ANALYSIS OF THE IMPACT OF TRADE OPENNESS, CO_2 EMISSIONS, AND CO_2 INTENSITY ON THE GROSS DOMESTIC PRODUCT IN SELECTED SOUTH ASIAN AND ASEAN COUNTRIES: A PANEL DATA ANALYSIS

by

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Submitted in partial fulfillment of the requirements

for the degree of Master of Arts

at

Dalhousie University

Halifax, Nova Scotia

December 2023

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In the last three decades, international trade has significantly changed in South Asian and ASEAN countries. The present study analysis the correlation between trade openness, CO_2 intensity and CO_2 emissions on real GDP based on the data of selected ASEAN and South Asian countries. This study also examines the elasticity of real GDP with respect to trade openness in selected countries in international trade and whether trade openness is positive or negative for them, based on data from 1990 to 2021. Using the Fixed and Random effects models and data on 12 countries from 1990 to 2021, the results provide statistically significant support to the hypothesis given regression model assumptions and suggest that the elasticity of trade openness with respect to real GDP is positive on average throughout the panel of countries over time. The Hausman test indicated choosing the fixed effect over the random effects model to draw inferences. However, both models are statistically significant and illustrate that a percentage increase in real GDP correlates with trade openness across the panel. Real GDP is increasing, but the trend rate of CO_2 is flat, slightly increasing upward over the period. The study also suggested possible policies to achieve more real GDP from trade openness.

Keywords: Trade Openness, Economic Growth, South Asia, ASEAN, Random Effects.

LIST OF ABBREVIATIONS

GDP	Gross Domestic Product
ASEAN	Association of Southeast Asian Nations
MENA	Middle East and North Africa
MNC	Multinational Company
BAU	Business-as-Usual
AEC	ASEAN Economic Community
ASW	ASEAN Single Window
GCF	Gross Capital Formation
CO_2	Carbon dioxide
AFTA	ASEAN Free Trade Area
FDI	Foreign Direct Investment
NBTOT	Net Barter Terms of Trade
LDC	Least Developed Countries
AMS	ASEAN Member States
ADB	Asian Development Bank
FY	Fiscal Year
FMOLS	Fully Modified Ordinary Least Squares
GMM	The Generalized Method of Moments

ACKNOWLEDGMENTS

I would like to express my gratefulness to my supervisor, Dr. Ruth Forsdyke, for her proficiency, knowledge, and persistence. I appreciate her vast knowledge and skill in International Trade. She gave me much assistance, such as theoretical ideas and logical structure, in writing the master thesis.

I would like to thank the second reader, Dr. Mrittika Samsuddin, for providing help at all levels of my thesis. With her excellent knowledge of econometrics, the econometric model has been modified correctly, and with her skills in statistical software, the estimation methods are more appropriate.

I would like to thank the third reader, Dr. Catherine Boulatoff, for assisting in better writing, logical structure of the introduction, and literature review. Her knowledge of international trade and econometrics made the study more comprehensive and educational.

I also would like to appreciate Dr. Casey Warman. Here, I have to say that the Research Method (ECON5525) by Dr. Casey Warman offers much support for applying Stata and applied Econometrics for specification tests and regressions and making tables and figures.

I would like to express my gratitude to Dr. Teresa Cyrus. I must say that International Trade (ECON 5330) by Dr. Teresa Cyrus gave me vast data collection knowledge and helped me know much better about international trade. The econometrics and empirical analysis could not be as beautiful and informative without her course.

I would like to thank my friend at Dalhousie University, Md. Ashfaq Uddin Khan, a PhD student in the Department of Economics at Dalhousie University. Working with Ashfaq made thesis time not so complicated and funny. I enjoyed studying with him. While working on my master's thesis, we discussed problems about research and shared ideas. Without his assistance, I could not finish my thesis on time.

In conclusion, I am also grateful to the Faculty of Graduate Studies and the Department of Economics at Dalhousie University.

CHAPTER 1: INTRODUCTION

Terms of trade, trade openness, and trade volatility strongly affect real GDP, especially during events of global integration or disintegration and recession when export prices converge or diverge globally (Blatman et al., 2007). Furthermore, real GDP improves the standard of living of some people of an economy, which depends on how goods and services are distributed among the population. Reductions in trade barriers occurred in the 1990s and the real GDP accelerated in both South Asia and ASEAN countries (Bajwa & Siddiqi, 2011). Trade in CO_2 emissions, foreign direct investment (FDI), gross capital formation (GCF), and gross domestic product (GDP) are widely discussed in the literature. However, no comprehensive studies exist on the South Asia and ASEAN regions together. Although South Asia and ASEAN have a lot of influence on the current international trade, the study extends the existing literature using cases from South Asian and ASEAN countries. However, the study uses only selected countries and periods because data is unavailable for all years in all countries. Empirical analysis of South Asia and ASEAN may provide a clearer picture of the success of trade openness and CO_2 intensity on real GDP.

Trade can occur in goods and services, technology, flows of ideas, and knowledge spillovers. International trade influences the economy through numerous channels, creating employment and capital formation, leading to better living standards in terms of higher real GDP. The world trading system has become gradually open and competitive over the 20th century. Restrictions are eliminated, and tariffs are reduced in both developed and developing countries. Some nations are attempting to embrace outward-looking economic policies, looking for ways to boost growth and employment through increasing export production and appealing to inward investment (Stiglitz,2017).

Trade openness can increase growth[1] in several ways, and it increases investments and creates massive benefits due to economies of scale and enlarged markets, technology, flow of information, and knowledge spillovers (Krugman and Obstfeld,2009). Although trade openness is considered an engine of growth in real GDP, it contributes to the carbon dioxide

[1] By economic growth, I mean a process by which a nation's production of goods and services increases overtime. Increase in capital goods, human capital, technology can all contribute to economic growth.

(CO_2) of production and energy consumption, adversely affecting GDP and environmental quality (Ullah et al., 2019). Several South Asian countries and ASEAN countries implemented trade reductions in trade barriers in the 1990s and have experienced higher economic growth in terms of real GDP (Bajwa & Siddiqi, 2011). CO_2 intensity of the GDP from trade openness can be described in three aspects. First, the economy shifts the production pattern due to specialization, and trade liberalization expands CO_2 emissions (Grossman and Helpman, 1991; Copeland and Taylor, 2004). Second, trade expands in CO_2 emissions because of a high level of economic activities, mainly in the export sector industries (Ullah et al., 2020). Third, the economy uses energy-intensive advanced technology that requires high energy consumption, leading to higher CO_2 emissions in the countries. For example, countries started manufacturing fossil fuel-powered factories, replacing home production, cottage industries, etc. On the other hand, economies with growing real GDPs might be better positioned to implement environmental policies, including installing low GHG-intensive energy technologies like wind power and solar power.

The emergence of trade openness is getting attention now that many ASEAN and South Asian countries have substantially increased real GDP. (World Bank, 2022). Besides this attainment, trade activities generated a lot of challenges for the environment, including mainly CO_2 emissions. For example, environmental degradation due to CO_2 emissions has severe costs for sustainable development and human health (Rock and Angel, 2007). However, Ikram et al. (2021) suggested that trade openness, FDI, and CO_2 do not adversely impact environmental degradation in Japan because policy efforts towards product variation hold the potential to solve environmental problems.

South Asia is economically one of the world's less developed areas regarding per capita GDP, accommodating more than 20 percent of the world's population (World Bank, 2022). Most South Asian countries followed restricted trade policies during their primary phases of development in the 1980s. The main reason behind this restriction was to protect the infant industries from foreign competition and reservation of foreign exchange for balance of payments support (Kemel et al.,2002). Also, intraregional trade has been historically

minimal for South Asia, *i.e.,* intraregional trade was less than 2 percent of real GDP compared to East Asian countries (Ahmed and Ghani, 2007).

The selected South Asian and ASEAN countries' trade trends are shown in Figure 1 because it will give a clear idea about recent trade after removing trade barriers from some countries. In Figure 1, the proxy measure for trade (total exports plus total imports)/total GDP) used in the graph for selected South Asian and ASEAN countries' total trade trends can be seen as some rise and fall upward but flatter from 1990 to 2021. This region mainly consists of many diverse nations compared to other parts of the world, and they are ethnically, culturally, historically, and economically different from others. Singapore is leading among the Association of Southeast Asian Nations (ASEAN) countries in economic development[2]. Singapore has achieved magnificent growth due to determined and well-planned trade policies (Zeeshan et al., 2021b). Malaysia's statistics show a significant increase in trade activities between 1991 and 2006; a decreasing trend was observed for trade due to international financial crises.

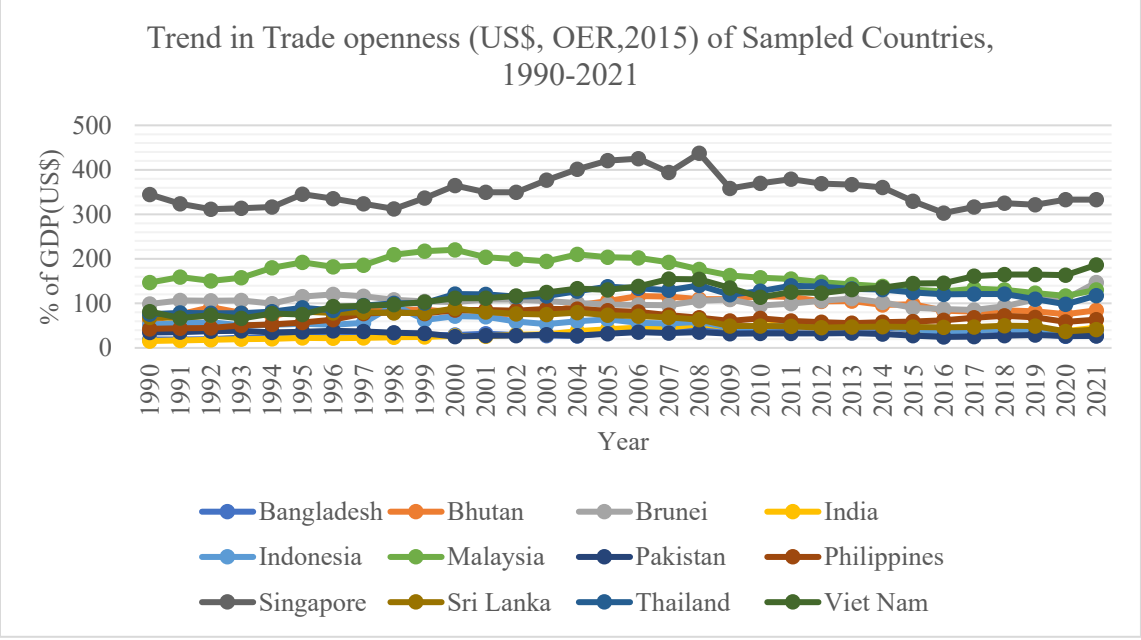

Figure 1 Source: World Development Indicator

[2] By economic development, I mean a process by which a nation's economic growth and progress changes or improves the environmental, physical, social, economic, and demographic factors.

Philippines, Indonesia, Brunei Darussalam, Thailand, and Vietnam show the same procedures up to 2015. After that, Thailand and Vietnam showed a rising trend due to exceptional reforms by their current regimes. Singapore established intense upward trade openness based on the proxy after removing trade barriers till 2008, and after 2008, a declining approach was observed. India, Pakistan, and Bangladesh trade showed a flat trend in the study period, which means trade showed no remarkable changes. However, Bhutan and Sri Lanka figures illustrate that the trade openness proxy rises between 1997 and 2007, and then a downward curve in trade openness is seen up to 2010 and a flat trend with no changes.

Figure 2 describes the relationship between the average CO_2 emission and GDP growth rates. Although the GDP growth rate is increasing in sampled countries, what about their CO_2 emissions? Generally, it is assumed that if GDP increases, CO_2 will increase. The data and statistics show that the GDP growth rates of sampled countries fluctuate over the periods. Due to COVID-19, the growth rate of selected sampled countries was negative in 2020, and for the Asian financial crisis in 1998, the growth rate was also negative. Otherwise, the GDP growth rate was positive over the period. On the other hand, the CO_2 emissions growth rate in selected countries shows a flat but slightly increasing upward trend in the period of 1990 -2021.

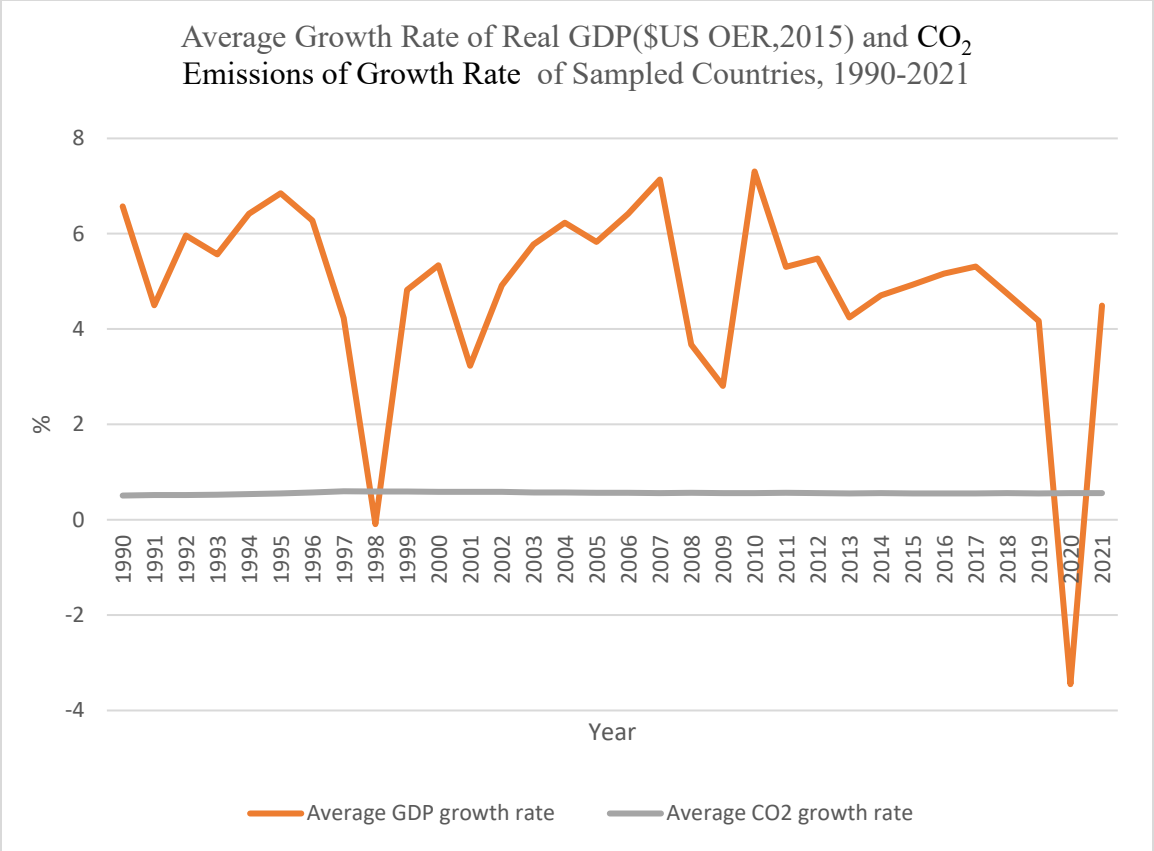

Figure 2 Source: World Development Indicator

Several studies have investigated the impact of trade openness on economic growth as measured by the real GDP and suggest that openness plays a significant role in increasing economic growth in many countries (Bajwa & Siddiqi, 2011; Zubair et al., 2020; Vural, 2020; Zubair et al., 2020). On the other hand, many studies concluded that trade openness harms economies for many countries. This research intends to fill in this gap by analyzing the impact of trade openness and other economic variables on the real GDP based on the data of selected ASEAN and South Asian countries and check if there is any statistical relationship between economic growth in real GDP and CO_2 emissions. This study also examines the effect of trade openness on real GDP in selected countries in international trade benefiting or harming them based on data from 1990 to 2021. In this context, the present study has developed the following hypothesis:

H1: Positive correlation between the volume of trade and real GDP.

H2: Trade Openness positively contributes to the CO_2 intensity of the GDP.

H3: Negative correlation between CO_2 emissions and real GDP.

The rest of the paper is organized as follows: chapter 2 presents a related literature review. While chapter 3 introduces data and methodology, chapter 4 focuses on empirical findings and discussion. Finally, chapter 5 concludes and summarizes the main findings.

CHAPTER 2: REVIEW OF LITERATURE

The relationship between economic growth based on real GDP as a proxy and trade volume and the relationship between real GDP and CO_2 emissions has been extensively examined in the empirical and theoretical literature including Baiman (2017), Romer (1986), Dollar (1992), and Vural (2020). In this chapter, firstly, the study gives an overview of theories based upon some factors that play crucial roles in affecting growth, and then, it looks at empirical support for these theories. Lastly, the study empirically analyzes real GDP growth as a proxy and the CO_2 intensity of the GDP.

2.1 Trade-Based Theories:

Terms of trade, trade openness, primary commodities, manufactured products, and their influences on economic growth have been at the bottom of many debatable discussions (Krishna and Mitra, 1998). Numerous views have developed over time regarding these concerns.

Both traditional trade theories' static and dynamic descriptions suggest that openness to international trade leads to elevated GDP. According to Ricardian and Hecksher-Ohlin's theories (traditional static theories), trade barrier reduction in the system of lower protectionism creates developments (e.g., it boosts the domestic production of goods and services by imposing tariffs) as the exchange gains and specialization gains make themselves evident in higher production of the export goods which would have been likely under a protective trade regime[3]. Theoretical dynamic versions of these models suggest that the production gains are even more significant due to the acceleration in accumulating additional resources (Barro, 2012).

[3] Specialization gains might occur if all inputs are assigned to their possible uses. On the other hand, exchange gains happen since production is done under the least cost conditions, and open trade leads to consumption gains through the potentially increased choice of goods and services and consumer prices.

Romer (1986) and Lucas (1988) presented new growth theories that supported the idea that trade openness positively impacts economic growth using the real GDP proxy in the short run. They discussed how the more countries are exposed to international trade, the bigger their ability to absorb innovative technologies from developed countries. On the other hand, Krugman (1994) has established that the consequences of international trade on economic growth are questionable because of the higher savings made possible by higher productivity levels or because of improved technology and forward and backward linkages in the export sector[4]. The consequence of these conventional models is that since trade openness can raise the accumulation rate of additional resources, more open countries may experience higher output growth. The late 20th-century trade models, which include the works of Krugman (1986), Dixit (1987), and Grossman (1992), theoretically illustrate that trade constraints may be welfare-augmenting under certain circumstances.

According to the classical point of view, terms of trade will increase over time for primary commodities (Baiman,2017). Classical economists established their forecast that natural resources and land are limited while the population level will continuously grow, and so will their consumption. So, the relative price of primary commodities will rise over time (Baiman,2017). Another view concerning terms of trade and economic development is from neoclassical economists. They assert that terms of trade changes determine countries' imports, which in turn defines a country's ability to export. They also underlined that this channel mainly depends on the development of a country. Hence, the "rate of the development" state changes in the terms of trade, which depends on output and consumption. Developing countries' terms of trade will deteriorate if the consumption of imported goods is higher than domestic production, which is taught to be an important source of instability, often causing financial vulnerability (Diakosavvas and Scandizzo, 1991).

[4] Technological improvements and the creation of forward and backward linkages depend on factors including institutional capacity, industrial policies, and education, and higher savings depend on several factors, including government policies and consumption patterns.

Prebisch and Singer initiated the most interesting trade and economic development hypothesis in 1950, known as the "Prebisch-Singer thesis" [5]. According to them, terms of trade between manufactured products and primary commodities have a downward trend in the long run. So, primary-commodities-dependent countries' terms of trade are on the way to decline since the price of primary commodities has dropped relative to the price of manufactured products over a long time. Primary commodities-dependent countries' terms of trade face two types of adverse effects—the first results from the two groups' different institutional properties of products and labor markets. The second adverse effect is from technological advancement since its effects are not equally spread between the two groups. Because of technological advancements' asymmetric effect on future demand, it is more beneficial to produce manufactured goods than agricultural goods. Therefore, the Prebisch-Singer hypothesized that gains from international trade won't be distributed equally between manufactured products exporting countries and primary-product-based countries. This provides a possible mechanism to explain why the inequality of income per capita between the two groups continued to expand prior to 2003 (Toye and Toye,2003).

Kaneko (2000) also investigated a possible relationship between terms of trade and economic growth using the GDP proxy in a small open-economy situation. Human capital accumulation is included in the model to investigate the relationship between the specialization structure and the economic growth of developing countries. The investigation concluded that the terms of trade could influence economic growth in the circumstances of a country specializing in the consumption of primary commodities; an increase in terms of trade leads to a rise in economic growth, and the inverse case is for a decrease in terms of trade.

[5] R. Prebisch, The Economic Development of Latin America and Its Principal Problems (New York: United Nations, 1950); also printed in the same title in Economic Bulletin for Latin America 7 (1962): 1–22. H. W. Singer, "The Distribution of Gains between Investing and Borrowing Countries," American Economic Review 40 (1950): 473–85.

Pryor (1966) attempted to suggest a structure for all the hypotheses established regarding the terms of trade and economic growth in real GDP. He applied the reciprocal demand curve to characterize supply and demand elasticities for imports and exports and analyzed the relationship between the terms of trade and growth in real GDP; most cases examined were undetermined.

2.2 Empirical Evidence:

Numerous empirical analyses support the above-discussed theories that openness to international trade has increased the GDP growth of many countries. For example, Edwards (1998) investigated 93 developing and developed countries from 1960 to 1990 and concluded that a country's openness to international trade was correlated with faster productivity growth. Also, Gundlach (1997), Chen (1999), and Naveed and Shabbir (2006) conducted different statistical investigations on both developing and developed countries and found a robust positive association between economic growth and trade openness. Dowrick and Golly (2004) studied both developing and developed countries and suggested that since 1980, developed countries have achieved more gains from international trade than developing countries based on the growth of real GDP per capita, investment ratio, and trade ratio.

Dollar (1992) found a significant negative correlation between growth and real exchange rate distortions (when a country's currency is observed steadily below or above its fair value), showing a positive trade growth link. He used real exchange rate distortions to examine whether the law of one price holds over the long run. Harrison (1996) used a time series cross-country analysis to examine the correlation between openness and economic growth and concluded that the correlation between these variables was robust. Frankel and Romer (2017) observed the association between trade and growth and considered geographic characteristics an influential factor in trade. The study statistically suggested that trade has a huge but significant and positive correlation with the country's income, and they used ordinary least square estimates for their analysis.

Rodriguez and Rodrik (2000) employed the Dollar[6] (1992) formula to a renewed version of the same data and realized that the same regressions now conceded the opposite signed outcome. Ekanayake, Vogal, and Veeramacheneni (2003) examined the causal relationship

between output level, inward FDI[7], and exports for a cross-section of developed and developing countries from 1960 to 2001. They employed vector autoregressive model (VAR) and error correction techniques, and the study supports a bi-directional causality between economic growth and export growth. Dollar (1992) studied the effects of trade on growth and poverty in 121 countries. The study provided statistical support for the theory that at individual and cross-country levels, open regimes lead to faster growth and poverty reduction in developing countries.

Din (2004) analyzed the export-led growth hypothesis for the five economies of the South Asian region using a multivariate time series framework, and their results suggested that long-run causality among exports, imports, and output only happened in Pakistan and Bangladesh. At the same time, all other countries had short-run causality between exports and output. Hassan (2005) studied the causal association between trade openness and economic growth and the formation of international trade in Bangladesh. The study employed the Granger-causality test and statistically found a long-run unidirectional causality from trade openness to economic growth. Blattman, Hwang, and Williamson (2007) examined the impact of terms of trade growth and volatility on economic growth in 35 countries (29 from the periphery and 6 from the core) between 1870 and 1939 using OLS (Ordinary least square) estimation. They determined that high price volatility in primary products and trade volatility are associated with more negligible economic growth and performance in developing countries, or the periphery in contrast with the developed countries, the core. They also indicated a channel through which volatility in the terms of trade could modify the GDP and Foreign Investment. In contrast, high trade fluctuations increase foreign investors' uncertainty and cause a decrease in capital inflows to the periphery (primary commodities-dependent countries). Sarkar (2008) researched a time series study of individual countries to examine the relationship between growth and openness (trade GDP ratio) and found no positive long-term association between openness and growth in most East Asian countries.

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[6] Dollar developed a cross-country measure of the outward orientation of the economy based on an international comparison of price levels compiled for 121 countries.

[7] Inward FDI is the worth of foreign investors' equity and net loans to company citizens in the reporting economy.

Klasra (2011) studied the long-run relationship between Foreign Direct Investment (FDI), trade openness, and economic growth in Turkey and Pakistan using the autoregressive distributed lags (ARDL) model and found a bi-directional causality between openness and growth in Pakistan, whereas for Turkey, a bi-directional relationship existed between FDI and exports.

Broda (2004) explored how the terms of trade shocks can provide a rationale for the changes in output and prices in developing countries subject to flexible or fixed exchange rate regimes. His analysis used post-Bretton Woods samples of 75 developing countries from 1973 to 1996. His work suggested that in the short run, any shock in terms of trade affects countries with flexible or fixed exchange rates and that countries with flexible exchange rates observe a lower effect on the real GDP than those with fixed exchange rates. This work suggests a significant impact of the terms trade shocks on the consumer price and Real GDP. Ghirmay, Sharma, and Grabowski (1999) investigated whether there is a causal association between terms of trade instability, export instability, investment, and economic growth in 14 developing countries between 1960 and 1990 by using the cointegration analysis and the multivariate error correction model. The results show that exports and terms of trade instability have long-run relationships with output.

The impact of trade openness on economic growth has become crucially dependent upon increased economic integration and international relations. Many studies have investigated the effects of trade openness on economic growth in several regional economies (Iyke, 2017; Majeed, 2010; Malefane, 2018) over the last decade. Few of the existing analyses support the proposition that trade openness has a positive impact on economic growth. Paudel (2014) examined the impacts of trade openness on economic growth and updated the widely used Sachs and Warner[8] (1995) index of trade liberalization for 193 countries up to 2010. After investigating the impacts of trade liberalization on economic growth using a dynamic growth model for panel data from 1985 to 2010, the findings suggest that trade openness's impacts on economic growth differ from country to country.

The member countries of the Association of Southeast Asian Nations (ASEAN) region have experienced high GDP growth rates since the early 1980s. Sing (2018) concluded that these regional economies have increased by an average of 5.3% annually since 2000 and

accomplished a combined gross domestic product (GDP) of US$ 2.8 trillion in 2017, with a potential market size of about 640 million consumers. These countries have applied reduction of trade restrictions policies and market-based approaches since 1990. All the ASEAN member countries have developed international trade integration by establishing the ASEAN Free Trade Area (AFTA) in 1990, and the ASEAN Economic Community (AEC) in 2015, and this integration has subsidized various member countries' substantial economic regulations processes (Maria et al., 2017). The AEC is the biggest economic community region in the developing world that will construct a unity market with the free movement of goods and services. The AEC agreed to employ AEC Blueprint 2025 for about thirteen issues to increase trade activities among the member countries at the end of 2018. As a result, mobility of goods and services, easier movement of capital and skilled labor, and foreign direct investment are argued by Maria et al. (2017) to be the main factors proposed to cause higher growth in the GDP in this region.

Mendoza (1997) studied the influences of terms of trade uncertainty on saving and economic growth in a stochastic endogenous growth model for 40 developing and industrial countries between 1971 and 1991. His model predicted that greater variability in terms of trade leads to lower economic growth. The study's main finding is a significant negative relationship between trade volatility or variability and economic growth and cross-country panel regression provides strong support for the models. Open trade may encourage specialization, making countries more vulnerable to shocks that increase the volatility in the terms of trade. Malefane (2018) examined the impact of trade openness on economic growth and employed the autoregressive distributed lag (ARDL) bound testing approach to investigate the dynamic impact of trade openness on economic growth in South Africa and found a robust positive effect of trade openness on economic growth over time in South Africa. Das & Paul (2011) used the Generalize Method of Moments (GMM) technique. This work suggested that growth in the labor force has an insignificant effect on output growth.

[8] The Sachs-Warner index is a combined measure of trade liberalization and economic openness developed by Sachs and Warner (1995) for 118 countries.

In contrast, growth in capital stock exhibits a positive and significant impact on output growth in 12 Asian countries. Majeed (2010), using a panel data set for 18 Asian countries from 1970 to 2008, found that openness to trade has been positive and significant in this region.

Nevertheless, Bajwa and Siddiqi (2011) used Panel cointegration and FMOLS (Fully Modified Ordinary Least Squares) techniques for short-run and long-run estimates. They concluded that in 1972-85, a unidirectional causality from GDP to Openness was found, whereas, in 1986-2007, there exists a bi-directional causality between GDP and Openness and suggested that in the long run, trade openness harms economic growth in picked South Asian Countries. In addition, (Ali et al., 2018 Rafat, 2018 Srinivasan et al.,2011) investigated the relevance and implication of capital formation, foreign direct investment, and human resources in encouraging economic growth. Basu and McLeod (1992) investigated the impact of terms of trade on capital accumulation in 20 developing countries between 1950 and 1987. Their work suggested a direct effect on the steady-state growth rate (economic growth rate) for volatility in export prices. They also suggested that larger variability in terms of trade shrinks the economic growth rate and that both the trend and the variability have large effects on the level of investment and GDP in small open economies.

Hadass and Williamson (2003) examined the impacts of terms of trade shockwaves on the economic growth of 19 countries between 1870 and 1940 in recurring Prebisch and Singer. Their work suggested that the terms of trade volatility were higher in developing countries in comparison to developed countries prior to War I. However, the asymmetric impact of optimistic relative price shocks improved the economic growth in the core and reduced it in the periphery.

2.3 Empirical Evidence Relating to Growth in GDP, CO_2 Emissions:

The significant involvement of trade in economic development also seriously threatens the countries' environmental degradation. Numerous studies suggest that trade leads to a rise in CO_2 emissions. Ullah et al. (2019) used a simultaneous equation method for the analysis and suggested that trade openness increased the CO_2 emissions in China from 1990 to 2017. Ferda Halicioglu (2009) examined trade, CO_2 emissions, and energy consumption in

Turkey, used the bounds testing to cointegration procedure, and observed that trade openness increases CO_2 emissions. Omri et al. (2015) concluded that financial development, trade, and economic growth trigger the degradation of environmental conditions in the Middle East and North African countries and employed simultaneous equation panel data models for 12 MENA countries from 1990 to 2011. Shahbaz et al. (2013) used the Zivot-Andrews structural break unit root test and the ARDL bounds testing approach and examined the concerned variable using the VECM Granger causality technique and concluded that trade openness expands CO_2 emissions in Indonesia. Zeeshan et al. (2021a, 2021b) examined the nexus between FDI, energy consumption, natural resources depletion and economic growth in Latin America. They applied the Structural Equation modeling approach and found a significant relationship among the variables.

Ullah et al. (2020) used time series data from 1998-2017, adopted the simultaneous equation approach, and found that trade liberalization in Pakistan is also correlated with CO_2 emissions. In a similar study, Grossman and Krueger (1991) employed a reduced form relationship between various environmental indicators and reported a positive relationship between trade openness and CO_2 emissions. Similarly, Copeland and Taylor (2004) using a unified framework, critically reviewed the empirical and theoretical evidence on issues of the Environmental Kuznets Curve, and found a positive relationship between CO_2 emissions and trade. Still, they came up with contrasting findings. They found that CO_2 emissions can be reduced by trade openness and claimed that technological inventions and energy-efficient equipment in the manufacturing process reduced CO_2 emissions and trade.

Vural (2020) used the panel cointegration test and concluded that most of the research on trade and environmental pollution emphasizes the direct impact of trade on emissions while ignoring that their relationship may be affected by other economic and social factors. Zubair et al. (2020) statistically found that foreign direct investment (FDI) plays an essential role in the impact of trade development on carbon emissions by using an autoregressive distributed lag (ARDL) bound testing to cointegration and used Vector Autoregressive model over the period 1980 to 2018 in Nigeria. Cole (2006) and Doney et al. (2009) used theoretical principles, focusing on scale, technique, and composition

effects, and they explored that trade openness possibly affects CO_2 emissions in industrial production and exports that closely depend on fossil fuels, the main cause of CO_2 pollution.

Saboori and Sulaiman (2013) conducted research that used the Autoregressive Distributed Lag (ARDL) methodology and Granger causality test based on the Vector Error-Correction Model (VECM) and found bidirectional causality exists between CO_2 emissions and economic growth. Many studies used the panel data and tested the validity of the Environmental Kuznets Curve (EKC) using both panel-based and time-series-based methodological approaches of cointegration and statistically found a dynamic relationship between per capita CO2 emissions and per capita GDP (Coondoo and Dinda, 2002; Apergis, 2016).

The provided literature discusses the impact of trade openness on GDP and CO_2 emission. Traditional trade theories, including Hecksher-Ohlin and Ricardian, suggest that reduction in trade barriers potentially lead to GDP increase due to gains from specialization and exchange. Dynamic trade theories suggest even more significant gains from trade openness. Moreover, 20th-century trade models propose that trade barriers may enhance well-being under certain circumstances. According to empirical evidence, various works of literature support the positive association between GDP growth and trade openness. The study also investigates the environmentally friendly aspect, revealing that trade openness might increase CO_2 emissions. Several studies have explored the correlation between trade openness and environmental degradation, particularly focusing on CO_2 emissions and GDP growth and revealing a dynamic relationship between CO_2 emissions and GDP growth. Although the existing literature covers a similar scope, the study contributes to the previous literature, mainly using cases from South Asian and ASEAN countries. The main objectives of this study are to examine the relationship between trade openness and real GDP and check the for a possible correlation between the CO_2 intensity, CO_2 emissions and real GDP of the selected South Asian and Southeast Asian countries.

CHAPTER 3: DATA AND METHODOLOGY

The impacts of trade openness on real GDP and the relationship between real GDP and CO_2 emissions have been the subject of much research, leading to many empirical and theoretical studies such as Mendoza (1997), Romer (1986), Krugman (1986), and Gundlach (1997), Copeland and Taylor (2004) and Saboori and Sulaiman (2013). The primary purpose of this study is to investigate the relationship between trade openness and real GDP and real GDP and CO_2 intensity of the GDP. To this end, this chapter proceeds as follows: firstly, it briefly discusses the data collection and variables, then the model of the study, and lastly, it provides the methodology of the study.

3.1 Data and Variables:

The study is based on annual data for selected South Asian countries (Bangladesh, India, Pakistan, Sri Lanka, and Bhutan) and East Asian countries (Singapore, Thailand, Vietnam, Philippines, Malaysia, Indonesia, and Brunei Darussalam) for the sample period 1990 to 2021. 12 South Asian and East Asian countries have been investigated, and 384 annual observations have been collected. The preference of the time cycle and countries depended on the accessibility of data collected from the World Bank's Database, World Development Indicators (WDI), Asian Development Bank, and the Penn World Table.

The investigation has used the lnGDP (Constant 2015 US$) as a proxy, with real GDP as the dependent variable. In contrast, the independent variables are gross capital formation (as a percentage of GDP), trade openness, net barter terms of trade, labour force participation (total), CO_2 intensity of the GDP, and fixed direct investment (% of GDP).

The study has used real GDP instead of real GDP per capita because the study is not examining well-being, for which GDP per capita is likely a better proxy. Real GDP shows comparisons for the quantity and value of goods and services. Terms of trade measure the relation between the prices of goods and services a country gets for its exports and the prices of goods and services it pays for its imports (Carbaugh, 2009). Thus, an improvement in an economy's terms of trade results from a rise in the real price of exports relative to the real price of imports, while an increase in the price of imports relative to the price of exports over a given period induces a deterioration. An improvement of the TOT

means that the price of exports has risen, and the volume of exports could fall based on the quantity effect. NBTOT is proxied by the ratio of export price index and import price index times 100. Trends in NBTOT for sampled countries have been drawn in Figure 6 in Appendix II.

Foreign direct investment (FDI) flows record the value of cross-border trades related to direct investment during a given time. The study used FDI as a share of GDP, and trends of FDI as a share of GDP for sampled countries have been drawn in Figure 7 in Appendix II. The study also used gross capital formation GCF as a share of GDP. Gross capital formation consists of fixed assets of the economy plus net changes in inventories. Fixed assets include land improvement, plant, machinery, equipment purchases, and the construction of roads, railways, and so on. Inventories are stocks of goods firms held to meet temporary or unexpected fluctuations in production. Trends in GCF for sampled countries have been drawn in Figure 5 in Appendix II. Carbon intensity measures carbon dioxide and other greenhouse gases (CO_2) per unit of activity, indicating how efficiently an economy uses carbon-based resources to generate economic output. This study has used the CO_2 intensity of GDP as a share of GDP. One measure of trade openness is the ratio of the monetary value of exports plus imports over the monetary value of the GDP.

3.2 Model Specification:

The main objectives of this study are to determine the correlation between trade openness and real GDP in selected South Asian and East Asian countries and then suggest appropriate recommendations for economic policies. Since terms of trade and trade openness cannot explain all the variations in the GDP, following the previous literature, the model employs a variety of control variables that may influence a country's growth.

For selecting economic variables, the study follows the literature (for example, Klasra 2009; Romer 1986; Lucas 1988); Harrison 1996; Frankel and Romer 1992; Ekanayake, Vogal, and Veeramacheneni 2003, Das & Paul 2011; Bajwa and Siddiqi 2011). In particular, the study follows Mankiw (2010), who followed the Solow model, which was developed in 1956, statistically showing how labour force, capital accumulation, and technological progress cooperate to determine an economy's growth level. As in this literature, the Neoclassical production function is used to investigate the effect of trade

openness on real GDP proxy for economic growth. Employment in the labour force and gross capital formation have been included in the model because they are crucial to determining economic growth.

The entity fixed effect regression model is:

$$Y_{it} = \alpha_i + \beta_1 X_{1,it} + \beta_2 X_{2,it} + \ldots + \beta_k X_{k,it} + \mu_{i,t} \quad [1]$$

where i = 1, ..., n, where n represents the number of entities, here countries and t = 1….T where T represents the number of time periods, and k is the number of regressors where

Y_{it} = is an i*t matrix with element i,t being $\ln GDP_{it}$

$X_{1,it}$ is an i*t matrix with element i,t being $\ln[GCF_{,it}]$

$X_{2,it}$ is an i*t matrix with element i,t being $ln[LabourForce_{,it}]$

$X_{3,it}$ is an i*t matrix with element i,t being $Ln[NBTOT_{,it}]$

$X_{4,it}$ is an i*t matrix with element i,t being $Ln[Openness_{it}]$

$X_{5,it}$ is an i*t matrix with element i,t being $Ln[CO_{2\ it}]$

$X_{6,it}$ is an i*t matrix with element i,t being $ln[FDI_t]$

α is a vector of length n, where the element, α_i represents the constant intercept term for entity i and β_i represents the slope coefficient for entity i, which is interpreted as the elasticity of the regressand with respect the the regressor and $\mu_{i,t}$ is an i*t matrix containing the error terms.

The regression was run as two different versions. In version 1, the regressors are described as follows:

GCF is Gross Capital Formation as a share of real GDP, NBTOT is Net Barter Terms of Trade, FDI is Foreign Direct Investment as a share of real GDP, Openness is trade openness, and CO_2 represents the CO_2 intensity of the GDP (which is total CO_2 emissions divided by the GDP)

In version 2, the regressands were levels and not shares as follows:

GCF is Gross Capital Formation, NBTOT is Net Barter Terms of Trade, FDI is Foreign Direct Investment, OPENESS = (TOTAL EXPORTS +TOTAL IMPORTS) and CO_2 represents TOTAL CO_2 EMISSIONS.

Now, the regressors and regressands are vectors of time series for a given country be written as follows:

$$lnY_t = \alpha + \beta_1 lnGCF_t + \beta_2 lnLabourForce_t + \beta_3 lnNBTOT_t + \beta_4 lnOpenness_t + \beta_5 lnCO_{2\,t} + \beta_6 lnFDI_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$t = 1 \ldots. T$$

Where **Y** is the real GDP for country at time t.

The control variables applied above contain:

GCF is Gross Capital Formation as a share of real GDP, NBTOT is Net Barter Terms of Trade, FDI is Foreign Direct Investment as a share of real GDP, Openness is trade openness, and CO_2 represents the CO_2 intensity of the GDP.

α is the constant, and μ is the error or disturbance term. μ is the error term with the standard statistical properties, while α represents the slope coefficient. The advantage of panel data is that it can exploit both the time series and cross-sectional features of data and deliver significant effective parameter estimations by reflecting larger sources of variation. Economic theory predicts positive signs for all coefficients as they contribute to growth in real GDP.

The anticipated signs of the coefficients in version 1 and 2 of the models are:

$\beta_1>0$, the coefficient on GCF as a share of GDP and also for the level of the GCF are expected to be positive as well since capital accumulation is predicted to have higher national output.

$\beta_2>0$, employment in the labour force affects the GDP positively, which is why the expected sign of its coefficient is positive.

$\beta_3>0$, the coefficient on NBTOT is expected to be positive, for version 1 and 2, as discussed above.

$\beta_4>0$ or $\beta_4<0$, the coefficient on trade openness is expected to be positive or negative since some of the literature has shown a negative relationship between openness to international trade and economic growth in real GDP.

$\beta_5>0$, the coefficient on FDI Direct Investment as a share of real GDP and on the FDI level are expected to be positive or negative since some of the literature attested to its bi-directional effect on growth in real GDP.

$\beta_6>0$, the coefficient of the CO_2 intensity (version 1) and the CO_2 level (version 2) are both expected to CO_2 be positive on growth in real GDP.

3.3 Methodology:

A panel data study is used to estimate equation (1), and an OLS time series regression is used for each country to estimate equation (2). The study has used the fixed effects model, which controls all time-invariant differences between the individual countries. As a result, the estimated coefficients of the fixed effects model cannot be biased because of omitted time-invariant characteristics; for example, a company's business practices may influence its level of spending or stock price. Business practices, culture, politics, religion, race, and gender are time-invariant and hard to measure. The study also has used the random effects model, which assumes that the error term is not correlated with the outcomes, allowing time-invariant variables to play a role as explanatory variables.

The outcome of both the fixed effects model (with constant slopes but different intercepts) and the Random Effects model (with a random constant term) are stated, and the Hausman test is calculated to estimate which model best fits the data. Furthermore, OLS (ordinary least square) estimation is estimated for each country. The study has used a unit root test to verify the stationarity of the time series using two different statistics. The Levin-Lin-Chu and Im-Pearson-Shin unit root tests are estimated to check whether the data is stationary or non-stationary.

Cross-sectional dependence is more problematic in macro panels with long time series (more than 20–30 years) than in micro panels. To examine whether the error term is uncorrelated, Breusch Pagan and Pesaran's test of cross-sectional independence is estimated as a variance component model. Moreover, the Wald test is estimated to

statistically test whether the independent variables are collectively significant for the model, and Wooldridge test for autocorrelation is estimated to test for serial correlation. Finally, the study has employed robustness checks to examine the validity of the findings.

CHAPTER 4: EMPIRICAL ANALYSIS

The primary purpose of this study is to investigate the statistical relationship between trade openness (both the share and level in version 1 and 2 respectively) and real GDP as a proxy for growth and the relationship between CO_2 intensity of the GDP (version 1) and emissions levels (version 2) and real GDP and consider how this CO_2 intensity of the GDP and CO_2 emissions levels (respectively for version 1 and 2) affects this relationship. This chapter is about empirical results based on data and methodology as informed by the literature reviews in the previous chapter. This chapter consists of three sub-sections. Firstly, it provides a descriptive trend analysis of sampled countries' GDP growth rate, descriptive statistics, and the main results.

4.1. Trend Analysis of GDP Growth Rate of Sampled Countries:

This section summarizes trends of GDP growth rates of sampled South Asian and Southeast Asian countries and then provides and discusses their descriptive statistics. First, selected South Asian countries and then ASEAN countries' GDP growth rates analysis is provided.

South Asia is a subregion of Asia attached to the Indian subcontinent. South Asia comprises Bangladesh, Sri Lanka, Pakistan, Maldives, Afghanistan, Nepal, India, and Bhutan. Many South Asian countries have experienced notable increases in education, health, and living standards (World Bank,2021), but a series of setbacks pushed this part of the world into an economic slowdown; these include Russia's invasion of Ukraine, an economic crisis in Sri Lanka, floods in Pakistan, and the lingering effects of the COVID-19 impacts on the region. According to the Council of Foreign Relations, the subcontinent's economy expanded faster than the global average from 2010 to 2018 (World Bank, 2021).

Figure 3 illustrates the trends of real GDP growth rates (as measured in $US, year 2015, using OER) in most South Asian countries and is illustrated to guide a discussion of key features of the real GDP growth rate graph and potentially explanatory historical context and it gives a clear idea about the trends in the real GDP growth rate of south Asian countries. The real GDP growth rate has not significantly changed in Bangladesh, India, Pakistan, Bhutan, and Sri Lanka and started decreasing from 2019 to 2020. So, with the

Covid 19, these countries' real GDP growth rates decreased. With the intensity of COVID-19, the real GDP growth rates of Bhutan decreased, but the economy increased by 4.6% percent in FY22/23 because of the reopening of borders for tourism in 2022 (World Bank, 2021)

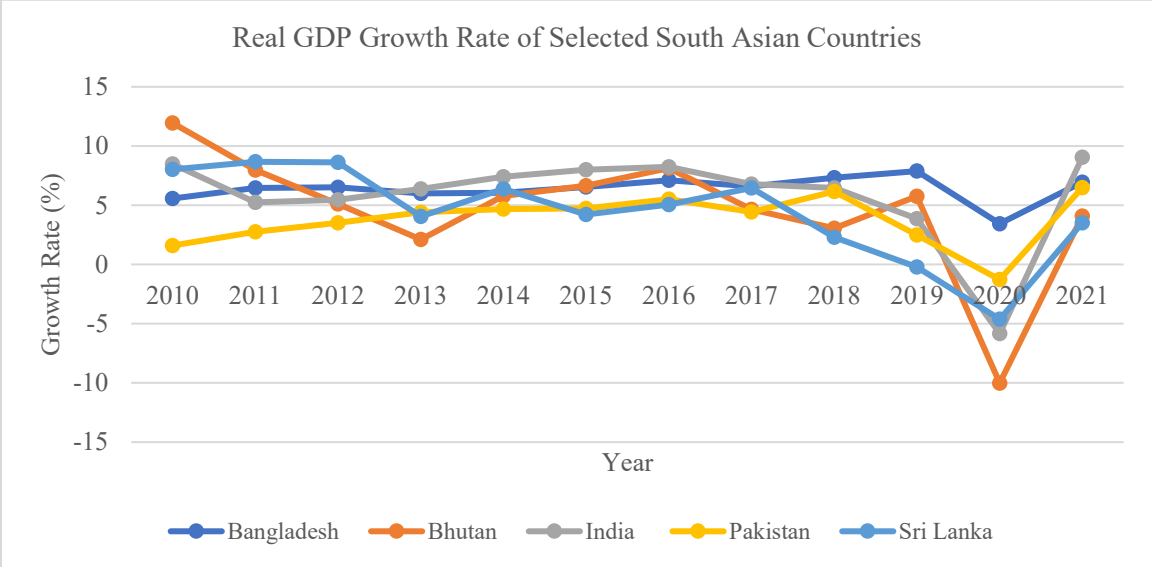

Figure 3 Source: World Development Indicator

India has successfully differentiated its manufactured product base and boosted its production abilities, and India is also considered one of the world's largest technology hubs. India has attracted FDI and has removed restrictions on FDI in significant sectors like defense, railways, real estate, and insurance, as well as progress toward energy efficiency (World Bank,2021). Bangladesh's real GDP growth rate is increasing in comparison to other South Asian countries. In contrast, Bangladesh is known mainly as a primary manufacturer of textile products; the country has seen fast economic growth, and this is because of high volumes of remittances and its efforts to develop infrastructure to reduce poverty (World Bank, 2021).

The next country to discuss is Sri Lanka. The tourism and travel industry, agricultural products like rice and tea exports, and textile production have traditionally boosted the Sri Lankan economy. The country remains susceptible to political tensions and financial imbalances despite the end of a decades-long civil war because there were efforts to reduce poverty, amplify growth, and boost its private sector (World Bank,2021). Pakistan's real

GDP growth rate declined by about 2.6% in 2020 as financial steadiness restrained domestic demand, cotton output decreased, and COVID-19 took its toll before edging up to 3.2% in 2021. Its growth is described mostly by private and government consumption, and it has benefited from exports and investment, primarily from China. Pakistan has gone through a series of economic crises, and most of them have been due to political uncertainty and floods (World Bank,2021).

In summary, South Asian countries' real GDP continues to grow as it has joined the global market; growth in manufacturing, diversifying agriculture, infrastructure development, and remittances made them poised for a robust real GDP growth rate (World Bank,2021).

Figure 4 illustrates the trends of real GDP growth rate in selected ASEAN countries and discusses vital features of the real GDP growth rate diagram. In 2020, ASEAN collectively became the fifth-largest economy in the world. ASEAN experienced an increase in the real GDP growth rate trend trend throughout 2010-2021 (figure 4) despite the global economic crisis in 2008-2009. However, in 2020, the real GDP fell for all countries, and the real GDP growth rate dropped, with an extreme case being The Philippines, which experienced a real GDP growth rate change from almost 7% to 10% due to the COVID-19 pandemic's impact. Note that the ability of the GDP per capita to serve as a good proxy for living standards depends upon the distribution of the real GDP gains. ASEAN's real GDP grew at an average annual growth of 5.0% during the last two decades (ASEAN Secretariat, 2021).

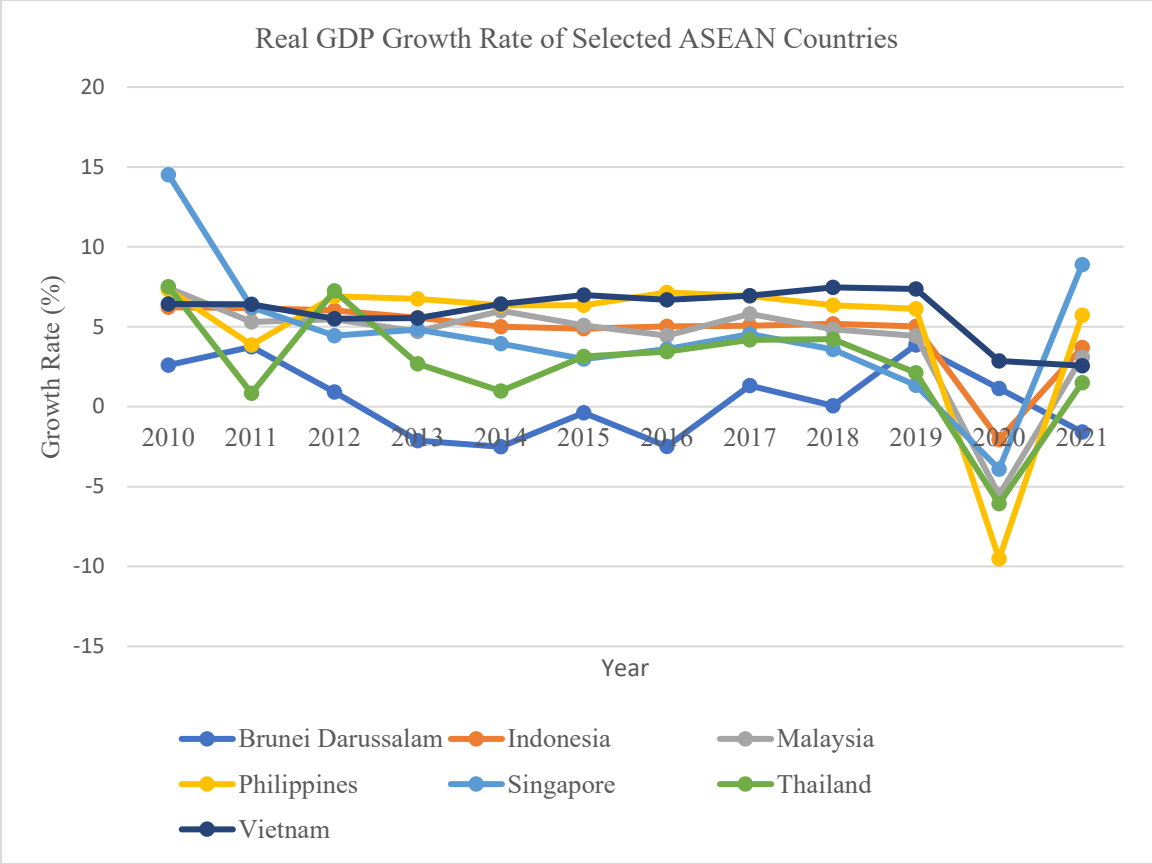

Figure 4 Source: World Development Indicators

ASEAN Member States' real GDPs mainly decreased in 2020 due to the impact of COVID-19, with massive real GDP contractions in Malaysia, the Philippines, Singapore, Thailand, and Indonesia. Only Brunei Darussalam and Vietnam showed positive real GDP growth rates. However, in late 2020, the GDP contraction in ASEAN Member States (AMS) was viewed to be less severe, reflecting the recovery process that started to take place. In 2021, six ASEAN member states showed a positive real GDP growth rate. A decomposition of the GDP growth suggested that services were the leading sector in ASEAN's economy from 2010 to 2020, with the share of the services sector to the region's GDP rising from 46.6% to 50.6% within time (ASEAN Secretariat). Due to the COVID-19 pandemic, ASEAN's total trade in services declined, and the decline was recorded for both exports and imports (ASEAN Secretariat,2021). Also, the share of the agriculture and manufacturing sectors decreased over the same period. Economic structures varied across AMS (ASEAN Member States) in 2020, and the share of the services sector was found to be the largest in Singapore, the Philippines, Thailand, and Malaysia. Meanwhile, manufacturing was the leading sector

in Brunei Darussalam, and agriculture remained an essential sector for Vietnam and Indonesia. Also, in 2020, the portion of travel to the total ASEAN exports of services was 10.3%, placing it as the fourth contributor to ASEAN exports of services (ASEAN Secretariat, ASEAN Stat Database,2021).

According to the ASEAN Secretariat, ASEAN's real GDP is now the fifth largest in the world, and ASEAN's real GDP went up. ASEAN has uninterruptedly fostered economic cooperation in trade, services, and investment, and ASEAN's political and security accomplishments contribute progressively to economic development (ASEAN Secretariat, ASEAN Stat Database,2021).

4.2 Descriptive Statistics:

The previous section discussed some trends in real GDP growth rates for the South Asian and ASEAN countries, and now it discusses the descriptive statistics, which have been illustrated in Table 1A for version 1 and Table 1B for version 2.

	Real GDP	**GCF**	**NBTOT**	**Trade Openness**	**CO_2 intensity of the GDP**	**Labour Force**	**FDI**
Mean	25.38371	28.46537	104.7305	.8931776	.5606634	6.41e+07	3.534048
Std. Dev.	1.83041	9.51821	29.11847	.7443919	.2598141	1.12e+08	5.258141
Maximum	28.64683	69.47258	273.0755	3.590351	1.291527	5.08e+08	32.69117
Minimum	19.8452	10.4374	66.76793	.086795	.126458	109916	.0044915
Observations	384	384	384	384	384	384	384

Table 1A Descriptive Statistics for Version 1 of the Model

Real GDP = The gross domestic product measured in billions of dollars (OER)

GCF = % of GDP (share of the GDP, US$, 2015, OER)

FDI = % of GDP (share of the GDP, US$, 2015, OER)

CO_2 intensity of the GDP = kg per constant 2015 US$ of GDP

	Real GDP	GCF	NBTOT	Trade Openness	CO_2 Emissions	Labour Force	FDI
Mean	25.38371	5.45597	104.7305	24.98526	.168693	6.41e+07	1.830945
Std. Dev.	1.83041	1.81923	29.11847	1.873653	.298765	1.12e+08	2.576842
Maximum	28.64683	9.77288	273.0755	27.11492	2.508528	5.08e+08	10.46578
Minimum	19.8452	1.3374	66.76793	19.9051	.204567	109916	.030289
Observations	384	384	384	384	384	384	384

Table 1B Descriptive Statistics for Version 2 of the Model

From data and statistics, the highest real GDP is from India, which is not surprising since it has a higher level of export diversification, a vast population, and large inflows of investments from global technology. Multinational Corporations (MNCs) make their real GDP from most of the countries from other sampled countries. The lowest real GDP is from Bhutan because this country is a small landlocked country. The most significant terms of trade are from Pakistan in 2002, which has noted relatively steady growth in the real GDP compared to the rest of the countries in the sample, and the smallest terms of trade were from Brunei Darussalam in 2002. The highest gross capital accumulation was from Bhutan in 2012. Due to rapid growth in the real GDP, Bhutan has substantially reduced poverty over the last two decades (World Development Indicator). Annual real GDP growth has increased since the 1980s, driven by the public sector-led hydropower sector and compelling service performance involving the tourism industry (World Bank, 2022). Singapore recorded the maximum level of trade openness in 2021. Singapore has opened its economy to the world and is also considered the safest and easiest country for doing business, making it the world's most market-oriented country. In contrast, Bangladesh's smallest level of trade openness was in 1992. The countries achieved the highest economic growth when they were more open to international trade. The lowest CO_2 intensity of the GDP was from Singapore because, in 2009, Singapore promised to reduce its emissions by 16% below BAU levels by 2020 in the Copenhagen Summit. Singapore has achieved this promise with a 32% reduction below BAU levels by 2020. India has the highest CO_2

intensity of the GDP, with the electricity and heat sector accounting for the most significant share of greenhouse gas emissions in India. The highest number of employed people in the labour force is from India in 2021, which is unsurprising since it is the most populous country in the sampled countries. The lowest number of employed people was from Brunei Darussalam in 1990. Singapore has the highest FDI, primarily in software, business and professional services, electronics, and heavy industry, and the lowest in Indonesia in 2000 because it was hit hard by the Asian financial crisis of 1997-98.

4.3. Results:

The major goal of this section is to show the results of the estimated model. The extensive form of the GDP regression includes Gross Capital Formation (% of GDP), Net Barter Terms of Trade, Trade Openness, CO_2 intensity of the GDP, Labor Force Participation, and FDI (% of GDP). This section first discusses the time series results for 12 countries and then the result from panel data regression using each fixed and random effects model. The Hausman test is estimated to determine which model best fits the data. After that, the Levin-Lin-Chu test and the Im-Pearson-Shin unit root test are estimated to check whether the data is stationary or non-stationary, and after this, Breusch - Pagan LM test of independence and Pesaran's Test of Cross-Sectional Independence test is the estimated to check country-wise correlation matrix of residuals. Lastly, the Wald Test is estimated to confirm that the independent variables are significant for the model.

An OLS time series regression has been done for each country; the findings are presented in Appendix I (Table 2). If trade openness rises by 1%, then the real GDP of Bangladesh falls by .345%. Trade openness appears to be related to a .42% fall in Bhutan's real GDP, which is significant at a 1 % confidence level. Then, for India, a 1% increase in the trade openness parameter seems to be associated with a .77% rise in the real GDP. Few countries seem to have a positive relationship between trade openness and real GDP, which can be large. But, for Bhutan and Bangladesh, trade openness harms the economy. Similarly, an increase in Bangladesh's TOT by 1% is associated with a fall in the real GDP of .09%. For India, an increase in the TOT of 1% is correlated with a 0.46% increase in the real GDP. Again, suppose trade openness rises by 1%. In that case, the real GDP of Singapore

increases by .22%, and for the Philippines, trade openness appears to be related to only a .6% increase in real GDP, which is significant at a 1 % confidence level.

4.3.1. Fixed Effects and Random Effects Results:

The findings of the estimation using Fixed effects and Random effects are given in Table 3A.

Dependent Variable: ln (Real GDP)

	GCF	NBTOT	Trade Openness	Labour Force	CO_2 intensity of the GDP	FDI	_Cons	R^2	Obs.
Fixed Effects	0.18** (0.05)	0.15** (0.05)	0.42** (0.04)	1.74** (0.06)	-0.18** (0.05)	-0.04** (0.01)	-4.41** (0.99)	0.85	384
Random Effects	0.15** (0.05)	0.15** (0.06)	0.53** (0.04)	1.05** (0.48)	-0.26** (.0560)	-0.03** (0.01)	-0.05 (0.96)	0.84	384

Table 3A Fixed Effect and Random Effect Results Version 1

**indicates coefficient is significant at 1% level.

* Indicates that the coefficient is significant at the 5% level, and standard errors are in parentheses.

The estimated fixed effect model provides statistical support that trade openness positively affects real GDP on average across the time in the panel. Hence, on average, a 1% change in trade openness is correlated with 0.42% more of real GDP, which is significant at a 1% confidence level. The findings are consistent with the results of the fixed effect model. According to the random effect model estimates, a 1% increase in openness across the year and between, on average, increases the real GDP by 0.534% and this finding is also statistically significant at a 1% confidence level. This result is consistent with previous findings by Edward (1998), Gundlach (1997), Naveed and Shabbir (2006), Frankel and Romer (1992) (Iyke, 2017; Majeed, 2010; Malefane, 2018), and Das and Paul (2011).

Moreover, both fixed and random effect models suggest that real GDP is positively affected by gross capital formation, labour force participation, and NBTOT. Using the fixed effect model, the coefficient on NBTOT is estimated to be 0.145, which can be interpreted as the elasticity of output to the change in the NBTOT, such as a 1% increase in the NBTOT is correlated with a 0.42% crease in the real GDP. This is consistent with the results in the Random Effects models. This result provides further statistical support for Broda's (2004) and Sharma and Grabowski's (1999) findings. Also, this finding is consistent with the hypothesis that improvements in terms of trade encourage an increase in the growth of the real GDP.

The coefficient on Gross Capital Formation as a share of GDP using the Fixed effect model is consistent with the Random effects. Thus, for fixed effects, an increase of 1% GCF (% of GDP) is associated with an increase of 0.17% in real GDP, while for random effects, an increase of 1% GCF (%of GDP) is associated with a rise of 0.15% in real GDP. Again, this is consistent with the theory that capital accumulation leads to higher real GDP on average across these countries and over the period considered. The findings are consistent with previous research by Basu and Mcleod (1992), Ali et al. (2018), Rafat (2018), and Srinivasan et al. (2011).

The coefficient on labour force participation is positive and significant, suggesting that an increase in employment of 1% is associated with an increase in real GDP in South Asian and Southeast Asian countries. This establishes the theory that labour, or human capital accumulation, increases national income. However, both models have slope and constant parameter estimates and show a negative role of the CO_2 intensity of the GDP on the real GDP and the shares of FDI on the real GDP. The findings are consistent with previous research by Mensah et al. (2019), Cai et al. (2018), Saboori and Sulaiman (2013), Vural (2020), Klasra (2009), (Maria et al., 2017).

Previous results can be mis specified because the independent variable has a share of GDP, so GDP exists on both sides of the model. Now, the study has estimated independent variables GCF, Openness, CO2 emissions and FDI as levels verses shares of the GDP as described earlier for version 2. The findings of the estimation using Fixed effects and

Random effects are given in Table 5. The study has found that the results are almost the same as previous results, which are positive and significant.

Dependent Variable: ln (Real GDP)

	GCF	NBTOT	Trade Openness	Labour Force	CO_2 Emissions	FDI	_Cons	R^2	Obs.
Fixed Effects	.07** .029	0.104** 0.032	.454** (0.015)	.786** (0.052)	-.199** (0.031)	-.042** (0.007)	.264 (0.629)	0.94	384
Random Effects	0.033 (0.03)	0.099** (0.03)	0.518** (0.01)	.524** (0.03)	-.236** (.03)	-.040** (0.01)	3.09** (0.43)	0.93	384

Table 3B Fixed Effect and Random Effect Results for Version 2 of the Model

**indicates coefficient is significant at 1% level.

* Indicates that the coefficient is significant at the 5% level, and standard errors are in parentheses.

The estimated fixed effect and random effect models provide statistical support that trade openness positively affects real GDP on average across the time in the panel. Hence, on average, a 1% change in trade openness is correlated with 0.45% more of real GDP, which is significant at a 1% confidence level and for the random effect model estimates, a 1% increase in openness across the year and between, on average, increases the real GDP by 0.5151%. However, both models have slope and constant parameter estimates and show a negative role of the CO_2 emissions on the real GDP. Both estimations has given the same significant and consistent results.

4.3.2. Hausman Test:

The study has used the Hausman test to determine which models suit this study. The null hypothesis of the test is:

H0: The random effect is appropriate.

The result of the Hausman test is summarized in Table 4A for version 1

Variables	Fixed effect -random effect	Probability of chi-square
GCF	.0261001	0.0000
Labor Force	.2605642	
NBTOT	-.0015373	
Trade Openness	-.1166946	
CO_2 intensity of the GDP	.0790842	
FDI	-.0033378	

Table 4A Hausman test for version 1

The study has found the chi-square probability is 0.0000, which indicates that the null hypothesis is rejected at the 1% significance level. The Hausman test results indicate choosing the fixed effect model to draw the inference. The coefficient of the fixed effect model is preferred over the random effect model because it is considered a more appropriate estimation for this dataset.

The result of the Hausman test is summarized in Table 4B for version 2.

Variables	Fixed effect -random effect	Probability of chi-square
GCF	.0356082	0.0000
Labor Force	.2624347	
NBTOT	0.004709	
Trade Openness	-.0643455	
CO_2 Emissions	0.0370036	
FDI	-.0017773	

Table 4B Hausman test for version 2

The study also employs the Hausman test to check which model is appropriate for the data and has found that choosing the fixed effect model to draw the inference is the same as previous results.

4.3.3. Panel Unit Root Test Results:

The study has used the Levin-Lin-Chu and Im-Pesaran-Shin Unit Root Tests to check the stationary data. For this analysis, the null hypothesis and alternative hypothesis are given below.

Ho: All Panels contain unit roots

Ha: Some panels are stationary.

Levin-Lin-Chu and Im-Pesaran-Shin Unit Root Test indicates the Levin et al. (2002) and Im et al. (2003) panel unit and stationery tests. Both tests examine the null hypothesis of non-stationary (unit root) and follow the asymptotic normal distribution. Both tests reject the null hypothesis of non-stationarity. Both versions of the model as illustrated in Tables 5A and 5B below.

	Levin-Lin-Chu Unit Root Test		**Im-Pesaran-Shin Unit Root Test**	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
GDP	-1.2255	-1.1032*	2.0501	-0.3173**
GCF	-3.1489***	-1.7722***	-1.8908***	-2.1957***
Labour Force	-5.4039***	-2.1752	-2.9555***	3.4252
NBTOT	-1.6133*	0.0310	-0.2466**	-1.8188**
Trade Openness	-4.0094**	-1.2734**	-2.5899	-0.8768***
CO_2 intensity	-0.9945**	-1.4820***	1.2373	0.0587***
FDI	-7.2891***	-6.1674***	-5.8350***	-6.3048***

Table 5A Panel Unit Root Results for Version 1

***indicates Coefficient is significant at 1% level; ** Indicates Coefficient is significant at 5% level; * Indicates Coefficient is significant at 10% level.

	Levin-Lin-Chu Unit Root Test		Im-Pesaran-Shin Unit Root Test	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
GDP	-1.2255	-1.1032*	2.0501	-0.3173**
GCF	-1.2278**	-2.9123***	-1.0987***	-1.3456**
Labour Force	-5.4039***	-2.1752	-2.9555***	3.4252
NBTOT	-1.6133*	0.0310	-0.2466**	-1.8188**
Trade Openness	-5.6404**	-1.5698*	-1.3814	-0.6260*
CO_2 Emissions	-1.2937**	-0.0512*	0.3456*	0.9089**
FDI	-5.2245*	-7.0695**	-4.3991***	-5.4309***

Table 5B Panel Unit Root Results for Version 2

4.3.4: Country-Wise Correlation Matrix of Residuals:

To check the Country-wise correlation matrix of residuals, the study has employed the Breusch - Pagan LM test of independence and Pesaran's Test of Cross-Sectional Independence. Firstly, the results of Breusch - Pagan LM test of independence and then the results of Pesaran's Test of Cross-Sectional Independence have been provided here.

Breusch - Pagan LM Test of Independence:

Table 7 shows the correlation analysis of South Asian and ASEAN countries for version 1 and 2. The results predict the relationship of various variables. For this test, the null hypothesis is:

Null hypothesis: Residuals across entities are not correlated.
Alternative hypothesis: Residuals across entities are correlated.

	Version 1	Version 2
Chi-Square	630.898	502.731
Pr>Chi square	0.55	0.09

Table 7 Breusch - Pagan LM Test of Independence Result for Version 1 and 2

As pr>0.05, it fails to reject the null hypothesis and hypothesis, providing statistical support for uncorrelated error terms.

Pesaran's Test of Cross-Sectional Independence:

Table 9 shows the correlation analysis of South Asian and ASEAN countries for both versions. The results predict the relationship of various variables. For this test, the null hypothesis is:

Null hypothesis: Residuals are not correlated.

Alternative hypothesis: Residuals are correlated.

	Version 1	**Version 2**
Chi-Square	6.698	7.718
Pr>Chi square	0.70	0.09

Table 9 Pesaran's Test of Cross-Sectional Independence test results

As pr>0.05, it fails to reject the null hypothesis and hypothesis, providing statistical support for uncorrelated error terms.

4.3.5. Modified Wald test for Groupwise Heteroskedasticity:

The study employs the Wald test for Groupwise heteroskedasticity, and for this test, the null hypothesis is:

Null hypothesis: Homoskedasticity

Table 10 shows the groupwise heteroskedasticity analysis of South Asian and ASEAN countries for version 1 and 2. The results predict the relationship of various variables.

	Version 1	**Version 2**
Chi-Square	8345.61	677.56
Pr>Chi square	0.098	0.50

Table 10 Modified Wald test for groupwise heteroskedasticity for Version 1 and 2

As Pr>0.05, it fails to reject the null hypothesis.

4.3.6. Testing for Serial Correlation:

Serial correlation tests are applied to macro panels with long-term series. Serial correlation coefficients cause standard errors to be smaller and higher squared than they should be. The study used the Woolridge test for autocorrelation in panel data.

H_0: No first-order autocorrelation.

	Version 1	Version 2
F (1, 125)	289.854	170.786
Pr>F	0.066	0.057

Table 11 Wooldridge Test for Autocorrelation for Version 1 and 2

As Pr>0.05, it fails to reject the null hypothesis.

4.3.6. Robustness checks:

Robustness checks are employed to confirm the validity of findings. The results are presented in Table 12A for version 1 and Table 12B for version 2. These results validate our previous findings, given in the above sections. In short, the sensitivity check confirms that the impact of EE and RE on the real GDP of South Asia and ASEAN countries remains positive and consistent. Thus, the findings are robust by altering the regression approach and by using different proxy.

Variables	GCF	Labour Force	NBTOT	Trade Openness	CO_2 Intensity of the GDP	FDI	Constant
Fixed Effect Model	0.179*** 0.139	1.736*** 0.2848	0.144*** 0 .148	0.417*** 0.147	-0.178*** 0.182	-.038*** 0.012	-4.411*** 5.634
Random Effect Model	0.154*** 0.141	1.476*** 0.239	0.146*** 0.131	0.534*** 0.119	-0.257*** 0.147	-.034*** 0.009	-0.052 5.081

Table12A Robustness Check of the Model for Version 1

Robust Standard Errors in parentheses

***p<0.01, **p<0.05, *p<0.1

Variables	GCF	Labour Force	NBTOT	Trade Openness	CO_2 Emissions	FDI	Constant
Fixed Effect Model	0.196** 0.178	1.144*** 0.623	0.217*** 0 .278	0.318*** 0.415	-0.056* 0.123	-.098*** 0.065	-3.312 5.678
Random Effect Model	0.435*** 0.121	1.768* 0.546	0.124** 0.389	0.365*** 0.145	-0.265*** 0.149	-.099** 0.067	-0.786 8.981

Table12B Robustness Check of the Model for Version 2

Robust Standard Errors in parentheses

***p<0.01, **p<0.05, *p<0.1

Overall, this study also estimated unit root test, country-wise correlation matrix of residuals heteroskedasticity, serial correlation and robustness check for the independent variables without the existence of GDP and have found that data are stationary, uncorrelated, homoskedastic and robust. So, it can be said that data, analysis, and statistics support that the elasticity of the real GDP with respect to the trade openness proxy is positive, and both fixed effect and random effects models are consistent with this result for both versions.

CHAPTER 5: CONCLUSION

This study investigated the statistical relationship between trade openness as a share of GDP in version 1 and level in version 2, and growth in the real GDP in selected South Asian and ASEAN countries. It examined the statistical relationship between real GDP and CO_2 intensity of the GDP and CO_2 emissions levels (respectively for version 1 and 2). Four other variables, gross capital formation as a share of GDP and the level of GCF, net barter terms of trade, FDI as a share of GDP and the level of FDI (respectively for Version 1 and version2), and labour force participation, have been included in the model to capture more of the variation in the real GDP.

The study suggested that trade openness positively correlates with the real GDP on average across time and the sample countries in the panel data. Two different models were used, Fixed Effects and Random Effects, and each conveyed the same message, and two different function form specifications were used for the panel data model. A Hausman test was used to determine which models suited this study, and this suggested that the fixed effect model suited it.

Gross capital formation respectively as a share of GDP (version 1) and level of GCF and labour participation (total) has also shown a positive relationship with GDP in the panel over time, suggesting that an expansion in capital and labour positively increases the real GDP. Terms of trade also show a positive significant correlation with the real GDP, indicating an improvement in terms of trade is correlated with the real GDP on average across the panel. This suggests that policies to increase the terms of trade may increase the real GDP and vice versa. However, both models are statistically significant and suggest negative correlation between real GDP and CO_2 intensity of the GDP and the level of CO_2 emissions on real GDP and FDI as a share of GDP and the level of FDI. Data and statistics show that real GDP is increasing, but the trend rate of the CO_2 intensity of the GDP remains negative over the period.

The study suggests some possible policies to achieve economic growth from trade openness. The results suggest that improvements in energy efficiency and replacing fossil

fuel energy with renewable energy (both of which reduce the CO_2 intensity of the GDP) may be correlated with higher GDP. However, the direction of causation is not known. For example, an increase in the GDP may enable investment in energy efficiency and renewable and vice versa; increases in energy efficiency and renewable might increase the GDP due to being able to market exports as low GHG. Trade openness has produced more pollution because of the less strict environmental policies. The governments of the selected countries should focus on green technologies when producing trade goods. There must be appropriate vocational institutes to direct and train the skilled workforce, which can efficiently influence economic growth and trade. Moreover, all countries need to work together to reduce the CO_2 intensity of the GDP rapidly.

The study's main limitation was the lack of data on many countries in the selected region. Because of a lack of data, many countries from selected regions are excluded from the study. Secondly, GDP is not the only measure of national output for the selected regions because GDP does not include some notable factors, such as the importance of the informal sector (e.g., much production done at home was not measured). Thirdly, a lack of proper data made a regional comparison between South Asia and ASEAN impossible. Future studies can be conducted to widen the literature by analyzing these variables using different regions, for example, Latin America, MENA, Sub-Saharan Africa, BRICS, and GULF countries.

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APPENDIX I

Independent Variables								
Countries		**Intercept**	**GCF**	**Labour Force**	**NBTOT**	**Trade Openness**	**CO_2**	**FDI**
Bangladesh	Coeff.	-38.10	-1.78	3.94	-0.09	-0.03	0.26	-0.01
	St.error	8.57	0.64	0.56	0.21	0.09	0.19	0.02
	t Value	-4.44	-2.78	7.05	-0.43	-0.40	1.36	-0.32
	P>|t|	0.00	0.01	0.00	0.67	0.70	0.19	0.76
	R2= 0.9885 F Val. = 359.1 Pr>F= 0.000							
Bhutan	Coeff.	-23.98	0.04	3.56	-0.01	-0.42	0.01	0.01
	St.error	1.85	0.06	0.21	0.25	0.10	0.02	1.85
	t Value	-12.94	0.58	16.63	-0.04	-4.11	3.78	0.37
	P>|t|	0.00	0.57	0.00	0.97	0.00	0.00	0.72
	R2= 0.9786 F Val.= 237.61 Pr>F= 0.000							
Brunei Darussalam	Coeff.	16.99	-0.03	0.50	0.04	0.10	-0.05	16.99
	St.error	0.55	0.01	0.04	0.02	0.06	0.05	0.00
	t Value	30.89	-2.53	11.27	1.76	1.80	-1.09	2.47
	P>|t|	0.00	0.02	0.00	0.09	0.08	0.29	0.02
	R2=.9593 F Val.=98.23 Pr>F=0.000							
India	Coeff.	-2.96	-0.59	1.60	0.46	0.77	-1.92	-0.15
	St.error	13.73	0.28	0.66	0.29	0.25	0.41	0.04
	t Value	-0.22	-2.11	2.42	1.60	3.06	-4.68	-3.60
	P>|t|	0.83	0.05	0.02	0.12	0.01	0.00	0.00
	R2=0.9732 F Val.=151.03 Pr>F=0.000							
Indonesia	Coeff.	-17.64	0.15	2.41	-0.14	0.07	-0.62	0.01
	St.error	1.01	0.09	0.07	0.10	0.06	0.12	0.01
	t Value	-17.42	1.71	33.48	-1.42	1.09	-5.33	0.59
	P>|t|	0.00	0.10	0.00	0.17	0.29	0.00	0.56
	R2=0.9946 F Val.=772.13 Pr>F=0.000							

Independent Variables								
Countries		**Intercept**	**GCF**	**Labor Force**	**NBTOT**	**Trade Openness**	**CO_2**	**FDI**
Malaysia	Coeff.	-0.68	0.07	1.60	0.05	0.56	-0.42	0.01
	St.error	0.77	0.05	0.04	0.14	0.08	0.14	0.01
	t Value	-0.88	1.24	36.20	0.37	7.32	-3.07	-0.86
	P>|t|	0.39	0.23	0.00	0.71	0.00	0.01	0.39
	R2=0.9966 F Val.=1230.53 Pr>F=0.000							
Pakistan	Coeff.	-6.77	0.48	1.71	0.18	0.05	-0.51	0.02
	St.error	1.73	0.12	0.07	0.05	0.09	0.15	0.02
	t Value	-3.91	4.01	23.39	3.94	0.59	-3.35	1.09
	P>|t|	0.00	0.00	0.00	0.00	0.56	0.00	0.29
	R2=0.9930 F Val.=591.81 Pr>F=0.000							
Philippines	Coeff.	-5.29	0.34	1.70	0.10	0.06	-0.32	0.06
	St.error	4.34	0.12	0.22	0.21	0.23	0.19	0.03
	t Value	-1.22	2.93	7.77	0.49	0.28	-1.75	2.29
	P>|t|	0.23	0.01	0.00	0.63	0.78	0.09	0.03
	R2=0.9778 F Val.=183.35 Pr>F=0.000							
Singapore	Coeff.	7.84	-0.03	1.14	0.12	0.22	-0.34	0.04
	St.error	2.29	0.06	0.13	0.28	0.13	0.10	0.02
	t Value	3.42	-0.43	8.65	0.41	1.68	-3.28	2.00
	P>|t|	0.00	0.67	0.00	0.68	0.11	0.00	0.06
	R2=0.9954 F Val.=911.41 Pr>F=0.0000							

Independent Variables								
Countries		**Intercept**	**GCF**	**Labor Force**	**NBTOT**	**Trade Openness**	**CO_2**	**FDI**
Sri Lanka	Coeff.	-61.21	0.54	5.20	0.24	-0.25	-0.15	0.04
	St.error	7.08	0.21	0.50	0.34	0.34	0.22	0.06
	t Value	-8.65	2.59	10.41	0.71	-0.74	-0.67	0.71
	P>|t|	0.00	0.02	0.00	0.48	0.46	0.51	0.49
	R2=0.9566 F Val.=91.79 Pr>F=0.000							
Thailand	Coeff.	-44.11	0.01	3.81	0.83	-0.12	-0.52	-0.02
	St.error	7.79	0.07	0.44	0.28	0.21	0.13	0.02
	t Value	-5.66	0.17	8.72	2.92	-0.54	-4.03	-0.76
	P>|t|	0.00	0.87	0.00	0.01	0.59	0.00	0.46
	R2=0.9763 F Val.=171.34 Pr>F=0.000							
Vietnam	Coeff.	17.20	-0.67	0.64	-0.06	0.54	0.69	0.07
	St.error	4.87	0.10	0.29	0.17	0.08	0.11	0.02
	t Value	3.53	-6.85	2.19	-0.36	6.60	6.41	3.28
	P>|t|	0.00	0.00	0.04	0.72	0.00	0.00	0.00
	R2=0.9972 F Val.=1501.09 Pr>F=0.000							

Table 2 OLS Time Series

	-e1	*-e2*	*-e3*	*-e4*	*-e5*	*-e6*	*-e7*	*-e8*	*-e9*	*-e10*	*-e11*	*-e12*
-e1	0.43											
-e2	0.69	2.70										
-e3	-0.34	-1.97	2.63									
-e4	0.58	1.58	-1.15	1.27								
-e5	0.26	0.86	-0.71	0.65	0.43							
-e6	-0.02	-0.14	0.21	-0.08	-0.05	0.06						
-e7	-0.02	-0.08	0.20	0.00	-0.02	0.01	0.08					
-e8	0.22	0.23	0.03	0.33	0.13	-0.01	0.05	0.28				
-e9	-0.06	-0.57	0.67	-0.23	-0.13	0.08	0.05	0.06	0.37			
-e10	0.39	2.47	-2.80	1.40	0.89	-0.25	-0.21	-0.06	-0.88	3.49		
-e11	0.23	1.03	-0.93	0.65	0.37	-0.06	-0.06	0.04	-0.26	1.15	0.51	
-e12	0.24	0.50	-0.25	0.41	0.22	0.00	-0.02	0.17	-0.01	0.29	0.19	0.23

Table 6 Breusch - Pagan LM test of independence

	-e1	*-e2*	*-e3*	*-e4*	*-e5*	*-e6*	*-e7*	*-e8*	*-e9*	*-e10*	*-e11*	*-e12*
-e1	1.00											
-e2	0.63	1.00										
-e3	-0.03	-0.78	1.00									
-e4	0.78	0.85	-0.66	1.00								
-e5	0.60	0.80	-0.71	0.88	1.00							
-e6	-0.14	-0.36	0.56	-0.28	-0.30	1.00						
-e7	-0.11	-0.18	0.46	-0.01	-0.10	0.18	1.00					
-e8	0.62	0.27	0.04	0.56	0.37	-0.07	0.35	1.00				
-e9	-0.14	-0.58	0.72	-0.33	-0.33	0.54	0.30	0.20	1.00			
-e10	0.32	0.80	-0.98	0.66	0.73	-0.55	-0.41	-0.07	-0.78	1.00		
-e11	0.49	0.88	-0.88	0.80	0.79	-0.33	-0.31	0.10	-.6121	0.86	1.00	
-e12	0.75	0.62	-0.33	0.76	0.69	-0.03	-0.03	0.65	-.0344	0.32	0.54	1.00

Table 8 Pesaran's Test of Cross-Sectional Independence

APPENDIX II

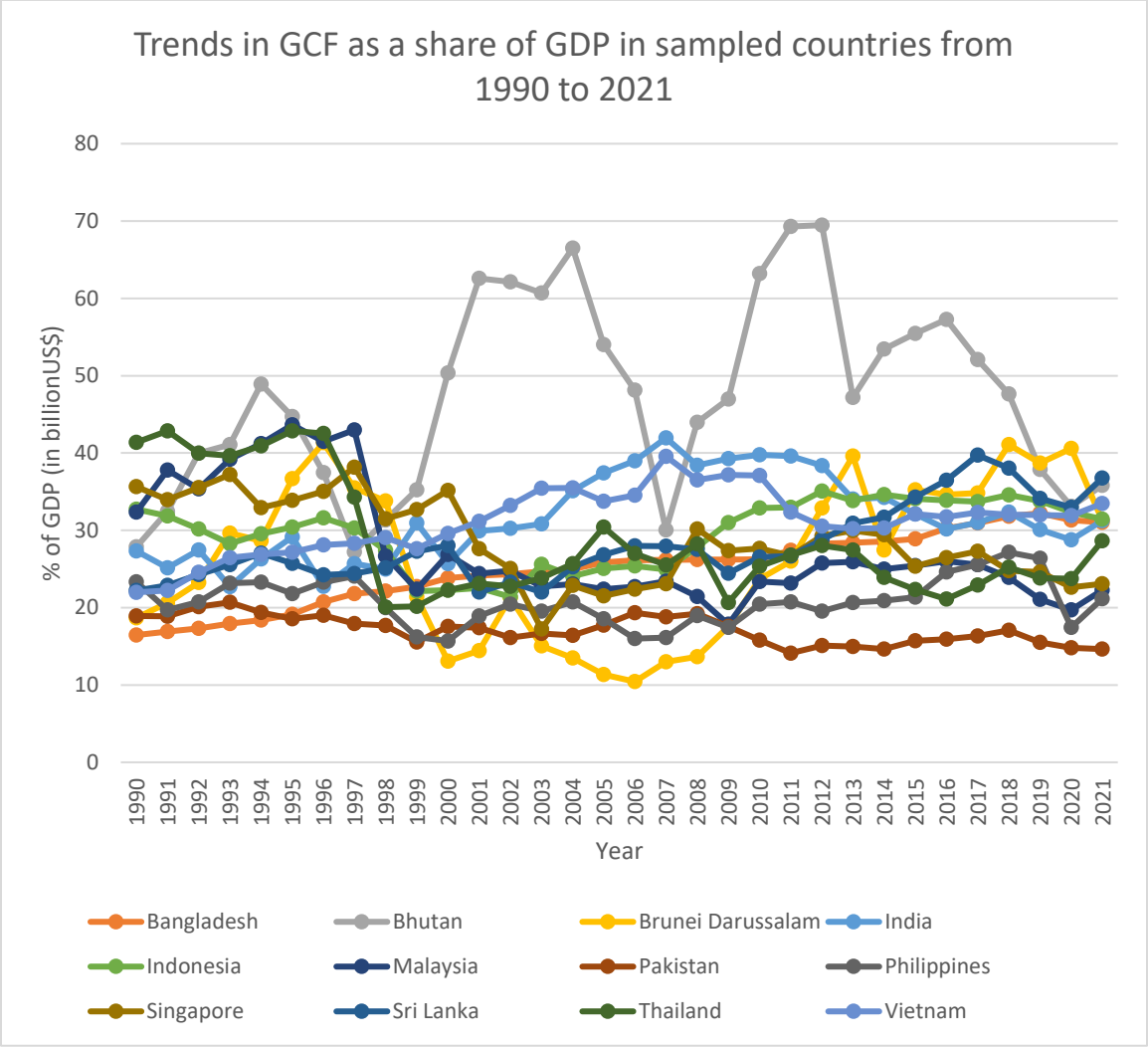

Figure 5 Source: World Development Indicators

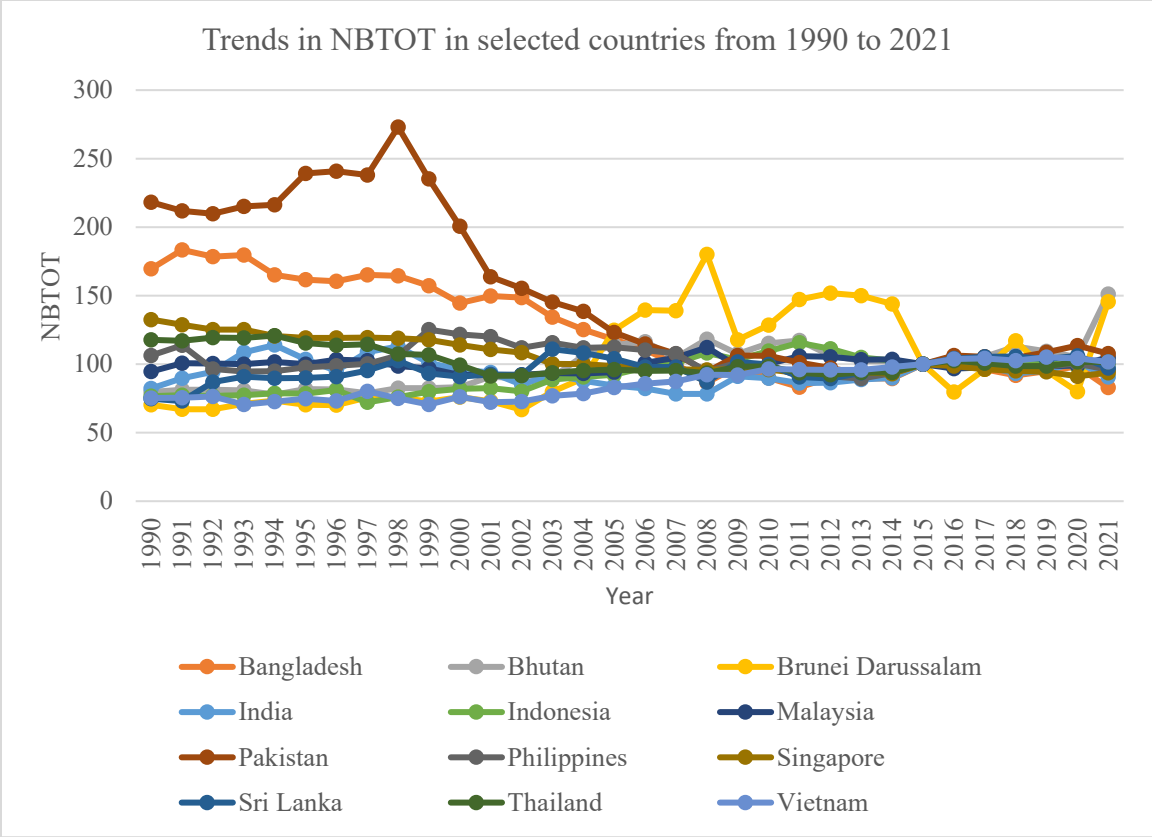

Figure 6 Source: World Development Indicators

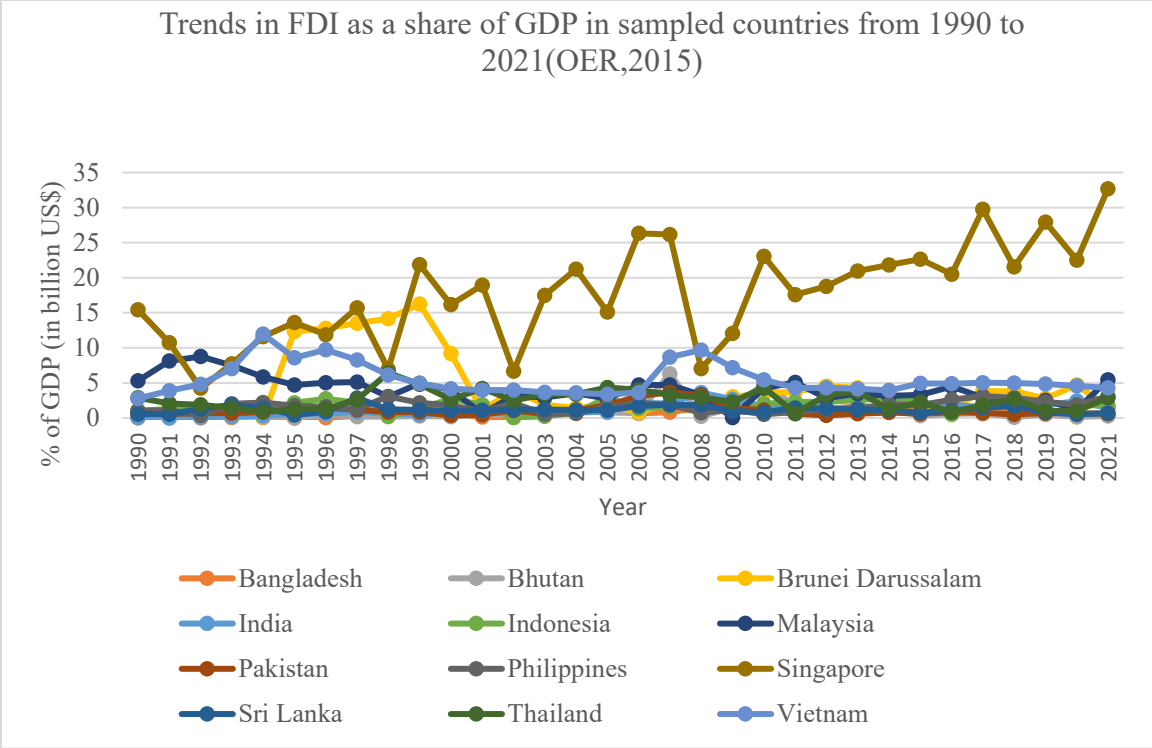

Figure 7 Source: World Development Indicators