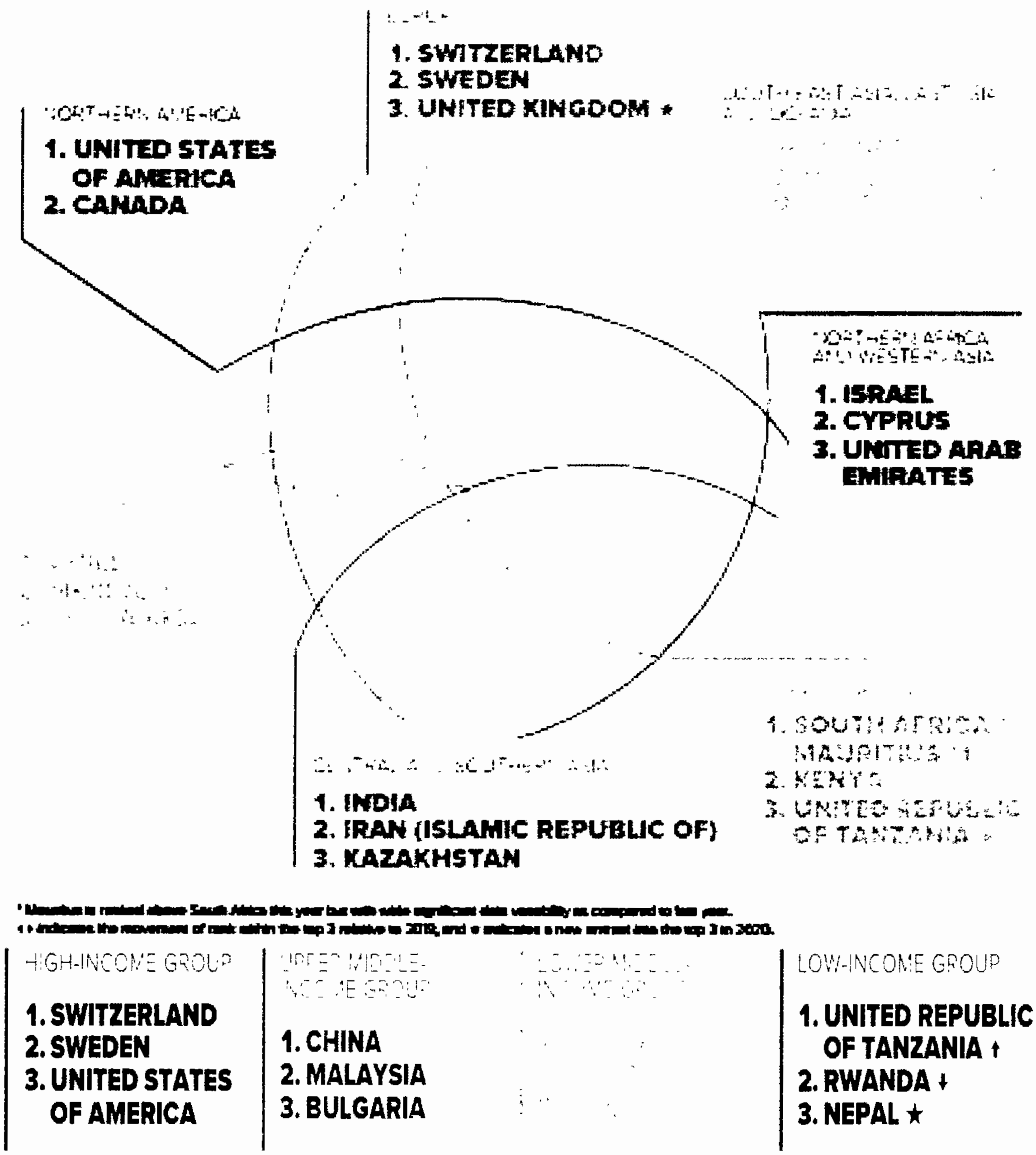
Figure C2: Scree Plot of Eigenvalues

This figure shows the eigenvalues on the vertical axis and the number of factors on the horizontal axis. It shows the scree plots for the sample of developing countries over the period of 1980–2016. The elbow in the scree plot shows the points at which the inclusion of additional factors does not support in explaining the variance of the data set significantly. Figure C2 shows that two factors have a large eigenvalue and explain a relatively large part of the variance contained in all three indicators. These two components explain 90 % of the variation in the data. Thus, according to the scree test suggested by Cattell, (1966) two factors are appropriate.



Source: Author's Own Construction

Figure C3: Top three Innovation Economies by Region and Income Group



Source: Global Innovation Index (GII) 2020

Appendix D.

Table D1: Results of Hausman Test

—coefficients --				
	(b)	**(B)**	**(b-B)**	**sqrt(diag(V_b -V_B))**
	FE	**RE**	**Difference**	**S.E.**
INV	0.970	0.020	-0.950	0.303
GSIZE	-1.937	-0.406	-1.531	0.389
INF	-0.000	-0.000	-0.000	. 0.000
DGDP	-0.0189	-0.035	-0.155	0.130
PRIV	-0.967	-0.613	-.354	0.182
IQ	1.790	1.866	-0.097	0.282

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 24.74

Prob>chi2 = 0.000

(V_b-V_B is not positive definite)

Table D2: Regression Results of MFPG (Fixed Effect Model): 5-YEARS AVERAGES

Dep. Var. MFPG	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HC	4.683*** (0.009)	4.587** (0.013)	4.681** (0.013)	4.688*** (0.006)	4.237** (0.034)	3.700* (0.083)	3.365* (0.096)
INV	1.398** (0.041)	1.292 (0.123)	1.396* (0.057)	1.357** (0.047)	1.460** (0.034)	1.306* (0.057)	1.727** (0.017)
GSIZE	-1.588** (0.046)	-1.631** (0.044)	-1.589** (0.048)	-1.666** (0.033)	-1.607** (0.045)	-1.606** (0.040)	-1.559** (0.037)
DGDP	-0.430* (0.089)	-0.448* (0.083)	-0.430* (0.090)	-0.373 (0.142)	-0.457* (0.069)	-0.366 (0.158)	-0.402* (0.093)
INF	- 0.001*** (0.000)	- 0.001*** (0.000)	- 0.001*** (0.000)	- 0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.002*** (0.008)
IQ	1.854** (0.022)	1.803** (0.029)	1.852** (0.022)	1.700** (0.041)	1.784** (0.033)	1.911** (0.022)	1.630* (0.055)
REM	0.277** (0.029)	0.268** (0.038)	0.277** (0.031)	0.301** (0.017)	0.270** (0.039)	0.250* (0.069)	0.158 (0.314)
CO2	- 1.389*** (0.007)	- 1.406*** (0.005)	- 1.389*** (0.006)	- 1.302*** (0.008)	-1.396*** (0.006)	-1.573*** (0.007)	-0.853 (0.186)
OPEN		0.244 (0.714)					
MTRADE			0.005 (0.992)				
ECI				-1.054 (0.221)			
POPG					-0.183 (0.606)		
ICT						0.114 (0.437)	
PRIV							-0.278 (0.382)
CONSTANT	5.349 (0.263)	5.321 (0.268)	5.344 (0.277)	6.105 (0.224)	6.327 (0.197)	6.092 (0.205)	1.298 (0.838)
Observations	284	284	284	283	284	284	280
Countries	48	48	48	48	48	48	47
R-squared	0.213	0.214	0.213	0.222	0.214	0.215	0.179
Wald Statistics	12.77	11.51	11.32	12.43	12.25	12.04	4.30
P Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman Test P Value	(24.74) 0.0002)	------------	------------	------------ --	------------	------------	--------------
Notes: As for Table 5.1							

Table D3: Regression Results of MFPG_H (Fixed Effect Model): 5-YEARS AVERAGES

Dep. Var. MFPG_H	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Initial level of MFPG_H	-0.194** (0.019)	-0.192** (0.019)	-0.198** (0.016)	-0.193** (0.022)	-0.193** (0.020)	-0.198** (0.014)	-0.202** (0.012)
FDI	0.356** (0.011)	0.352** (0.014)	0.273* (0.074)	0.362** (0.018)	0.379** (0.015)	0.400*** (0.006)	0.399*** (0.008)
GSIZE	-1.717* (0.056)	-1.765* (0.051)	-1.711* (0.055)	-1.700* (0.064)	-1.697* (0.064)	-1.753** (0.047)	-1.766** (0.046)
INF	-1.249** (0.022)	-1.247** (0.021)	-1.188** (0.025)	-1.254** (0.021)	-1.259** (0.021)	-1.241** (0.020)	-1.288** (0.021)
CO2	-1.569*** (0.000)	-1.524*** (0.002)	-2.326*** (0.004)	-1.539*** (0.003)	-1.483*** (0.002)	-1.343*** (0.005)	-1.205* (0.068)
DGDP	-1.282** (0.016)	-1.264** (0.017)	-1.185** (0.027)	-1.274** (0.022)	-1.274** (0.017)	-1.217** (0.022)	-1.261** (0.016)
IQ	2.171** (0.029)	2.173** (0.033)	2.501** (0.024)	2.176** (0.029)	2.162** (0.026)	2.240** (0.025)	2.022* (0.053)
ECI		0.018 (0.986)					
ICT			0.207 (0.168)				
OPEN				-0.135 (0.858)			
MTRADE					-0.375 (0.576)		
POPG						0.458 (0.214)	
ADR							1.473 (0.385)
Constant	21.642*** (0.005)	21.194*** (0.006)	24.523*** (0.002)	21.807*** (0.003)	22.164*** (0.003)	17.967** (0.030)	12.422 (0.347)
Observations	262	261	262	262	262	262	262
R-squared	0.278	0.277	0.286	0.278	0.279	0.284	0.282
Wald Statistics	5.53	4.83	5.04	4.95	4.91	4.88	5.36
P Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Countries	48	48	48	48	48	48	48

Notes: As for Table 5.1

Table D4: A Priori Expectations for the Explanatory and Control Variables used in the Regression Analysis

Variable	Priori Sign	Yearly data sign / outcome	Rationale	5 Years averages sign / outcome	Rationale
INV	+ve	+ve	Consistent with a priori expectations	+ve	Consistent with a priori expectations
GSIZE	-ve	-ve	Consistent with a priori expectations	-ve	Consistent with a priori expectations
INF	-ve	-ve	Consistent with a priori expectations	-ve	Consistent with a priori expectations
GDPG	-ve	-ve	Consistent with a priori expectations	-ve	Consistent with a priori expectations
PRIV	+ve	-ve	Most of the people in developing nations are still lagging in the adoption of financial products and services. The inadequate financial services coupled with underdeveloped financial sector lead towards a lower industrial value-added and hence productivity growth. This finding is in line with one of the recent empirical attempts by Akinlo et. al. (2021)	-ve	Most of the people in developing nations are still lagging in the adoption of financial products and services. The inadequate financial services coupled with underdeveloped financial sector lead towards a lower industrial value-added and hence productivity growth. This finding is in line with one of the recent empirical attempts by Akinlo et. al. (2021)
HC	+ve	-ve	There are some cross-section and panel data evidence which show either insignificant or significant and negative impact of HC on output growth and TFP growth (among others see Knight et al., 1993; Benhabib and Spiegel, 1994; Hamilton and Monteagudo, 1998; Pritchett, 2001; and Freire-Seren, 2001). So, this finding is also consistent with existing empirical literature.	+ve	Consistent with a priori expectations
IQ	+ve	+ve	Consistent with a priori expectations	+ve	Consistent with a priori expectations
MTRADE	+ve	+ve	Consistent with a priori expectations	+ve	Consistent with a priori expectations

Cont.....

Table D4: A Priori Expectations for the Explanatory and Control Variables used in the Regression Analysis

Variable	Priori Sign	Yearly data sign / outcome	Rationale	5 Years averages sign / outcome	Rationale
OPEN	+ve	+ve /-ve	The empirical evidence on productivity growth effects of OPEN remains rather mixed. Nevertheless, most of the empirical attempts find a positive significant impact of OPEN on growth. (See for example, Keefer and Knack, 1995; Edwards, 1998; Hall and Jones, 1999; Miller and Upadhyay, 2000; Rodrik, 2001; and Alcala and Ciccone, 2004). Edwards (1998) argues that more open countries experienced faster productivity growth. Similarly, Miller and Upadhyay (2000) find a positive significant impact of OPEN on productivity growth. Contrarily, Rodriguez and Rodrik (2000) do not find a significant and robust impact of OPEN on growth.	+ve /-ve	The empirical evidence on productivity growth effects of OPEN remains rather mixed. Nevertheless, most of the empirical attempts find a positive significant impact of OPEN on growth. (See for example, Keefer and Knack, 1995; Edwards, 1998; Hall and Jones, 1999; Miller and Upadhyay, 2000; Rodrik, 2001; and Alcala and Ciccone, 2004). Edwards (1998) argues that more open countries experienced faster productivity growth. Similarly, Miller and Upadhyay (2000) find a positive significant impact of OPEN on productivity growth. Contrarily, Rodriguez and Rodrik (2000) do not find a significant and robust impact of OPEN on growth.
FDI	+ve	+ve	Consistent with a priori expectations	+ve	Consistent with a priori expectations
REM	+ve	-ve	The possible reason might be that remittances are mainly devoted to daily consumption needs and altruistic motives.	+ve	Consistent with a priori expectations
ICT	+ve	+ve	Consistent with a priori expectations	+ve	Consistent with a priori expectations
CO2	-ve	-ve	Consistent with a priori expectations	-ve	Consistent with a priori expectations
ADR	-ve	-ve	Consistent with a priori expectations	N/A	N/A
ECI	+ve	-ve	Negative but insignificant	+ve	Consistent with a priori expectations
POPG	-ve	+ve /-ve	In most of the cases, consistent with a priori expectations	-ve	Consistent with a priori expectations

Appendix E.

Table E1: Direct, Indirect and Conditional Effects of Public Debt on MFPG (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
INV, MFPG	(1) INV	(2) MFPG	(3) INV	(4) MFPG
Initial level of MFP		-0.075*** (0.000)		-0.132*** (0.000)
DGDP	0.414*** (0.000)	-0.343*** (0.000)	0.037*** (0.003)	-2.496*** (0.000)
INV		0.934*** (0.000)		5.773*** (0.000)
DGDP*INV				0.709*** (0.000)
HC				-6.198*** (0.000)
IQ				3.040*** (0.000)
OPEN				1.070*** (0.000)
PRIV				-0.871*** (0.000)
GSIZE				-1.700*** (0.000)
INF				-0.936*** (0.000)
ICT				0.217*** (0.000)
POPG				-0.387*** (0.001)
RPCGDP			0.180*** (0.000)	
Indirect Effects of Public Debt on MFPG (5-YEAR AVERAGES)				
Investment (INV) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		0.215*** (0.004)	0.068	0.362
Conditional Effects of Public Debt on MFPG (5-YEAR AVERAGES)				
Investment (INV) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of IQ (25th percentile)		0.493*** (0.005)	0.148	0.837
Average level of IQ (50th percentile)		0.525*** (0.005)	0.155	0.895
High level of IQ (75th percentile)		0.555** (0.006)	0.161	0.949
Observations	267	267	260	260
Countries	49	49	49	49

Notes: As for Table 6.1. DGDP*INV is the interaction of public debt and investment. RPCGDP is the Real GDP per capita.

Table E2: Direct, Indirect and Conditional Effects of Public Debt on MFPG_H (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
INV, MFPG_H	(1) INV	(2) MFPG_H	(3) INV	(4) MFPG_H
Initial level of MFP_H		-0.063*** (0.000)		-0.184*** (0.000)
DGDP	0.736*** (0.000)	-0.550*** (0.000)	0.421*** (0.000)	-2.134*** (0.000)
INV		-0.815*** (0.000)		-2.348*** (0.000)
DGDP*INV				0.407*** (0.000)
PRIV				-0.448*** (0.000)
GSIZE				0.118*** (0.004)
OPEN				0.816*** (0.000)
ECI				1.244*** (0.000)
IQ				2.466*** (0.000)
INF				-0.637*** (0.000)
POPG				-0.150*** (0.000)
CO2PC				-0.414*** (0.000)
RPCGDP			0.196*** (0.000)	
Indirect Effects of Public Debt on MFPG_H (5-YEAR AVERAGES)				
Investment (INV) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-0.989*** (0.000)	-1.279	-0.699
Conditional Effects of Public Debt on MFPG_H (5-YEAR AVERAGES)				
Investment (INV) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of INV (25th percentile)		0.814*** (0.000)	0.548	1.081
Average level of INV (50th percentile)		1.024*** (0.000)	0.695	1.353
High level of INV (75th percentile)		1.221** (0.000)	0.833	1.608
Observations	273	273	263	263
Countries	49	49	49	49

Notes: As for Table 6.1. DGDP*INV is the interaction of public debt and investment. RPCGDP is the Real GDP per capita.

Table E3: Direct, Indirect and Conditional Effects of Human Capital On MFPG (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
IQ, MFPG	(1) IQ	(2) MFPG	(3) IQ	(4) MFPG
Initial level of MFP		0.021 (0.421)		-0.169*** (0.000)
HC	0.696*** (0.000)	1.476*** (0.000)	1.843*** (0.000)	-1.280** (0.015)
IQ		0.564*** (0.000)		1.579*** (0.000)
HC*IQ				0.291** (0.018)
GSIZE				-0.587*** (0.000)
INV				0.728*** (0.000)
OPEN				0.247*** (0.000)
PRIV				0.565*** (0.000)
INF				-0.671*** (0.000)
M2				-1.899*** (0.000)
ICT				0.115*** (0.000)
POPG				0.197*** (0.000)
FDI				0.295*** (0.000)
GDPG			0.035* (0.085)	

Indirect Effects of Human Capital on MFPG (5-YEAR AVERAGES)			
Institutional Quality (IQ) (Mediator or Channel Variable)	**Indirect Effects**	**95% Confidence Interval**	
	2.911*** (0.000)	2.338	3.484

Conditional Effects of Human Capital on MFPG (5-YEAR AVERAGES)			
Institutional Quality (IQ) (Moderator Variable)	**Conditional Effects**	**95% Confidence Interval**	
Low level of IQ (25th percentile)	3.859*** (0.000)	2.726	4.992
Average level of IQ (50th percentile)	4.399*** (0.000)	2.823	5.975
High level of IQ (75th percentile)	4.874*** (0.000)	2.891	6.857

Observations	286	286	255	255
Countries	49	49	49	49

Notes: As for Table 6.1. HC*IQ is the interaction of HC and institutional quality. GDPG is the GDP growth.

Table E4: Direct, Indirect and Conditional Effects of Institutional Quality on MFPG (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
OPEN, MFPG	(1) OPEN	(2) MFPG	(3) OPEN	(4) MFPG
Initial level of MFP		-0.580*** (0.000)		-0.090*** (0.000)
IQ	0.961*** (0.000)	1.100*** (0.000)	-0.799*** (0.000)	1.695*** (0.000)
OPEN		-1.090*** (0.000)		0.110 (0.161)
IQ*OPEN				0.102*** (0.000)
HC				-0.852*** (0.000)
PRIV				0.068*** (0.000)
GOV				-0.493*** (0.000)
INV				0.118*** (0.001)
DGDP				-0.131*** (0.000)
M2				-1.379*** (0.000)
INF				-0.831*** (0.000)
ECI				0.603*** (0.000)
ICT				0.275*** (0.000)
POPG				-0.180*** (0.000)
MTRADE			1.974*** (0.000)	
Indirect Effects of Institutional Quality on MFPG (5-YEAR AVERAGES)				
Trade Openness (OPEN) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-0.088 (0.169)	-0.213	0.037
Conditional Effects of Institutional Quality on MFPG (5-YEAR AVERAGES)				
Trade Openness (OPEN) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of OPEN (25th percentile)		-1.316*** (0.000)	-1.803	-0.830
Average level of OPEN (50th percentile)		-1.442*** (0.000)	-1.983	-0.900
High level of OPEN (75th percentile)		-1.582*** (0.000)	-2.186	-0.977
Observations	278	278	263	263
Countries	49	49	49	49

Notes: As for Table 6.1. IQ*OPEN is the interaction of institutional quality and trade openness. MTRADE is ratio of merchandise trade to GDP.

Table E5: Direct, Indirect and Conditional Effects of Institutional Quality on MFPG_H (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
OPEN, MFPG_H	(1) OPEN	(2) MFPG_H	(3) OPEN	(4) MFPG_H
Initial level of MFP-H		-0.101*** (0.000)		-0.219*** (0.000)
IQ	-1.882*** (0.000)	3.171*** (0.000)	0.144*** (0.000)	2.641*** (0.000)
OPEN		-0.306*** (0.000)		-1.430** (0.036)
IQ*OPEN				0.782*** (0.000)
INV				1.471*** (0.001)
PRIV				1.744*** (0.000)
GSIZE				0.729* (0.054)
DGDP				-0.841*** (0.000)
INF				-1.123*** (0.000)
M2				-5.657*** (0.000)
CO2PC				-0.611*** (0.000)
POPG				-0.074 (0.582)
MTRADE			0.930*** (0.000)	
REM			0.028*** (0.000)	

Indirect Effects of Institutional Quality on MFPG (5-YEAR AVERAGES)

Trade Openness (OPEN) (Mediator or Channel Variable)	Indirect Effects	95% Confidence Interval	
	-0.205** (0.038)	-0.400	-0.011

Conditional Effects of Institutional Quality on MFPG (5-YEAR AVERAGES)

Trade Openness (OPEN) (Moderator Variable)	Conditional Effects	95% Confidence Interval	
Low level of OPEN (25th percentile)	1.462*** (0.000)	0.910	2.014
Average level of OPEN (50th percentile)	1.655*** (0.000)	1.021	2.290
High level of OPEN (75th percentile)	1.843*** (0.000)	1.127	2.558

Observations	278	278	254	254
Countries	49	49	49	49

Notes: As for Table 6.1. IQ*OPEN is the interaction of institutional quality and trade openness. MTRADE is ratio of merchandise trade to GDP.

Table E6: Direct, Indirect and Conditional Effects of Openness on MFPG (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
IQ, MFPG	(1) **IQ**	(2) **MFPG**	(3) **IQ**	(4) **MFPG**
Initial level of MFP		-1.334*** (0.000)		-0.106*** (0.000)
OPEN	0.122*** (0.000)	-3.136*** (0.000)	0.699*** (0.000)	-0.420*** (0.000)
IQ		4.207*** (0.000)		0.375*** (0.000)
OPEN*IQ				0.237*** (0.000)
HC				-0.844*** (0.000)
PRIV				-0.583*** (0.000)
GSIZE				0.014 (0.716)
INV				0.482*** (0.000)
DGDP				-0.052*** (0.004)
INF				-0.853*** (0.000)
ECI				0.588*** (0.000)
ICT				0.210*** (0.000)
CO2PC				-0.031* (0.063)
POPG				-0.145*** (0.000)
RPCGDP			0.154*** (0.000)	
Indirect Effects of Openness on MFPG (5-YEAR AVERAGES)				
Institutional Quality (IQ) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		0.262*** (0.000)	0.170	0.354
Conditional Effects of Openness on MFPG (5-YEAR AVERAGES)				
Institutional Quality (IQ) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of IQ (25th percentile)		2.759*** (0.000)	2.023	3.496
Average level of IQ (50th percentile)		3.013*** (0.000)	2.206	3.821
High level of IQ (75th percentile)		3.299*** (0.000)	2.411	4.185
Observations	278	278	263	263
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN *IQ is the interaction of trade openness and institutional quality. RPCGDP is the real per capita GDP.

Table E7: Direct, Indirect and Conditional Effects of Openness on MFP_H (5-YEAR AVERAGES)

Dependent Variables IQ, MFPG_H	(1) Baseline Model (1) IQ	(1) Baseline Model (2) MFPG_H	(2) Final Model (3) IQ	(2) Final Model (4) MFPG_H
Initial level of MFP-H		-0.060*** (0.000)		-0.266*** (0.000)
OPEN	-0.430*** (0.000)	-0.249*** (0.000)	0.110*** (0.000)	-2.256*** (0.002)
IQ		1.711*** (0.000)		2.123*** (0.000)
OPEN*IQ				1.094*** (0.000)
PRIV				1.318*** (0.000)
GSIZE			0.266*** (0.000)	0.969*** (0.004)
DGDP				-2.264*** (0.000)
INF				-0.453*** (0.009)
M2				-3.320*** (0.000)
ECI				1.539*** (0.000)
POPG				0.449*** (0.000)
CO2PC				-0.653*** (0.000)
FDI			0.032*** (0.000)	
Indirect Effects of Openness on MFPG_H (5-YEAR AVERAGES)				
Institutional Quality (IQ) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		0.233*** (0.000)	0.118	0.349
Conditional Effects of Openness on MFPG_H (5-YEAR AVERAGES)				
Institutional Quality (IQ) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of IQ (25th percentile)		1.992*** (0.000)	1.219	2.764
Average level of IQ (50th percentile)		2.188*** (0.000)	1.334	3.042
High level of IQ (75th percentile)		2.373*** (0.000)	1.442	3.305
Observations	2856	285	254	254
Countries	49	49	49	49

Notes: As for Table 6.1. IQ*OPEN is the interaction of institutional quality and trade openness. MTRADE is ratio of merchandise trade to GDP.

Table E8: Direct, Indirect and Conditional Effects of Investment on MFPG (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
DGDP, MFPG	(1) **DGDP**	(2) **MFPG**	(3) **DGDP**	(4) **MFPG**
Initial level of MFP		-0.042*** (0.000)		-0.089*** (0.000)
INV	1.260*** (0.000)	0.632*** (0.000)	0.838*** (0.000)	0.837*** (0.000)
DGDP		0.441*** (0.000)		0.288** (0.022)
INV*DGDP				-0.128*** (0.005)
HC				0.247 (0.109)
IQ				0.768*** (0.000)
GSIZE			0.629*** (0.000)	-0.474*** (0.000)
FDI				0.373*** (0.000)
ICT				0.070*** (0.000)
M2				-0.979*** (0.000)
INF				-0.562*** (0.000)
POPG				0.158*** (0.000)
GDPG			-0.077*** (0.001)	

Indirect Effects of Investment on MFPG (5-YEAR AVERAGES)

Public Debt (DGDP) (Mediator or Channel Variable)	Indirect Effects	95% Confidence Interval	
	0.241** (0.031)	0.022	0.461

Conditional Effects of Investment on MFPG (5-YEAR AVERAGES)

Public Debt (DGDP) (Moderator Variable)	Conditional Effects	95% Confidence Interval	
Low level of Public Debt (25th percentile)	-0.884** (0.008)	-1.540	-0.227
Average level of Public Debt (50th percentile)	-1.015** (0.009)	-1.772	-0.258
High level of Public Debt (75th percentile)	-1.137** (0.009)	-1.988	-0.286

	(1)	(2)	(3)	(4)
Observations	267	267	251	251
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN *IQ is the interaction of trade openness and institutional quality. RPCGDP is the real per capita GDP.

Table E9: Direct, Indirect and Conditional Effects of Investment on MFPG_H (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
DGDP, MFPG_H	(1) DGDP	(2) MFPG	(3) DGDP	(4) MFPG
Initial level of MFP-H		-0.069*** (0.000)		-0.131*** (0.000)
INV	1.314*** (0.000)	0.885*** (0.000)	1.176*** (0.000)	1.264*** (0.000)
DGDP		-0.614** (0.000)		-0.259** (0.031)
INV*DGDP				-0.133*** (0.003)
PRIV				-0.139** (0.018)
OPEN				0.138** (0.028)
IQ				1.008*** (0.000)
ICT				0.079*** (0.000)
M2				-0.668*** (0.000)
INF				-0.927*** (0.000)
CO2				-0.060*** (0.004)
GDPG			-0.148*** (0.000)	
GSIZE			0.442*** (0.007)	
Indirect Effects of Investment on MFPG_H (5-YEAR AVERAGES)				
Public Debt (DGDP) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-0.305** (0.032)	-0.584	-0.026
Conditional Effects of Investment on MFPG_H (5-YEAR AVERAGES)				
Public Debt (DGDP) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Public Debt (25th percentile)		-1.948** (0.000)	-2.867	-1.029
Average level of Public Debt (50th percentile)		-2.139** (0.000)	-3.189	-1.089
High level of Public Debt (75th percentile)		-2.318** (0.009)	-3.491	-1.145
Observations	273	273	267	267
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN *IQ is the interaction of trade openness and institutional quality. RPCGDP is the real per capita GDP.

Table E10: Direct, Indirect and Conditional Effects of Openness on MFPG (5-YEAR AVERAGES)

Dependent Variables ECI, MFPG	(1) Baseline Model (1) ECI	 (2) MFPG	(2) Final Model (3) ECI	 (4) MFPG
Initial level of MFP		-0.100*** (0.000)		-0.108** (0.045)
OPEN	0.321*** (0.000)	0.427*** (0.000)	0.109*** (0.000)	3.384*** (0.000)
ECI		2.003*** (0.000)		9.593*** (0.000)
OPEN*ECI		-0.708*** (0.000)		-2.412*** (0.000)
ICT			0.033*** (0.000)	0.127* (0.059)
HC				-3.651*** (0.000)
INF				-1.060*** (0.000)
M2				-3.480*** (0.000)
LDGDP				-1.001*** (0.000)
PRIV				0.762*** (0.009)
IQ				2.066*** (0.000)
POPG				-1.290*** (0.000)
Indirect Effects of Openness on MFP Growth (5-YEAR AVERAGES)				
Innovation (ECI) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		1.048*** (0.000)	0.574	1.522
Conditional Effects of Openness on MFP Growth (5-YEAR AVERAGES)				
ECI (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Innovation (25th percentile)		0.336*** (0.000)	0.158	0.514
Average level of Innovation (50th percentile)		0.104* (0.084)	-0.014	0.220
High level of Innovation (75th percentile)		-0.094 (0.144)	-0.220	0.032
Observations	277	277	270	270
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN *ECI is the interaction of trade openness and economic complexity index used as a proxy for innovation capacity.

Table E11: Direct, Indirect and Conditional Effects of Openness on MFPG_H (5-YEAR AVERAGES)

Dependent Variables	(1) Baseline Model		(2) Final Model	
ECI, MFPG_H	(1) ECI	(2) MFPG_H	(3) ECI	(4) MFPG_H
Initial level of MFP-H		-0.206*** (0.000)		-0.103*** (0.000)
OPEN	0.095*** (0.000)	-0.691*** (0.000)	-0.336*** (0.005)	1.183*** (0.000)
ECI		4.228*** (0.000)		4.674*** (0.000)
OPEN*ECI				-1.118*** (0.000)
INV				0.496*** (0.000)
GSIZE				-0.226*** (0.000)
ICT			-0.016 (0.551)	0.148*** (0.000)
INF				-0.945*** (0.000)
M2				-0.865*** (0.000)
PRIV				0.024 (0.201)
POPG				-0.201*** (0.000)
CO2				-0.081*** (0.000)
IQ			0.336** (0.047)	
RPCGDP			0.123* (0.052)	
Indirect Effects of Openness on MFPG_H (5-YEAR AVERAGES)				
Innovation (ECI) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-1.570** (0.005)	-2.666	-0.475
Conditional Effects of Openness on MFPG_H (5-YEAR AVERAGES)				
ECI (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Innovation (25th percentile)		-0.555** (0.005)	-0.943	-0.168
Average level of Innovation (50th percentile)		-0.225** (0.005)	-0.382	-0.067
High level of Innovation (75th percentile)		0.056** (0.020)	0.009	0.105
Observations	284	284	267	267
Countries	49	49	49	49

Notes: As for Table 6.1. OPEN *ECI is the interaction of trade openness and economic complexity index used as a proxy for innovation capacity. RPCGDP is the real per capita GDP.

Table E12: Direct, Indirect and Conditional Effects of Public Debt on MFPG *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
INV, MFPG	(1) INV	(2) MFPG	(3) INV	(4) MFPG
C_DGDP	-0.092 (0.351)	-0.572*** (0.000)	-0.117*** (0.000)	-0.560*** (0.000)
C_INV		2.968*** (0.000)		4.053*** (0.000)
C_DGDP*INV				2.952*** (0.000)
C_HC				-2.857*** (0.000)
C_OPEN				3.295*** (0.000)
C_PRIV				-2.209*** (0.000)
C_INF				-1.469*** (0.000)
C_IQ				2.028*** (0.000)
C_M2			0.190*** (0.000)	-2.828*** (0.000)
C_POPG				-0.415*** (0.001)
C_REM			0.030*** (0.000)	
C_RPCGDP			0.114*** (0.000)	
Indirect Effects of Public Debt on MFPG *(Demeaned Data)*				
Investment (INV) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-0.476*** (0.000)	-0.546	-0.405
Conditional Effects of Public Debt on MFPG *(Demeaned Data)*				
Investment (INV) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of INV (25th percentile)		-0.460*** (0.000)	-0.529	-0.392
Average level of INV (50th percentile)		-0.474*** (0.000)	-0.544	-0.404
High level of INV (75th percentile)		-0.481*** (0.000)	-0.551	-0.410
Observations	1,419	1,419	1,207	1,207
Countries	49	49	49	49

Notes: As for Table 6.1. C_ DGDP*INV is the interaction of public debt and investment. C_ RPCGDP is the Real GDP per capita.

Table E13: Direct, Indirect and Conditional Effects of Public Debt on MFPG_H
(Demeaned Data)

Dependent Variables INV, MFPG_H	(1) Baseline Model		(2) Final Model	
	(1) INV	(2) MFPG_H	(3) INV	(4) MFPG_H
C_DGDP	-0.044*** (0.000)	-0.406*** (0.000)	-0.086*** (0.000)	-1.242*** (0.000)
C_INV		2.512*** (0.000)		5.052*** (0.000)
C_DGDP*INV				3.060*** (0.000)
C_OPEN				1.683*** (0.000)
C_PRIV				-2.164*** (0.000)
C_INF				-1.294*** (0.000)
C_IQ				3.068*** (0.000)
C_M2			0.216*** (0.000)	-3.280*** (0.000)
C_POPG				-0.026 (0.802)
C_REM			0.020*** (0.000)	
C_RPCGDP			0.149*** (0.000)	
C_DGDP			-0.086*** (0.000)	-1.242*** (0.000)
Indirect of Public Debt on MFPG_H ***(Demeaned Data)***				
Investment (INV) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		-0.436*** (0.000)	-0.504	-0.368
Conditional Effects of Public Debt on MFPG ***(Demeaned Data)***				
Investment (INV) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of INV (25th percentile)		-0.424*** (0.000)	-0.490	-0.358
Average level of INV (50th percentile)		-0.434*** (0.000)	-0.502	-0.367
High level of INV (75th percentile)		-0.440*** (0.000)	-0.508	-0.372
Observations	1,464	1,464	1,207	1,207
Countries	49	49	49	49

Notes: As for Table 6.1. C_ DGDP*INV is the interaction of public debt and investment. C_ RPCGDP is the Real GDP per capita.

Table E14: Direct, Indirect and Conditional Effects of Human Capital on MFPG *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
IQ, MFPG	(1) IQ	(2) MFPG	(3) IQ	(4) MFPG
C_HC	-3.120*** (0.000)	2.800*** (0.000)	1.115*** (0.002)	0.918*** (0.000)
C_IQ		3.358*** (0.000)		2.504*** (0.000)
C_HC*IQ				13.726*** (0.000)
C_INV				2.754*** (0.000)
C_OPEN				1.883*** (0.000)
C_PRIV				-0.541*** (0.000)
C_GSIZE				-1.230*** (0.000)
C_M2				-3.644*** (0.000)
C_ECI				0.785*** (0.000)
C_ICT				0.197*** (0.000)
C_CO2PC				1.477*** (0.000)
C_POPG				0.566*** (0.000)
Indirect Effects of Human Capital on MFPG *(Demeaned Data)*				
Institutional Quality (IQ) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		2.793*** (0.002)	1.012	4.573
Conditional Effects of Human Capital on MFPG *(Demeaned Data)*				
Institutional Quality (IQ) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of IQ (25th percentile)		2.797*** (0.002)	1.014	4.580
Average level of IQ (50th percentile)		2.890*** (0.002)	1.048	4.732
High level of IQ (75th percentile)		3.032*** (0.002)	1.099	4.965
Observations	1,483	1,483	1,301	1,301
Countries	49	49	49	49

Notes: As for Table 6.1. C_ HC*IQ is the interaction of HC and institutional quality. C_ GDPG is the GDP growth.

Table E15: Direct, Indirect and Conditional Effects of Institutional Quality on MFPG *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
OPEN, MFPG	(1) **OPEN**	(2) **MFPG**	(3) **OPEN**	(4) **MFPG**
C_IQ	0.442** (0.018)	3.267*** (0.000)	0.611*** (0.000)	2.985*** (0.000)
C_OPEN		0.642*** (0.000)		3.243*** (0.000)
C_IQ*OPEN				5.165*** (0.000)
C_HC				0.257 (0.753)
C_GSIZE				-4.565*** (0.000)
C_PRIV				-1.459*** (0.000)
C_INV				0.661** (0.030)
C_DGDP				-0.939*** (0.000)
C_ECI				2.601*** (0.000)
C_INF				-0.000 (0.949)
C_CO2PC				-0.243 (0.497)
C_POPG				-0.251* (0.062)
Indirect Effects of Institutional Quality on MFP Growth *(Demeaned Data)*				
Trade Openness (OPEN) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		1.981*** (0.000)	1.638	2.324
Conditional Effects of Institutional Quality on MFP Growth *(Demeaned Data)*				
Trade Openness (OPEN) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of OPEN (25th percentile)		1.962*** (0.000)	1.6197	2.305
Average level of OPEN (50th percentile)		1.990*** (0.000)	1.647	2.332
High level of OPEN (75th percentile)		2.063*** (0.000)	1.717	2.408
Observations	1,467	1,467	1,258	1,258
Countries	49	49	49	49

Notes: As for Table 6.1. C_ IQ*OPEN is the interaction of institutional quality and trade openness. C_MTRADE is ratio of merchandise trade to GDP.

Table E16: Direct, Indirect and Conditional Effects of Institutional Quality on MFPG *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
OPEN, MFPG_H	(1) OPEN	(2) MFPG_H	(3) OPEN	(4) MFPG_H
C_IQ	0.541*** (0.002)	4.158*** (0.000)	0.173*** (0.000)	4.493*** (0.000)
C_OPEN		0.226*** (0.000)		1.511*** (0.000)
C_IQ*OPEN				5.003*** (0.000)
C_GSIZE				-4.455*** (0.000)
C_PRIV				-1.463*** (0.000)
C_INV				4.819*** (0.000)
C_DGDP				-1.534*** (0.000)
C_ECI				3.512*** (0.000)
C_INF				-0.144 (0.611)
C_ICT				0.095** (0.038)
C_CO2PC				-0.568* (0.070)
C_POPG				0.253** (0.042)
C_HC			0.237*** (0.000)	
C_MTRADE			0.725*** (0.000)	
C_REM			0.016*** (0.000)	
Indirect Effects of IQ on MFPG *(Demeaned Data)*				
Trade Openness (OPEN) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		0.261*** (0.000)	0.166	0.356
Conditional Effects of IQ on MFPG *(Demeaned Data)*				
Trade Openness (OPEN) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of OPEN (25th percentile)		0.256*** (0.000)	0.161	0.351
Average level of OPEN (50th percentile)		0.263*** (0.000)	0.169	0.358
High level of OPEN (75th percentile)		0.283*** (0.000)	0.188	0.379
Observations	1,523	1,523	1,191	1,191
Countries	49	49	49	49

Notes: As for Table 6.1. C_ IQ*OPEN is the interaction of institutional quality and trade openness. C_MTRADE is ratio of merchandise trade to GDP.

Table E17: Direct, Indirect and Conditional Effects of Openness on MFPG *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
IQ, MFPG	(1) IQ	(2) MFPG	(3) IQ	(4) MFPG
C_OPEN	0.100 (0.337)	-1.819*** (0.000)	0.072*** (0.000)	-3.136*** (0.004)
C_IQ		6.369*** (0.000)		3.861*** (0.000)
C_OPEN*IQ				8.036*** (0.001)
C_HC				3.514* (0.084)
C_PRIV				-1.446*** (0.001)
C_GSIZE				-4.434*** (0.000)
C_INV				3.143*** (0.000)
C_DGDP				0.188 (0.562)
C_MTRADE				2.293** (0.019)
C_ICT				0.079 (0.476)
C_INF				-0.004 (0.773)
C_M2				0.778 (0.280)
C_POPG				0.708*** (0.000)
C_FDI			0.107*** (0.000)	
Indirect Effects of Openness on MFPG *(Demeaned Data)*				
Institutional Quality (IQ) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		0..278*** (0.000)	0.131	0.424
Conditional Effects of Openness on MFPG *(Demeaned Data)*				
Institutional Quality (IQ) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of IQ (25th percentile)		0.274*** (0.000)	0.129	0.419
Average level of IQ (50th percentile)		0.279*** (0.000)	0.133	0.425
High level of IQ (75th percentile)		0.292*** (0.000)	0.142	0.443
Observations	1,467	1,467	1,165	1,165
Countries	49	49	49	49

Notes: As for Table 6.1. C_ OPEN *IQ is the interaction of trade openness and institutional quality. RPCGDP is the real per capita GDP.

Table E18: Direct, Indirect and Conditional Effects of Openness on MFPG_H *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
IQ, MFPG_H	(1) IQ	(2) MFPG_H	(3) IQ	(4) MFPG_H
C_OPEN	-0.358*** (0.000)	0.428*** (0.000)	0.145*** (0.000)	-3.390*** (0.000)
C_IQ		3.395*** (0.000)		3.591*** (0.000)
C_OPEN*IQ				8.145*** (0.000)
C_PRIV				-1.830*** (0.000)
C_GSIZE				-5.405*** (0.000)
C_INV				5.411*** (0.000)
C_DGDP				-1.506*** (0.000)
C_MTRADE			-0.193*** (0.000)	3.958*** (0.000)
C_INF				-1.124** (0.036)
C_POPG				0.772*** (0.000)
C_FDI			0.047*** (0.000)	
C_HC			0.712*** (0.000)	
C_ECI			0.012 (0.658)	
Indirect Effects of Openness on MFPG_H *(Demeaned Data)*				
Institutional Quality (IQ) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		0..520*** (0.000)	0.234	0.807
Conditional Effects of Openness on MFPG_H *(Demeaned Data)*				
Institutional Quality (IQ) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of IQ (25th percentile)		0.513*** (0.000)	0.230	0.796
Average level of IQ (50th percentile)		0.523*** (0.000)	0.236	0.811
High level of IQ (75th percentile)		0.551*** (0.000)	0.251	0.851
Observations	1,523	1,523	1,165	1,165
Countries	49	49	49	49

Notes: As for Table 6.1. C_ OPEN *IQ is the interaction of trade openness and institutional quality. C_ RPCGDP is the real per capita GDP.

Table E19: Direct, Indirect and Conditional Effects of Investment on MFPG *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
DGDP, MFPG	(1) **DGDP**	(2) **MFPG**	(3) **DGDP**	(4) **MFPG**
C_INV	-0.340* (0.062)	2.957*** (0.000)	-1.233*** (0.000)	1.870*** (0.000)
C_DGDP		-0.604*** (0.000)		-0.997*** (0.000)
C_INV*DGDP				-0.228* (0.086)
C_HC				2.473*** (0.000)
C_OPEN				1.193*** (0.000)
C_PRIV				-0.409*** (0.000)
C_GOV				-1.584*** (0.000)
C_IQ				4.202*** (0.000)
C_M2				-3.266*** (0.000)
C_ECI				2.003*** (0.000)
C_CO2PC				1.116*** (0.000)
C_POPG				0.005 (0.892)
C_GDPG			-0.347*** (0.000)	
Indirect Effects of Investment on MFPG				
Public Debt (DGDP) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		1.229*** (0.000)	0.842	1.615
Conditional Effects of Investment on MFPG				
Public Debt (DGDP) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Public Debt (25th percentile)		1.216*** (0.000)	0.831	1.600
Average level of Public Debt (50th percentile)		1.227*** (0.000)	0.841	1.613
High level of Public Debt (75th percentile)		1.232*** (0.000)	0.845	1.620
Observations	1,419	1,419	1,264	1,264
Countries	49	49	49	49

Notes: As for Table 6.1. C_ OPEN *IQ is the interaction of trade openness and institutional quality. C_ RPCGDP is the real per capita GDP.

Table E20: Direct, Indirect and Conditional Effects of Investment on MFPG_H *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
DGDP, MFPG_H	(1) DGDP	(2) MFPG_H	(3) DGDP	(4) MFPG_H
C_INV	-0.038** (0.035)	4.727*** (0.000)	-0.618*** (0.000)	1.898*** (0.000)
C_DGDP		-2.322*** (0.000)		-2.136*** (0.000)
C_INV*DGDP				-3.098*** (0.000)
C_OPEN				2.364*** (0.000)
C_PRIV				-2.761*** (0.000)
C_GSIZE			-0.088** (0.011)	-5.699*** (0.000)
C_IQ				2.516*** (0.000)
C_M2				-0.194 (0.542)
C_ECI				3.311*** (0.000)
C_INF			0.047** (0.029)	-1.812*** (0.000)
C_CO2PC				3.489*** (0.000)
C_POPG				1.639*** (0.000)
C_GDPG			-0.016*** (0.000)	
Indirect Effects of Investment on MFPG_H *(Demeaned Data)*				
Public Debt (DGDP) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		1.320*** (0.000)	1.129	1.511
Conditional Effects of Investment on MFPG *(Demeaned Data)*				
Public Debt (DGDP) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Public Debt (25th percentile)		1.232*** (0.000)	1.042	1.423
Average level of Public Debt (50th percentile)		1.309*** (0.000)	1.118	1.499
High level of Public Debt (75th percentile)		1.346*** (0.000)	1.154	1.537
Observations	1,464	1,464	1,235	1,235
Countries	49	49	49	49

Notes: As for Table 6.1. C_ OPEN *IQ is the interaction of trade openness and institutional quality. C _RPCGDP is the real per capita GDP.

Table E21: Direct, Indirect and Conditional Effects of Openness on MFPG *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
ECI, MFPG	(1) ECI	(2) MFPG	(3) ECI	(4) MFPG
C_OPEN	-0.014*** (0.000)	4.050*** (0.000)	0.050*** (0.000)	-5.428*** (0.000)
C_ECI		1.485*** (0.000)		3.879*** (0.000)
C_OPEN*ECI				26.797*** (0.000)
C_HC				16.084*** (0.000)
C_ICT			0.009*** (0.000)	0.731*** (0.000)
C_MTRADE				6.716*** (0.000)
C_GSIZE				-2.743*** (0.000)
C_INV				9.342*** (0.000)
C_INF				-2.182*** (0.000)
C_M2				-10.393*** (0.000)
C_POPG				0.260** (0.050)
C_PRIV			-0.051*** (0.000)	
Indirect Effects of Openness on MFPG *(Demeaned Data)*				
Innovation (ECI) (Mediator or Channel Variable)		**Indirect Effects**	**95% Confidence Interval**	
		1.048*** (0.000)	0.574	1.522
Conditional Effects of Openness on MFPG *(Demeaned Data)*				
Innovation (ECI) (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Innovation (25th percentile)		1.048*** (0.000)	0.127	0.241
Average level of Innovation (50th percentile)		0.193*** (0.000)	0.135	0.252
High level of Innovation (75th percentile)		0.203*** (0.000)	0.144	0.264
Observations	1,540	1,540	1,372	1,372
Countries	49	49	49	49

Notes: As for Table 6.1. C_ OPEN *ECI is the interaction of trade openness and economic complexity index used as a proxy for innovation capacity

Table E22: Direct, Indirect and Conditional Effects of Openness on MFPG_H *(Demeaned Data)*

Dependent Variables	(1) Baseline Model		(2) Final Model	
ECI, MFPG_H	(1) ECI	(2) MFPG_H	(3) ECI	(4) MFPG_H
C_OPEN	0.019*** (0.000)	0.731*** (0.005)	0.241*** (0.000)	-0.672*** (0.005)
C_ECI		-3.992*** (0.000)		4.207*** (0.000)
C_OPEN*ECI				2.750* (0.059)
C_MTRADE				1.893*** (0.000)
C_GSIZE				-2.137*** (0.000)
C_INV				4.026*** (0.000)
C_INF				-1.015*** (0.000)
C_M2				-1.741*** (0.000)
C_POPG				0.053 (0.541)
C_CO2				1.454*** (0.000)
C_PRIV			0.018*** (0.000)	
C_ICT			-0.016*** (0.000)	
Indirect Effects of Openness on MFPG *(Demeaned Data)*				
		Indirect Effects	**95% Confidence Interval**	
Innovation (ECI) (Mediator or Channel Variable)		1.014*** (0.000)	0.866	1.161
Conditional Effects of Openness on MFPG *(Demeaned Data)*				
ECI (Moderator Variable)		**Conditional Effects**	**95% Confidence Interval**	
Low level of Innovation (25th percentile)		1.009*** (0.000)	0.862	1.156
Average level of Innovation (50th percentile)		1.014*** (0.000)	0.866	1.161
High level of Innovation (75th percentile)		1.019*** (0.000)	0.871	1.167
Observations	1,540	1,540	1,408	1,408
Countries	49	49	49	49
Notes: As for Table 6.1. C_ OPEN *ECI is the interaction of trade openness and economic complexity index used as a proxy for innovation capacity				