THE IMPACT OF FINANCIAL DEVELOPMENT AND ICT ON TOTAL FACTOR PRODUCTIVITY: A PANEL ANALYSIS OF BRI COUNTRIES

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THESIS AND DEFENSE APPROVAL FORM

The undersigned certify that they have read the following thesis, examined the defense, are satisfied with the overall exam performance, and recommend the thesis to the Faculty of Management Sciences for acceptance.

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ABSTRACT

In this study, we have analyzed the TFP growth in 45 low and middle-income BRI countries. BRI low and middle-income countries have low TFP growth due to many factors. Long-term output growth is significantly influenced by the development of total factor productivity (TFP) in the country. Several determinants have an impact on TFP growth, but this study is specifically examining the impact of ICT and FD on TFP growth. We have also used some control variables which include FDI, Trade, and institutional quality index. The study used the GMM, a dynamic panel data analysis technique, with data from the years 2000 to 2020. Our results found a significant relationship between ICT and TFP. ICT advancements and innovations facilitate economic activities and have improved economic performance. FD and TFP have also shown positive and significant results, which show that financial growth can lower capital expenses and financial risk. FDI and institutional quality index have also a positive association with TFP growth. Only the trade sector has shown negative results, which shows that imports are higher than exports in these countries, also exports are low mainly due to the quality of the exports.

Keywords: Total Factor Productivity, Financial Development, Information and Communication Technology, Generalized Method of Moments

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LIST OF ABBREVATIONS

BRI	Belt & Road Initiative
TFP	Total Factor Productivity
FD	Financial Development
ICT	Information and Communication Technology
FDI	Foreign Direct Investment
IQI	Institutional Quality Index
GMM	Generalized Method of Moments
PCA	Principal Component Analysis
ICRG	International Country Risk Guide
WDI	World Development Indicators
IMF	International Monetary Fund

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DEDICATION

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CHAPTER 1

INTRODUCTION

In most of countries variation in per capita income can be explained by differences in total factor productivity (TFP) rather than differences in inputs such as physical capital, human capital, and labor (Hsieh & Klenow, 2010). It is therefore not surprising that TFP is a common, if not the most common, a measure of the stock of knowledge or technology. Long-term output growth is significantly influenced by the development of total factor productivity (TFP). The countries that were able to increase their TFP grew at a significantly higher rate and for a sustained duration, according to several studies (Colecchia & Schreyer, 2000). Total factor productivity (TFP), usually referred to as multifactor productivity, and measures how efficiently the economy utilizes the inputs necessary to produce goods and services.

Total factor productivity (TFP) is the amount of output that cannot be accounted for by the volume of inputs used in the production process. As a result, its level is based on how efficiently and extensively the inputs are used throughout production. It indicates a change in the production process brought on by technical advancement (Barro, 1999). TFP is essential for understanding how the economy grows and changes, and how per capita income varies across nations. TFP exhibits a strong inverse relationship with output and hours worked at business cycle (RBC) frequencies. The real business cycle literature was started by Kydland and Prescott (1982) as a result of this insight. In the traditional business cycle model, pro-cyclical labor supply and investment spread shock to TFP, leading to variations in output and labor productivity at business cycle frequencies with amplitude that mimics the US data. Subsequent Pro-cyclical fluctuations have been incorporated by work into the observed TFP. Unmeasured capacity utilization and labor hoarding in the regulatory framework, in this manner, shocks to aggregate might cause TFP oscillations. In addition to the conventional interpretation which assigns them to aggregate, demand shocks in supply.

By the allocation of inputs more efficiently and appropriately, TFP can also boost economic growth, which can result in production approaching the ideal ratio of inputs and outputs. (Balk, 2001). A country may produce at the limit of its ability to

produce, but advances in technology push the limit further and allow for the creation of more with the same amount of input. Technical innovation and increases in economic efficiency in the use of factor inputs are essentially incorporated into the idea of TFP growth. Through the impact that economies of scale have on adjusting the scale of operations, TFP may also help to boost economic growth (Jorgenson & Griliches, 1967). The efficiency of factor utilization is determined by many socio-political and economic factors, including government policy, institutions, market structure, and weather shocks, according to Bosworth and Collins (2008), who claim that the TFP evaluates both technical and sociopolitical efficiency.

Productivity growth opens up the possibility for rises in living standards. The rise in productivity is thought to be significantly influenced by investments in information and communication technology (ICT). At the business, industry, and national levels, this link has been thoroughly researched in both developed and developing nations, with the majority of studies demonstrating that ICT has a positive and economically significant impact on productivity. BRI developing countries have low TFP because of a lack of Research and Development and a lack of ICT. The development of the economy is significantly influenced by information and communication technologies (Bresnahan et al., 1999). ICT's importance in promoting economic growth on different fronts is being documented in a growing body of recent development literature. ICT was developed to increase a country's capability for production and economic development (Hong, 2016). ICT can also serve as a beneficial link between national productivity efforts and international value chains. ICT decreases poverty, promotes competitiveness, boosts efficiency, and improves officials' capacity to administer the public sector more effectively. According to a Griffith and Van (2004) study, long-term worker productivity growth is a result of information technology advancement. Estimates from Colecchia and Schreyer (2000) concur with Griffith and Van (2004), who find that ICT has a significant and long-term effect on productivity growth. Information technology can help an economy grow because it stimulates investment, which lowers investment prices and boosts ICT use, and because ICT lowers the cost of newly installed capital, which is essential to an economy's expansion.

Along with ICT, growth in the stock of knowledge is also really important for total factor productivity growth, which can lead to work on Research & Development in the country. Aiming to acquire knowledge in all of their economic activities will help

all nations compete with developed nations and grow their production by following the norms of economic globalization, which are accelerating in the modern world. Investment in knowledge is among the most effective ways to increase productivity, and productivity is the best method to increase output. Economic frontiers are dissolving, and productivity improvement is now the focal point of global economic competitiveness. As a result, a shift to a knowledge-based economy would create the conditions for closing the technical gap between developing and developed nations, boost total factor productivity (TFP), and ultimately lead to continuous and sustainable economic growth. Even though emerging economies usually have low TFP and therefore a high potential for productivity increases through R&D, it may be incorrect to assume that domestic R&D performed in developing economies, whether it's aimed at transferring technology from industrial countries or at discovering new knowledge, also has a significant impact on TFP in these nations. According to (Coe & Helpman, 1995) hypothetically, R&D spending has the potential to boost productivity through different methods. The first benefit is that it enables the production of new products and services that make better use of the resources already in existence. It also makes it simpler to benefit from implementing technological advancements made by other nations. Thirdly, the benefits of international R&D can boost domestic productivity both directly and indirectly. Directly, via learning new manufacturing techniques and technologies, and indirectly, through importing products and services that have new technology built in.

It is observed that any system that performs what finance should perform has to have an impact on economic growth. By encouraging savers to invest a larger portion of their wealth in productive assets and by supporting riskier but more productive technologies, financial institutions can raise total factor productivity (TFP) and the marginal productivity of capital, as demonstrated by Bencivenga and Smith (1991) and Greenwood and Jovanovic (1990). As a result, the steady-state growth rate of income may be permanently and continuously impacted by the progress of the financial sector. The information available currently on the results of financial reforms and the relationship between finance and economic growth is not particularly shocking. Hussein and Mohieldin (1997) showed that interest rate liberalizations had no appreciable effect on savings and investment, while on the other hand Hussein (1999) and Shourbagui (2003) all showed a positive, significant, and one-way association between growth and

bank-based financial development. The impact of the market-based and bank-based financial changes on investment or TFP efficiency, however, has not been examined in any of the research that is currently accessible. This study's objectives are to accomplish that and determine the degree to which the process of fostering wider financial development has been successful in promoting economic efficiency.

This study is analyzing the growth of TFP in BRI low and middle income countries. Belt and Road Initiative (BRI) has been launched with the aim of building land and maritime networks to link Asia with Africa and Europe to enhance regional integration, boost commerce, and foster economic growth. The term, first introduced in 2013 by China's President Xi Jinping, was inspired by the idea of the Silk Road, a network of trade routes that connected China to the Mediterranean through Eurasia for millennia and was established during the Han Dynasty 2,000 years ago. The Belt and Road Initiative (BRI), also known as "One Belt, One Road," is made up of two parts: the Silk Road Economic Belt, a land route linking China to South Asia, South East Asia, Central Asia, Russia, and Europe; and the 21st Century Maritime Silk Road, a water route connecting China's coastal regions to South Asia, the South Pacific, the Middle East, and Eastern Africa to Europe. In addition to power plants and telecommunications networks, the BRI has been linked to a major investment program for the building of infrastructure for ports, highways, trains, and airports. The amount of loans made through China's state-run BRI has decreased since 2019. The BRI is currently emphasizing "high-quality investment" more in Chinese, particularly through utilizing project financing, risk mitigation techniques, and green finance more frequently. 147 countries had signed an MOU (Memorandum of Understanding agreement) with China and joined the Belt and Road Initiative as of March 2022, making the BRI an increasingly significant umbrella framework for China's bilateral commerce with BRI partners.

Since the objective of the BRI project is to boost production capacity and the expansion of the local economy, this study attempts to investigate whether ICT and financial development help the selected 45 BRI countries to attain their goal.

1.1 Objectives of the Study

Based on the discussion in the above chapter, this study's primary objective is to look at the growth of Total Factor Productivity in 45 low and middle-income BRI countries. So, the particular and wide objective of the study is as follows:

- The main objective of this paper is to measure the impact of Information and Communication Technology on the Total factor productivity (TFP) of BRI countries (low and middle-income).
- The second objective of the study is to examine the Financial Development impact on the Total Factor Productivity of BRI countries (low and middle-income).

1.2 Research Questions

I. What is the impact of Information and Communication Technology (ICT) on Total Factor Productivity?

II. What is the impact of Financial Development on Total Factor Productivity?

1.3 Research Hypothesis

Any research project needs to have a strong hypothesis. We would be able to form that hypothesis after analyzing the literature.

H_o: ICT does not affect Total Factor Productivity in BRI Countries.

H_1: ICT affects Total Factor Productivity in BRI Countries.

H_o: Financial Development (FD) does not affect Total Factor Productivity in BRI Countries.

H_1: Financial Development affects Total Factor Productivity in BRI Countries.

1.4 Significance of the Study

In most developed countries, total factor productivity (TFP) is the primary driver of growth. Developing strategies to improve growth prospects requires an understanding of the factors that influence TFP growth. Mostly BRI developing and underdeveloped countries are suffering due to a deficiency of total factor productivity. Growth in total factor productivity is one of the major keys to the development of a country. This study captures the impact of ICT along with financial development on Total Factor Productivity in BRI developing and under-develops countries, which can help out the policymakers to incorporate the results of this research to design policies that may lead to improved TFP in the country. This study also helps researchers and academicians to understand the link between ICT, FD, and TFP. The findings of the study will be helpful for the investors to make strategies to enhance TFP based on FD and ICT.

CHAPTER 2

LITERATURE REVIEW

The study's main goal is to demonstrate how changes in the financial development and in information and communication technology affect total factor productivity. In light of this, the chapter on literature review describes the prior studies that are relevant to our research, along with their methodology and conclusions. Additionally, it discusses the research gap of the study and offers the pertinent facts regarding the research. The research gap for our study is given in the end of this chapter.

2.1 Financial Development and Total Factor Productivity

Increased productivity in emerging nations may result from financial development. Numerous types of research have been done on the expansion of TFP and financial development. Zhang (2005), for instance, uses growth accounting to calculate China's TFP and finds that the country's financial development has a significant positive impact on the growth of its TFP. Zhao (2010) demonstrates how financial development influences financial deepening in the central and western regions but not in the eastern regions, where it promotes TFP development. They estimated TFP growth rate using the nonparametric stochastic frontier DEA approach. The DEA technique examines the mechanism by which financial development influences Chinese TFP by separating TFP into two categories: technological advancement and efficiency improvement. By including the financial institution as a variable, they investigate if the institutional environments in various locations would have an impact on how FD affects TFP growth. The authors' goal is to offer some conceptual and practical backing for China's decision to change its economic model by enacting financial sector reforms. Empirical studies have shown that FD can increase the TFP development, although this impact is notably beneficial and may rely on different factors, according to the currently available literature. For instance, according to Inklaar (2008), not all financial development metrics would enhance TFP growth. The traditional metrics do not significantly drive TFP development, just the financial development efficiency indicator does. The stage of economic growth has a significant impact on the relationship between financial development and TFP, as demonstrated by Rioja (2004). Financial development in wealthy nations will generally encourage TFP growth, but this is not always the case in

developing nations. However, some contrary conclusions might be drawn. For instance, Huang and Lin (2009) found that financial development has a greater beneficial impact on TFP growth in emerging nations.

Another way that financial development influences TFP growth is through the advancement of technology. In their study from 2022, Ali and Malik examined how financial development affected the relationships between knowledge spillover and total factor productivity (TFP). The results show a mutually reinforcing relationship between knowledge spillover and financial development's effects on total factor productivity. The findings suggest that the differences in national wealth seen over the past 20 years may be the result of complementary policies adopted by various countries. So, improved total factor productivity requires complementary policy approaches. In nations without additional reforms, an increase in knowledge spillover would not enhance TFP. These requirements must be met in order for these nations to fully benefit from knowledge spillover; failure to do so will result in lost opportunities. By including business ventures and financial conflict in the neoclassical model, Buera et al. (2008) demonstrate that when talented entrepreneurs face obstacles to obtaining finance, the expansion of little and intermediate size, high businesses is similarly hampered. Financial intermediaries have a dual impact on the development of technology, according to King (1993). First, the financial institutions' agent costs would be reduced when appraising entrepreneurs' innovation activities the more advanced the financial sector is. Second, the financial system spreads out the risks associated with innovation, which fosters an environment that is conducive to business technical advancements. Saint-Paul (1992) underlines the value of the financial markets' capacity for risk diversification in advancing technology. Enterprises would be exposed to intertemporal innovation investment risks due to the risks in the procedure of research and development (R&D). However, financial markets can spread out intertemporal risks, increasing the likelihood that technical innovations by businesses will succeed. Financial distortion results in resource mismatch in terms of allocative efficiency, which has a detrimental impact on TFP growth. A credit quota problem and unfavorable selection will result from incomplete credit market information. A two-sector concept that includes both tradable and non-tradable areas is developed by Buera et al. (2008). They find that less financial development is biased toward lower-productivity activities since tradable businesses frequently require a substantial investment in fixed assets and less financial development results in inefficient capital

allocation. Financial difficulties consequently have an unequal impact on TFP. Grossman (1980) demonstrates how easier access to private information for investors results in more incentives for them to dedicate more time to researching important information like enterprise production and investment ideas. A solid financial system will enable the reduction of liquidity risk and the redirection of investment toward projects with better-expected returns due to a drop in transaction costs. According to Aghion et al. (2005), enterprises that are subject to strict credit restrictions and imperfect financial markets are more prone to limit long-term investment since it carries a larger liquidity risk and comparatively lower pro-cyclical return. Therefore, financial obstacles make it less likely for businesses to make long-term investments, which hold back the growth of their production.

Han, et al. (2015) uses extensive province panel data for the years 1990 to 2009 to evaluate the impact of China's regional financial development on TFP development. They examine the connections between financial development and technological advancement, the two elements of TFP, using the nonparametric stochastic frontier data envelopment method. The study demonstrates that, as opposed to efficiency changes, Chinese financial development has a substantial impact on encouraging TFP growth through technological advancement. The misallocation of resources might be corrected more effectively and expeditiously through financial development, which would support TFP development. The findings suggest that China needs to enhance the regional financial system as well as better optimize the distribution of financial resources. By using the data, from twenty-six manufacturing industries between the years 1965 to 2003 and a panel of 77 mostly underutilized nations, Arizala, et al. (2013) assess the effect of FD on industry-level TFP development. When adjusting for industry time and country time fixed effects, a substantial correlation between FD and industry-level TFP increase is shown. Both statistically and economically meaningful outcomes are obtained. The annual growth rate of TFP can increase by up to 0.6% annually with an increase of one SD in FD, based on the external funding requirements of the industries. The results hold up well to various samples and requirements. Yao (2012) estimates in his paper about re-examining the relationships between total factor productivity growth and FD and the intermediate channels using the three samples of national level, coastal regions, and inland areas. He does this by using China's regional panel data from 1997 to 2008 and the data from the provinces. According to the findings, regional factors have an impact on the rise of TFP

as a result of China's financial development; technological advancement, not increased technical efficiency, serves as the intermediary channel via which financial development encourages TFP growth. It suggests that enhancing the excellence of economic growth requires accelerating the reform of China's financial system to support financial development.

Green development has gained widespread acceptance along with the expansion of the BRI structure. Both from a political and economic standpoint, financial support is seen as crucial to promoting sustainable business. If FD is helpful to environmentally friendly development in BRI countries, that is one preliminary question that merits research. Considering the success of green development from three angles can help us better understand how financial development affects it, Yang & Ni (2022) build a model in their thesis to address this subject. Their research work promoted G-TFP, a synthetic measure of the effectiveness of green development, constructed on panel data from fifty-one BRI nations from 2005 to 2017. The findings show that (1) throughout the study period, the financial size, financial depth, and financial efficiency of BRI nations have a negative impact on the effectiveness of green development. (2) In light of the diverse characteristics of BRI nations, their study also demonstrates the heterogeneity of the impact of FD on the efficacy of green development. (3) Their research indicates how FD affects the efficacy of green development through a variety of channels. The partial linear functional-coefficient model's results show that the relationship between financial development and technological advancement varies with wealth. The BRI countries should fully embrace the high concept of "carbon neutrality" to benefit from the empirical conclusions of this paper. The Malmquist index is used in the current study by Shiu, et al. (2006) to assess China's TFP change and its two components using the Data Envelopment Analysis methodology. They discover that China saw an increase in total factor production between 1993 and 2001, with the majority of this rise being attributed to technical advancement rather than an increase in efficiency. The effect of FD on productivity growth in China is also examined by the authors using a panel dataset spanning 29 Chinese provinces from 1993 to 2001 and the Generalized Method of Moment system estimation. Empirical findings indicate that during this time, China's productivity growth has been greatly influenced by the development of the financial sector, mostly due to its positive impact on efficiency.

According to the neoclassical growth theory, financial development boosts gross savings and investment by having an impact on capital accumulation, which in turn speeds up economic growth. Romer's (1986) endogenous growth theory emphasizes how endogenous technical advancements can contribute to stable economic growth. Some researchers examine the impact of financial development by optimizing resource allocation, while others examine it through technical innovation by incorporating it into the endogenous economic growth model. Financial distortion results in resource mismatch in terms of allocative efficiency, which has a detrimental impact on TFP growth. A credit quota problem and unfavorable selection will result from incomplete credit market information. The investor's decisions will be impacted by the latter element, which will also lessen the effectiveness of resource allocation. By showing how little attention corporations would give to investing in technical innovation and human capital in the case of a stock market crash, Greenwald et al. (1990) demonstrate how this would lessen the impact of "learning by doing" and technological advancement. There aren't many studies on TFP growth and regional economic development in China. FD is essential because it can increase a nation's financial system's economic efficiency. For instance, financial development increases extend banking activities and FDI and improve the activities of the stock market within a nation (Katircioğlu et al. 2018). In the same way that financial development lowers capital costs and financial risk. Additionally, it enhances transparency between creditors and debtors and offers more alternatives for the use of financial capital.

The scope of cross-border investment is also expanded by the financial sector's development, giving people wider access to the newest energy-efficient products and cutting-edge technology. For instance, financial growth encourages people to take out loans and purchase expensive luxury goods like homes, air conditioners, refrigerators, cars, and washing machines, which contribute to increasing financial activities in the country. Similar to how economic growth lowers the cost of capital for firms, which they can use to expand their facilities, establish new locations, and purchase additional machines and equipment (Sadorsky 2010). Additionally, the expansion of the stock market provides firms with more funding options and equity financing, enabling them to increase their output and, thus, reduce environmental pollution. According to Danish et al. (2018), increasing the standard of living can have an impact on environmental sustainability and economic growth. Providing less expensive loans, enables producers to

purchase cutting-edge gear and equipment. Therefore, it is clear that financial development promotes economic expansion. The ecological footprint is employed in the paper to quantify the effects of FD on the environment. In the literature, there aren't many examples that show a connection between financial progress and ecological footprint. For example, Charfeddine (2017) discovered that Qatar's FD had a favorable impact on the country's ecological footprint. Financial development increases Qatar's ecological footprint, according to similar facts cited by Mrabet and Alsamara (2017), Uddin, et al. (2017)'s research on the 27 nations with the greatest emissions indicated that financial development reduces ecological impact.

By examining how financial development affects the ecological footprint, the research by Baloch, M. et al. (2019) attempts to add to the body of literature already in existence. For a panel of fifty-nine BRI countries from 1990 to 2016, they used the Driscoll-Kraay panel regression model to achieve the goal. According to the research, financial development leaves a bigger ecological footprint. Additionally, environmental pollution is caused by increased ecological footprints from economic growth, energy use, FDI, and urbanization. To verify the accuracy and validity of the findings, many diagnostic tests have also been used. The study's findings have led to several policy recommendations for Belt and Road countries to reduce their environmental impact. Evaluating the growth benefits of international financial integration and whether they outweigh the hazards that come with it are hotly contested topics among policymakers and academics. This argument has been reignited by the recent financial crisis. The assumed benefits of financial integration for economic growth have not been proven by prior empirical studies. Using dynamic panel regression models, Arif-Ur-Rahman, M. et al (2020) seek to look at the connection between financial openness and an increase in TFP for a sizable section of nations from the year 1970 to 2014. The dataset includes many metrics for financial transparency. They discover data suggesting a link between greater TFP growth and financial integration. Numerous integration metrics demonstrate a perfect correlation between financial integration and TFP growth. The result also raises the possibility of a strategy to lessen the marginal effects of financial integration on TFP growth. The current overall economic unrest and excessive private financing, particularly in recent past years, appear to have had an impact on this conclusion, nevertheless.

2.2 Information and Communication Technology and Total Factor Productivity

The adoption of ICT has integrated economies, increased micro, and macro level production performance, raised lifestyle, and consequently accelerated economic growth. Because of its extraordinary growth in the field of ICT, countries with advanced technologies have a significant impact on the overall outcome globally. Investing in ICT capital stock has varied effects on the productivity of all factors, according to earlier studies. The results of these researches demonstrate both the good and negative effects of ICT investment. In contrast to underdeveloped countries, where the ICT coefficient is negligible, Dewan and Kraemer (2000) find that the capital stock of ICT has a favorable effect on GDP growth in advanced countries. According to the studies by Dimelis et al (2011), and O'Mahony et al (2005), ICT capital has a sizable positive effect on output growth for both the UK and the US, all of which are based on dynamic panel data calculations. According to Basu and Fernald's (2007) research, with significant lags, the US ICT capital growth is favorably connected with the industry's TFP acceleration, whereas, there is a negative correlation between the acceleration of TFP and current ICT capital growth. Niebel investigates how ICT affects economic growth in emerging, developing, and developed nations (2017). The findings challenge the claim that emerging and developing economies are "leapfrogging" developed ones through the use of ICT because they show that they do not benefit from investments in this sector more than developed ones. According to research work by Bacchini et al. (2014), ICT can help an economy emerge from a recession when it will increase the GDP of the country by 0.4% and also capital stock will increase by 1.2%. ICT's contribution to infrastructure development led to increased output for five ASEAN nations, according to research by Mahyideen et al. (2012). Given that public infrastructure has been enhanced as a result of the ability to reduce costs and save time, by advanced medium, the infrastructure has an indirect effect on labor productivity. The study discovered that a specific ASEAN nation's economic growth was positively impacted by its IT infrastructure.

Economic performance has improved as a result of ICT growth and the innovations it fosters. The role of ICT in determining the impact of foreign direct investment (FDI) on the dynamics of total factor productivity (TFP) is examined by Asongu and Odhiambo (2022). Data from 25 SSA nations form the basis of their study.

The engaged TFP productivity dynamics include TFP, real TFP, welfare TFP, and real welfare TFP, whereas ICT is evaluated by internet penetration. On the Generalised Method of Moments, the empirical evidence is founded. Their research demonstrates that, with the exception of regressions involving real TFP growth, where the estimations fail post-estimation diagnostic tests, it is clear that information technology (i.e., internet penetration) modulates FDI to favourably influence TFP dynamics (i.e., TFP, welfare TFP, and welfare real TFP). Schumpeter (1942) addresses many innovations kinds and says that they might be fresh markets, new product mixtures, or new product lines. ICT can spark relationships that increase productivity, which is one of its features. They can have a synergistic impact on the entire knowledge-based economy, resulting in the creation of new knowledge and higher productivity. It is made feasible by the quick dissemination of information and innovation to the production sector through their temporal and spatial properties. Thus, significant investment in ICTs by developed nations, particularly in production sectors, has aided in moving toward a world knowledge-based economy (Fukuda 2020). ICTs are a factor in determining how much is produced today and are improving productivity and efficiency across many industries. As a result, the availability, adoption, and use of ICT have a positive effect on economic performance, overall competitiveness, and economic development (Toader et al. 2018). According to some scholars, the changes brought about by electricity and steam power during the first industrial revolution and the ICT revolution are comparable (Vu et al. 2020, Frank et al. 2019, and Park 2018). As defined by the UN, ICTs are GPTs that assist power structure. The outcome of this emergence of a new paradigm that is dependent on the usage of information and knowledge, ICTs' wide-ranging implications on both the economic and social fronts. According to Taalbi (2019), nearly every economic sector in today's economies is being impacted by ICTs, which also enable foster innovation and entrepreneurship, and create knowledge spillovers.

Additionally, Czernich, et al. (2011) founds that they are facilitating supportive developments, which are driving economic advanced activities. In further research areas, two viewpoints are used to examine the connection between ICTs and TFP growth. In one area of research, exogenous growth models are used to analyze the connection between ICTs and economic growth. Based on the endogenous growth idea, the second stream investigates this link. A study by Fernandez, et al. (2020) also tells us that technological change is crucial for economic progress in both scenarios. The findings vary according to

the nation or set of nations examined, the periods taken into account, and the methodologies used. ICTs have a greater impact on economic development in rich countries than in underdeveloped countries because of differences in the determinants between the two groups of nations. The majority of studies concentrate on industrialized regions due to the dearth of data on developing nations. ICT's theoretically backed effects on TFP and economic growth The evolution of rapidly developing technical breakthroughs and growth as the engine driving modern economic growth has drawn more attention from economists (Grossman &Helpman, 1991; Aghion & Howitt, 1992).

ICT, also known as GPTs (General purpose Technologies), which have acted as a catalyst for new economic development, have significantly sped up the pace of technology since the steam engine, which was followed by electricity and then electricity again (David, 1990). These GPTs have received widespread recognition as a result of their crucial role in the early stages of the economy's growth, variety of advantages, application across numerous sectors, and technological complementarities (Bresnahan and Trajtenberg, 1995). It is impossible to overstate how crucial GPTs are to the transformation of the economy because the beginning phase of execution requires a significant reallocation of resources away from the industry accountable for the best possible manufacture of goods and toward the creation of new complementary investments. The economy as a whole suffers from this reallocation of resources since it lowers output, raises the demand for skilled labor, lowers wages for unskilled labor, and lowers overall productivity. The application of GPTs is realized across many industries once the economy has successfully navigated this important phase and complementary investments have been developed. A transitional period of the country's economic cycle has begun marked by increased TFP and output growth as well as a large increase in the average hourly wage rate across the economy. ICT shares all forms of GPTs like the technology, according to David (1990) and also Bresnahan and Trajtenberg (1995).

ICT has strong ties to many different industries as a technology, and a wide range of ancillary items have been developed (such as communication networks and software products) to increase its overall productivity. ICT has many key characteristics, such as (a) making deals for products and services at minimal prices, which also enables profits through expertise, economies of scale, and identification of relative benefits; (b) efficient information management, minimal processing fees, and provision of services in easing change in an organization, in addition to the teaching of skills realized; (c) facilitating

communication between people and information, which imply that the cost of ICTs increases as the number of users increases, and (d) the speedier and more effective redistribution of performing inputs. It is anticipated that as ICT advances continue, economic growth would pick up speed and productivity will increase. The literature's extensive details show that while ICT was quickly adopted by the US economy, it took decades for Europe to recognize ICT's hidden consequences (Jorgenson, Ho, & Stiroh, 2003). IMF and World Bank disagree about the function of ICT in the creation of projects, and other development organizations also have different views on this matter. While some people think that investing in ICT projects would pay off, others, including the Asian Productivity Organization, are skeptical of these advantages. However, there is growing agreement among economists and development experts about technological innovation and its spread, which can significantly boost productivity and spur economic growth (Dedrick, Gurbaxani, & Kraemer, 2003). Kendrick (1961), Solow (1987), Abramovitz (1989), Schumpeter, and Backhaus were among the first to advocate for this viewpoint. Romer (1990), like other economists, stressed the close connection between technological advancement and economic growth. Diffusion technology thus offers the potential for increased rewards through investment.

Since telephones are the primary means of information and communication, it is crucial to examine how widely they are used in the nation. According to Sridhar et al (2007), economic expansion and telephone penetration were found to be related. The findings, as stated for OECD economies, are important when applying a straightforward Pearson's correlation coefficient, but the degree of significance is lower than that of the OECD countries. Landline phones appear to contribute 1.62% more to growth than mobile phones do. Estimates are significant but not particularly high. According to Mahmood et al. (2019), South Asia's economy is significantly affected by ICT. ICT usage must increase in all nations if they want to spur economic expansion. Recent research has demonstrated that ICT has long-term effects on several nations. Van and Piatkowski explored how information and communication technologies can have a multifaceted impact on CEE (Central and Eastern European) evolving nations. In the instance of Poland, their findings suggested that information and communication technology capital will eventually provide a statistically significant contribution to product development. The results show that ICT capital is crucial to the pace and spread of knowledge, which boosts economic growth by allowing companies to adopt the concepts, methods, and

ideas of more developed nations. Ranasinghe (2004) used survey-based data for the Sri Lankan economy to investigate the impact of ICT on the labor market. The survey-based data demonstrates evidence for weak usage of ICT since Sri Lanka's rural sector has not assimilated the use of ICT and it is distant from where it ought to be. ICT is spreading quickly in some sectors of the economy, which will cause the loss of existing employment and the creation of new ones to speed up the expansion of the labor market. In a study on the approval and consent of employees, Chandrasekhar (2001) looked at how information and communication technology helped them preserve their sizable goods market.

Information and communication technology development is more prevalent than other types of development. The current development of information and communication technology is more exciting than that of other technologies. By establishing that information technology influences all types of research and facilitates the proliferation and deployment of other technologies, Rotmans et al.'s (2005) study provide evidence for this claim. Information technology has acknowledged substantial improvements in the efficiency and usefulness of labor by increasing the approach to knowledge and information. It also increases productivity by raising labor's level of proficiency and effectiveness. By improving the marginal productivity of the manufacturing inputs, economies are positively stimulated. As stated in recent growth theory, the advancement of science and technology will have a favorable long-term impact on a nation's growth. Sichel and Oliner (2007) found that advancements in ICT are mostly responsible for the improved productivity of recognized nations. They described how enhanced ICT helped keep American economic growth going for a long time. Thus, enhancing information and communication technology has positive effects on output. Similar findings were made by Van et al. (2003) when they investigated the function of ICT in various aspects of production and discovered that enhancing ICT in businesses and industries boosted labor productivity. Niebel (2014) further highlights ICT's role in growth; in emerging and developing nations, ICT showed normal growth rates, whereas growth rates in industrialized nations were low. Non-ICT capital services also grew more slowly than ICT capital. With the help of three ICT indices, Moradi and Kebryaee (2010) looked at how ICT affects economic growth. The effect of ICT expenditures on economic expansion is greater in economies with a relatively higher ICT Opportunity Index. ICT

spending provides 0.8% points annually to GDP, which shows that it has a very beneficial effect on economic expansion.

In terms of empirical research, Guetet and Drine et al. (2007) investigated the impact of the development of information and communication technologies on both income inequality and economic growth by using nation-wise panel data for fourteen Middle East and North Africa (MENA) nations. For oil-rich nations, they discovered a beneficial influence. In the majority of economies, R&D has been crucial to growth. Studies have demonstrated that R&D investments have a variety of effects, and these effects change from one country to the next. Increased Research and Development fundings have a favorable effect on TFP, as demonstrated by Grossman and Helpman (1991a, 1991b). A significant amount of literature, the positive impact of R&D efforts on output has been empirically demonstrated, starting with the foundational work of Coe and Helpman (1995), primarily focused on cross-country data. In their study of 16 OECD nations from 1980 to 1998, Guellec et al (2001) discovered a considerable positive impact of R&D on TFP. R&D intensity and productivity growth show a positive and significant link, according to Zachariadis (2004), who used manufacturing and aggregate sector data for 10 OECD nations between 1971 and 1995. In their study Hammar and Belarbi (2021) look into the nonlinear relationship between R&D spending, productivity, innovation, and high-tech export goods. R&D spending, creativity, productivity, and exports of medium- and high-tech products all have different effects. According to the innovation indicators utilized or the most acceptable threshold variable level, both positive and negative effects are observed. According to the findings, target metrics for conducting an innovation policy can include the degree of economic development. When discussing the importance of ICT sector, it is necessary to remember that Human Capital has a favorable impact on the nation's economic development. Benhabib and Spiegel (1994) found that HC stock had a favorable impact on TFP through its influence on the process of catching up with more advanced economies for 78 counties over the period 1965-1985. Canton (2007) revealed that HC stock had a favorable impact on TFP for the years 1960, 1970, 1980, 1990, and 2000 in a sample of 31 nations. According to De la Fuente (2011), HC has a favorable, significant, and sizeable impact on productivity for 21 OECD nations between 1960 and 1990. Positive HC effects on productivity were found by Mason et al (2012) utilizing a five country data-set spanning multiple industries.

According to a study by Amri, et al. (2018), the author examines the relationship between CO2 emissions, TFP as a measure of income, ICT, commerce, FD, and energy consumption in Tunisia from 1975 to 2014. This objective is accomplished using the breakpoint method and autoregressive distributed lag (ARDL). The findings show that the Kuznets environmental curve (EKC) assumption cannot be accepted by obtaining a greater value for the long-period TFP variable whereas for the short-period one. The influence of ICT on CO2 emissions as a pollution indicator is also negligible, according to our results. The environment is also badly impacted by trade, financial development, and energy use. Therefore, Tunisian authorities should raise TFP, develop ICT, expand the monetary section, increase the fraction of renewable energy consumption, and lower energy consumption resulting from the import and export of commodities. These objectives will be attained through strengthening Tunisia's technology and innovation capabilities, expanding the utilization of ICT in the construction, transportation, and industrial sections, those that are thought to be the most polluting as well as by developing renewable energy initiatives. Using panel data analysis throughout 1996–2013, Shahabadi, et al. (2018) assess the effects of knowledge-based economy factors on the TFP of developing nations (known as China, Russia, South Korea, Singapore, India, Brazil, and South Africa). They compare these economies with the G7 economies. According to the findings, the ratios of foreign R&D authorized supply to GDP and ICT authorized supply to GDP, respectively, have the highest beneficial effects on TFP in advanced nations. Although, when compared to the industrialized economies of the G7, the local R&D authorized stock to GDP ratio and the share of education costs to GDP have less of an effect on Total factor productivity. Although, in these nations, authors observe the beneficial impact of foreign R&D stock through the importation of commercial partners' technologies, customization of those technologies to meet domestic requirements, and use of this factor alongside local R&D activities, which provides an appropriate environment for improving TFP and moving toward a knowledge-based economy.

Using panel data analysis, Heshmati and Shiu (2006) also looked into the development of Information and Communication Technology in thirty Chinese provinces between 1993 and 2003. The results demonstrate that investments in ICT and FDI have significant and positive effects on an increase in overall productivity. A 1% increase in ICT investment boosts overall productivity by 0.46%, while a 1% increase in FDI boosts

overall productivity by 0.98%. As stated in their research, ICT has a substantial and beneficial impact on the expansion of production. However, this effect is modest, and like in other emerging nations, the effect of capital from sources other than ICT on growth is more significant due to a lack of certain complementary elements such as adequate infrastructure and human capital. For 23 OECD countries and 15 developing nations between 1992 and 1996, Seo, et al. (2006) analyzed the impact of factors like ICT on TFP. According to their essay, network effects and domestic ICT investment are the two main ways that ICT might impact TFP. The ICT network variable is the ratio of foreign investment in ICT to all foreign investment. They contrast two sets of OECD and emerging nations in their analysis. The findings demonstrate that ICT investment has an important multiplier impact on the rise of TFP in emerging nations. Additionally, affluent nations have a substantial association between Total factor productivity expansion and ICT investment expansion, but developing nations do not.

The globalization movement has caused many nations to think about developing their technology, which has made electronic finance a significant factor in all economic and financial sectors. The goal of Alshubiri, et al. (2019) study is to examine how ICT has affected the FD index of 6 GCC nations between 2000 and 2016. Their research is distilled into two key ICT indicators: fixed broadband and Internet users as proxies for ICT; domestic credit to the private sector as a share of GDP and wide money supply as proxies for the FD index. Growth in fixed broadband has a statistically positive influence on the two FD proxies, according to this methodology, which assumes fixed effects estimations. The benefits of ICT (broadband) outweigh those of Internet users about domestic loans as a proportion of a proxy for GDP. The financial development increases by nearly 2% for every 1% rise in fixed broadband, but only by about 0.09% when the Internet user variable is taken into account. When ICT rose by 1%, the one that is different MS (money supply) proxy rose by 0.4 %. Additionally, the MS (money supply) rose by 0.11% as the proportion of Internet users rose by 1%. A generalized method of moment estimator was utilized in the paper to check for the endogeneity issue, and the results support those of the FE's earlier work. Contrary to the legitimate and considerable negative effects of economic growth and natural resources, it was discovered that trade openness and urbanization positively and favorably affected both FD proxies. The study's key finding is that the GCC nations should work together to create an efficient information infrastructure to create effective economic sectors. ICT and Research and

Development's impact on TFP growth in Sweden's various industries is examined by Edquist, et al. (2017). R&D alone has a substantial correlation with the current TFP increase, showing indirect impacts. ICT and TFP do not significantly correlate in the short run, but there is a significant correlation with a 7 to 8 year lag. Thus, Research and Development have a far greater impact on TFP than ICT investments. Additionally, the authors separate ICT capital into software and hardware capital. They claim that this difference has never been made in prior research work looking at TFP at the level of the industry. The findings demonstrate a strong correlation between TFP growth and lagged hardware capital services growth. To benefit from the long-term TFP advantages of production restructuring, expenditures other than hardware are required.

Shiu, A. (2006) provide in their article the panel econometrics estimation approach of evaluating the technical change and TFP increase of thirty (30) Chinese provinces in the period of 1993 to 2003. The estimation of the Translog production functions was done using the random effects model with heteroscedasticity variances. There are two different ways to define technical change: using the overall index approach and the single-time trend. Estimates of TFP increase could be obtained based on the measurements of technological change, and their causes were looked at using regression analysis. We contrast the non-parametric Solow residual with the parametric TFP growth measure. TFP has shown positive development in every province for the sample. The regional split reveals that as compared to the western area, the normal TFP expansion is larger in the eastern and central regions. It is discovered that investments in ICT and FDI are important contributors to the TFP gap. Even though these two variables were shown to have a considerable impact on TFP, their impact on production was found to be less than that of more conventional production inputs. International trade and ICT appear to be the main drivers of economic development in the time of digital globalization. The effects of employing ICTs and having more open trade are examined by Dahmani, et al. in (2022). The Dumitrescu and Hurlin Granger causality test is performed, using a CS-ARDL model using panel data for fourteen economic sectors from 1995 to 2018. The empirical data indicate that the usage of ICTs and higher economic development in Tunisia have a long-term association. Trade openness and gross fixed capital formation also significantly and favorably influence economic development. Additionally, the authors look at the long and short-term correlations between these variables. There are

two unidirectional and four bidirectional causal links between the variables, according to the Dumitrescu and Hurlin test.

2.3 Foreign Direct Investment and Total Factor Productivity

China's outward FDI is quickly increasing throughout the BRI region, driven by the BRI. To boost their production, trade, and infrastructure, several BRI host nations that are emerging or undeveloped in general are accepting increased Chinese OFDI. Contrary to traditional models that assume foreign investment stimulates productivity growth by generating technological diffusion from the developed world to the developing economies, it is questioned whether China, as a developing country, has enough technological capacity to generate technological spillovers for developing BRI host countries and what role the technology gap plays in catching up to these spillovers. The study by Razzaq, et al. (2021) does this by examining the effect of Chinese OFDI-induced technology spillovers on TFP development subject to the existence of a technology gap between BRI host nations and China. They used SGMM and FGLS estimators in their research, which yields two major conclusions. The production development of BRI host nations is first boosted by China's OFDI; nevertheless, the productivity spillovers are smaller in scope across all parameters. Second, when the technological gap widens, there is a corresponding decline in productivity spillovers from Chinese OFDI, and these spillovers become less significant after a certain threshold.

The study by Amann, et al. (2015) investigates the "feedback impact" of FDI on TFP development in developing nations through cross-border technology spillovers. Over the 1990 to 2010 period, they looked at the impact of Research and Development's spillover arising from outward FDI flows from eighteen developing nations into thirty-four OECD nations, contrasting it with the impact of spillovers resulting from inward FDI flows. The findings support the hypothesis that FDI increases productivity development, but the effect is significantly greater when Research and Development intensive developed nations invest in developing nations as opposed to the reverse. This result is also supported by bilateral elasticity data for individual nations. The impact of global technological information exchange on the economic performance of enterprises and industries across international borders is examined by Keller (2010). This study concentrates on international trade and multinational corporate activity as channels for technical externalities, or spillovers, as a significant amount of the world's technology

investments are produced by businesses that operate beyond national boundaries. A review of current empirical studies on technology spillovers through trade and FDI served as the discussion's framework, along with a model of trade, FDI, and endogenous technology transfer. There is proof that both multinational corporations' operations and international commerce result in technological spillovers. The analysis indicates the need for more information on technology and innovation as well as difficulties for upcoming empirical research. In addition to providing finance, new technology and intangibles like administrative and organizational skills and marketing networks can also be acquired through foreign direct investment (FDI). The impacts of FDI on collective TFP in a sample of sixteen OECD nations are examined in the study by Pessoa, et al. (2005) using a panel data approach. They built a statistical descriptive model that enables us to demonstrate that FDI positively affects TFP, probably because FDI provides a channel for the transfer of technologies across borders.

Although the literature has showed the importance of FDI for the technology sector, there is conflicting practical confirmation about the impact of FDI on the overall development of nations. The inconsistent findings in the previous studies could be the result of a breakdown to take endogeneity and the capability for abortion of the hosting nations into consideration. Baltabaev, et al. (2014) shows that larger FDI stock result in higher productivity growth by using panel data for forty-nine nations in the years 1974 to 2008 and the presence of IAP (Investment Promotion Agencies) in the host countries as a tool. Additionally, they discover a sizable positive relationship between FDI stock and proximity to the technological frontier, implying that as FDI stock grows, so does a country's capacity to absorb innovations created at the borders. In recent years, both the absolute and relative importance of outbound foreign direct investment (FDI) from developing nations has increased dramatically. Even so, the amount of research on how FDI from these nations affects their home countries is remarkably scant. In a study, Herzer, et al. (2011) looks at the long-term link between total factor productivity and outbound FDI for a sample of 33 developing nations between 1980 and 2005. They discovered, using panel co-integration approaches, that enhanced factor productivity is both a result and a cause of increasing outward FDI and that outward FDI generally has a robust positive long-run influence on overall factor productivity in developing nations.

Using an aggregate production function, Arsoy (2012) estimates how much FDI contributed to the overall growth and examines in case FDI affected Turkey's TFP for the

period 1960 to 2005. In his work, he makes the case that the two primary ways FDI can influence a host nation's economic growth are through technology spillovers and the buildup of physical capital. Additionally, he aims to show how FDI, TFP, and economic growth are causally related in his article. He then uses some cutting-edge econometric methods to assess the many pathways via which FDI is connected to TFP. The results clearly show that FDI enhances TFP and development through capital accumulation and technology spillovers. Carmen et al. (2005) explain that although there is theoretically a positive relationship between growth and FDI, the empirical research is much less clear-cut. Some studies by (Nachum et al., (2000); Van Pottelsberghe and Lichtenberg, 2001) find beneficial impacts of outbound FDI on the investing country, but also raise concerns about a possible adverse effect of inbound FDI on the host nation. This arises from a potential decline in domestic innovation capacity or the displacement of homegrown businesses. They contend that rather than spreading cutting-edge innovations developed in the sending nation, inward FDI generally aims to benefit from the advantages of the host country. Other studies have produced more significant results. For example, Nadiri (1993) indicates that US-sourced capital has favorable and notable benefits on the expansion of the industrial sectors in Japan, the UK, France, and Germany.

A positive impact of FDI flows from industrial countries on the development of developing countries is also found by Borensztein et al. (1998). A minimal level of human capital is also mentioned, emphasizing the necessity of absorptive capacity. They also remark that FDI has a positive impact on productivity. Blonigen and Wang (2004) specifically emphasize cross-country heterogeneity as the key element determining how FDI affects growth. The effect of FDI on the host economy most certainly varies significantly depending on the receiving industry, too. An obvious illustration is a fact that significant FDI in Nigeria's extractive sector has not improved the nation's economic record (Akinlo, 2004). It is plausible that the possibility of positive spillovers depends on factors besides a nation's overall absorption capacity and that this capacity varies across various economic sectors or industries. As a result, the effects of FDI vary depending on the receiving industry or sector as well as the absorption capacity or stage of development of each country. The level of intra-industry vs. inter-industry spillovers will then further determine the effect of FDI on the country.

According to previous studies, there is "general excitement over FDI" (Harms and Meon (2011), Amann, et al. (2015) which stands in stark contrast to common worries

that Mergers and Acquisitions (hereinafter M&As), a key method of entrance, are "minimally useful for economic growth, if not completely negative." Both beliefs don't seem likely to be true, according to a closer look at the relevant theoretical and empirical literature, especially when you consider that the possibilities of benefiting from various FDI host nations' developed and developing economies may differ significantly. The positive effects of FDI on productivity and economic growth should not be taken for granted, according to recent studies. Through the transfer of developed managerial and technological skills, FDI is expected to improve productivity in the host country (De Melo, 1997; Caves, 1974). Since foreign companies stimulate domestic competitors to adopt new products and manufacturing techniques, which increase productivity in comparison to a situation without FDI, it is also believed that FDI increases competition. On the other hand, Aghion et al. (2008) provide a Schumpeterian development approach that clarifies the reason why additional FDI could only be advantageous for growth in regions where local manufacturing is reasonably near to the technology frontier. Contrarily, where local producers cannot absorb new technologies because they are too far behind the technical frontier, growth is static or even curtailed.

Findlay (1978) stated that for developing host nations to benefit from FDI-related technology movements, the technological gap "must not be too great." If foreign enterprises enter the market and displace domestic competitors, FDI may even lower productivity (Aitken and Harrison, 1999). The difficulties in the theory are reflected in several empirical contributions. Regression analysis performed by Alfaro et al. (2004) revealed that "FDI is the only variable which is ambiguously involved in promoting economic growth; the benefits of FDI on growth rely on properly developed domestic financial systems." Durham (2004) also emphasizes the importance of institutional and FD for the ability of host nations to absorb cutting-edge technology. According to Mayer-Foulkes and Nunnen Kamp's convergence regressions from 2009, FDI only aids host nations in catching up to if starting income stages are already fairly high, the advanced source nations' per capita income on average. Additionally, Alfaro et al. (2009) claimed that the weak evidence for an exogenous positive impact of FDI on economic growth was first found in the macroeconomics empirical literature. Additionally, the findings of the study imply that regional characteristics, such as the development of regional financial markets or the degree of education in the nation, may limit a country's potential to gain from FDI externalities, or absorptive capacities

According to Borensztein et al. (1998), FDI investment only results in technology transfer and enhanced economic growth if the host nation has a minimum level of human capital stock. Alfaro et al. (2004) further offer proof that only nations with highly developed financial markets get considerable FDI benefits in terms of their growth rates. The fact that South Korea and Japan benefited from foreign technology investment through technology transfer and the development of human capital capabilities is evidence that these findings are congruent with the reality of East Asian countries.

For host nations to gain from technology transfers by multinational corporations with US headquarters, Xu (2000) contends that they must possess an adequate human capital foundation. Herzer (2012) discovers that many factors, including reliance on primary exports, explain the substantial differences in the growth outcomes of FDI among emerging host nations. Concerns that M&As are less effective than green field FDI in fostering economic development in the host nations are covered in detail in UNCTAD's 2000 report, which is more directly relevant to the issue of different types of FDI. The most common concern is that mergers and acquisitions (M&As) did not increase production capacity at the point of entrance and can lessen competitiveness in the receiving country. The consequences on local productive ability, however, mostly depend on whether the domestic resources are spent or reinvested. Greenfield FDI and M&As both boost the host nation's foreign financial resources. According to UNCTAD (2000), there is no reason to believe that the two entry mechanisms will have different effects on capital formation over the long term. In addition, Calderon et al. (2004) discovered that advanced sequential FDI inflows of the green field type usually follow higher M&A transactions. Models that emphasize the capacity impacts of various FDI entry channels frequently ignore the spillover effects that foreign companies might have on domestic firms' productivity. Once more, UNCTAD does not anticipate any substantial variations in the extent of ties to local businesses that are built by either mode of FDI over the long term. However local enterprises often have stronger ties to other companies in the economy than new foreign entrants since it takes time to establish local supplier relationships; these ties are likely to last after a merger or purchase and may even be increased (UNCTAD, 2000).

The theoretical model developed by Mattoo et al. (2004) makes clear the connections among the approach of FDI entrance, market structure, and technology transfers. Two key elements that shape the production impacts of FDI inflows in the host

nation are the extent of technology transfers and the level of market competition. Both elements are dependent on the method of entrance the foreign investor selects. Although, in terms of the amount of technological transfer, one modality does not without a doubt predominate over the other, according to Mattoo et al. (2004) argument. Greenfield FDI has a bigger impact on improving competitiveness than M&As. On the one hand, the foreign company's incentive to transfer expensive technology is increased by the purchase's acquisition of a relatively bigger market share for the foreign firm. On the other side, in more competitive environments, there may be larger strategic motivations to transfer technology to overtake domestic competitors in the market. Regarding the dissemination of managerial and technological expertise associated with FDI, a similar theoretical ambiguity exists. The potential for knowledge transmission appears to be especially significant for this type of FDI given that the most efficient businesses are typically thought to prefer entry through green field FDI (e.g. Stepanok, 2015; Raff et al., 2012).

The biggest motivation to preserve better information and avoid spillovers, however, is found in the most successful businesses. As a result, knowledge dissemination is not always less in the event of M&As. Comparing entrance via M&As to green field FDI, technological dissemination, and Following entrance, upgrading can go more quickly. In contrast to green field investments, mergers and acquisitions directly involve existing companies, albeit under new ownership. This results in a slower effect of the latter on the technology of other local enterprises (via, for example, competition and demonstration). Greenfield FDI may drive existing domestic enterprises out of the market in situations where there is a significant technology gap between domestic firms and foreign entrants. These theoretical difficulties cannot be clarified by the limited observed panel research papers suggesting the impacts of various FDI strategies on TFP growth. According to Harms and Meon (2011), M&As have no discernible impact on economic growth in emerging host nations, whereas green-field FDI does. The sample of Harms and Meon (2011), in contrast to Wang and Wong (2009), comprises emerged host countries. This might assist to clarify why Wangand Wong (2009) discovered that M&As can benefit host nations with enough human resources. Calderon et al. estimation results reveal that economic growth comes before both types of FDI, even though there doesn't seem to be a statistically important backward influence on both green field FDI and M&As to economic growth. By excluding M&A sales from overall FDI inflows, all

three studies estimate green field FDI. Despite the shortage of statistical information on green field FDI before, the drawbacks of treating green field FDI like a residual are well understood (UNCTAD, 2000). As a result, the validity of the results is in doubt, at the very least in terms of the FDI's green field mode. Furthermore, factors accumulation, increased production capacity, or increased factor productivity may be the cause of FDI-related growth effects. The productivity benefits of various FDI forms are frequently not isolated in prior empirical investigations.

A major exception is provided by Balsvik and Haller's (2011) country research on Norway. These authors investigate whether green field FDI and M&As in the same industry and labor market region have an effect on the productivity of local businesses using microdata for Norwegian businesses. Balsvik and Haller (2011) discover, perhaps somewhat surprisingly, that new addition via green field FDI in the same sector and location negatively affects the production of local producers whereas recent arrival through M&As in the same industry (but not in the same area) benefits local enterprises' productivity. Some new and different studies that make use of microdata concentrate on the R&D activities of MNE affiliates that were founded through acquisitions or green field FDI. Bertrand et al. (2012) found that affiliates that Swedish MNEs purchase is more likely than affiliates that Swedish MNEs develop through green field FDI to engage in R&D and have a higher R&D intensity. The authors conclude that limiting M&As to encourage green field FDI may decrease knowledge about FDI shift to the host nations, which can limit the possibility for productivity-enhancing spillovers.

2.4 Trade and Total Factor Productivity

The aim of the study by Fox, et al. (1998) is to evaluate the contribution of each of the main elements investigating Australia’s GDP growth: increases in the endowments of labor and capital technical development, changes in domestic output prices, and changes in the terms of trade. Both an econometric strategy and an index number technique are employed. Additionally, they consider many approaches to breaking down TFP increase into predictable and cyclical components. Because the output sector of an open economy is represented using the GDP function approach, all of their empirical findings have solid theoretical underpinnings. Using data from a sample of 16 OECD nations between 1971 and 1995, in his research, Mendi, et al. (2007), searches for evidence to support the importance of global trade in disembodied technology as a specific channel for

dissemination. Their report discovers that technology is disseminated globally, which is consistent with earlier findings. Statistics from the OECD's Technology Balance of Payments, which are information at the country level on international trade in disembodied technology, serve as the benchmark for measuring international trade in technology. The present study uses DOLS as the calculation approach since the econometric results account for the variables' non-stationarity. The study demonstrates how the productivity of the importer is impacted differently by commerce in disembodied technology in different nations. In particular, technology imports inside OECD nations outside the G7 raise the host nation's TF, beginning with the first few years of the survey period, when the benefit was greater. In the case of G7 nations, no data is supporting this favorable impact of technology exchange on productivity.

A theory developed by Chanda, et al. (2008) from their research divides aggregate total factor productivity (TFP) into two parts: one that shows relative efficiency between sectors and the other that reflects absolute efficiency. According to a study on development accounting, differences in relative efficiency between different sectors may account for up to 85% of the global variation in total factor productivity (TFP). According to estimation outcomes, recent findings emphasizing the significance of robust property rights protection, financial development, and geographic advantage for the amount of TFP can be explained by their effects on relative efficiency. The study by Abizadeh, S. investigates the connection between an increase in TFP and trade openness. Given the differences in the traceability of commodities across sectors and the ongoing structural change, they examine whether trade openness has had a diverse impact on the TFP growth of the three major sectors of an economy. While openness has been proven to have a favorable effect on TFP growth across the economy as a whole, the agricultural and industrial sectors have not seen any discernible effects. They discover that the favorable impact on the economy as a whole was generally transparent regarding TFP growth attributable to the favorable correlation between the two variables for the services sector. Authors go on to say that by failing to account for temporal considerations and structural change when examining the trade-TFP link, they may have missed the absence of a universal consensus in earlier studies.

Dovis, et al. (2009) attempted to investigate how sensitive total factor productivity (TFP) was to foreign competition in the context of a European nation. The TFP of Spanish manufacturing enterprises is calculated using the Olley and Pakes technique, and

the effect of EU tariffs, the existence of imports from abroad, and other factors are investigated at the firm level. By using the System-GMM technique, they discover that European tariffs have a negative influence on TFP, whereas competition in the form of increasing foreign product presence on the domestic market and firm imports results in improvements in TFP. These two effects also work in concert with one another. They discover evidence of significant disparities across enterprises based on their participation in international markets. Given that China's BRI has been in place for almost five years, it is vital to determine whether it has helped the development of local green economies. The research by Liu, et al. (2019), focusing on the major provinces along its path, uses a GML index based on SBM directional distance function to evaluate the domestic GTFP (green total factor production) and statistically examines the BRI's net influence on provincial green total factor productivity. The findings show that regional green total factor production development along the SREB and the MSR differs significantly from that of the province and that the BRI has been instrumental in promoting both the provincial and two regional GTFPs (green total factor production). The results also show that the provincial green total factor production development is relatively good, with technological advancement serving as its primary driver. Despite being minimal, R&D investment restrains the growth of the provincial green total factor productivity. Economic growth and green total factor production have a U/shaped relationship, and the current economic state of the province and green total factor production are inversely correlated.

The green total factor production is negatively impacted by trade between the nations and provinces along the route. The provinces should respect foreign commerce, strengthen their innovation systems, develop their talent pools, and actively participate in BRI construction if they want to support green total factor production development. Attempts have been made by Habib, et al. (2019) to look into the effects of Research and Development, HC, and IPR spending on TFP, which results in economic development. The panel data technique is applied to a sample of sixteen nations separated into the BRIC (China India Brazil, and Russia) and CEE nations. For the years 2007–2015, the researchers compared the 16 nations using a fixed effect model as an estimation approach for regression. According to the findings, Research and Development, HC, and IPR spending in all sample sets are positive and are substantial determinants in predicting changes in TFP. Furthermore, especially in the case of emerging nations, IPRs by

themselves do not speed up economic progress. The present study offers insightful information about the significance of Research and Development, HC, and IPR activities and their effect on TFP, which drives economic growth, taking into account the significance of BRIC and CEE nations as well as the lack of research on these regions with the variables and techniques used in the current study. IPRs foster a supportive environment for economic growth, R&D, and knowledge production. Different countries can improve their economic position through innovation, HC, trade, R&D efforts, and FDI, yet the relative importance of these routes may vary among nations depending on their development stages.

According to Singer (1949), most countries' international trade policies were based on the import substitution model before the 1970s, and the relationship between trade openness and economic growth has been empirically studied in economics. However, neoclassical growth theories, like the Solow growth model put forth in 1956, presuppose that innovation and the steady-state rate of output growth are fully exogenous. Or, to put it another way, the rise of per capita output is controlled by trade openness, whereas technical improvement is seen as exogenous. Endogenous growth theories have challenged and found deficiencies in the neoclassical model, particularly in the form of long-run development. (e.g Howitt and Aghion (1998); Grossman and Helpman (1991); Sala-i-Martin, Miller (2004); Sala-i-Martin (1996); and Doppelhofer, et al. (1995). They verified a link between the implementation of trade openness initiatives, technical advancement, and economic development. New economic growth models created by Lucas (1988) and Romer (1986) assume that technological advancement is endogenous, which enables the formulation of long-term growth patterns. Sachs et al. (1995) empirically find the link between economic development and trade openness in 122 nations in their fascinating research of -convergence. They confirm that the growth rates of outward-looking nations are generally higher than those of inward-looking nations. Numerous empirical studies that look at the link between economic growth and trade openness are available, but the conclusions are frequently disputed. There is ample evidence from cross-country research that expanding openness promotes growth (Wacziarg and Welch 2008; Dollar and Kraay 2004; Sala-i-Martin 1996; Jouini 2015; Sachs et al. 1995; Chang and Mendy 2012; Dollar 1992). Alternatively, According to the study of Rodriguez and Rodrik (2000), Yanikkaya (2003), and Levine and Renelt (1992), even if there seems to be a conflict between openness and growth, finding a direct

mutually beneficial relationship between the two is challenging. However, when different trade indicators were taken into account, Harrison (1996) showed that there is a relatively favorable influence of trade on growth. Using a system GMM estimator, Petkovski (2015) and Fetahi-Vehabi, discovered that trade benefits nations with higher per capita incomes and capital formation. By utilizing dynamic panel data analysis to examine the effects of trade liberalization on growth for developing nations, Trade openness has a time-lag effect on GDP, according to research by Greenaway, Morgan, and Wright from 2002. Using different trade openness indicators and panel data analysis, Yanikkaya (2003) demonstrated that there is a straightforward connection between growth and trade openness.

The data on the indirect impact of trade openness on economic growth through various routes is also supported by a small body of studies. For instance, Darku and Yeboah (2018) used the beginning point of income as a channel to analyze the relationship between openness and development in emerging countries and Asian tigers (Taiwan, Hong Kong, Singapore, and South Korea). According to his findings, a country's baseline level of income determines the connection between growth and trade openness. Vijil (2018) examined the openness growth link in an unbalanced panel of one hundred and sixty-nine (169) nations from 1988 to 2014 using the GMM estimate approach, using variety and quality in exports as variables. Their findings demonstrate that in the growth impact of trade openness, there is a nonlinear trend. They also conclude that the quality and variety of the nation's exports are a requirement for trade openness' beneficial effects on economic growth. In a panel data set spanning 46 nations from 1983 to 2007, Chang and Hang (2014) investigate the impact of trade openness on economic growth according to the degree of FD. Their findings imply that stock market growth may have a more significant indirect impact on GDP growth than trade openness does. Zyurt and Daumal (2013) examined how openness affects growth using initial GDP per capita figures for 26 Brazilian states. They found that while trade openness has a negative net impact on growth below a specific threshold, it has a positive net impact on growth for states with per capita incomes more than $5450 in constant prices. FD is emphasized as a major factor influencing the connection between growth and trade by Stiglitz (2004), Aghion and Howitt (2005), and Beck (2002). According to research by Busse and Groizard and Blalock and Veloso (2005), through the TFP development level, long-term imports of new technology boost GDP growth in underdeveloped nations (2008).

Zahonogo (2016) used three distinct methods in 42 Sub-Saharan African nations between 1980 and 2012 to investigate the impact of trade openness on economic growth. His research indicates that trade openness only benefits economic development over a long period, positively, and significantly to a certain point, after that the effect begins to fade. Ramzan, Sheng, et al. (2019)'s empirical findings show that trade openness has a significant impact on GDP growth in countries the crucial value or threshold level is exceeded during TFP development but has a negative effect in countries where TFP development is lower than these threshold levels. Using various data sources, estimate techniques, and results that are consistent with our theoretical premise, their investigation validates the non-linear openness-growth effect.

Knowledge has become the most important factor in production as a result of the growth of the knowledge economy. In a study, the evolution of China's potential to absorb foreign information as well as the TFP of China's 31 provinces is analyzed by Yu, H. et al. (2022) using the system GMM estimate method. They also look at potential intermediate impacts of FDI, FDI outward, commerce, export, and direct spillovers of technology between Cross-national Knowledge Transfer (hereinafter CNKT) and TFP. In their findings, they discovered: (1) CNKT has upgraded Chinese TFP and benefits import, direct technology spillover, FDI, and export. This demonstrates that CNKT not only contributes to China's TFP improvement but also offers a creative knowledge pool for absorbing global technological spillovers. (2) The expansion of human capital, openness, domestic R&D capability, and economic growth absorbs into CNKT, which is beneficial for absorbing and applying advanced knowledge from around the world. (3) Direct technology spillover, import trade, and FDI all help to some extent moderate the relationship between CNKT and TFP, with import trade technology spillover having the highest impact. Whether foreign aid to education has a substantial impact on growth in Sub-Saharan Africa is examined in the paper by Asiedu, et al. (2014). They account for baseline per capita income, inflation, investments, government consumption, trade openness, and institutional quality in their analysis of 38 nations from 1990 to 2004. The authors' findings show that (i) primary education assistance has a significant and positive effect on growth; (ii) post-primary education assistance has a negative impact or, at best, no significant impact; and (iii) growth increases as primary education assistance as a share of total education assistance rises.

2.5 Institutional Quality Index and Total Factor Productivity

Chong and Zanforlin (2004) made the initial effort to combine institutional elements into a uniform growth model for Latin America. They did not quantify the effect of these variables on TFP, but their work is notable since it was the first in a series of attempts to do so. In contrast, the only data used in subsequent research has come from the ICGR (International Country Risk Guide). Using data from two sources, they assess institutional quality. Their study used an average of five ICGR factors to measure institutional quality: risk of expropriation, government repudiation of contracts, the tradition of law and order, corruption in government, and bureaucratic quality. The study's findings are crucial because they demonstrate that greater institutional quality is linked to greater regional economic growth. The study's weakness is that the parameters don't make it possible to measure how institutional quality affects TFP. There is still no agreement on this, as we shall see. Similar findings are obtained by de Gregorio and Lee (2004) and Chong and Zanflorin (2004). Regressions including institutional factors are included, although they do not explicitly model their impact on TPF. Government spending, the application of the law, the rate of inflation, democracy, and openness served as stand-ins for the institutional variables in this case. Although the effects of each of these factors on economic growth appear to be as anticipated, this study does not account for their implications on TFP. This essay presents another trade-off. A large number of institutional factors, including indices of the rule of law, are more recent. Other metrics like inflation and openness can be derived for far longer periods. This may lead to a trade-off between the quality of the measurement and the availability of data. The literature's publications don't make it clear how to solve this issue.

TFP is connected to Latin America’s low economic growth issue in W. Charles (2010) research. In the modern history of the area, slow economic growth has been the biggest issue. The report conducts a comprehensive literature analysis on the factors that influence Latin American economic growth and demonstrates that the main issue appears to be the slow increase in TFP. Additionally, the caliber of the institutions in the area is related to this issue. Unfortunately, it is extremely challenging to define institutional quality in a meaningful sense. This has an impact on regional economic growth policy. TFP and institutional quality were first explicitly taken into account in Fernandez-Arias, et al. (2005) empirical work. They discovered that TFP is the region's main cause of trailing growth, which is now widely acknowledged. Here, however, there is a distinction

because they also make an effort to identify the variables affecting TFP increase. The following variables were examined for their impact on TFP: inflation, private sector credit, education, the black market premium, life expectancy, openness, government consumption, imports of machinery and equipment, and the ICRG variable as mentioned in the earlier paper. The results showed that ICRG, Openness, and Inflation all appeared to have the most significant relationships to TFP. While it is apparent that each of these factors "works," it is less clear why they do so or possibly how they combine. These findings are provocative and quite intriguing, as is customarily the case, but they raise a lot more questions than they answer. In regards to Latin America's comparatively modest growth, Cole, et al. (2005) arrives at quite similar findings. The important findings collected from their empirical research paper are that the region's lackluster growth is nearly entirely a result of the TFP's slow expansion. They go on to say that the issue is not a lack of expansion in human capital. Their main objective is to describe TFP issues. They do, however, tackle the problem in a very different manner than the earlier work. They contend that obstacles to innovation include trade restrictions like tariffs and internal hurdles like high entry costs, underdeveloped capital markets, and labor laws. In turn, this has decreased the region's countries' productivity. Although the authors add case-type examples to the approach's strong intuitive reasoning, it is challenging to put into practice empirically.

TFP's significance in explaining Latin America's subpar growth performance is confirmed by Chumacero and Fuentes (2006) article. The research does not, however, examine potential reasons for the region's poor TFP growth; instead, it focuses more on identifying structural breaches in the empirical connections. The paper of Cole, et al. is updated helpfully by Grier (2007). In this study, growth equations for Latin America from 1955-1995 are estimated. The outcomes validate that decreased TFP is a root cause of limited growth. The estimates derived for a sample of industrialized countries are then compared to those for Latin America by the author. The empirical findings are not intended to directly estimate their impacts on TFP, but rather to explain this gap. The study by Ngo and Duc (2020) examines the effects of institutional quality, TFP, and correlative variables among them on TFP development in thirteen low and middle-income Asian nations from 2000 to 2018. The research examines the World Bank dataset using the different GMMs. The empirical findings indicate that, in contrast to institutional drivers, TFP and the interaction variable have a significant effect on the increase of TFP.

The poor institutions in these low-middle-income nations explain the detrimental effect. The study's conclusions imply two ideas. First and foremost, the government needs to keep enhancing TFP; it is related to the use of technological advances, advancements in management approaches, and a trained workforce. The second, and far more important, the conclusion is that the government must place a strong focus on institutional change and future governance. Various governments in low- and middle-income Asian nations will be able to establish developmental states with the aid of Japan, Korea, and Singapore's successful experiences. To advance and achieve its aims, the developmental state likely aggressively meddles with the market. By doing this, these economies may be able to escape the infamous "middle-income trap."

The empirical research on TFP's effects on growth in the East Asian region was carried out by Felipe (1999). The estimations of TFP growth for the country, even for the same nation and period, differ widely, according to the author, and their influence on East Asian growth is a task with declining returns. The measurement and impact of TFP on economic growth in China and South Asia from 1989 to 2003 were the subjects of Srinivasan's (2005) study. The author discovered that obtaining continuous productivity growth depends on social and economic institutions that are working well. In developing Asian nations, Zhuang et al. (2010) looked into the connections between good institutional governance, economic growth, and income disparity. According to a statistic, the study compares income per capita and inequality indices with a data set from the World Bank that includes 6 variables to quantify institutional quality throughout the years from 1998 - 2008. The study concludes that the primary development goal for growing Asian economies should be strong governance and that in comparison to other countries across the world, the rule of law, the standard of governance, and the efficacy of government are all above average. The study also demonstrates that between 1998 and 2008, these three variables rose faster than the global average, which greatly boosted the region's economic development. The nation’s economic development strategy might therefore be based on enhancing public governance across the board. In 12 Asian economies, Park (2010) examined how total factor productivity growth had changed over time. The paper examines the primary determinants of TFP growth, notably intangible elements like HC (human capital) and R&D capital, by conducting an empirical analysis utilizing a large-scale worldwide data collection. The long-period prediction of total factor productivity development for Asian countries from 2010 to 2030 is based on

benchmark models that are created as a result of these empirical assessments. The impact of TFP increase on early and later economic growth in twelve Asian economies was assessed by Park (2012). The author examines the TFP features by assessing the TFP growth model, explores the TFP characteristics by evaluating the TFP growth model, assesses the factors influencing TFP growth, and provides a long-term TFP growth estimate. Both the developed and mathematically valid endogenous growth theory and the neoclassical growth theory are available. Less is known about political economics growth theory, which focuses on how underlying ability and social institutions affect economic growth. Even though it emphasizes the importance of institutions for economic growth, the majority of its studies are limited to empirical analyses based on different nations (La Porta et al. 1997; Acemoglu et al., 2002), in large part because the idea of a society's fundamental capability is so broadly construed.

Considerations might be made regarding fiscal policy, essential institutions (such as democracy, judicial systems, property protection, and contract execution), or the extent of government rent-seeking. However, it might be challenging to identify a single indicator in empirical investigations that accurately captures the overall underlying capability of a community. Due to this absence of a theory, it is difficult to describe the institutional aspects of the growth of transitioning nations, especially the Chinese, whose 30 years of growth have been very different from those of other nations. The findings of many studies make it challenging to pinpoint the mechanism underlying Chinese economic development. The rule of law and financial development has been shown in several empirical studies to be crucial for a country's growth (Levine 1999; McKinnon 1973; Acemoglu, Johnson, and Robinson 2001, 2002; Klein and Olivei 2008). The situation in China, on the other hand, is rather different. There has been enormous growth there, but there has been little to no increase in the quality of the financial institutions or the institutions themselves. Without fully developing its legal and financial institutions, China has seen phenomenal progress, according to Allen, Qian, and Qian (2005). It also emphasized how crucial private companies are to the economic growth of China.

Yao and Yueh (2009) declared that prior Chinese growth had been more factor-driven and introduced the "mystery of China's economic growth." Because TFP is growing slowly and makes a small contribution to economic growth, they contend that this growth pattern cannot be sustained. Panel data with fixed effects were estimated for 12 Asian countries between 1970 and 2007 to determine the following important

findings: Firstly, over the last ten years, the growth model has changed to one that is productivity-based. Secondly, over the previous few decades, TFP growth has been significantly influenced by catch-up effects, and in the most recent decade, knowledge capital has finally boosted its contribution to TFP growth in Singapore, Hong Kong, Taiwan, Singapore, and Korea, but stalled or weakened in other Asian nations. Thirdly, the results show that significant TFP growth will take place between the years 2010 and 2020 and between 2020 and 2030, and that productivity-based growth will continue to drive the long-term rise of Asian economies. Using the Granger causality test, Law et al. (2013), in contrast to the majority of the studies mentioned above, 60 nations studied from 1990 to 2008 and from 1996 to 2008 to determine the relationship between institutional quality and economic progress. World Governance Indicator (WGI) and ICRG databases were both employed in the study. The estimation results show that institutions and economic development are mutually dependent. This relationship changes with varying levels of per capita income. In high-income countries, economic growth encourages better institutional quality, whereas, in lower-income nations, economic development appears to increase institutional quality.

Venard (2013) examined, using a sample of 120 nations, the connections between institutional quality, corruption levels, and economic progress. Three claims are made by the author: (i) A nation with strong institutions will have lower levels of corruption; (ii) a nation with strong institutions will have more rapid economic growth; and (iii) a country with lower levels of corruption will have faster economic growth. To provide a framework for institutional quality divided into two categories of countries with inadequate institutional quality (having an average of indicators below 0) and exceptional institutional quality Five metrics from the World Bank's public governance index are used in the study (with an average score of indicators above 0). Data for these two groups were tested in 1998, 2001, 2004, and 2007 using the partial least squares (PLS) approach. The findings demonstrate that all of the aforementioned hypotheses are true. Economic development is slowed down by high levels of institutional corruption. Additionally, The author argues that improving institutional quality and reducing corruption are more effective ways to encourage economic development in countries with weak institutions. Azam and Emirullah (2014) conducted an experimental analysis between 1985 and 2012 to determine the impact of corruption on the economic growth of nine selected Asia-Pacific countries. The findings demonstrate that corruption and inflation have a

detrimental impact on economic development in these nations when employing the approaches of assessing fixed and random effects. The authors advise making cutting back on corruption and reining in inflation one of the top priority for putting macro and public policies into practice.

Fayissa and Gill (2015) conducted an empirical analysis of the association between public administration and economic growth using panel data for 37 Asian and Coastal countries between the years 1996 and 2013. GDP per capita and GDP growth are the dependent variables in two empirical models, whereas institutions (as measured by one of six indexes derived from WGI data), total investment, FDI, aid, and trade openness are the explanatory factors. The authors use pooled OLS, fixed effects, and generalized mixed models (GMM) techniques to demonstrate a favorable association between public governance and economic growth in these countries. The implication is that institutional reforms must be implemented thoroughly to boost growth and help certain countries in the area escape poverty. Bhattacharjee and Haldar (2015) used FE and the system Generalized Method of Moments to explore the factors influencing economic growth in four of South Asia's largest economies, highlighting the importance of institutions (SGMM). They demonstrate that in several South Asian countries, the two institutional determinants of government efficacy and voice and accountability are accurate predictors of growth. Tebaldi (2016) used the system GMM to examine the variables affecting TFP increase in sixty-three nations between 1960 and 2011. The findings showed that initial conditions have a substantial impact on the dynamics of TFP since lower initial TFP economies continued to lag behind nations that were initially in a stronger position. Findings from this study indicate that institutional quality and openness are important drivers of TFP growth. While better institutions promote efficiency and technical advancement, globalization serves as a crucial conduit for the transfer of information and technological advancement between nations, which promotes TFP expansion. To find the connection between economic growth and institutions in ten ASEAN nations between 1996 and 2014, Karimi and Daiari (2018) employed the GMM approach. The empirical data show that a composite WGI and the rate of economic growth in the selected ASEAN countries have a positive relation. The results of this investigation also revealed a bidirectional causation effect between the two variables. The growth model in fifteen Asian nations from 1970-2014 was most recently studied by Das and Upadhyay (2019). The evidence points to a strong impact of human capital on both production growth and

growth via TFP. The author's findings show that a country's total factor productivity grows more rapidly the less developed it is (i.e., the wider the income gap), which enables faster income convergence. There is some evidence that the income gap and human capital interact, and this causes human capital to have an even greater impact on the increase of all factors contributing to productivity.

The findings from this literature review reveal a lack of significant extant on the specifics of the topic for this research. Indeed, it is clear that the result of previous studies is increasing the knowledge but those studies haven't considered both ICT and FD as a determinant of TFP. Furthermore, studies in the literature haven't analyzed the impact of ICT and financial development on TFP of particularly developing countries of BRI. Previous studies have not checked the robustness of results using different methods to calculate TFP. But this study have used both Cobb-Douglas Production Function and Translog Production Function to calculate TFP, it helps us in checking the robustness of our results. Therefore, this paper is an attempt to bridge the gap in the literature by investigating the impact of ICT along with FD on total factor productivity in developing BRI countries.

CHAPTER 3

METHODOLOGY

The method of evaluating the effects of financial development and information and communication technology on total factor productivity is covered in this chapter. This chapter includes construction of independent variable i.e TFP, econometric model of the study, description and theoretical background of all variables, data source and estimation technique.

3.1Construction of Independent Variable TFP

The construction of two different types of TFP is based on the basic Solow-Swan growth model. According to Abdullah and Chowdhury (2020), we presume the Cobb-Douglas production function:

$$Y_{it} = AK_{it}^{\beta} (L_{it})^{1-\beta} \quad (3.1)$$

Y represents real GDP (Gross domestic product), K represents real physical capital, L represents the total labor force, β represents the contribution of capital to total output, and A represents TFP.

Output per worker can be expressed as the following, divide the two sides of the equation (3.1) by L:

$$y_{it} = Ak_{it}^{\beta} \quad (3.2)$$

Where

$$y_{it} = \frac{Yit}{Lit}$$

And

$$k_{it} = \frac{Kit}{Lit}$$

TFP which is represented by A can be calculated from Equation (3.2) as follows:

$$A = \frac{y_{it}}{k_{it}^{\beta}} \quad (3.3)$$

This TFP estimate is our initial one. Let's refer to it as tfp1.

We develop a capital stock K series for tfp1 estimation. We determine the capital stock's initial level using the steady-state relationship of the Solow model proposed by

Harberger in 1978. (Beck et al., 2000; Nehru and Dhareshwar, 1993; King and Levine, 1994):

$$K_0 = \frac{I_0}{\delta + g} \quad (3.4)$$

g represents the average geometric growth rate of the GDP during the period; I_0 represents the initial investment, and δ represents the capital stock's constant depreciation rate. We presume a 5% rate of depreciation. The series on capital stock is generated using the perpetual inventory method:

$$K_{it} = I_t + (1-\boldsymbol{\delta}) K_{i,t-1} \quad (3.5)$$

$\boldsymbol{\delta}$ represents the depreciation rate in equation (3.5) and I_t, represents the investment.

We generated the output, investment, and labor series in accordance by following Caselli (2005). We estimate Y, I, L, and the size of the population to determine the initial and subsequent stock of capital as well as TFP. To calculate the TFP, we require information on the income share of labor, but this data is not easily accessible. The income share of labor, according to the literature by (Gollin, (2002); Bernanke & Gurkaynak (2001); Abdullah and Chowdhury, (2020), ranges from 0.65 to 0.8. We use a fixed labor share of 0.65 for our TFP1.

3.2 Translog Production Function

Now we are using the Translog Production function to estimate TFP

$$Y_{it} = f(K_{it} L_{it}) \quad (3.6)$$

Where $K_{i,t}$ and $L_{i,t}$ denote, respectively, capital and labor. We must define a functional form for 3.6 to do the empirical analysis, and we want to maintain this form as flexible as feasible. We, therefore, assume that the production function is a Translog specification, which is usually considered to be an appropriate second-order approximation for any production function. We can rewrite (3.1) as:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + (\boldsymbol{\delta}_{11} \ln K^2_{it})/2 + (\boldsymbol{\delta}_{22} \ln L^2_{it})/2 + \boldsymbol{\delta}_{12}(\ln K_{it})(\ln L_{it}) + \varepsilon_{it} \quad (3.7)$$

Where ε_{it} a transitional error term.

Under the usual symmetry assumption (that is, $S_{12}=S_{21}$), we can also calculate production elasticities of input,

$$S_{1,it} = \frac{\partial \ln Yit}{\partial \ln Kit} = \widehat{\beta_1} + \boldsymbol{\delta}_{11} \ln K_{it} + \boldsymbol{\delta}_{12} \ln L_{it} \quad (3.8)(a)$$

$$S_{2,it} = \frac{\partial \ln Yit}{\partial \ln Lit} = \widehat{\beta_2} + \boldsymbol{\delta}_{22} \ln L_{it} + \boldsymbol{\delta}_{12} \ln K_{it} \quad (3.8)(b)$$

Following that, returns to scale are defined as the total of input elasticities,

$$RTS_{it} = \sum_{j=1}^{2} S_{j,it} \quad (3.9)$$

Thus, TFP can be calculated as:

$$TFP_{it} = (RTS_{it} - 1) \times \frac{S1,it \ln Kit + S2,it \ln Lit}{RTS_{it}} \quad (3.10)$$

The Translog production function allows for non-linear relationships between inputs and outputs. The Translog function may provide a more accurate representation of underlying production process. It also permits a larger flexibility, that is, translog production function also allows variation in returns to scale. The Translog production function's ability to capture non-linearities and substitution possibilities makes it useful for policy analysis.

3.3 Theoretical Framework

TFP has a significant impact on economic development. But other factors can have an impact on TFP. Here, we see that the strategy for private sector development to promote economic growth and combat poverty includes the expansion of the financial sector in emerging markets and developing nations. The combination of companies, products, and markets is known as the financial sector. The findings demonstrate that rather than efficiency change, financial development significantly influences TFP growth. According to Han and Shen (2015), the misallocation of resources might be better corrected and TFP growth would be enhanced the sooner financial development occurs.

$$TFP = f(FD, X) \quad (3.11)$$

Where (TFP) shows our dependent variable i.e total factor productivity, (FD) shows the first independent variable i.e financial development and (X) shows the vector of control variables.

Along with FD, another important factor that can affect Total Factor Productivity is ICT. ICT also plays a role to examine the TFP growth of an economy. The use of ICT has integrated economies, increased macro- and micro-level production performance,

raised lifestyle, and consequently accelerated economic growth. Because of its extraordinary growth in the field of ICT, countries with advanced technologies have a significant impact on the overall outcome globally.

$$TFP = f(FD, ICT, X) \quad (3.12)$$

Where (TFP) shows our dependent variable i.e total factor productivity, (FD) shows the financial development, (ICT) shows the second independent variable i.e information and communication technology and (X) shows the vector of control variables.

3.4 Model

Based on the theoretical background, as discussed in section (3.3), present study is going to estimating the following model followed by Han and Shen (2015). The log form of all variables are used for analysis

$$tfp_{it} - tfp_{it-1} = \alpha + (\beta_0 - 1)tfp_{it-1} + \beta_1 FD_{it} + \beta_2 ICT_{it} + \beta_3 X_{it} + \eta_i + \lambda_t + \varepsilon_{it} \quad (3.13)$$

Alternatively, we can write it as

$$\Delta tfp_{it} = \alpha + \theta tfp_{it-1} + \beta_1 FD_{it} + \beta_2 ICT_{it} + \beta_3 X_{it} + \eta_i + \lambda_t + \varepsilon_{it} \quad (3.14)$$

Where,

tfp = Total Factor Productivity

FD = Financial Development

ICT = Information & Communication Technology

X_{it} = Vector of Control Variables

ηi = Country-specific effects

λt = Time-specific effects

3.4.1 Description of Variables

In this research, our main dependent variable is Total Factor Productivity (TFP) and we are estimating the index of TFP. TFP is the major driver for growth in the economy. TFP is the term used to describe the productivity of all inputs combined. This may be the result of improved organizational techniques or improvements in characteristics (such as more suitable talents or embedded technologies). TFP can be

defined as development based on technological innovation and efficiency attained through improved capital management and labor skills. The coefficient of lag of TFP is (β-1), which shows the convergence. It means if there was any shock in previous year, it will reduce in next years.

Our first independent variable is Financial Development which can affect TFP. Economic theories suggest that efficient financial systems promote economic expansion by directing wealth to its most profitable uses. FD is particularly crucial for maintaining growth in developing nations since the efficiency of investment will supplant the quantity of investment as the region's growth-inducing factor.

ICT is the second independent variable that can affect TFP growth in economies. We are taking the number of internet users in BRI countries (low & middle-income countries) which can show the impact of ICT on TFP. ICT is responsible for the rapid changes and growth that are occurring in the world. Thus, it is safe to state that this sector is one that every nation must invest in, Amri (2018). Only by investing in ICT will developing nations be able to grow.

Other than these three independent variables, we have some control variables which also affect TFP. The detail about these control variables is as follow:

Each region uses a certain amount of foreign money to generate all of its goods and services, which is known as a foreign direct investment (FDI). FDI not only supplies money but also contributes to the dissemination of technology and optimizes resource allocation through modeling and mimicking effect, spillover effect, competitive effect, and the movement of technological manpower.

Open economies have the propensity to grow more quickly, innovate, increase productivity, and provide their residents with higher salaries and more opportunities, among other things. Trade benefits households with lower incomes by giving consumers more affordable goods and services. Trade's contribution to economic progress also results in the exchange of cultures and developmental chances. Providing individuals with employment possibilities and raising taxes for the government, even enhances a nation's financial performance. This has a significant positive impact on the finances and incomes of the nation.

Institutional Quality Index which includes six dimensions namely Government Stability, Investment Profile, Corruption, Law and Order, Democratic Accountability, and

Bureaucracy Quality can also affect the TFP growth. Better quality work of these institutions helps to boost the economy. We have constructed an index of IQI using six dimensions (as mentioned above) by employing PCA (principal component analysis). The outcome of PCA is given in Appendix B. After getting the factor loadings, we used Arithmetic weighted sum to construct the index of IQI.

A well-functioning legal system ensures that contracts are enforceable and disputes are resolved fairly and efficiently. The rule of law provides a stable and predictable environment for economic activities, encouraging investment, trade, and technological progress. When individuals and businesses have confidence in the legal system, they are more likely to engage in productive activities that enhance TFP. Democratic accountability, one of the indicators in the IQI, refers to the responsiveness of the government to its citizens and stakeholders. A higher level of democratic accountability can lead to better governance practices and policies that promote economic growth and productivity. By ensuring effective governance, democratic accountability may enhance TFP through improved resource allocation, reduced corruption, and increased transparency.

Good governance practices, including transparency, accountability, and reduced corruption, promote economic efficiency and productivity. Transparent institutions foster a level playing field, reducing barriers to entry and encouraging fair competition. They also facilitate efficient resource allocation and discourage rent-seeking behaviors, leading to improved TFP. Effective regulatory frameworks can balance the need for oversight and market efficiency. Well-designed regulations promote competition, innovation, and consumer protection. Excessive or burdensome regulations, on the other hand, can hinder business activities, impede entrepreneurship, and limit productivity growth. Institutions that support education, skills development, and research and development contribute to the growth of human capital. A well-educated and skilled workforce can better adapt to technological advancements, innovate, and contribute to productivity gains across various sectors of the economy. We have applied PCA (Principal component analysis) through Stata. After we got factor loadings, we used arithmetic weighted sum to make index.

3.4.2 Data Source

The description of variables used in this study along with the data sources are reported in Table 3.1.

Table 3.1

Data Source of Variables

Sr.#	Variables	Variables	Source
1	Y	GDP	WDI
2	K	Gross Fixed Capital Formation	WDI
3	L	Labor Force	WDI
4	FD	Financial Development	IMF
5	ICT	Information & Communication Technology	WDI
6	Trade	Trade	WDI
7	FDI	Foreign Direct Investment	WDI
8	IQI	Institutional Quality Index; (Government Stability, Investment Profile, Corruption, Law and Order, Democratic Accountability and Bureaucracy Quality)	ICRG

3.5 Estimation Technique

3.5.1 GMM (Generalized Method of Moments)

We choose to use the GMM approach rather than the typical panel approaches, which include the random-effect and fixed-effect panel models, to estimate the coefficients of the variables included in the model in equation (3.13) for a variety of reasons. We can eliminate all the problems with endogeneity, serial correlation, and country-specific effects by employing the GMM technique, as discussed in Arellano and Bover (1995) and Arellano and Bond (1991). With a sample of numerous nations like the one employed in this study, typical panel methods can cause the issue of country-specific effects.

Additionally, A lagged dependent variable in the growth model's equation (3.13) employed in our paper confirms the model's dynamic nature, specifically the past year TFP that may impact the present TFP. In the standard GMM framework, reverse

causality can be handled by using second- and higher order lags of the dependent variables as instruments (Leszczensky and Wolbring (2019). The time period for this study is 21 years for 45 countries, and in case of T<N, GMM is the best option. (Ahmad et al., 2020; Uddin et al., 2017; Khan et al., 2020). Also the variables of the model are interlinked; GMM is the best suitable technique to deal with the possible endogeneity and multicollinearity issues. For example trade allows countries to access goods and services that they may not produce efficiently domestically. This exposure to foreign technologies, practices and managerial techniques can contribute to improving TFP by adopting more efficient methods. Institutions that prioritize education, healthcare, and workforce development contribute to a skilled and innovative workforce, which is crucial for TFP growth. A well-educated workforce is more capable of adopting new technologies and driving productivity improvements. Institutions that protect property rights are crucial for FDI. Foreign investor wants assurance that their intellectual and physical property will be secure and that they can operate without the fear expropriation. Furthermore, endogeneity may be an issue with the independent variables included in our model, which is challenging to address with traditional panel approaches. Since several studies used the lagged values of the corresponding explanatory variables as internal instruments to deal with endogeneity (reverse causation, omitted variables, simultaneity, and measurement error), this estimator's main benefit is that it does not need any external instruments and instead could reduce the potential endogeneity of the explanatory variables through internal instruments. Moreover, it is important to note that the GMM estimator method can be used in either a one-step or two-step approach (Arellano and Bond 1991). When the independence and homoscedasticity requirements for the estimated parameters are violated, using the residuals from the first step estimation, a two-step estimator creates a weighted consistent variance-covariance matrix. In our study, we generally advocate using a two-step GMM estimator instead of a one-step GMM estimator, as in previous studies (Lee et al. 2012; Andrianaivo and Kpodar 2011; Albiman and Sulong 2016; Wamboye et al. 2015)

3.5.2 Cross-Sectional Dependence Test

With the Cross-Sectional Dependence (hereinafter CD) test, we are starting the econometric analysis. Panel data usually suffer from CD and ignoring CD accounts for cross-sectional errors, producing results that are unreliable and skewed (O'Connell, 1998). To check for CD among the panel countries, we used Pesaran's (2004) CD technique. The following equation is used for the CD test,

$$CD= \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=0}^{N-1}\sum_{j=i+1}^{N}\rho_{ij}\right) \quad (3.15)$$

Where CD represents the cross-sectional dependence, ρij represents the cross-sectional correlation of errors between i and j, T represents the period and N represents the panel cross-sections.

3.5.3 CADF (cross-section augmented Dickey-Fuller) and CIPS (cross-section Im-Pesaran) Unit Root Tests

This study is using second-generation rather than first-generation panel unit root testing because in the presence of CD, first generation tests produce invalid results. It employs the Pesaran-developed cross-sectional augmented Dickey-Fuller (CADF) and cross-sectional augmented Im-Pesaran-Shin (CIPS) models (2007). These tests are preferable to first-generation tests in terms of power and resistance to heterogeneous CD. The equation for the CADF test is following:

$$\Delta TFP_{it} = \alpha_{it} + \beta_i TFP_{it-1} + \rho_i T + \sum_{j=0}^{N}\theta_{it}\Delta TFP_{i,t-j} + \varepsilon_{it} \quad (3.16)$$

Where TFP_{it}, ε_{it}, i, and t are the analyzed variables, the residuals of the model, the CD in the panel, and the period, respectively.

The CIPS equation that is suggested by Pesaran (2007) shown below:

$$CIPS= \frac{1}{N}\sum_{i=1}^{N} CADF_i \quad (3.17)$$

Where $CADF_i$ is the CD-augmented Dicky Fuller statistic.

3.5.4 Westerlund Panel Cointegration Test

To obtain a statistically significant coefficient of the variables, the variables must be stationary, however if variables are not, we need to check the existence of cointegration. It determines whether there is long-run equilibrium relationship between variables or not. Due to the non-stationarity of the analyzed variables in our case, we apply the Westerlund (2007) cointegration test to account for the heterogeneity problem

in time series panel data. A cointegrated cross-section of the panel must exist, according to the panel statistics, whereas the panel's cointegration is determined by the group statistics. Utilizing the following equation, the Westerlund Panel Cointegration test:

$$\Delta TFP_{it} = \delta_i d_t + \alpha_i TFP_{i,t-1} + \acute{\lambda}_i X_{i,t-1} + \sum_{j=1}^{pi} \alpha_{ij}\, \Delta TFP_{i,t-1} + \sum_{j=-qi}^{pi} \gamma_{ij}\, \Delta X_{i,t-1} + \varepsilon_{it} \quad (3.18)$$

Where i, t, ε_{it}, and d_t are the cross-sections, the period, the residuals of the model, and the model's deterministic components, respectively.

CHAPTER 4

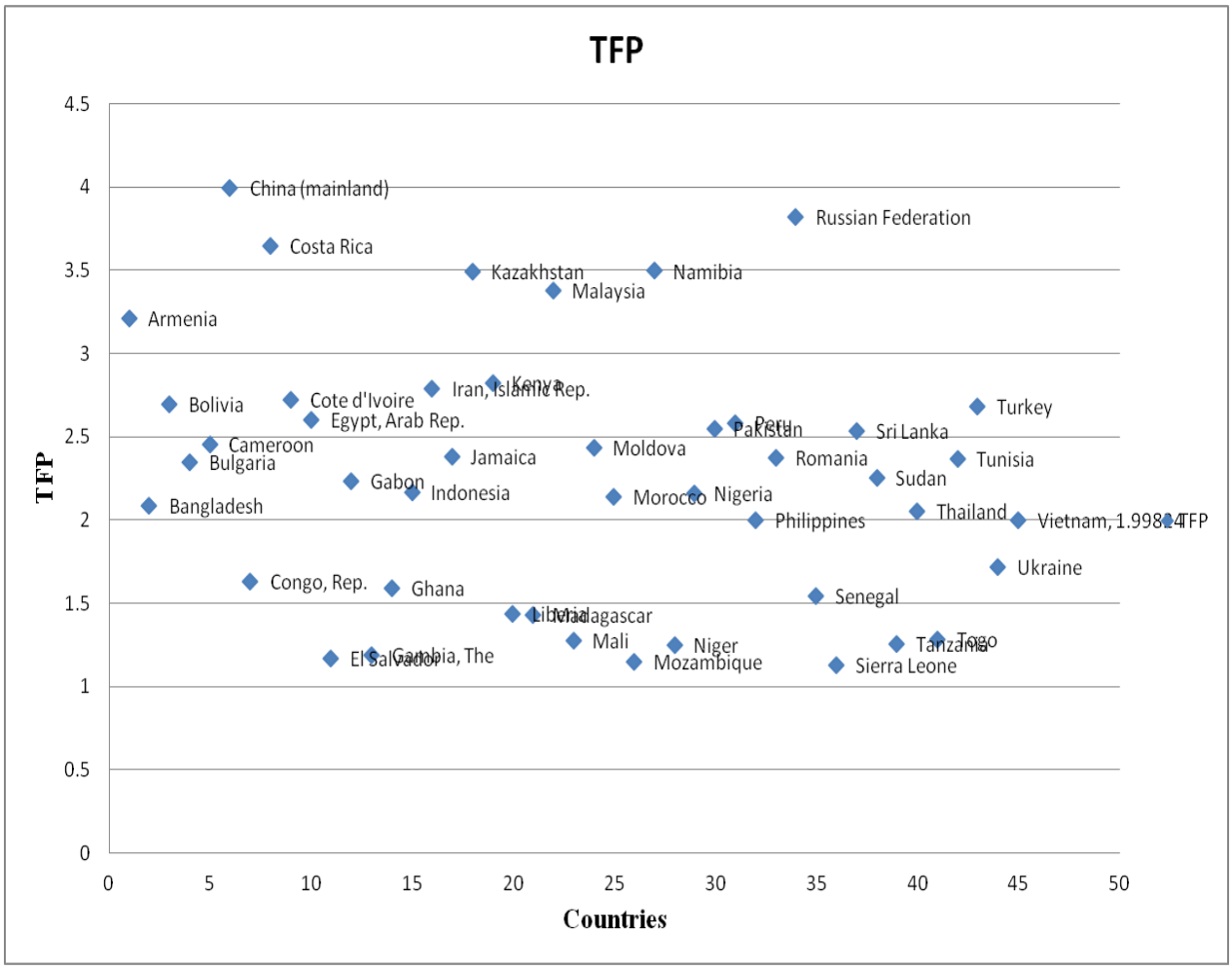
RESULTS AND DISCUSSIONS

This chapter reports all the results after estimation and further provides the interpretation of results and discussion which can lead us to the final conclusion.

This study used two approaches to measure tfp. The graph of tfp for the year 2018 for all countries is given in figure 4.1. The last observation was for year 2020, but the economic activities of this year has been affected by Covid 19, that's why we have taken 2018 which is considered to be a smooth year. The graph is showing data of TFP for 45 low and middle income BRI countries. This TFP is calculated using Translog production function.

Figure 4.1

TFP of BRI Countries



The descriptive statistics of the main variables are shown in Table 4.1 which helps in understanding the structure of data.

Table 4.1

Descriptive Analysis

Variables	Mean	Min	Max	S.D	Skew	Kurtosis
TFP1	2.219	0.023	4.145	0.021	0.237	3.313
TFP2	3.859	3.290	4.572	0.235	0.375	3.278
FD	0.237	0.03	0.74	0.149	1.0287	3.571
ICT	8.263	4.266	10.999	1.055	-0.386	3.182
Trade	14.241	10.731	18.137	1.322	0.403	3.748
FDI	12.842	8.447	16.584	1.307	0.304	3.548
IQI	0.787	0.358	1.251	0.159	0.249	2.984

Note: TFP1, TFP calculated from Cobb Douglas Production Function; TFP2, TFP calculated from Translog; FD, Financial Development; Internet Users, Proxy for ICT; FDI, Foreign Direct Investment; Institutional Quality Index, Government Stability, Investment Profile, Corruption, Law and Order, Democratic Accountability and Bureaucracy Quality.

Source: Author's own calculations

Table 4.1 shows the descriptive statistical analysis of all the variables, TFP1, TFP2, FD, Internet users, Trade, FDI, and Institutional Quality Index. The results indicate that the data has minimal fluctuation and is highly stable and also normally distributed.

GMM estimator is one of the dynamic panel data techniques utilized in this study to examine the causal association of TFP growth with ICT and FD. Since the variables in this approach are presumed to be stationary, it is most important to use the right unit root tests to determine whether the variables utilized in the analysis are stationary. The tests developed to detect the stationary are classified into the first and second-generation unit root tests when the panel data literature is taken into consideration. Depending on whether there is a relationship between the elements making up the panel, these tests are different from one another (cross-sectional dependence). It is assumed that there is no dependence between the cross-sectional units in first-generation unit root tests like those conducted by Im, Pesaran, and Shin (2003), Choi (2001), Hadri (2000), and Levin et al., Lin and Chu (2002). The cross-sectional dependence is taken into consideration by

second-generation unit root tests like Bai and Ng (2004), MADF by Taylor and Sarno (1998), CADF & CIPS by Pesaran (2007), and SURADF by Breuer et al (2002). and The second-generation unit root test CADF and CIPS are used in this study to examine stationarity.

Table 4.2

Cross Dependence Test

Variables	CD-test	P-value
TFP1	86.46	0.000***
TFP2	68.86	0.000***
FD	59.05	0.000***
ICT	137.63	0.000***
Trade	136.76	0.000***
FDI	54.43	0.000***
IQI	43.36	0.000***

Note: TFP1, TFP calculated from Cobb Douglas Production Function; TFP2, TFP calculated from Translog; tfp1, FD, Financial Development; Internet Users, Proxy for ICT; FDI, Foreign Direct Investment; Index, Institutional Quality Index which include Government Stability, Investment Profile, Corruption, Law and Order, Democratic Accountability and Bureaucracy Quality. ******* indicates a significance level at 1%.

Source: Author's own calculations

The results in table 4.2 show that the p-value of TFP1, TFP2, FD, Internet users, Trade, FDI, and Institutional Quality Index are less than 0.01, that is, values are significant at one percent level of significance. The significant results show that there is cross-sectional dependence between the variables and that the null hypothesis has been rejected. The null hypothesis is that cross-sectional independence does not exist. This means that the stationary analysis that will be conducted will make use of cross-sectional dependence-aware second-generation panel unit root tests. To determine if the variables in the study are stationary or not, the CADF test and CIPS test of second-generation panel unit root estimators, created by Pesaran (2007), are applied.

Table 4.3

CADF and CIPS Unit Root Tests

Variables	CADF		CIPS	
	Level	1st Difference	Level	1st Difference
TFP1	-0.521	-2.566***	-0.131	-2.200***
TFP2	-1.680	-2.279***	-1.694	-2.468***
FD	-2.414***	-3.700***	-3.028***	-5.049***
ICT	-2.478***	-3.167***	-1.984	-4.004***
Trade	-1.762	-2.688***	-1.768	-3.704***
FDI	-2.408***	-3.773***	-2.996***	-5.149***
IQI	-2.548***	-3.528***	-2.309***	-4.133***

Source: Author's own calculations

The results presented in Table 4.3 are the CIPS and CADF tests. The results in the table for CIPS and CADF show that FD, FDI, and index are stationary at their levels (1% significance levels), whereas TFP1, TFP2, ICT, and Trade are not stationary at level. As a result, there is adequate evidence from the tests to reject the null hypothesis. At the 1% level of significance, For the CIPS and CADF tests, every variable under consideration becomes stationary at its first difference and is integrated at order one. Some of the variables are not stationary at level; this study uses a co-integration test to avoid spurious results. Since there is cross-sectional dependency we have used the Westerlund cointegration test.

Table 4.4

Westerlund Panel Cointegration Test

Statistics	Value	z-value	p-value
Gt	-6.492	-27.072	0.000
Ga	-0.329	11.919	1.000
Pt	-19.595	-32.854	0.000
Pa	4.186	12.479	1.000

Source: Author's own calculations.

The results of the Westerlund cointegration test are listed in Table 4.4. Both probability statistics and group statistics are used in the Westerlund cointegration test. The fact that both the group statistics and probability statistics have significant p-values supports the test's conclusion that the investigated variables are cointegrated in the selected panel.

Table 4.5

GMM Results

	TFP1			TFP2		
Variables	**Coefficient**	**t-value**	**p-value**	**Coefficient**	**t-value**	**p-value**
Tfp_{t-1}	0.963	4.20	0.00***	0.543	6.24	0.00***
FD	0.168	2.69	0.010**	0.734	3.75	0.00***
ICT	0.133	1.95	0.058*	0.421	2.72	0.009**
Trade	-0.70	-9.98	0.00***	-0.588	-2.48	0.017**
FDI	0.578	9.82	0.00***	0.246	4.10	0.00***
IQI	2.802	7.38	0.00***	0.620	1.92	0.061*

Note: TFP1**,** TFP calculated from Cobb Douglas Production Function; TFP2**,** TFP calculated from Translog; tfp1, TFP from the previous year; FD, Financial Development; Internet Users, Proxy for ICT; FDI, Foreign Direct Investment; Index, Institutional Quality Index which include Government Stability, Investment Profile, Corruption, Law and Order, Democratic Accountability and Bureaucracy Quality. ***, **, * indicates significance level at 1%, 5% and 10% respectively.

Source: Author's own calculations

We have calculated TFP in two different methods. The first method is Cobb Douglas Production Function, mentioned as TFP1 and the second method is Translog, which is mentioned as TFP2. The results in Table 4.5 show the relationship between TFP and FD, ICT, Trade, FDI & Institutional Quality Index.

Results with TFP1 as Dependent Variable

All of these variables are in log form, as was already mentioned, which shows the one percentage change in how one variable affects another. As shown in the results, we can see that the TFP1 of the previous year is positively related to the current year's TFP1. The coefficient value of lagged tfp is 0.963 which implies that β-1 is equal to -0.037. The higher the value of lagged coefficient the lower will be the rate of convergence. In this

case, the results show that we have a slow convergence rate. Thus it can be concluded that the rise in previous years of Total Factor Productivity affects TFP in current and upcoming years. The value of the coefficient of lag TFP shows the persistency in TFP.

Our study has two core independent variables, which are FD and ICT. In the above results, it has been shown that FD and TFP have a positive relationship. This means by increasing 1 percent FD, TFP will increase by 0.17%, and the probability value is 0.01 which indicates it is significant at 1 percent level of significance. A country's financial system can become more economically efficient because of financial development, which is essential. For example, financial development increases FDI and banking activities and boosts stock market activity within a nation (Katircioglu et al. 2018). Financial growth also lowers capital expenses and financial risk. It enhances openness between creditors and debtors and expands alternatives for capital financing. Additionally, FD sector expansion increases access to the most recent energy-efficient products and cutting-edge technologies while broadening the scope of cross-border investment. This shows the major impact of FD on TFP growth for any country. FD makes easy access for people to use financial instruments for the latest technology which eventually affects the TFP growth positively. The findings of Han and Shen's (2015) are also similar to our results, which show that FD has a strong beneficial impact on TFP growth.

We have used the data of Internet users as a substitute for ICT and the results have shown a positive coefficient which means that there is a positive relationship between ICT and TFP. This means by increasing 1 percent ICT, TFP will increase by 0.13%, and the probability value is 0.058, which shows that it is significant at a 10 percent level of significance. The growth of ICT helps to learn new knowledge and techniques which are more efficient while performing any given task. ICT advancements and innovations facilitate economic activities and have improved economic performance. The ability to create interactions that increase productivity is a characteristic of ICT. Their complementary impacts have the potential to have an impact on the entire knowledge-based economy, resulting in the creation of new knowledge and increased productivity. Thus, the shift to a global knowledge-based economy has been facilitated by the more developed country's major investment in ICTs, particularly in productive sectors (Fukuda 2020). ICTs are one of the factors influencing modern production and are boosting

productivity and efficiency across numerous industries. Therefore, the availability, adoption, and usage of ICTs have a significant impact on TFP (Toader et al. 2018).

Our control variables are Trade, Foreign Direct Investment (FDI), and Institutional Quality Index. The coefficient of trade in the above results is significant but negatively associated with TFP. This shows that the balance of trade is negative in BRI developing countries because there are more imports than exports. There could be several reasons for the negative coefficient of trade, but the major reason for fewer exports is the quality of exports and the lack of infrastructure. Trade deficits in BRI developing countries arise from a lack of effective capacity to produce their goods, so a country needs to work on the quality of exports, which can lead to TFP growth. Another reason for negative impact of trade is that these countries often specialize in the export of primary commodities or low value-added products to meet the demands of global markets. This resource concentration leads to a lack of diversification and inhibits technological progress and innovation, which are crucial drivers of TFP growth. As a result, the overreliance on a narrow range of resources hampers the overall productivity of these countries. The trade relationships between BRI developing countries and their trading partners, particularly with more advanced economies, often exhibit significant power imbalances. These imbalances can result in unfavorable trade terms, including unequal access to markets, intellectual property rights issues, and limited technology transfer. Such unequal trade relationships create barriers for BRI developing countries to upgrade their industries and enhance their TFP. As a consequence, the negative impact of these imbalanced trade relationships on TFP becomes evident. This result is in accordance with the findings of Ramzan et.al, (2019), Akinlo and Adejumo (2016) and Abizadeh & Pandey (2009).

FDI and TFP also have a positive and significant relationship. By increasing one percent of FDI, there will be a 0.34% increase in TFP. The probability value is less than 0.01, which shows that it is significant at 1 percent level of significance. FDI is considered to have a significant and positive impact on the TFP growth of a country by many academics and policymakers. In addition to providing direct capital finance, FDI can also establish connections with local businesses, which can assist a country's economy to take off by providing access to vital knowledge and technology. In a study by Woo (2009), they investigates how FDI affected TFP growth across a wide range of countries from 1970-2000. The estimated results showed that FDI has a direct and

positive impact on TFP growth. Additionally, Pessoa (2005) research work on the impacts of FDI on aggregate TFP in an analytical descriptive approach finds that FDI has a favorable control on TFP for a panel of OECD nations, leading to the conclusion that FDI benefits the TFP of the host country. However, a study by Hee Ng (2006, 2007) examines how FDI inflows affect TFP and efficiency change in both East Asian and sub-Saharan economies.

Institutional Quality Index and TFP also have a positive and significant relationship. For the institutional quality index we have used data on Government Stability, Investment Profile, Corruption, Law and Order, Democratic Accountability, and Bureaucracy Quality. The coefficient of the Institutional Quality Index shows that a one percent increase in the index can cause a 2.8% increase in TFP. TFP estimation and its impact on economic development in China and South Asia between 1989 and 2003 were the subjects of Srinivasan's (2005) study. The author discovered that obtaining continuous productivity growth depends on social and economic institutions that are working well. Tebaldi (2016) used the system GMM to look at what drove TFP growth in sixty-three (63) nations between 1960 and 2011. The findings showed that initial circumstances have a significant impact on the dynamics of TFP, the countries with lower initial TFP lagged behind the ones that were initially in a stronger position. According to this study's findings, openness and institutional quality are significant predictors of TFP increase. While superior institutions support technological advancement and efficiency, globalization serves as a crucial conduit for the transfer of information and technological advancement between nations, which promotes TFP expansion.

Results with TFP2 as Dependent Variable

TFP2 is calculated from Translog production function. In the above results, TFP2 from the previous year has a significant and negative impact on current year TFP2. The coefficient value of lagged tfp is 0.543 which implies that β-1 is equal to -0.457 indicating moderate rate of convergence. Thus the value of the coefficient of lag TFP shows the persistency in TFP.

As mentioned earlier our study has two core independent variables, which are FD and ICT. In the above results for TFP2, FD and TFP2 also have a positive and significant. It indicates that by increasing one percent Financial Development, TFP2 will increase 0.73%. So it clearly shows the importance of the financial development sector in the

growth of a country's Total Factor Productivity. Results for TFP2 have also shown a positive coefficient for internet users which means that there is a positive relationship between ICT and TFP. By increasing one percent internet users, TFP2 will increase around 0.42%. The probability value is less than 0.01, which shows that it is significant at 1 percent level of significance

Control variables are Trade, FDI, and Institutional Quality Index. The coefficient of Trade in TFP2 is also significant but negative, which indicates that imports are higher than exports in developing BRI countries. FDI and TFP2 have a positive and significant relationship. By increasing one percent FDI, there will be around a 0.25% increase in TFP2. Institutional Quality Index and TFP2 have also a positive and significant relationship, which means any changes in the institutional quality index will affect TFP2 directly.

Both the TFP1 and TFP2 have similar significance of the variables and signs of the coefficients values. The same results show that results are robust. Coefficients values of TFP2 are relatively higher than the coefficients values of TFP1. Both TFP's result shows the negative relation of trade with TFP, and positive relation of TFP with all the other variables which includes $TFP_{t-1,}$ FD, ICT, FDI and IQI.

Results in case of Pakistan

We estimated regression model for Pakistan separately and the results are given in Appendix. The outcome of regression analysis shows that FD and ICT have a positive impact on TFP and both are significant in case of Pakistan. FDI has also a positive impact and the probability value shows that the coefficient is significant. However trade and IQI are not significant in case of Pakistan. Since we have limited sample size available to run a regression analysis on time series we couldn't observe the long run impact of trade and IQI in case of Pakistan.

CHAPTER 5

CONCLUSION AND POLICY RECOMMENDATIONS

This study is conducted to investigate the relationship of TFP growth with ICT and FD in 45 BRI developing countries. The study used the GMM, a dynamic panel data analysis technique, with data from the years 2000 to 2020. TFP growth and ICT have a positive association, according to the conclusions drawn from model estimations, which mean that more ICT activities in the country can affect TFP positively, which can also increase the productivity growth of the country. The findings of this study provided strong support to the hypothesis of endogenous growth theories, according to which information and communication technology activities have a beneficial impact on TFP growth by encouraging technological advancements and raising productivity. The financial sector is also a major factor that can affect the TFP of a country. Our results also show a positive relation between Financial Development and TFP growth.

The empirical results of this study point to several policy implications that can assist policymakers, responsible authorities, and government officials in selected nations to achieve sustained TFP growth.

- Since ICT affects TFP positively, government in BRI countries should improve the infrastructure required to enable information and communications technology (ICT). This could include building high-speed internet networks, improving access to mobile devices and computers, and providing training and education to help people develop the skills they need to use these technologies effectively. By improving ICT infrastructure and promoting digital literacy, governments can help to increase productivity and efficiency in the economy, which can lead to higher levels of total factor productivity (TFP).
- FD is essential because it can increase a nation's financial system's economic efficiency. Government should encourage financial sector reforms to enhance transparency, strengthen banking system and foster a conducive environment for financial institutions to operate. There is a need to enhance access to finance to SMEs by establishing credit guarantee schemes and facilitating capital investments. Developing capital markets, such as stock and bond markets, can help to improve the allocation of capital to productive

investments. This can help to improve TFP by enabling businesses to access the capital they need to invest in new technologies and expand their operations.

These policy measures can help the BRI low and middle income countries to achieve the higher level of productivity and country's stability.

REFERENCES

Abdullah, M., & Chowdhury, M. (2020). Foreign direct investment and total factor productivity: any nexus?. *The Journal of Applied Economic Research*, 14(2), 164-190.

Abizadeh, S., & Pandey, M. (2009). Trade openness, structural change and total factor productivity. *International Economic Journal*, *23*(4), 545-559.

Aghion, P., Angeletos, G. M., Banerjee, A., & Manova, K. (2005). *Volatility and Growth: Credit Constraints and Productivity-Enhancing Investment* (No. 11349). National Bureau of Economic Research, Inc.

Ahmad, M., Khattak, S. I., Khan, A., & Rahman, Z. U. (2020). Innovation, foreign direct investment (FDI), and the energy–pollution–growth nexus in OECD region: a simultaneous equation modeling approach. *Environmental and Ecological Statistics, 27*, 203-232.

Albiman, M. M., & Sulong, Z. (2016). The role of ICT use to the economic growth in Sub Saharan African region (SSA). *Journal of Science and Technology Policy Management*, *7*(3), 306-329.

Ali, N., & Malik, Z. K. (2022). Knowledge spillover and total factor productivity across countries: role of financial development. *Pakistan Journal of Social Research*, *4*(04), 494-501.

Alshubiri, F., Jamil, S. A., & Elheddad, M. (2019). The impact of ICT on financial development: Empirical evidence from the Gulf Cooperation Council countries. *International Journal of Engineering Business Management*, *11*.

Amann, E., & Virmani, S. (2015). Foreign direct investment and reverse technology spillovers: The effect on total factor productivity. *OECD Economic Studies, 2014*(1), 129-153.

Amri, F. (2018). Carbon dioxide emissions, total factor productivity, ICT, trade, financial development, and energy consumption: testing environmental Kuznets curve hypothesis for Tunisia. *Environmental Science and Pollution Research, 25*, 33691-33701.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies, 58*(2), 277-297.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics, 68*(1), 29-51.

Arif-Ur-Rahman, M., & Inaba, K. (2020). Financial integration and total factor productivity: in consideration of different capital controls and foreign direct investment. *Journal of Economic Structures, 9*, 1-20.

Arısoy, İ. (2012). The impact of foreign direct investment on total factor productivity and economic growth in Turkey. *The Journal of Developing Areas*, 17-29.

Arizala, F., Cavallo, E., & Galindo, A. (2013). Financial development and TFP growth: cross-country and industry-level evidence. *Applied Financial Economics, 23*(6), 433-448.

Asiedu, E. (2014). Does foreign aid in education promote economic growth? Evidence from Sub-Saharan Africa. *Journal of African Development, 16*(1), 37-59.

Azam, M., & Emirullah, C. (2014). The role of governance in economic development: Evidence from some selected countries in Asia and the Pacific. *International Journal of Social Economics, 41*(12), 1265-1278.

Bacchini, F., Bontempi, M. E., Golinelli, R., & Jona Lasinio, C. (2014). ICT and Non-ICT investments: short and long run macro dynamics (No. 956). *Quaderni-Working Paper DSE*.

Bai, J., & Ng, S. (2004). A panic attack on unit roots and cointegration. *Econometrica, 72*(4), 1127-1177.

Balk, B. M. (2001). Scale efficiency and productivity change. *Journal of productivity analysis, 15*, 159-183.

Baloch, M. A., Zhang, J., Iqbal, K., & Iqbal, Z. (2019). The effect of financial development on ecological footprint in BRI countries: evidence from panel data estimation. *Environmental Science and Pollution Research, 26*, 6199-6208.

Baltabaev, B. (2014). Foreign direct investment and total factor productivity growth: New macro-evidence. *The World Economy*, *37*(2), 311-334.

Barras, R. (1990). Interactive innovation in financial and business services: the vanguard of the service revolution. *Research Policy*, *19*(3), 215-237.

Barro, R. J. (1999). Notes on growth accounting. *Journal of Economic Growth*, *4*, 119-137.

Basu, S., & Fernald, J. (2007). Information and communications technology as a general-purpose technology: Evidence from US industry data. *German Economic Review*, *8*(2), 146-173.

Bencivenga, V. R., & Smith, B. D. (1991). Financial intermediation and endogenous growth. *The Review of Economic Studies*, *58*(2), 195-209.

Bernanke, B. S., & Gürkaynak, R. S. (2001). Is growth exogenous? taking mankiw, romer, and weil seriously. *NBER Macroeconomics Annual*, *16*, 11-57.

Bhattacharjee, J., & Haldar, S. K. (2015). Economic growth of selected South Asian countries: Does institution matter?. *Asian Economic and Financial Review*, *5*(2), 356-370.

Bosworth, B., & Collins, S. M. (2008). Accounting for growth: comparing China and India. *Journal of Economic Perspectives*, *22*(1), 45-66.

Bresnahan, T. F. (1999). Computerisation and wage dispersion: an analytical reinterpretation. *The Economic Journal*, *109*(456), 390-415.

Bresnahan, T. F., Brynjolfsson, E., & Hitt, L. M. (2002). Information technology, workplace organization, and the demand for skilled labor: Firm-level evidence. *The Quarterly Journal Of Economics*, *117*(1), 339-376.

Breuer, J. B., McNown, R., & Wallace, M. (2002). Series-specific unit root tests with panel data. *Oxford Bulletin of Economics and Statistics*, *64*(5), 527-546.

Broda, C., Greenfield, J., & Weinstein, D. E. (2017). From groundnuts to globalization: A structural estimate of trade and growth. *Research in Economics*, *71*(4), 759-783.

Buera, F. J., Kaboski, J. P., & Shin, Y. (2011). Finance and development: A tale of two sectors. *American Economic Review*, *101*(5), 1964-2002.

Caselli, F. (2005). Accounting for cross-country income differences. *Handbook of Economic Growth*, *1*, 679-741.

Chanda, A., & Dalgaard, C. J. (2008). Dual economies and international total factor productivity differences: Channelling the impact from institutions, trade, and geography. *Economica*, *75*(300), 629-661.

Chandrasekhar, C. P. (2001). *ICT in a Developing Country Context: An Indian Case Study* (No. HDOCPA-2001-01). *Human Development Report Office (HDRO), United Nations Development Programme (UNDP).*

Chang, C. C., & Mendy, M. (2012). Economic growth and openness in Africa: What is the empirical relationship?. *Applied Economics Letters*, *19*(18), 1903-1907.

Choi, I. (2001). Unit root tests for panel data. *Journal of International Money and Finance*, *20*(2), 249-272.

Chong, A., & Zanforlin, L. (2004). Inward-looking policies, institutions, autocrats, and economic growth in Latin America: an empirical exploration. *Public Choice*, *121*(3-4), 335-361.

Chumacero, R. A., & Fuentes, J. R. (2006). Economic growth in Latin America: structural breaks or fundamentals?. *Estudios de Economía*, *33*(2), 141-154.

Coe, D. T., & Helpman, E. (1995). International r&d spillovers. *European Economic Review*, *39*(5), 859-887.

Colecchia, A., & Schreyer, P. (2000). ICT investment and economic growth in the 1990s: is the United States a unique case? A comparative study of nine OECD countries. *Review of Economic Dynamics*, *5*(2), 408-442.

Dahmani, M., Mabrouki, M., & Ben Youssef, A. (2022). ICT, trade openness and economic growth in Tunisia: what is going wrong?. *Economic Change and Restructuring*, *55*(4), 2317-2336.

Das, S., & Upadhyay, M. (2019). Growth of real GDP and total factor productivity in Asia with an emphasis on Malaysian growth. *Atlantic Economic Journal*, *47*, 391-413.

De Gregorio, J., Lee, J. W., Lederman, D., & Roubini, N. (2004). Growth and adjustment in East Asia and Latin America. *Economía, 5*(1), 69-134.

Dewan, S., & Kraemer, K. L. (2000). Information technology and productivity: evidence from country-level data. *Management Science*, *46*(4), 548-562.

Dollar, D. (1992). Outward-oriented developing economies really do grow more rapidly: evidence from 95 LDCs, 1976-1985. *Economic Development and Cultural Change*, *40*(3), 523-544.

Dollar, D., & Kraay, A. (2004). Trade, growth, and poverty. *The Economic Journal*, *114*(493), F22-F49.

Dovis, M., & Milgram-Baleix, J. (2009). Trade, tariffs and total factor productivity: the case of Spanish firms. *World Economy*, *32*(4), 575-605.

Duan, Y., He, Q., Feng, W., Li, D., & Fu, Z. (2010). A study on e-learning take-up intention from an innovation adoption perspective: A case in China. *Computers & Education*, *55*(1), 237-246.

Edquist, H., & Henrekson, M. (2017). Do R&D and ICT affect total factor productivity growth differently?. *Telecommunications Policy*, *41*(2), 106-119.

Fayissa, B., & Gill, F. (2016). Revisiting the growth-governance relationship in developing Asian and Oceanic economies. *Journal of Economics and Finance*, *40*, 803-816.

Felipe, J. (1999). Total factor productivity growth in East Asia: A critical survey. *The Journal of Development Studies*, *35*(4), 1-41.

Fernández-Arias, E., Blyde, J. S., Gill, I. S., Monge Naranjo, A., Neumeyer, P. A., Fernández Valdovinos, C. G., ... & Servén, L. (2011). Sources of Growth in Latin America: What Is Missing*?*. *Inter-American Development Bank*.

Fletcher, K. K., Liu, X. F., & Tang, M. (2015). Elastic personalized nonfunctional attribute preference and trade-off based service selection. *ACM Transactions on the Web (TWEB)*, *9*(1), 1-26.

Fox, K. J., & Kohli, U. (1998). GDP growth, terms-of-trade effects, and total factor productivity. *Journal of International Trade & Economic Development*, *7*(1), 87-110.

Fullerton Jr, T. M., Sawyer, W. C., & Sprinkle, R. L. (2010). Intra-industry trade in Latin America and the Caribbean. *The International Trade Journal*, *25*(1), 74-111.

Gollin, D. (2002). Getting income shares right. *Journal of political Economy*, *110*(2), 458-474.

Greenwald, B. C., Kohn, M., & Stiglitz, J. E. (1990). Financial market imperfections and productivity growth. *Journal of Economic Behavior & Organization*, *13*(3), 321-345.

Greenwood, J., & Jovanovic, B. (1990). Financial development, growth, and the distribution of income. *Journal of Political Economy*, *98*(5, Part 1), 1076-1107.

Grier, R. (2007). Losing ground: Latin American growth from 1955 to 1999. *Southern Economic Journal*, *74*(1), 177-203.

Griffith, R., Redding, S., & Reenen, J. V. (2004). Mapping the two faces of R&D: Productivity growth in a panel of OECD industries. *Review of Economics and Statistics*, *86*(4), 883-895.

Grossman, S. J., & Stiglitz, J. E. (1980). On the impossibility of informationally efficient markets. *The American Economic Review*, *70*(3), 393-408.

Guetat, I., & Drine, I. (2007, March). The information and communication technologies impact on MENA countries growth performance. In *Sixth International Conference of the MEEA* (Vol. 14, p. 16).

Guillaumont Jeanneney, S., Hua, P., & Liang, Z. (2006). Financial development, economic efficiency, and productivity growth: Evidence from China. *The Developing Economies*, *44*(1), 27-52.

Habib, M., Abbas, J., & Noman, R. (2019). Are human capital, intellectual property rights, and research and development expenditures really important for total factor productivity? An empirical analysis. *International Journal of Social Economics*, *46*(6), 756-774.

Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. *The Econometrics Journal*, *3*(2), 148-161.

Han, J., & Shen, Y. (2015). Financial development and total factor productivity growth: Evidence from China. *Emerging Markets Finance and Trade*, *51*(sup1), S261-S274.

Harberger, A. C. (1978). On the use of distributional weights in social cost-benefit analysis. *Journal of Political Economy*, *86*(2, Part 2), S87-S120.

Herzer, D. (2011). The long-run relationship between outward foreign direct investment and total factor productivity: Evidence for developing countries. *The Journal of Development Studies*, *47*(5), 767-785.

Hsieh, C. T., & Klenow, P. J. (2010). Development accounting. *American Economic Journal: Macroeconomics*, *2*(1), 207-223.

Huang, H. C., & Lin, S. C. (2009). Non-linear finance–growth nexus: A threshold with instrumental variable approach 1. *Economics of Transition*, *17*(3), 439-466.

Hussein, K., & Mohieldin, M. (1997). Interest Rates, Investment and Growth under Financial Repression: The Egyptian Experience. *Arab Economic Journal*, *9*, 3-26.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53-74.

Inklaar, R., & Koetter, M. (2008). Financial dependence and industry growth in Europe: Better banks and higher productivity (No. GD-100). *Groningen Growth and Development Centre, University of Groningen.*

Jorgenson, D. W., & Griliches, Z. (1967). The explanation of productivity change. *The Review of Economic Studies*, *34*(3), 249-283.

Jorgenson, D. W., & Vu, K. (2007). Information technology and the world growth resurgence. *German Economic Review*, *8*(2), 125-145.

Jouini, J. (2015). Linkage between international trade and economic growth in GCC countries: Empirical evidence from PMG estimation approach. *The Journal of International Trade & Economic Development*, *24*(3), 341-372.

Karimi, M. S., & Heshmati Daiari, E. (2018). Does institutions matter for economic development? Evidence for ASEAN selected countries. *Iranian Economic Review*, *22*(1), 1-20.

Katircioglu, S., Katircioğlu, S., & Altinay, M. (2018). Interactions between tourism and financial sector development: evidence from Turkey. *The Service Industries Journal*, *38*(9-10), 519-542.

Keller, W. (2010). International trade, foreign direct investment, and technology spillovers. In *Handbook of the Economics of Innovation* (Vol. 2, pp. 793-829). North-Holland.

Khan, A., Chenggang, Y., Khan, G., & Muhammad, F. (2020). The dilemma of natural disasters: Impact on economy, fiscal position, and foreign direct investment alongside Belt and Road Initiative countries. *Science of the Total Environment*, *743*, 140578.

King, R. G., & Levine, R. (1993). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics*, *108*(3), 717-737.

Kinnunen, T., Saeidi, R., Sedlák, F., Lee, K. A., Sandberg, J., Hansson-Sandsten, M., & Li, H. (2012). Low-variance multitaper MFCC features: A case study in robust speaker verification. *IEEE Transactions on Audio, Speech, and Language Processing*, *20*(7), 1990-2001.

Kpodar, K., & Andrianaivo, M. (2011). ICT, Financial Inclusion and Growth: Evidence from African Countries. *IMF Working Paper, (11/73).*

Kydland, F. E., & Prescott, E. C. (1982). Time to build and aggregate fluctuations. *Econometrica: Journal of the Econometric Society*, 1345-1370.

Law, S. H., Lim, T. C., & Ismail, N. W. (2013). Institutions and economic development: A Granger causality analysis of panel data evidence. *Economic Systems*, *37*(4), 610-624.

Leszczensky, L., & Wolbring, T. (2022). How to deal with reverse causality using panel data? Recommendations for researchers based on a simulation study. *Sociological Methods & Research*, *51*(2), 837-865.

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1-24.

Levine, R., & Renelt, D. (1992). A sensitivity analysis of cross-country growth regressions. *The American Economic Review*, 942-963.

Levine, R., Loayza, N., & Beck, T. (2000). Financial intermediation and growth: Causality and causes. *Journal of Monetary Economics*, *46*(1), 31-77.

Liu, Z., & Xin, L. (2019). Has China's Belt and Road Initiative promoted its green total factor productivity? Evidence from primary provinces along the route. *Energy Policy*, *129*, 360-369.

Lo, D., Hong, F., & Li, G. (2016). Assessing the role of inward foreign direct investment in Chinese economic development, 1990–2007: Towards a synthesis of alternative views. *Structural Change and Economic Dynamics*, *37*, 107-120.

Mahyideen, J. M., Ismail, N. W., & Hook, L. S. (2012). A pooled mean group estimation on ICT infrastructure and economic growth in ASEAN-5 countries. *International Journal of Economics and Management*, *6*(2), 360-378.

Matteucci, N., O'Mahony, M., Robinson, C., & Zwick, T. (2005). Productivity, workplace performance and ICT: Industry and firm-level evidence for Europe and the US. *Scottish Journal of Political Economy*, *52*(3), 359-386.

Mendi, P. (2007). Trade in disembodied technology and total factor productivity in OECD countries. *Research Policy*, *36*(1), 121-133.

Meng, Q., & Li, M. (2002). New economy and ICT development in China. *Information Economics and Policy*, *14*(2), 275-295.

Moradi, M. A., & Kebryaee, M. (2010). Impact of information and communication technology on economic growth in selected Islamic countries. *Quarterly Journal of New Economy and Commerce*.

Nehru, V., & Dhareshwar, A. (1993). Sources, methodology and results. *Revista de Análisis Económico*, *8*(1), 37-59.

Ng, T. H. (2007). Foreign direct investment and productivity: Evidence from Sub-Saharan Africa. *(Vienna: UNIDO)*.

Ngo, M. N., & Nguyen, L. D. (2020). Economic growth, total factor productivity, and institution quality in low-middle income countries in Asia. *The Journal of Asian Finance, Economics and Business*, *7*(7), 251-260.

O'Connell, P. G. (1998). The overvaluation of purchasing power parity. *Journal of International Economics*, *44*(1), 1-19.

O'Mahony, M., & Vecchi, M. (2005). Quantifying the impact of ICT capital on output growth: a heterogeneous dynamic panel approach. *Economica*, *72*(288), 615-633.

Park, J. (2010). Projection of long-term total factor productivity growth for 12 Asian economies. *Asian Development Bank Economics Working Paper Series*, (227).

Peretto, P., & Smulders, S. (2002). Technological distance, growth and scale effects. *The Economic Journal*, *112*(481), 603-624.

Pesaran, M. H. (2004). General diagnostic tests for cross-sectional dependence in panels. *Empirical Economics*, *60*(1), 13-50.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, *22*(2), 265-312.

Pessoa, A. (2005). Foreign direct investment and total factor productivity in OECD countries: evidence from aggregate data (No. 188). *Universidade do Porto, Faculdade de Economia do Porto.*

Razzaq, A., An, H., & Delpachitra, S. (2021). Does technology gap increase FDI spillovers on productivity growth? Evidence from Chinese outward FDI in Belt

and Road host countries. *Technological Forecasting and Social Change*, *172*, 121050.

Rioja, F., & Valev, N. (2004). Finance and the sources of growth at various stages of economic development. *Economic Inquiry*, *42*(1), 127-140.

Rodriguez, F., & Rodrik, D. (2000). Trade policy and economic growth: a skeptic's guide to the cross-national evidence. *NBER Macroeconomics Annual*, *15*, 261-325.

Romer, P. M. (1986). Increasing returns and long run growth. *The Journal of Political Economy*. vol. 94. *N*, *5*, 102-1037.

Sachs, J. D., Warner, A., Åslund, A., & Fischer, S. (1995). Economic reform and the process of global integration. *Brookings Papers on Economic Activity*, *1995*(1), 1-118.

Saint-Paul, G. (1992). Technological choice, financial markets and economic development. *European Economic Review*, *36*(4), 763-781.

Sala-i-Martin, X. X. (1996). Regional cohesion: evidence and theories of regional growth and convergence. *European Economic Review*, *40*(6), 1325-1352.

Sarno, L., & Taylor, M. P. (1998). Real exchange rates under the recent float: unequivocal evidence of mean reversion. *Economics Letters*, *60*(2), 131-137.

Seo, H. J., & Lee, Y. S. (2006). Contribution of information and communication technology to total factor productivity and externalities effects. *Information Technology for Development*, *12*(2), 159-173.

Shahabadi, A., Kimiaei, F., & Arbab Afzali, M. (2018). The evaluation of impacts of knowledge-based economy factors on the improvement of total factor productivity (a comparative study of emerging and G7 economies). *Journal of the Knowledge Economy*, *9*, 896-907.

Shiu, A., & Heshmati, A. (2006). Technical Change and Total Factor Productivity Growth for Chinese Provinces: A Panel Data Analysis (No. 98). *The Ratio Institute.*

Sridhar, K. S., & Sridhar, V. (2007). Telecommunications infrastructure and economic growth: Evidence from developing countries. *Applied Econometrics and International Development*, *7*(2).

Srinivasan, T. N. (2005). Productivity and economic growth in South Asia and China. *The Pakistan Development Review*, 479-503.

Tebaldi, E. (2016). The dynamics of total factor productivity and institutions. *Journal of Economic Development*, *41*(4).

Toader, E., Firtescu, B. N., Roman, A., & Anton, S. G. (2018). Impact of information and communication technology infrastructure on economic growth: An empirical assessment for the EU countries. *Sustainability*, *10*(10), 3750.

Uddin, M. A., Ali, M. H., & Masih, M. (2017). Political stability and growth: An application of dynamic GMM and quantile regression. *Economic Modelling*, *64*, 610-625.

Venard, B. (2013). Institutions, corruption and sustainable development. *Economics Bulletin*, *33*(4), 2545-2562.

Wacziarg, R., & Welch, K. H. (2008). Trade liberalization and growth: New evidence. *The World Bank Economic Review*, *22*(2), 187-231.

Wamboye, E., Tochkov, K., & Sergi, B. S. (2015). Technology adoption and growth in sub-Saharan African countries. *Comparative Economic Studies*, *57*, 136-167.

Westerlund, J., & Edgerton, D. L. (2007). A panel bootstrap cointegration test. *Economics letters*, *97*(3), 185-190.

Woo, J. (2009). Productivity growth and technological diffusion through foreign direct investment. *Economic Inquiry*, *47*(2), 226-248.

Yang, L., & Ni, M. (2022). Is financial development beneficial to improve the efficiency of green development? Evidence from the “Belt and Road” countries. *Energy Economics*, *105*, 105734.

Yanikkaya, H. (2003). Trade openness and economic growth: a cross-country empirical investigation. *Journal of Development Economics*, *72*(1), 57-89.

YAO, Y. J. (2012). Financial Development and Total Factor Productivity Growth: Does Regional Disparity Matter?. *Contemporary Finance & Economics*, (03), 1489.

Yu, H., Zhang, J., Zhang, M., & Fan, F. (2022). Cross-national knowledge transfer, absorptive capacity, and total factor productivity: The intermediary effect test of international technology spillover. *Technology Analysis & Strategic Management*, *34*(6), 625-640.

Zachariadis, M. (2004). R&D-induced Growth in the OECD?. *Review of Development Economics*, *8*(3), 423-439.

Zhang, J., & Yu, J. (2005). Reinvestigating the relationships between financial deepening and productivity in China: 1978-2001. *Economic Research Journal.*

Zhuang, J., de Dios, E., & Martin, A. L. (2010). Governance and institutional quality and the links with economic growth and income inequality: With special reference to developing Asia. *Asian Development Bank Economics Working Paper Series*, (193).

Appendix A

BRI low and Middle Income Countries

Armenia	Iran, Islamic Rep.	Peru
Bangladesh	Jamaica	Philippines
Bolivia	Kazakhstan	Romania
Bulgaria	Kenya	Russian Federation
Cameroon	Liberia	Senegal
China (mainland)	Madagascar	Sierra Leone
Congo, Rep.	Malaysia	Sri Lanka
Costa Rica	Mali	Sudan
Cote d'Ivoire	Moldova	Tanzania
Egypt, Arab Rep.	Morocco	Thailand
El Salvador	Mozambique	Togo
Gabon	Namibia	Tunisia
Gambia, The	Niger	Turkey
Ghana	Nigeria	Ukraine
Indonesia	Pakistan	Vietnam

Appendix B

Institutional Quality Index

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.8039	0.8883	0.5039	0.5039
Comp2	0.9156	0.0814	0.1983	0.7022
Comp3	0.8342	0.0831	0.1197	0.8219
Comp4	0.7511	0.2509	0.0925	0.9144
Comp5	0.5002	0.0641	0.0663	0.9807
Comp6	0.4361	-	0.0193	1.0000

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Unexplained
ngs	-0.0589	0.7057	-0.0145	0.5085	-0.1001	0.4792	0
nlaw	0.2318	0.5307	0.2581	-0.6220	0.4593	0.0107	0
ndem	0.4616	- 0.4333	0.3512	0.2337	0.4303	0.5443	0
ncor	0.4494	0.0735	0.6611	0.1138	-0.5230	-0.2630	0
ninv	0.5332	0.1646	- 0.4181	0.3789	0.3010	-0.5288	0
ibur	0.4935	- 0.0046	- 0.5082	-0.3787	-0.4792	0.3538	0

Appendix C

Results in Case of Pakistan

tfptranslog	Coef.	Std. Err.	t	p > | t |	[95% Conf.	Interval]
FD	0.0284	0.0140	2.02	0.047	0.0549	0.0111
ICT	0.0415	0.0219	1.89	0.081	0.0153	0.0702
TRADE	-0.0120	0.0113	-1.06	0.376	-0.0174	0.1501
FDI	0.0104	0.0052	2.00	0.051	0.0497	0.0289
IQI	0.0532	0.0316	1.68	0.212	0.0291	0.0404
_cons	3.812	1.108	3.44	0.00	3.7215	3.9641