Investigation the Nexus Between Bioethanol Fuel, Trade Deficit, And Economic Growth In Pakistan

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CERTIFICATE

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I Moona Umar Hayat hereby state that my M-Phil thesis titled "Investigation the Nexus between Bioethanol Fuel, Trade Deficit and Economic growth in Pakistan" is my own work and has not been submitted previously by me for taking any degree from the Pakistan Institute of Development Economics or anywhere else in the country/world.

At any time if my statement is found to be incorrect even after my Graduation the university has the right to withdraw my M-Phil degree.

Signature of Student

Name of Student

Moona Umar Hayat

Dedication

To my beloved father Mr. Umar Hayat Khanzada (Late) who has helped me stand today, lent me his strength when needed, and believe in me like no other, and my sister Fatima Umar Hayat Khanzada, thanks to her for giving wings to my dream to fly, without her support I couldn't achieve my goals.

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ABSTRACT

Pakistan has a major energy shortage. Oil and gas reserves in the country are low, and the economy is heavily reliant on oil imports the cost of the country's oil imports has been negatively affecting the balance of payments and placing a significant strain on the economy. The country is becoming more and more dependent on fossil fuels, and the future of its energy depends on the precarious import oil supply, which is prone to disruptions and price volatility. In Pakistan, 28 percent of all commercial energy consumption is accounted for by the transportation industry. This study investigates the impact on Pakistan's economic growth of the trade deficit (generated by reducing the import of oil and export of ethanol by 10%), using the annual frequency of time series data (1990 to 2020) by applying a co-integration analysis and VECM (Vector Error Correction Model). The empirical evidence indicates that applying the trade deficit and trade gain (at the same price of oil) have a negative effect on economic growth while trade gains with increment in oil prices by 10%, 15%, and 20% have affected economic growth positively. However, in the short-run trade deficit and economic growth has no relationship. These results interpreted evidence that if Pakistan starts using ethanol (E-10) in oil it will reduce the burden on fossil fuels and trade balance but this is not conducted properly and treated solidly and fairly, which offers alternative insights into Pakistan's ethanol policies for promoting economic growth.

Keywords: Bio-ethanol, E-10, Economic growth, and Fossil fuel

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
CFD	Contract of Difference
EEA	European Environment Agency
EU	European Union
GDP	Gross Domestic Product
GHGs	Green House Gases
MDGs	Millennium Development Goals
PEMA	Pakistan Ethanol Manufacturing Association
PIDE	Pakistan Institute of Development Economics
PSO	Pakistan State Oil
USA	United States of America
β	Beta

CHAPTER 1

INTRODUCTION

Energy is a key element of our lives and one of the basic variables to keep up with the economic development of any country. There is a close linkage between the availability of energy and the sustainable growth of a nation since energy is essential to conduct the process of production. To meet the UN Millennium Progress Goals (MDGs), access to energy must be improved as it is a significant barrier to economic and social development. The United States' EIA (Energy Information Administration) predicts that world energy consumption will escalate by fifty-six percent between 2010 and 2040 (US Department of Energy, 2013). The energy demand-supply gap is already affecting the developing world and could get worse globally. When analyzing future alternative energy plans, this scenario needs to be approached analytically and with the use of solid scientific methods. The only way to address the problems of long-term energy security and environmental sustainability is to implement effective technologies at lower costs that can use more abundant, cheaper, and cleaner energy sources.

Fossil fuels are the primary source of energy in most industrialised and developing nations. In addition to causing risks to human health and the environment, the uneven distribution of fossil fuels, together with their crucial role in the current energy production systems, raises concerns about energy security. The insecurity of markets and pricing is also a disadvantage in their use from an economical perspective. Furthermore, they are non-renewable resources, which raises questions regarding their availability to both the present and future generations. Avoiding complete depletion will reduce the environmental impact in the applicable impact category. Another drawback in their use is market and price volatility, which has serious economic repercussions. Non-renewable energy sources have been copied as a result of the continuous use of fossil fuels.

The enormous disparity between the supply and demand for fossil fuels in many countries has been observed over the past few decades due to the increase in its demand rapidly. According to the World Energy Forum, if oil reserves are consumed at a rate of 3 percent annually, they will run out in less than 45 years. (Kafuku & Mbarawa, 2010).

All of these concerns contribute to today's unsustainable energy systems and the search for new strategies to diminish the negative effects that energy systems have on society, the environment, and the economy will increase their sustainability. Developing sustainable energy systems continues to be difficult for most nations, despite government, global organisations, and other stakeholders' efforts. New rules have been adopted in recent decades, and incentives for renewable energy have been offered through support mechanisms such as feed-in tariffs. Many alternative techniques have been considered, such as demand-side measures and smart grids, to meet the issues that a shift to low-carbon energy systems poses for a sustainable future. It is vital to develop methods for evaluating energy systems and policies to determine whether the paths chosen are beneficial or not.

Energy systems constantly evolving, thus it's critical to measure and evaluate these changes as they relate to the achievement of the set objectives. European nations are on the cutting edge of these changes, and renewable energy sources are a crucial component of new energy policies and anticipated trajectories. But the need for fossil fuels in energy systems remains crucial.

Countries like Sweden and Iceland, with a low share of fossil fuel energy consumption and a high ratio of renewable energy, Norway is an exception, with high percentages for both fossil fuel based energy and renewable energy (Al- Mulali, Solarin, & Ozturk, 2016).

Mostly South Asian countries fulfill their energy demand from fossil fuels mostly. Currently, fossil fuels account for about 85% of total power generation in Bangladesh, India, and Pakistan.

Transportation plays a significant role in today's society, accounting for roughly 20% of global energy consumption (Capuano, 2019). Shipping, aviation, rail, and road transportation all have social and economic repercussions and are connected to all of an economy's major sectors directly or indirectly. However, the transportation sector uses an enormous amount of fossil fuel energy of all-out utilization, which is continuously increasing and currently using 27% of essential energy and it is predicted that this demand will increase by 80% up to 2030 and By 2050, it will have increased by more than 80%. (Mindali, Raveh, & Salomon, 2004).

Since 2014, transportation-related oil consumption has risen at an annual rate of 2.2 percent on average. Within the sector, road transport consumes the most oil-derived fuels, accounting for 71 percent of overall consumption in the EU in 2017. Despite a decline since 2007, road transport energy use in 2017 was still 28% greater than in 1990. Between 2000 and 2017, the percentage of diesel used in road transport increased from fifty-two percent to seventy-two percent, which is an alarming situation and shows that Europe's car fleet has been increasingly dieselized over that period. Recently, the trend to adopt renewable energy has been observed and the share of renewable energy used in transportation raised by 8.1% in 2018 from 7.4% in 2017, according to an early EEA report for 2018. At the EU level, the share of renewable energy in transportation is still falling short of what is needed to achieve the 2020 goal. The percentage of alternative energy used in transportation varies by country, raising from 32% in Sweden to less than 0.4 percent in the United States. Finland and Sweden are the only two EU countries that have already achieved their objective of a 10%

renewable energy contribution to transportation (Safwat Kabel & Bassim, 2019). Biofuels account for nearly all renewable energy in this industry (nearly 90%), with electricity playing a minor part. Increased usage of renewable electricity in the transportation industry would alleviate the need for bio-fuels to meet the target EU has set (EU's 10% plan) (EEA, 2018).

The transportation sector is confronted with three significant issues: fossil fuel depletion, crude oil price volatility, and rigorous environmental laws. Alternative fuels have the potential to solve these problems. Biofuels are being aggressively researched as an alternative since they have fewer complications in terms of manufacturing, storage, transportation, and application in internal combustion engines.

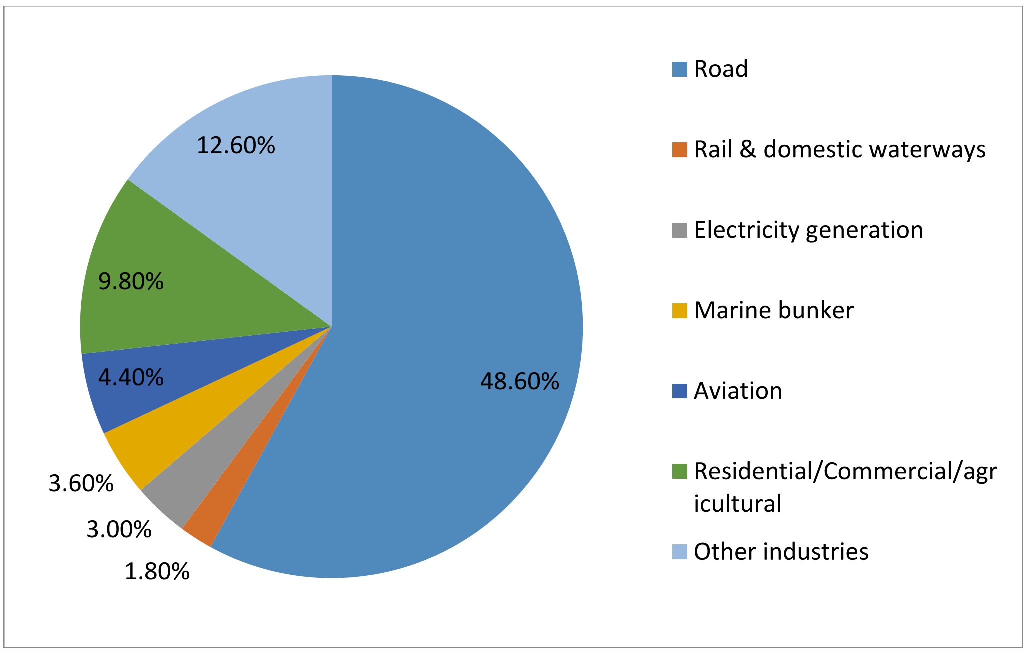

Figure 1.1: Distribution of oil demand in the OECD in 2020, by Sector

Source: (https://www.statista.com/statistics/3071)

Due to diminishing fossil fuel supplies, volatile oil prices, climate change concerns, air pollution, and an increasing need for fuel in the transportation sector, biofuel production has sparked interest in various countries. Raise in the price of fossil fuel products previously, the world is trying to reduce its dependency on fossil fuels with renewable energy. Renewable energy's proportion of transport energy in the EU increased from 7.4 percent in 2017 to 8.1 percent in 2018. This is considerably below the EU's 10-percentage-point aim for 2020. Developed countries like Brazil, Turkey, and the USA moving towards different alternative sources of energy such as ethanol. Biodiesel appears to be an exceptionally fascinating and, exceptionally encouraging resource all around the world; the awareness of energy and natural issues related to consuming petroleum products has urged numerous scientists to research the chance of utilizing alternative renewable energy rather than oil and its subordinates. Currently, the developing nations are focusing on energy mix to reduce the reliance on fossil fuels for energy production.

Bio-fuel is also recognized as a green, sustainable, feasible source of the energy that is formed from alternative, and sustainable sources. The most predominant bio-fuels, bio-diesel from vegetable seeds and ethanol from corn, wheat, and sugar cane, are delivered from food crops, which harvest on rich agricultural land (Demirbaş, 2008). Biofuel energy has been utilized all through man's long history. The greater part of them were alcohols created by the aging of substances like starch or sugars, others were plant oils (Antoni, Zverlov, & Schwarz, 2007). However, a full investigation of biodiesel just became known during the 1980s because of interest in renewable, sustainable, and environmentally friendly energy for lightening the weight from fossil fuel energy sources and diminishing the greenhouse gases (GHG) emissions. Biodiesel is characterized as mono-alkyl esters of long-chain unsaturated fats got from vegetable oils or animal fats and liquor with or without a catalyst.

The majority of the nations all around the world like Brazil, Malaysia, Indonesia, the USA, Germany, France, and other European nations have already attained their goal to reduce their trade deficits resulting from the high imported oil to meet their energy demand and set up projects to add ethanol to gasoline which produced sustainable and economically feasible transportation fuel and advancing the rural economy (Ghani & Gheewala, 2021). In 1997, Brazil's trade deficit was eight billion dollars out of which six billion dollars was spent on crude oil; its bioethanol program reduced its oil imports from four hundred to three hundred million barrels. (Zanin et al., 2000). In 2009, the US used 10.6 billion gallons of domestically produced ethanol which reduced its oil imports bills by 21 billion dollars. Turkey made it mandatory to blend 2% and 3% into gasoline in 2013 which caused a fall in the cost of imported fuel for road transportation between 1.1% to 7% and a fall of about 30% in its trade deficit. (Çağatay, Taşdoğan, & Özeş, 2017)

In 2006, Pakistan State Oil (PSO) assessed the Ethanol blending in petroleum by10% (E10) in limited, followed by its marketing in 2010. Ethanol (fuel-graded) is also produced by some distilleries; but no subsidy has been given to these initiatives and noone think toward the country's energy matrix, there is no clear policy is present for ethanol blends at the national level to today date. This paper analyzes different scenarios if the oil price increased by 10% or 15% or 20% in the international market then how can we reduce the trade deficit which would be increased along with the oil price as oil is a natural resource and the supply of oil is diminishing day by day and Pakistan's oil demand depend on foreign fuel.

1.1 Statement of the Problem (SoP)

Pakistan is an agricultural country and has restricted assets for unrefined fuel oil. Pakistan fulfills its oil demand by importing oil into the country. According to the provisional figures compiled by the Pakistan Bureau of Statistics, in the financial year 2021, Pakistan imported Petroleum crude at least 785,000 tones which cost Pakistan's economy around Rs.35, 146 million. The demand for fossil fuel has been exceeded by 52 percent from what it imported all of last year. It is obvious that these import bills are a stain on Pakistan's economy. One of the major consumers of domestic petroleum is the transportation sector. As the population of Pakistan is increasing, its demand for petroleum products is also growing and this sector became one of the greatest sectors to import oil. According to (British Petroleum Company, 2018) during the last 5 years, the consumption of petroleum products has shot up to five hundred and eighty-nine thousand barrels which are 40% of the overall energy consumption of the country. In 2018 the growth of 60.35% has been observed in Pakistan's spending on importing crude oil which cost the country 3.738 billion dollars. (Arshad Hussain, 2018)

Pakistan is struggling on financial and natural fronts, and is in critical need of economical energy supplies, especially for its transportation area. The desire for sustainable economic growth and a decreased trade deficit in developing countries like Pakistan is simply adopting alternative energy sources. Nonetheless, Pakistan only satisfies 15% of oil demand from reserves present in the country which is not enough to meet its total demand. Therefore, Pakistan has to import oil to fulfill its annual consumption demand of oil. The import bill can be shortened by developing projects based on renewable energy sources for the transportation sector and ethanol is an incredible other option. (Goldemberg, 2007). The potential of the country to produce ethanol is significantly high. Four billion liters of ethanol can be produced annually by Pakistan's sugar industry. (Mirza, Ahmad, & Majeed, 2008). Sugarcane can play a vital role to fulfill the demand for oil in the form of ethanol-blended fuels in the transportation sector but unfortunately, its role has been limited in the past. By trading molasses just US$100 million can be procured while by utilizing crude molasses to deliver mixed ethanol fuel, Pakistan can save around 600 million. (Arshad, 2010). Secondly, Pakistan is losing its ethanol market due to various factors and there is clearly a decrease in ethanol export according to PEMA. Ethanol decreased 0.86 USD/GAL or 28.67% from the starting of 2022, conferring to trading on a contract for difference (CFD) that keep the records of the benchmark market for sugar cane. Two of the seven existing distilleries have closed as a result of lost commerce with the EU, and another five new distilleries will likely give up on their ambitions to open due to market uncertainty. It is possible to transform the volume of ethanol exported to the EU into industrial, superfine, or fuel ethanol. However, the government's domestic fuel ethanol program is necessary for its conversion into fuel ethanol. Petroleum utilization is around 1.6 million tons, and a 10% mixing of ethanol can bring about 160,000 tons of fuel ethanol utilization. Pakistan can deliver this amount of ethanol from sugarcane molasses. Using gasoline in the transportation sector could result in annual savings of between $200 and $400 million as well as additional advantages for the environment and human health.

(Rashid & Altaf, 2008) estimated that If Pakistan starts using blended ethanol with a ratio of 10% it could help the nation in reducing upon fossil fuels, Pakistan's estimated annual gasoline consumption will be around 2 billion liters; we only need 199.85 million liters of ethanol for fuel, which is only 40% of the existing capability for bioethanol production. These calculations indicate that, for a relatively small investment, we may immediately begin blending ethanol with gasoline. Pakistan can save roughly 2% of the cost of importing fossil fuels by using 10% ethanol blended oil in the transportation sector. The reason behind selecting E10 and E20 only and not higher order blends is that these blends can be used in the conventional internal combustions engines (ICE) without any alteration. On the other hand, vehicles with specifically modified engines, viz, flex fuel vehicles (FFV), are required to use gasoline-ethanol blends higher than E20.

Based on the narrative of SoP as stated in the preceding text, I am narrowing my research problem into “INVESTIGATION OF THE NEXUS BETWEEN BIOETHANOL

FUEL, TRADE DEFICIT AND ECONOMIC GROWTH IN PAKISTAN" and have operationalized my topic into the following research questions and objectives.

1.2 Research Questions

Pakistan is dependent on imported fossil fuels which are increasing its trade deficit. Five different scenarios have been built to give insight into the role bioethanol fuel can play to reduce this gap. All the scenarios have discussed below in section 1.4. In this section research questions are formed on the basis of h

i. Could bioethanol reduce the dependence on foreign petroleum and reduce Pakistan's trade deficit if oil prices increased in the international market?

ii. What will be the impact on the economic growth of that 10% reduction from the total export of ethanol and total imports of petroleum?

1.3 SIGNIFICANCE STATEMENT OF THIS RESEARCH

The significance of this research will redound the benefit of society that ethanol mixed fuel can bring to the development of Pakistan's economy and environment. Pakistan is an oil import country. The main objective of this study is to determine the economic feasibility of the usage of sugarcane as feedstock to produce bioethanol fuel in Pakistan. The findings of this study will show the potential of Ethanol fuel as a replacement for gasoline and how it can contribute in diminishing the balance of payment of Pakistan.

Collaboration of the automobile sector, industry and academia partnership, public-private sector alliance, and involvement of state-owned industries in the ethanol plan can reduce the trade deficit of Pakistan. Before choosing the topic, I have taken interview surveys with different people in the capital city of Pakistan. I found that because of the high prices of petroleum products and unawareness of ethanol fuel, people have to buy fuel whose price is rising rapidly and early finding showed me that many people didn't even hear about PSO and the government collateral ethanol project. This study can contribute in the field of research and policy making to rethink about usage of bioethanol fuel as alternative of imported fossil fuel and spread awareness about it. This study is beneficiary for the government institutes such as Ministry of Energy and PSO to work on this field and reduce the dependency on fossil fuel.

1.4 Objectives of the Research

The main purpose of this piece of research is to provide insight that how the usage of bioethanol fuel instead of fossil fuel could be beneficial for Pakistan's economy and its impact on trade deficit. This study is giving a new direction to reduce the dependency on fossil fuel in case of an increase in fuel prices in the international market. Calculate the trade deficit created by ethanol export and oil import. This has been done by building five different scenarios which are mentioned below:

- Calculate the trade gain from a reduction of 10% from the total export of ethanol and total imports of petroleum.
- Calculate the trade gain from a reduction of 10% from the total export of ethanol and total imports of petroleum with a 10% increment in oil price.
- Calculate the trade gain from a reduction of 10% from the total export of ethanol and total imports of petroleum with a 15% increment in oil price.
- Calculate the trade gain from a reduction of 10% from the total export of ethanol and total imports of petroleum with a 20% increment in oil price.

Using both qualitative and quantitative methods. We will create five hypotheses, what will be the trade deficit and trade gain, and how it will affect our growth in the future. The objective of this research work is to give a scalable framework to policymakers to take initiatives to use ethanol as blended fuel in the face of future uncertainty. The main objectives of this study are

- Evaluate the potential of foreign exchange savings from reduced fossil fuel imports by 10% and 10% reduction in ethanol export (use it as biofuel in the transportation sector) and import of oil on the trade balance in all scenarios. (10% 15%, and 20% increase in oil prices)

- Reduced 10% from both commodities' impact on the economic growth by using the new trade gain we get by blended ethanol in petroleum products.

- Propose institutional and economic policy alternatives to promote the domestic use of biofuels.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are many studies that discovered that consumption of energy and GDP growth have a long-run economic relationship (Oh & Lee, 2004). Bioethanol development may have socioeconomic and environmental consequences. The findings demonstrate that increasing bioethanol production while also improving feedstock cultivation efficiency is the most efficient strategy to lead to sustainable economic growth (Kaenchan, Puttanapong, Bowonthumrongchai, Limskul, & Gheewala, 2019). The finding of many studies indicates that both capital formation and ethanol use are favorably correlated with economic performance, the findings indicate. Keeping other variables fixed, we observed that an absolute increase in ethanol usage results in a 2.2% increase in economic growth in the country. Additionally, a 100% increase in capital formation would boost Brazil's economic performance by 13.9 percent. GDP growth, bio-fuel energy use, capital, urbanisation, and global trade are all correlated in long term, the findings indicate. Additionally, the consumption of biofuel energy, capital, urbanisation, total population, and globalisation all contribute to Brazil's economic growth. (Al- Mulali et al., 2016).

Despite the extensive literature analysis, only a few researchers have explored the relationship between bio-fuel energy use and GDP. Several scholars such as (Yildirim & Aslan, 2012) and (Bildirici, 2013) have discovered the link between bio-fuel energy usage and GDP growth.

(Urbanchuk & Partner, 2017) found out that the ethanol sector generates a trade surplus and contributes to the reduction of the USA's trade imbalance. Ethanol also helps the USA by lowering reliance on imported oil, increasing the availability of petroleum products, reducing the US trade deficit, and emitting less greenhouse gas than regular gasoline. The authors further stated in the study that Domestic biofuel production (ethanol and biodiesel) continues to contribute to the continuous drop in reliance on imported oil. In 2019, the production of 15.8 billion gallons of ethanol displaced 540 million barrels of crude oil that would have been used to make gasoline. When applied to imports, the expected value of crude oil displaced by ethanol in 2019 is over $32 billion. This money remains in the American economy and, combined with the GDP, contributes to the country's strength.

Brazil is one of the world's biggest exporters of bioethanol and the second-biggest maker after the United States. Most of Brazil's ethanol is produced by sugar cane, most are utilized locally subbing 40% of Brazilian petroleum utilization and roughly 20% is traded to the USA, EU, and different business sectors. Ethanol reduces the country's demand for imported oil, reducing the trade deficit and assuring a reliable supply of fuel in the event of a disruption in international supplies. Biofuels appear to be an excellent substitute for fossil fuels, which are always fraught with environmental, economic, and stability challenges (Ghobadian, Najafi, Rahimi, & Yusaf, 2009)

These days, bio-ethanol is assuming a significant part as an alternative fuel for cars in Thailand as the development of bio-ethanol has quickly expanded from 0.4 M liter each day in 2006 to 1.1 M liter daily in 2010 (Silalertruksa & Gheewala, 2011)

Vojvodina's transport sector is one of the significant consumers of energy. Oil is the major fuel utilized in this area. Oil is an imported item and is additionally not climate well friendly. There is a huge potential for bioethanol fuel creation from molasses in the country. Bioethanol is an eco-friendly, and sustainable fuel that can be utilized after mixing with gasoline in the transportation sector. The utilization of bioethanol fuel is expected to be 23.3 hundred thousand in 2026. (Dodić, Popov, Dodić, Ranković, & Zavargo, 2009)

This is an era of global mass transportation and energy utilization in this sector is predicted to increase by an average of 1.8 percent a year between 2017 and 2035 (IEA, 2017). (Atabani et al., 2012) stated in their research that the transportation sector is the second biggest energy-consuming sector and records for thirty percentage of the world's total energy, of which 80% is road transport. Practically all petroleum energy utilization in the transportation area is from oil (97.6%) with a limited quantity from LPG. Around ¾ an increase in oil demand comes from the transportation sector (Rabé, 2006).

Lately, the increase in world oil prices caused a sharp improvement in demand for biofuel production globally. The production and consumption of liquid biofuels (bioethanol and biodiesel) is the technique adopted by the Colombian government to decrease oil dependency and decrease the trade balance (Quintero, Montoya, Sánchez, Giraldo, & Cardona, 2008). The consumption of bioethanol as a vehicle fuel has many benefits. The mixing of bioethanol with fuel will decrease the fossil fuel import and the relating import bills. The utilization of native fuel ensures a specific level of safety in the energy supply (Dodić et al., 2009).

With the expanding gap between the energy demand and supply in the modern world, such requirements from the limited energy resources like fossil fuels are impossible, it’s only burdening the economy and rising the temperature of the earth. (Mohan, Babu, & Sarma, 2008). One of the attractions of biodiesel is that it's more environmentally friendly and harmless than petroleum fuels, bringing about the less environmental effect on the climate. Moreover, the demand for bio-ethanol is probably going to increase steadily in the coming years as per the 15 years elective energy advancement plan (2008-2022) which intends to accomplish 9 M.litre each day of bio-ethanol creation in 2022 (Huo, Wu, & Wang, 2009).

(Anušić, 1993) used data from the Republic of Croatia from (1991–1992) to explore the idea that a budget deficit is inherently harmful to a stable and efficient economic system. Citing Keynesian economic theory, he explained that an increment in the budget deficit will lead to an increment in real interest rates, which would affect real investment and lead it to a deprecation. The entire economy and its smoothness are negatively impacted by budget deficits, but this also depends on the internal circumstances and financing methods of each nation. Same as (Huynh, 2007) conducted his research while gathering information from developing Asian nations between 1990 and 2006. Simply by looking at trends in Vietnam, he concluded that the budget deficits have a detrimental affectt on the GDP growth of any country. (Fatima, Ahmed, Rehman, & Finance, 2011)discussed in their paper how the fiscal deficit may have both direct and indirect effects on economic development. The facts mentioned above also support the conclusion that a country's fiscal imbalance has a significantly adverse impact on GDP growth. In the case of Pakistan, the nation has been dealing with a fiscal deficit for many years.

In 2013, Jayachandrun calculated in his paper (Jayachandran, 2013) how exchange rates affect GDP and trade. The primary goal of the study was to look into how the exchange rate affected Indian companies. He employs time-series data from 1970 until 2011. The variables used in this study include foreign investment, exchange rate, imports, and exports. The study's findings supported the correlation between real exchange rates, exchange rate instability, gross domestic product, and international economic activity as well as actual export and import. According to his findings, real exports and imports in India are significantly impacted negatively by exchange rates, which means that larger exchange rates rise and fall tend to reduce real exports. He advised keeping the currency rate steady on an annual basis to increase foreign investment. A country's GDP may be impacted if its exports grow faster than its imports, hence it is always preferable for a nation to attempt and generate its needs-based items rather than importing them. (Blavasciunaite, Garsviene, & Matuzeviciute, 2020) has performed research to conclude the linkage between economic growth and trade imbalance. Trade deficit served as the study's main independent variable. From 1988 to 2011, a sample of annual data spanning 24 years was collected for the study. For data analysis in the survey, the histogram, scatter plot matrix, and OLS method of regression were utilised. The rupee value is continuously falling against the US dollar, according to the histogram's exchange rate. FDI also has a negative relationship with Pakistan's economic expansion. With the exception of transaction volume, the scatter plot graph demonstrated a positive correlation between both dependent and independent variables.

(Nweke, Odo, & Anoke, 2017) This suggests that the estimation's outcome can be trusted when making long-term economic policy decisions. It also implies that, if vigorously pursued, measures promoting gross capital formation and economic growth may ultimately be advantageous to the Nigerian economy.

Several empirical studies have investigated the connection between changes in the price of oil and economic expansion. In the United States, (J. D. J. J. o. p. e. Hamilton, 1983) discovered an adverse correlation between macroeconomic activities and oil prices. Hamilton's results were also supported by (Carruth, Hooker, & Oswald, 1994) whose study also discovered that between 1948 and 1972, changed in oil prices rapidly and unpredictably had a huge impact on GDP growth. His research showed, a 10% increment in crude oil prices resulted in a 0.6% deterioration in growth of GDP in the third and fourth quarters after the shock. Later, Granger causality tests and non-linear modifications to the models were introduced by (Lee, Ni, & Ratti, 1995), and (J. D. J. J. o. m. e. Hamilton, 1996). Their results also showed the adverse correlation between oil price volatility and economic downturns as well as Grunger causality from oil prices to growth before 1973 but no Grunger causation from 1973 to 1994.

(Bartleet & Gounder, 2010) studied the impact of change in oil prices in New Zealand and observed the direct correlation between economic-growth and net price shock of oil, utilising both linear and non-linear oil price transformation. Additionally, many researchers have discovered that the shock of the oil price significantly affected inflation and currency exchange rates. Jin (2008) conducted a comparative analysis of the effects of the oil price shock and exchange rate volatility on economic growth and found that oil price hikes have an adverse effect on economic growth in Japan and China and an affirmative impact on economic-growth in Russia. In particular, a 10% constant increase in global oil prices is related to Japanese GDP and weakening it by 1.07 % and a 5.16 % escalation in Russian GDP. On the one hand, a rise in the real exchange rate affects the GDP growth of Japan and China negatively while GDP of Russia affects positively. The relationship between exports, imports, and economic growth occur the center stage in development literature when economists try to analyze the different levels of economic growth of an economy (Shihab, Soufan, Abdul-Khaliq, & Science, 2014). (Afzali 2016) found a stable, as well as a strong relationship between economic growths and exports there, exists bi-directional causality between industrial exports and economic progress in Pakistan's economy.

2.2 Contribution to Literature

If we look at the evaluation of performance indicators done in literature so far, we come to know they only focused on the cost-effectiveness of ethanol and its environmental effects.

This study differs from previous literature in the sense that it will involve the assessment of how the trade balance will be the effect if Pakistan starts using E-10 (10% ethanol and 90% petrol) in transportation. Hence, this study will explore additional dimensions and attempt empirical research to assess the impact of usage of bio-ethanol fuel in transport based on sustainable development of Pakistan in terms of trade deficit and economic growth.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This chapter of the study is mainly focuses on the study's methodology, which involves the methods and processes used to perform the analysis. Theoretical background, an empirical framework for quantitative analysis, data collection, variables construction, and qualitative analysis are among the topics covered.

3.2 Research Description

In identifying and trying to understand the relationship between variables, a quantitative methodology is good (Creswell & Poth, 2016). This study will abide by both quantitative and qualitative methods to measure the impact caused by using bio-ethanol fuel in the transportation sector on Pakistan’s import bills. To examine the numerical data from available sources such as the World Bank data bank, the quantitative research approach will be used. For accuracy, the data was confirmed from many sources and entered into a uniform format.

Pakistan's bioethanol industry is still in its infancy, which frequently makes it difficult to obtain actual quantitative data from the enterprises managing the bio-ethanol fuel projects. This research paper is also dependent on similar economic feasibility studies in Pakistan. If oil prices are increased rapidly in the future, Pakistan can reduce its trade deficit by using the ethanol we export as biofuel by blending it with gasoline.

This study was carried out to explore the impact of bioethanol fuel and its impact on Pakistan’s economy. To calculate this impact on trade balance five scenarios have been built. First, the trade deficit is calculated by simply subtracting the total value of imports from the total value of export.

$$TD(E) = (X_E - I_O) \quad (3.1)$$

then the second scenario of trade gain will be calculated which is getting from the reduction of 10% of the ethanol from the total share of export from 1990-to 2020 same as the reduction of imported petroleum by 10% from the total share of gasoline import at the same price and how that 10% could help Pakistan's economy.

$$TG(E) = (X_o \times 0.1) - (I_o \times\ 0.1) \quad (3.2)$$

In the third scenario, we assume that in the future oil prices will be increased by 10% then how which will affect the trade gain we have generated previously. Its impact on trade gain will be calculated by reducing 10% of both commodities and increase in petroleum price by 10% and then subtracting the new export value from the new import value.

$$TG(E) = [\{(X_E \times 0.1)\} - \{(O_p \times 1.10)(I_o \times 0.1)\} \quad (3.3)$$

Where $TG(E)$represents the trade gain, X_E shows the export of ethanol, O_p represents the oil price and I_O represents the import of petroleum.

We are taking 10% blended ethanol fuel because E10 ethanol-blended oil in which ninety percent oil and ten percent ethanol has been introduced by Pakistan State Oil (PSO) as part of the government's strategy to promote alternate energy resources.

In the fourth scenario, we assume that in the future oil prices will be increased by 15% then how which will affect the trade gain we have generated previously. Its impact on trade gain will be calculated by reducing 10% of both commodities and increase in petroleum price by 10% and then subtracting the new export value from the new import value.

$$TG(E) = [\{(X_E \times 0.1)\} - \{(O_p \times 1.15)(I_o \times 0.1)\} \quad (3.4)$$

Where $TG(E)$represents the trade gain, X_E shows the export of ethanol, O_p represents the oil price and I_O represents the import of petroleum.

In the fifth scenario, we assume that in the future oil prices will be increased by 10% then how it will affect the trade gain we have generated previously. Its impact on trade gain will be calculated by reducing 10% of both commodities and increase in petroleum price by 20% and then subtracting the new export value from the new import value.

$$TG(E) = [\{(X_E \times 0.1)\} - \{(O_p \times 1.20)(I_o \times 0.1)\} \quad (3.5)$$

Where $TG(E)$represents the trade gain, X_E shows the export of ethanol, O_p represents the oil price and I_O represents the import of petroleum.

3.4 Theoretical Framework

After generating the result of trade deficit and trade gains as above then its impact on growth will be examined. To identify the correlation between Ethanol, Trade deficit, and Trade gain in Pakistan, and how it will impact our economic growth Cobb Douglas's production function has been used. It is extensively used to symbolize the connection between inputs and output. It was initially planned by (Ohlin, 1926) and tested against statistical confirmation (Cobb & Douglas, 1928). These two (Cobb & Douglas, 1928) published a paper in which they check American economic growth in a model from 1899 to 1922. They represent a condensed view of how the economy works, where the amount of labour and money spent determines the result of production. Despite the fact that there are other elements that also affect the performance of country’s economic, their model turned out to be very accurate. The following function is used.

$$Y_t = f(K_{t,} L_t, TD(E)_t, \mathrm{ER}_t) \quad (3.6)$$

$$Y_t = f(K_{t,} L_t, TG(E)_t, \mathrm{ER}_t) \quad (3.7)$$

In above equation Y represents the aggregate output or real GDP, K represents the capital stock, $TD(E)$ trade deficit, generated by subtracting imports of petroleum from the export of ethanol, exchange rate is denoted by ER, and subscript t is the time, whereas in eq (3.7) $TD(E)$ represents the trade gain, generated by subtracting the imports of petroleum from exports of ethanol at different prices of petroleum.

$$LnGDP_t = \mathrm{Y}_t = \beta_0 + \beta_1 LnK_t + \beta_3 LnL_t + \beta_4 LnTD(E)_t + \beta_5 Ln\mathrm{ER}_t + \mu_t \quad (3.8)$$

Where LnDP, LnGCF, LnL, t, and LnTD(E), LnLER, represent natural logarithms of real GDP, Capital formation, labor force, Trade Deficit energy, Exchange rate deterministic time trend, respectively. All variables are logs transformed and TD $(E)_t$ by adding one minus the minimum value to avoid null or negative values.

$$LnGDP_t = \mathrm{Y}_t = \beta_0 + \beta_1 LnK_t + \beta_3 LnL_t + \beta_4 LnTG(E)_t + \beta_5 Ln\mathrm{ER}_t + \mu_t \quad (3.9)$$

Where LnDP, LnGCF, LnL, t, and LnTD(E), LnLER, represent natural logarithms of real GDP, Capital formation, labor force, and Trade Deficit energy, Exchange rate deterministic time trend, respectively. All variables are logs transformed and TG $(E)_t$ by adding 1 minus the minimum value to avoid logs with null values. The same equation will be used in all scenarios to estimate the impact of a 10% reduction in the import of oil and export of ethanol. We put the calculated value of Trade Deficit (E) and Trade Gain in our model in the above-proposed growth equation. This study used the Cobb Douglas production function to check the correlation between trade deficit, trade gain, and economic growth. Control variable such as inflation trade openness has been used to control the omited variable baises. JB test for normality of residuals, LM test for autocorrelation, breush godfrey LM test for heteroskedasticity. For multicollinearity either construct the correlation matrix of the independent variables or Variance inflation factor.

Cobb Douglas's production function is arithmetically tractable, simple, and well designed to first-order conditions for driving factor demand or cost function. Finally, the Cobb Douglas production function can be used for any observed data (Michl, 1999).

The time series method will be used to estimate the theoretical model described above. The above equations are used in the preceding model to analyze the correlation between economic-growth, and bio-ethanol fuel by using the annual time-series data of Pakistan from the period 1990 to 2020.

3.4 Empirical Framework

3.4.1 Test of Stationarity

To find out the stationarity in the case of the time series data there are two important methods first is the graphical analysis and the other method is Unit root tests. In this analysis, we have employed the Unit root methodology proposed by Dickey and Fuller to explore whether the series is integrating I(0) or I(1).

3.4.2 Augmented Dickey-Fuller Unit Root test (ADF)

According to (Mahadeva & Robinson, 2004) non-stationarity series are very common in macroeconomics. To acquire reliable regression results, first we need to confirm that our model could not be subject to "spurious regression" (Gujarati, Porter, & Gunasekar, 2012). To check the stationarity of the sequence we have employed the ADF test statistics on all variables by using the constant term and trend (Dickey & Fuller, 1979).

3.4.3 Johansen and Juselius (1990) Co-integration Test

(Kyophilavong, Ogawa, Kim, & Nouansavanh, 2018) sustained that co-integration is when X and Y related to each other in a special case. As a result, the two stochastic trends will be quite related to one another and we would anticipate them to move in unison. We should be able to identify a combination of them that eliminates a non-stationarity when we combine them. This shows that all the avaiabele in model are co-integrated. This seemed that if there is a some kind of relationship between the two variables, making co-integration a very effective tool for identifying the presence of economic structure. There are two methodologies of co-integration i.e Johansen and Juselius (1990) and Engle and Grunger (1987) are commonly employed to explore the co-integration in the series. The phenomena when all the variables are integrated into order one then, in this case, we cannot use the Engle-Grunger approach. Because our series is mostly integrated of order one we have employed the Johansen Juselius co-integration methodology to explore the relationship among varaiables (long-run and short-run) (Bashier, Siam, & Education, 2014) justifies the use of the former in the present study.

3.4.4 Vector Error Correction Model (VECM)

According to (Ozcelebi & Finance, 2011) the VAR model has some very good characteristics, like its simplicity. The future calculation determined from Vector auto-regessive model (VAR) are more accurate than those obtained from the far more complex simultaneous equation in most of the cases. (Mahmoud, 1984). If the co-integration is recognized among the variables, this study will follow the Vector Error Correction Model (VECM) approach which is another version of VAR, not the normal VAR will be followed. This model is intended for use with time series which are non-stationary that are known to be co-integrated. The specification of VEC models contains the co-integration relations, so it assumes that the economy converges to the long-run relationships. On the other hand, it allows also for the short-run adjustment dynamics. (Gujarati et al., 2012) sustained the concept that the co-integration is a linear combination of time series which are stationary and the error correction mechanism is also considered a bridge that connects the short-run of variables to their long-run behavior.

3.5 Hypotheses Development

The following hypothesizes are formulated based on the empirical literature given in chapter two theoretical framework

(i) H_A^1: There is a Negative relationship between Trade Deficit (Export of Ethanol and Import of Petroleum) and economic growth.

(ii) H_B^1: There is a Positive relationship between Trade Gain (generated by reduction of ethanol export and petroleum import by 10%) and economic growth.

(iii) H_C^1: There is a Positive relationship between Trade Gain (generated by reduction of ethanol export and petroleum import by 10% and increment of the oil price by 10%) and economic growth.

(iv) H_D^1: There is a Positive relationship between Trade Gain (generated by reduction of ethanol export and petroleum import by 10% and increment of the oil price by 15%) and economic growth.

(v) H_E^1: There is a Positive relationship between Trade Gain (generated by reduction of ethanol export and petroleum import by 10% and increment of the oil price by 20%) and economic growth.

3.6 Source of Data

The annual time series data for Pakistan's real GDP, real gross fixed capital formation (K) exchange rate (ER), and labour force (L) from 1990 to 2020 will be acquired from the World Development Indicators (WDI). Data for different types of energy usage, including ethanol, and total non-renewable use for transportation will be extracted from the Energy Yearbook and Pakistan Bureau of Statistics (1990 to 2020)

CHAPTER 4
RESULTS AND DISCUSSION

4.1 INTRODUCTION

In this section, we empirically investigate the effect of the trade deficit and trade gain which is calculated by using excel, and how the trade deficit and trade gain will impact the GDP growth of Pakistan. Five scenarios have been created:

- Calculate the trade deficit by subtracting the total export bill of ethanol from the total import of oil bill.
- Calculate trade gain by reduction of 10% of the ethanol from the total share of export same as the reduction of imported petroleum by 10% from the total share of gasoline import at the same price and then calculate the impact of that 10% on the balance of payment.
- Calculate the trade gain if the oil price would increase in the future by 10% then how it will affect the trade gain we have generated previously. Its impact on trade gain will be calculated by reducing 10% of both commodities and increase in petroleum price by 10% and then subtracting the new export value from the new import value.
- Calculate the trade gain if the oil price would increase in the future by 15% then how it will affect the trade gain we have generated previously. Its impact on trade gain will be calculated by reducing 10% of both commodities and increase in petroleum price by 15% and then subtracting the new export value from the new import value.
- Finally, calculate the trade gain if the oil price would increase in the future by 20% then how it will affect the trade gain we have generated previously. Its impact on trade gain will be calculated by reducing 10% of both commodities and increase in petroleum price by 20% and then subtracting the new export value from the new import value.
- To check the impact of trade deficit and trade gain, given above on GDP growth, time-series data has been used (from 1990 to 2020). The independent variables are capital,

Labor Force, Exchange Rate, Trade Deficit, and Trade Gain. All variables are in log form.

4.2 Unit Root Test.

If the time series data is non-stationary then sometimes result would be not accurate. If the data is found non-stationary, then the long-run relationship needs to be checked. (Gujarati et al., 2012) Therefore, to check stationarity we are using the Augmented Dickey-Fuller. The-null hypothesis for this testing is that the series contain unit roots and the result for ADF is reported in table 1.

Table 4.1: ADF Test for Stationarity

S.R No	Variables	Level		1st Difference	
		t-stats	Probability	t-stats	Probability
1	GDP	-0.942763	0.7596	-3.127763	0.0359
2	Capital	-1.210426	0.6566	-4.774972	0.0006
3	Labor Force	-0.571768	0.8621	-5.924626	0.0000
4	Exchange Rate	-2.167383	0.2217	-4.156879	0.0031
5	Trade Deficit	3.857720	1.0000	-8.865336	0.0000
6	Trade Gain	5.750655	1.0000	-3.255586	0.0271
7	Trade Gain (10%)	-1.892246	0.3311	-5.181461	0.0002
8	Trade Gain (15%)	-1.890985	0.3317	-5.181581	0.0002
9	Trade Gain (20%)	-1.890985	0.3317	-5.181581	0.0002

However, the null hypothesis of unit roots at differenced is rejected at a 1% significant level for both the constant and consistent with trend cases, indicating that all variables have become stationary at the 1st difference.

This investigation indicates that no data sequence is stationary at the level, however, they are stationary at the 1st difference, indicating that all variables of our interest are non-stationary at the level and become stationary at the first difference

4.3 Johansen Juselius (JJ) Co-integration Tests

Using the same order as the integrated variables, we will plot the results of the unit root analysis to see if co-integration has occurred. (Johansen & Juselius, 1990) the method was used to explore co-integration. This method includes two test statistics for co-integration: the trace test and the maximum Eigenvalue test.

Once we have recognized the order of integration in our sequences in the above section, then the next task is to find the number of co-integrating vectors or long-run equilibrium relationships among the variables. Note that when series are found to be integrated of the same order, such as I(1) as in our situation, it indicates that an equilibrium relationship is present among all the variables. (Dwyer, 2015) We conducted a co-integration test in line with the Johansen test specified in the equation.

To specify the number of co-integration relations, we must examine the following hypothesis:-

- If the value criticized is less than the statistic of the trace then one rejects H^o therefore there exists at least one co-integration relation.
- If the trace statistic is not greater than the critiqued value, then $H^o$is accepted so there is no co-integration relationship.

We apply the Johansen co-integration test to all scenarios such as the current price of oil, which increased by 10%, 15%, and 20%, and the outcomes of these tests are given in tables 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8 and 4.9, 4.10, 4.11. Tables 4.2, 4.4, 4.6, and 4.8, 4.10 show the results of trace statistics whereas Tables 4.3, 4.5, 4.7, and 4.9, 4.11 present the results of maximum Eigen statistics. Trace statistics and maximum Eigen statistics values help to find the rank(s) which shows the number of vector(s) containing long-run relations. It is apparent from Tables 4.2, 4.4, 4.6, and 4.8, 4.10 that the null hypothesis of no rank is rejected at a 1 percent significant level. Moreover, the results of Tables 4.3, 4.5, 4.7, and 4.9, 4.11 reveal that the null hypothesis of no rank was also rejected at a 1 percent level of significance. As a result, the findings of both trace and max-Eigen statistics support the existence of a single co-integration vector in the model. It indicates that the variables have a long-term relationship. It is implied by the trace statistics that there is only one co-integrating vector in the equation because the null hypothesis that there is no co-integrating vector was rejected at a level of 1 %. The finding of one co-integrating vector was further supported by the results of the maximum Eigen value test in which the null hypothesis that there is no co-integrating vector was rejected at 1% and no other null hypothesis could be rejected which implied that there is only one co-integrating vector in the equation.

The lag length is determined on the basis of AIC criteria. Table 4.2 presents the results of the VAR Lag Order selection criteria for LGDPGRt, LREMOt and LREMIt.

Table 4. 2 VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	25.28988	NA	1.70e-07	-1.399302	-1.163562	-1.325471
1	176.0587	239.1506*	2.99e-11*	-10.07301	-8.658571*	-9.630028*
2	201.2729	31.30038	3.49e-11	-10.08779*	-7.494639	-9.275645

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 4.3: Johansen Co-integration Trace Value Test Result: First Scenario

Sr. No	Null Hypothesis	Trace Statistic	5% Critical Value	Probability
1	$R = 0$	83.87577	69.81889	0.0025
2	$R \leq 1$	49.46377	47.85613	0.0350
3	$R \leq 2$	29.62091	29.79707	0.0524
4	$R \leq 3$	12.99908	15.49471	0.1148
5	$R \leq 4$	2.806093	3.841465	0.0939

Note: The co-integration between all the variables: Trace test indicates 2 co-integrating eqn(s) at the 0.05 level.

Table 4. 4: Johansen Co-integration Maximum Eigenvalue Test Result: First Scenario

S.r. No	Null Hypothesis	Maximum Eigen Statistic	5% Critical Value	Probability
1	$R = 0$	34.41200	33.87687	0.0431
2	$R \leq 1$	19.84286	27.58434	0.3521
3	$R \leq 2$	16.62182	21.13162	0.1906
4	$R \leq 3$	10.19299	14.26460	0.1996
5	$R \leq 4$	2.806093	3.841465	0.0939

Note: The co-integration between all the variables: Maximum Eigen-Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

"In the case of co-integration results, there are two test statistics for co-integ ration, the Trace test, and the Maximum Eigenvalue test"(Johansen & Juselius, 1990). We compare the probability of the Trace test with a 5% probability that is with a 0.05 value. So on this basis, we do not accept the null hypothesis of no co-integration and reject it. Tables 4.2 and 4.3 represents the outcomes of the co-integration test with the trade deficit. The results of Trace Stat value test statistics show there are two co-integrated equations among the variables at none and most 1. The null hypothesis of none and at most one co-integrating equations are rejected since the trace test statistics is better than the critical value at a 5% level of significance. Similarly, the results of maximum eigenvalue statistics show the existence of one co-integrating equation.

The null hypothesis of none co-integrating equations is rejected because the maximum eigenvalue statistics is larger than the critical value at a 5% level of significance. So both the results of Johanson co-integration show that there is a long-run equilibrium between the trade deficit and economic growth in Pakistan, so this error will correction model can be retained.

4.4 The Empirical Estimation: Vector Error Correction Model (VECM)

(Ghali, 1998) Once the non-stationary variables become stationary in order 1 and there is a co-integration relation, the econometric instructions guides us to use the error correction model. The estimation of the error correction model is delineated in two phases (Chen, Pang, & Zheng, 2010); the first phase is to discover the impact of all variables and long-term economic growth, and the second phase is find the relationship between all variables and short-term economic growth. In our research, the objective of an estimation built on a vector error correction model (VECM) model is to define the effect of the trade deficit on economic growth (both short-term and long-term) VECM specifications restore the relationship between long-term behavior between existing variables converging into co-integration relationships but still allowing changes dynamic change in the short term. This co-integration terminology is known as an error correction because if there is a deviation in the long term the variable is corrected gradually through short-term partial adjustments.

Long-Run Relationship

$$LnGDP_t = 9.306 + \underset{\substack{(0.084) \\ [2.619]}}{0.136\, LnK_{t-1}} + \underset{\substack{(2.103) \\ [4.190]}}{10.330 LnL_{t-1}} - \underset{\substack{(0.007) \\ [-3.571]}}{0.027 LnTD(E)_{t-1)}}$$

$$\underset{\substack{(0.250) \\ [-5.973]}}{-1.493\, Ln\mathrm{ER}_{t-1}} \qquad (4.1)$$

Equation 4.1 represents the long-run form of vector error correction (VECM) for the first scenario where capital and labor have an affirmative impact on GDP growth and appreciate economic growth in the long run as error correction terms are positive and highly significant. Whereas exchange rate and trade deficit are also highly significant but have an adverse effect and depreciate economic growth over a long period of time. These results are in line with (Awan, Mukhtar, & Humanities, 2019).

Short-run Relationship by VEC

Variable	Co-efficient	Standard error	t-stats	Probability
$D(LNK)$	0.10886	0.020360	5.346675	0.0000
D(LNEX)	-0.061077	0.050310	-1.21400	0.2382
D(LNTRADEDEFICIT)	-8.21E-05	0.000515	-0.159413	0.8749
CointEq(-1)*	-0.247538	0.018799	-13.16762	0.0000

The table above shows that in the short-run only capital has a significant impact on economic growth and the exchange rate and trade deficit are insignificant. In line with the finding of (Belloumi, 2014)) that in the short run, only capital investment is significant at the 5% level and other variables of economic growth, trade and labor are not significant and also in line with the findings of (Pavlic, Svilokos, & Tolic, 2015).

Table 4.5 Johansen Co-integration Trace Value Test Result: Second Scenario

S.R No	Null Hypothesis	Trace Statistic	5% Critical Value	Probability
1	$R = 0$	90.93834	69.81889	0.0004
2	$R \leq 1$	47.31813	47.85613	0.0561
3	$R \leq 2$	20.76252	29.79707	0.3726
4	$R \leq 3$	10.18545	15.49471	0.2667
5	$R \leq 4$	0.650717	3.841465	0.4199

Note: The co-integration between all the variables: Trace Value Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

Table 4. 6 Johansen Co-integration Maximum Eigenvalue Test Result: Second Scenario

S.r No	Null Hypothesis	Maximum Eigen Statistic	5% Critical Value	Probability
1	$R = 0$	43.62021	33.87687	0.0025
2	$R \leq 1$	26.55561	27.58434	0.0673
3	$R \leq 2$	10.57707	21.13162	0.6892
4	$R \leq 3$	9.534731	14.26460	0.2443
5	$R \leq 4$	0.650717	3.841465	0.4199

Note: The co-integration between all the variables: Maximum Eigen Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

Tables 4.4 and 4.5 show the results of the co-integration test with trade gain. The results of Trace Stat value test statistics show there is one co-integrated equation among the variables at none. Similarly, the results of maximum eigenvalue statistics show the existence of only one co-integrating equation.

The null hypothesis of none co-integrating equations is rejected because the maximum eigenvalue statistics is greater than the critical value at a 5% level of significance. So both the results of Johanson co-integration show that there is a long-run equilibrium between trade gain and economic growth in Pakistan, so the VECM (error correction model) can be applied.

4.5 The Results of Estimation VECM of Second Scenario

Long-Run Relationship

$$LnGDP_t = 62.67045 + \underset{\substack{(0.460) \\ [3.24323]}}{0.572LnK_{t-1}} \; \underset{\substack{(1.064) \\ [3.671]}}{+0.430LnL_{t-1}} \; \underset{\substack{(0.026) \\ [-5.669]}}{-\ 0.147LnTG(E)_{t-1}}$$

$$\underset{\substack{(0.958) \\ [-6.042]}}{-\ 5.791\ Ln\mathrm{ER}_{t-1}} \qquad (4.2)$$

The primary intention of this study is to find the impact of the trade deficit/gain (Calculated form using of bioethanol fuel) on the economic growth. The results indicate that trade deficit has a significant impact on the economic growth but this relationship is negative. (Hanif, Raza, Gago-de-Santos, & Abbas, 2019) Equation 4.2 represents the long-run form of vector error correction (VECM) for the first model where capital and Labor have a positive impact on economic growth and appreciate economic growth in the over a long period of time error correction terms are highly significant and positive. Whereas, trade gain and exchange rate have an adverse impact and depreciate the economic growth over a long period of time.

Short-run Relationship by VEC

Variable	Coefficient	Standard error	t-stats	Probability
D(LNEX)	-0.049828	0.053529	-0.930862	0.3620
D(LNTRADEDEFICIT)	-0.077359	0.179765	-0.430334	0.6711
CointEq(-1)*	-0.425885	0.053814	-7.913979	0.0000

Table 4. 7 Johansen Co-integration Trace Value Test Result: Third Scenario

S.r No	Null Hypothesis	Trace Statistic	5% Critical Value	Probability
1	$R = 0$	81.86445	69.81889	0.0040
2	$R \leq 1$	41.20171	47.85613	0.1823
3	$R \leq 2$	21.37193	29.79707	0.3348
4	$R \leq 3$	8.139542	15.49471	0.4506
5	$R \leq 4$	0.037829	3.841465	0.8457

Note: The co-integration between all the variables: Trace Value Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

Table 4. 8 Johansen Co-integration Maximum Eigenvalue Test Result: Third Scenario

S.r No	Null Hypothesis	Maximum Eigen Statistic	5% Critical alue	Probability
1	$R = 0$	40.66274	33.87687	0.0067
2	$R \leq 1$	19.82979	27.58434	0.3530
3	$R \leq 2$	13.23238	21.13162	0.4311
4	$R \leq 3$	8.101713	14.26460	0.3685
5	$R \leq 4$	0.037829	3.841465	0.8457

Note: The co-integration between all the variables: Maximum Eigen Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

Tables 4.6 and 4.7 show the results of the co-integration test with trade gain. The results of Trace Stat value test statistics show there is one co-integrated equation among the variables at none. Similarly, the outcome of max: eigenvalue statistics show the existence of only one co-integrating equation. The null hypothesis of none co-integrating equations are rejected because the maximum eigenvalue statistics is greater than the critical value at a 5% level of significance. So both the results of Johanson co-integration show that there is a long-run equilibrium between trade gain and economic growth in Pakistan, so the error-correction model can be applied.

4.5 The Results of Estimation VECM

Consequently, we resort to the application of the Vector Error Correction Model (VECM). The regression of the Vector Error Correction Model (VECM) will recognize the long term relationship amongst these variables of interest and tie it to deviations that may occur in the short term (Lorde et al. 2009).

Long-run Relationship

$$LnGDP_t = -2.260641 + \underset{[13.3689]}{\underset{(0.016)}{0.225LnK_{t-1}}} + \underset{[24.3334]}{\underset{(0.055)}{1.355\,LnL_{t-1}}} + \underset{[5.84909]}{\underset{(0.01971)}{0.115LnTG(E)_{t-1}}}$$

$$- \underset{[-12.412]}{\underset{(0.030)}{0.384Ln\mathrm{ER}_{t-1}}} \qquad (4.3)$$

The normalized co-integrated vector is reported in equation (4.3). The estimates represent the long-run elasticity of GDP growth with respect to capital, labor, exchange, and trade gain with an increment of price by 10%. The significant positive coefficient of capital, labor, and trade gain show that these variables move in the same direction with economic growth in the long run while the exchange rate is also highly significant but has an adverse effect on economic growth over the long period of time. (Kala, Masbar, & Syahnur, 2018)

Short–run Relationship by VEC

Variable	Co-efficient	Standard Error	t-stats	Probability
$D(LN$EXCHANGE_RATE)	-0.24429	0.08157	-2.99474	0.0069
CointEq(-1)*	-0.32164	0.04416	-7.28272	0.0000

Table 4. 9 Johansen Co-integration Trace Value Test Result: Fourth Scenario

S.r. No	Null Hypothesis	Trace Statistic	5% Critical Value	Probability

1	$R = 0$	81.86398	69.81889	0.0040
2	$R \leq 1$	41.20582	47.85613	0.1822
3	$R \leq 2$	21.36900	29.79707	0.3350
4	$R \leq 3$	8.135180	15.49471	0.4511
5	$R \leq 4$	0.037835	3.841465	0.8457

Note: The co-integration between all the variables: Trace Value Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

Table 4. 10 Johansen Co-integration Maximum Eigenvalue Test Result: Fourth Scenario

S.r. No	Null Hypothesis	Maximum Eigen Statistic	5% Critical Value	Probability
1	$R = 0$	40.65816	33.87687	0.0067
2	$R \leq 1$	19.83682	27.58434	0.3525
3	$R \leq 2$	13.23382	21.13162	0.4310
4	$R \leq 3$	8.097345	14.26460	0.3689
5	$R \leq 4$	0.037835	3.841465	0.8457

Note: The co-integration between all the variables: Maximum Eigen Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

Table number 4.8 and 4.9 represent the empirical result of the co-integration test with trade gain in the fourth scenario. The results of Trace Stat value test statistics show there is one co-integrated equation among the variables at none. Similarly, the results of maximum eigenvalue statistics show the existence of only one co-integrating equation. The null hypothesis of none co-integrating equations is rejected because the maximum eigenvalue statistics is greater than the critical value at a 5% level of significance. So both the results of Johanson co-integration show that there is a long-run equilibrium between trade gain and economic growth in Pakistan, so the error-correction model will be applied to check the relationship amongst variables.

Long-Run Relationship

$$LnGDP_t = 2.505 + \underset{\substack{(0.016)\\[13.351]}}{0.225LnK_{t-1}} + \underset{\substack{(0.055)\\[24.348]}}{1.356LnL_{t-1}} + \underset{\substack{(0.031)\\[12.422]}}{0.385LnTG(E)_{t-1}}$$

$$- \underset{\substack{(0.011)\\[-10.384]}}{0.117Ln\mathrm{ER}_{t-1}} \qquad (4.4)$$

Equation 4.4 represents the long-run form of vector error correction (VECM) for the first model where capital, Labor, and trade gain (with an increase of 15% oil price) have a positive impact on economic growth and appreciate economic growth in long- run, error correction terms are highly significant and positive. Whereas, the exchange rate has a negative impact and depreciate the economic growth in the long-run.

Short-run Relationship by VEC

Variable	Co-efficient	Standard Error	t-stats	Probability
D(LNEXCHANGE_RATE)	-0.007857	0.008198	-0.958366	0.3483
CointEq(-1)*	-0.355037	0.018085	-19.63133	0.0000

Table 4. 11 Johansen Co-integration Trace Value Test Result: Fifth Scenario

S.r. No	Null Hypothesis	Trace Statistic	5% Critical Value	Probability
1	$R = 0$	81.86398	69.81889	0.0040
2	$R \leq 1$	41.20582	47.85613	0.1822
3	$R \leq 2$	21.36900	29.79707	0.3350
4	$R \leq 3$	8.135180	15.49471	0.4511
5	$R \leq 4$	0.037835	3.841465	0.8457

Note: The co-integration between all the variables: Trace Value Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

Table 4. 12 Johansen Co-integration Maximum Eigenvalue Test Result: Fifth Scenario

S.r. No	Null Hypothesis	Maximum Eigen Statistic	5% Critical Value	Probability
1	$R = 0$	40.65816	33.87687	0.0067
2	$R \leq 1$	19.83682	27.58434	0.3525
3	$R \leq 2$	13.23382	21.13162	0.4310
4	$R \leq 3$	8.097345	14.26460	0.3689
5	$R \leq 4$	0.037835	3.841465	0.8457

Note: The co-integration between all the variables: Maximum Eigen Statistic indicates 1 co-integrating eqn(s) at the 0.05 level.

Above tables (4.10 and 4.11) represent the empirical results of the co-integration test with trade gain in the fifth scenario. The results of Trace Stat value test statistics show there is one co-integrated equation among the variables at none. Similarly, the results of maximum eigenvalue statistics show the existence of only one co-integrating equation. The null hypothesis of none co-integrating equation is rejected because the maximum eigenvalue statistics is greater than the critical value at a 5% level of significance. So both the results of Johansen co-integration show that there is a long-run equilibrium between trade gain and economic growth in Pakistan, so the error-correction model will be used to acquire the relationship between all the variables.

Long-Run Relationship

$$LnGDP_t = -17.335 + \underset{\substack{(0.016)\\ [13.351]}}{0.255LnK_{t-1}} + \underset{\substack{(0.055)\\ [24.348]}}{1.356LnL_{t-1}} + \underset{\substack{(0.011)\\ [10.384]}}{0.117LnTG(E)_{t-1}} - \underset{\substack{(0.031)\\ [-12.442]}}{0.385Ln\mathrm{ER}_{t-1}} \quad (4.5)$$

Equation 4.5 represents the long-run form of vector error correction (VECM) for the first model where capital, Labor, and trade gain (with an increase of 20% oil price) have a positive impact on economic growth and appreciate economic growth in the long-run, error correction terms are highly significant and positive. Whereas, the exchange rate has a negative impact and depreciates the economic growth over the long period of t time.

Short-run Relationship by VEC

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNEXCHANGE_RATE)	-0.007857	0.008198	-0.95836	0.3483
CointEq(-1)*	-0.355037	0.018085	-19.6313	0.0000

In short run some variables are insignificant whereas in the long run there is impact of those variables as (Razzaque, Bidisha, & & Khondker, 2017) showed in their study that in the long run, a 10 per cent depreciation of the real exchange rate is associated with, on average, a 3.2 per cent rise in aggregate output. However, a contractionary effect is observed in the short run so that the same magnitude of real depreciation would result in about a half per cent decline in GDP.

[1]

CHAPTER 5

QUALITATIVE ASSESSMENT

As concern about dependence on fossil fuels and global warming grows, finding

[1] We applied the cumulative sum (CUSUM) tests proposed by Brown et al. (1975) to the residuals of the model estimated for sub-periods in order to determine the stability of the elasticities of long-run equilibrium models. This result points to the stability of the estimated parameters for the 1990 to 2020 periods. We do not report the results of CUSUM here to conserve space but they are available from the author upon request

renewable energy sources that lower the dependency on fossil fuels draws a lot of interest. One method to lower both the usage of fossil fuel oil and environmental pollution is the production of ethanol (bioethanol) from biomass. The usage of bioethanol-blend fuel in cars can greatly cut down on the consumption of petroleum and greenhouse gas emissions from the exhaust. Pakistan is one of the largest exports of ethanol to the world and began when four distilleries began converting molasses into ethanol with value-added. Before this, the entire average annual production of two million tonnes of molasses was exported at a loss and never brought in more than $60 a tonne.

Pakistan State Oil (PSO) was established on January 1st, 1974, when the government acquired control and merged National Oil (PNO) and Dawood Petroleum Limited (DPL) to become Premiere Oil Company Limited (POCL). Petroleum Storage Development Corporation (PSDC) was established on June 3, 1974, not long after that. On August 23, 1976, PSDC changed its name to State Oil Company Limited (SOCL). After that, on September 15, 1976, SOCL acquired the Esso undertakings and took over control. The Premier Oil Company Limited and State Oil Company Limited merged on December 30 of that year to form Pakistan State Oil (PSO).

In 2008, the Pakistan Ethanol Manufacturers Association (PEMA) was founded. In Punjab, Sindh, and Khyber Pakhtunkhwa, there are 20 ethanol distilleries that are members of the Association. PEMA's informal organisation enables its members to continue participating in provincial zones.

I have interviewed the concerned department “Pakistan State Oil (PSO) and Pakistan Ethanol Manufacturing Association (PEMA). The discussion was based on the following questions.

Discussion Questions:

i. What are the actions the government is taking toward the exploration of alternative and economical energy resources to reduce the dependency on imported petroleum products?

ii. Why is Pakistan lagging behind other countries in the usage of ethanol as blended gasoline?

iii. What are the challenges faced by Pakistan in the adoption of bioethanol fuel?

iv. How the government can is discouraging the export of ethanol and give incentives in order to promote the bioethanol program?

v. Why program launch by PSO was failed in 2006?

vi. How can PSO spread awareness about bioethanol fuel to reduce the dependency on foreign fuels and achieve a sustainable growth path in the long run?

Response

PSO took the initiative and started working on coal but it was failed miserably so the government is thinking about working on electric vehicles but currently not working on exploring any alternative source to reduce the dependency on imported petroleum products.

Pakistan has yet to set a target for ethanol-to-gasoline blends. There is a dearth of lack of thought and comprehensive national bioethanol policies and regulations. When there is a need to stimulate the growth of specific renewable energy technologies, policies that do not comply with the plans for bioethanol fuel development may be declared. The bioethanol industry lacks a well-defined framework

This untapped area needs government attention. Initially, the government of Pakistan has to subsidies the promotion of bioethanol fuel because the pricing was almost the same as petrol. Lack of government interest, price ceiling, and well-defined policy framework is the main reason Pakistan is lagging in the adoption of bioethanol fuel.

All over the world, wherever the Bio-fuels industry has flourished, tax subsidies by the government have played a major role. These subsidies will discourage the export of ethanol and encourage the mill owners to sell their products to the government or oil refineries. The lack of competent institutions with clear mandates and long-term-focused action plans results in weak institutional coordination. The inter-institutional coordination of the institutions and agencies involved in the development of bioethanol fuel was inadequate. The failure of this initiative was also largely attributed to pricing, and investors' interest in this sector has been hindered by the slow implementation of policies. A Price ceiling was another issue PSO faced in 2006.

CHAPTER 6

CONCLUSION AMD POLICY RECOMMENDATIONS

6.1 Conclusion

The high price of oil, the rapidly increasing prices of petroleum goods, and the need for energy security initially drove up demand for biofuels on a global scale. In countries with a strong potential for producing biofuels, some support measures were implemented, and the results were positive: a decreased reliance on fossil fuels, increased income from agricultural exploitation, and reduced environmental losses when compared to fossil fuels. This empirical study evaluated how the use of biofuels (bioethanol and biodiesel) in transportation affected factors of sustainable development and economic growth.

The study aimed to uncover the existent relationship between the use of bio-ethanol fuel and sustainable economic growth for the period 1990 to 2020 (30 years) in Pakistan. The time series econometric technique has been used to achieve this goal. Although the different studies conducted on this topic area have been extensively covered in the introductory and literature review sections. This research is among one of the very few studies, which have explored, empirically, what if Pakistan used ethanol in oil by 10% instead of exporting it then what will be the impact on economic growth. To investigate this relationship co-integration and the Error Correction Model (VECM) have been applied. The unit root properties of the data were examined using the Augmented Dickey-Fuller test (ADF) after that the co-integration and the Error Correction Model (VECM) were applied. The empirical outcomes represents that all the series are stationary at the first difference. The procedure of the co-integration test shows the presence of co-integration among the series, which forces us to apply the Error Correction Model to estimate the long-run and short-run relationship among variables. The result shows us that in the long run, the trade deficit (generated by subtracting the total value of petroleum oil from ethanol export) has an adverse effect on economic development, same as trade gain (generated from a 10% reduction of the total value of petroleum and) affect economic growth negatively. However, it’s seen that if oil prices are increased then there is no short-run effect of the trade deficit on economic growth. Economically, the estimation result reveals that the usage of bioethanol fuel effect GDP growth of the country in a positive manner i.e. all the way through the 30 years and it would have positive contribution in the economic development of Pakistan. The role of ethanol in Pakistan's energy system has remained relatively limited. Due to a deficiency of planning, lack of interest in this area, and execution in this multi-stakeholder sector, efforts to strengthen its standing as a fuel blend have not shown notable benefits. However, given the availability of molasses, the nation's current economic situation, and its dedication to achieving climatic and socioeconomic goals, it may be expected that sugarcane bioethanol may once again be highlighted in future policies. But this phenomenon has also been generally underexplored.

6.2 Policy Recommendation

To reduce Pakistan's oil dependency and promote sustainable energy, the government should consider introducing bio-ethanol fuel. There are few important policy implications extracted for this study that how could Pakistan start using bioethanol mix fuel and diminish the trade balance if oil prices increase in future.

1. Create a regulatory framework: The government should create a regulatory framework for the production and sale of ethanol fuel. This framework should include guidelines for production, quality standards, and pricing regulations.

2. Promote ethanol production: The government should provide support to farmers and ethanol producers to increase production. This support could include access to financing, technical assistance, and training.
3. Mandate the Use of Bio-Ethanol: The government should mandate the use of bio-ethanol in gasoline blends. Initially, the government could start with a 5% bio-ethanol blend, which could be gradually increased to 10%. This will help reduce Pakistan's oil dependency and also reduce emissions. Encourage the use of ethanol fuel: The government should promote the use of ethanol fuel by incentivizing its use in public transportation, such as buses and taxis. The government could also mandate the use of ethanol fuel in government vehicles.
4. Develop infrastructure: The government should invest in the development of infrastructure for the production, storage, and distribution of ethanol fuel. This could include building ethanol refineries, storage facilities, and transportation infrastructure.
5. Partner with other countries: The government should explore partnerships with other countries to export ethanol fuel. This could help generate revenue for Pakistan and promote the use of ethanol fuel worldwide.
6. Research and Development: The government should invest in research and development to improve the efficiency of bio-ethanol production. This could include developing new strains of yeast that can ferment molasses more efficiently or improving the distillation process.
7. Public Awareness Campaign: The government should launch a public awareness campaign to educate the public about the benefits of using bio-ethanol. This could include television and radio commercials, billboards, and social media campaigns.

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